6. Air & Ground Noise

6.1 Introduction

6.1.1 This Chapter has been prepared by AMEC and Rupert Taylor. The Chapter uses information prepared by the Civil Aviation Authority (CAA).

6.1.2 The Chapter should be read in conjunction with the project description (Chapter 3). The Chapter presents an assessment of the:

- changes in air noise (Section 6.8);
- changes in ground noise (Section 6.9);
- changes in air and ground noise combined (Section 6.10);
- noise effects during construction of the new airfield infrastructure (Section 6.11); and
- vibration effects resulting from noise during start-of-roll (Section 6.12).

6.1.3 The Chapter considers the:

- potential effects of noise;
- type and nature of the noise sources;
- sensitivity of the receptors exposed (and their response); and the
- existing and proposed measures designed to reduce the effects of aircraft noise.

6.1.4 The assessment considers relevant legislation, policy and technical guidance to determine whether significant effects (adverse or beneficial) are likely to occur as a result of the scheme. The assessment of significant effects has been based on the application of criteria defined in the guidance where significance has been based on a quantitative evaluation. A number of alternative metrics to describe how noise affects communities have also been considered in the assessment. Technical terms are explained in **Appendix G**.

6.2 Technical, Legislative and Policy Context

Technical Context

6.2.1 Noise is defined as ‘unwanted sound’. Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. Possible adverse effects associated with noise include:

- Annoyance;
- Sleep disturbance;
- Hearing damage;
- Interference with task performance;
- Interference with use of facilities; and
- Effects on quality of resources, including tranquility and the so called soundscape.

6.2.2 Health effects including indirect effects of noise, i.e. stress caused by annoyance and/or health effects of sleep disturbance, and consequent effects on morbidity and mortality, are considered within the Health and Equalities Impact Assessment (submitted with the planning application alongside this ES).

6.2.3 Annoyance has historically been given strong weighting, although interference with task performance and use of facilities has economic as well as social consequences. Hearing damage occurs at noise exposures much higher than those encountered in the general environment. Hearing damage associated with occupational noise has been scoped out of this assessment.

Legislative Context

6.2.4 Noise from airports is considered in a number of planning policy documents and is also subject to legislative control and regulation. At an international level, standards governing aircraft noise emissions are set by the International Civil Aviation Organization (ICAO).

6.2.5 In the UK, the DfT and Defra are responsible for regulating the various environmental aspects of the aviation industry. In addition, the UK CAA also has powers as a regulator and certificating authority of air transport and aerodromes and provides specialist aviation advice to Government.

6.2.6 At a local level, local planning authorities such as London Borough of Hillingdon (LBH) also have some control over the development of airports and aerodromes through planning policy.

Aviation Legislation

6.2.7 Relevant aviation legislation includes:

- The Civil Aviation Act (2006);

- The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003; and
- The Transport Act (2000).

6.2.8 The ***Civil Aviation Act*** gives powers to the Secretary of State (SoS) in the control of aircraft noise at particular airports. These airports are usually referred to as 'noise designated'. Heathrow is 'noise designated' and this gives the SoS controls including enforcement powers on matters such as: the use of airspace; implementation of noise insulation schemes and grants; and aircraft noise emissions.

6.2.9 The 2006 explanatory notes to the Civil Aviation Act 2006[1] state, in relation to powers of the SoS in relation to noise management and mitigation at designated airports, that:

'…The manager [i.e. the airport operator] *is placed under a duty to comply with any such directions. New section 78(6A) will allow directions under subsection (6) to be given for the purposes of avoiding, limiting or mitigating the effect of noise and vibration either generally or in any particular area, for example arising from use of a particular runway. So directions could be used to move noise from one area to another, even if this does not limit or mitigate the total amount of noise suffered generally, so long as it avoids, limits or mitigates the amount of noise in a particular area.'*

'For example, Heathrow has two main independently operable runways, as may other airports designated under section 78 in future. The power to direct the aerodrome manager to use a particular runway would provide local residents with predictable periods of relief from aircraft noise.

6.2.10 It is considered that the explanatory note provides an example that is equivalent to that of the ending of the Cranford Agreement and subsequent full runway alternation during easterly operations.

6.2.11 The ***Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003*** transposes EC Directive 2002/30/EC and ICAO Assembly Resolution A33-7[2] in UK law. The Regulations establish a 'balanced approach' to airport noise management with respect to environmental benefits and economic incentives, but without imposing measures that would be overly restrictive.

6.2.12 The ***Transport Act 2000*** provides guidance to the UK CAA on the environmental objectives the UK CAA must adhere in the exercising of its duties with regards to environmental objectives, which includes noise.

Environmental Noise Legislation

6.2.13 Relevant environmental noise legislation includes:

- The Environmental Protection Act 1990;
- The Environmental Noise (England) Regulations 2006; and
- The Control of Pollution Act 1975.

[1] Explanatory Notes to Civil Aviation Act 2006, 2006 Chapter 34.

[2] ICAO. A33-7: Consolidated statement of continuing ICAO policies and practices related to environmental protection. 2001.

6.2.14 The ***Environmental Protection Act 1990*** gives powers to local authorities and the public to address noise nuisances. This power relates to the fact that local Environmental Health Officers are usually the first point of contact for many people with respect to potential noise nuisance. The Act however clearly stipulates that they have no powers to control aircraft noise, which is specifically excluded from the *Environmental Protection Act 1990*.

6.2.15 The ***Environmental Noise (England) Regulations 2006*** transposed EC Directive 2002/49/EC into UK law. It is commonly referred to within the UK as the 'Environmental Noise Directive' or END. The Regulations relate to the management and assessment of environmental noise.

6.2.16 The Regulations define 'major airports' as those with more than 50,000 ATMs per calendar year. Under the Regulations Heathrow qualifies as a 'major airport' and must by law prepare 'strategic noise maps' and a 'noise action plan' over a 5-year cycle. However, Heathrow voluntarily prepare noise maps every year. Under the Regulations the aim of the noise action plans is to manage and reduce environmental noise where necessary and to preserve environmental noise quality where it is good. Under the Regulations, Heathrow is considered the competent authority for drafting the noise action plan and the CAA are responsible for the production of the strategic noise maps.

6.2.17 A Noise Action Plan for Heathrow Airport was submitted to the Secretary of State for Transport in November 2009 and was formally adopted in May 2011. The Noise Action Plan was prepared under guidance provided by Defra[3]. This guidance aims to ensure that Noise Action Plans prepared by relevant airports meet the requirements of the Environmental Noise Directive and transposed regulations. The guidance makes clear in the determination of the acceptability or otherwise of current impacts that Airport Operators should:

'as a first priority, consider what further measures should be taken in areas shown by the noise maps to have residential premises exposed to more than 69 dB $L_{Aeq,16h}$'.

6.2.18 The ***Control of Pollution Act*** addresses noise from construction sites. Section 60 of the Act allows local authorities to serve notice on a construction site where it sees a need to ensure best practicable means, including restrictions on working hours or practices are employed to minimise noise. Section 61 of the act allows contractors to obtain prior consent in the form of an agreement between the local planning authority and contractor responsible for the construction works, allowing works to take place under a prescribed methodology and with certain conditions attached.

Policy Context

National Planning Policy Framework (NPPF)

6.2.19 The National Planning Policy Framework (NPPF) was published in March 2012 and replaced Planning Policy Guidance Note 24: *'Planning and Noise'* (PPG24).

6.2.20 The NPPF (paragraph 109) states that the planning system should contribute to and enhance the natural and local environment by:

[3] Guidance for Airport Operators to produce airport noise action plans under the terms of the Environmental Noise (England) Regulations 2006 (as amended), Defra, March 2009.

"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land instability".

6.2.21 The NPPF does not define what it considers to be an *'unacceptable risk'* or an *'unacceptable level'*. To this end, it is the role of assessors and decision makers to determine what is and is not acceptable in each case.

Noise Policy Statement for England (NPSE)

6.2.22 The *Noise Policy Statement for England* (NPSE) published in 2010 sets out the long term vision of Government noise policy. The Noise Policy Vision is to:

"Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development".

6.2.23 The NPSE draws on two established concepts from toxicology that are currently being applied to noise effects namely NOEL 'No Observed Effect Level' and LOAEL 'Lowest Observed Adverse Effect Level'. The NPSE extends these concepts and introduces the concept of a SOAEL 'Significant Observed Adverse Effect Level'. This is the level above which significant adverse effects on health and quality of life occur.

6.2.24 The second aim of the NPSE refers to the situation where the effect lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development (paragraph 1.8 of the NPSE). This does not mean that such adverse effects cannot occur.

6.2.25 The third aim seeks, where possible, to positively improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development, recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

Aviation Policy Framework (APF)

6.2.26 The Government's Aviation Policy Framework (APF) was published in March 2013. In relation to aviation noise, the APF states that the Government's overall policy is:

"to limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise".

6.2.27 The APF states that this objective is consistent with the Government's Noise Policy as set out in the NPSE.

6.2.28 Chapter 3 of the APF focuses specifically on noise and other local environmental impacts. The APF states that the Government's policy on aviation noise will be consistent with international approaches and European law. It states that the Government fully recognises ICAO Resolution A33-7 as transposed into UK law.

6.2.29 In relation to noise policy metrics, the APF reaffirms the use of the 57 dB $L_{Aeq,\ 16h}$ as the *'approximate onset of significant community annoyance'.* The 57 dB $L_{Aeq,\ 16h}$ has been incumbent within Government aircraft noise policy for several decades however, the APF states that:

'Although there is some evidence that people's sensitivity to aircraft noise appears to have increased in recent years, there are still large uncertainties around the precise change in relationship between annoyance and the exposure to aircraft noise'.

6.2.30 The APF goes on to state that Government will:

'…continue to treat the 57 dB $L_{Aeq, 16h}$ as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance.'

6.2.31 The APF does however point out that:

'… this does not mean that all people within this contour will experience significant adverse effects from aircraft noise. Nor does it mean that no-one outside of this contour will consider themselves annoyed by aircraft noise'

6.2.32 The APF acknowledges that The Airports Commission has recognised that there is no firm consensus as to how to measure the noise impacts from aviation and that further detailed work will be carried out. On this basis, the APF states that the Government will keep the policy under review in light of any new emerging evidence.

6.2.33 Paragraph 3.19 identifies that the Government considers other noise metrics than just the $L_{Aeq, 16hr}$ to be important in communicating noise impacts to local stakeholders. The APF states that:

'Average noise exposure contours are a well established measure of annoyance and are important to show historic trends in total noise around airports. However, the Government recognises that people do not experience noise in an average manner and that the value of the $L_{Aeq, 16h}$ indicator does not necessarily reflect all aspects of the perception of aircraft noise. For this reason we recommend that average noise contours should not be the only measure used when airports explain how locations under flight paths are affected by noise. Instead the Government encourages airport operators to use alternative measures which better reflect how aircraft noise is experienced in different localities, developing these measures in consultation with their consultative committee and local communities. The objective should be to ensure a better understanding of noise impacts and to inform the development of targeted noise mitigation measures'

6.2.34 With respect to compensation schemes, Paragraphs 3.36 – 3.41 of the APF set out the Government's expectations. Paragraph 3.36 of the APF states that:

'The Government continues to expect airport operators to offer households exposed to levels of noise of 69 dB $L_{Aeq, 16h}$ or more, assistance with the costs of moving'

6.2.35 Paragraph 3.37 of the APF states that:

'The Government also expects airport operators to offer acoustic insulation to noise-sensitive buildings, such as schools and hospitals, exposed to level of noise of 63 dB $L_{Aeq, 16h}$ or more. Where acoustic insulation cannot provide an appropriate cost-effective solution, alternative mitigation measures should be offered'

6.2.36 The APF goes on to state in Paragraph 3.40 that:

'Where airport operators are considering developments which result in an increase in noise, they should review their compensation schemes to ensure that they offer appropriate compensation to those potentially affected. As a minimum, the Government would expect airport operators to offer financial assistance towards acoustic insulation to residential properties which experience an increase in noise of 3 dB of more which leaves them exposed to levels of noise of more than 63 dB $L_{Aeq, 16h}$ or more'

Noise and Airspace Use

6.2.37 The APF provides the Government's view on how it expects noise to be distributed around airports. To this end, the APF promotes the equitable distribution of noise in relation to its policy concerning noise and airspace use. With specific reference to the Cranford Agreement, Paragraph 1.63 of the APF states that:

"To further improve operations and resilience at Heathrow we confirmed the ending of the Cranford Agreement. This is an informal but long-standing agreement not to use the northern runway for departures when the wind was in from the east (roughly 30% of the time)… Following implementation, noise will be distributed more fairly around the airport, extending the benefits of runway alternation to communities under flight paths during periods of easterly winds…".

National, Regional and Local Planning Policy

6.2.38 **Table 6.1** presents an overview of national, regional and local planning policies that are relevant to the assessment.

Table 6.1 Relevant National, Regional and Local Planning Policy

Policy reference	Policy issue
National Planning Policies	
National Planning Policy Framework	See Section 6.2.19 (above).
The Noise Policy Statement for England	See Section 6.2.22
Regional Planning Policies	
Sounder City – London Ambient Noise Strategy	The 'Sounder City' London Ambient Noise Strategy discusses principal environmental noise sources that affect London.
The London Plan – Policy 6.6	Policy 6.6 (Aviation) provides the policy for airports and states that adequate airport capacity serving a wide range of destinations is critical to the competitive position of London in a global economy but also that the aviation industry should meet its full environmental and external costs
The London Plan – Policy 7.15	Policy 7.15 (Reducing noise and enhancing soundscape) seeks to minimise the adverse impacts of noise in the vicinity of development proposals and separate noise sensitive development from major sources of noise, to implement the objectives of the Mayor's Ambient Noise strategy. It states that development proposals should promote new technologies and improved practices to reduce noise at source.
Local Planning Policies	
Hillingdon Local Plan (adopted Nov 2012)	Strategic objective SO10 of the recently adopted Local Plan aims to:
Strategic Objective SO10	*"Improve and protect air and water quality, reduce adverse impacts from noise including the safeguarding of quiet areas and reduce the impacts of contaminated land."*
Strategic Objective SO23	*"Develop and implement a strategy for the Heathrow Opportunity Area, in order to ensure that local people benefit from economic and employment growth and social and environmental improvements including reductions in noise and poor air quality."*

Policy reference	Policy issue
Policy EM8	Policy EM8: Land, Water, Air and Noise, contains the following on noise: The Council will investigate Hillingdon's target areas identified in the Defra Noise Action Plans, promote the maximum possible reduction in noise levels and will minimise the number of people potentially affected. The Council will seek to identify and protect Quiet Areas in accordance with Government Policy on sustainable development and other Local Plan policies. The Council will seek to ensure that noise sensitive development and noise generating development are only permitted if noise impacts can be adequately controlled and mitigated.
Noise Supplementary Planning Document - London Borough of Hillingdon (April 2006)	The Supplementary Planning Document provides advice to guide planning applicants. It is largely written from the perspective of new residential development and its relationship to noise sources. It notes "….that aircraft noise is a significant issue in the determination of planning applications around Heathrow Airport and RAF Northolt, although a number of measures have been implemented to minimise the impact of aircraft noise on surrounding areas."

6.3 Data Gathering Methodology

Desk Study at the Scoping Stage (June 2011)

6.3.1 A data gathering exercise undertaken during the scoping stage in 2011 reviewed the following information:

- 2011 daytime air noise contours for Heathrow;
- Historic runway usage modal splits;
- Historic data relating to the number of people and area exposed to air noise levels of 57 dB $L_{Aeq, 16h}$; and
- Data relating to the number of people and area exposed to air noise levels of 55 dB L_{den} and 50 dB L_{night} between 2006 and 2010.

6.3.2 The review allowed conditions relating to aircraft noise exposure to be understood and to help facilitate scoping.

Desk Study at the Assessment Stage (2012 - 2013)

6.3.3 Details of key information gathered as part of the desk study at the assessment stage is presented in **Table 6.2**.

Table 6.2 Key Information Gathered for the Assessment

Data	Description	Supplied By
Air Traffic Movements	Total Air Traffic Movements (ATMs) for the 2015 baseline and assessment cases. The ATMs present the number of movements against aircraft type, Noise Preferential Routes (NPRs) and Standard Arrival Routes (STARs) for 16-hour daytime, 12-hour daytime, 4-hour evening and 8-hour night-time periods. ATMs have been provided for annual and 92-day summer periods.	HAL Forecasting
Non-ATMs	For the purposes of forecasting and noise modelling, annual non-ATMs have been assumed as 5,000 based on a review of non-ATMs over the last 5 years. The fleet mix and diurnal profile of the ATMs has been evaluated from 2012 non-ATM data. It should be noted that Non-ATMs have been decreasing over recent years and that as ATMs move towards the permitted 480k, there will be less opportunity for Non-ATMs to occur.	HAL
Airfield Designs	Proposed airfield designs including the proposed Runway Access Taxiways (RATs) (**Figure 3.6**) and noise barrier (**Figure 3.7**) have been obtained from HAL. These drawings have been used to model ground noise effects as discussed in Section 6.6.	HAL
Base Mapping and Topographic Data	Mapping information of the airport and its surroundings has been obtained. This information has been used for the presentation of noise contours and to facilitate ground noise modelling.	HAL
Population Information	Information relating to the population and local demographic in communities surrounding the airport has been acquired from CACI. The information has been used to prepare population exposure assessments of air, ground and combined air and ground noise.	CACI
Community Localities	Data relating to the location of communities and localities surrounding the airport has been obtained from the use of the Ordnance Survey Address Layer 2 product.	Ordnance Survey
Statutory Noise Maps	2006 road traffic and railway noise maps produced under the Environmental Noise (England) Regulations 2006 (as amended). These noise maps have been used ascertain an understanding of the influence of other noise transportation noise source upon the ambient noise climate in communities surrounding the airport.	Defra
Heathrow specific noise assessments and documentation	A range of noise assessments and reports specific to Heathrow Airport have been used to inform and provide context. These include the Heathrow Airport Noise Action Plan; Annual Noise Contour reports issued by the CAA; and consultation documents relating to the revision of the Heathrow noise mitigation scheme.	Various

6.3.4 Much of the information gathered as part of the desk study has been used to refine the scope and facilitate assessments.

Survey Work

6.3.5 Survey work, in the form of site visits, have been undertaken in certain areas under the arrival and departure paths of Runway 09L where the greatest impacts from full easterly runway alternation are expected. Site visits to Longford and Cranford have been carried out to observe baseline operations. Specific survey work has been undertaken to provide additional understanding of the potential effects of the Project.

6.3.6 During consultation in the Longford area a concern was expressed regarding possible vibration effects induced by low frequency noise from Runway 09L departures (particularly during start-of-roll). In order to understand whether this effect should be investigated further, a combined noise and vibration survey was undertaken in the vicinity of the eastern end of

Runway 27L. The survey has been used to inform the scope and assessment of potential noise induced vibration effects.

Consultations

6.3.7 The scope of this assessment has been subject to consultations. Some of these consultations have been undertaken through meetings and workshops which are described in Section 4.4 of this ES. This has also lead to the exchange of correspondence to clarify the approach to the assessment.

6.4 Current and Baseline Conditions

6.4.1 The current (or most recent) conditions are described below and this is followed by a description of the conditions anticipated in the year of assessment (i.e. 2015).

Current (or Most Recent) Conditions

Modal Splits

6.4.2 **Appendix G** presents actual and 'standard' modal splits for the Airport. The appendix shows that over the last 6 years there has been a trend towards westerly operations in excess of 80% during the 92-day summer period. In recent years, this westerly trend has resulted in the 'standard' modal split increasing from 76%W/24%E in 2010 to 78%W/22%E in 2012. However, as set out in **Appendix G** the long term average is 76%W/24%E.

6.4.3 **Appendix G** shows that over the course of a full calendar year, the typical modal split for the airport is approximately 71%W/29%E.

6.4.4 Therefore, on average 29% of the airports operations are in an easterly direction and 71% in a westerly direction.

Alternation, Respite and Relief

6.4.5 **Runway alternation** allows arrivals to be scheduled on one runway with departures occurring on the other until a set time in the day (i.e. 1500hrs) when the arrivals switch to the alternative runway. Currently this only occurs during westerly operations. Runway alternation is scheduled in advance so that communities can, to some extent, predict when they will or will not be overflown. **Full Runway Alternation** – i.e. the ability to alternate the runways during both easterly and westerly periods of operation according to a published schedule can provide communities who live under final approaches and the initial stages of departures with scheduled periods of respite from aircraft overflying. This can be achieved using **Reflective Alternation** - the designated runway for westerly arrivals will become the designated runway for easterly departures and vice versa for any given day. This enables communities, particularly those closest to the runway ends to predict with much greater certainty the periods when they will be overflown or not. Through consultation, the Airport understands that communities living around the airport value the ability to know in advance as to when they will be overflown or not.

6.4.6 For the purposes of this assessment a distinction has been drawn between respite and relief.

6.4.7 **Relief** is the absence of overflights, subject to the uncertainty of changes in runway operational mode due to changes in wind direction. Scheduled relief is absence of overflights that is only predictable provided that the direction of operation does not change due to a change in wind direction.

6.4.8 **Respite** is the predictable absence of overflights regardless of wind direction. A community under the approach or departure routes for one runway, not being overflown because approaches or departures are on the other runway, and they can continue to be free of overflights should operations change direction, because of a change in wind direction, provided that landings and departures can switch runways at the same time as they switch direction. This necessitates the ability to have runway alternation on easterly as well as westerly operations. At present during westerly operations, the application of the runway alternation pattern means that some communities under final approaches and the initial stages of departures experience scheduled periods of relief.

6.4.9 However the lack of easterly runway alternation means that any scheduled relief potentially provided by the current westerly alternation pattern can be compromised by unpredictable changeover to easterly operations required by prevailing weather conditions. This results in some communities being overflown when they may have expected not to be and others experiencing periods of unexpected relief from overflights.

6.4.10 At present during easterly operations, without ful**l** runway alternation, departures always occur from the southern runway with arrivals occurring on the northern runway. There is no scheduled runway alternation pattern which means for communities under final approaches such as those within Windsor or Colnbrook and for communities under initial departures such as Hatton, there is no respite from aircraft overflights. However, for communities such as Cranford and Stanwell Moor, these are no longer overflown.

6.4.11 As shown by **Appendix G**, on average around 25-30% of the airports operations are easterly with around 70-75% occurring to the west. This means that runway alternation occurs for 70-75% of the time, and as such, relief is available to communities on any given day of westerly operations. However, longer term predictability is not possible since there is a 25-30% chance that the airport could be operating on easterly operations during which there are currently no respite periods scheduled. For some communities (such as Windsor, Colnbrook and Hatton) during prolonged periods of easterly operations this results in several days of overflight without any respite and for others (such as Old Windsor, Stanwell Moor and Cranford) unexpected periods of relief.

6.4.12 These conditions are the same as those that will be occurring in 2015 (i.e. the baseline conditions without the Project).

Air Noise

6.4.13 The most recent air noise information obtained from the ERCD[4] is for **2011**. ‘Standard’ and ‘actual’ air noise contours are produced to reflect the respective 2011 actual modal split (83%W/17%E) and the 2011 standard modal split (77%W / 23%E) for the 92-day summer period. The contours are reproduced in **Figure 6.1** and **Figure 6.2** respectively.

6.4.14

[4] ERCD - Directorate of Airspace Policy, CAA, ERCD Report 1201, Noise Exposure Contours for Heathrow Airport 2011.

6.4.15 **Table 6.3** reproduces the area and population exposed to various levels of daytime air noise in 2011 for both the actual and standard modal splits.

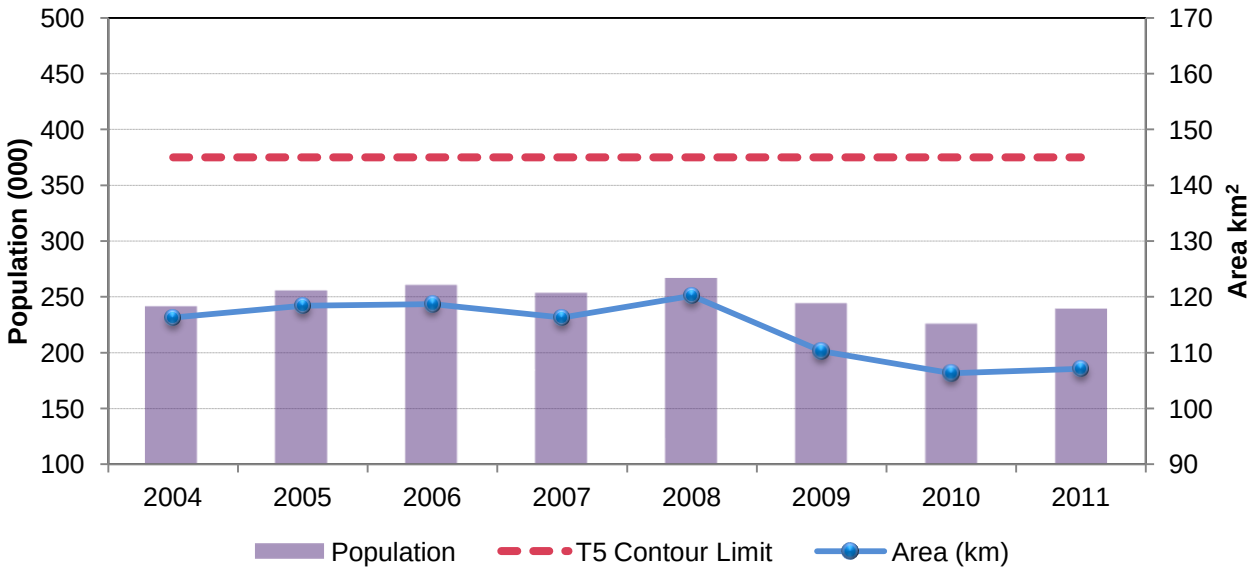
Table 6.3 2011 Actual and Standard Air Noise Contour Areas and Population Exposure Statistics

Air Noise Contour Level $L_{Aeq,\ 16\text{-}hour}$, dB	2011 Actual Model Split (83%W / 17% E)		2011 Standard Modal Split (77%W / 23%E)	
	Area (km^2)	Population	Area (km^2)	Population
≥ 57	108.8	243,350	107.1	237,750
≥ 60	58.9	101,150	58.0	101,050
≥ 63	33.9	41,900	34.1	42,800
≥ 66	20.3	13,050	20.2	12,750
≥ 69	10.0	3,250	9.9	3,100
≥ 72	5.4	250	5.3	300

Note: Areas are given to the nearest 0.1km^2 and populations to the nearest 50. Statistics prepared by ECRD in Report 1201

6.4.16 The areas and populations exposed to air noise levels above 57 $L_{Aeq\ 16h}$ between 2004 and 2011 are presented in **Figure 6.3**. Overall, there have been fluctuations (up and down) in the spatial extent of the area of the 57 dB $L_{Aeq\ 16h}$ 'standard mode' air noise contour over this period. When compared to the permitted limit of 145 km^2 set by conditions attached to the Terminal 5 Planning Decision, the 57 dB $L_{Aeq\ 16h}$ contour is well within this limit.

Figure 6.3 Area and Population Exposed to 57 dB $L_{Aeq,\ 16h}$ since 2004 (Standard Mode)



6.4.17 In addition to the $L_{Aeq,\ 16h}$ metric, air noise contours have been produced at Heathrow in terms of the annual average day-evening-night noise indicator, L_{den}, and the annual average night-time noise indicator, L_{night}. The most recent available L_{den} and L_{night} contours are for 2010 and

can be obtained from ERCD Report 1107[5]. This work was commissioned voluntarily by HAL to meet commitments made in the airport's Noise Action Plan. **Table 6.4** presents 2010 annual average L_{den} and L_{night} air noise exposure statistics in terms of area and population.

6.4.18 These contours represent the 2010 annual average standard modal splits rather than a rolling 20-year 'standard' 92-day modal split as used in the production of the $L_{Aeq,\ 16h}$ contours.

Table 6.4 2010 L_{den} and L_{night} Air Noise Exposure Statistics

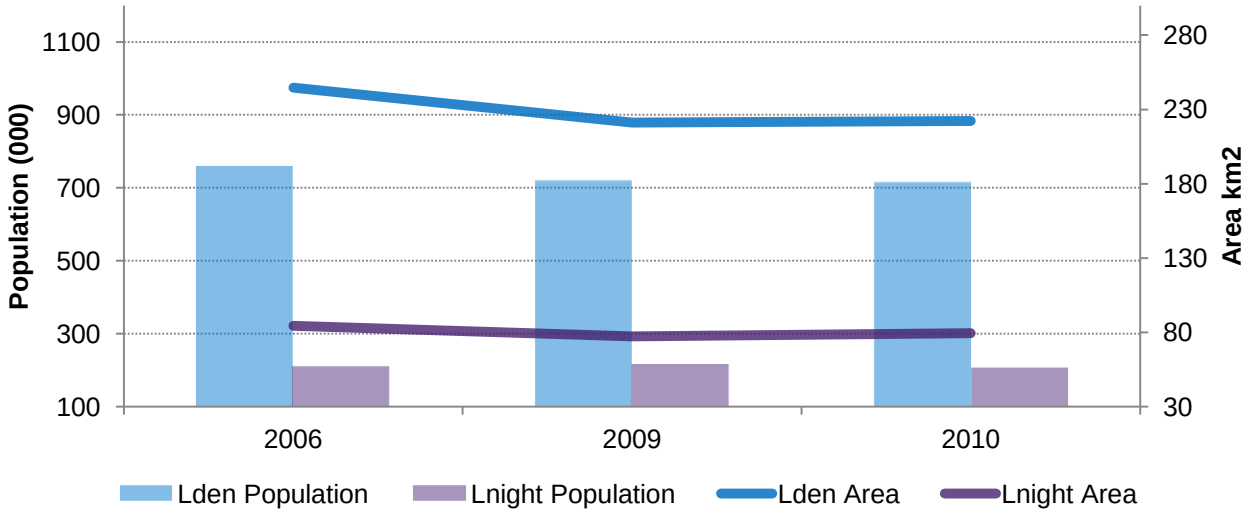
2010 L_{den} (66%W / 34%E)			2010 L_{night} (68%W / 32%E)		
Air Noise Contour Level	**Area (km^2)**	**Population**	**Air Noise Contour Level**	**Area (km^2)**	**Population**
≥ 55	222.3	712,100	≥ 50	79.2	203,300
≥ 60	79.7	178,500	≥ 55	29.2	55,600
≥ 65	32	42,200	≥ 60	9.8	12,000
≥ 70	10.8	4,800	≥ 65	3.6	1,300
≥ 75	4	100	≥ 70	1.5	0

Note: Populations rounded to the nearest 100. Statistics prepared by ERCD

6.4.19 **Figure 6.4** presents trends in the population and area of the 55 dB L_{den} and 50 dB L_{night} air noise contours for the period 2006-2010. There has been a decrease since 2006 in the areas of both noise contours and the numbers of people living within these contours. The contours were not produced in 2007 and 2008 as this was not required. Heathrow in 2009 committed to producing these contours annually as a voluntary agreement.

[5] ERCD - Directorate of Airspace Policy, CAA, ERCD Report 1107, Noise Action Plan Contours for Heathrow Airport 2010.

Figure 6.4 55 dB L_{den} and 50 dB L_{night} trends in population and area



Ground Noise

6.4.20 Unlike air noise contours, ground noise contours are not produced on an annual basis for the Airport[6]. However, ground noise contours have been developed to describe the 2015 baseline conditions.

6.4.21 Based on observations made during site visits, ground noise may be audible at the Airport boundary and surrounding areas (moving clockwise from the north) of Sipson, Harmondsworth, Harlington, Cranford, Hatton, East/West Bedfont, Stanwell, Stanwell Moor and Longford.

Surface Access Noise and Other Noise Sources

6.4.22 Road traffic noise sources in the vicinity of the Airport include the M4 and M25 motorways, the M4 motorway and A4 spurs, other major A-roads and many local roads. These road networks form the primary routes for airport traffic. Recent road traffic noise studies for the airport indicate road traffic noise is likely to be audible at most locations around the Airport. These studies have also shown that most receptors within 500m of the motorway network will be exposed to noise levels of greater than 60 dB $L_{Aeq, 16h}$.

6.4.23 The Airport is served by a number of overground and underground railways. Railway noise maps prepared by Defra in 2006 show that the influence of railway noise in areas surrounding the Airport is localised and small in comparison to road traffic noise.

6.4.24 Other noise sources in the area around the Airport have localised effects and include:

- Noise generated from the operation of the Lakeside Energy from Waste Plant in Colnbrook (adjacent to the M25 motorway);

[6] Nevertheless, several ground noise studies have been undertaken for the Airport in relation to specific projects (i.e. Terminal 5).

- Other local industrial buildings; and
- Airport maintenance facilities located at the eastern end of the airfield.

2015 Baseline Conditions

6.4.25 Baseline conditions for 2015 are set out in Sections 6.8-6.12 and **Appendix G**.

6.5 Environmental measures incorporated into the scheme

6.5.1 Heathrow Airport employs a number of measures aimed at controlling noise from its operations which are outlined in **Appendix G**. As a result of full runway alternation during easterly operations, the Airport would continue to provide existing mitigation schemes but would also provide additional mitigation as outlined in the following section.

Noise Insulation and Compensation Schemes

6.5.2 **Table 6.5** sets out the Airport's proposals in respect of the insulation and compensation schemes that it proposes to offer (if planning permission is granted and the Project is implemented). These schemes are an extension of the existing schemes offered by the Airport (as set out in **Appendix G**).

Table 6.5 Mitigation and Compensation incorporated into the Scheme

Type	Scheme	Property Type	Policy Reference	Eligible Buildings	Eligibility Criteria	Offer
Insulation	Enhanced Residential Scheme	Residential	APF Paragraph 3.39	Households	63dBA Leq contour AND a 3dBA increase in noise exposure.	Free noise assessment to determine statement of need. 100% contribution towards insulation/ventilation costs based on statement of need.
	Community Buildings	Community	APF Paragraph 3.37	Schools, colleges, registered nurseries, hospitals, hospices, community halls and libraries.	63dBA Leq contour AND a 3dBA increase in noise exposure.	As per current Community Buildings Scheme.
Compensation	Enhanced Home Relocation Assistance	Residential	APF Paragraph 3.36	Households	69dBA Leq contour.	As per existing Home Relocation Assistance scheme.

Longford Noise Wall

6.5.3 In order to mitigate ground noise and start-of-roll noise effects for receptors in the Longford area, a noise barrier will be constructed along the airport perimeter boundary. The noise

barrier will be 5m high and will attenuate noise from aircraft during taxiing. The mitigating effect of the noise wall is reflected in the assessment of ground noise effects in Section 6.9. Also see Section 3.2 for a description of the noise barrier.

Reflective Alternation

6.5.4 The scheme will introduce reflective alternation during easterly operations. The introduction of reflective alternation will ensure that when a runway is scheduled not to be in use for that period of the day (either before or after 15:00), that if the wind direction changes and airport operations switch from westerly to easterly mode predictable periods of respite will be provided to some communities, even though as a result of the Project they will become overflown (see **Figure 6.5**).

Mitigation of Noise Induced Vibration

6.5.5 HAL will assess any pre-existing lightweight structures or conservatories in the area of Longford within 500m of start-of-roll to assess what action may be taken to mitigate any effects from noise induced vibration. If mitigation is possible the airport will finance works up to a maximum value of £10,000.

6.6 Scope of the Assessment

6.6.1 The following sections set out the scope of the assessment. The scope was originally outlined in the Scoping Report (**Appendix D**) and has taken account of consultation responses and subsequent additional investigations.

6.6.2 The scope of the assessment has considered two distinct phases:

- The construction phase (i.e. the construction of the enabling works that would allow of full runway alternation); and
- The operational phase (i.e. full runway alternation in 2015).

6.6.3 During both of these phases the potential noise sensitive receptors and potentially significant noise effects are considered. These are discussed in the following sections along with the rationale for assessment.

Potential Receptors

6.6.4 **Table 6.6** identifies the types of noise sensitive receptors that could be affected by the Project.

Table 6.6 Potential Receptors Considered in the Assessment

Receptor	Type of Effect
Dwellings	Annoyance, sleep disturbance
Other residential	Annoyance, sleep disturbance
Educational facilities	Interference with teaching and task performance, annoyance
Healthcare facilities	Annoyance, speech interference, sleep disturbance
Places of Worship	Speech interference, musical quality, annoyance, intrusion
Community facilities	Speech interference, musical quality, annoyance, intrusion
Open spaces	Effects on tranquil areas, on enjoyment of recreational facilities, speech interference effects on areas of landscape and historic value

6.6.5 Places of work are assessed as part of overall community noise annoyance (reflected in the **Table 6.6** as dwellings/other residential) or as educational or healthcare facilities.

Receptors Scoped Out

6.6.6 Mechanically sensitive facilities for the recording of sound, highly sensitive equipment such as electron microscopes and other cases where the physical effects of excessive sound prevent the correct operation of the equipment have specified criteria for an acceptable noise environment. It is considered that none of these facilities are located close enough to the airport to be affected by the Project and as such this category of receptor has been 'scoped out' of the assessment. Acoustical resources, such as theatres and auditoria or similarly sensitive facilities have also been scoped out of the assessment as none of these facilities have been identified as potentially being affected by the Project.

Potentially Significant Effects

Construction Phase - Construction Noise Effects

6.6.7 The Project involves the construction of new airfield infrastructure and a noise barrier at Longford (as set out in Section 3.3). The level of noise generated during construction activities will be dependent upon the type of plant and equipment used.

6.6.8 Noise from construction activities during these night-time periods upon residential receptors near to the airfield, such as those in Longford, is potentially significant.

Operational Phase – Air and Ground Noise Effects

6.6.9 The Project is likely to result in a number of effects on the air and ground noise climate at the Airport and its surroundings. As the Project only affects easterly operations, it would only lead to operational changes during this time. Although easterly operations account on average for less than 30% of the overall movements at the airport, the Project has the potential to result in changes in overall levels of noise exposure which may lead to changes in community annoyance and sleep disturbance effects for residential receptors.

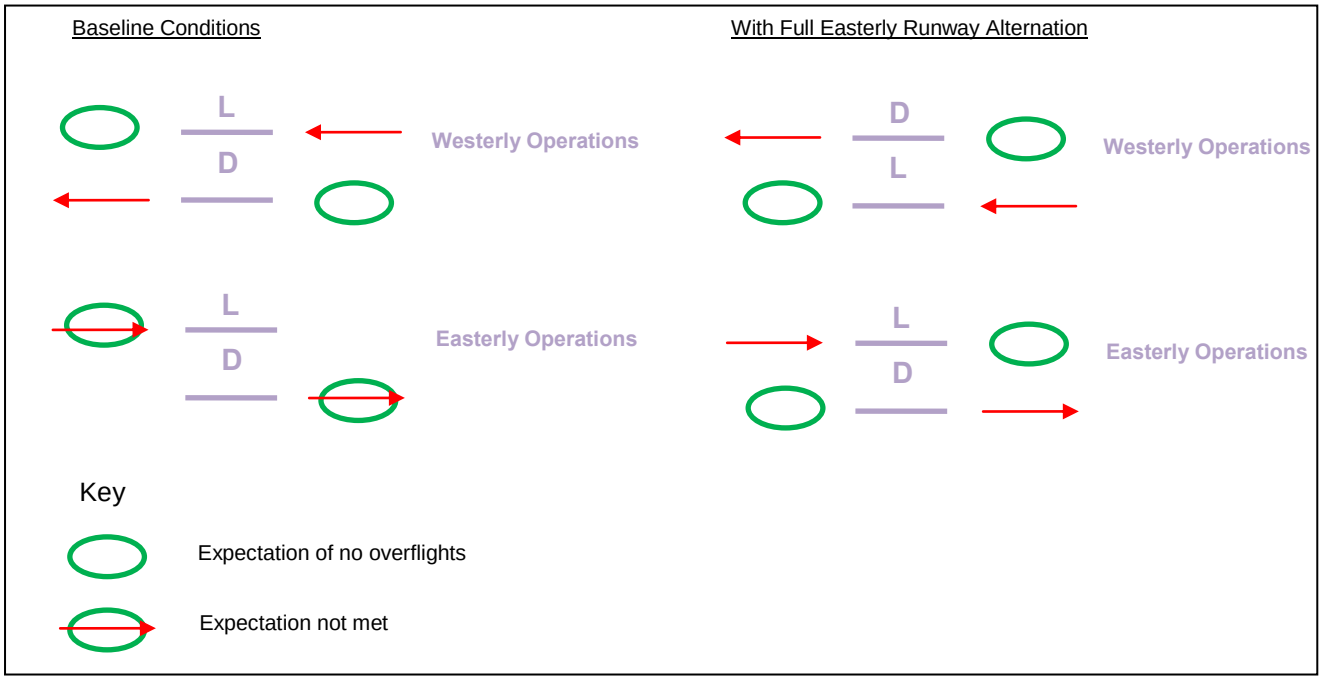
6.6.10 During easterly operations alone, some localities may experience changes in aircraft operations that lead to other beneficial or adverse effects. These effects include:

- The introduction of predictable periods of respite;
- Changes (either adverse or beneficial) in periods of respite;
- Change in periods of relief; and
- Changes in the level of overflights.

6.6.11 These effects would occur as a result of the introduction of reflective alternation during easterly operations.

6.6.12 **Figure 6.5** shows how the concept of reflective alternation works, despite changes in wind direction, to provide predictable periods of respite. It shows that the Project will introduce predictable periods of respite for all localities overflown, particularly close to the airport. This is because by "reflecting" the use of the landing runway to a departure runway, according to a published schedule, when the wind conditions change, it enables the area being overflown to remain the same. However it would also result in a loss of relief and increased overflights for localities situated under approaches to the southern runway and initial departure route from the northern runway during periods of easterly operations.

Figure 6.5 Illustration of the Concept of Reflective Alternation during a change in wind direction



6.6.13 The current arrangements result in an uneven distribution of overflights for the communities closest to the runway ends. Based on the current long term modal splits Hatton and Poyle will each be overflown by approximately 32% of all flights whilst Cranford and Stanwell Moor will be overflown by around 18% (of all flights both easterly and westerly). The purpose of the

Government decision to remove the Cranford Agreement and enable full easterly alternation was to create a more even distribution of overflight.

Operational Phase - Effects from Surface Access Noise and Other Sources

6.6.14 The change in operation would not give rise to any change in passenger numbers or associated road traffic or railway movements as the airport would continue to operate within its existing limit of 480,000 ATMs per year. Changes in noise from surface access and other sources have therefore been scoped out of the assessment.

Operational Phase – Noise Induced Vibration Effects

6.6.15 Potential noise induced vibration effects at receptors in Longford as a result of low frequency start-of-roll noise are scoped into the assessment.

Summary

6.6.16 In summary, the following potentially significant effects have been 'scoped-in' to the ES for the sensitive receptors identified in **Table 6.6**.

Air Noise Effects

- Air noise effects in terms of a change in overall air noise exposure following the change in operations in 2015;
- Air noise exposure effects in terms of overall absolute levels of air noise;
- Changes in periods of relief and respite;
- Changes in likely annoyance and
- Changes in the numbers of overflights.

Ground Noise Effects

- Ground noise effects in terms of change in ground noise exposure following the change in operation in 2015; and
- Ground noise effects in terms of its contribution to overall noise exposure.

Construction Noise Effects

- Construction noise related to the development of new airfield infrastructure and the proposed Longford noise barrier.

Noise Induced Vibration

- Assessment of potential air noise induced vibration effects from Runway 09L departures in 2015 at residential receptors with lightweight constructions.

Scoped-Out Effects

6.6.17 For clarity, the following effects have been scoped-out of the assessment.

- Changes in surface access noise; and
- Ground-borne structural vibration effects.

6.7 Assessment Methodology

6.7.1 This section presents the methodology and approach to the assessment of the potentially significant effects identified in Section 6.6.

Relevant Assessment Guidance

6.7.2 Guidance in relation to the assessment of noise is effect and receptor specific. The main noise effects at residential receptors include community annoyance and sleep disturbance. For other noise sensitive receptors, such as schools and hospitals, it is necessary to consider alternative guidance.

6.7.3 **Table 6.7** summarises the guidance documents that have been considered in the determination of the effect thresholds used in this assessment. Full details concerning these documents and the approach to determining assessment thresholds is discussed in **Appendix G**.

Table 6.7 References used to Support the derivation of Noise Assessment Thresholds

Receptor Type	Reference Sources
Residential Receptors (Community Annoyance)	• Aviation Policy Framework (APF) March 2013, The Stationary Office. • *CAA (1985) Aircraft Noise Index Study* (ANIS). Department for Transport. • Directive 2002/49/EC • Guidance for Airport Operators to produce airport noise action plans under the terms of the Environmental Noise (England) Regulations 2006 (as amended), Defra, March 2009 • The Environmental Noise (England) Regulations 2006 (as amended) • European Commission's Environmental Noise Directive Report Mechanism (ENDRM) • Attitudes to Noise from Aviation Sources in England (ANASE) 2002. • European Environment Agency (EEA) (2010) Technical Report 11/2010 "Good practice guide on noise exposure and potential health effects". • WHO (2011) report Burden of disease from environmental noise Quantification of healthy life years lost in Europe • European Commission (2002) Working Group on Dose-Effect Relations document Position paper on dose response relationships between transportation noise and annoyance.
Residential Receptors (Sleep Disturbance)	• CAA / ERCD (2013) Report 1208, 'Aircraft Noise and Sleep Disturbance: A Review', K, Jones. 2013. • Ollerhead J B et al (1992); Report of a Field Study of Aircraft Noise and Sleep Disturbance. Department of Transport, December 1992. • CAA (2007) Guidance on the Application of the Airspace Change Process - CAP 725. • World Health Organisation (2009) Night Noise Guidelines for Europe.
Educational Facilities	• Education Funding Agency (2012) Acoustics performance standards in priority schools building programme. • Hopkins, C., Hall, R., James, A., Orlowski. R., Canning, D., et al., Acoustic Design of Schools, A Design Guide, Building Bulletin 93, department for education and skills, The Stationery Office. • Stansfeld, S.A., Berglund, B., Clark, C., López Barrio, I., Fischer, P., Ohstrom, E., Haines, M.M., Head, J., Hygge, S., van Kamp, I., Berry, B.F., Road traffic and Aircraft Noise exposure and Children's cognition and Health, The Lancet, Volume 365, Issue 9475, 4 June 2005, pp 1942-1949.

Healthcare Facilities	• The Department of Health Specialist Services, Health Technical Memorandum 08-01: Acoustics (HTM 08-01 Acoustics).
Places of Worship and Community Facilities	• Sound Insulation and noise reduction for buildings-Code of practice, BS 8233:1999, British Standards Institution, 1999

Noise Exposure Change and Significance

6.7.4 As far as noise from airborne aircraft around an airport is concerned, when there is an airport development of some kind, there may be a change in several of the variables included in the noise index used to characterise the noise environment. The index value itself may or may not change. If the value of the index is measured and compared with the results of a social survey of the population affected and there is a change in the relationship between the two, it is necessary to apply statistical methods to consider whether that change is due to noise change. Here the concept of significance, in the statistical sense rather than the environmental sense, arises.

6.7.5 Noise and social surveys involve regression analyses between noise indices and measures of annoyance. The resulting relationship between noise level and annoyance is subject to uncertainty which may be expressed in terms of a confidence interval. In large meta-analyses of many social survey results, the typical standard deviation of a regression curve relating percent highly annoyed to noise index of an L_{Aeq} kind, for aircraft noise, is about 1 dB(A). This means that the 95% confidence interval is about 2 dB either side of the mean, and one third of results fall outside a band 1 dB either side of the mean.

6.7.6 One may consider the significance of social and noise survey results by looking at the probability that a social survey would reveal a change in annoyance at a range of magnitudes of noise change, as follows:

- If two different noise environments differ by 1 dB on an L_{Aeq}-based index there is approximately a 10% probability that a social survey would show no change in annoyance. On a scale from 0 to 100, annoyance would change in magnitude by about 2%. The percentage of the population who are highly annoyed would increase by less than 1.5%.

- If two different noise environments differ by 2 dB on an L_{Aeq}-based index there is approximately a 2.5% probability that a social survey would show no change in annoyance. On a scale from 0 to 100, annoyance would change in magnitude by about 4.5%. The percentage of the population who are highly annoyed would increase by slightly less than 3%.

- If two different noise environments differ by 3 dB on an L_{Aeq}-based index there is only approximately a 0.5% probability that a social survey would show no change in annoyance. On a scale from 0 to 100, annoyance would change in magnitude by about 7%. The percentage of the population who are highly annoyed would increase by slightly less than 4.5%.

6.7.7 For specific surveys the standard deviation is much larger, around 4 dB(A). Based on the ANIS and ANASE results, for any social survey location:

- If two different noise environments differ by 1 dB on the $L_{Aeq\ 16h}$ index there is approximately a 20% probability that a social survey would show no change in annoyance.

- If two different noise environments differ by 2 dB on the $L_{Aeq\ 16h}$ index there is approximately a 16% probability that a social survey would show no change in annoyance.

- If two different noise environments differ by 3 dB on the $L_{Aeq\ 16h}$ index there is approximately a 12% probability that a social survey would show no change in annoyance.

6.7.8 A 3 dB change has been widely used in environmental statements as the point at which a change in the noise environment is regarded as significant. The above considerations suggest that this threshold is appropriate.

6.7.9 It must be borne in mind that the comparison of two different noise environments does not apply to a rapid or short term change, and when change does take place over a short time, there may be a greater effect on human response than is apparent when two different unchanging environments are compared. Similar considerations arise in the assessment of highway noise from trunk roads, as set out in the Highways Agency's *'Design Manual for Roads and Bridges'*. This provides two methods of estimating the percentage of people bothered by noise, the first estimates the effect of the opening of a new scheme and applies soon after the scheme and *"for several years afterwards"* after which the second method applies. In the first method, a 1 dB change results in a 21% change in the percentage of people *"bothered very much or quite a lot"* by traffic noise. When comparing two steady state environments, or the pre-development and the long term annoyance, the effect of a 1 dB change is only of the order of 1 to 2% depending on the noise level. The corresponding percentages for 3 dB are 30% (short term) and 3% to 5% (long term).

6.7.10 These considerations lead to the conclusion that when a step-change occurs, there is a greater effect than would be found on comparing the annoyance that had existed for a period of years.

Construction Noise

6.7.11 BS 5228-1:2009 includes an informative annex (Annex E) on the significance of noise effects, citing illustrative methods based on previous major projects. In this case the focus is on assessing noise effects at night, when much of the work would be undertaken due to its proximity to operational areas. The Example Method 2 of Annex E provides a methodology for the assessment of construction noise effects based upon changes in ambient noise levels due to construction activities. Construction noise is considered to be a significant impact where it results in an increase in total noise level (i.e. pre-construction ambient noise levels plus construction noise levels) of 5 dB or more, as set out in **Table 6.8** to lower cut-off values of 65 dB and 45 dB $L_{Aeq,T}$, from construction noise alone for day and night-time periods respectively.

Table 6.8 Example Method 2 – 5 dB(A) Change Method

Noise Level Change in Total Ambient Noise Level $L_{Aeq, T}$	Significance
< 5 dB(A)	Not Significant
≥ 5 dB(A)	Significant

Subject to lower cut-off values of 65 dB and 45 dB $L_{Aeq, T}$ for day and night-time periods respectively.

Significance subject to periods of threshold exceedance

6.7.12 In addition to the noise level significance criteria, for construction noise to be significant, some understanding of the duration of effects is required. Where noise from construction works is predicted to exceed thresholds for at least 10 days in 15 days, or for 40 days in a six-month period, construction noise has been considered to be significant. Given that the proposed construction works would generally be undertaken for two-week periods at a time, this temporal criterion would be met for all instances where the noise level criteria are exceeded.

6.7.13 There are no suggested significance criteria for non-residential receptors, such as business premises or recreational areas. Instead, BS5228-1:2009 states that the significance methodology presented in Example Method 2 may apply to: residential housing; hotels and hostels; and buildings with religious, education and health and/or community uses.

Vibration Effects

6.7.14 BS 6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings'* provides a table of vibration dose value (VDV) ranges which might result in various probabilities of adverse comment within residential buildings. The threshold of *"Adverse comment possible"* has been taken as the threshold of significance, namely $VDV_{b/d,day}$ 0.4 $ms^{-1.75}$ and $VDV_{b/d,night}$ 0.2 $ms^{-1.75}$. BS 5228-9:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* contains a normative annex on the significance of vibration effects. It notes that for construction it is considered more appropriate to provide guidance in terms of the Peak Particle Velocity (PPV), since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage.

Methodology for the Assessment of Aircraft Noise Effects

6.7.15 Aircraft noise effects have been considered in terms of overall noise exposure and during easterly mode operations. The assessment primarily considers those receptors where noise levels exceed 57 dB $L_{Aeq\ 16h}$ index, this being the threshold used to signify the approximate onset of significant community annoyance. Mitigation has been considered in line with current government guidance.

6.7.16 The assessment has been based upon a comparative assessment of two core scenarios:

- 2015 baseline i.e. without easterly runway alternation; and
- 2015 with the implementation of full runway alternation on easterlies.

6.7.17 The number of movements assumed in each scenario is 480,000 ATMs. In response to consultation, a further 5,000 non-ATMs have also been included within the assessment.

Residential Receptors

Community Annoyance (Primary Assessment)

6.7.18 In compliance with Government Policy (APF), a primary assessment of aircraft noise community annoyance effects has been undertaken using the $L_{Aeq, 16h}$ index.

6.7.19 Levels of aircraft noise exposure in terms of $L_{Aeq, 16h}$ and corresponding noise contours have been prepared by the ERCD using ANCON (version 2.3) information relating to fleet mix and route assumptions provided by Heathrow.

6.7.20 ANCON is the established method for calculating aircraft noise exposure at Heathrow Airport and is used in annual reporting. The software calculates aircraft noise using information obtained from noise measurement stations located around the airport and measured radar tracks. ANCON is designed to incorporate measures such as reflective alternation into its exposure calculations.

6.7.21 The mode adopted for the assessment (the 'assessed mode') has been established as 76%W/24%E. The assessment has considered exposure and changes in aircraft noise above a threshold of 57 dB $L_{Aeq, 16h}$ and estimated the number of dwellings, population and area exposed.

6.7.22 The minimum change presented by the assessment above 57 dB $L_{Aeq, 16h}$ is 1 dB(A) where a decrease in air noise exposure of 1 dB(A) or more is considered a beneficial effect and an increase of 1 dB(A) or more is considered adverse.

6.7.23 With reference to relevant guidance, significant effects (either beneficial or adverse) are considered to occur when a receptor is subject to changes of greater or equal to 3 dB where the receptor has been exposed to at least 57 dB $L_{Aeq, 16h}$ or more in either the baseline or with full runway alternation.

6.7.24 The assessment is presented in Section 6.8.

Community Annoyance (Secondary Assessment)

6.7.25 To fulfil commitments made during consultation, a secondary assessment of community annoyance effects has been undertaken using the L_{den} index. Aircraft noise exposure in terms of L_{den} has also been prepared by ERCD using ANCON.

6.7.26 The mode adopted for the assessment (the 'assessed mode') has been calculated by ERCD and is 69%W/31%E. The assessment has considered exposure and changes in aircraft noise above a threshold of 55 dB L_{den} and estimated the number of dwellings, population and area exposed.

6.7.27 The minimum change presented by the assessment above 55 dB L_{den} is 1 dB(A) where a decrease in air noise exposure of 1 dB(A) or more is considered a beneficial effect and an increase of 1 dB(A) or more is considered adverse.

6.7.28 With reference to relevant guidance, significant effects (either beneficial or adverse) are considered to occur when a receptor is subject to changes of greater or equal to 3 dB where the receptor has been exposed to at least 55 dB L_{den} or more in either the baseline or with full runway alternation.

6.7.29 Although an assessment of effect is taken for L_{den}, the assessment is presented in **Appendix G**. This approach has been taken to reflect the Government's decision to reaffirm the use of the $L_{Aeq, 16h}$ as the principle of community annoyance.

Community Annoyance - Alternative Measures

6.7.30 In compliance with Government Policy (APF Paragraph 3.19), alternative measures have been used to present and assess the changes resulting from the Project. The following measures have been adopted for assessment:

- Frequency and changes in easterly movements against Noise Preferential Routes (NPRs) and arrivals tracks; and
- Respite / relief contours and percentages during easterly operations.

6.7.31 Reductions in the frequency of overflights over a particular locality are considered a beneficial effect whereas increases are considered adverse. The introduction of / and or increase in periods of respite is considered beneficial, as is any increase in relief. Decreases in respite or a net loss in periods without overflight (the sum of the change in respite and change in relief) is considered to have an adverse effect.

6.7.32 Localities are considered to be overflown should they fall within areas defining dispersed departure tracks are located 250m either side of final approaches.

6.7.33 The number of movements assigned within these areas is based on forecast movements and route allocations as adopted within the ANCON model.

6.7.34 In addition, a calculation of the population 'Annoyed' and 'Highly Annoyed' using the 'assessed mode' noise exposure data has been undertaken with and without full easterly runway alternation. The dose-response relationship used for the calculation of the population 'Annoyed' and 'Highly Annoyed' has been taken from the European Environment Agency (EEA) published Technical Report 11/2010 "Good practice guide on noise exposure and potential health effects". Decreases in population annoyance are considered beneficial effects whereas increases are considered adverse. The dose-response relationship adopted from the publication is based on post-1996 research. This approach reflects that taken within the HIA.

Community Annoyance Sensitivity Tests and Additional Information

6.7.35 Sensitivity tests have been prepared for the assessment of community annoyance for both the L_{den} and $L_{Aeq, 16h}$ noise indicators. As a sensitivity test, westerly/easterly modal splits over the last 20 years have been considered and subsequent changes in population exposure around the 'assessed' modal split have been calculated and based on outputs from ANCON.

6.7.36 The sensitivity tests are presented in **Appendix G**.

6.7.37 Additional information, in the form of $L_{Aeq, 8h}$ single mode air noise contours is also presented in **Appendix G**. This information is provided in response to consultation.

Residential Receptors – Overview of Community Annoyance Effects Criterion

6.7.38 Based upon the assessment described above, the following assessment outcomes are considered important considerations in the evaluation of the Project. These are:

- The number and changes in the population who are exposed to air noise exposure levels of 57 dB $L_{Aeq, 16h}$ or more as determined by the primary assessment of $L_{Aeq, 16h}$;
- The population who experience beneficial changes of at least 1 dB(A) in air noise exposure verses the population who experience adverse changes of at least 1 dB(A) above a threshold of 57 dB $L_{Aeq, 16h}$ as determined by the primary assessment of $L_{Aeq, 16h}$;
- Net changes in the population 'Annoyed' and 'Highly Annoyed';
- The demonstration of the introduction to and/or changes in respite and relief through the easterly runway alternation; and
- The population exposed to either beneficial or adverse significant changes in air noise exposure as determined by the primary assessment of $L_{Aeq, 16h}$.

Residential Receptors - Night Time Sleep Disturbance

6.7.39 For the assessment of night-time aircraft noise sleep disturbance effects the following noise exposure data has been calculated using ANCON:

- 90 dB SEL from the B747-400 type aircraft during easterly departures on 09L; and
- 'assessed mode' L_{night} (2300-0659) air noise exposure levels;

6.7.40 Based upon the relevant guidance outlined above and in **Appendix G**, significant effects (either beneficial or adverse) are considered to occur when a receptor is subject to changes of greater or equal to 3 dB where the receptor has been exposed to at least 45 dB L_{night} or more in either the baseline or with full easterly runway alternation, and is subject to aircraft noise events of at least 90 dB SEL from the B747-400 aircraft type.

6.7.41 It should be noted that the use of the B747-400 aircraft type within the night-time assessment reflects a situation that can occur during the night-time period however this does not reflect standard operational procedures. B747-400 departures are not scheduled between 2300-0600hrs. However, although, they cannot be scheduled in the night-time period they can operate during the night-time due to late aircraft and delays.

Non-Residential Sensitive Receptors

6.7.42 With reference to the assessment guidance, for the purpose of assessing air noise effects upon other sensitive receptors such as education establishments, additional information has been provided and interpretations have been made including:

- $L_{Aeq, 16h}$ noise levels, for use in conjunction with historical data describing the variability of short term $L_{Aeq,T}$ levels as presented in **Appendix G** for the assessment of effects upon education establishments and healthcare facilities; and
- Where applicable and in specific locations, maximum noise levels (L_{Amax}) noise levels.

6.7.43 For all non-residential sensitive receptors, significant effects (either beneficial or adverse) are considered to have occurred when a receptor is subject to changes of greater or equal to 3 dB where the receptor has been exposed to the following outdoor noise level thresholds:

- **Education Establishments**: 50 dB $L_{Aeq, T}$ (where T is 30 minutes during teaching hours) and 70 dB L_{Amax}
- **Places of Worship**: 57 dB $L_{Aeq, 16h}$
- **Healthcare Facilities**: 55 dB $L_{Aeq, T}$ during daytime periods; and 50 dB $L_{Aeq, T}$ and 70 dB L_{Amax} for night-time periods (where T is 1 hour)

Methodology for the Assessment of Ground Noise Effects

6.7.44 Ground noise effects have been considered in terms of overall noise exposure.

6.7.45 The assessment has been based upon a comparative assessment of two core scenarios:

- 2015 baseline i.e. without full easterly runway alternation; and
- 2015 with the implementation of full runway alternation on easterlies.

6.7.46 The number of movements assumed in each scenario is 480,000 ATMs. In response to consultation, a further 5,000 non-ATMs have also been included within the assessment.

6.7.47 Levels of ground noise exposure have been calculated using the LimA noise modelling suite. A 3D topographic model has been developed within the software suite using digital mapping and terrain data. Topographic obstacles to noise such as buildings and landscaping features have been incorporated including the proposed Longford Noise Wall. The noise source emission model, including notably ground movements by routing, aircraft and times is based on inputs obtained from air emissions modelling at the airport. The noise emission model has included aircraft taxiing, Auxiliary Power Units (APUs) running at stand and aircraft at hold points. Noise emission levels for these sources have been obtained from aircraft technical manuals, research projects and measurements. Noise propagation calculations within the model have been made using International Standard ISO 9613-2 *Acoustics - Attenuation of sound during propagation outdoors*.

6.7.48 The assessment has adopted the same assessment and significance criteria for each type of noise sensitive receptor as applied for air noise. Alternative measures and sensitivity tests as described for air noise have not however been prepared for air noise.

6.7.49 Where L_{Amax} or SEL noise levels are required, the ground noise assessment has adopted values associated with air noise.

Methodology for the Assessment of Combined Air and Ground Noise

6.7.50 The assessment of combined air and ground noise has been based on logarithmic summations of separate levels of air and ground noise. These summations are based on noise exposure levels obtained from the LimA and ANCON models.

6.7.51 As with ground noise, the assessment has adopted the same assessment and significance criteria for each type of noise sensitive receptor as applied for air noise. Alternative measures and sensitivity tests as described for air noise have not however been prepared.

Methodology for the Assessment of Construction Noise Effects

6.7.52 The construction noise assessment has considered the infrastructure works associated with the construction of the new taxiway and the Longford Noise Barrier. The noise model follows the proposed construction methodology as set out in Chapter 3.

6.7.53 Noise levels due to the construction phase have been calculated using BS 5228:2009-1. Noise emission data has been obtained from BS 5228:2009-1 based on available information and plant considered to be 'typical' for the works that would be required. Noise calculations have been made at locations representative of 'groups' of residential dwellings on Bath Road and in Longford.

6.7.54 The assessment has considered three construction activities. These are:

- Excavation and construction of new pavement areas;
- Concrete breakout; and
- Noise Wall construction.

6.7.55 The construction plant schedule used as the basis of the noise predictions is given in **Appendix G**. The modelled construction plant and working patterns have been derived from the project information. Estimates of numbers of plant and percentage-working-times have been made and are documented alongside the construction plant schedule in **Appendix G**. For the taxiway, works have been split into two activities:

- Excavation / construction of new pavement areas; and
- Concrete breakout.

6.7.56 Other areas of working include: a temporary stockpile within the airport operational boundary; concrete crushing facility off-site; and concrete batching works. These have not been assessed as part of the construction noise assessment as they are unlikely to result in any significant noise effects.

6.7.57 The ambient noise levels used in the assessment are the 2015 baseline predicted ground noise levels, as used in the ground noise assessments. Whilst these levels may provide an under-estimate of actual ambient levels as they exclude contributions from air and road traffic, this would result in a worst-case assessment of construction noise effects. This is considered appropriate given the nature of the construction assumptions currently available and would result in an assessment that provides a robust indication of significant effects.

6.7.58 Significant effects have been assessed in accordance with the methodology outlined in **Table 6.10.**

Summary of Evaluation Methodology

6.7.59 The determination of significance has largely been based on the relevant assessment guidance and criteria outlined in the preceding sections along with, where applicable, policy considerations.

6.7.60 This guideline is not directly related to the categories of *'Significant'* and *'Not significant'* that underpins EIA. The determination of significance in EIA is based largely on the sensitivity of a particular receptor, as well as the magnitude of change in noise levels (which in this case is related to noise levels in 2015 with and without the Project). The actual overall level of noise can also influence the determination of significance, since it may either exceed or comply with relevant guideline noise levels, irrespective of the amount of change in predicted noise levels.

6.7.61 For the purposes of this assessment, three levels of noise magnitude have been defined based upon relevant guidance. These magnitudes (low, medium and high) are considered to align with assessment concepts advocated by the NPSE. A qualitative description of each noise magnitude is provided in

6.7.62

6.7.63 Table 6.9.

Table 6.9 Noise Magnitude Definitions

Magnitude	Description
Low	No Observed Effect
Medium	Observed Effect Level (i.e. effects between the lowest and significant observed effect levels)
High	Significant Observed Effect Level

6.7.64 As shown in **Table 6.9** a *'high'* noise magnitude is considered to result in significant effects whereas a *'low'* magnitude is not considered to result in significant effects. Although the assessment is based mainly upon noise level magnitude, it may be inappropriate to conclude that a *'high'* magnitude of effect has arisen simply because the relevant guideline limits have been exceeded. The apportionment of magnitude from *'low'* to *'high'* has therefore taken this situation into account by considering the predicted change in noise levels and applying an element of professional judgement which is guided by the amount that the predictions exceed the limits, together with the duration of the effects. A *'medium'* noise magnitude represents a situation where it is considered that an effect has occurred (either beneficial or negative) but the magnitude of the effect is not significant.

6.7.65 Receptors can have different levels of noise sensitivity depending upon a number of factors. As outlined in Section 6.8 different receptor groups are also subject to different noise effects which also influence their sensitivity to noise. For example, schools are considered as noise sensitive during the school day however during night-time periods, as they are normally unoccupied, it is not possible for any noise effects to occur and may therefore be considered insensitive to noise during these hours. Residential receptors are considered to be sensitive to noise, however potential noise effects differ during the day and night-time periods.

Significance Criteria

6.7.66 Using the relevant guidance outlined in this section it is possible to consider both noise sensitivity and the magnitude of effect for each receptor. Based on this guidance, the following significance criteria outlined in **Table 6.10** have been adopted for the assessment of air, ground and cumulative noise effects for receptors scoped into the assessment.

Table 6.10 Significance Criteria

Receptor / Effect		Magnitude of Effect / Significance		
		Low **Not Significant**	**Medium** **Not Significant**	**High** **Significant**
Residential Dwellings				
Air Noise, Ground Noise and Combined Noise	**Primary Assessment** Daytime (Community Annoyance)	Outdoor $L_{Aeq,\ 16h}$ < 57 dB OR Outdoor $L_{Aeq,\ 16h}$ ≥ 57 dB with change of < 1 dB in either Outdoor $L_{Aeq,\ 16h}$	Outdoor $L_{Aeq,\ 16h}$ ≥ 57 dB AND change of 1≥ or <3 dB	Outdoor $L_{Aeq,\ 16h}$ ≥ 57 dB AND change ≥ 3 dB
	Secondary Assessment (Presented in Appendix G) Daytime (Community Annoyance)	Outdoor L_{den} < 55 dB OR Outdoor L_{den} ≥ 55 dB with change of < 1 dB in Outdoor L_{den}	Outdoor L_{den} ≥ 55 dB AND change of 1≥ or <3 dB	Outdoor L_{den} ≥ 55 dB AND Change ≥ 3 dB
	Night-time (Sleep Disturbance)	<1 dB change in L_{night} where SEL ≥ 90 dB and L_{night} ≥ 45 dB	1≥ or <3 dB change in L_{night} where SEL ≥ 90 dB and L_{night} ≥ 45 dB	≥ 3 dB change in L_{night} where SEL ≥ 90 dB and L_{night} ≥ 45 dB
Construction Noise		Significant Effects to be determined as per methodology		
Noise Induced Vibration Day: 0700-2300hrs Night: 2300 – 0700hrs		Qualitative assessment based upon the following threshold criteria for significant effects of: $VDV_{b/d,day}$ 0.4 $ms^{-1.75}$ and $VDV_{b/d,night}$ 0.2 $ms^{-1.75}$		
Education Establishments				
Air, Ground and Combined Noise *(where T = 30 minutes)*		Outdoor L_{Amax} < 70 dB OR Outdoor $L_{Aeq,\ T}$ < 50 dB OR Outdoor L_{Amax} ≥ 70 dB WHERE Outdoor $L_{Aeq,\ T}$ ≥ 50 dB AND Change of < 1 dB in $L_{Aeq,\ T}$	Outdoor L_{Amax} ≥ 70 dB AND 1≥ or <3 dB change in $L_{Aeq,\ T}$ WHERE Outdoor $L_{Aeq,\ T}$ ≥ 50 dB	Outdoor L_{Amax} ≥ 70 dB AND ≥ 3 dB change in $L_{Aeq,\ T}$ WHERE Outdoor $L_{Aeq,\ T}$ ≥ 50 dB

Receptor / Effect		Magnitude of Effect / Significance		
		Low **Not Significant**	**Medium** **Not Significant**	**High** **Significant**
Healthcare Facilities				
Air, Ground and Combined	*Daytime*	Outdoor $L_{Aeq,\ T}$ ≥ 55 dB	1≥ or <3 dB change in $L_{Aeq,\ T}$ WHERE Outdoor $L_{Aeq,\ T}$ ≥ 55 dB	≥ 3 dB change in $L_{Aeq,\ T}$ WHERE Outdoor $L_{Aeq,\ T}$ ≥ 55 dB

Noise *(where T = 1h)*	*0700-2300hrs*	OR Outdoor $L_{Aeq, T}$ ≥ 55 dB AND Change of < 1 dB in $L_{Aeq, T}$		
	Night-time *02300-0700hrs*	Outdoor L_{Amax} < 70 dB OR Outdoor $L_{Aeq, T}$ < 50 dB OR Outdoor L_{Amax} ≥ 70 dB WHERE Outdoor $L_{Aeq, T}$ ≥ 50 dB AND Change of < 1 dB in $L_{Aeq, T}$	Outdoor L_{Amax} ≥ 70 dB AND 1≥ or <3 dB change in $L_{Aeq, T}$ WHERE Outdoor $L_{Aeq, T}$ ≥ 50 dB	Outdoor L_{Amax} ≥ 70 dB AND ≥ 3 dB change in $L_{Aeq, T}$ WHERE Outdoor $L_{Aeq, T}$ ≥ 50 dB
Places of Worship and Community Facilities				
Air, Ground and Combined Noise		Outdoor $L_{Aeq, 16h}$ < 57 dB OR Outdoor $L_{Aeq, 16h}$ ≥ 57 dB AND change of < 1 dB	Outdoor $L_{Aeq, 16h}$ ≥ 57 dB AND change of 1≥ or <3 dB	Outdoor $L_{Aeq, 16h}$ ≥ 57 dB AND change of ≥ 3 dB

6.8 Assessment of Air Noise Effects

Residential Receptors

6.8.1 This section presents the assessment of air noise effects for residential receptors. Significant effects are determined based upon the results of the assessment from the core scenarios. Additionally, as recommended by the Aviation Policy Framework (3.19), alternative measures are reported to assist in the interpretation and the assessment of effects. The assessment also considers mitigation guidance as outlined in the APF and with reference to the environmental measures outlined in **Table 6.5.**

6.8.2 The secondary assessment of community annoyance using the L_{den} is presented in **Appendix G**. As discussed in Section 6.7, this approach has been taken to reflect the Government's decision to reaffirm the use of the $L_{Aeq, 16h}$ as the principle of community annoyance.

Daytime Community Annoyance – Primary Assessment ($L_{Aeq, 16h}$)

6.8.3 **Figure 6.6** presents 2015 'assessed mode' $L_{Aeq, 16h}$ air noise contours with full easterly runway alternation. In comparison to the equivalent 2015 baseline contours presented in **Figure 6.7**, **Figure 6.6** shows a redistribution of air noise around the airport and is therefore consistent with the DfT's policy objective inherent in its decision to end the Cranford Agreement. The most noticeable change in the shape of the contours is to the western extent of the 57 dB $L_{Aeq, 16h}$ contour which reduces the area encompassed within Windsor. There is limited change in the eastern extent of the 57 dB $L_{Aeq, 16h}$ contour. The north-eastern extent of the 57 dB contour now fully encompasses Cranford with some areas of Cranford falling within the 60 dB contour. To the south-east, the contours retract with some areas of Feltham falling outside of the 57 dB contour.

6.8.4 **Table 6.11** presents an analysis of population exposure to $L_{Aeq, 16h}$ with and without full runway alternation on easterlies. The table presents the change in population exposure within each noise level band.

6.8.5 **Table 6.11** shows that full runway alternation on easterlies results in a decrease of 4,800 dwellings exposed to 57 dB $L_{Aeq, 16h}$ which corresponds to a population of around 10,500.

6.8.6 The table shows increases in the number of dwellings exposed to air noise levels of 63-69 dB $L_{Aeq, 16h}$. The table also shows an increase in the number of dwellings and population exposed to noise levels of 72 dB $L_{Aeq, 16h}$ or more.

Table 6.11 Assessment of Residential Population Exposure, Air Noise $L_{Aeq, 16h}$

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
$L_{Aeq, 16h}$	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 57	108.9	104500	251600	109.5	99700	241100	+0.6	-4800	-10500
≥ 60	59.3	42500	106900	59.7	43100	109250	+0.4	600	2350
≥ 63	34.2	17150	43550	35.4	18050	48600	+1.2	900	5050
≥ 66	20.1	5300	14400	20.3	5700	15400	+0.2	400	1000
≥ 69	9.9	1350	3550	9.9	1350	3500	0	0	-50
≥72	5.4	350	900	5.4	400	1100	0	50	200

6.8.7 **Figure 6.8** present noise difference contours showing noise exposure increases and decreases respectively in 1 dB increments for areas experiencing at least 57 dB $L_{Aeq, 16h}$. **Figure 6.8** shows that increases in $L_{Aeq, 16h}$ noise levels are likely to occur in two main areas:

- At the western end of Runway 09L; and
- Under the initial stages of the 09L departure routes.

6.8.8 At the western end of Runway 09L, increases in $L_{Aeq, 16h}$ of at least 3 dB are mainly confined to the airport boundary, although parts of Longford experience increases of 1-2 dB. Increases of 1-2 dB are shown to occur into areas of Hounslow to the east of the Airport with increases of 3 dB or more occurring over Cranford.

6.8.9 **Figure 6.20** shows that decreases in $L_{Aeq, 16h}$ noise exposure levels are likely to occur in the following areas:

- Under the arrival path for Runway 09L;
- At the western end of Runway 09R; and
- Under the initial stages of the 09R departure routes.

6.8.10 **Figure 6.20** shows decreases of up to 1-2 dB $L_{Aeq, 16h}$ in areas of Windsor and under approaches to the northern runway. Decreases of 1-3 dB are shown to occur in areas of North Feltham, Hatton and East Bedfont.

6.8.11 **Table 6.12** presents the number of residential dwellings experiencing changes of 1 dB or more where noise levels are greater than or equal to 57 dB $L_{Aeq, 16h}$ with full easterly runway alternation scenarios. With reference to the significance criteria outlined in **Table 6.10** the table also presents the noise magnitude and associated significance.

Table 6.12 Noise Magnitude and Significance of Changes in $L_{Aeq, 16h}$ where $L_{Aeq, 16h}$ is greater or equal to 57 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥5 and <6 dB	High	350	1050	**Significant - Adverse**
	≥4 and <5 dB	High	800	2000	**Significant - Adverse**
	≥3 and <4 dB	High	550	1400	**Significant – Adverse**
	≥2 and <3 dB	Medium	1100	3000	Not Significant - Adverse
	≥1 and <2 dB	Medium	4250	11100	Not Significant – Adverse
Decrease	≥1 and <2 dB	Medium	14400	33950	Not Significant - Beneficial
	≥2 and <3 dB	Medium	900	2150	Not Significant – Beneficial
	≥3 and <4 dB	High	0	0	**Significant - Beneficial**
	≥4 and <5 dB	High	0	0	**Significant - Beneficial**
	≥5 and <6 dB	High	0	0	**Significant - Beneficial**
Total Increases (≥1dB)			7050	18550	Adverse
Total Decreases (≥1dB)			15300	36100	Beneficial
Total Significant Adverse Effects			1700	4450	Significant Adverse
Total Significant Beneficial Effects			0	0	Significant Beneficial

6.8.12 **Table 6.12** shows that more residential dwellings and population will experience beneficial changes in air noise exposure than adverse changes in air noise exposure. The ratio of those receiving beneficial effects to those receiving adverse effects is around 2:1.

6.8.13 **Table 6.12** shows that there would be more residential dwellings and population experiencing significant (≥3 dB) adverse effects than significant beneficial effects. In total there are 1700 residential dwellings experiencing significant (≥3 dB) adverse effects whereas no residential dwellings would experience significant beneficial effects.

6.8.14 Although significant effects are presented in **Table 6.12** the number of properties experiencing a significant effect located in the higher noise contours and therefore eligible for mitigation under the Airport's Home Relocation Assistance and Residential Insulation Schemes is presented in **Table 6.13.** The criteria used are consistent with the APF.

Table 6.13 Residential Dwellings Qualifying for Noise Mitigation Schemes

Mitigation Scheme	Criteria	Number of Qualifying Dwellings
Home Relocation Assistance	New to 69 dB $L_{Aeq, 16h}$	175
Residential Insulation Scheme	63 dB $L_{Aeq, 16h}$ and 3 dB Increase	350

Changes in Easterly Operations and Movements (30% of overall operations)

6.8.15 As outlined in Section 6.6, the introduction of full runway alternation during easterly operations does not affect how communities and localities around the airport are overflown during westerly operations. Changes in a person's experience of aircraft noise would only occur during easterly operations and on average, these occur for around 30% of the year.

6.8.16 **Figure 6.10** and **Figure 6.11** present baseline arrival tracks and dispersed departure routes for easterly operations without full runway alternation, east and west of the airport respectively.

6.8.17 The figures show that currently localities under approaches to Runway 09L during easterly operations, including Windsor, are exposed to the majority of arrivals without relief while localities under approach to Runway 09R such as Old Windsor and Horton receive relief from aircraft noise.

6.8.18 To the east of the airport, localities under departure routes from Runway 09R are overflown with the departures dispersing as the aircraft move further away from the airport. The frequency to which locations under the departure routes are overflown is a function of routing and the concentration of the aircraft around the main departure tracks. To this end, as aircraft move further away from the airport the ability to schedule periods of overflight and the frequency to which a location is directly overflown reduces.

6.8.19 For communities closer to the airport such as Hatton and Feltham North, aircraft have not had time to disperse and as such these localities are directly over-flown at a greater frequency with no periods of respite. For localities immediately east of Runway 09L, such as Cranford, during baseline easterly operations, these receive relief during easterly operations in addition to the scheduled periods of relief during westerly operations, resulting in periods of respite.

6.8.20 **Figures 6.12** and **Figure 6.13** presents arrival and dispersed departures routes with full easterly runway alternation. To illustrate the changes in locations which are overflown, the dispersed departure tracks from Runway 09L and Runway 09R are overlaid to present:

- Localities which would be subject to scheduled departure overflights from Runway 09L and would therefore observe an increase in departure overflights (Pink);
- Localities which are already subject to departures from Runway 09R and therefore could see decreases in overflights; and (Yellow)
- Localities which are already subject to scheduled departure overflights from 09R and are likely to see no change (Orange)

- Forecast movements and change to movements on each departure and arrival routes a result of full easterly runway alternation.

6.8.21 **Figure 6.13** shows that to the west of the airport changes in overflights will be most apparent under the final approaches to Runway 09R and 09L. For localities under final approaches to Runway 09R such as Old Windsor, Wraysbury and Stanwell Moor, overflights will increase by 302, from 26 to 328 movements per day during easterly operations.

6.8.22 For localities under final approaches to Runway 09L such as Windsor, Datchet, Colnbrook and Poyle, overflights will reduce in total by 302, from 630 to 328 movements per day.

6.8.23 In 2015 there would be no change in westerly operations compared to the current operational practice, whereby half of all departing aircraft would use Runway 27R (the northern runway) and half would use Runway 27L (the southern runway), equating to approximately 328 departures on average, from each runway on a typical westerly day. Half of arriving aircraft would also continue to use Runway 27R and half would use Runway 27L equating to 328 arrivals, on average onto each runway on a typical westerly day. This is shown on **Figures 3.4** and **3.5**.

6.8.24 To the east of the airport, communities immediately east of Runway 09R such as parts of Hatton and Feltham North will experience decreases in overflights. However for communities immediately east of Runway 09L such as Cranford, these become overflown by Runway 09L departures. In locations further from the airport, localities such as Norwood Green and Hounslow Heath would experience frequent overflights from easterly departures however areas such as Heston would observe a decrease in overflights.

6.8.25 **Table 6.14** summarises the changes outlined above for a selection of locations. The percentages presented are considered typical for the locality as due to the nature of dispersed departures, over flights across the locality can vary.

Table 6.14 Example of Movements by Locality during Easterly Operations

Community / Locality		**Number of days of easterly operations)**	**Percentage of all departure / arrivals during easterly operations**		**Relief** (note that with reflective alternation on change of wind direction, scheduled relief on easterly operations becomes respite)	
			2015 Baseline	**With Easterly Runway Alternation**	**2015 Baseline**	**With Easterly Runway Alternation**
East of the Airport (Departures)	Hounslow Heath	3 days out of 10 (30%)	0%	20-30%	Respite	50% scheduled relief
	Cranford		38%	50%	Relief	50% scheduled relief
	North Feltham		84%	42%	None	50% scheduled relief

Community / Locality		Number of days of easterly operations)	Percentage of all departure / arrivals during easterly operations		Relief (note that with reflective alternation on change of wind direction, scheduled relief on easterly operations becomes respite)	
			2015 Baseline	With Easterly Runway Alternation	2015 Baseline	With Easterly Runway Alternation
	Norwood Green		0%	19%	Relief	50% scheduled relief
West of the Airport (Arrivals)	Windsor	3 days out of 10 (30%)	95%	50%	None	50% scheduled relief
	Stanwell Moor		95%	50%	None	50% scheduled relief
	Old Windsor		5%	50%	Relief	50% scheduled relief
	Wraysbury		5%	50%	Relief	50% scheduled relief

Relief –Localities under Easterly Approaches (30% of overall operations)

6.8.26 **Figure 6.14** and **Figure 6.15** present maps of relief for 2015 with and without the Project for localities under easterly approaches. The figures illustrate the percentage of time without aircraft overflight on approach to the northern and southern runways during easterly operations over the course of a 16-hour day. As easterly operations account for around 30% of overall movements, the figures represent a situation that occurs for around 30% of the time.

6.8.27 **Figure 6.14** shows that during easterly operations some localities directly under Runway 09L are free from overflights for less than 5% of the time i.e. they are overflown for 95% of the time. There are no scheduled periods of relief. For localities under approach to Runway 09R such as Old Windsor and parts of Stanwell Moor, these are free from overflight for around 95% of the time and as such receive relief.

6.8.28 **Figure 6.15** shows that following the introduction of full runway alternation, communities located under the approaches to both Runway 09R and Runway 09L are free from overflights for the same amount of time and have equal periods of respite (i.e. 50%). This respite will be predictable, i.e. it will be respite, as it will occur during scheduled periods of the day according to the proposed alternation schedule i.e. during morning or afternoon periods and can be aligned to "reflect" the westerly alternation schedule

6.8.29 **Table 6.15** summarises the effects for the communities overflown and located within the composite 57 dB $L_{Aeq,\ 16h}$ contour. The table shows the amount of relief (by percent) experienced by these communities with and without full easterly runway alternation. This percentage has been converted into 'hours' as a percentage of the total 16-hour day.

6.8.30 **Table 6.15** shows that for all communities located under easterly approaches, the Project would result in predictable periods of relief.

6.8.31 For communities under approach to Runway 09L such as Windsor, the Project would introduce planned periods of respite for half of the time, i.e. scheduled morning or afternoon periods whereas in the baseline, they are overflown through the day. For these communities, the project results in beneficial effects.

6.8.32 For communities located under approach to Runway 09R, the project would result in a loss of relief during the daytime period. Although the effects upon these communities would be adverse, the Project ensures that planned periods of respite would occur and that during easterlies these communities would be overflown during either scheduled morning or afternoon periods only. During the night-time period, there would be no change in operations.

6.8.33 In summary, **Figure 6.15** and **Table 6.15** demonstrate that the project will result in a more equitable distribution of overflights and predictable respite for communities located under easterly approaches. These periods of respite would be scheduled and would occur for 8-hours at a time during the morning or afternoon periods, benefitting around 60,000 people.

Table 6.15 Respite Percentages for Localities on Easterly Approaches

Locality / Community	**Respite / Relief**				**Summary of Effect**
	2015 Baseline		**With Easterly Runway Alternation**		
	Relief	**Respite**	**Relief**	**Respite**	
CASTLE (WINDSOR) CLEWER NORTH (WINDSOR) CLEWER SOUTH (WINDSOR) COLNBROOK WITH POYLE DATCHET PARK (WINDSOR) TRINITY (WINDSOR)	**No** 5% (<1 hour) 630 overflights	**No** respite and little or no relief during easterly conditions	**Yes - Planned** 50% (8 hours) 328 overflights	**Yes** Periods of relief will be predictable using a published reflective alternation schedule	**Beneficial** Introduction of scheduled periods of relief (respite)
HORTON OLD WINDSOR STANWELL MOOR WRAYSBURY	**Yes** 95% (15 hours) 26 overflights	**No** Relief is dependent upon the occurrence of easterly operations which cannot be predicted			**Adverse** Loss of relief however localities will receive scheduled periods of relief (respite)

Relief – Localities under Easterly Departures (30% of overall operations)

6.8.34 **Figure 6.16** and **Figure 6.17** present respite maps for 2015 with and without full easterly runway alternation respectively for localities under easterly departures which account for 30% of overall operations. **Figure 6.14** and **Figure 6.15** present the amount of time without overflight in percent.

6.8.35 Unlike localities under easterly approaches, **Figure 6.16** and **Figure 6.17** show that respite is a function of movements on departure routes. Localities will therefore be overflown throughout the day but to a lesser extent or frequency than localities for approaches.

6.8.36 For 2015 baseline conditions **Figure 6.16** shows that parts of Feltham North are without overflight for 20% of the time during easterly operations with communities such as Heathfield being without overflight for less than 40% of the time. To the north east, parts of Cranford, Heston Central and Hounslow West are without overflight for around 60% of the time. For parts of Hatton and localities immediately east of Runway 09R, some of the population are overflown for the majority of the day without any relief.

6.8.37 **Figure 6.17** shows that following the introduction of full runway alternation, some localities lose relief and become overflown. In comparison to the 2015 baseline, the figure shows that many localities overflown in the 2015 baseline will receive improvements in respite.

6.8.38 In general, for communities under easterly departure tracks, full easterly runway alternation will result in some localities receiving the following effects:

- Become overflown, losing relief, thus receiving adverse effects but they would be overflown for scheduled periods (i.e. during morning or afternoons) thus receiving scheduled periods of relief;
- Were overflown and continue to be overflown and observe changes in relief and respite; and
- Were overflown throughout the day but are now overflown for scheduled periods thus receiving scheduled periods of respite and as such will observe beneficial effects.

6.8.39 Examples of communities receiving beneficial effects through the introduction of planned periods of respite include Bedfont, Heston Central and Heston East. Where these are overflown throughout the day in the 2015 baseline, full easterly runway alternation will result in them being overflown for scheduled periods, providing respite as a result of reflective alternation during westerly operations.

6.8.40 Examples of communities that are overflown more but receive planned periods of relief as a result of full easterly runway alternation include Cranford, Hounslow Heath, Hounslow West and Hounslow South. Although these communities will become overflown, they will be overflown during scheduled periods according to the runway alternation schedule, and receive respite as a result of reflective alternation during westerly operations.

6.8.41 Localities which will be overflown throughout the period of easterly operations, but will observe changes in the number of overflights, includes Feltham North where different parts of the community will experience both increases and decreases in overflights.

6.8.42 In summary, for localities situated under easterly departures, there will be both beneficial and adverse effects.

Levels of Annoyance

6.8.43 **Table 6.16** presents the total population which can be considered 'Annoyed' or 'Highly Annoyed' with and without full runway alternation that are exposed to at least 57 dB $L_{Aeq, 16h}$ or more with and without full runway alternation.

Table 6.16 Overall Changes in Population Annoyed and Highly Annoyed by Aircraft Noise

Annoyance	Populations			Effect
	2015 Baseline	With Full Easterly Runway Alternation	Change	
Annoyed	108,800	108,700	-100	Beneficial
Highly Annoyed	55,200	55,150	-50	Beneficial

6.8.44 **Table 6.16** shows that there is no material change in the overall number of people annoyed or highly annoyed.

Overview of Effects – Overview of Community Annoyance Effects

6.8.45 The assessments presented above have demonstrated the following community annoyance effects. With reference the effects criterion outlined in Section 6.7:

- As demonstrated in **Table 6.12,** more people will experience beneficial effects in terms of air noise exposure than adverse effects by a factor of around 2:1;
- As demonstrated in **Table 6.11,** around 10,500 people will no longer be exposed to air noise levels of at least 57 dB $L_{Aeq, 16h}$
- Overall levels of community people 'Annoyed' or 'Highly Annoyed' will not change materially and will reduce slightly as a result of the Project.
- There will however be more significant adverse effects than significant beneficial effects.
- The introduction of scheduled periods of respite from overflights resulting in beneficial effects for localities under easterly approaches to the northern runway;
- The loss of relief and adverse effects for localities under approaches to the southern runway however these localities would receive scheduled periods of respite;
- Beneficial effects for many localities that are currently overflown by easterly departures from the southern runway through the introduction of planned periods of respite.
- Adverse effects for localities that become overflown by easterly departures from the northern runway. Several of these localities will have planned periods of respite resulting from reflective runway alternation.

- All localities not under the existing arrival and departure routes during westerly operations will continue to experience periods of relief, which based on current trends would be for around 70% of the time.

Night – Sleep Disturbance

6.8.46 **Figure 6.18** presents L_{night} contours with full easterly runway alternation. A comparison of the 2015 baseline L_{night} air noise contours presented in **Figure 6.19** with the L_{night} contours shows that the effect of implementing full runway alternation on easterlies is to make the shape of the contours more symmetrical. This results in most of Windsor falling outside of the 50 dB L_{night} contour.

6.8.47 **Table 6.17** presents an analysis of population exposure to different levels of L_{night} with and without full runway alternation on easterlies. The table shows that full runway alternation on easterlies results in a decrease of 1500 dwellings exposed to noise levels of at least 45 dB L_{night}. At all other noise level bands, the number of dwellings exposed to aircraft noise increases. However the implementation of full runway alternation on easterlies does not result in any new dwellings being exposed to noise levels of more than 65 dB L_{night}.

Table 6.17 Assessment of Residential Population Exposure, Air Noise L_{night}

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
L_{den}	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 45	159.5	289150	658500	158.4	287650	654600	-1.1	-1500	-3900
≥ 50	68.9	78400	187500	68.9	78700	188500	0	+300	+1000
≥ 55	23.4	20750	54150	23.5	21200	55200	+0.1	+450	+1050
≥ 60	8.0	4300	12150	8.1	4350	12400	+0.1	+50	+250
≥ 65	2.9	650	1950	2.9	650	1950	0	0	0
≥ 70	1.2	2	5	1.2	2	5	0	0	0

6.8.48 In accordance with the significance criteria presented in **Table 6.10**, **Table 6.18** presents the number of residential dwellings experiencing changes in L_{night} that are exposed to a minimum of 45 dB L_{night}. The table shows for receptors experiencing 45 dB L_{night} or more, there are no residential dwellings experiencing increases of 3dB or more. This result corresponds with **Figure 6.20** which shows that increases of 3 dB or more in L_{night} air noise levels are confined to the end of Runway 09L and fall within the airport boundary.

Table 6.18 Noise Magnitude and Significance of Changes in L_{night} where L_{night} is at least 45 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥3	High	0	0	**Significant – Adverse**
	≥2 and <3 dB	Medium	400	1200	Not Significant – Adverse
	≥1 and <2 dB	Low	2650	6500	Not Significant – Adverse
Decrease	≥1 and <2 dB	Medium	7550	18100	Not Significant – Beneficial
	≥2 and <3 dB	Medium	0	0	Not Significant – Beneficial
	>3	High	0	0	**Significant – Beneficial**
Total Increases (≥1)			0	0	Adverse
Total Decreases (≥1)			0	0	Beneficial

6.8.49 The significance criteria also require consideration of exposure to 90 dB SEL. A comparison of the 45 dB L_{night} contour and 90 dB SEL contours presented in **Figures 6.20** and **6.21** shows that spatially, the 90 dB SEL footprints encompass a much greater extent than the 45 dB L_{night} contour to the east. To the west, the 90 dB SEL contours generally fall within the extents of the 45 dB L_{night} contour.

6.8.50 When combining the changes in L_{night} with the extent of the 90 dB SEL footprints, and the extents of the 45 dB L_{night} contour, it is considered that Cranford is worst affected by full runway alternation during easterlies. However, as changes in L_{night} do not reach or exceed 3 dB, it is concluded that there would not be significant adverse effects. However, it should be noted that there are no scheduled departures during the night period at Heathrow.

Non-Residential Sensitive Receptors

Education Establishments

6.8.51 As discussed in Section 6.7, some understanding of short-term noise levels is required in order to assess noise impacts upon educational establishments. In order to assist this understanding, noise monitoring data from four noise monitoring terminals located around the airport has been utilised. Monitoring data has been collated and processed to calculate $L_{Aeq, 30min}$ noise levels from the four noise monitors for each half hour period throughout 2010. Based on this information average $L_{Aeq, 30min}$ noise levels for each half hour period during the day have been calculated along with the average $L_{Aeq, 16h}$ and average L_{Aeq} representative of a normal school day between 0800 and 1700hrs. This analysis is presented graphically and discussed in full in **Appendix G**.

6.8.52 The results of the analysis presented in **Appendix G** shows that there is no firm correlation between $L_{Aeq, 16h}$ and short-term $L_{Aeq, 30min}$ noise levels. However using a conservative statistical analysis for the purposes of this assessment it is assumed that $L_{Aeq, 30min}$ is around 5.5 dB higher than $L_{Aeq, (0800-1700hrs)}$ which is approximately the same as the $L_{Aeq, 16h}$ mean. On this basis, for the purposes of this assessment, $L_{Aeq, 30min}$ is considered to be 5.5 dB higher than $L_{Aeq, 16h}$.

6.8.53 With reference to the significance criteria outlined in **Table 6.10** it is considered that a 50 dB $L_{Aeq,\ 30min}$ threshold for significant effects is appropriate in relation to the relevant guidance. Based upon the analysis outlined above, this corresponds to a threshold of 44.5 dB $L_{Aeq,\ 16h}$. For the purposes of the assessment, a threshold of 44.5 dB $L_{Aeq,\ 16h}$ has been adopted however, it is stressed that this reflects a highly conservative approach and that there is likely to be significant uncertainty in the calculated air noise levels at this threshold. This threshold is significantly below the threshold (63 dB $L_{Aeq,\ 16h}$) identified in Government policy (APF) for the provision of noise insulation for community buildings.

6.8.54 With reference to the significance criteria outlined in **Table 6.10**, consideration of noise events above an outdoor 70 dB L_{Amax} is required. Based on an analysis of measured noise data and L_{Amax} noise levels and calculations undertaken at the location of education establishment, it is considered likely that all education establishments exposed to increases of 3 dB L_{Aeq} would also be exposed to an outdoor noise event levels of 70 dB L_{Amax} from 09L departures and would be subject to short-term noise levels above 50 dB $L_{Aeq,\ 30min}$. Although it is considered that full runway alternation on easterlies would result in short-term noise levels above the 50 dB $L_{Aeq,\ 30min}$ threshold, given the information outlined in **Appendix G**, the existing airport operations and other ambient noise sources that are not related to the airport could also result in short-term noise levels above 50 dB $L_{Aeq,\ 30min}$.

6.8.55 Based on the criteria above, 15 education establishments have been identified with significant increases in air noise of at least 3 dB L_{Aeq}, maximum noise levels above the 70 dB L_{Amax} threshold due to departures from Runway 09L and likely occurrences of short-term noise levels above 50 dB $L_{Aeq,\ 30min}$. Only one of these education establishments is exposed to levels of 57 dB $L_{Aeq,\ 16h}$ or more.

6.8.56 In accordance with the guidance in the APF and with reference to the Extended Community Buildings Mitigation Scheme, none of the establishments with significant effects will be eligible under the scheme.

Healthcare Facilities

6.8.57 As discussed in Section 6.7, some understanding of short-term noise levels is required in order to assess noise impacts upon healthcare facilities. As in the case of the assessment of educational establishments, in order to assist this understanding, noise monitoring data from four noise monitoring terminals located around the airport has been utilised. Monitoring data has been collated and processed to calculate $L_{Aeq,\ 1h}$ noise levels from four noise monitors for each hourly period throughout 2010. Based on this information average $L_{Aeq,\ 1h}$ noise levels for each hour period during the day have been calculated along with the average $L_{Aeq,\ 16h}$ and L_{night} . This analysis is presented graphically and discussed in full in **Appendix G**.

6.8.58 As in the case of $L_{Aeq,\ 30min}$ for education establishments, there is no direct correlation between $L_{Aeq,\ 16h}$ and $L_{Aeq,\ 1h}$ however using a conservative statistical analysis for the noise monitors considered representative of post-Cranford Agreement conditions a relationship has been assumed. For the purposes of this assessment, it is considered conservative that for daytime periods (0700-2300hrs) $L_{Aeq,1h}$ is around 5 dB higher than $L_{Aeq,\ 16h}$ and that for night-time periods (2300-0700hrs) $L_{Aeq,\ 1h}$ is around 5.5 higher than $L_{Aeq,\ 16h}$.

6.8.59 With reference to the significance criteria outlined in **Table 6.10** it is considered that a 55 dB $L_{Aeq,\ 1hr}$ daytime and a 50 dB $L_{Aeq,\ 1h}$ night-time threshold for significant effects is appropriate in relation to the relevant guidance. Based upon the analysis outlined above, this corresponds to a threshold of 50 dB $L_{Aeq,\ 16h}$ for daytime and 44.5 dB L_{night} for night-time. For the purposes

of the assessment, these thresholds have been adopted however, it is stressed that this reflects a highly conservative approach and that there is likely to be significant uncertainty in the calculated air noise levels at this threshold.

6.8.60 Based on calculations made at healthcare facilities, the assessment has identified five facilities which are expected to receive noise exposure greater than 50 dB $L_{Aeq,\ 16h}$ (55 dB $L_{Aeq,\ 1h}$) and experience an increase of 3 dB as a result of full runway alternation during easterly operations. It is therefore concluded that these facilities would be exposed to significant effects during daytime periods. However, none of these fall within the 57dBA contour.

6.8.61 For night-time periods, no healthcare facilities have been identified as receiving increases of 3 dB above a threshold of 44.5 dB L_{night}. As such, it is concluded that there are no significant adverse night-time effects upon healthcare facilities.

6.8.62 In accordance with the APF and with reference to the Extended Community Buildings Mitigation Scheme, none of the above healthcare facilities are eligible under the scheme as none of the facilities are exposed to a level of 63 dB $L_{Aeq,\ 16h}$ or above. Further analysis has shown that none of these receptors fall within the 57 dB $L_{Aeq,\ 16h}$ contour.

Community Facilities and Places of Worship

6.8.63 **Table 6.19** presents an analysis of community facilities and places of worship exposed to different levels of $L_{Aeq,\ 16h}$ with and without full runway alternation on easterlies.

Table 6.19 Assessment of Community Facilities and Places of Worship, Air Noise

Noise Level $L_{Aeq,\ 16h}$	Total Number of Community Facilities and Places of Worship		Change
	2015 Baseline	2015 with Full Runway Alternation on Easterlies	
≥ 57	173	170	-3
≥ 60	69	72	+3
≥ 63	18	19	+1
≥ 66	5	5	0
≥ 69	1	1	0
≥ 72	0	0	0

6.8.64 The table shows that the introduction of full runway alternation on easterlies results in a reduction in the number of community facilities and places of worship exposed to 57 dB $L_{Aeq,\ 16h}$ however the number of these facilities exposed to air noise levels of 60 dB $L_{Aeq,\ 16h}$ or more would increase. **Table 6.20** presents a breakdown of the noise level increases for receptors exposed to 57 dB $L_{Aeq,\ 16h}$ with or without full runway alternation.

Table 6.20 Noise Magnitude and Significance of Changes in $L_{Aeq, 16h}$ where $L_{Aeq, 16h}$ is at least 57 dB

Increase / Decrease		Magnitude	Number of Facilities	Significance
Increase	≥3 dB	High	3	**Significant – Adverse**
	≥2 and <3 dB	Medium	0	Not Significant - Adverse
	≥1 and <2 dB	Medium	9	Not Significant – Adverse
	≥0 and <1 dB	Low	99	Not Significant – Adverse
Decrease	>0 and <1 dB	Low	40	Not Significant – Beneficial
	≥1 and <2 dB	Medium	18	Not Significant - Beneficial
	≥2 and <3 dB	Medium	1	Not Significant – Beneficial
	≥3 dB	High	0	**Significant - Beneficial**
Total Increases (≥1dB)			3	Adverse
Total Decreases (≥1dB)			0	Beneficial

6.8.65 **Table 6.20** shows that there are no community facilities and places of worship which experience decreases of 3dB or more as a result of full runway alternation on easterlies. The table does however show 3 facilities which would experience increases of 3 dB or more.

6.8.66 In accordance with the APF and with reference to the Extended Community Buildings Mitigation Scheme, none of the above places of worship are eligible under the scheme as these buildings are exposed to air noise levels of less than 63 dB $L_{Aeq, 16h}$. Further analysis shows that these three facilities are however exposed to levels of air noise of at least 60 dB $L_{Aeq, 16h}$

6.9 Assessment of Ground Noise Effects

6.9.1 The following sections present the assessment of ground noise effects upon noise sensitive receptors.

Residential Receptors

Daytime Community Annoyance – Primary Assessment ($L_{Aeq, 16h}$)

6.9.2 **Figure 6.22** presents 2015 'assessed mode' $L_{Aeq, 16h}$ air noise contours with full easterly runway alternation. In comparison to the equivalent 2015 baseline contours presented in **Figure 6.23**, **Figure 6.22** shows a redistribution of ground noise around the airport. The most noticeable change in the shape of the contours is to the westerly extents. To the south-west, the 57 dB $L_{Aeq, 16h}$ contour contracts, whereas to the north-west in Longford, the contour expands to encompass most of Longford.

6.9.3 **Table 6.21** presents an analysis of population exposure to $L_{Aeq, 16h}$ with and without full runway alternation on easterlies. The table presents the change in population exposure within each noise level band. The table shows that full runway alternation on easterlies results in an increase of 150 dwellings exposed to 57 dB $L_{Aeq, 16h}$ and an increase of 50

dwellings exposed to 60 dB $L_{Aeq, 16h}$. The table also shows no increase in the number of dwellings and population exposed to noise levels above 63 dB $L_{Aeq, 16h}$ or more.

Table 6.21 Assessment of Residential Population Exposure, Ground Noise $L_{Aeq, 16h}$

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
$L_{Aeq, 16h}$	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 57	11.0	800	1950	11.3	950	2200	+0.3	+150	+250
≥ 60	8.4	50	150	8.7	100	200	+0.3	+50	+50
≥ 63	6.8	50	100	6.8	50	100	0	0	0
≥ 66	5.1	50	100	5.2	50	100	+0.1	0	0
≥ 69	3.4	60	100	3.6	50	100	+0.2	0	0
≥72	2.0	0	0	2.0	0	0	0	0	0

6.9.4 **Figure 6.24** and **Figure 6.25** present noise difference contours showing noise level increases and decreases respectively in 1 dB increments for areas experiencing noise level of at least 57 dB $L_{Aeq, 16h}$.

6.9.5 **Figure 6.24** shows that the main increases in ground noise within the 57 dB $L_{Aeq, 16h}$ contour outside of the airport boundary occur within Longford where increases of up to 5 dB are observed. **Figure 6.25** shows that the decreases in ground noise within the 57 dB $L_{Aeq, 16h}$ contour outside of the airport boundary are in locations where there are no residential dwellings.

6.9.6 **Table 6.22** presents the number of residential dwellings experiencing changes of 1 dB or more where noise levels are greater than or equal to 57 dB $L_{Aeq, 16h}$ with full easterly runway alternation. With reference to the significance criteria outlined in **Table 6.10**, the table also presents the noise magnitude and associated significance.

Table 6.22 Noise Magnitude and Significance of Changes in $L_{Aeq, 16h}$ where $L_{Aeq, 16h}$ is at least 57 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥5 and <6 dB	High	0	0	**Significant - Adverse**
	≥4 and <5 dB	High	10	20	**Significant - Adverse**
	≥3 and <4 dB	High	50	150	**Significant – Adverse**
	≥2 and <3 dB	Medium	100	200	Not Significant - Adverse
	≥1 and <2 dB	Medium	0	0	Not Significant – Adverse

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Decrease	≥1 and <2 dB	Medium	0	0	Not Significant - Beneficial
	≥2 and <3 dB	Medium	0	0	Not Significant – Beneficial
	≥3 and <4 dB	High	0	0	**Significant - Beneficial**
	≥4 and <5 dB	High	0	0	**Significant - Beneficial**
	≥5 and <6 dB	High	0	0	**Significant - Beneficial**
Total Increases			160	370	Adverse
Total Decrease			0	0	Beneficial
Significant Increases			60	170	**Significant Adverse**
Significant Decreases			0	0	**Significant Beneficial**

6.9.7 **Table 6.22** shows that full runway alternation on easterlies would result in only increases of 2 dB or more in noise exposure at residential dwellings and that there are no dwellings exposed to noise levels decreases of 1 dB or more. In total 60 residential dwellings would be exposed to increases of 3dB or more in ground noise exposure as a result of full runway alternation on easterlies. With reference to **Figure 6.24**, these dwellings are located in Longford.

Overview of Effects

6.9.8 The primary assessment of daytime community annoyance using the $L_{Aeq,\ 16h}$ indicator has identified a total of 60 residential dwellings that will be exposed to significant adverse effects. None of these dwellings are located within the 63 dB $L_{Aeq,\ 16h}$ contour and therefore would not qualify for the Airport's proposed Residential Insulation Scheme.

6.9.9 The secondary assessment of daytime community annoyance using the Lden indicator as presented in **Appendix G** has identified a total of 70 residential dwellings that would experience significant adverse effects.

6.9.10 In both the primary and secondary assessments, no residential dwellings have been identified with decreases of 3dB or more.

Night – Sleep Disturbance

6.9.11 **Figure 6.26** presents L_{night} ground noise contours for the implementation of full runway alternation on easterlies in 2015. A comparison of the contours presented in **Figure 6.26** with the 2015 baseline L_{night} ground noise contours presented in **Figure 6.27** shows that changes in the size and extent of the contours like the L_{den} and $L_{Aeq,\ 16h}$ indices would almost exclusively occur to the west of the airport. To the south-west of the airport, the contours contract slightly resulting in some dwellings in areas of Stanwell falling outside of the 45 dB L_{night} contour. To the north-west of the airport, the extents of the contours increase resulting in a greater number of dwellings in Longford and Harmondsworth becoming exposed to 45 dB L_{night}.

6.9.12 **Table 6.23** presents an analysis of population exposure to L_{night} with and without full runway alternation on easterlies. The table presents the change in population exposure within each assessed noise level band. The table shows that full runway alternation on easterlies results in an increase of 35 dwellings exposed to 45 dB L_{night}. The table also shows increases in the number of dwellings exposed to ground noise levels of at least 50 dB increases by 31. There are no increases in exposure above 55 dB L_{night}.

Table 6.23 Assessment of Residential Population Exposure, Ground Noise L_{night}

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
L_{night}	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 45	15.7	2670	6430	15.9	2710	6470	+0.2	40	40
≥ 50	8.8	80	230	8.8	110	290	0	30	70
≥ 55	6.0	41	79	6.0	41	79	0	0	0
≥ 60	3.3	0	0	3.4	0	0	+0.1	0	0
≥ 65	1.1	0	0	1.1	0	0	0	0	0
≥ 70	0.1	0	0	0.1	0	0	0	0	0

6.9.13 **Table 6.24** presents the number of residential dwellings experiencing changes of 1 dB or more in L_{night} as a result of full easterly runway alternation. With reference to the significance criteria outlined in **Table 6.10**, the table also presents the noise magnitude and associated significance of these changes. The table is accompanied by **Figure 6.28** and **Figure 6.29** which present the corresponding respective increases and decreases in L_{night} where L_{night} is greater than 45 dB.

Table 6.24 Noise Magnitude and Significance of Changes in L_{night} where L_{night} is at least 45 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥5 and <6 dB	High	0	0	**Significant - Adverse**
	≥4 and <5 dB	High	0	0	**Significant - Adverse**
	≥3 and <4 dB	High	0	0	**Significant – Adverse**
	≥2 and <3 dB	Medium	30	50	Not Significant - Adverse
	≥1 and <2 dB	Medium	190	370	Not Significant – Adverse
Decrease	≥1 and <2 dB	Medium	20	90	Not Significant - Beneficial
	≥2 and <3 dB	Medium	0	0	Not Significant – Beneficial
	≥3 and <4 dB	High	0	0	**Significant - Beneficial**

Increase / Decrease	Magnitude	Dwellings	Population	Significance
≥4 and <5 dB	High	0	0	**Significant - Beneficial**
≥5 and <6 dB	High	0	0	**Significant - Beneficial**
Total Increase (≥1dB)		220	420	Adverse
Total Decreases (≥1dB)		20	90	Beneficial

6.9.14 **Table 6.24** shows that in total more residential dwellings would be exposed to increases in L_{night} of greater than 1 dB than decreases of greater than 1 dB. The table shows that there are no significant increases or decreases.

6.9.15 The significance criteria also require consideration of exposure to 90 dB SEL. A comparison of the 45 dB L_{night} contour and 90 dB SEL contours presented in **Figure 6.28** and **Figure 6.29** shows that spatially, the 90 dB SEL footprints encompass a much greater extent than the 45 dB L_{night} contour to the east. To the west, the 90 dB SEL contours generally fall within the extents of the 45 dB Lnight contour.

6.9.16 When combining the changes in L_{night} with the extent of the 90 dB SEL footprints, and the extents of the 45 dB L_{night} contour, properties in Longford are the worst affected by full runway alternation during easterlies however as changes in L_{night} do not reach or exceed 3 dB, it is concluded that there would not be significant adverse effects.

Non-Residential Sensitive Receptors

Education Establishments

6.9.17 As discussed in Section 6.9, and as outlined in Section 6.10 for the assessment of air noise, some understanding of short-term noise levels is required in order to assess noise impacts upon educational establishments. As discussed in Section 6.10 for education establishments, a regression analysis of noise levels measured at Heathrow has shown that there is no direct correlation between $L_{Aeq,\ 16h}$ and $L_{Aeq,\ 30min.}$ For the purpose of the assessment, as a conservative approach, it has been assumed that $L_{Aeq,\ 30min}$ is around 5.5 dB higher than $L_{Aeq,\ (0800\text{-}1700hrs)}$ which is approximately the same as the $L_{Aeq,\ 16h}$ mean. On this basis, for the purposes of this assessment, $L_{Aeq,\ 30min}$ is considered to be 5.5 dB higher than $L_{Aeq,\ 16h.}$

6.9.18 With reference to the significance criteria outlined in **Table 6.10** it is considered that a 50 dB $L_{Aeq,\ 30min}$ threshold for significant effects is appropriate in relation to the relevant guidance. Based upon the analysis outlined above, this corresponds to a threshold ranging between 44.5 dB $L_{Aeq,\ 16h}$. For the purposes of the assessment, a threshold of 44.5 dB $L_{Aeq,\ 16h}$ has been adopted however, it is stressed that this reflects a highly conservative approach and that there is likely to be significant uncertainty in the calculated air noise levels at this threshold.

6.9.19 Calculations made at educational establishments show that there are no education establishments that are exposed to ground noise levels of greater than 50 dB $L_{Aeq,\ 30min}$ (i.e. 44.5 dB $L_{Aeq,\ 16h}$) as a result of full runway alternation during easterly operations. As there are no education establishments that are exposed to levels above this threshold, it is concluded that there are no education establishments exposed to significant ground noise effects.

Healthcare Facilities

6.9.20 As discussed in Section 6.9, and as undertaken for the assessment of air noise in Section 6.10, some understanding of short-term noise levels is required in order to assess noise impacts upon healthcare facilities. As per the assessment of air noise, a 55 dB $L_{Aeq,\ 1hr}$ daytime and a 50 dB $L_{Aeq,\ 1h}$ night-time threshold is assumed to correspond to a threshold of 50 dB $L_{Aeq,\ 16h}$ for daytime and 44.5 dB L_{night} for night-time based on a conservative statistical approach.

6.9.21 For ground noise, there is only one healthcare facility that is exposed to noise levels meeting the 55 dB $L_{Aeq,\ 1h}$ (50 dB $L_{Aeq,\ 16h}$) criterion with full runway alternation during easterly operations. When comparing noise exposure against 2015 baseline conditions, it is predicted that noise exposure would decrease. It is therefore concluded that there are no significant daytime ground noise effects upon healthcare facilities.

6.9.22 For night-time periods, there are no healthcare facilities that would be exposed to 44.5 dB L_{night} (i.e. 50 dB $L_{Aeq,\ 1h}$) and as such it is concluded that there would be no significant adverse effects.

Community Facilities and Places of Worship

6.9.23 In 2015, it is predicted that there would be no community facilities and places of worship exposed to ground noise levels in excess of 57 dB $L_{Aeq,\ 16h}$. This is also the case in the 2015 baseline.

6.9.24 It is therefore concluded that full runway alternation during easterly operations would not result in any significant beneficial or adverse ground noise effects on community facilities or places of worship.

Predicted Effects and their Significance

6.9.25 In summary, the assessment of ground noise has identified the following effects:

- There will be significant ground noise effects at 70 residential dwellings in Longford as a result of aircraft taxiing to the western end of the northern runway. None of these residential dwellings are exposed to levels of ground noise above 63 dB $L_{Aeq,\ 16h}$ and therefore do not qualify for the Airport's Enhanced Residential Scheme however the Longford Noise Wall helps mitigate these effects;

- No significant effects have been identified for any of the non-residential noise sensitive receptors.

6.10 Assessment of Combined Air and Ground Noise

6.10.1 The assessment of combined air and ground noise has been undertaken for all receptor groups. The assessment of combined air and ground noise adds together noise from both ground noise and air noise in order to illustrate combined effects. As outlined in Section 6.7, the criteria adopted for the assessment of combined air and ground noise reflects those separately adopted for air and ground noise.

Residential Receptors

Daytime Community Annoyance – Primary Assessment ($L_{Aeq, 16h}$)

6.10.2 **Figure 6.30** presents $L_{Aeq, 16h}$ combined air and ground noise contours for the implementation of full runway alternation on easterlies in 2015. A comparison with the 2015 baseline combined $L_{Aeq, 16h}$ contours presented in **Figure 6.31** shows a redistribution of noise from the airport. The redistribution is almost identical to that described for the $L_{Aeq, 16h}$ air noise contours in Paragraph 6.10.2. **Figure 6.30** also shows that as per the 2015 baseline, ground noise typically has an influence on combined air and ground noise levels to the north and south of the airport with its influence on combined levels reducing at distances to the east and west.

6.10.3 **Table 6.25** presents an analysis of population exposure to $L_{Aeq, 16h}$ with and without full runway alternation on easterlies. The table presents the change in population exposure within each noise level band.

6.10.4 **Table 6.25** shows that full runway alternation on easterlies results in a decrease of approximately 4,700 dwellings exposed to 57 dB $L_{Aeq, 16h}$ despite an increase in the area encompassed by the 57 dB $L_{Aeq, 16h}$ contour. Again like air noise, the table shows an increase of approximately 1,700 dwellings exposed to noise levels of 63 dB $L_{Aeq, 16h}$ or more and at higher noise level bands the table shows further increases.

6.10.5 The similarity of the combined air and ground noise results to the $L_{Aeq, 16h}$ air noise results outlined in **Table 6.25** demonstrates the influence of air noise in comparison to ground noise.

Table 6.25 Assessment of Residential Population Exposure, Combined Air and Ground Noise $L_{Aeq, 16h}$

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
L_{den}	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 57	111.0	105450	253900	111.6	100750	243500	+0.6	-4700	-10400
≥ 60	60.4	43700	109450	61.0	44050	111050	+0.6	350	1600
≥ 63	35.6	17400	44200	36.6	19150	49150	+1.0	1750	4950
≥ 66	22.1	5400	14500	22.3	5900	15700	+0.2	500	1200
≥ 69	12.3	1350	3550	12.4	1400	3600	+0.1	50	50
≥ 72	7.5	350	900	7.6	400	1100	+0.1	50	200

6.10.6 In accordance with the significance criteria outlined in **Table 6.10**, **Figure 6.32** and **Figure 6.33** present noise difference contours showing increases and decreases in $L_{Aeq, 16h}$ respectively as a result of the implementation of full runway alternation on easterlies. The noise difference contours are presented for locations where noise levels are greater or equal to 57 dB $L_{Aeq, 16h}$.

6.10.7 **Figure 6.32** clearly shows increases in combined air and ground noise at the start-of-roll and under departures to the north-east of Runway 09L. Increases in air noise are also apparent under the arrival path of Runway 09R. Like the air noise results, increases of more than 3 dB $L_{Aeq,16h}$ are apparent to the north-east of the airport over Cranford. The figure shows that in Longford, combined air and ground noise exposure levels would increase by 1-3 dB. **Figure 6.33** shows that decreases mainly occur at the 27R runway end and into Feltham. The decreases are no more than 1-2 dB.

6.10.8 **Table 6.26** presents the number of residential dwellings experiencing changes in excess of 1 dB where noise levels are greater than or equal to 57 dB L_{Aeq} with full easterly runway alternation scenarios. With reference to the significance criteria outlined in **Table 6.10** the table also presents the noise magnitude and associated significance.

Table 6.26 Noise Magnitude and Significance of Changes in $L_{Aeq, 16h}$ where $L_{Aeq, 16h}$ is at least 57 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥5 and <6 dB	High	70	150	**Significant - Adverse**
	≥4 and <5 dB	High	700	1800	**Significant - Adverse**
	≥3 and <4 dB	High	850	2300	**Significant – Adverse**
	≥2 and <3 dB	Medium	1110	3050	Not Significant - Adverse
	≥1 and <2 dB	Medium	3950	10100	Not Significant – Adverse
Decrease	≥1 and <2 dB	Medium	8000	18500	Not Significant - Beneficial
	≥2 and <3 dB	Medium	650	1550	Not Significant – Beneficial
	≥3 and <4 dB	High	0	0	**Significant - Beneficial**
	≥4 and <5 dB	High	0	0	**Significant - Beneficial**
Total Increases (≥1dB)			6680	17400	Adverse
Total Decreases (≥1dB)			8650	20000	Beneficial
Total Significant Adverse Effects			1620	4250	**Significant Adverse**
Total Significant Beneficial Effects			0	0	**Significant Beneficial**

6.10.9 **Table 6.26** shows that more residential dwellings would experience reductions in $L_{Aeq, 16h}$ combined air and ground noise rather than increases, however there are no significant decreases. The table shows that approximately 1620 residential dwellings would experience increases of 3 dB $L_{Aeq, 16h}$ or more in combined air and ground noise and therefore the effects would be significant adverse. These numbers are similar to those reported for air noise.

Overview of Significant Effects

6.10.10 The primary assessment of daytime community annoyance using the $L_{Aeq, 16h}$ indicator has identified a total of 1631 residential dwellings that will be exposed to significant adverse effects.

6.10.11 The secondary assessment of daytime community annoyance using the L_{den} indicator as presented in **Appendix G** has identified a total of 4550 residential dwellings that would experience significant adverse effects.

In both the primary and secondary assessments, no significant beneficial effects have been identified. However as discussed in this assessment, other effects are also identified and assessed even if they are not, according to established protocol, considered to be significant. These effects are still important considerations in the decision making process because they allow a more complete understanding of noise and help to explain its redistribution with the Project in place.. This is in line with the guidance contained in the APF (see paragraph 6.2.33 of this document).

Night-time - Sleep Disturbance

6.10.12 **Figure 6.34** presents L_{night} combined air and ground noise contours for the implementation of full runway alternation on easterlies in 2015. A comparison of the contours presented in **Figure 6.34** with the 2015 baseline presented in **Figure 6.35** shows that changes in the size and extent of the contours like the L_{den} and $L_{Aeq,\ 16h}$ air noise contours would almost exclusively occur to the west of the airport. To the south-west of the airport, the contours contract slightly resulting in some dwellings in areas of Stanwell falling outside of the 45 dB L_{night} contour. To the north-west of the airport, the extents of the contours increase resulting in a greater number of dwellings in Longford and Harmondsworth becoming exposed to 45 dB L_{night}.

6.10.13 **Table 6.27** presents an analysis of population exposure to L_{night} combined air and ground noise with and without full runway alternation on easterlies. The table presents the change in population exposure within each assessed noise level band. The table shows that full runway alternation on easterlies results in a decrease of around 1800 dwellings exposed to 45 dB L_{night}. The table also shows the number of dwellings exposed to combined air and ground noise levels of at least 55 dB increases by 370. There are no increases in exposure above 65 dB L_{night}.

Table 6.27 Assessment of Residential Population Exposure, Combined Air and Ground Noise L_{night}

Noise Level	2015 Baseline			2015 with Full Runway Alternation on Easterlies			Change		
L_{night}	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population	Area (km^2)	Dwellings	Population
≥ 45	165.1	293100	668000	163.9	291250	663200	-1.2	-1850	-4800
≥ 50	71.1	79600	190450	71.1	79550	190800	0	-50	350
≥ 55	26.5	21050	54750	26.7	21400	55700	+0.2	350	950
≥ 60	10.9	4300	12250	11.0	4350	12400	+0.1	50	150
≥ 65	4.7	650	1950	4.8	650	1950	+0.1	0	0
≥ 70	1.3	2	5	1.3	2	5	0	0	0

6.10.14 **Table 6.27** presents the number of residential dwellings experiencing changes in excess of 1 dB in L_{night} as a result of full easterly runway alternation. With reference to the significance criteria outlined in **Table 6.10,** the table also presents the noise magnitude and associated significance of these changes. The table is accompanied by **Figure 6.36** and **Figure 6.37** which present the corresponding respective increases and decreases in L_{night} where L_{night} is greater than 45 dB.

Table 6.28 Noise Magnitude and Significance of Changes in L_{night} where L_{night} is at least 45 dB

Increase / Decrease		Magnitude	Dwellings	Population	Significance
Increase	≥3	High	0	0	**Significant – Adverse**
	≥2 and <3 dB	Medium	0	0	Not Significant - Adverse
	≥1 and <2 dB	Medium	2600	6400	Not Significant – Adverse
Decrease	≥1 and <2 dB	Medium	6800	16550	Not Significant – Beneficial
	≥2 and <3 dB	Medium	0	0	Not Significant – Beneficial
	≥3	High	0	0	**Significant - Beneficial**
Total Increases (≥1dB)			2600	6400	Adverse
Total Decreases (≥1dB)			6800	16550	Beneficial

6.10.15 **Table 6.27** shows that in total more residential dwellings would be exposed decreases in L_{night} of greater than 1 dB than increases of greater than 1 dB. The table shows that there are no significant increases or decreases.

6.10.16 The significance criteria also require consideration of exposure to 90 dB SEL. A comparison of the 45 dB L_{night} contour and 90 dB SEL contours presented in **Figures 6.36** and **Figure 6.37** shows that spatially, the 90 dB SEL footprints encompass a much greater extent than the 45 dB L_{night} contour to the east. To the west, the 90 dB SEL contours generally fall within the extents of the 90 dB SEL contours.

6.10.17 When combining the changes in L_{night} with the extent of the 90 dB SEL footprints, and the extents of the 45 dB L_{night} contour, properties in Longford are the worst affected by full runway alternation during easterlies, however as changes in L_{night} do not reach 3 dB, it is concluded that there would be no significant adverse effects.

Non-Residential Sensitive Receptors

Education Establishments

6.10.18 As with the assessments of air and ground noise individually, some understanding of short-term noise levels has been incorporated into the assessment of educational establishments. For these assessments a conservative approach has been adopted where the $L_{Aeq,\ 30min}$ is assumed to be 5.5 dB higher than $L_{Aeq,\ (0800\text{-}1700hrs)}$ which is approximately the same as the $L_{Aeq,\ 16h}$ mean. On this basis, for the purposes of this assessment, $L_{Aeq,\ 30min}$ is considered to be 5.5 dB higher than $L_{Aeq,\ 16h}$.

6.10.19 With reference to the significance criteria outlined in **Table 6.10** it is considered that a 50 dB $L_{Aeq, 30min}$ threshold for significant effects is appropriate in relation to the relevant guidance. Based upon the analysis outlined above, this corresponds to a threshold ranging between 44.5 dB $L_{Aeq, 16h}$. For the purposes of the assessment, a threshold of 44.5 dB $L_{Aeq, 16h}$ has been adopted however, it is stressed that this reflects a highly conservative approach and that there is likely to be significant uncertainty in the calculated air noise levels at this threshold.

6.10.20 As with the assessments of air and ground noise, consideration of noise events above an outdoor 70 dB L_{Amax} is also required. Based on an analysis of measured noise data and L_{Amax} noise levels and calculations undertaken at the location of the education establishments, it is considered likely that all education establishments exposed to increases of 3 dB L_{Aeq} would also be exposed to outdoor noise event levels of 70 dB L_{Amax} from 09L departures and would be subject to short-term noise levels above 50 dB $L_{Aeq, 30min}$. Although it is considered that full runway alternation on easterlies would result in short-term noise levels above the 50 dB $L_{Aeq, 30min}$ threshold, given the information outlined in **Appendix G**, the existing airport operations and other ambient noise sources that are not related to the airport could also result in short-term noise levels above 50 dB $L_{Aeq, 30min}$.

6.10.21 Based on the criteria above, 15 education establishments have been identified with significant increases in combined air and ground noise of at least 3 dB L_{Aeq}, maximum noise levels above the 70 dB L_{Amax} threshold due to departures from Runway 09L and likely occurrences of short-term noise levels above 50 dB $L_{Aeq, 30min}$. These are same educational establishments identified with significant adverse air noise effects in Section 6.8.

6.10.22 There are no educational establishments exposed to significant beneficial effects.

Healthcare Facilities

6.10.23 The assessment of Healthcare Facilities for combined air and ground noise has followed the same approach as for air and ground noise as outlined in Section 6.10 and 6.11. The results for combined air and ground noise reflect the results of obtained for air noise. To this end, it is concluded that there would be significant adverse effects during daytime periods for 5 healthcare facilities. These are the same health care facilities identified as having significant adverse air noise effects.

6.10.24 As in the case for air and ground noise, it is also concluded that there would be no significant adverse effects upon healthcare facilities during night-time periods.

Community Facilities and Places of Worship

6.10.25

6.10.26 **Table** 6.29 presents an analysis of community facilities and places of worship exposed to $L_{Aeq, 16h}$ combined air and ground noise with and without full runway alternation on easterlies.

Table 6.29 Assessment of Community Facilities and Places of Worship, Combined Air and Ground Noise

Noise Level $L_{Aeq, 16h}$	Total Number of Community Facilities and Places of Worship		Change
	2015 Baseline	2015 with Full Runway Alternation on Easterlies	
≥ 57	179	173	-6
≥ 60	71	73	2
≥ 63	20	20	0
≥ 66	5	6	1
≥ 69	1	1	0
≥ 72	0	0	0

6.10.27 The table shows that the introduction of full runway alternation on easterlies results in a reduction in the number of community facilities and places of worship exposed to 57 dB $L_{Aeq, 16h}$ however the number of these facilities exposed to air noise levels of 60 dB $L_{Aeq, 16h}$ or more would increase. These results reflect the effects identified for air noise. **Table 6.30** presents a breakdown of the noise level increases for receptors exposed to 57 dB $L_{Aeq, 16h}$ with or without full runway alternation.

Table 6.30 Noise Magnitude and Significance of Changes in $L_{Aeq, 16h}$ where $L_{Aeq, 16h}$ is at least 57 dB

Increase / Decrease		Magnitude	Number of Facilities	Significance
Increase	≥3 dB	High	3	**Significant – Adverse**
	≥2 and <3 dB	Medium	0	Not Significant - Adverse
	≥1 and <2 dB	Medium	7	Not Significant – Adverse
	≥0 and <1 dB	Low	102	Not Significant – Adverse
Decrease	>0 and <1 dB	Low	42	Not Significant – Beneficial
	≥1 and <2 dB	Medium	19	Not Significant - Beneficial
	≥2 and <3 dB	Medium	0	Not Significant – Beneficial
	≥3 dB	High	0	**Significant - Beneficial**
Total Increases (≥1dB)			112	Adverse
Total Decreases (≥1dB)			61	Beneficial

6.10.28 The table shows that there are no significant beneficial effects upon community facilities and places of worship as a result of full runway alternation on easterlies in combined air and ground noise. However, the table shows 3 community facilities and places of worship which

would experience significant adverse combined air and ground noise effects. These are the same places of worship that would experience significant air noise effects.

6.11 Assessment of Construction Noise Effects

6.11.1 Results obtained from the noise model show that the highest predicted construction noise levels for all construction activities and receptors would fall below the 65 dB $L_{Aeq,\ T}$ significance threshold for daytime periods. It is therefore concluded that for daytime periods, construction noise would not be significant.

6.11.2 From night-time construction activities, significant impacts are predicted for some properties located on Bath Road, in Longford.

6.11.3 No. 613 Bath Road and Littlebrook Nursery are predicted to experience 7-8 dB(A) increases in total night-time ambient noise levels above the lower threshold value of 45 dB $L_{Aeq,\ T}$ as a result of the construction of the noise wall.

6.11.4 For Littlebrook Nursery, these exceedances and increases occur during the construction of western section of the noise barrier (as shown in **Figure 3.7**). In practice, it may be possible for these sections of barrier to be constructed during the daytime. Furthermore, Littlebrook Nursery is not likely to be in use at night, and therefore these effects are not considered significant.

6.11.5 No. 613 Bath Road is considered to be representative of approximately 6 residential properties. The western section of the noise barrier runs near to the southern elevations of these properties, and it is not unexpected that night-time works result in some impact. The noise model shows that for No. 613 Bath Road, total night-time ambient noise levels would increase by 7-8 dB to approximately 58 dB $L_{Aeq,\ 8h}$ as a result of construction activities. It is therefore concluded that construction noise effects during the night-time construction of the noise barrier are significant.

6.12 Assessment of Noise Induced Vibration

6.12.1 As discussed in Section 6.4, investigation work regarding potential noise induced vibration effects during aircraft start-of-roll has been undertaken.

6.12.2 In order to understand whether there is a risk of noise induced vibration effects from departing aircraft during start-of-roll on Runway 09L at receptors in Longford, a combined noise and vibration $_{survey}$ was undertaken in the vicinity of the eastern end of Runway 27L. The survey was undertaken at the far end of Myrtle Avenue, 475m from the runway threshold, and 130m to the south of the extended runway centreline between the hours of 1500-1700hrs during westerly departures. The survey occurred within an occupied property with access to a conservatory at the rear. The conservatory was glazed with sealed unit glazing and had a raised floor. The location was selected as a proxy in the absence of being able to directly measure 09L departures in Longford.

6.12.3 Significant low frequency noise was audible during departures on 27L and the conservatory structure was induced to vibrate so as to cause creaking of the structure. The occupants reported that their dining table, in a room adjacent to and with open access to the

conservatory, was on occasions felt to vibrate. No vibration was reported elsewhere in the property.

6.12.4 The noise and vibration measurements identified coincidental low frequency noise and vibration effects. Analysis of these measurements identified that the low frequency noise components were reciprocated in vertical vibration of the conservatory floor. In terms of vibration, measured Vibration Dose Values (VDV_b) as defined in BS 6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting'* were $0.43ms^{-1.75}$ for the 2 hour measurement period. Assuming that the measured VDV_b during the 2 hour period is representative of the typical 8 hours for which departures on 27L normally occur then it may be concluded that air noise inducted vibration effects results in *"Adverse comment possible"* as defined by BS 6472-1:2008. The vibration measurements did not demonstrate any vibration approaching criteria for the onset of structural damage.

6.12.5 The nearest properties to the threshold of Runway 09L are located in Longford approximately 250m away. From aerial imagery some of these properties appear to have lightweight structures on facades overlooking the airport. It is therefore considered that a similar set of circumstances which resulted in noise induced vibration effects during departures on Runway 27L could occur in Longford during departures on Runway 09L. Although the proposals include the construction of the noise wall between these properties and the end of Runway 09L, the effectiveness of the noise barrier on the low frequency noise generated during start-of-roll would be much less than for noise generated during from aircraft taxiing. The properties in Longford are further away from the runway centreline than at the property where measurements were undertaken for departures on Runway 27L. Aircraft engines are directional in terms of their noise emissions. It is therefore possible that because of this directivity, low frequency noise may be lower than could occur in Longford.

6.12.6 The findings indicate that significant noise induced vibration effects at properties with lightweight structures in Longford cannot be ruled out. It is therefore considered that the Project introduces a likelihood of significant noise induced vibration effects in Longford in lightweight structures attached to residential dwellings. The potential for significant effects cannot be discounted. It is therefore concluded that the proposals may give rise to significant noise induced vibration effect at certain properties within Longford.

6.12.7 Effects will be assessed and if possible mitigated as part of the Airport's Mitigation Package.

6.13 Cumulative Effects

6.13.1 With reference to Section 4.8, planning applications with potential cumulative effects have been identified. It is considered that these applications would not materially affect the outcomes of the assessments outlined in Section 6.8-6.14 and as summarised in Section 6.16.

6.13.2 During consultation it has been requested that the air and ground noise assessments consider the cumulative effects of Operational Freedoms. These cannot be assumed to be in use in 2015 and are currently subject to review following the end of the trial in March 2013. trail. If these freedoms were to be adopted, these would not form part of a standard operating practice as by definition they are tactical measures used to help prevent or recover from delay and disruption. Since the extent of delay or disruption cannot be forecast it is not possible to predict how and when the freedoms would be used.

6.13.3 Work is being undertaken on the effect of these freedoms on levels of air noise which would be taken into consideration by the Department for Transport (DfT) in their evaluation of the results of the trial.

6.14 Overview of Mitigation

6.14.1 As outlined in Section 6.5, the Project includes a number of environmental measures and mitigation schemes. This section presents an overview of these schemes, eligibility those benefiting from mitigation.

Mitigation and Compensation Schemes

6.14.2 A summary of buildings eligible for mitigation and compensation under the Airport's enhanced schemes is presented in **Table 6.31**.

Table 6.31 Eligibility under Mitigation and Compensation incorporated into the Scheme

Type	Scheme	Property Type	Policy Reference	Eligible Buildings	Eligibility Criteria	Offer	Eligible Buildings
Insulation	Enhanced Residential Scheme	Residential	APF Paragraph 3.39	Households	63dBA Leq contour AND a 3dBA increase in noise exposure.	Free noise assessment to determine statement of need. 100% contribution towards insulation/ventilation costs based on statement of need.	175
	Extended Community Buildings Scheme	Community	APF Paragraph 3.37	Schools, colleges, registered nurseries, hospitals, hospices, community halls and libraries.	63dBA Leq contour AND a 3dBA increase in noise exposure.	As per current Community Buildings Scheme.	0
Compensation	Enhanced Home Relocation Assistance	Residential	APF Paragraph 3.36	Households	69dBA Leq contour.	As per existing Home Relocation Assistance scheme.	350

6.14.3 The table shows that 175 dwellings would be eligible for insulation under the Airport's Enhanced Residential Scheme and that 350 would be eligible for compensation under the Airport's Enhanced Home Relocation Assistance Scheme.

Longford Noise Wall

6.14.4 In order to mitigate ground noise and start-of-roll noise effects a noise wall will be constructed. Calculations show that it will on average provide attenuation of around 3 dB

from aircraft taxiing and at hold for residential dwellings overlooking the airport in Longford. It is also expected to mitigate noise from start-of-roll.

Implementation of Reflective Alternation

6.14.5 Based on the assessment of alternative measures presented in Section 6.8, reflective alternation during easterly operations would result in around 60,000 people as considered by the assessment would experience predictable periods of respite as a result of the Project. These periods of respite would be scheduled and would occur for 8-hours at a time during either morning or afternoon periods.

Assessment of Vibration effects

6.14.6 Based on our analysis of the vibration effects in Myrtle Avenue during westerly operations, there is a risk of vibration effects on lightweight structures in the Longford area due to start-of-roll activities on Runway 09L.

6.14.7 The Airport does not have access to all the properties in the area, but our visual assessment of aerial imagery indicates that there may be some such existing structures. As part of our mitigation proposals HAL will assess any pre-existing lightweight structures or conservatories in the area (with 475m of start-of-roll SOR) to assess what action may be taken to mitigate the effects. If mitigation is possible HAL will finance works up to a maximum value of £10,000.

Summary of Proposed Mitigation

6.14.8 In summary we intend to provide the following mitigation measures:

- Residential acoustic insulation for all 175 existing households within the 63 dB $L_{Aeq,\ 16h}$ noise contour that experience an increase of 3 dB or more as a result of the implementation of full easterly alternation
- Home relocation assistance for the 350 households which will fall within 63 dB $L_{Aeq,\ 16h}$ noise contour as a result of the implementation of full easterly alternation
- The provision of a noise wall for the village of Longford
- More periods of respite for communities.
- Assessment of vibration effects for households with lightweight conservatories or similar structures within 475m of the SOR with financial assistance up to a maximum of £10,000 if mitigation is possible.

6.15 Summary of Effects and Proposed Mitigation

6.15.1 Within the Assessment of Effects sections (6.8 – 6.13) it has been clearly indicated when an effect that arises as a result of the scheme is considered to be significant. However within these sections other effects are also identified and assessed even if they are not, according

to established protocol, considered to be significant. These effects are still important considerations in the decision making process because they allow a more complete understanding of noise and its redistribution. This is in line with the APF (see paragraph 6.2.33 of this document). This summary section therefore provides details of all effects detailed in the Assessment of Effects Sections regardless of whether they are considered to be significant in EIA terms or not. Set out below are the key effects arising from the assessment of the project.

- Based on the primary assessment of $L_{Aeq, 16h}$ the project results in more people experiencing beneficial effects in terms of air noise exposure by a factor of 2:1
- Around 10,500 people will no longer be exposed to air noise levels at or above 57 dB $L_{Aeq, 16h}$.
- The overall number of people likely to be “Annoyed” or “Highly Annoyed” will reduce slightly as a result of the project
- Around 1700 people within the 57 dB $L_{Aeq, 16h}$ will experience an increase in noise greater than 3dB of which 350 fall within the 63dB contour and will qualify for the enhanced residential insulation scheme.
- Although around 1500 people fall out of the air noise 45 dB L_{night} the Project has a very limited impact of the nature of night time operations and so it is not unexpected that there are no significant effects in respect of night time sleep disturbance for air or ground noise identified.
- There are no Educational Establishments, experiencing a significant change in air or ground noise levels and located within the 63dBA contour and only 1 within the 57 dB contour.
- There are no Healthcare Facilities, Community Facilities or Places of Worship experiencing a significant change in air or ground noise levels and located within the 63dBA.
- Based on the primary ground noise assessment there are 60 dwellings experiencing an increase in ground noise of 3dBA or more although none of these are within the 63dB noise contour.
- The Project introduces a likelihood of significant noise induced vibration effects in Longford in lightweight structures attached to residential dwellings. Effects will be assessed and if possible mitigated as part of the airport’s Vibration Mitigation Package

6.15.2 In consideration of these effects the following mitigation and compensation package has been developed in order to minimise the impact of increases in noise exposure to those residents worse affected by the change in the airport’s operation and which is in accordance with the most recent Government guidance contained in the APF.

- Home relocation assistance for all 175 households newly exposed to 69 dB LAeq, 16h noise contour or more;

- Residential acoustic insulation for the 350 households which will fall within 63 dB LAeq, 16h noise contour as a result of the implementation of full easterly alternation and which will experience an increase of 3dB or more increase;

- The provision of a noise wall for the village of Longford;

- More predictable periods of respite for communities affected by the implementation of full easterly alternation that would benefit approximately 60,000 people; and

- Assessment of vibration effects for households with lightweight conservatories or similar structures within 475m of the SOR with financial assistance up to a maximum of £10,000 if mitigation is possible.