Heathrow
Making every journey better

amec

Heathrow Airport Limited

Heathrow's North-West Runway

Air and Ground Noise Assessment

18 June 2014

AMEC Environment & Infrastructure UK Limited

1

Glossary and Abbreviations

AC	Airports Commission
ANASE	Attitudes to Noise from Aviation Sources in England Study
ANCON	ANCON is the CAA's UK civil aviation aircraft noise contour model. It is developed to international standards and incorporates noise measurements and radar track information obtained from the London airports including Heathrow.
APF	Aviation Policy Framework
APU	Auxiliary Power Unit
ASAS	Airport Surface Access Strategy
ATM	Air Traffic Movement
CAA	Civil Aviation Authority
CACI	CACI are a company that prepare demographic datasets
CCD	Continuous Climb Departures
CDA	Continuous Descent Approach
CDM	Collaborative Decision Making
D	Departing (i.e. the runway is used for departing aircraft only)
DALY	Disability Adjusted Life Years
Defra	Department of Food, Environment and Rural Affairs
DfT	Department for Transport
DL	Departure-Landing (i.e. the runway is used for departures and landings at the same time)
DMRB	Design Manual for Roads and Bridges
DW	Disability Weighting
EGR	Engine Ground Running
ERCD	The CAA's Environmental Research and Consultancy Department
FEGP	Fixed Electrical Ground Power
G2	Generation 2 aircraft as defined by Sustainable Aviation
GPU	Ground Power Unit
GRE	Ground Running Enclosure
HP	Hedonic Pricing
ICAO	International Civil Aviation Organisation
IGCB	Interdepartmental Group on Cost and Benefits of Noise
INM	Integrated Noise Model – this is an aircraft noise modelling tool that is used internationally to assess noise from airports. It is developed by the Federal Aviation Administration and is designed to comply with the latest international standards. The model is developed using certified aircraft noise emission data and industry recognised flight procedures.

L	Landing (i.e. the runway is used for landing aircraft only)
$L_{Aeq, 16hr}$	Equivalent continuous sound level of aircraft noise in dB during an average summer day. For conventional historical contours this is based on the daily average movements that take place in the 16 hour period (0700-2259 hrs local time) during the 92 day period between the 16 June and 15 September inclusive.
$L_{Aeq, 8hr night}$	Equivalent continuous sound level of aircraft noise in dB during an average summer night. The indicator uses average movements that take place during an 8 hour night-time period (0230-0659 hrs local time) during the 92 day period between the 16 June and 15 September inclusive.
LBH	London Borough of Hillingdon
L_{den}	The day, evening, night level, L_{den} is a composite of a 12-hour annual average daytime noise level (L_{day}), a 4-hour annual average evening noise level ($L_{evening}$) with a penalty of 5 dB added, and an 8-hour annual average night-time noise level (L_{night}) with a penalty of 10 dB added.
mppa	Million Passengers Per Annum
N60 (night-time)	
N70 (daytime)	
NIR	Noise Insulation Regulations
nmi	Nautical Mile
NPPF	National Planning Policy Framework
NPSE	Noise Policy Statement for England
OS	Ordnance Survey
PBN	Precision-Based Navigation
PCA	Pre-Conditioned Air
SA	Sustainable Aviation
SAF	The Airports Commission's Sustainability Appraisal Framework
SP	Stated Preference
TAAM	Total Airspace and Airport Modeller
WHO	World Health Organisation
WTP	Willingness to Pay

Contents

1. Introduction

1.1 Background

This report has been prepared by AMEC Environment & Infrastructure UK Limited on behalf of Heathrow Airport Limited (HAL). To meet the growing need for additional air capacity, HAL has proposed an extension to the existing Airport[1]. The proposed development would include:

- A 3,500m runway to the north-west of the existing Airport;
- Two new terminal buildings;
- Aircraft movement areas and taxiways;
- Various aircraft stands (pier serviced stands and remote stands);
- Car parking; and
- Ancillary uses.

Further details of the development can be found in Heathrow's submission to the Airports Commission.

This report provides the technical assessment and the details underlying **Part 5.2 A Quieter Heathrow** presented in Volume 1 of HAL's submission to the Airports Commission[1]. The assessment of potential effects with and without mitigation was undertaken in accordance with the Commission's Sustainability Appraisal Framework (SAF) as described below[2].

The technical content of the report relates to air and ground noise. In order to address the Commission's requirements, **Section 2** of the report describes the legislative and policy context relevant to the assessment. **Section 3** describes the current baseline noise conditions around Heathrow Airport. **Section 4** presents an outline, and where necessary, expands on the Mitigation Strategy for noise as presented in Part 5.2 of Heathrow's May 2014 submission to the Airports Commission[1]. **Section 5** describes the assessment methodologies adopted for the assessment of impacts. The results of these assessments are presented in **Section 6** and conclusions are given in **Section 7**.

The appendices to this document provide detailed assessment methods, technical information and assessment outputs.

[1] Heathrow (2014) Taking Britain further – Heathrow's plan for connecting the UK to growth

[2] Airports Commission (2014) Appraisal Framework. April 2014. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/300223/airports-commission-appraisal-framework.pdf

1.2 Requirements of the Airports Commission

The Airports Commission's Sustainability Appraisal Framework (SAF) states that the following should be demonstrated with respect to aircraft noise:

- Details of mitigation strategies that can be put in place to mitigate the impacts upon populations affected by noise such as respite regimes;
- Identification of any night-noise implications and details of strategies to mitigate night-noise; and
- A description of impacts on designated sites, heritage sites and tranquillity, along with strategies to mitigate these impacts.

The Commission state that the appraisal should:

- Be underpinned by detailed noise contour maps based on a selection of average and frequency based noise measures;
- Be assessed based on net impact i.e. considering the absolute number of population affected above stated thresholds of noise;
- Be assessed at local level considering background noise levels;
- Be considerate to noise from aircraft on the ground, from sources such as taxiing, APUs, hold and engine testing (known as aircraft ground noise);
- Consider noise from surface access road traffic;
- Identify changes in areas of land, numbers of people and other amenities either newly exposed or removed from noise exposure thresholds; and
- Identify the costs and benefits of a scheme's impact through a monetisation taking into account effects on annoyance, sleep disturbance and quality of life.

The appraisal supports the Airports Commission's objective which is to:

"minimise and where possible reduce noise impacts".

1.3 Scope of the Work

1.3.1 Aircraft Noise

The aircraft noise assessment has considered the noise generated by aircraft in flight-related phases (including start-of-roll and reverse thrust). The scope of work has included:

- Development of a Mitigation Strategy appropriate to the development of a third runway located to the NW of the airport that is an evolution of the July 2013 proposals. The Mitigation Strategy has considered:
    - Encouraging the development and adoption of quieter planes;
    - Optimising the masterplan infrastructure;
    - Implementation of new procedures; and
    - Development of airspace design options to minimise and where possible reduce the impacts of noise.
- Assessment of the impacts of these options for "early" operation case (considered to be 2030 with 570K movements serving 103 mppa) and "mature" operation (considered to be 2040 with 740K movements serving 130 mppa). These assessments have been considered against current day (or baseline) and future base cases;
- Assessment of Heathrow's proposed airspace options with respect to the SAF including consideration of respite for the future airport cases with respect to the current day and future base cases.

1.3.2 Ground Noise

Aircraft ground noise is the noise generated by aircraft whilst on the ground during taxiing, hold and whilst at stand. Other sources of ground noise include surface access road traffic noise. For both strands of ground noise, the following scope of work has been undertaken:

- The capturing and understanding of the baseline ground noise environment through attended and observed measurements at locations and communities around the existing 2R and proposed 3R airport boundaries;
- Noise modelling of various potential mitigation measures in order to help define the Mitigation Strategy for ground noise; and
- Modelling and population exposure assessments of noise exposure from road traffic noise and airside ground noise in order to inform understanding of the overall impacts.

1.4 Heathrow's Objectives

Heathrow's aircraft noise objectives are as follows:

- To develop a three-runway airport where noise, including night noise, affects fewer people than today;
- To maintain the principle of runway alternation to provide periods of noise respite for communities around Heathrow and to explore whether there are opportunities to enhance periods of relief through innovative airspace design;

- To provide free noise insulation and compensation in high noise areas and areas exposed to significant new noise, consulting with local communities when designing insulation schemes to understand priorities;
- To minimise the impacts of airside activities through appropriate mitigation; and
- To consider the noise implications of Heathrow's proposals on public open spaces and other non residential receptors.

2. Legislative and Policy Context

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).

In the UK, the Department for Transport (DfT) and the Department for Environment, Food and Rural Affairs (Defra) are responsible for regulating the various environmental aspects of the aviation industry. In addition, the UK Civil Aviation Authority (CAA) also has powers as a regulator and certificating authority of air transport and aerodromes and provides specialist aviation advice to Government.

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.

Noise from other airport associated infrastructure such as the road network is also considered in policy and legislation.

A complete description of relevant legislation and policy is provided in **Appendix A** and summarised in the following sections.

2.1 Aviation Legislation

Relevant aviation legislation includes:

- The Civil Aviation Act (2006):
  - This Act gives the Secretary of State (SoS) influence in the control of noise at ‘designated’ airports. Heathrow is a ‘noise designated’ airport and as such the SoS has enforcement powers on matters such as airspace use and noise insulation schemes.
- The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations (2003):
  - This Act transposes EC Directive 2002/30/EC and ICAO Assembly Resolution A33-7[1] in UK law. The Regulations establish a ‘balanced approach’ to airport noise management.
- The Transport Act (2000):
  - The Act defines noise as an ‘environmental objective’ of the UK Civil Aviation Authority (CAA).

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

2.2 Environmental Noise Legislation

Relevant environmental noise legislation includes:

- The Environmental Protection Act (1990):
  - This gives powers to local authorities and the public to address noise nuisances. The Act however specifically excludes aircraft noise from under these powers.
- The Environmental Noise (England) Regulations (2006):
  - This Act transposes EC Directive 2002/49/EC into English law. It requires the preparation of strategic noise maps and associated Noise Action Plans every 5 years for 'major' airports.
- The Noise Insulation Regulations (1975):
  - This Act makes it compulsory for noise insulation to be provided to residential dwellings where noise from new or realigned road carriageways results in certain levels and changes to road traffic noise.

2.3 Policy Context

Aviation Policy Framework (APF)

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".

The policy makes clear that the Government fully endorses ICAO's 'balanced approach' to airport noise management.

In relation to noise policy metrics, the APF adopts the 57 dB $L_{Aeq, 16h}$ as the measure of the:

'approximate onset of significant community annoyance'.

The policy does however recognise that people that are exposed to noise below the 57 dB measure may be annoyed and conversely those who experience noise above it may not.

Both the APF and the Airports Commission have recognised that there is no firm consensus as to how to measure the noise impacts from aviation. The policy therefore introduces the use of alternative measures to describe noise impacts.

The policy sets out the Government minimum expectations with regards to noise insulation and compensation schemes. In summary the Government expects airport operators to:

- Offer acoustic insulation to **noise sensitive buildings** such as schools and hospitals exposed to noise levels 63 dB $L_{Aeq, 16hr}$ or more;
- Offer financial assistance towards acoustic insulation to **residential dwellings** that are exposed to a 3 dB increase in aircraft noise that leaves them exposed to at least 63 dB $L_{Aeq, 16hr}$ or more; and
- Offer assistance with the costs of moving to households that are exposed to 69 dB $L_{Aeq, 16hr}$ or more.

The APF is underpinned by core principles of collaboration and transparency. It promotes constructive consultation between aircraft noise stakeholders and community engagement. The APF states that it is:

'Government's objective is to encourage the aviation industry and local stakeholders to strengthen and streamline the way they work together'.

It also makes clear that noise mitigation includes a range of operational measures such as airspace use and respite regimes, and that mitigation is not solely limited to noise insulation and compensation.

The policy makes clear that many of its objectives *'…align with policy set out in the National Planning Policy Framework… for the provision of viable infrastructure to support sustainable development'* and that its noise objective is *'… consistent with the Government's Noise Policy, as set out in the Noise Policy Statement for England (NPSE)'*.

National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) was published in March 2012. The NPPF covers all types of development and is not aviation specific. The NPPF (paragraph 109) states that the planning system should contribute to and enhance the natural and local environment by:

"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".

Noise Policy Statement for England

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".

The NPSE is a framework for the assessment of all noise issues with the exception of occupational noise. The NPSE does not specifically address airport noise.

2.4 General Guidance

Road Traffic Noise

The Highways Agency guidance document *Design Manual for Roads and Bridges* (DMRB) (Vol. 11, 2011, Rev.1) includes guidance on the interpretation of changes in road traffic noise levels ($L_{A10,\ 18hr}$) for determining the potential magnitude of impact.

World Health Organisation (WHO) Guidelines

The WHO has prepared a number of guidance documents relating to community noise, exposure and health. These documents have considered noise exposure across a range of transportation and other environmental noise sources and are not focussed on one particular source of noise such as road traffic or aviation.

The WHO report *Guidelines for Community Noise* (1999) presents guideline noise exposure levels for community noise to avoid health effects and annoyance. The guidelines recommend a noise level of 55dB $L_{Aeq,\ 16hr}$ to avoid serious annoyance in outdoor living areas, but also acknowledges that around 40% of the population of the European Union are already exposed to levels above this guideline.

The WHO report *Night Noise Guidelines for Europe* (2009) presents night time noise exposure guidelines that aim to protect the public from adverse health effects. The report recommends a guideline value of 40 dB L_{night} to protect against the risk of night-time health effect. The report however acknowledges that people are already exposed to levels above this and therefore provides an 'Interim Target' of 55 dB L_{night} where achievement of the 40 dB L_{night} guideline is not feasible in the short-term.

The WHO report *'Burden of Disease from Environmental Noise'* (2011) provides a review of evidence supporting dose-response in relation to environmental noise and health effects. The document discusses all forms of environmental noise from transportation sources and provides case studies from research. The document provides a meta-analysis of current research to provide relationships linking chronic exposure to environmental noise to health effects. This includes relationships that facilitate estimates of Disability Adjusted Life Years (DALYs) – a quantification of the burden of disease as a result of environmental noise.

Attitudes to Noise from Aviation Sources in England (ANASE) Study

The ANASE study was commissioned in 2002 by the Government to re-evaluate people's attitudes to aircraft noise. The study identified potential changes in attitudes, although the findings of the study were not considered sufficiently conclusive by the Government to support a change in noise policy. The study did however provide research facilitating the monetisation of aircraft noise.

3. Existing Noise Conditions around Heathrow

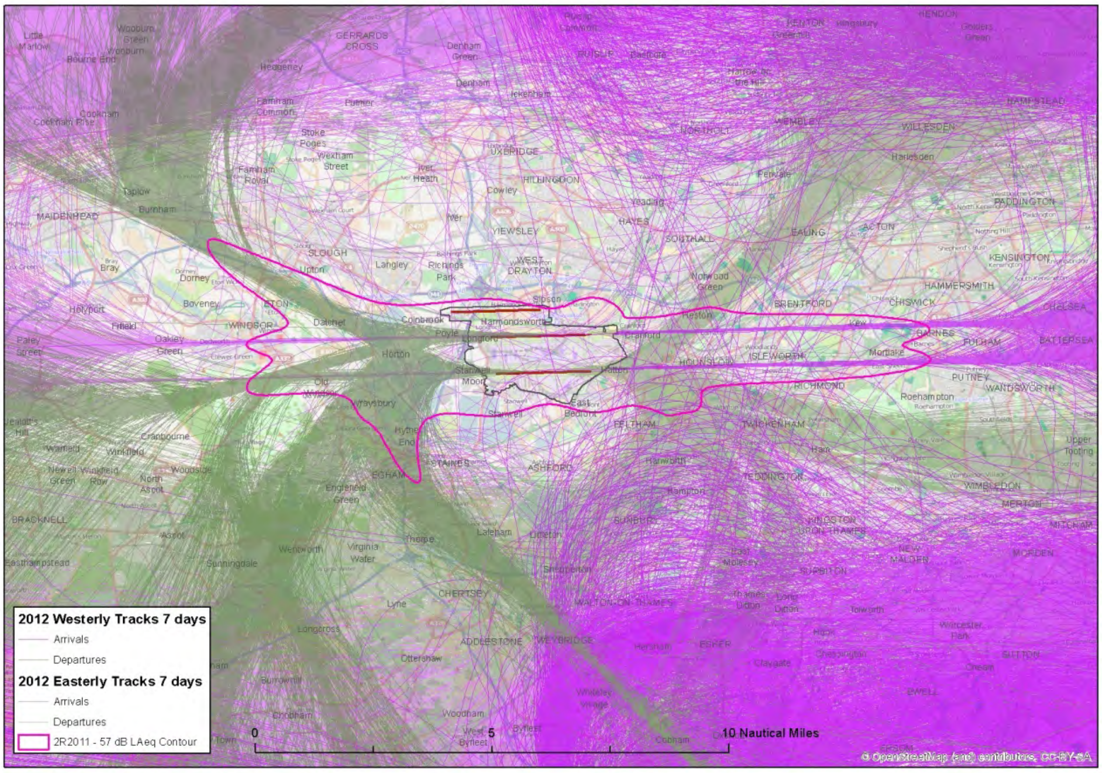
A series of baseline studies have been undertaken at locations around Heathrow. These are presented in full in **Appendix B**. This section provides a high level overview of the baseline conditions around the airport and demonstrates how baseline data have been used to inform the Mitigation Strategy and the assessments.

3.1 Description of Baseline Conditions

Aircraft Noise

Figure 3.1 shows existing flight tracks (showing 7 days of easterly and 7 days of westerly operations) in combination with the existing 57 $L_{Aeq,\,16hr}$ noise contour. The figure shows that some locations are overflown more than others and that some locations experience departing aircraft whereas other experience arrivals or a combination of both. The figure shows that within the baseline 57 dB $L_{Aeq,\,16hr}$ noise contour, aircraft tend to be either on initial departure or final approach.

Figure 3.1 Current Flight Tracks and Baseline 57 dB $L_{Aeq,16hr}$ Noise Contour

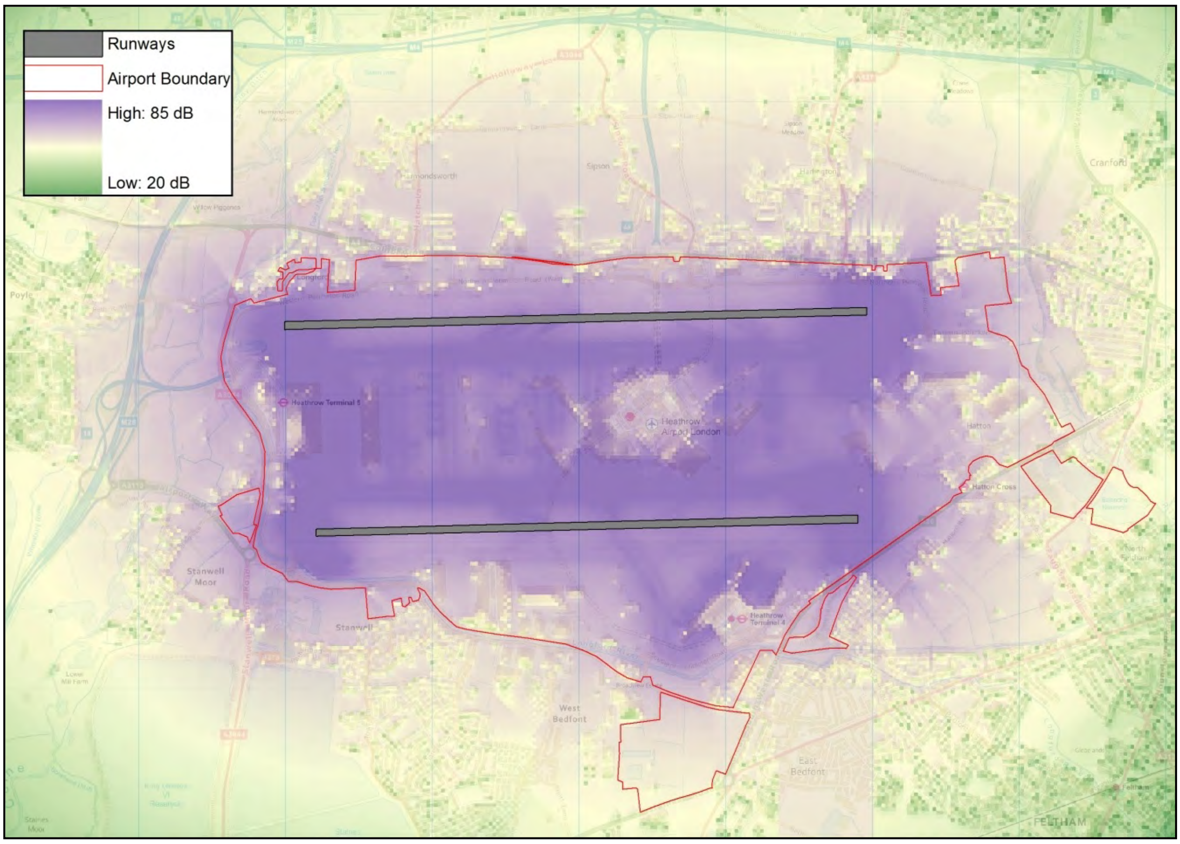


Aircraft Ground Noise

Figure 3.2 shows the distribution of aircraft ground noise around the airport. The figure demonstrates that aircraft ground noise exposure is typically related to proximity of a location or community to the airport boundary. The figure also shows how the noise is screened by structures and buildings.

The figure shows that aircraft ground noise is apparent around the runway ends as aircraft hold before departures. It is at these locations where aircraft ground noise is most likely to impact communities. The figure shows noise from aircraft as they taxi. Unlike aircraft holding, this noise is largely contained within the airfield boundary. Likewise, noise from aircraft at stand is also apparent from the running of APUs. Although noise at stand is not a large component of aircraft ground noise during the day, at night, and when movements are at their lowest, noise from aircraft at stand can be audible at locations around the airport.

Figure 3.2 Intensity of Aircraft Ground Noise



Road Traffic Noise

Figure 3.3 presents the relative levels of road traffic noise around the airport. The figure shows that road traffic noise is a significant contributor to the local ambient noise climate. Not all of this traffic is directly associated with Heathrow airport, however on certain roads the proportion of airport traffic will be greater than for others. The figure illustrates the level of noise produced by the M4 and M25 in comparison to the local road network.

Figure 3.3 Road Traffic Noise

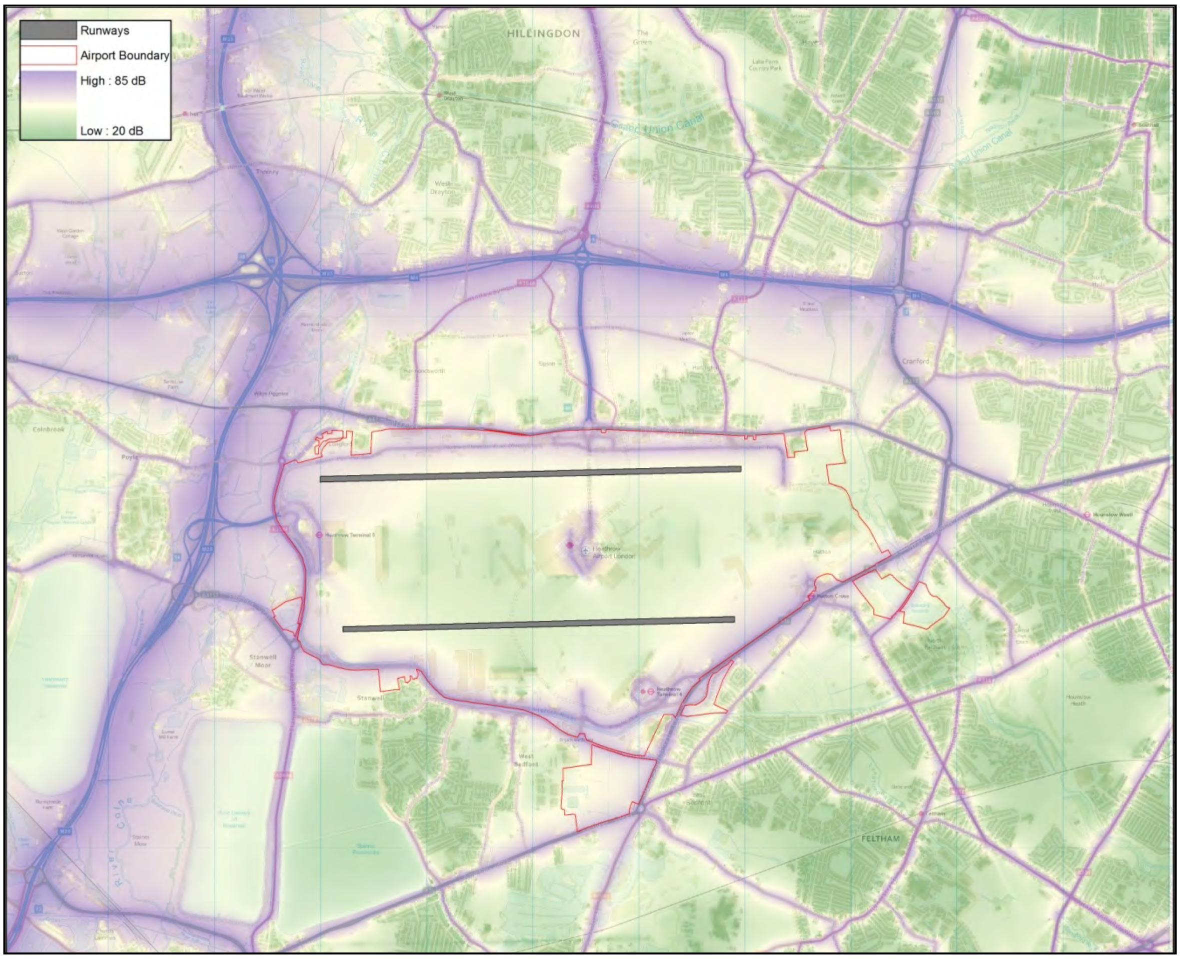


Figure presented to same noise level scale as Figure 3.2.

Other Sources

There are a number of other noise sources that contribute towards the baseline noise climate in the vicinity of Heathrow. These include industrial and commercial facilities, and the local and national rail networks.

3.2 Use of the Baseline Data

The baseline data presented in **Appendix B** has been used for several purposes.

For aircraft noise exposure, current conditions have been used to assess how future levels of noise exposure compare to levels today. For ground noise, baseline data has been used for assessment purposes but also to inform on the potential impacts as a result of ground operations. This was used to help prescribe and identify mitigation in the development of the Mitigation Strategy.

The baseline data has also been used to establish any particular temporal considerations. For example, during the night when aircraft noise is at its lowest, what other airport noise sources are audible.

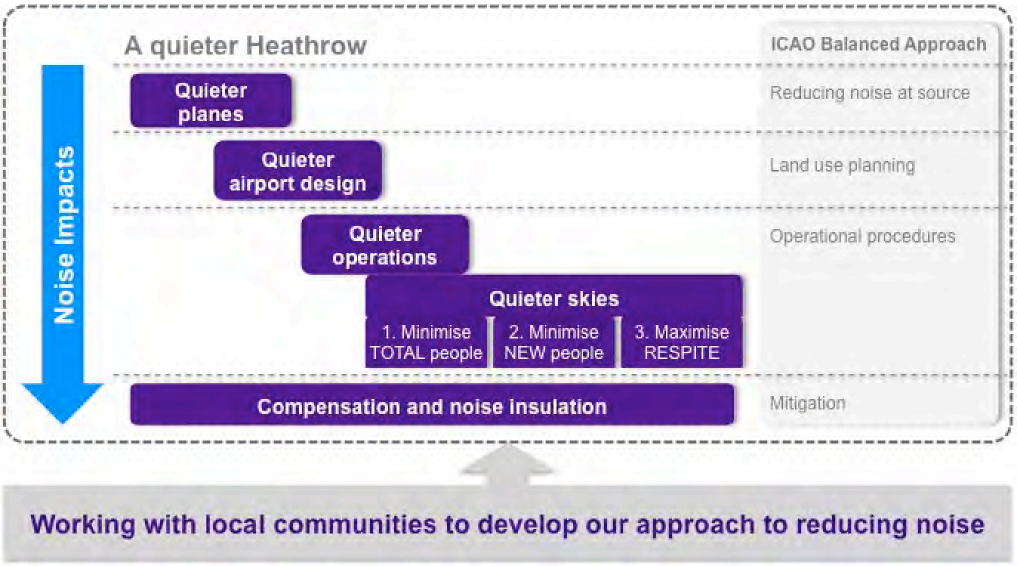
4. Mitigation Strategy

In Heathrow's submission to the Commission in May 2014 an approach to mitigation was set out. This approach has informed Heathrow's proposed Mitigation Strategy which is summarised in *'Taking Britain Further'*. This Mitigation Strategy is based on the internationally agreed ICAO 'Balanced Approach' to managing noise, involving the following steps:

- Reducing noise at source;
- Designing the airport infrastructure to be as quiet as possible;
- Reducing noise through quieter procedures;
- Considering where and when aircraft are flown;
- Offering compensation and mitigation after all the other measures have been taken into account; and
- Working with local communities to understand their priorities.

The Mitigation Strategy was prepared prior to the release of the recently published CAA Report CAP 1165 *'Managing Aviation Noise'*. This document presents and discusses a number of potential measures for reducing aviation's noise impacts and subsequently challenges the aviation industry to do more. Heathrow's Mitigation Strategy has been reviewed against CAP 1165 and is consistent with many of the opportunities and measures detailed by the CAA. Indeed the Mitigation Strategy also considers other opportunities such as the provision of respite.

Figure 4.1 A Quieter Heathrow



In summary, the Mitigation Strategy shown in Figure 4.1, comprises of the following:

- **Quieter planes** – the continued adoption of quieter airplane technology;
- **Quieter airport design** – an optimised Masterplan in terms of runway location and displaced thresholds to minimise the number of people affected;
- **Quieter operations** – taking advantage of new opportunities to reduce impacts through operational measures including runway mode rotation, night flight management and steeper approaches;
- **Quieter skies** – the development and presentation of 3 airspace options designed to reduce impacts on the ground based on differing policy objectives:
  - **Option T**: to minimise the total number of people overflown;
  - **Option N**: to minimise the number of new people overflown; and
  - **Option R:** to maximise opportunities for respite.
- **Quieter ground operations –** reducing noise from aircraft whilst on the ground and from surface access road traffic.

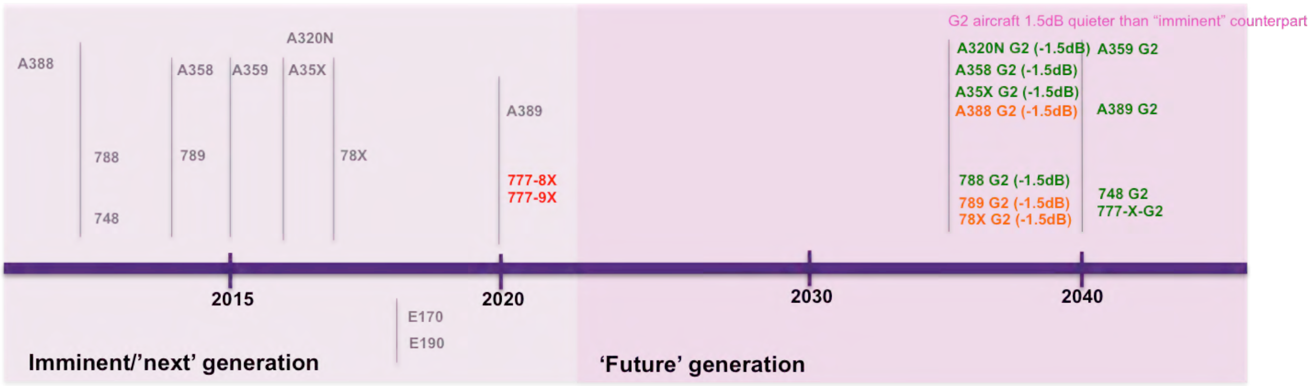
4.1 Quieter Planes – Fleet Assumptions

Based on discussions with industry partners in the Sustainable Aviation group and existing airline customers, Heathrow has developed realistic and credible assumptions regarding aircraft noise performance for imminent and future aircraft types and the development and adoption of new aircraft types.

Heathrow is committed to encouraging its airline partners to use the latest and quietest aircraft. Currently more than 98% of aircraft operating conform to the latest, quietest standard, ICAO Chapter 4. Heathrow believe that it can continue to attract the most modern and quietest aircraft through a range of incentives and restrictions. Already more than 50% of aircraft are compliant with the latest noise standard (known as Chapter 14). Based on internal consultations, industry knowledge, DfT forecasts, discussions with the CAA and other industry partners, Heathrow has developed the following timeline for the introduction of aircraft though the next 20-30 years at Heathrow.

Heathrow has historically attracted a more modern and quieter fleet, with airlines bringing their latest technology to operate. There is no indication to consider that this would not continue.

Figure 4.2 Timeline Presenting Expected Approximate Entry into Service of Aircraft at Heathrow



Using this timeline and the approach advocated by Sustainable Aviation[2], a number of credible assumptions have been developed regarding the noise emissions of these aircraft types. These assumptions are based on *'current'*, *'imminent'* and *'future'* aircraft types as defined by the Sustainable Aviation group. It should be noted that Sustainable Aviation also use the term Generation 2 to describe these aircraft, which is indicated in the figure using the term G2.

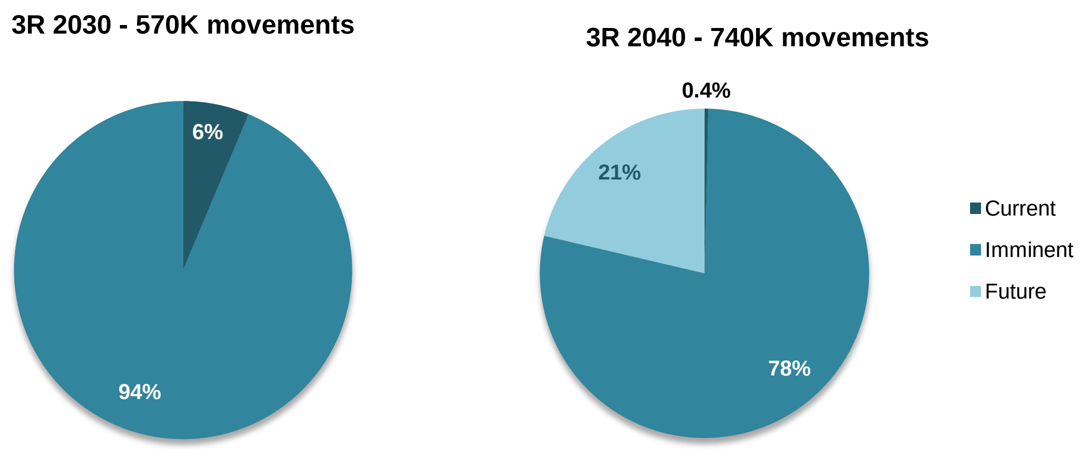
The A380 is regarded as 'imminent' and entered service around 2007. The SA roadmap indicates approximately 30 years for development of the Generation 2 version of this type, and so it is considered that entry into service around 2035 is a reasonable assumption for this future generation. Smaller Generation 2 types could be expected in service around 2025, with twin aisle and large types around 2035. There have been no assumed Future generation aircraft in 2030 regardless of size. It is expected that the Future Generation aircraft will start to come into service around 2035 and there will be approximately a 20% adoption of these types by 2040. These assumptions are slightly more optimistic than the DfT forecasts for 2030 and 2040 however given Heathrow's historic ability to attract a more modern and quiet fleet are considered plausible

These assumptions are presented in **Appendix C**.

It is projected that by 2030 around 95% of aircraft will be the latest and quietest, described by Sustainable Aviation as 'imminent' technology – or referred to within this document as 'next generation' technology. In 2040 around 20% are projected to be 'future' generation aircraft, 80% of the 'imminent'/ next generation.

[2] The SA Noise Road-Map 'A Blueprint for Managing Aviation Sources to 2050', Sustainable Aviation (2013)

Figure 4.3 Aircraft Fleet by Year



4.2 Quieter Airport Design

4.2.1 Masterplan Optimisation

A key factor in Heathrow's decision to move the new runway location further south when compared to the July 2013 submission was that noise modelling results indicated that there was a reduction in the number of people affected by noise. This reduction was in the order of 5% exposed to noise levels greater than 57 dB $L_{Aeq,16hr}$ noise exposure and largely because parts of west-London and the south-eastern part of Slough were less affected.

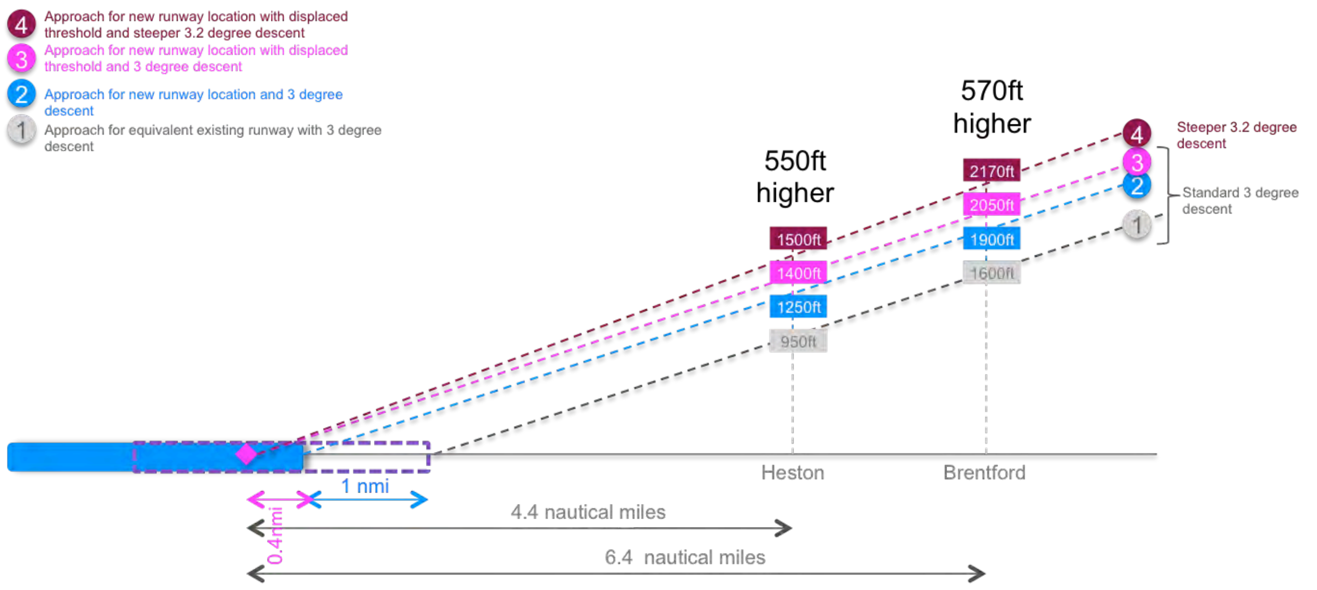
4.2.2 Displacing the Runway Threshold

The new runway and its associated infrastructure have been designated such that the point at which an aircraft lands is 700m down the runway from the runway end. This is known as a 'displaced threshold' and has the effect of increasing the height at which aircraft approach the airport. Since the aircraft are higher this results in noise levels on the ground being reduced.

As part of the infrastructure changes associated with the new runway, the overall Masterplan also includes significant modifications to the existing infrastructure that are required to enable significant displacement of the thresholds of the existing runways.

Figure 4.4 below indicates the benefits in terms of height over communities that moving the runway west, displacing the threshold and increasing the angle of descent can bring.

Figure 4.4 Benefits of Displacing the Runway Threshold and Steeper Approaches



4.3 **Quieter Operations**

Heathrow has developed a number of ways for to operate the airport more quietly. These include:

- Rotating runway use;
- Steeper approaches; and
- Night flights runway rotation

The assumptions behind each of these are explained further below.

Runway (mode) Rotation

In order to balance the number of arriving aircraft with the number of departing aircraft at a three-runway airport, one runway must be dedicated to Landing (L) aircraft, one to Departing (D) aircraft and the third must be used for both departing and landing aircraft simultaneously (DL).

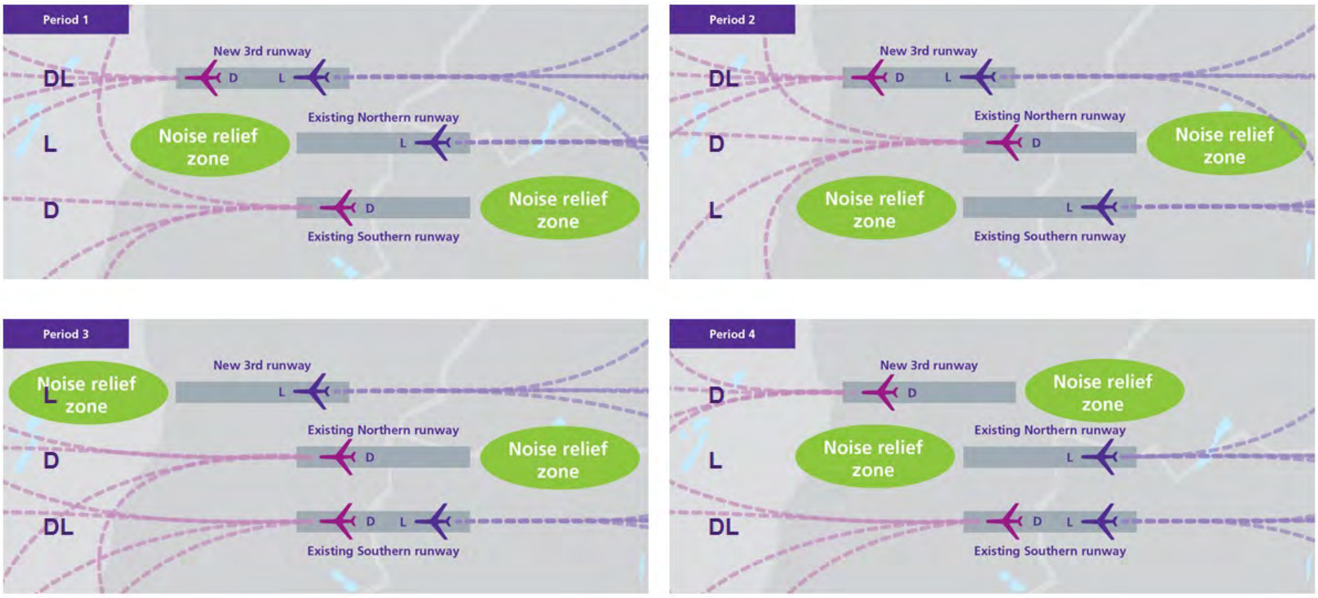
In effect, on the DL runway each departure movement is followed by a landing movement and then by another departure movement. By rotating these three uses around the three runways, it is possible to establish four different operating modes. This is illustrated in Figure 4.5.

Figure 4.5 Rotating Runway use to produce Alternative Operating Modes

	Mode 1	Mode 2	Mode 3	Mode 4
Northern runway	DL	DL	L	D
Centre runway	L	D	D	L
Southern runway	D	L	DL	DL

The use of Modes 1-4 can be rotated (or alternated) to provide and distribute noise relief. Each runway has at least one Departure and one Landing mode of operation as can be seen when reading horizontally across the patterns. This ensures respite can be provided for both arrivals and departures under the flight path for the runway. Figure 4.6 presents a series of illustrative examples that demonstrate how this can work for westerly operations. For easterly operations, the same principles apply.

Figure 4.6 Illustration of Effect on Noise Relief of Rotating the Four Operating Modes (shown for westerly operations)



Through the combined use of these four operating modes, relief can be provided from overflight to those communities closest to the airport. The effect is more pronounced under arrivals flight paths, because for the last four nautical miles the aircraft have to be lined up with the runway and are lower than the equivalent point on departure.

Adoption of four patterns of runway use (modes) would allow Heathrow to deliver relief from overflight from arriving and departing aircraft for communities closest to the airport (e.g. Colnbrook, Poyle, Hounslow, Harlington, Sipson). This is similar to the existing system, known as “runway alternation” which provides respite from aircraft noise to people that live under Heathrow’s westerly arrival flight paths.

There are a number of ways in which runway mode rotation can be implemented to provide respite. At this stage Heathrow has not developed any firm proposals, and instead intend that any system of rotation would be developed through public consultation.

4.3.1 Continuous Decent Approaches (CDA)

Aircraft operating at Heathrow are already required to follow a CDA for the existing runways. CDA would also be implemented for the new runway. Future arrivals would follow these approaches to a greater degree of accuracy through wider use of precision-based navigation technologies (e.g. GBAS). Research presented by ERCD has demonstrated that this measure has the potential to provide noise benefits of over 4 dB between 10 and 20 nmi from the runway threshold[3].

4.3.2 Steeper Approaches

Steeper approaches enable aircraft to be higher over areas on their approach to the airport. They also increase the rate of descent, thus reducing the amount of engine noise produced during landing. The CAA encourage steeper approaches3 to reduce noise however, the angle of approach can be limited by safety, operational and aircraft constraints. The international standard glide path is 3 degrees and is operated at almost all airports unless obstacles prohibit.

Based on advice from the aviation industry it is understood that Heathrow can implement a 3.2 degree approach for both the two existing runways and the proposed new runway in 2030. Based on this advice Heathrow believe it is feasible that a 3.5 degree approach would be achievable in 2040. This has been taken forward as an assumption within the assessment.

Steeper approaches are already being considered by the airport. Heathrow has made commitments to trial steeper approaches as part of its May 2013 ‘*A Quieter Heathrow*’ publication and in response to consultation on night flights.

The use of segmented approaches that would allow the majority of the approach to be undertaken at an even steeper angle before levelling off in preparation for the glide slope has not been included in the mitigation strategy. This potentially offers further noise reduction.

[3] Civil Aviation Authority CAP1165, ‘*Managing Aviation Noise*’ May 2013

4.3.3 Night Flights

To further reduce the impacts of night flights Heathrow has proposed to expand the current form of runway rotation for those aircraft arriving before 06:00hr to ensure that each runway is used in turn (where possible and within weather condition limitations).

As a result, each approach path could, for example, be used 1 night in every 6 - providing respite 5 nights out of 6. Weather conditions could play a part in a sequence being maintained around all 6 approaches, but even under unfavourable weather conditions (primarily wind direction), it would be possible to deliver respite for a minimum of 1 night in 3.

Heathrow has confirmed that any decision on the form of this rotation would be informed by further consultation with industry partners and communities.

4.4 Quieter Skies – Airspace Options

A significant programme of airspace modernisation is underway across Europe, including in the UK and in London which will be completed over the next decade. Airspace, often designed several decades ago, will be able to take advantage of the latest technology to navigate aircraft more precisely and operate more efficiently. Such 'Precision Based Navigation' (PBN) can also offer significant noise benefits. It allows routes to be redesigned more precisely to avoid the most densely populated areas. Heathrow recognise that this could mean a greater concentration of aircraft on specific tracks. However it will also be possible to create a number of routes for arrivals and departures, and to alternate these routes to deliver predicable periods of respite.

Heathrow is committed to taking full advantage of opportunities to manage airspace differently, working with local communities to identify changes that could benefit them. As part of the UK's Future Airspace Strategy, Heathrow is currently trialling new airspace management procedures to test the concept of providing predictable periods of respite.

Should a third runway be built at Heathrow, this would require an airspace redesign. The following section outlines the various options and concepts that could underpin this redesign, aligned with a number of noise objectives.

Airspace Options and Noise Objectives

The current Government policy objective set out in the Aviation Policy Framework (APF) is to *"limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise"*.

In support of the objectives of the APF the Airports Commission have stated an objective for noise *"to minimise and where possible reduce the impacts of noise"*. In the context of a new runway, this can be achieved in a number of ways.

Minimising impacts can be achieved by limiting the number of people that are overflown with the result that each person exposed to noise would be likely to experience greater overflight. Alternatively, more people can be exposed to overflight but provided relief from aircraft events and therefore reduce the overall impact on each person.

Heathrow has developed and assessed three airspace options that aim to provide policy makers with different approaches to achieving their noise objective:

- **Option T:** Designed to minimise the ***total number of people overflown*** (which is a refinement of the proposals in 2013);
- **Option N**: Designed to minimise the ***number of people newly overflown***; and
- **Option R:** Designed to ***maximise respite*** through the use of alternating arrival and departure routes.

There are advantages and disadvantages of each of these options in terms of the number of people overflown, the number of people exposed to noise, the number of new people overflown and the amount of respite that can be provided. It is not possible to fulfil all three objectives simultaneously and so the three options conflict with each other. Each of these options has been considered as part of the assessment.

Figure 4.7 Different Ways in which the Objective of 'Minimising Noise' can be Interpreted

Heathrow has worked closely with NATS to design indicative solutions for the airspace for a three-runway airport to meet each of these objectives. The designs conform to ICAO and CAA safety guidance and balance a runway throughput with ability to maintain the use of four separate operating modes in a rotating pattern i.e. runway alternation. Some of the route principles are currently being trialled at Heathrow or have been trialled elsewhere.

Airspace Design and Operational Noise Management

For each of the three proposed airspace options Heathrow has worked closely with NATS Heathrow to develop a final set of routes which have then been assessed. These are considered by NATS as being realistic and achievable and have been designed against design principles which themselves include various noise management and routing principles. These design principles are expanded in **Appendix C** and include features such as:

- Continuous Decent Approaches (CDA);
- Continuous Climb Departures (CCD); and
- Precision Based Navigation (PBN).

Indicative route designs for each airspace option and proposed operating modes are described and presented in the following sections. The design of the airspace would be subject to public consultation and engagement.

Routes are presented as a 1km corridor representing 500m either side of a PBN-based centre line to a distance of approximately 15 nmi from the airport. To provide reference and context routes are drawn over a typical day of westerly or easterly flight tracks.

Current trials at Heathrow indicate a high degree of accuracy and consistency of aircraft tracks when operating PBN based routes. These trials indicate typical concentration over approximately 300m, even when in a turn, with even better performance when flying on a straight track. The 1km corridor can therefore be considered as providing an indication of the worst-case maximum spread of future aircraft flight tracks.

The figures are presented in a summarised format within the following sections and can be found in more detail in **Appendix H**. All figures should be read using the key outlined in Table 4.1 below. The grey tracks represent the airports existing flight tracks as described and presented in the baseline in Section 3.1.

Table 4.1 Key for Airspace Options

Key	
(green line)	Option Landing Corridor
(blue line)	Option Departure Corridor
(grey line)	Existing Track

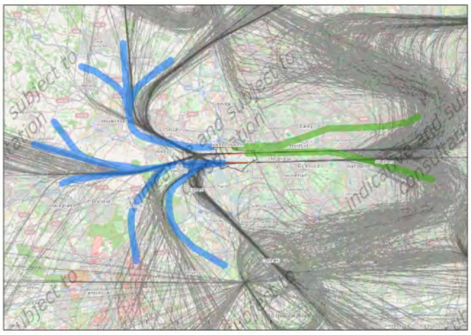
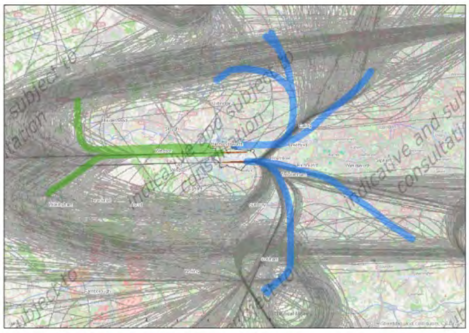
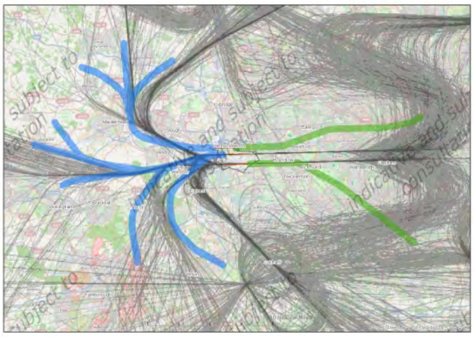
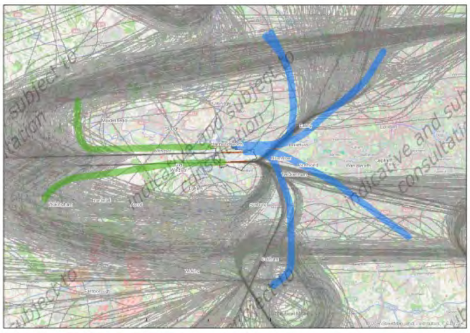
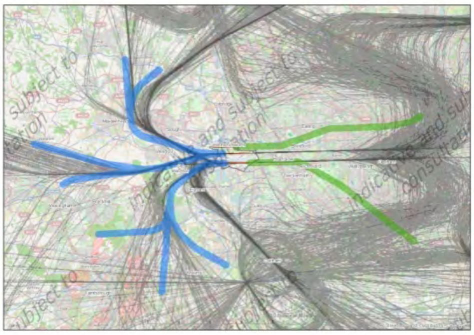
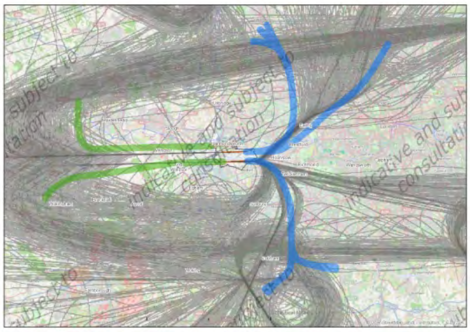
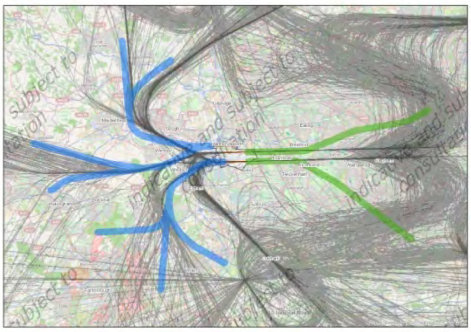
4.4.1 Option T: Minimise the *TOTAL* number of people overflown

This option minimises the total number of people overflown by landing and departing aircraft. This involves the use of the core structure of today's routes as the starting point which has been optimised to further reduce the total number of people overflown. These routes have been modified by overlaying the existing structure onto a population density map and adjusting each route in turn to areas of lowest population density.

For example, the route known as Dover (DVR), which during westerly operations currently tracks directly over Staines and Egham, has been combined with a route known as Midhurst (MID) that has also been slightly revised. By co-locating these routes they now fly over and affect fewer people than the two routes individually. In this example, the co-located routes are over areas that are likely to already experience overflight. In addition, the routes that track to the north-west between Slough and Maidenhead have been changed to reduce the number of people in Slough that are overflown.

The arrival paths to each runway have been modified to form 'curved' or 'staggered' approaches. This helps to avoid the most densely populated areas of London. As a result, significant areas of central, east and west London would no longer be overflown. Many areas would have noticeably fewer aircraft overhead, however other areas that are overflown today would become more consistently overflown. This would be a noticeable change for people living there.

Figure 4.8 – Option T – Minimise *Total* People – All Modes

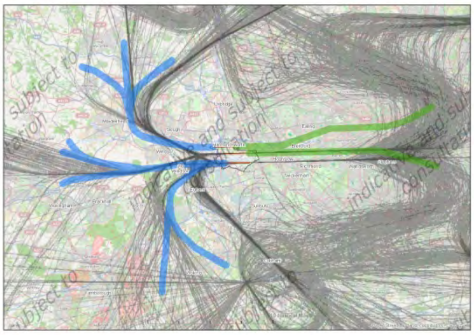
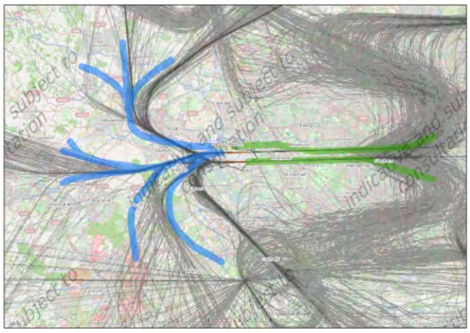
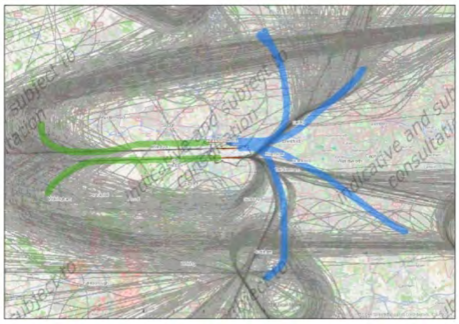
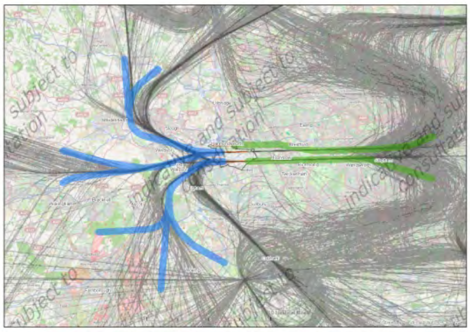
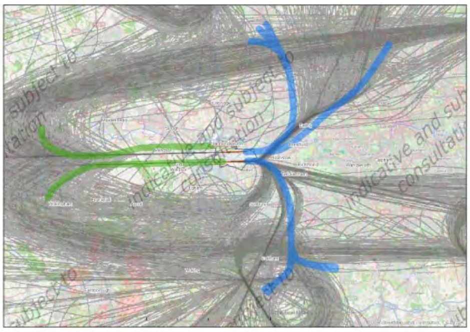
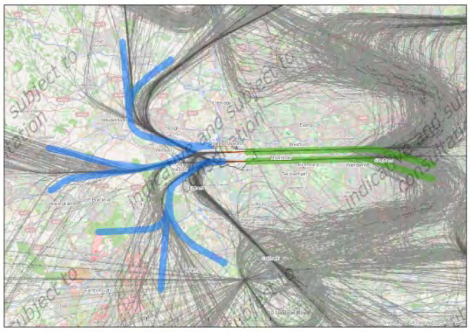
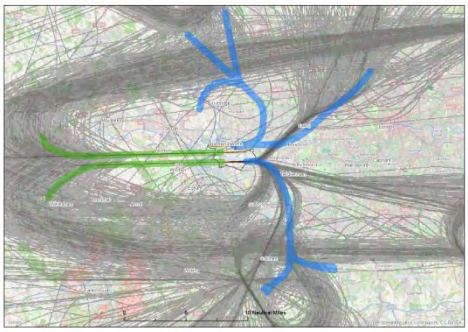
	Westerly	Easterly
DL L D		
DL D L		
L D DL		
D L DL		

Key	
Green line	Option Landing Corridor
Blue line	Option Departure Corridor
Grey line	Existing Track

4.4.2 Option N: Minimise the number of NEW people overflown

The core structure of the Option T routes has been used. In this case there are also a number of variations developed using typical current flight track data to indicate communities that would routinely be overflown today. There are approach routes to the new northern runway in modes when the centre runway is not being used for arrivals (in modes L-D-DL, DL-D-L) that have been modified such that the ground track is co-located with the approach to the centre runway. Aircraft switch to the final approach to the northern runway to intercept at 4 nmi. This occurs for easterly and westerly operations. It means that aircraft on approach to the northern runway (in the relevant mode) do not fly over new areas of north-west London where they would with the Option T design. As with Option T, noise relief is provided through alternation of the runway modes.

Figure 4.9 – Option N – Minimise *New* People – All Modes

	Westerly	Easterly
DL L D		
DL D L		
L D DL		
D L DL		

Key

- Option Landing Corridor
- Option Departure Corridor
- Existing Track

4.4.3 Option R: Maximise *RESPITE*

The third option (Option R) seeks to maximise the amount of respite that can be offered to communities in addition to that provided through mode rotation.

Consultation responses showed that 62% of all respondents felt that providing periods of relief from aircraft was more important than minimising the number of communities overflown (of those that chose to answer the specific question the ratio was 3:1 in favour of providing periods of relief).

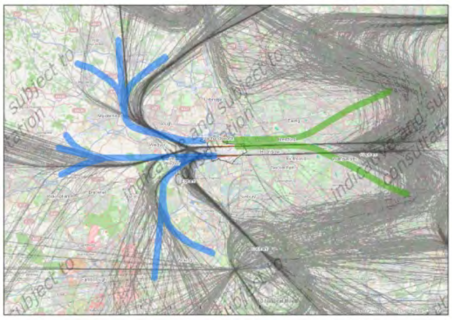
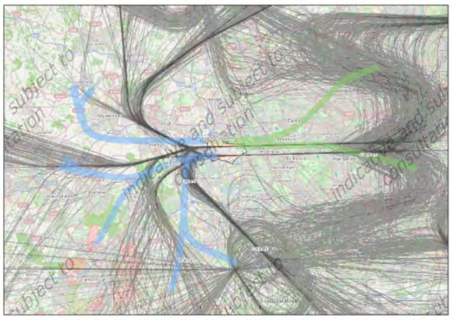
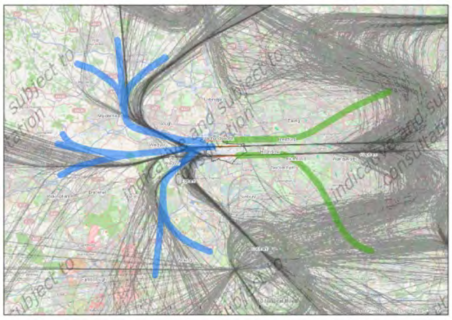
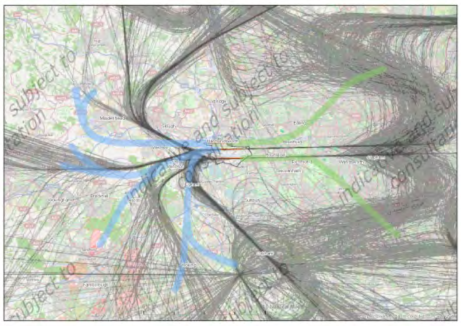
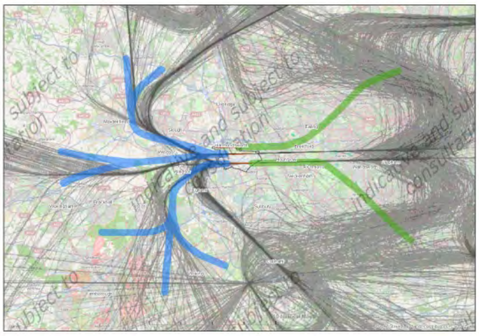
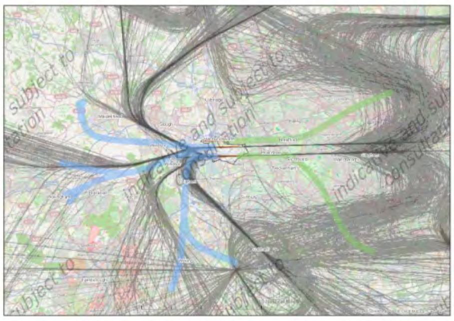
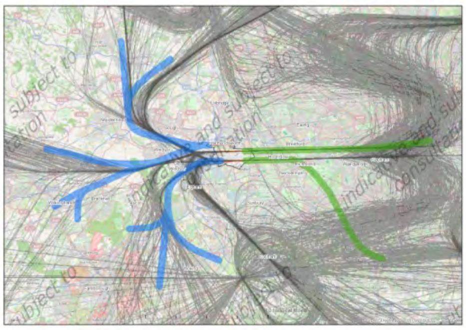
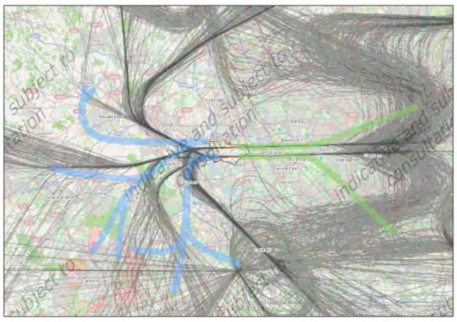
The basic design (Option T) delivers relief through alternation using different runway modes. Although this works well for communities close to the airport, this relief is mainly from arriving aircraft. In Options T and N, departures from different runways can share routes. There will therefore be households that would experience no respite from departures.

Option R aims to provide respite for those overflown by departures (beyond approximately 2.5 nmi) and by arrivals (beyond 4 nmi) by utilising the improved accuracy provided by PBN to fly alternate routes, whilst continuing to provide respite to those closer to the airport through mode rotation.

Two distinct alternatives for each route (both departure and approach to each runway) have been developed for each operating mode. Flights can then be alternated between these routes in a similar manner to today's runway alternation, maximising the ability to deliver relief for all communities. It also adopts the same solution for arriving flights where they are further out than the 4 nmi final approach. It provides two alternative routes for each arrival path to each runway, joining them together at the final approach start point. Within the airspace constraints Heathrow has tried to make the route options as far apart as possible to provide maximum opportunity for respite.

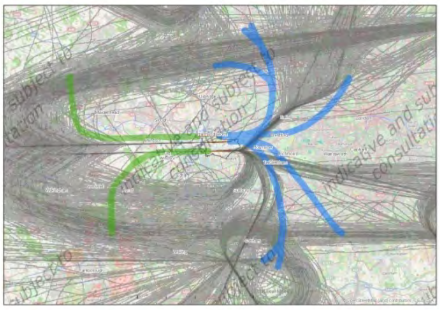
The way in which this option would be operated would be the subject of consultation. For the purposes of this assessment it has been assumed that each mode has been used equally.

Figure 4.10 – Option R – Maximise *Respite* – Westerly Modes

Westerly Operations Only		
	Period 1	Period 2
DL L D		
	Period 1	Period 2
DL D L		
	Period 1	Period 2
L D DL		
	Period 1	Period 2
D L DL		

Key	
(green)	Option Landing Corridor
(blue)	Option Departure Corridor
(grey)	Existing Track

Figure 4.11 – Option R – Maximise Respite – Easterly Modes

Easterly Operations Only		
	Period 1	Period 2
DL L D		
	Period 1	Period 2
DL D L		
	Period 1	Period 2
L D DL		
	Period 1	Period 2
D L DL		

Key	
Green line	Option Landing Corridor
Blue line	Option Departure Corridor
Grey line	Existing Track

4.5 Ground Noise

4.5.1 Aircraft Ground Noise

The Mitigation Strategy for ground noise has considered two domains of mitigation: physical and operational. Physical mitigation includes purposefully designed measures to screen noise from the airside and from the local road network. Operational mitigation includes measures that aim to reduce noise at source.

Physical Mitigation

The Masterplan includes a number of physical mitigation measures that will help reduce noise from airside ground operations.

The design of the Masterplan layout has, as far as possible, maximised the distances between taxiways, aprons and stands thus helping reduce the aircraft ground noise experienced by those who live near to the airport boundary. At the boundary the Masterplan includes noise bunding and acoustic fencing at five key locations that will help reduce noise from airside operations for people living in Harmondsworth, Sipson, Poyle, Stanwell and Stanwell Moor. It is these locations that will observe the most change in aircraft ground noise as a result of a third runway.

These physical measures include:

- A 5m high noise attenuation bund at the boundary with Sipson;
- A 3m high bund at the boundary with Harmondsworth; and
- 5m high acoustic fences at the boundaries with Poyle, Stanwell and Stanwell Moor.

The design of these measures has taken into consideration the likely effectiveness of the measures, design sensitivities of the airfield and landscape and visual impacts. The heights of these measures are the maximum possible without causing undue interference with other aspects of the masterplan such as the glide slopes.

Aircraft Engine Ground Running (EGR) was identified during consultation as a potential issue during the night. The Masterplan includes a new location for aircraft Engine Ground Running (EGR) which is very close to an existing EGR location and enclosure. A Ground Running Enclosure (GRE) designed specifically to reduce this noise has been included and costed for within the Mitigation Strategy. This GRE will reduce EGR noise by providing an acoustic screen between aircraft and surrounding communities.

During the design of the terminals and ancillary uses, Heathrow has committed to ensuring that other noise producing plant and activities are screened from communities either through informed placement or through further physical measures.

Operational Mitigation

Physical mitigation will help reduce the airport's ground noise impacts however noise-reduced operating practices and the use of quieter airside equipment also forms part of the Mitigation Strategy.

Heathrow will where practicable, employ measures that will help reduce the noise the aircraft make while they are on the ground. These measures share many of the principles within Air Quality Mitigation Strategy.

To avoid producing noise on the ground, Heathrow will provide:

- Fixed Electrical Ground Power (FEGP) and Pre-Conditioned Air (PCA) at all aircraft stands, to avoid the need for aircraft to produce noise through using their APU whilst on-stand. As part of the Air Quality Mitigation Strategy, the airport will aim to reduce APU running times to a maximum of 40 minutes for wide-body jets and to 20 minutes for narrow-body jets;
- Stand-by Ground Power Units (GPUs) will be used should FEGP be unavailable;
- Collaborative Decision Making (CDM)[4] will reduce taxi and hold times, thus reducing the amount of time aircraft are producing noise whilst stationary and during taxiing. This will help to reduce emissions from aircraft both on the ground and in the air;
- New and modern airside equipment such as electric vehicles and clatter-resistant baggage trolleys that will further reduce airside noise; and
- Procedures will be developed with ground service operators to ensure that all airside equipment is suitably maintained to avoid noise from wear and tear.

In addition to the above, the strategic use of aircraft stands during quieter periods such as the night has been investigated. This measure attempts to maximise the amount of airside activity that is shielded from receptors by terminal buildings and airport structures. This measure will require further development through ground movements modelling. Heathrow will be expanding its current Noise and Track Keeping systems to include ground movement data which will further help facilitate this measure.

Heathrow's existing Ground Running Enclosure (GRE) is subject to noise restrictions limiting the average and total duration during the night. Any change or relocation of the airport's GRE is likely to require similar restrictions.

4.5.2 Road Traffic Noise

Within the Mitigation Strategy, Heathrow has made a provision to erect roadside noise barriers along new and realigned sections of carriageway and where communities are most likely to experience increases in road traffic noise as a result of development.

[4] CDM is a management process that involves co-operation between pilots, airlines, ground crew, air traffic control and airspace management agencies which aims to eliminate flight delays both in the air (no stacking) and on the ground (reduced hold and taxi times).

Heathrow has committed to providing up to 4km of roadside noise barriers. The effectiveness of these barriers has been considered along sections of the realigned A4 and the A3113 where increases in road traffic noise is likely due to new and realigned carriageways and increased traffic volumes. The Masterplan and preliminary civil designs for the M25 includes placing sections of motorway within a cutting and tunnel which will further assist in reducing road traffic noise.

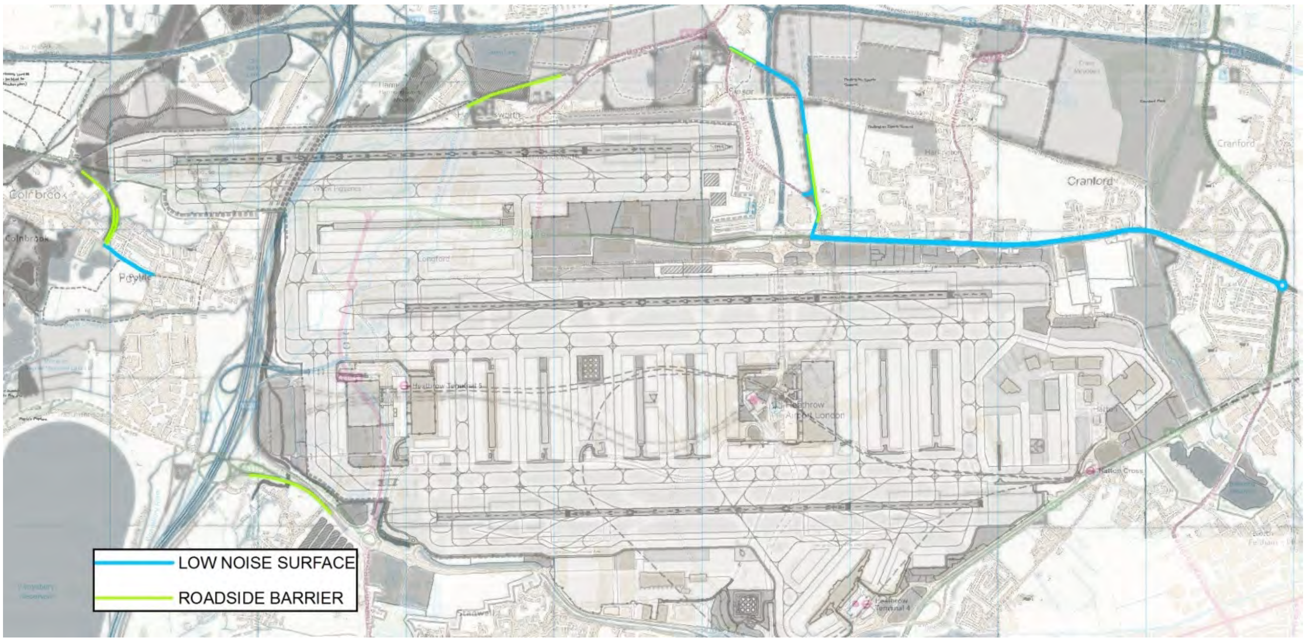
Road traffic noise due to airport traffic will be managed through the development of the Airport Surface Access Strategy (ASAS) which will ensure that a three-runway Heathrow Airport does not generate any more road traffic than is the case today with a two-runway airport.

To further reduce road traffic noise impacts, low-noise surfacing will be used where practical and effective. With reference to best practice guidance, these surfaces are to be located where road traffic noise could increase as a result of a three-runway Heathrow and traffic conditions make these surfaces effective. Two locations have been highlighted where low-noise surfaces in the form of pervious surfacing would be advantageous. These locations are:

- Bath Road between Colnbrook and Poyle; and
- The A4 between Henlys Roundabout and the Tunnel Road Roundabout.

The location of potential road traffic noise measures are identified within Figure 4.13. The blue lines show where low-noise surfacing could be provided. The green lines illustrate where roadside barriers could also be located.

Figure 4.12 Potential Locations of Roadside Noise Barriers and Low Noise Surfacing



4.6 Insulation and Compensation

Heathrow's Mitigation Strategy will help reduce noise, although there will still be dwellings and community facilities that will be adversely affected by noise. Heathrow has therefore made provision for a noise insulation scheme that will reduce noise levels inside these properties.

Heathrow has allocated a £250 million fund to pay for noise insulation and compensation for dwellings and community buildings that are exposed to significant new noise.

At this stage there are no proposals as to how this fund would be allocated around the Airport. Heathrow propose that the specifics of any noise insulation and compensation scheme be developed in consultation with local communities. Heathrow is working with a panel of local community representatives to develop a more detailed consultation on noise insulation and compensation proposals.

In high-level terms the noise insulation and compensation package would comprise of three core elements:

- An offer to buy homes;
- A relocation assistance package; and
- A noise insulation scheme.

Over the past two years Heathrow has supplemented its existing noise insulation schemes with its Quieter Homes Initiative. This scheme includes engaging directly with homeowners to assess the needs of their property and offering a 100% contribution to the specific insulation costs with a range of products and styles appropriate for that property. Heathrow has received feedback that indicates this has been particularly well received. As a result, Heathrow will take this approach to help inform dialogue with community representatives and consultation during Summer 2014.

5. Assessment Methodology

5.1 Key Assumptions for Assessment

Based on the Mitigation Strategy and through consultation with key industry stakeholders the following key assumptions have been adopted for assessment purposes. These key assumptions are presented in Table 5.1 below.

Table 5.1 Key Assumptions for Assessment

Assumption	2R Base	2R 2030	2R 2040	3R 2030	3R 2040	Comment
Airport Capacity (Movements / % capacity)	480k / 100%	480k / 100%	480k / 100%	570k / 77%	740k / 100%	3R airport at circa 80% capacity in 2030, 100% in 2040
Displaced Thresholds	✖	✖	✖	✔	✔	Significant airfield works required for displaced thresholds. It is proposed that for the existing runways these would be incorporate as a part of the overall airfield masterplan development for a 3R airport. Not part of masterplan for 2R airport.
Approach Glideslope (degrees)	3.0	3.2	3.5	3.2	3.5	Increasing the glideslope to 3.2 degrees is already planned for Heathrow. It is considered that a 3R airport could incorporate a 3.5 degree slope by 2040.
Fleet	Current Imminent	Current Imminent	Current Imminent Future	Current Imminent	Current Imminent Future	Heathrow has always been able to attract a more modern and "quieter fleet". <1% 'current' in 2040.
Optimised arrival routes	Existing	Existing	Existing	✔	✔	Use of PBN procedures will improve accuracy and consistency of the approach flight tracks in the future.
Continuous Descent Approach	✔	✔	✔	✔	✔	PBN procedures will precisely guide all aircraft in a continuous descent following glideslope angle in future 2R and 3R cases. Guided descent picked up from 6,000ft. Currently not all aircraft follow continuous descent.
Optimised departures	Existing	Existing	Existing	✔	✔	For a 3R airport the airspace must be redesigned so it has been assumed that the opportunity to optimise would be taken.
Continuous Climb Departure	✔	✔	✔	✔	✔	Advance airspace management and PBN will enable every departure to operate a continuous climb-out in the future 2R and 3R cases. Currently not all aircraft follow continuous climb.
Night-time rotation before 06:00	✔	✔	✔	✔	✔	Rotation at night possible in 2R scenario as well 3R scenarios.

Table 5.1 (continued) Key Assumptions for Assessment

Assumption	2R Base	2R 2030	2R 2040	3R 2030	3R 2040	Comment
Full Runway Alternation during Easterly and Westerly Conditions	✖ West Only	✔	✔	✔	✔	2R - Runway alternation assumed in both easterly and westerly operations for 2030 and 2040. 3R - Mode rotation – 4 modes available to rotate in both easterly and westerly direction. Baseline conditions include the Cranford Agreement which means runway alternation only occurs during westerly conditions.
Night Flights (23:30-06:00)	✔	✔	✔	✔	✔	Night flights would continue but there would be no more than today.
Airport Traffic	n/a		n/a	No increase in airport traffic compared to 2R		Airport Surface Access Strategy (ASAS) demands no more airport traffic than today for 3R
Aircraft Ground Noise Emissions	Measured			No noisier than today		There is no direct correlation between aircraft noise levels in the air verses those on the ground. It is therefore assumed that aircraft ground noise emissions will be no worse than today.

5.2 Assessment Scenarios

This section outlines the various scenarios that have been considered for assessment. The scenarios consider the assumptions outlined in Section 5.1. The core headline scenarios relate to either a two or three-runway Heathrow operating in 2030 or 2040. Current day baseline conditions have also been considered.

The baseline operating Air Traffic Movements (ATMs) at Heathrow were 480k per annum. This level of aircraft movement is a limit that was set through a planning condition as part of Heathrow's Terminal 5 planning consent. This limit has been assumed for a two-runway Heathrow in 2030 and 2040.

In 2030, it is assumed that a three-runway Heathrow would operate at 570k movements per annum (around 80% capacity). In 2040, it is assumed that a three-runway Heathrow would reach capacity at 740k per annum. These assumptions are based on a number of forecasting considerations such as market growth rates and demand.

A full description of the development of the fleet forecast scenarios is provided in **Appendix C.**

5.2.1 Aircraft Noise

For aircraft noise and airside ground noise, the following scenarios have been considered:

- Baseline 'today', 480k movements per annum;

- ‘Do-minimum’[5] base cases - 480k movements per annum, 2R 2030 and 2R 2040;
- Assessment cases:
  - 3R 2030 - 570k movements per annum;
  - 3R 2040 - 740k movements per annum.

In order to support the evidence provided in Heathrow’s May 2014 publication *‘Taking Britain Further’* consideration has been given to current baseline conditions using the most recent relevant information.

5.2.2 Road Traffic Noise

For road traffic noise, the assessment has considered scenarios with and without a new runway in 2030 and with a new runway in 2040. This approach allows short-term and long-term impacts to be assessed as per the DMRB guidance.

5.3 Noise Modelling

A full description of the noise modelling methodology is presented in **Appendix D.**

5.3.1 Aircraft Noise

Aircraft noise modelling has been used for two primary purposes:

- To help guide the iterative development of the masterplan and noise mitigation measures;
- To assess impacts using the Commission’s noise ‘scorecard’.

Two noise models have been used:

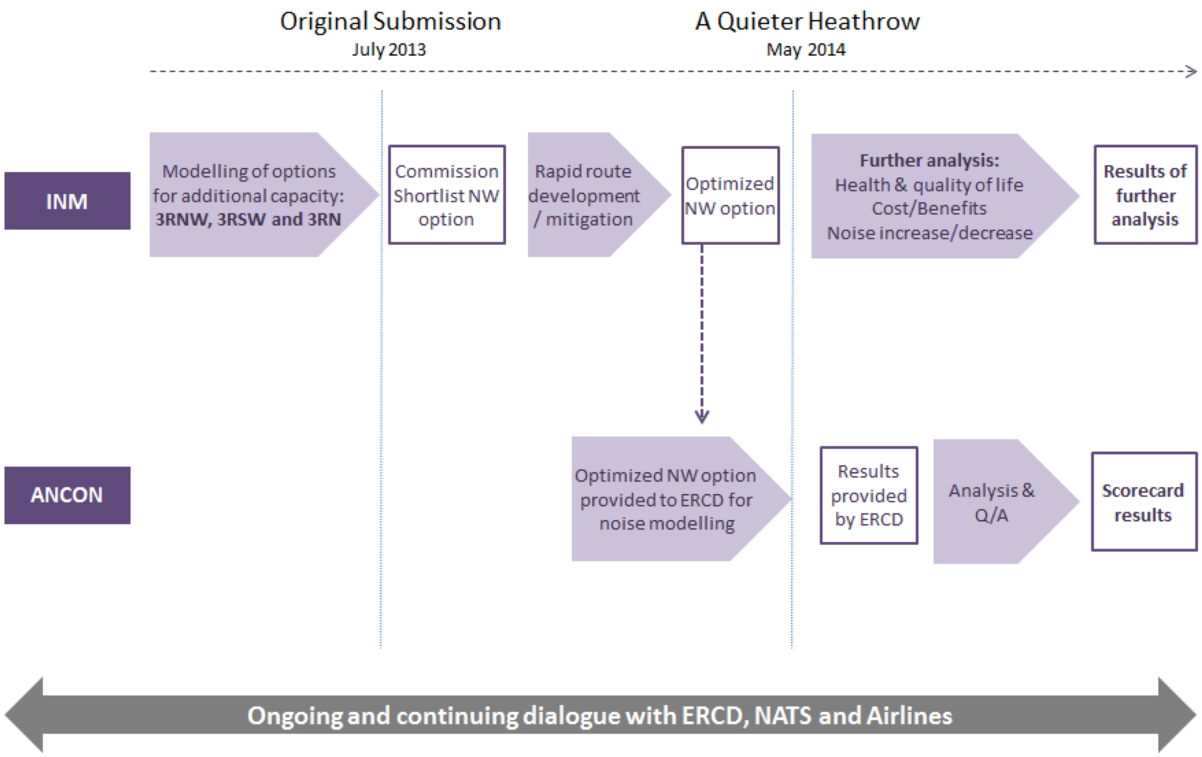
- **INM** noise modelling has been used to help inform the development of the masterplan and the Mitigation Strategy. This software has allowed multiple airspace options and mitigation measures to be rapidly assessed and updated in very short time frames – guiding the iterative optimisation of the proposals; and
- The CAA’s Environmental Research and Consultancy Department (ERCD) were commissioned to use their **ANCON** noise model to assess the key noise metrics set out within the Commission’s noise “scorecard” (presented in Section 6). This was undertaken once the NW option was finalised following the optimisation process guided by INM.

Both models are compliant with international standards for aircraft noise modelling.

[5] Airports Commission Sustainability Appraisal Framework (SAF) discusses ‘do-minimum’ scenarios as assessment base cases which consider future levels of airport traffic and predicted technological improvements.

Figure 5.1 below shows the noise modelling approach in terms of a timeline.

Figure 5.1 Aircraft Noise Modelling and Masterplan Preparation



ANCON has been used to corroborate the INM modelling and has been used to provide the resultant key noise metrics set out within the Commission's noise scorecard. The results of the INM modelling have also been used for assessment purposes. This is clarified in Section 5.4.

INM-ANCON Comparison

A comparison of the INM and ANCON modelling has been undertaken and is presented in **Appendix E**. The comparison has demonstrated a good level of correlation between the INM and ANCON outputs in terms of overall contour shape and area. Similar trends in terms of noise exposure between the scenarios outlined in Section 5.2 have been identified in both sets of model results.

Although the trends identified in the results of the modelling are comparable for INM and ANCON, there are a number of differences between the two, including:

- INM produces smaller contours than ANCON at lower exposure values such as 54 dB $L_{Aeq, 16hr}$ and 55 dB L_{den}; and

- ANCON produces smaller contours at higher noise exposure values such as 69 dB $L_{Aeq,\ 16hr}$, and 70 dB L_{den}.

Based on discussions with ERCD the differences outlined above are a result of the following factors:

- Consideration of CDA and CCD:
  - INM considers in full these measures as proposed by Heathrow and as identified by the CAA in the document *'Managing Aircraft Noise'* as techniques to limit and reduce aircraft noise on the ground;
  - ANCON considers the vertical alignment of arrivals and departures based on today's average profiles although ERCD have made some adjustments to the final approach glideslopes from 10-12nmi reflect the proposed 3.2 and 3.5 degree descents;
  - This means that at locations further from the airport ANCON models aircraft at a lower height than INM. This is responsible for ANCON generating larger noise contours at the lower noise exposure levels.
- There are differences between the INM and ANCON aircraft emission datasets, however, these are broadly consistent.

A comparison of the calculated INM and ANCON contour areas is provided in Table 5.3 below for each of the modelled 2030 and 2040 'do-minimum' and 3R airspace options. The table presents the calculated contour areas in km^2 from INM and ANCON along with a comparison of the contour areas as a percentage of the ANCON contour size against its equivalent from INM. Where the percentage is more than 100%, this indicates that ANCON produced a larger contour than INM. Conversely, where the percentage is less than 100%, this indicates that ANCON produced a contour smaller than INM. The table also presents the average comparison.

Table 5.2 Comparison of Contour Areas between ANCON and INM

	57 dB $L_{Aeq\ 16hr}$			55 dB L_{den}			48 dB $L_{Aeq,\ 8hr\ (night)}$		
Modelled Option	**INM**	**ANCON**	**Comp.**	**INM**	**ANCON**	**Comp.**	**INM**	**ANCON**	**Comp.**
2030 2R 'do minimum'	62.7	69.5	111%	116.7	136.1	117%	69.0	76.2	110%
2040 2R 'do minimum'	63.3	66.1	104%	116.5	125.8	108%	69.3	69.3	100%
2030 Option T	86.1	87.8	102%	151.2	160.9	106%	76.9	86.0	112%
2040 Option T	102.0	99.1	97%	181.4	180.4	99%	90.5	90.3	100%
2030 Option N	88.1	91.7	104%	154.7	170.4	110%	81.2	91.1	112%
2040 Option N	104.6	103.4	99%	184.8	190.3	103%	96.0	95.0	99%
2030 Option R	83.1	85.0	102%	145.9	154.2	106%	75.9	84.5	111%
2040 Option R	98.9	95.8	97%	176.7	173.6	98%	88.9	89.2	100%
	Average		**102%**	**Average**		**106%**	**Average**		**106%**

Table 5.3 shows that for each of the key metrics, ANCON typically produces larger contours than its INM equivalent. On average, the difference in contour areas is less than 10% and, as observed above, can generally be found most significantly in the areas dominated by the westerly approach paths.

5.3.2 Ground Noise

For the assessment of ground noise from airside and road traffic noise sources, 3D noise models have been developed using the LimAarc noise modelling suite. These noise models have used various digital mapping datasets available from Ordnance Survey alongside specific airport designs including the masterplan. Ground noise emission models have been developed from data sources including road traffic models and airport ground movements modelling.

5.4 Aircraft Noise Assessment

For each air noise assessment scenario and Heathrow's three airspace options, a number of assessments have been undertaken. These are outlined in the following sections.

5.4.1 Population Affected by Noise

The noise model contour outputs have been 'overlaid' against geographical population data to calculate the number of people affected by noise for the various relevant metrics and scenarios. This population exposure analysis has been based upon recently updated data from CACI. This information has allowed populations to be assessed against base year data and against forecast 2030 and 2040 data.

Where comparisons are made between years, for example the baseline year and 2030, the assessment has adopted the 'baseline' population. This has allowed changes in the population exposed to noise to be assessed against a consistent base. For example, where a 30% reduction in the number of people exposed is presented between the baseline year and a future year, this is based on the 'baseline' population (i.e. no population growth).

It should be noted that forecast populations are simply forecasts as undertaken by CACI using available information. It is not possible to determine with any great accuracy the exact location of any population change or identify whether Heathrow development would affect it.

The detailed results of the aircraft noise assessment presented in **Appendix E** provide data that considers baseline and forecast populations i.e. with and without population growth.

When making comparisons to the baseline, the most recent available data has been used. For INM, this is for 2011, and for ANCON this is for 2012. The INM model has used 2011 to keep consistency with the July 2013 submission. However, the population data for this was updated using the 2013 CACI update based on the 2001 census.

Table 5.4 outlines the noise exposure metrics that have been given consideration in the assessment. T hese metrics align with the SAF 'noise measurement' metrics as defined in the 'Noise scorecard'. In presenting the 'noise scorecard' in Section 6.1 the table presents the metric value which has been adopted. For $L_{Aeq, 16hr}$, L_{den} and $L_{Aeq, 8hr night}$ this value is the lowest of the presentation range set out by the Commission. For the N70 and N60, the presentation value has been selected since this is the point at which differences between the scenarios become apparent.

Table 5.3 Noise Exposure Metrics considered within Assessment

Metrics	Presentation Range	Noise Scorecard Presentation Value
LAeq, 16hr	54 dB to 72 dB in 3 dB bands	54 dB $L_{Aeq, 16hr}$
Lden	55 dB to 75 dB in 5 dB bands	55 dB L_{den}
$L_{Aeq, 8hr night}$	48 dB to 72 dB in 3 dB bands	48 dB $L_{Aeq, 8hr night}$
N70 day	Presented in bands from 50 events	50 events (N70)
N60 night	Presented in bands from 25 events	25 events (N70)

5.4.2 Assessment of Changes in Noise Exposure

An assessment of change in noise exposure has been undertaken at postcode points, compared to the baseline noise exposure, in bands representing:

- Significant adverse change (an increase in average noise level of at least 3 dB);
- No change (i.e. a change of less than 3 dB); and
- Significant improvement (a reduction in average noise level of at least 3 dB).

This has been assessed within a noise exposure threshold defined by the composite of the outer boundary of the lowest stated Appraisal Framework noise scorecard metrics (i.e. 55 dB L_{den}, 54 dB $L_{Aeq,16hr}$, 48 dB L_{night}) for either the existing or future cases. This combined "area of interest" indicates the areas where people may be considered affected by aircraft noise now or in the future according to standard metrics.

This assessment has been based on INM model outputs.

5.4.3 Assessment of Respite

There is currently no agreed method for assessing respite or its value to the local community. The Commission identified relief or respite from noise as important but provided no guidance on how to assess or evaluate its effectiveness and/or value.

Respite is a function of the noise level that could cause disturbance and the degree of overflight. Both of these aspects are the subject of significant debate. For example, when is an aircraft considered to be causing a disturbance and in what frequency might that be acceptable? As a result, the analysis and justification can become complex. Heathrow is currently undertaking a number of surveys designed to aid further understanding of this mitigation measure.

In the absence of an agreed methodology it has been necessary to develop a means for assessing the degree of respite being provided currently and in the future for the potential airspace options. The focus has been to develop a methodology that is easy to understand. Consequently the approach has removed the noise related aspect and the acceptable frequency of flights and considers only whether an area is overflown or not. The key aspects of the methodology include:

- The study area for respite has been set as follows:
  - Within a distance of 15 nmi from the airport;
  - This reflects the range within which the vast majority of complaints are received and is significantly further than the standard contours extend;
  - Aircraft on approach would be at around 4,500 ft AAL with today's 3 degree glideslope and 5,000 ft AAL on a steeper 3.2 degree approach. On departure, aircraft are in the region of 6,000ft AAL;
  - As defined in Section 4.4, all routes are defined as a corridor 1km wide, which is a corridor of 500m either side of a PBN centreline. PBN has been shown in trials to enable consistent and accurate flight paths where the spread of aircraft is typically around 300m. It is considered that 500m corridor is sufficient to define what might reasonably be considered to be direct overflight.
- A property is considered to be overflown if it is within the area contained by a 1km corridor of an arrival or departure route in a specific mode within a range of 15 nmi of the airport (as presented in the airspace design options in Section 4.4 and presented in **Appendix H**);
- If a property is overflown (i.e. it is within a mode route corridor), it does not receive respite during that mode;
- It is assumed that the modes in each direction are operated evenly across a defined period. As the modes are rotated the number of modes where a property is within the area of a route are counted, these are periods when respite is not provided;
- When a property is not within a mode route corridor, the property receives respite during that mode;
- No consideration is given to the number of aircraft or frequency of flights during a mode (i.e. it could be 1 flight or 100 flights).

By way of example, if a property is within the route corridor structure associated with 1 of 4 westerly modes, then the property is potentially overflown 25% of the time; it therefore receives 75% respite during westerly operations. If that same property is then not within the corridor for any easterly modes, then there is 100% respite during easterly operation.

Following on from identification of the degree of respite provided when the modes are rotated and the likely proportion of easterly and westerly operations, it is then possible to identify the approximate number of days that an area may be overflown in a year. For example, following the respite example above, if an area is overflown by 1 westerly mode and no easterly modes and the split of movements is 80% westerly and 20% easterly, then the area could expect to be overflown for approximately 20% of the year.

A fully worked example of calculating respite using the methodology described above is provided in **Appendix G**.

5.4.4 Monetisation – Health, Annoyance and Social Cost

The Commission has proposed a methodology for the monetisation of aviation noise. However, the Commission also acknowledge that there is no commonly agreed method for monetising aviation noise.

It is clear that monetising the noise effects of aviation is an important issue and would allow social and environmental costs to be recognised alongside the significant economic benefits when making decisions on new capacity. However, there is no optimal approach for doing this and given the limitations and uncertainties of the various potential methodologies no monetisation data has been prepared for this submission. Heathrow has previously acknowledged both the value and challenges of monetising the effects of noise. Indeed in their submission to the Airports Commissions Noise Discussion Paper they recommended that an expert panel should be established which represents the interests of different stakeholders in order to identify what methodology if any is appropriate to use in the Commissions work.

Heathrow recognises that this is an important issue and given the lack of consensus on the most appropriate methodology intends to produce a separate note shortly.

5.5 Ground Noise Assessment

5.5.1 Aircraft Ground Noise

The assessment of aircraft ground noise has considered the following sources of aircraft ground noise:

- Taxiing;
- APUs;
- Holding; and
- Moving between holds.

A full assessment methodology is presented in **Appendix F**.

Assessment of Event Levels and Mitigation Performance

The assessment has considered the performance of a variety of physical and operational mitigation measures that will help reduce noise impacts from aircraft ground noise. These assessments have considered noise levels with and without the proposed physical mitigation, and where possible, potential operational measures. An assessment has been undertaken to evaluate the effect of the proposed mitigation on the level of noise exposure to aircraft ground noise.

Population Exposure Assessment

A population exposure assessment has been undertaken with respect to the $L_{Aeq, 16hr}$, L_{den} and $L_{Aeq, 8hr}$ night noise metrics. The exposure bands outlined in Table 6.1, as required in the Scorecard, have been reproduced. The assessment has considered scenarios with and without mitigation in 2030 and 2040. The assessment has considered noise exposure changes compared to baseline conditions using the same approach outlined in Section 5.4.2 for aircraft noise.

For the population exposure assessment, all assessments are based on OS Address Layer 2 information to identify residential dwellings and postcode information provided by CACI to identify the population per household. No consideration has been given to population growth due to the detailed spatial aspects of the noise model which would require an understanding of the exactly location of new households.

5.5.2 Road Traffic Noise

The most notable impacts due to road traffic noise will occur in the opening year, or during early operation of the new road network incorporating a new runway at Heathrow. It is at this time that people may experience a change in road traffic noise as a result of the development.

Unlike the aircraft noise assessment, a comparison of 3R verses 2R has been made between 2030 3R and 2030 2R, and again for 2040 3R and 2040 2R. This is because any comparison back to baseline conditions would consider changes in road traffic noise that are not directly influenced by the airport's operations. For example, background traffic trends alone could distort the direct effect of the change in the road network.

The SAF requires the identification of roads that will experience a change of at least 25% in road traffic. This change under DMRB guidance is equivalent to 1 dB based on traffic flow alone. This does not consider any change in other road traffic characteristics, such as vehicle composition or traffic speeds. For this assessment, roads with a change of at least 1 dB, based on noise modelling results, have been identified.

Assessment of Mitigation Performance

An assessment has been undertaken to consider the potential performance of the proposed roadside noise barriers and road surfacing. The assessment has considered road traffic noise in terms of the $L_{A10, 18hr}$[6] noise metric with and without mitigation in the form of noise change maps to demonstrate performance. An assessment, as described in the following section considering noise exposure levels, has also been undertaken with and without mitigation.

[6] The $L_{A10, 18hr}$ noise metric is synonymous in UK legislation, policy and guidance for the assessment of road traffic noise. It is often referred to as the 'UK Traffic Noise Index'.

Population Exposure Assessment

A population noise exposure assessment has been undertaken to compare road traffic noise in 2030 and 2040 with and without a third runway. The assessment has considered noise level change magnitudes as defined by the DMRB for the 'short-term'.

The exposure assessment has considered two key noise exposure thresholds, amongst others:

- 57 dB $L_{A10, 18hr}$ (equivalent to 55 dB $L_{Aeq, 16hr}$ as described by WHO);
- 68 dB $L_{A10, 18hr}$ – noise exposure threshold used as part of the assessment of statutory noise insulation under the Noise Insulation Regulations 1975;
- As per the assessment of Aircraft Ground Noise, no consideration has been given to population growth, and as such, baseline populations have been used within the assessment.

Noise Insulation Regulations Assessment

A high level indicative assessment against the criteria outlined under the Noise Insulation Regulations (NIR) has been undertaken. This has sought to identify any residential dwellings that would be eligible for noise insulation under the regulations by satisfying the following criterion:

- Exposure to road traffic noise levels of at least 68 dB $L_{A10, 18hr}$;
- A change of 1 dB in noise exposure as a result of new or realigned carriageway; and
- Located within 300m of any new or realigned carriageways.

The assessment is considered high level as it has been based on 10m noise level grids, rather than noise calculation at building facades.

6. Evidence for Key Findings

This section presents the key findings which are supported by the detailed assessment outcomes and further information as provided in **Appendices E - I**.

6.1 Noise Scorecard

Table 6.1 presents a 'noise measurement' scorecard summary. The scorecard assumes no increase in population between the base year and future years. The scorecard presented in Table 6.1 considers population exposure above the stated thresholds. The information presented is based on the ANCON modelling outputs detailed in **Appendix E**. Where data is available, a comparison against the baseline conditions is provided. A comprehensive set of results including the number of households and area exposed to different levels of aircraft noise are presented in **Appendix E** along with corresponding noise contours maps.

Table 6.1 Noise Measurement Scorecard – Population Exposure – ANCON Outputs

Metric	2012/13	2030 (570k movements)				2040 (740k movements)			
	2R	2R	3R			2R	3R		
	Baseline	Do-min	Opt T	Opt N	Opt R	Do-min	Opt T	Opt N	Opt R
54 dB $L_{Aeq, 16hr}$	586,050[3]	373,350	297,600	387,700	319,800	322,400	345,950	457,950	364,600
57 dB $L_{Aeq, 16hr}$	237,350[2]	169,500	170,350	184,950	173,550	152,800	187,800	202,900	192,800
69 dB $L_{Aeq, 16hr}$	3,200[1]	950	200	250	200	350	600	600	600
55 dB L_{den}	725,000[1]	446,350	428,100	460,350	361,650	375,050	408,450	525,450	399,050
48 dB $L_{Aeq, 8hr}$ (night)	n/a[4]	220,750	203,150	234,650	194,650	199,100	207,900	240,650	206,250
> 50 events N70 daytime	n/a	169,700	184,400	184,600	176,750	154,000	176,400	173,650	179,300
> 25 evens N60 night	n/a	120,050	30,300	93,400	37,950	103,250	103,750	160,300	108,950

n/a – not currently available

[1] ERCD Report 1305

[2] ERCD Report 1301

[3] Provided by ERCD and based on ERCD Report 1301

[4] Not available for 2012 however this will be produced for 2013 as part of ERCD's annual noise contouring for Heathrow. This will be published in Summer 2014.

The scorecard demonstrates some key findings, some of which were outlined in Heathrow's *'Taking Britain Further'*. The scorecard shows that:

- For the $L_{Aeq,\,16hr}$ and L_{den} metrics and reported thresholds, population noise exposure would be less than the baseline i.e. less than today;
  - This finding is expanded on in Section 6.2.1.
- In 2030, population exposure is comparable regardless of option, including the do-minimum case;
- Population exposure to aircraft noise would be higher for a three-runway Heathrow in 2040 than a two-runway in 2040, although there are some exceptions;
- The various airspace options all have different effects on population exposure:
  - **Option N** will result in the most people exposed to levels of 54 dB and 57 dB $L_{Aeq,\,16hr}$, and 55 dB L_{den} regardless of assessment year;
  - **Option T** will results in the lowest number of people exposed to 54 dB and 57 dB $L_{Aeq,\,16hr}$, regardless of assessment year; and
  - **Option R** is the best option in terms of 55 dB L_{den} and 48 dB $L_{Aeq,\,8hr}$ night-time noise exposure.
- For the N70 event metric:
  - **Option T** and **Option N** results in the most number of people exposed to at least 50 events in 2030; and
  - In 2040, event level exposure to 50 N70 events per day is reasonable consistent;

The results demonstrate that through the Mitigation Strategy and the aviation industry's commitment to improve aircraft noise, a lower number of people can be exposed to noise than today with a third runway at Heathrow. In 2030, population exposure could be comparable, if not lower for three-runway Heathrow than for a two-runway Heathrow. In 2040, population noise exposure would be higher with a third runway than without.

The results also demonstrate a compromise for policymakers in terms of the proposed airspace options and the various objectives these seek to achieve. For example:

- **Option T** would result in the fewest number of people exposed to aircraft noise by measure of 55 dB L_{den} and 57 dB $L_{Aeq,\,16hr}$. However, owing to the design of the routes to facilitate this, although many areas would have noticeably fewer aircraft overhead, other areas that are overflown today would become more consistently overflown. This would be a noticeable change for people living in these areas;
- **Option N** would result in the largest number of people being exposed to aircraft noise by measure of the $L_{Aeq,\,16hr}$ and L_{den} metrics, however it would limit those who become newly exposed to aircraft overflight; and

- **Option R** performs somewhere between **Option T** and **Option N** with respect to the noise scorecard measures. However, as is demonstrated in Section 6.2, it will provide people with predictable periods of respite from aircraft noise.

For the N70 event metric, no comparison can be made to today since this information is not currently available. However the results show that in 2030 and 2040, event exposure would be higher with a third runway than without.

For the N60 metric, the results indicate that in 2030, population exposure to night noise events would be considerably less compared to the 2R ‘do-minimum’ cases. In 2040, event level population exposure would become comparable between the 2R ‘do-minimum’ and the 3R options with the exception of Option N.

6.2 Further Evidence for ‘Taking Britain Further’

Section 6.2 presents technical assessments which expand upon the information provided in Heathrow’s May 2014 submission ‘Taking Britain Further’. The assessments are presented against the key statements made within the May 2014 submission.

6.2.1 The Number of People affected by Noise will be less than Today

The results of both the INM and ANCON noise modelling indicate reductions in the total number of people affected by each of the three airspace options in both 2030 and 2040, when compared to today’s population for the $L_{Aeq,\ 16hr}$ and L_{den} noise metrics.

Figure 6.1 and 6.2 present a summary of the results with respect to relative change in population exposure from the baseline for the INM and ANCON model 57 dB $L_{Aeq,\ 16hr}$ outputs. The INM model outputs were used to inform the results presented in Figure 5.11 of *‘Taking Britain Further’* and these are reproduced graphically in Figure 6.1 with Figure 6.2 providing an ANCON equivalent set of results. The results underpinning Figure 6.1 and 6.2 are presented in Table 6.2 and Table 6.3 respectively.

The full sets of results are presented in Tables E4 to E11 of **Appendix E** for INM and Tables E21 – E28 for ANCON. These tables include key comparisons for others metrics including 55 dB L_{den}, 54 dB $L_{Aeq,\ 16hr}$ and 69 dB $L_{Aeq,\ 16hr}$.

Table 6.2 Population Changes Against Baseline Year for the 57 dB $L_{Aeq, 16hr}$ – INM Results

Runways/ Option	Year		
	2011[1]	2030	2040
2R	249,000	**-43%** (140,850)	**-44%** (138,700)
3R Option T	n/a	**-34%** (163,350)	**-21%** (196,400)
3R Option N	n/a	**-31%** (170,650)	**-18%** (204,200)
3R Option R	n/a	**-31%** (170,700)	**-18%** (204,800)

[1] The latest INM modelled baseline year is 2011

Figure 6.1 Change in Population Exposed to 57 dB $L_{Aeq, 16hr}$ – INM Results

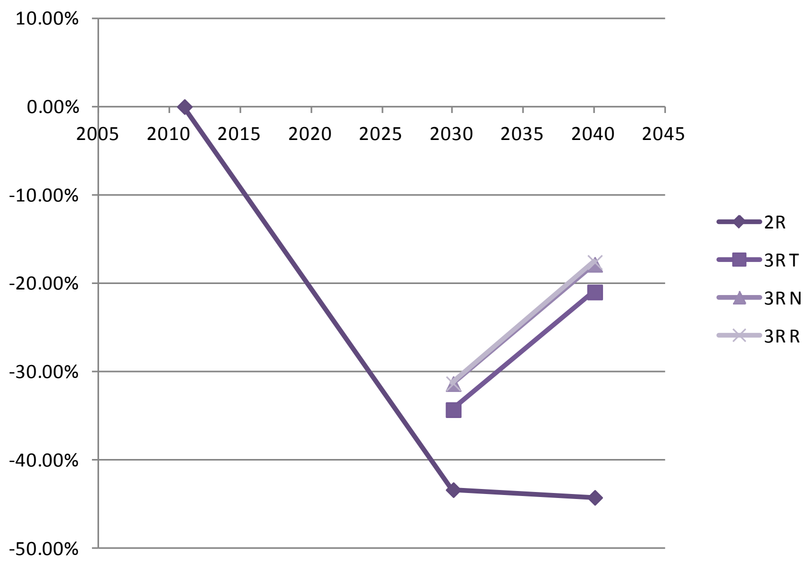


Table 6.3 Population Changes against Baseline Year for the 57 dB $L_{Aeq, 16hr}$ – ANCON Results

Runways / Option	Year		
	2012[2]	2030	2040
2R	237,050	**-28%** (169,500)	**-36%** (152,800)
3R Option T	n/a	**-28%** (170,350)	**-21%** (187,800)
3R Option N	n/a	**-22%** (184,950)	**-14%** (202,900)
3R Option R	n/a	**-27%** (173,500)	**-19%** (192,800)

[1] The latest ANCON modelled baseline year is 2012

Figure 6.2 Change in Population Exposed to 57 dB $L_{Aeq, 16hr}$ – ANCON Results

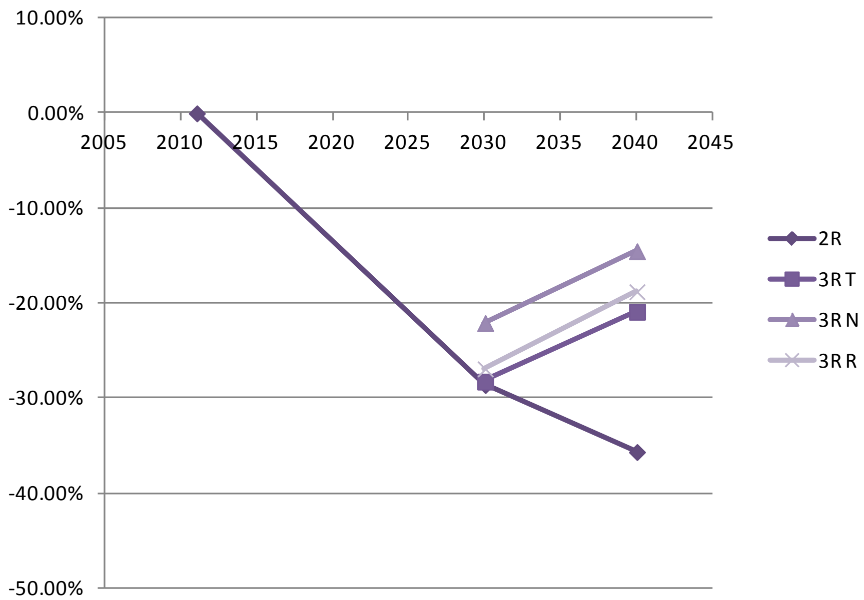


Figure 6.1 shows that INM indicates that across the 3R airspace options there is around a 30-35% reduction in the number of people exposed to 57 dB $L_{Aeq, 16hr}$ compared to today. In 2040, this reduction is around 20%. The ANCON modelling results presented in Figure 6.2 show a similar trend to those presented in Figure 6.1 using INM. The results indicate that the number of people exposed to 57 dB $L_{Aeq, 16hr}$ will reduce by around 20-30% in 2030 and around 15-20% in 2040.

Both noise models indicate that the number of people affected by noise by measure of the 57 $L_{Aeq, 16hr}$ metric will be less than today.

The results also support the findings of the noise scorecard that indicates that in 2030 and 2040 noise exposure will be higher for a 3R Heathrow than for a 2R Heathrow.

Appendix E demonstrates that these trends are the same for the 54 dB $L_{Aeq,\ 16hr}$ and 55 dB L_{den} measures.

Night Noise will affect less People when compared to Today

As described in Section 3, a new runway at Heathrow will allow more opportunities for night time runway alternation. This, combined with the other mitigation measures, leads to reductions in night time noise exposure when compared to today. Figure 6.3 and Figure 6.4 present a summary of the results with respect to the relative change in population exposure from the baseline for the INM model 48 dB $L_{Aeq,\ 8hr}$ and 50 dB $L_{Aeq,\ 8hr}$ outputs respectively. The corresponding population and changes are provided in Table 6.4 and Table 6.5. The presentation of the results for the 50 dB $L_{Aeq,\ 8hr}$ metric is to achieve consistency with the results presented in Figure 5.11 of *'Taking Britain Further'*.

Table 6.4 Population Changes Against Baseline Year for the 48 dB $L_{Aeq,\ 8hr\ (night)}$ – INM Results

Runways/ Option	Year		
	2011	2030	2040
2R	453,100	**-56%** (201,100)	**-55%** (204,000)
3R Option T	n/a	**-60%** (181,450)	**-54%** (207,400)
3R Option N	n/a	**-55%** (206,050)	**-45%** (247,800)
3R Option R	n/a	**-61%** (176,500)	**-54%** (209,000)

Figure 6.3 Change in Population Exposed to 48 dB $L_{Aeq,\ 8hr\ (night)}$ – INM Results

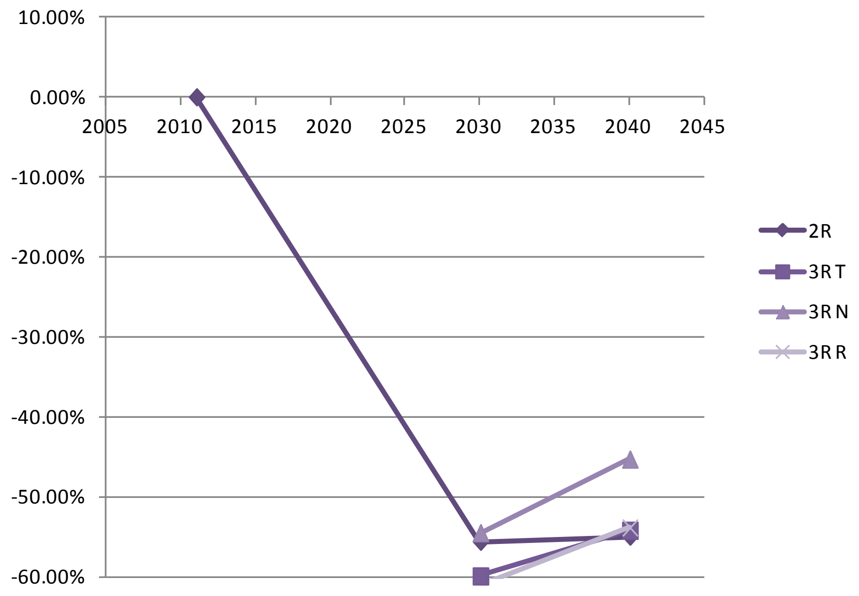
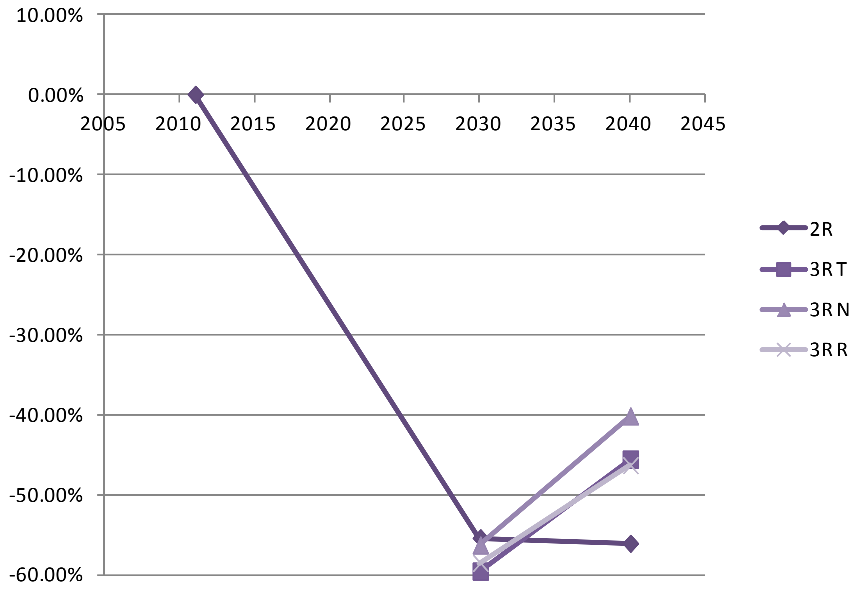


Table 6.5 Population Changes Against Baseline Year for the 50 dB $L_{Aeq,\ 8hr\ (night)}$ – INM Results

Runways/ Option	Year		
	2011	2030	2040
2R	292,050	**-55%** (130,100)	**-56%** (128,100)
3R Option T	n/a	**-60%** (117,950)	**-46%** (158,850)
3R Option N	n/a	**-56%** (127,500)	**-40%** (174,600)
3R Option R	n/a	**-59%** (120,950)	**-46%** (156,620)

Figure 6.4 Change in Population Exposed to 50 dB $L_{Aeq,\ 8hr\ (night)}$ – INM Results



The results show that in 2030 and 2040, the number of people exposed to night-time noise above 48 dB $L_{Aeq,\ 8hr}$ and 50 dB $L_{Aeq,\ 8hr}$ would more than half compared to today, both with and without a third runway. The results indicate that in 2040, although night-time noise exposure would be higher than for an equivalent 2R Heathrow (around 10% more people), the total number exposed to these thresholds would still be at least 40% lower than today.

Most People Overflown Today will experience lower Noise Levels than Today

Whilst a third runway would lead to increases in noise at certain communities, the majority of communities surrounding Heathrow would experience a reduction in noise compared to baseline conditions today.

Above the relevant assessment thresholds described in Section 5.4, the change of noise level at each population point has been calculated for each of the key metrics (L_{den}, $L_{Aeq,\ 16hr}$ and $L_{Aeq,8hr\ (night)}$) and for each airspace option. Figures 6.5 to Figure 6.7 present the change in these metrics for each of the airspace options in 3 dB bands and the corresponding proportion of the population exposed. Larger figures are provided in **Appendix J**. This analysis has been conducted using the INM modelling, however the trends illustrated do not significantly differ from a similar analysis undertaken using the ANCON results.

This analysis indicates that the 80% of people exposed to noise experience at worst, no significant change to their average noise exposure. Those that experience an increase are in areas where there is direct overflight unique to the new runway (Sipson, Harlington) or where new routes have been placed (e.g. Englefield Green, Brentford).

Figure 6.5 Change in $L_{Aeq,\ 16hr}$, L_{den} and L_{night} Noise Exposure for Option T 'Minimise Total'

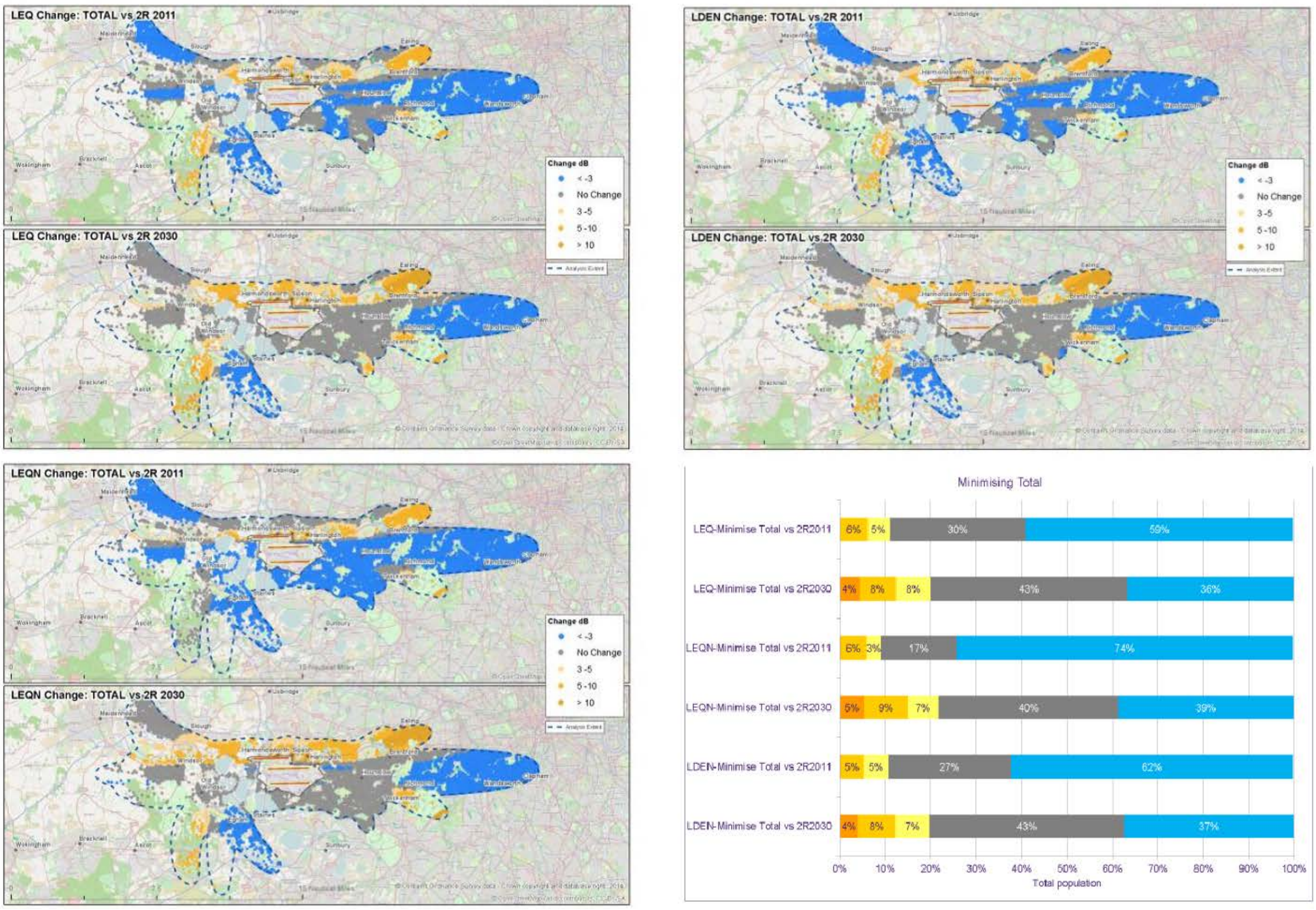


Figure 6.6 Change in $L_{Aeq,\,16hr}$, L_{den} and L_{night} Noise Exposure for Option N 'Minimise New

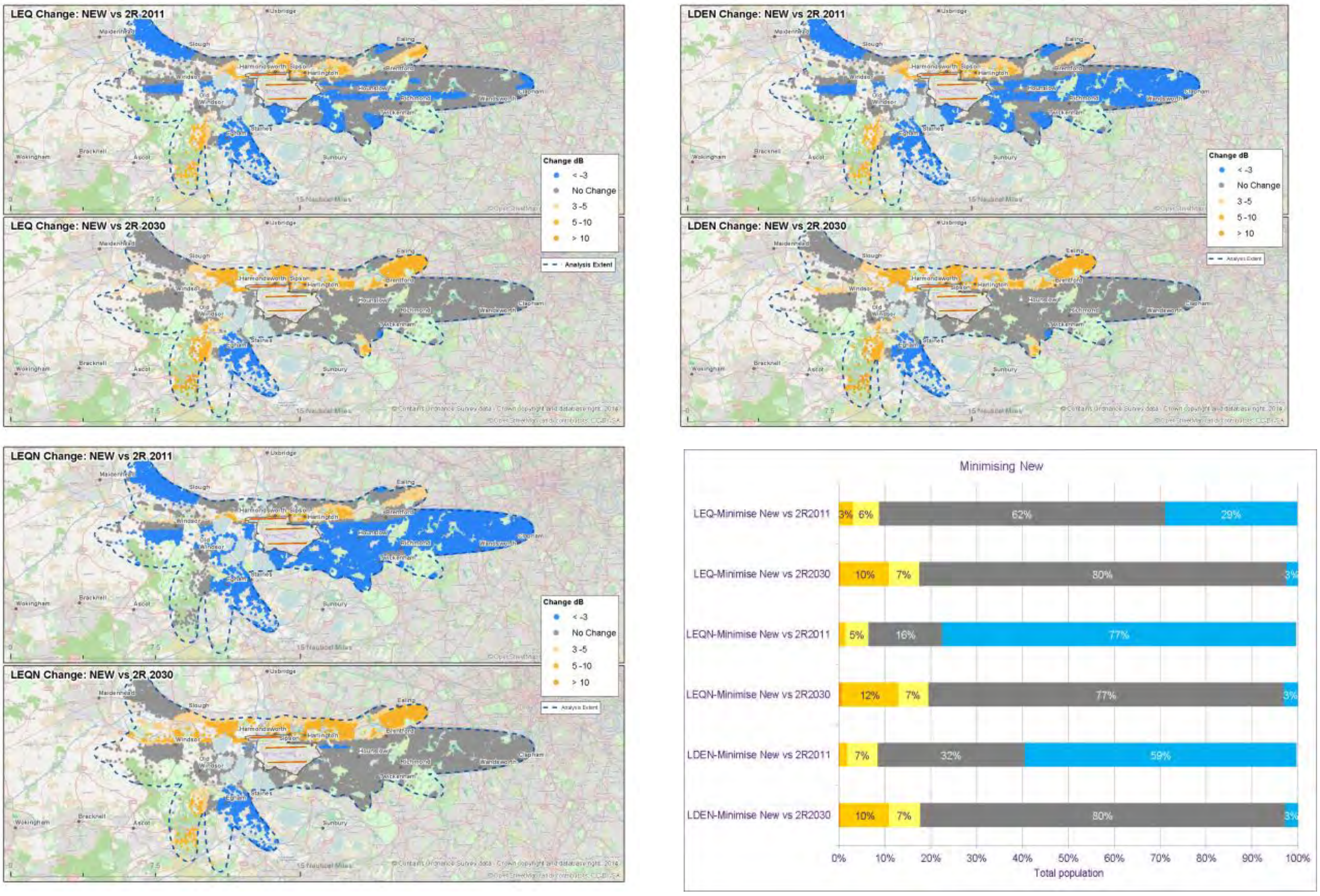
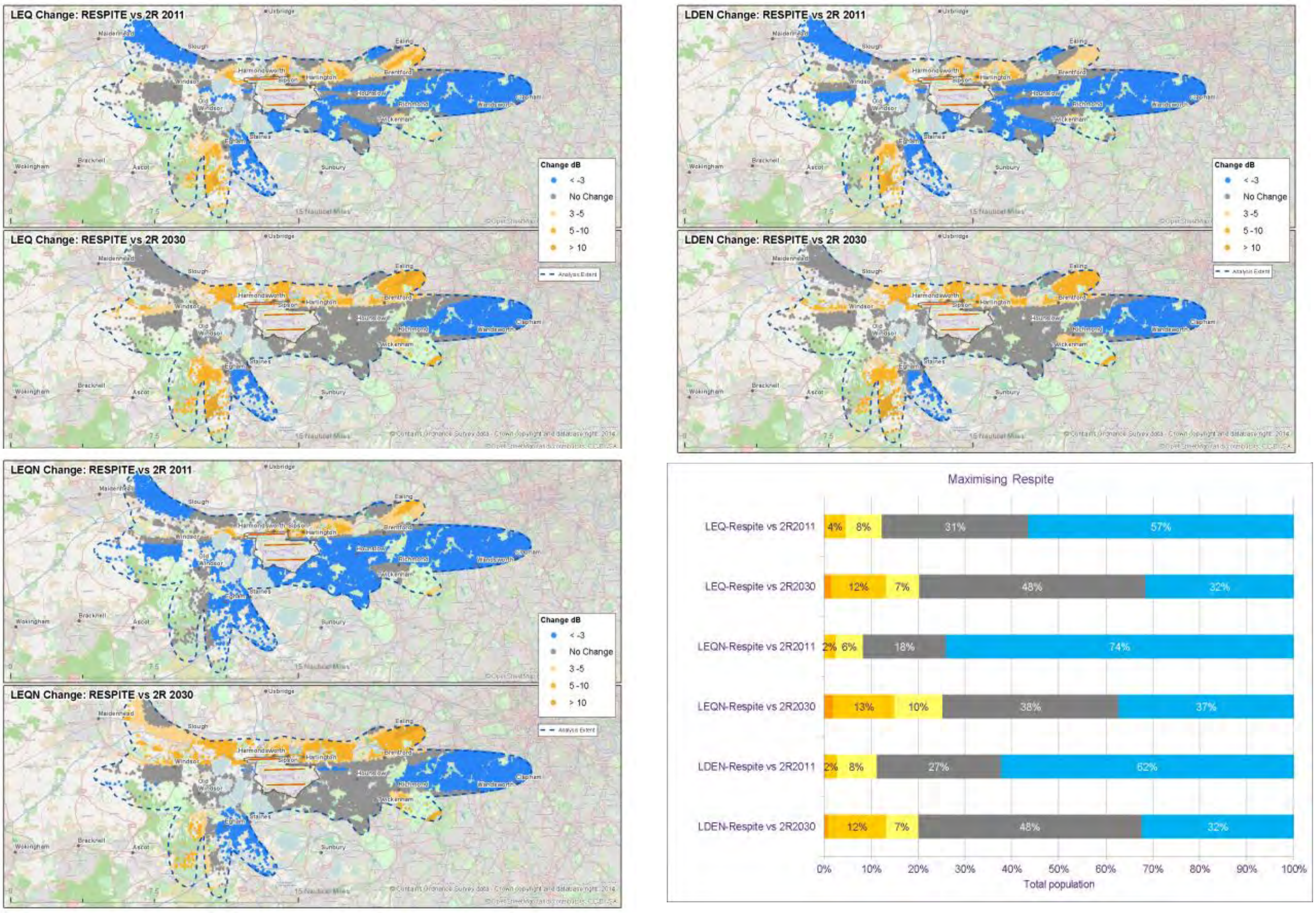


Figure 6.7 Change in $L_{Aeq,\,16hr}$, L_{den} and L_{night} Noise Exposure for Option R 'Maximum Respite'



Option R provides Respite to all Communities

All of the three-runway airspace options provide a degree respite to those that are overflown.

Option R provides respite for all communities that are overflown (based on the respite methodology proposed in Section 5.4.3). For all communities and those that are overflown, only 1% receive respite from a change of operating direction, i.e. the experience of respite is weather dependent (primarily wind direction). This is particularly the case for those people who are closest to the airport.

Figure 6.8 and Figure 6.9 illustrate respite percentages at postcode points for Option R during easterly and westerly operations respectively. The figures show the total number of modes that people are overflown by and the approximate number of days those areas could expect overflight within approximately 15 nmi of the airport when averaged across the whole year.

Figure 6.10 provides a quantitative comparison of percentage respite for those overflown during easterly and westerly operations for Option R in 2030. This indicates that 99% of those overflown would experience at least 25% respite regardless of the direction of operation with 94% of those people overflown experiencing respite at least 50% of the time.

44% of the population overflown would receive respite at least 75% of the time, and during westerly operations 29% of the people overflown in total would receive at least 75% respite during westerly operations and are provided with 100% respite during easterly operations (i.e. they are not overflown during easterly operations).

Approximately 35% of people overflown overall are not overflown during easterly operations. Less than 0.5% of those people overflown only get respite when there is a change from westerly to easterly operations.

Figure 6.8 Spatial Analysis of the Proportion of Respite received during Westerly Operations for Option R

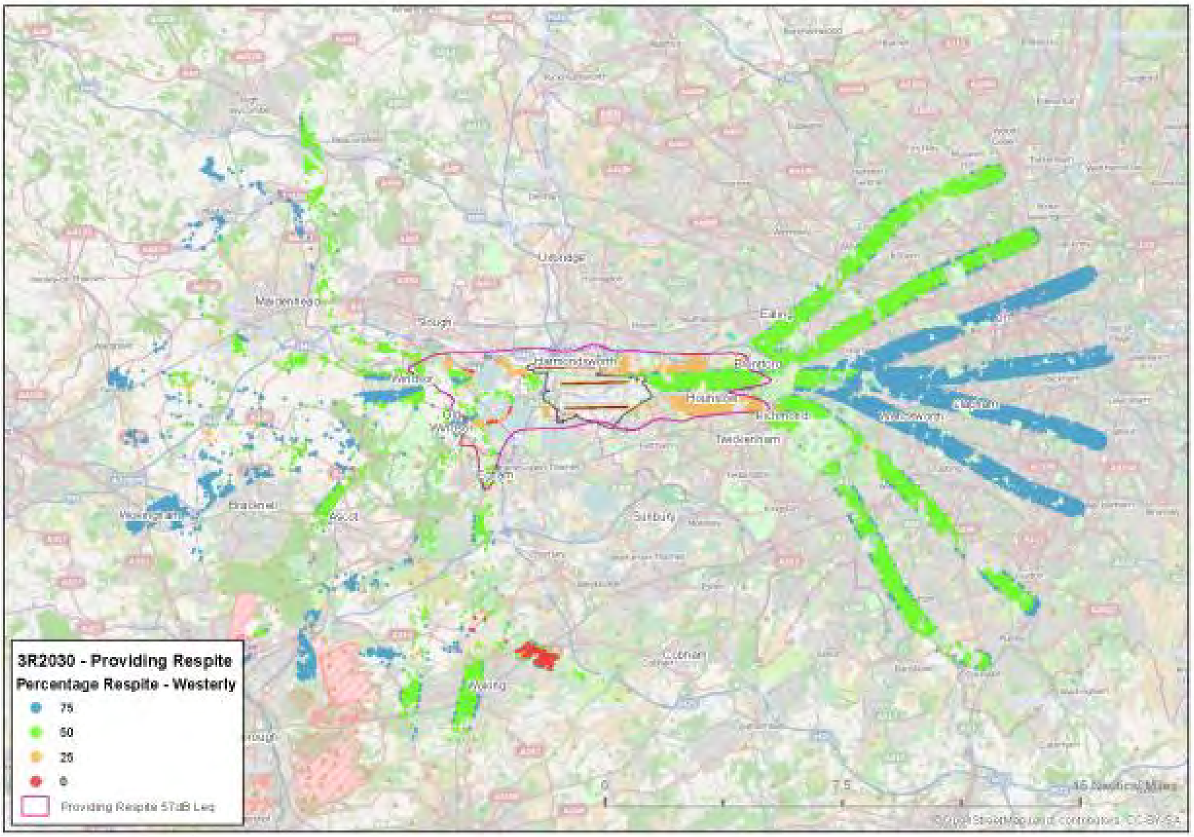
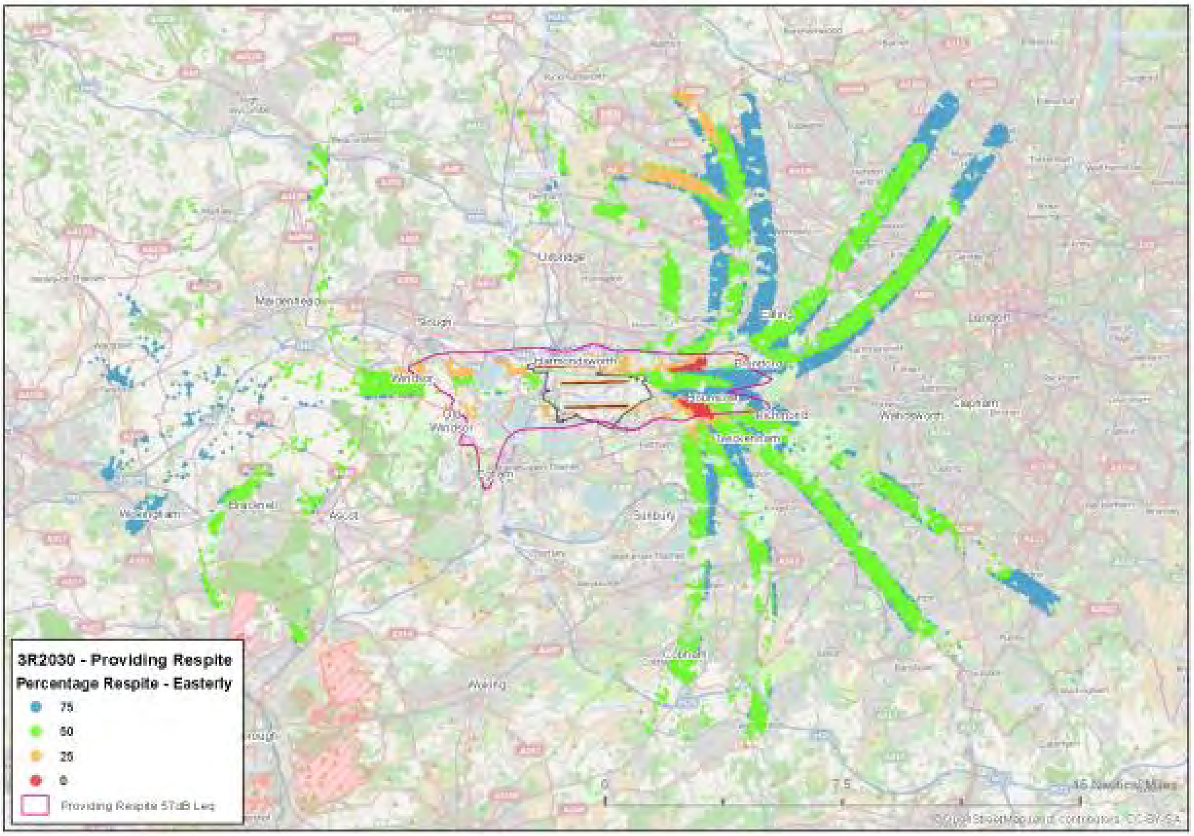


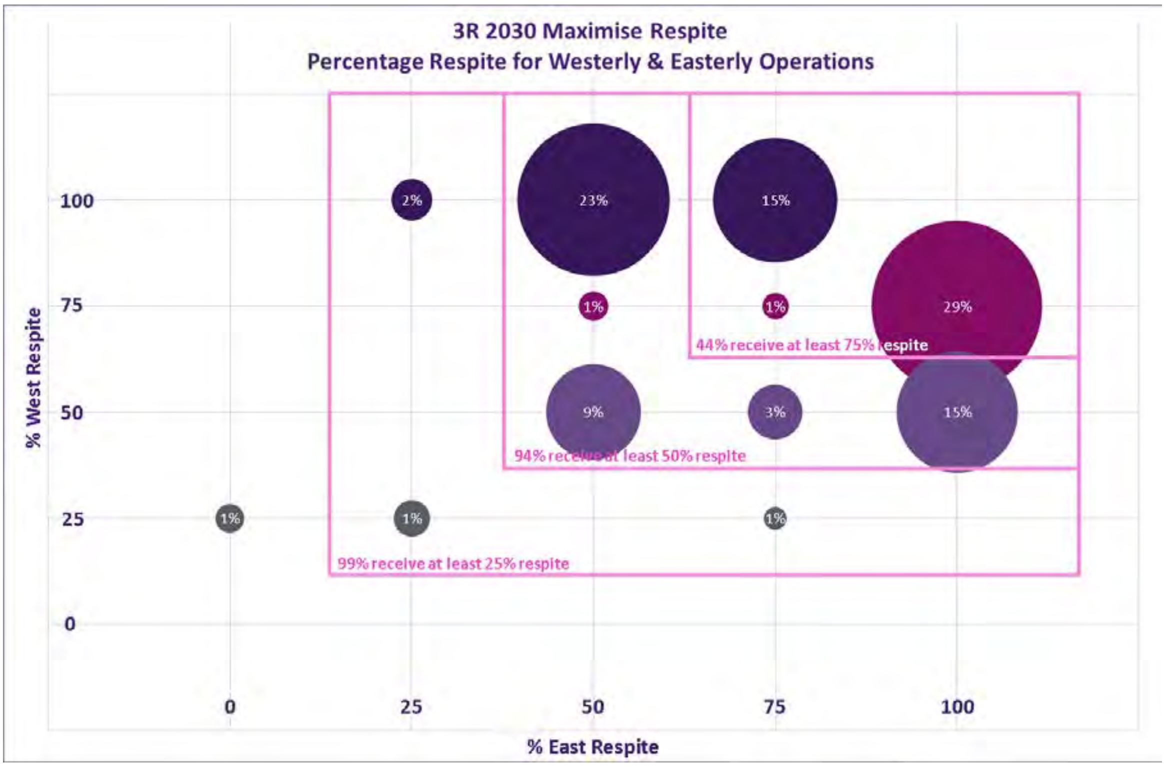
Figure 6.9 Spatial Analysis of the Proportion of Respite received during Easterly Operations for Option R



It should be noted that a two-runway Heathrow in 2030 would also offer better opportunities for respite than is available in the current two-runway airspace configuration, this is due to the introduction of runway alternation during easterly operations and also largely due to the greater degree of predictability and concentration around a single route that will come with advanced PBN technologies. It should be noted however, that this respite is largely for those overflown by arriving aircraft and not departures.

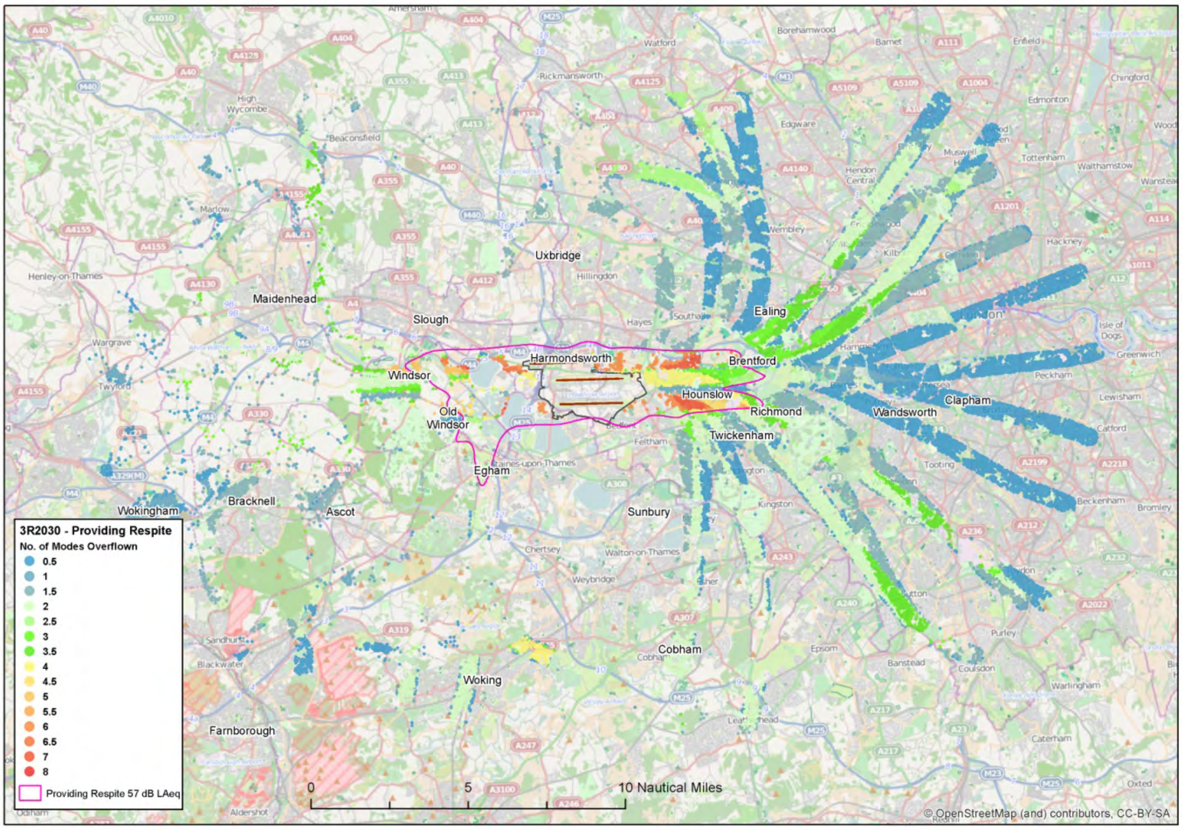
This is demonstrated in Figure 6.10 which provides a quantitative comparison of percentage respite for those overflown during easterly and westerly operations. This shows that the current airspace, although providing respite, leaves many without respite regardless of operating direction. For Option R, the routes provide a much fairer distribution of noise providing a greater proportion of people with respite.

Figure 6.10 Quantitative Analysis of Respite



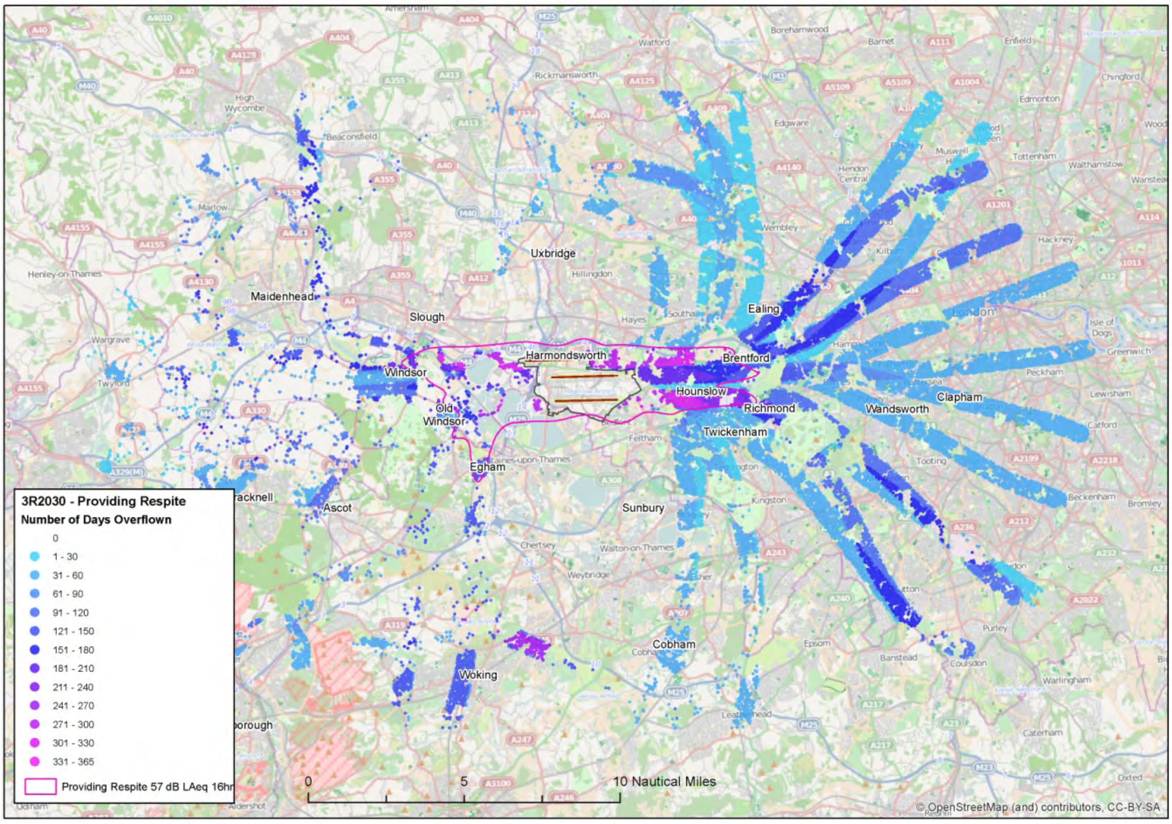
The analysis of respite can be expanded to examine the number of modes in which an area would experience overflight. Figure 6.11 indicates the spatial distribution of overflight across all modes for Option R. It should be noted that whilst there are a total of 8 modes, each has two airspace alternatives to provide respite. As a result there are a total 16 “half” modes. In order to keep consistency and enable comparability with the other airspace options each half mode is captured in the spatial analysis. So a value of 3.5 modes would indicates that an area is overflown by seven half modes. Figure 6.11 suggests that most areas can be seen to experience overflight by less than 4 full modes, especially at locations further from the airport.

Figure 6.11 Spatial Analysis of the Number of Modes for which Areas are Overflown in Total for Option R



Using the number of modes overflown and the annual split of easterly and westerly operations it is possible to estimate the number of days per year that an area may experience overflight. This is shown in Figure 6.12. It should be noted that this method of analysis takes no account of the frequency of overflight nor the height and or noise level of the aircraft; it does not therefore provide an indication of the degree of disturbance. Each of the figures is shown with the INM generated 57 dB $L_{Aeq,16hr}$ contour to provide some reference with average noise levels.

Figure 6.12 Spatial Analysis indicating the Number of Days per Year for which Areas are Overflown in Total for Option R



A similar analysis follows for each of the other illustrative airspace options. The spatial analysis images are shown here in a summarised format and are provided in more detail in **Appendix K.**

For Option T and Option N respite is provided in the form of mode rotation only. That means those closest to the airport (within a few nautical miles) receive respite from departures as the modes rotate. Once the routes have merged, no respite is provided from departures. This means a greater proportion of people under the approaches to the airport would benefit from mode rotation.

Spatial analysis for Option T is provided in Figure 6.13, with quantitative analysis provided in Figure 6.14. Option T analysis indicates that for this airspace design, 52% of those people overflown (according to the definition of overflight presented above), will experience respite at least 50% of the time regardless of whether the operating on westerly or easterly operations; 39% of the population overflown would receive respite 75% of the time.

24% of people receive at least 75% respite during westerly operations and are then not overflown during easterly operations. Approximately 40% of people are overflown during westerly operations and are then not overflown during easterly operations. Approximately 6% of the population overflown receive no respite during westerly operations and are provided with 100% respite during easterly operations (i.e. they are not overflown during easterly operations). For example, an area such as Fulham may fall into this category. Currently, according to the methodology for analysing respite, this area would receive no respite during westerly operations.

Figure 6.13 Spatial Analysis of Respite, Modes Overflown and Days Overflown for Option T

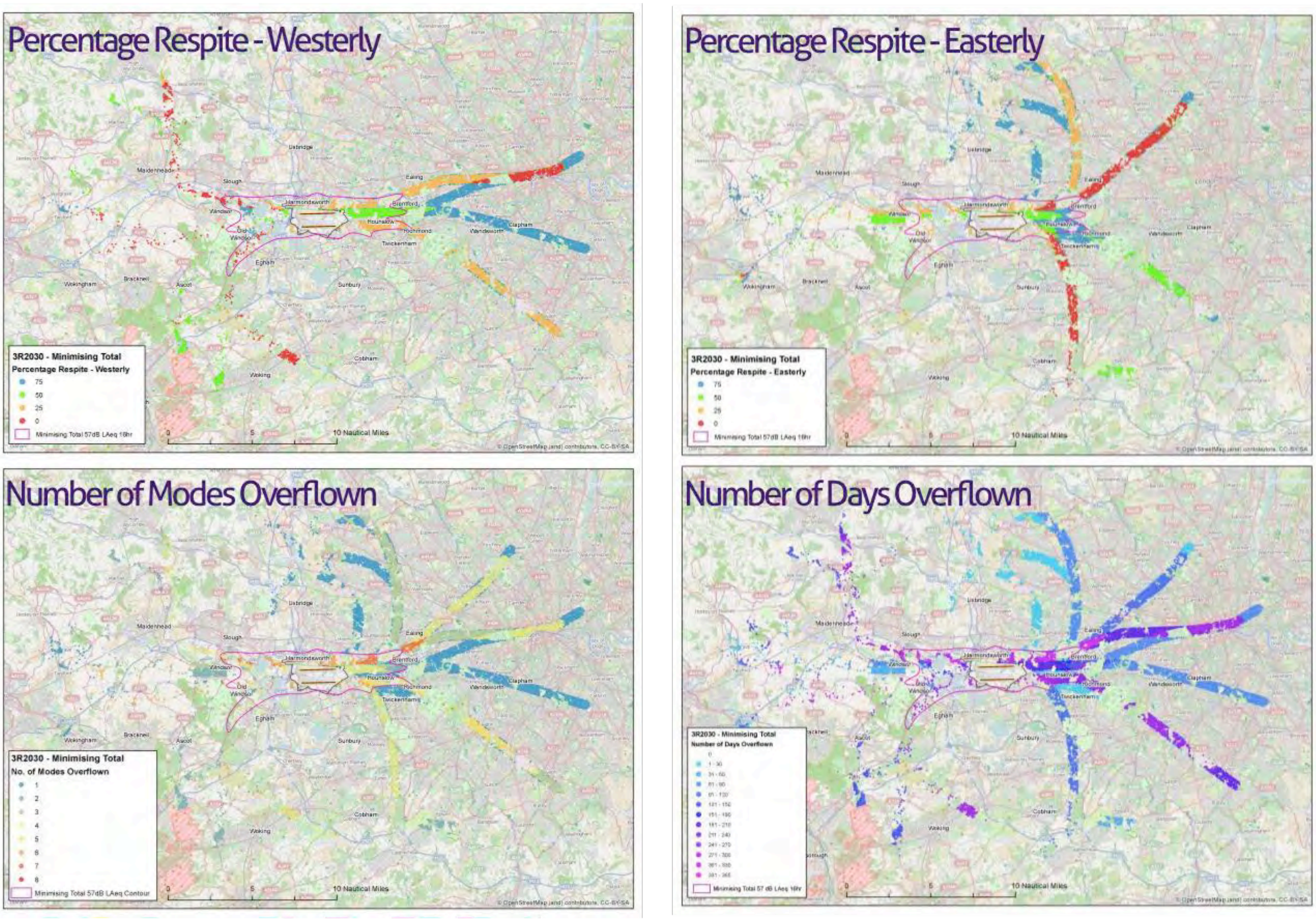
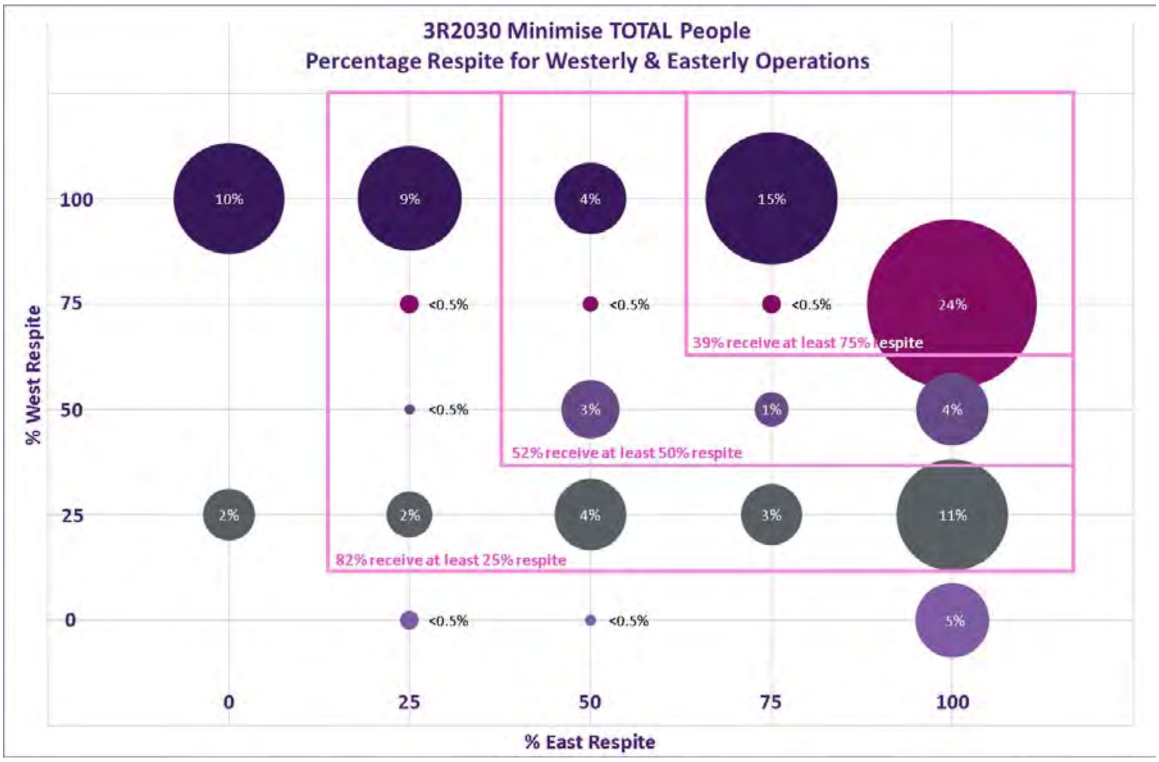


Figure 6.14 Quantitative Analysis of Respite for Option T



Spatial analysis for Option N is provided in Figure 6.15, with quantitative analysis provided in Figure 6.16. Analysis of Option N indicates that for this airspace design 52% of those people overflown (according to the definition of overflight presented above) will experience respite at least 50% of the time regardless of whether operating on westerly or easterly operations. 25% of the population overflown would receive respite 75% of the time during westerly operations. 8% of the population overflown would receive no respite during westerly operations and are provided with 100% respite during easterly operations. Approximately 50% of those people overflown overall, are only overflown during westerly operations.

The greatest difference in each option comes in the proportion of people who receive at least 50% respite regardless of direction of operation, where the R option is significantly better than the T or N options. It is also noted that the navigational technologies that would be help facilitate respite improvements for a three-runway airport would also be available in a two-runway Heathrow in 2030. Consequently the degree of respite would also improve.

Figure 6.15 Spatial Analysis of Respite, Modes Overflown and Days Overflown for Option N

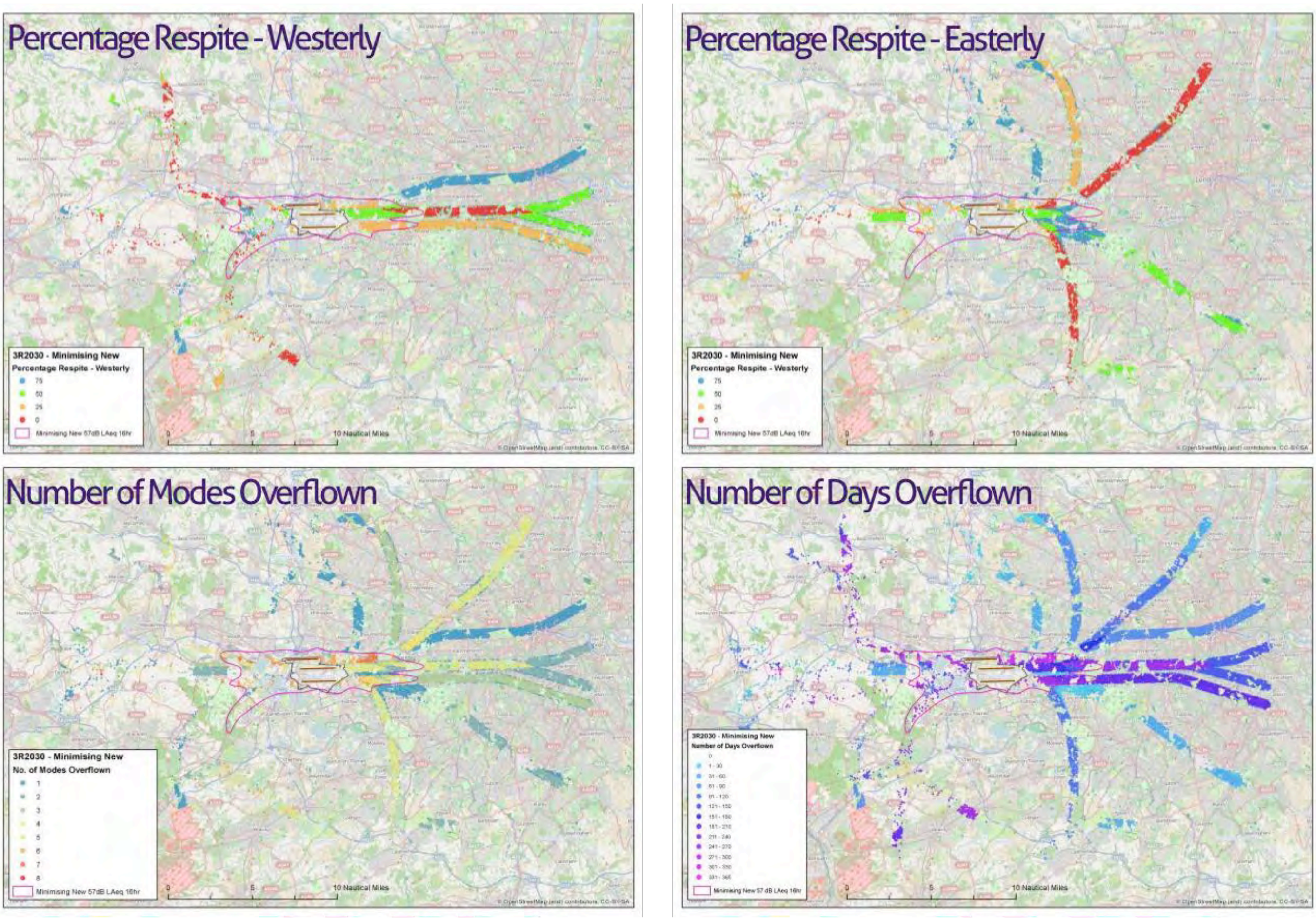
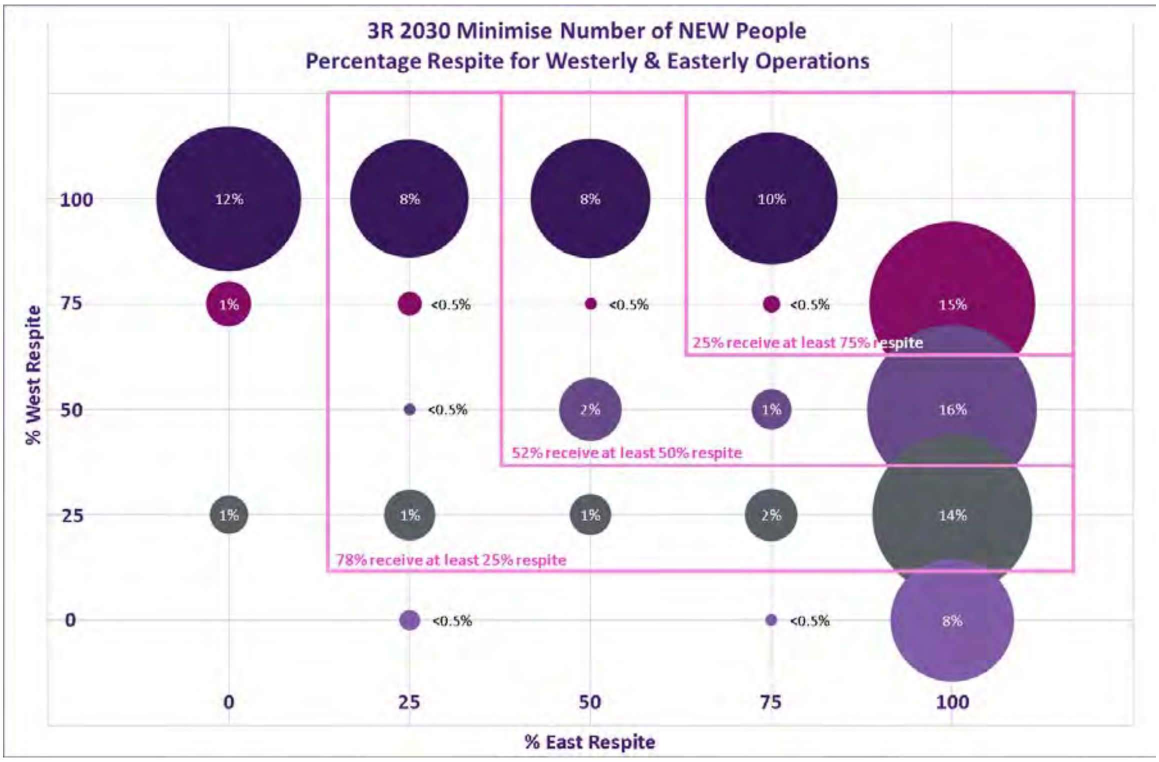


Figure 6.16 Quantitative Analysis of Respite for Option N



6.3 Ground Noise

This section presents high level findings of the ground noise assessments detailed in **Appendix F**.

6.3.1 Aircraft Ground Noise

Mitigation will help Reduce Noise Levels

The assessments presented in **Appendix F** demonstrate that physical mitigation in the form of perimeter bunding and fencing can help reduce noise exposure and noise event levels at locations that are most likely to be the most affected by the development.

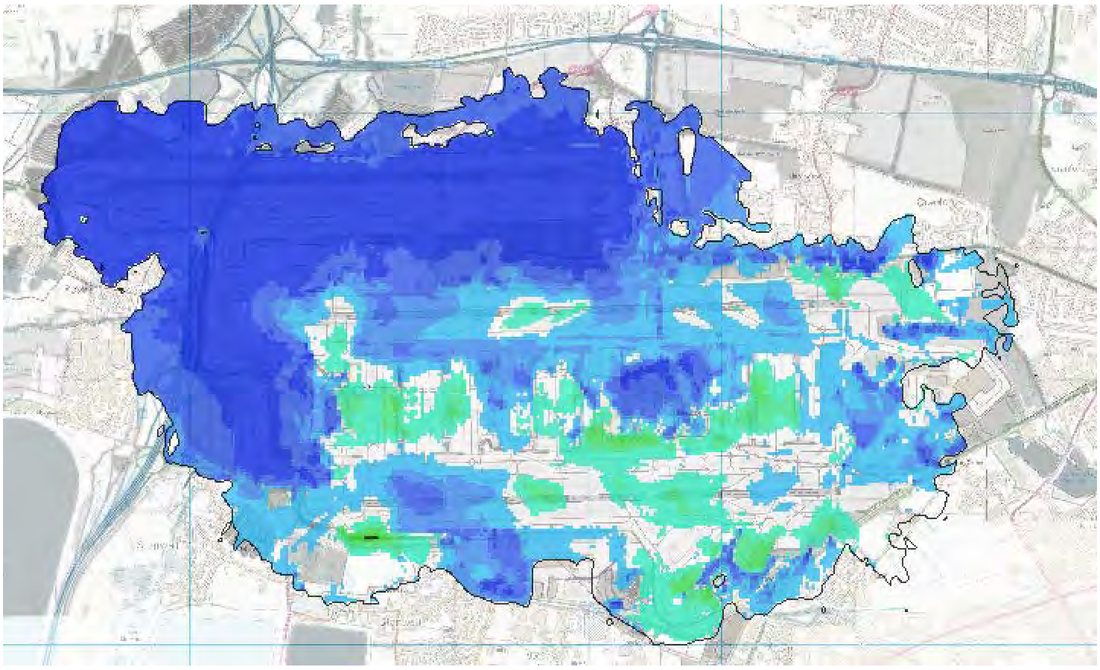
For Sipson and Poyle, the mitigation will help reduce noise levels from taxiing aircraft and aircraft within hold. For other locations such as Harmondsworth, the mitigation will help reduce noise from taxiing aircraft.

Noise from aircraft APUs cannot be reduced significantly using conventional physical mitigation. This has a limited effect on noise from aircraft at stand due to their elevated locations. An assessment of the concept of strategic stand use has been undertaken and has shown a much larger reduction in noise from APU running can be obtained through strategic selection of stands. This measure would provide benefits to Harmondsworth, Sipson and Poyle and would help reduce noise during more sensitive periods such the night.

Aircraft Ground Noise Exposure Will Increase at Locations Next to the Extended Boundary

Aircraft ground noise exposure will increase as a result of a third runway. This is due to the extension of the airfield boundary to the north and north-west and the subsequent exposure of dwellings within Sipson, Harmondsworth and Poyle. At locations around the existing 2R airfield boundary, noise exposure will remain comparable today.

Figure 6.17 Aircraft Ground Noise Changes ($L_{Aeq,16hr}$)



Mitigation will Help Reduce Those Exposed to the Highest Levels of Aircraft Ground Noise

Although noise exposure will increase, physical noise mitigation will help reduce the number of people exposed to the highest levels of aircraft ground noise. **Appendix F** demonstrates that by including physical mitigation, nobody will be left exposed to noise levels of more than 69 dB $L_{Aeq,\ 16hr}$ and only a number of isolated dwellings would be exposed to levels above 66 dB $L_{Aeq,\ 16hr}$.

6.3.2 Road Traffic Noise

Overall Road Traffic Noise Exposure will Reduce

Appendix F shows that the construction of a new runway and the associated road network will result in a decrease in overall noise exposure within the study area. The number of people exposed to noise levels of at least 57 dB $L_{A10,\ 18hr}$ (or 55 dB $L_{Aeq,\ 16hr}$) will reduce by around 7,000 as a result of a new runway. The number of people exposed to noise levels above the Noise Insulation Regulations eligibility threshold of 68 dB $L_{A10,\ 18hr}$ would reduce by around 1,700. This reduction in population exposure is due to the following factors:

- Redistribution of road traffic;
- Improvements due to mitigation that would be incorporated into the development such as noise barriers and road surfacing; and
- Property loss.

Mitigation will Help Reduce the Impacts of Changes in Road Traffic Noise

Appendix F demonstrates that mitigation will help reduce the impacts of changes in the road network and traffic patterns as a result of the development. Roadside barriers and noise-reduced surfacing will help reduce levels of traffic noise at those who will be most affected.

Noise Insulation is Likely for those worst affected

A high level indicative assessment of changes in noise exposure against eligibility under the Noise Insulation Regulations 1975 has been undertaken and is presented in **Appendix F**. This assessment has demonstrated that it is likely that a small number of properties would be eligible for noise insulation under these Regulations. These properties are located between Colnbrook and Poyle and to the north of Sipson. The assessment has indicated a total of 40 dwellings where the eligibility criteria is met.

It is however stressed that a more detailed assessment would need to be undertaken in the future in full adherence to the Regulations using detailed information.

7. Conclusions

The technical report has provided the technical methodology, background and policy setting for appraisal of Heathrow's proposed Mitigation Strategy. It has outlined baseline conditions around Heathrow and has provided an appraisal of the potential impacts with reference to the requirements and objectives of the Airports Commission's Sustainability Appraisal Framework for aircraft noise.

The Mitigation Strategy presented in Section 4 sets out a number of measures that have been developed to mitigate and reduce the potential future impacts of a new runway at Heathrow. The Strategy has been reviewed with the measures encouraged by the CAA in their recent *"Managing Aviation Noise"* publication and has found to be broadly consistent. The measures proposed by Heathrow in the Mitigation Strategy are based on collaborative discussions with industry stakeholders and, as such, the assumptions used for assessment purposes are considered robust and credible. The Mitigation Strategy outlines commitments to consult community stakeholders on certain aspects of the mitigation measures such as respite regimes. This approach aligns with Government aviation and planning policy.

The assessment presented in this report has considered noise from relevant sources as identified by the Commission including aircraft noise, aircraft ground noise and road traffic noise. These sources have been assessed against relevant noise measures, such as $L_{Aeq,\ 16hr}$, as identified by the Commission in their 'Noise Scorecard'. The assessment has been based on noise modelling techniques using models including INM and ANCON. Where appropriate and where possible, the ground noise assessments have considered the performance of certain mitigation measures highlighted within the Mitigation Strategy.

The technical report has demonstrated that the noise exposure trends for aircraft noise as presented in Heathrow's May 2014 submission to the Airports Commission *'Taking Britain Further'* occur using both the INM and ANCON models. These models and the subsequent assessment of their outputs against a baseline population dataset have indicated that a third runway at Heathrow would:

- Result in less people being exposure to aircraft noise than today;
- Would result in less night-time noise exposure than today; and
- Could provide significant decreases in noise exposure for more people than significant increases in noise exposure, compared to today.

The results do however indicate that:

- When compared to a 'do-minimum' scenario in 2030, population noise exposure could be comparable, if not lower for three-runway Heathrow; and
- In 2040 population noise exposure would be higher for a three-runway Heathrow than for a two-runway Heathrow.

An assessment of changes in noise exposure supports the findings above. This assessment has demonstrated that when compared to today, more people would experience decreases in noise exposure in 2030 with a third-runway. When compared to a ‘do-minimum’ in 2030, more people would experience decreases as a result of a third-runway than increases.

The respite assessment presented in Section 6 demonstrates that it is possible to provide respite to almost all communities through respite airspace design options such as Option R. For this option, almost all people (94%) would receive at least 50% respite regardless operating direction. The assessment highlights the opportunities that a third runway and advanced PBN technologies could deliver in terms of providing respite to from aircraft noise, and how this could be greater than today.

Monetisation has not been considered in this document. Instead and in response to the lack of consensus regarding the most appropriate monetisation methodology, Heathrow will provide a separate note to the Commission shortly.

An assessment of aircraft ground noise has shown that noise exposure will increase due to a third runway. However, these increases are in part mitigated through physical and operational mitigation measures that will help reduce the number of people exposed to the highest levels of aircraft ground noise. Indeed there are further opportunities that can be explored to reduce these impacts further. The population exposed to road traffic noise will reduce as a result of the development through a number of factors including the redistribution of noise, mitigation and property loss.

Appendix A
Policy, Legislation and Guidance

A.1 Aviation Legislation

Relevant aviation legislation includes:

- The Civil Aviation Act (2006);
- The Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003; and
- The Transport Act (2000).

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.

The ***Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003*** transposes EC Directive 2002/30/EC and ICAO Assembly Resolution A33-7[7] 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.

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.

A.2 Environmental Noise Legislation

Relevant environmental noise legislation includes:

- The Environmental Protection Act 1990;
- The Environmental Noise (England) Regulations 2006; and
- The Noise Insulation Regulations 1975;

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*.

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.

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

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.

The Noise Insulation Regulations 1975 (as amended 1988) are used to assess which properties are eligible for statutory noise insulation. The Regulations provide a series of eligibility criteria for which certain properties would qualify for insulation measures or grants. The eligibility criteria is based on a number of factors including noise level criteria, building use and distance conditions. The regulations apply to residential dwellings and within 300m of new or realigned carriageways. Paragraph 3 of the Regulations sets out the noise level eligibility criteria. The paragraph makes reference to the "specified level" which relates to a noise level of 68 $dBL_{A10,18hr}$. Paragraph 3(2) of the Regulations state that buildings are eligible for noise insulation if the following criteria are met:

- (a) the relevant noise level[8] is greater by at least 1 dB(A) than the prevailing noise[9] and is not less than the specified level, and
- (b) noise caused or expected to be caused by traffic using or expected to use that highway makes an effective contribution to the relevant noise level of at least 1 dB(A).

A.3 Policy Context

Aviation Policy Framework (APF)

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".

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

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.

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:

[8] *"relevant noise level"* means the level of noise, expressed as a level of dB $L_{A10,18hr}$, one metre in front-of-the most exposed of any windows and doors in a façade of a building caused or expected to be caused by traffic using or expected to use any highway.

[9] "prevailing noise level" means the level of noise, expressed as a level of dB $L_{A10,18hr,}$ one metre in front-of-the most exposed of any windows and doors in a façade of a building caused by road traffic using any highway immediately before works for the construction of a highway or additional carriageway, or for the alteration of a carriageway, as the case may be, were begun.

'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'.

The APF goes on to state that Government will:

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

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'

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.

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 LAeq, 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'

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 LAeq, 16h or more, assistance with the costs of moving'

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 LAeq, 16h or more. Where acoustic insulation cannot provide an appropriate cost-effective solution, alternative mitigation measures should be offered'

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 LAeq, 16h or more'

National Planning Policy Framework (NPPF)

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

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

"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".

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

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".

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.

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.

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.

A.4 General Guidance

Road Traffic Noise

The Highways Agency guidance document *Design Manual for Roads and Bridges* (DMRB) (Vol. 11, 2011, Rev.1) includes guidance on the interpretation of changes in road traffic noise levels ($L_{A10,\ 18hr}$) for determining the potential magnitude of impact. The document suggests differing criteria for short term (i.e. within 15 years of development opening) and long term effects, as outlined in Table A.1 and Table A.2 respectively.

Table A.1 DMRB Classification of Magnitude of Noise Impacts in the Short-term

Noise Change in dB $L_{A10,18hr}$	Magnitude of Impact
0	No Change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table A.2 DMRB Classification of Magnitude of Noise Impacts in the Long-term

Noise Change in dB $L_{A10,18hr}$	Magnitude of Impact
0	No Change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

In assessing potential changes in road traffic noise, DMRB requires a screening exercise to be undertaken. This screening exercise is based on changes in road traffic flows that are likely to result in at least a 1 dB change in road traffic noise exposure. As a guide to the potential for these impacts, the guidance recommends identifying roads where road traffic will increase by at least 25% or reduce by at least 20%. This is believed to be the source of the Airports Commission's appraisal method for road traffic noise.

DMRB also provide a methodology for the assessment of annoyance using exposure-based annoyance relationships. These relationships are used as part of the noise impacts from road traffic noise. The methodology that applies these relationships for that purpose is provided by the Department for Transport (DfT) in their 'Transport analysis guidance' WebTAG.

In addition to providing a method of assessment, DMRB also makes various recommendations with regards to measures and best practice in reducing road traffic noise. These measures include the use of low noise surfaces, the construction of roadside barriers and traffic alleviation schemes.

World Health Organisation (WHO) Guidelines

The WHO has prepared a number of guidance documents relating to community noise, exposure and health. These documents have considered noise exposure across a range of transportation and other environmental noise sources and are not focussed on one particular source of noise such as road traffic or aviation.

The WHO report *Guidelines for Community Noise* (1999) presents guideline noise exposure levels for community noise to avoid health effects and annoyance. The guidelines recommend a noise level of 55dB $L_{Aeq, 16hr}$ to avoid serious annoyance in outdoor living areas however acknowledge that around 40% of the population of the European Union are already exposed to levels above this guideline.

The WHO report *Night Noise Guidelines for Europe* (2009) presents night time noise exposure guidelines that aim to protect the public from adverse health effects. The report recommends a guideline value of 40 dB L_{night} to protect against the risk of night-time health effect. The report however acknowledges that people are already exposed to levels above this and therefore provides an 'Interim Target' of 55 dB L_{night} where achievement of the 40 dB L_{night} guideline is not feasible in the short-term.

The WHO report *'Burden of Disease from Environmental Noise'* (2011) provides a review of evidence supporting dose-response in relation to environmental noise and health effects. The document discusses all forms of environmental noise from transportation sources and provides case studies from research. The document provides a meta-analysis of current research to provide relationships linking chronic exposure to environmental noise to health effects. This includes relationships that facilitate estimates of Disability Adjusted Life Years (DALYs) – a quantification of the burden of disease as a result of environmental noise.

Attitudes to Noise from Aviation Sources in England (ANASE) Study

The ANASE study was commissioned in 2002 by the Government to re-evaluate people's attitudes to aircraft noise. The study identified potential changes in attitudes however the findings of the study were not considered conclusive by the Government to support a change in noise policy. The study did however provide research facilitating the monetisation of aircraft noise.

Appendix B
Existing Baseline Conditions

B.1 Existing Noise Conditions around Heathrow

It is important to consider existing conditions when making an assessment of potential future impacts. People experience what it is like today, not what it might be like in the future and it is generally difficult for people to understand what change may occur.

The existing noise environment has been considered in terms of where aircraft typically currently fly, the associated aircraft noise contours and by acoustically characterising areas that may experience significant noise level change with a future Heathrow. This characterisation has been undertaken for all relevant airport noise sources including road traffic noise.

The existing noise conditions, or baseline, around the airport vary significantly. Aircraft noise is a significant contributor in many of the local areas, but there are several other significant sources of noise in the vicinity of the airport including several major roads and railways and also general suburban noise in the built up areas of London, Slough, Windsor and Maidenhead. There are also some areas that would be considered more rural, though currently there appear to be few areas that would be considered tranquil.

In order to gain an appreciation of the existing noise conditions a two-staged approach has been adopted. Firstly, noise modelling has been used to determine the amount of people currently affected by aircraft noise. Secondly, a high-level baseline noise characterisation exercise has been undertaken to gain a qualitative appreciation of the noise climate in certain areas surrounding the airport.

B.2 Where do Aircraft Fly Today?

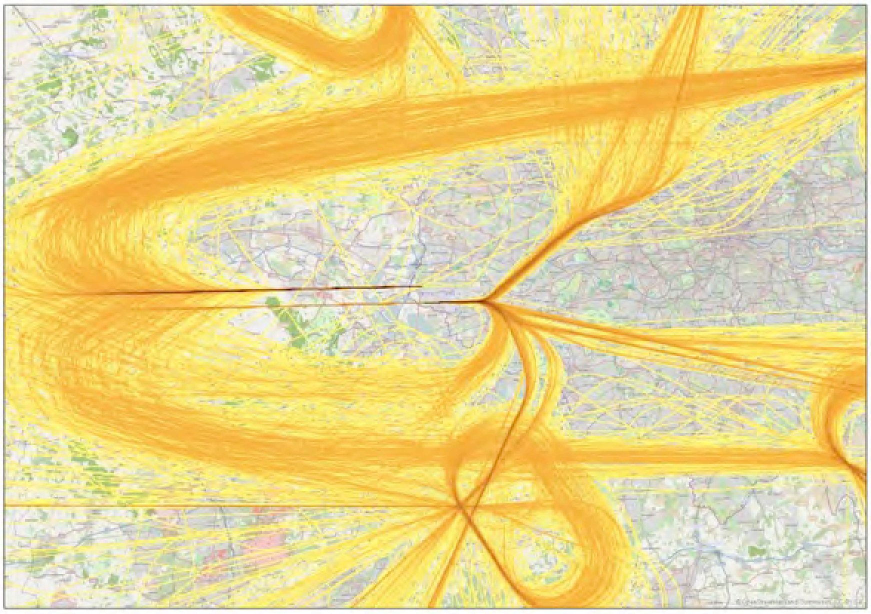
On departure, aircraft follow Noise Preferential Routes up to 4,000ft. Heathrow's noise management programme over the last twenty years has improved adherence to these routes to over 95%. On approach, aircraft fly from the holding points, or stacks, to join the final approach. The "final approach" is a straight line to the runway, descending with a glideslope at 3 degrees using Instrument Landing System (ILS). The path followed to the final approach varies and is given flexibility to meet operational needs. Most aircraft follow what is called Continuous Descent Approach (CDA) during this phase. This is a quieter approach procedure, and as a result of work by Heathrow, use is now generally over 85% during the day and 95% at night. Aircraft generally join the final approach anywhere between 8 nmi and 20 nmi during the daytime and beyond 10 nmi at night.

The areas overflown depend on the direction that the airport is operating. For example areas over by westerly arrivals may not be overflown at during easterly operations. Further, on westerly operations there is a principal of runway alternation applied where the runway used for arrival is switched at 3pm. In principal one runway is used from 7am to 3pm then the other from 3pm to 11pm thereby providing periods of respite to those overflown to the east of the airport. Currently over 90% of aircraft land at Heathrow in accordance with the published pattern of runway use. Runway alternation is not currently operated during easterly operations as a result of the Cranford Agreement; this agreement prevents departures from the northern runway (it is noted that there is currently a planning application in the Appeal process to carry out airfield works to enable runway alternation) during easterly operations.

The following figures indicate for both westerly and easterly operations where aircraft fly (on a typical single day) which show how areas of overflight may vary for each current mode of operation.

Figure B.1 A Typical Day of Westerly Operations

Figure B.2 A Typical Day of Easterly Operations



B.3 Existing Aircraft Noise Exposure

Aircraft noise is described using a number of metrics. The following graphics and tables present the key metrics as defined by the Airport Commission's noise scorecard and currently used in the formation of UK Aviation noise policy.

The numbers of people currently affected by aircraft noise around Heathrow are shown below in Table B.1.

Table B.1 Current Population Exposed to Aircraft Noise for Key Noise Metrics

Metric and Contour Boundary	INM 2011	ANCON 2012
Annual Lden (55)	634,450	725,000[1]
Summer Leq (69)	5,500	3,200[2]
Summer Leq (57)	248,550	237,350[2]
Summer Leq (54)	478,000	586,050[2]
Leq Night 8hr (48)	453,450	n/a

[1] ERCD Report 1305

[2] ERCD Report 1301

B.4 Noise Characteristics of the Area

An exercise has been undertaken to characterise the noise environment at a number of communities to the north of the airport.. The primary purpose of this exercise was to gain an appreciation of the noise character of communities which may experience a significant increase in aircraft noise should a third runway be built.

The methodology for this characterisation exercise is summarised as follows:

- Visit locations and make qualitative observations regarding the noise character of the area; and
- Undertake a “snapshot” of short duration attended noise measurements

The noise observation locations are summarised in Table B.2.

Table B.2 Noise Observations and Monitoring Locations

Ref	Representative Community/ Locality	Monitoring Location(s)	Noise Monitoring Period
1	North Hayes	Larch Crescent	Daytime
2	South Hayes	Crawford Park Road, Wyre Grove Laburnum Road and Crowland Ave Monmouth Road	Daytime
3	Osterley	Thornbury Road, Jersey Road and Borough Road	Daytime
4	Brentford	7 Renelagh Road, 5 Liverpool Road and 30 Grange Road	Daytime
5	Shepherds Bush	30 Adelaine Grove, 25 Savley Road and 106 Wormholt	Daytime
6	Hounslow	Southall Lane, Avenue Gardens and Bleriot Road	Daytime
7	West Drayton	Wise Lane	Daytime
8	Richings Park	Old Slade Green (1) and Old Slade Green (2)	Daytime
9	Harlington	Grampian Close and Malvern Road	Daytime / Night-Time
10	Sipson	Chitterfield Grate and Harmondsworth Lane	Daytime / Night-Time
11	Poyle	Albany Park	Daytime / Night-Time
12	Harmondsworth	Harmondsworth Lane	Daytime / Night-Time
13	Cranford	Waye Avenue	Daytime / Night-Time
14	Hatton / East Bedfont	Myrtle Avenue	Daytime / Night-Time
15	Stanwell / West Bedfont	Northumberland Close	Daytime / Night-Time
16	Stanwell Moor	Stanwell Moor	Daytime / Night-Time

Table B.3 Descriptions of Existing Daytime and Night-Time Community Noise Environments

Ref	Monitoring Location	Description of Current Observed Noise Climate
1	North Hayes	The main sources of noise in the North Hayes residential area are; road traffic noise on the A312 to the east and the A4020 through the middle of the area running east to west; and occasional aircraft noise when there is a lower level of road traffic noise. The area is predominantly residential so local road traffic and other associated noises are also contributing noise sources at residential receptors. Along Yeading Brook and South of the A4020 are six amenity spaces (Belmore Playing Fields, Hayes End Recreation Ground, Rosedale Park, Grassy Meadow, Barra Hall Park and Bell House Field) which are likely to have a more natural noise character with traffic noise being less predominant.
2	South Hayes	The main sources of noise in the South Hayes area are aircraft noise as the dominant source and road traffic noise from the M4, A312 and N. Hyde Road being the main source when aircraft noise is not audible. The South Hayes area has an industrial area north of the railway line and a residential area to the south of the railway line bounded by the M4 to the south. Within the industrial area the noise sources are characterised by road traffic, railway and plant/machinery noise. Within the residential area noise sources are characterised by local road traffic, domestic activities and birdsong.
3	Osterley	Osterley has three main areas; Osterley House and Gardens bounded to the north by the M4; a residential area north of the A4 with the underground Piccadilly line running through on the surface; and a residential area south of the A4 and north of the A315. The Osterley House and Gardens are characterised by road traffic noise from the M4 to the north with aircraft audible when flying on a path overhead. Natural sounds such as birdsong are predominant in the area. The residential areas are characterised by local road traffic on the A4 and A315 and general domestic sounds. Residential dwellings near to the Piccadilly line are characterised by the periodic sound of trains passing. Noise from aircraft overhead is a more significant part of the local character when aircraft are arriving on runway 27R.
4	Brentford	The Brentford area is mainly residential. Through the middle of Brentford runs the M4 on a raised flyover and the A4 underneath, these main roads will be a major source of road traffic noise in adjacent areas. Further away from the M4 and A4 local road traffic noise and domestic noise are more dominant. Aircraft noise is audible throughout the area.
5	Shepherds Bush	The Shepherds Bush area is mainly residential with a large commercial area to the north west bounded by the A3220 and the A40. Road traffic noise from 'A' roads is the dominant noise source and is consistent throughout the area. Areas that are further away or shielded from the road traffic noise from 'A' roads are dominated by local road traffic. Aircraft noise is audible occasionally
6	Hounslow	Hounslow is a predominantly residential area positioned due east of the 27R runway at Heathrow. The noise climate is generally characterised by arriving or departing aircraft and local road traffic noise from 'A' roads. Local domestic noises also contribute to the noise character in residential areas away from the 'A' roads.
7	West Drayton	West Drayton is mainly residential and bordered by the M25 to the west; a railway line to the north; Stockley Road to the east; and the M4 to the south. Heathrow airport is due south of the area. The noise character of the area is more influenced by road traffic noise the closer to the M25, M4 or Stroudly Road on the west, south or east side's respectively. To the north of the area rail noise is part of the local noise character. The whole area is also characterised by aircraft noise however this is likely to be more dominant closer to the centre of West Drayton away from the major traffic noise sources. Local general domestic and natural sounds also characterise the area on residential roads.

Table B.3 (continued) Descriptions of Existing Daytime and Night-Time Community Noise Environments

Ref	Monitoring Location	Description of Current Observed Noise Climate
8	Richings Park	Richings Park is a semi-rural and residential area with a golf course and fields to the west; bounded by a railway line to the north; the M25 to the east; and the M4 to the south. The noise in the area is characterised by road traffic noise from the M4 and M25 and arrivals/departures at Heathrow airport to the south. To the north of the area railway noise also contributes to the noise character. Birdsong is audible throughout the area with local traffic and domestic noise being audible in the residential sector to the north east.
9	Harlington	The daytime noise environment at properties within Harlington, to the north of the airport, consisted of road traffic noise on the A4 – Bath Road and air noise from arrivals on the northern runway and departures on the southern runway. Airside activity noise was not audible at this location. The night-time noise environment consists of road traffic noise from the A4 – Bath Road and occasional airside activities, such as APU and aircraft movements. Additional contributors included vehicle reversing beepers in nearby industrial estate, and occasional birdsong.
10	Sipson	The noise environment during the daytime period at properties within Sipson consists of a constant 'hum' from road traffic movements on the M4 to the north and the M4 airport access route to the east of the village. Additional contributors to the noise environment include air noise, industrial activities at a waste disposal site to the west of the village, and road traffic movements on the A408 – Sipson Road, which runs parallel to the M4 airport access route. Airside activities including aircraft taxiing off 27R were audible at this location. During the night-time period the noise from the M4 reduces significantly yet is still dominant at a majority of properties within the village. Noise from industrial activities, such as HGV reversing sirens, within the waste disposal compound to the west of the village was occasionally audible in addition to birdsong.
11	Poyle	The daytime noise environment at the monitoring location within Poyle, to the west of the airport, had significant contributions from road traffic noise from the M4 to the north-west, and the M25 to the east. Air noise from aircraft landing on to the northern runway into 09L was a significant contributor to the existing noise environment, with additional contributions from light levels of traffic on the local road network. Noise from airside activities was not audible during the daytime period. Noise levels from road traffic movements on the M4 and M25 also dominated the night-time noise environment at the monitoring location. During traffic lulls on the M25 and the local road network, noise from aircraft APU during taxiing could be audible. Additional contributors included noise from extraction fans at nearby industrial unit.
12	Harmondsworth	The daytime noise environment included significant contributions from road traffic movements on the M4 and aircraft departure noise from the southern runway. Additional contributions included road traffic movements using the A3044 – Holloway Lane. Airside activities, such as aircraft taxiing off 27R were visible but not audible at the monitoring location. The night-time noise environment at locations within Harmondsworth is dominated by road traffic movements on the M4 in addition to occasional movements on Bath Road. Birdsong was clearly audible at a number of locations within Harmondsworth, as was noise from extraction fans within the nearby Polar Park industrial estate to the south.
13	Cranford	The daytime noise environment at the closest properties to the airport within Cranford is dominated by air noise and road traffic movements on the A4, A30 and A312. Additional noise contributors included arrivals taxiing off 27R and industrial noise contributions including fan noise from the Heathrow Estate to the south. During the night-time period, the noise environment is dominated by road traffic movements on the A4, A30 and A312. Audible airside activities were not witnessed during night-time visits.

Table B.3 (continued) Descriptions of Existing Daytime and Night-Time Community Noise Environments

Ref	Monitoring Location	Description of Current Observed Noise Climate
14	Hatton / East Bedfont	The noise environment at properties within Hatton during the daytime is dominated by road traffic movements on the A30, with occasional additional movements on Hatton Road. Air noise from aircraft departures off the southern runway were also audible. Airside activities including aircraft using the southern runway taxi route were visible but not audible at the monitoring location due to the significant road traffic noise impacts. The night-time noise environment is dominated by road traffic movements on the A30. Occasional airside activities including aircraft taxiing were visible at the monitoring location but not audible.
15	Stanwell / West Bedfont	For properties within Stanwell and West Bedfont, the daytime noise environment is dominated by road traffic movements on the A30 and on the local road network. The daytime noise environment also consists of air noise from aircraft departures on the southern runway, and airside activities including aircraft taxiing onto 09R. Additional noise contributors included HGV movements within the airport boundary and the adjacent industrial estates. Noise levels from road traffic movements on the A30 also dominate the night-time noise environment. Additional night-time noise contributors include airside activities, including aircraft APU, and HGV movements within the adjacent industrial estates.
16	Stanwell Moor	The daytime noise environment for properties within Stanwell Moor is dominated by road traffic noise, predominantly from the M25 to the west, but with additional contributions from the A3113 – Airport Way and A3044 – Stanwell Moor Road. Airside activities, such as aircraft APU and taxiing onto 09R were also audible. During the night-time period, noise levels from the surrounding road networks are reduced, however the noise environment is still dominated by road traffic noise from the M25. Noise from airside activities were not noted during the night-time period.

B.5 Existing Community Ambient and Background Noise Levels

Table B.4 Existing Community Daytime and Night-Time Ambient and Baseline Noise Levels

Ref	Monitoring Location	Daytime		Night-Time	
		Ambient Noise Level, $L_{Aeq, T}$ dB	Background Noise Level, $L_{A90, T}$ dB	Ambient Noise Level, $L_{Aeq, T}$ dB	Background Noise Level, $L_{A90, T}$ dB
1	North Hayes	55	53	n/a	n/a
2	South Hayes	55	51	n/a	n/a
3	Osterley	64	55	n/a	n/a
4	Brentford	68	53	n/a	n/a
5	Shepherds Bush	63	59	n/a	n/a
6	Hounslow	64	57	n/a	n/a
7	West Drayton	64	62	n/a	n/a
8	Richings Park	62	60	n/a	n/a
9	Harlington	59	56	42	38
10	Sipson	54	52	50	47
11	Poyle	60	51	53	51
12	Harmondsworth	60	52	60	51
13	Cranford	64	55	43	40
14	Hatton / East Bedfont	76	59	52	45
15	Stanwell / West Bedfont	68	57	57	43
16	Stanwell Moor	53	55	52	45

Appendix C
Fleet and Forecast Assumptions

C.1 Long-term Traffic Forecasts

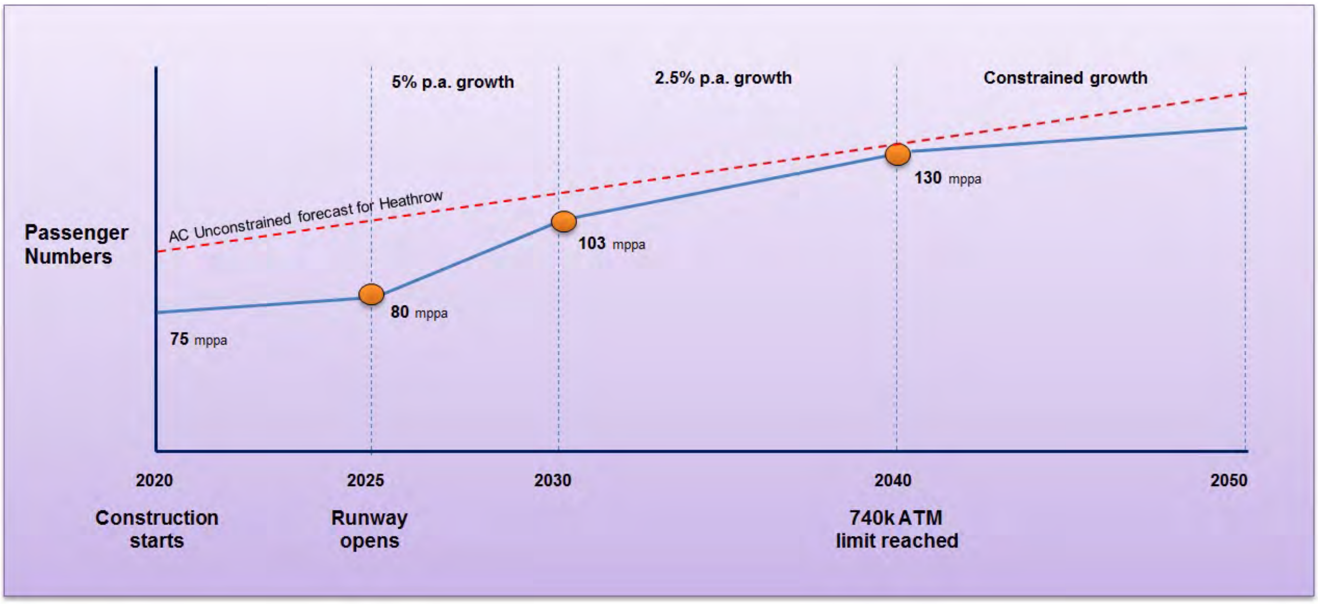
Figure C.1 illustrates Heathrow's forecast traffic growth over the next 25 years in comparison to the unconstrained growth forecast supplied by the Airports Commission. The blue line shows how Heathrow has predicted that passenger demand will move from a constrained growth path towards this unconstrained growth path – this modelling arrives at a very similar mid-2030s demand level to the Commission's Interim Report.

In practice, these assumptions on growth represent a central case. The actual path is dependent on many factors, one of which will be the strategy for releasing airport capacity. This will be determined through working in conjunction with ACL, NATS and the airlines. For example, additional slot capacity may be released at a steady rate over time, rather than making all the theoretical capacity available on day one. Alternatively, a faster rate of release may drive faster growth depending on airline economics.

Environmental factors and the planning application process are also likely to play a significant part in defining how slot growth is released. This could be through potential environmental impact limits, which would have to be adhered to when determining how aircraft movements would grow over time.

There is risk in both directions on the growth path assumptions. The central case has been used to develop the strategic test schedules by which airport facilities have been sized. It has been used for the environmental impact assessments. A first operation date for the third runway of 2025 has been assumed. 2030 and 2040 have been selected as design years to represent an early phase operation and a mature operation respectively. Test schedules have been developed for these years.

Figure C.1 Central Case Assumptions on Passenger Growth at Heathrow with a Third Runway



2R/3R Strategic Test Schedules

Example schedules for a busy day's flights allow testing of a masterplan for actual operating capacity and also for impacts. Test schedules for this purpose are far more precise than annual aggregate passenger numbers. Heathrow has developed baseline two-runway strategic test 'busy day' schedules for 2030 and 2040. For the expanded masterplan, Heathrow has developed two, three-runway 'busy day' scenario schedules: a 2030 schedule equivalent to 570,000 annual movements and a 2040 740,000 annual movement schedule.

The schedules are based on a Friday in July to test the most extreme case, therefore using the summer schedule as a base. In the case of the three-runway schedules, additional arrival-departure flight pairs are added according to the market growth rates from the econometric model. This is necessarily a simplifying assumption. While accurate for testing capacity, it will not necessarily predict the actual mix of destinations or aircraft on a given day in 2030 or 2040.

Base passenger numbers are assigned to each flight by applying load factors from given hours and arrival/departures splits using average historic load factors. Market growth rates from the econometric model are applied to the base passengers to produce a flight level passenger demand for each schedule. Aircraft type changes are carried out on the basis of fleet plans supplied by carriers or known aircraft orders, and, where appropriate, if forecast demand exceeds capacity. The flight level passenger forecast is then calculated using 95^{th} percentile load factors on an hourly, market and arrival/departure basis. This methodology has been used at Heathrow for defining capacity for the last three years.

C.2 Fleet Assumptions

Using the timeline outlined in Section 4.1 and the approach of the Sustainable Aviation Roadmap, a number of assumptions have been developed regarding noise levels of these aircraft types. The following table summarises the proportions of aircraft types for each scenario.

Table C.1 Aircraft Fleet Assumptions

Aircraft Family	2R 2030	2R 2040	3R 2030	3R 2040
A320 family (Current)	6%	0%	6%	0%
A320 NEO (Imminent)	57%	51%	52%	47%
A320 NEO (Future)	0%	13%	0%	12%
Other Code C (Current)	0%	0%	1%	0%
A350 family (Imminent)	4%	1%	7%	3%
A350 family (Future)	0%	1%	0%	1%
Generic Code E (current & imminent)	4%	0%	0%	0%
Generic Code E (Future)	0%	4%	0%	3%
B777 (current)	0%	0%	0%	0%
B777 (Imminent)	3%	2%	3%	4%
B787 family (Imminent)	15%	13%	18%	13%
B787 family (Future)	0%	3%	0%	3%
A388 (imminent)	7%	6%	7%	5%
A388 (Future)	0%	1%	0%	1%
Generic Code F (748, 77X (Imminent))	4%	4%	6%	7%

In 2030 it is expected that 85-90% of operating aircraft will be imminent aircraft types, for example, the A320 NEO and the A350. There will still be approximately 10-15% of the current aircraft types, for example, the current A320 family. There will be no future (Generation 2) aircraft operating by 2030 which are expected to start operating around 2035. In 2040 approximately 20% of the forecast operating aircraft are of this future generation technology.

Heathrow's Mitigation Strategy is marginally more optimistic than the latest DfT 2030 forecast for a two-runway Heathrow. The amendments made reflect what airlines have told Heathrow about their orders for aircraft and their future fleet plans. For example, the DfT forecasts that approximately 80% of the A320 (single aisle, short-haul) would be Generation 1 (imminent technology). Heathrow has therefore assumed 90% of these aircraft would be Generation 1 in 2030.

Whilst these are the types that it is considered will be operating, modelling them requires a further set of assumptions to be made since there are no noise characteristics for these future aircraft types.

C.3 Airspace Design Assumptions

In developing the airspace designs, Heathrow has consulted with NATS to ensure that the designs are credible and robust (see **Appendix H**).

NATS is confident that the London Terminal Manoeuvring Area (TMA) airspace will support a three-runway Heathrow. Route designs and operational modes will not constrain the resilience or operational capacity of the expanded airport. NATS also believes that no other airports will be adversely affected by Heathrow's expansion.

All aircraft will operate using Precision Based Navigation (PBN). This system gives a high degree of accuracy to aircraft routing and positioning that enables shorter distances between aircraft on the same route.

We have assumed the following when designing the approach flight paths:

- Continuous descent approaches are conducted to all runways:
  - Independent parallel final approaches can be conducted to any two runways and all approaches will be steeper than today at 3.2 degrees in 2030 and 3.5 degrees in 2040.
- GBAS technologies will be in place to allow precision approaches from 2030;
  - This will be the primary navigational aid for landing, with the current ILS retained for resilience purposes and all-weather operating capability.
- Aircraft are established and stabilised on the straight run in to the runway or 'final approach';
  - This is at a height of 1,000 feet (approx. 3 nautical miles (nmi) from the threshold on a 3.2 degree approach).
- Long-distance turns are possible to give 'curved approaches';
  - These enable aircraft to turn onto the final approach closer in than today's 8-mile joining point. This joining from a curved approach has a minimum turn radius of 2 nmi and must intercept the final approach no closer than 4 nmi from the threshold, as stabilisation on any straight section requires approximately 1.5 nmi. These curved approaches are able to deliver the same capacity as a 'straight in' approach. The angle of intersection from a curved approach to any straight-line segment can be no more than 30 degrees.

It has been assumed the following when designing the take-off flight paths:

- All aircraft fly straight ahead to 1 nmi from the end of the runway to maintain an efficient operation and allow for aircraft separation requirements. These splits are not required from a runway being used in Departures and Landing mode (DL), as the assumption is that any two departures will be separated by an arrival;
- Turns in departure routes have a radius of not less than 2 nmi to allow for Code F size aircraft;
- **Continuous climb departures** can be conducted from all runways, independent parallel departures can be conducted from any two runways and routes from different runways in use at the same time must diverge;
- **Required Navigational Performance (RNAV)** Standard Instrument Departures (SIDs) exist with any pair of diverging routes, permitting one minute departure separations for non wake vortex separated pairs of aircraft;

- Routes allow northbound aircraft to depart from the southernmost runway (and vice versa), using either wrap around or long way round SIDs. These SIDs exist to permit compass departures where a northbound/southbound imbalance exists: for example, a Dover (DVR) North SID, which allows DVR departures to depart from the northernmost departure runway. This will permit 'Compass Departures' to be maintained despite a departure route imbalance;

- Where SID tracks from different runways cross, vertical separation of 1,000 feet exists at the crossing point, maintaining the SIDs independence of each other;

- To ensure maximum flexibility and resilience of operation, each runway in each mode of operation has the same set of departures routes. It is assumed that aircraft will continue to be directed along a set of specific routes in a similar manner to today and not be dispersed. There are a similar number of routes as today and each is available from every runway.

For each option, illustrative operation route structures are presented for two modes to show the principles of each. The routes presented should be seen as indicative of the principles and not definitive. Each route is presented as a 1 kilometre wide zone (500 metres either side of a centre line). The designs, while challenging some of today's assumptions, are considered realistic and deliverable.

The overall route structure is nominally the same as today. NATS Heathrow has allocated flights in the schedule to routes based on the same principles as today. For example if an aircraft current uses the westerly BPK, i.e. heading north during westerly operations then it will use an equivalent BPK in 2030. To ensure that there are options for aircraft using the principal of compass departures, there is an equivalent route heading south for those that may be heading north from a southern runway and a route that would head north for those heading south from a northern runway.

Appendix D
Detailed Noise Modelling Methodologies

D.1 INM Modelling

D.1.1 Information regarding the INM Model

The Integrated Noise Model (INM) is a computer model that evaluates aircraft noise impacts in the vicinity of airports. It is developed based on the algorithm and framework from SAE AIR 1845 standard, which used Noise-Power-Distance (NPD) data to estimate noise accounting for specific operation mode, thrust setting, and source-receiver geometry, acoustic directivity and other environmental factors. The INM can output either noise contours for an area or noise level at pre-selected locations.

The core calculation modules of INM are based on standards documents produced by the Society of Automotive Engineers (SAE) Aviation Noise Committee (A-21). This internationally represented committee is composed of research institutions, engineering firms, aircraft and engine manufacturers, government regulatory agencies, and end-users of noise modelling tools. The INM's core computation modules are also compliant with other international standards documents including European Civil Aviation Conference (ECAC) Document 29 and International Civil Aviation Organization (ICAO) Circular 205. The five relevant documents pertaining to this release of INM are:

- SAE-AIR-1845 "Procedure for the Calculation of Airplane Noise in the Vicinity of Airports";
- SAE-AIR-5662 "Method for Predicting Lateral Attenuation of Airplane Noise";
- SAE-ARP-866A "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity";
- ECAC Doc 29 "Report on Standard Method of Computing Noise Contours around Civil Airports"; and
- ICAO Circular 205 "Recommended Method for Computing Noise Contours Around Airports".

The INM is an internationally accepted model, used by many countries around the world to generate their noise contours. It contains a wide variety of noise metrics and the ability to set up and model custom metrics.

D1.1.2 Setting up the INM

RealContours™ Modelling

The INM was adapted to more closely reflect the Heathrow operation using analysis of the existing tracks using RealContoursTM. It should be noted that this was used to verify and set-up the model and to inform of the setup of future scenarios. All noise exposure data was generated using INM7d.

Radar data from the Heathrow Noise and Track monitoring (NTK) for 2011 was provided by Heathrow and using the RealContoursTM system (RCV2) each day of the year was setup and modelled. This generated a 24 hour

LDEN set of contours for each day of the year. Additionally the 16-hour LAeq contours were derived for the 92 days specified for that metric.

Initially, standard aircraft substitutions, standard INM arrivals profiles and city-pairs were used to select the stagelength to be modelled. These results were compared to the ERCD 2011 contour sets generated using ANCON and the differences analysed.

INM uses full power take-offs for all of its profiles whereas ANCON uses a minimum safe power take-off for its procedures (less take-off thrust means less start of take-off roll noise). There is a difference in departure take-off power and the lateral attenuation algorithm used in each model.

The departure lobes from INM were smaller compared to ANCON so the stagelength selection process was changed to use a best altitude profile match. This method chooses the best stagelength and INM profile match. These changes provided a larger departure contour set and a better match to ANCON. For this reason, the analysis reported herein includes adjustments in stagelengths and additional departure profiles to enhance the departure noise results.

Population Data

Population data was obtained from CACI. This data included two files:

- Postcode data which is the refined current year data for 238,851 individual locations. Each point contained the location, number of people, number of households, number of schools and hospitals.
- Sector data which is the forecasted population data for 2030 and 2040. Each sector is made up of several postcodes.

In order to keep the future data at the same refinement as the current year data, the percentage difference was computed between the current year and the forecast year and the percentage difference applied to each postcode building in the 2030 and 2040 postcode data set.

These points were entered into a relational database and each point was assigned a noise level interpolated from the noise modelling grid. Results from every model run are stored in the database for later analysis.

Terrain Data

In the L_{eq} Report 1201, ERCD models the topography around Heathrow Airport by accounting for terrain height. Lateral attenuation and noise screening/reflection effects due to uneven terrain were not taken into account. Terrain height is accounted for by applying a geometrical correction to the source-receiver distances and elevation angles.

The INM has a similar function and terrain data was provided in a 3TX/3CD format. This data is in a 3-arc second resolution which is approximately 90 meters. The data ranged in elevation from zero to 246m above Mean Sea Level (MSL) and covered the modelling area. This terrain data was included in all of the Sustainability Appraisal modelling.

Line of sight blocking was not used in this modelling due to the lack of significant terrain issues and the large increase in run time that this option creates.

NPD Adjustment

Modified Noise-Power-Distance (NPD) curves was used for all of the modelling analysis. Noise levels for NPD curves are based on SAE-AIR-1845 atmospheric absorption coefficients. The spectral class associated with the noise identifier and operational mode is used in the adjustment process.

- SAE-AIR-1845 atmospheric absorption losses are removed from the curves.
- SAE-ARP-866A atmospheric absorption losses are employed in the curves. Absorption is a function of temperature and relative humidity.

Profile Stage Number

Profile stage is a one-digit number that distinguishes members in a profile group. It is called "stage" because it is used to identify stage lengths for departure profiles. Stage length is a range of flight distances. Departure stage lengths are defined as follows:

Table D.2 INM Stage Lengths

Stage Length	Distance
1	0 to 500 nmi
2	501 to 1000 nmi
3	1001 to 1500 nmi
4	1501 to 2500 nmi
5	2501 to 3500 nmi
6	3501 to 4500 nmi
7	4501 to 5500 nmi
8	5501 to 6500 nmi
9	over 6500 nmi

The idea behind using stage length is that the longer the flight, the heavier the average take-off weight due to increased fuel requirements. Historically, it has been easier to obtain flight length data than average aircraft weight data, so stage length has been used as a surrogate for aircraft take-off weight (which ultimately affects the climb performance of a given aircraft).

Stagelength numbers were initially assigned based on the city-pair distance provided in the schedules. For the modelling scenarios, the stagelengths selected were adjusted for several of the INM types modelled. The stagelengths were increased to reflect an analysis of 2011 evaluation modelling. Details of those adjustments are provided in those sections.

Profiles

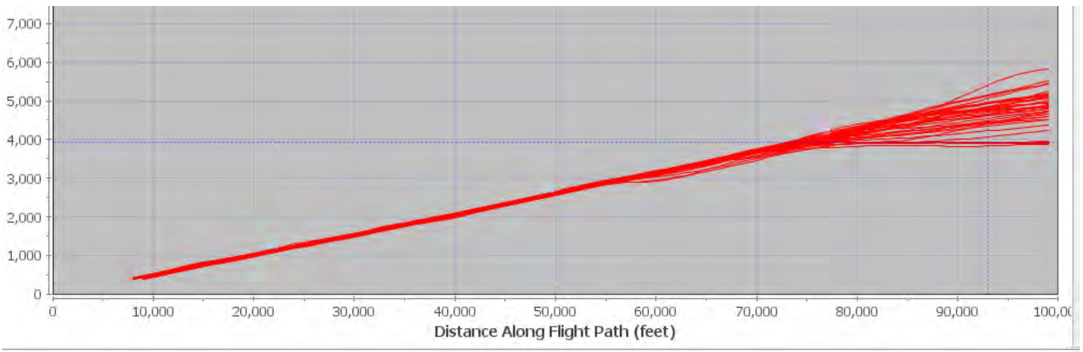
INM standard profiles start at 6,000 feet Above Airfield Level (AAL) for approaches and end at 10,000 feet AAL for departures. INM standard aircraft do not exist above these altitudes; consequently, no noise is produced. For this modelling effort, several of the noise metrics and levels being evaluated are a great distances from the airport so the INM model profiles were modified. This is a standard practice when the study area exceeds the immediate airport environs or air traffic procedures are being evaluated.

Arrival Profiles

INM aircraft follow a 3-degree descent from 6,000 feet AAL except many commercial aircraft arrival profiles include a level segment at 3,000 feet. The profiles were modified to descend from 10,000 feet to 6,000 feet AAL in 1,000 feet increments. During a review of arrivals profiles from Heathrow's noise and flight track (NTK) system data it was evident that arriving aircraft do not level off at 3,000 feet as provided in the INM standard arrival profiles.

Figure 1 below displays a sample of arrivals to 27L at Heathrow. In general, the profiles are on a 3-degree descent from 5,000 feet. There are some segments of level flight evident, generally at 4,000 feet and higher. However, the level segment in the INM model profiles at 3,000 feet was removed, leaving just the 3-degree approach which simulates an optimised profile descent.

Figure D.1 Arrivals to 27L 2011 (example)



It is considered that in 2030 with precision-guided navigation that continuous descent will be applied across all aircraft from 6000ft and the observed current observed level segment or descent at less than the glideslope gradient would not occur. It is considered that this would be the case in both a 2R and 3R Heathrow in the future with PBN in operation. The same assumption has been made through the current and 2030 the improvements that have been indicated are conservative estimates.

The INM arrival profiles are an optimised profile decent with no level off sections. For the 2030 modelling cases for both the 2 Runway and 3 Runway layouts a glide slope of 3.2 degrees was used. For 2040, the 2 runway layout used a 3.2 degree glide slope and for the 3 runway layout a 3.5 degree glide slope was modelled. These has been applied to every approach profile.

Departure Profiles

Many INM aircraft types include Standard, ICAO-A and ICAO-B departure profiles. Each of these use maximum take-off thrust but reduce thrust, and flaps at different segments of the flight profile.

For this analysis, the departure profiles were modified to continue to climb from 10,000 feet to 18,000 feet AAL in 2,000 feet increments. In general, INM profiles have an unrestricted climb after 5,500 feet AAL.

All stagelengths were selected based on the city pairs provided in the schedule of operations. They were then adjusted based on the results of the 2011 INM 7.0d Evaluation modelling. In the 2011 evaluation modelling, RealContours™ assigns a unique flight profile to each operation. RealContours™ compares the radar data profile to a set of profiles available for each aircraft, and then matches the “best profile” to each operation. This method allows for an accurate representation of each individual operation. The INM uses stagelengths as surrogates for weights. These are selected by the distance between the two airports.

As an example, Heathrow has A380 departures to Dubai, which is 2,972 nmi from Heathrow. Based on the City-pair (LHR- DBX) the stagelength selected should be a stagelength 5 (2500 nmi – 3500 nmi). However based on the profile matching a stagelength 8 is a better match. Also the ICAO-B, procedure with its thrust cut-back at 1,000’ is a better match for the Day departure and the ICAO-A procedure is a better match for the Evening departure with a cut-back at 3,000’. The RCV2 matching uses track distance to select the best match. The distance used for this analysis is 5 nmi (30,380 feet) from brake release. For most aircraft types this is a sufficient distance. For the long haul flights, this is sufficient distance to determine the rotation point, initial climb and location of an early thrust cut-back as shown in Figure 3.

Further evaluation also showed a difference in the profiles used between east and west departures. The additional level of profile selection was added to the SA modelling. The modelled profiles match the ratio of modelled profiles for each time period evaluated in the 2011 INM 7.0d Evaluation data:

- ICAO-A – represents a Distant Noise Abatement Profile (NADP-2) with a thrust cutback at 1,500’; and
- ICAO-B – represents a Close-in Noise Abatement Profile (NADP-1) with a thrust cutback at 1,000’.

The percentages in Figure D.2 were applied to each runway end and route by INM aircraft type.

Figure D.2 A380 Departure Profile Selection in RealContours™

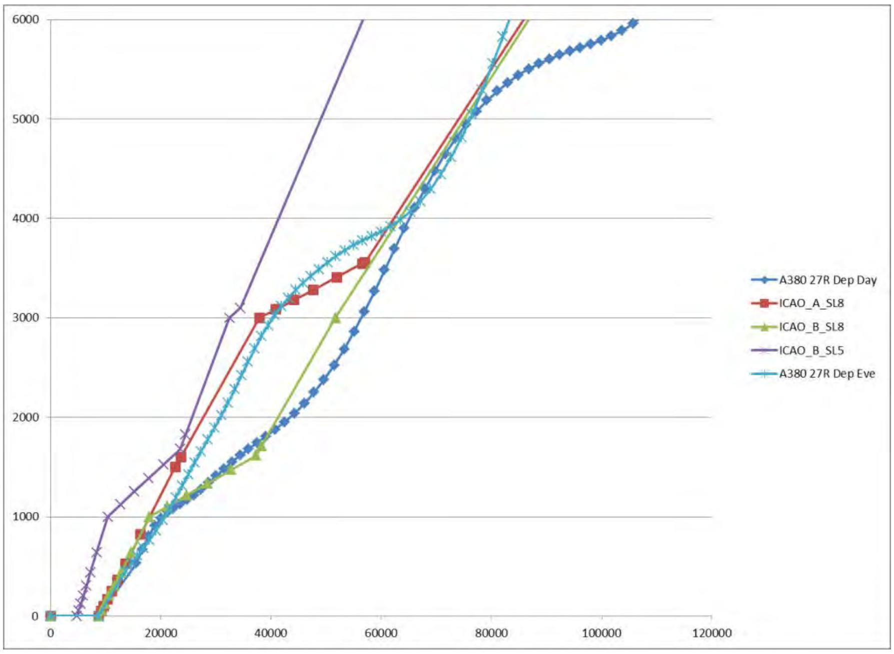


Table D.2 INM Altitude Profile Selection

Direction	Aircraft INM ID	Operation (A Arrival, D Departure)	INM Profile	Day	Evening	Night
East	7478	D	ICAOA_EX	8%	16%	9%
East	7478	D	ICAOB_EX	92%	84%	91%
West	7478	D	ICAOA_EX	34%	38%	44%
West	7478	D	ICAOB_EX	66%	62%	56%
West	7478_G2	D	ICAOB_EX	66%	62%	56%
East	7478_G2	D	ICAOA_EX	8%	16%	9%
East	7478_G2	D	ICAOB_EX	92%	84%	91%
West	7478_G2	D	ICAOA_EX	34%	38%	44%
East	7773ER	D	ICAOA_EX	40%	58%	63%
East	7773ER	D	ICAOB_EX	39%	35%	38%
East	7773ER	D	STD_EXT	21%	8%	0%
West	7773ER	D	ICAOA_EX	55%	71%	83%
West	7773ER	D	ICAOB_EX	31%	25%	17%
West	7773ER	D	STD_EXT	14%	4%	1%
East	7773ER_G2	D	ICAOA_EX	40%	58%	63%

Table D.2 (continued) INM Altitude Profile Selection

Direction	Aircraft INM ID	Operation (A Arrival, D Departure)	INM Profile	Day	Evening	Night
East	7878R_G2	D	ICAOA_EX	2%	36%	50%
East	7878R_G2	D	ICAOB_EX	98%	64%	50%
West	7878R_G2	D	ICAOA_EX	10%	46%	47%
West	7878R_G2	D	ICAOB_EX	90%	54%	53%
East	A319-131	D	ICAOA_EX	61%	56%	52%
East	A319-131	D	ICAOB_EX	39%	44%	48%
West	A319-131	D	ICAOA_EX	59%	56%	55%
West	A319-131	D	ICAOB_EX	41%	44%	45%
East	A320-232	D	ICAOA_EX	28%	36%	41%
East	A320-232	D	ICAOB_EX	72%	64%	59%
West	A320-232	D	ICAOA_EX	39%	48%	59%
West	A320-232	D	ICAOB_EX	61%	52%	41%
East	A321-232	D	ICAOA_EX	46%	50%	54%
East	A321-232	D	ICAOB_EX	54%	50%	46%
West	A321-232	D	ICAOA_EX	58%	62%	65%
West	A321-232	D	ICAOB_EX	42%	38%	35%
East	A350-1000	D	ICAOA_EX	2%	36%	50%
East	A350-1000	D	ICAOB_EX	98%	64%	50%
West	A350-1000	D	ICAOA_EX	10%	46%	47%
West	A350-1000	D	ICAOB_EX	90%	54%	53%
East	A350-1000_G2	D	ICAOA_EX	2%	36%	50%
East	A350-1000_G2	D	ICAOB_EX	98%	64%	50%
West	A350-1000_G2	D	ICAOA_EX	10%	46%	47%
West	A350-1000_G2	D	ICAOB_EX	90%	54%	53%
East	A350-800	D	ICAOA_EX	2%	36%	50%
East	A350-800	D	ICAOB_EX	98%	64%	50%
West	A350-800	D	ICAOA_EX	10%	46%	47%
West	A350-800	D	ICAOB_EX	90%	54%	53%
East	A350-800_G2	D	ICAOA_EX	2%	36%	50%
East	A350-800_G2	D	ICAOB_EX	98%	64%	50%
West	A350-800_G2	D	ICAOA_EX	10%	46%	47%
West	A350-800_G2	D	ICAOB_EX	90%	54%	53%
East	A350-900	D	ICAOA_EX	2%	36%	50%

Table D.2 (continued) INM Altitude Profile Selection

Direction	Aircraft INM ID	Operation (A Arrival, D Departure)	INM Profile	Day	Evening	Night
East	A350-900	D	ICAOB_EX	98%	64%	50%
West	A350-900	D	ICAOA_EX	10%	46%	47%
West	A350-900	D	ICAOB_EX	90%	54%	53%
East	A350-900_G2	D	ICAOA_EX	2%	36%	50%
East	A350-900_G2	D	ICAOB_EX	98%	64%	50%
West	A350-900_G2	D	ICAOA_EX	10%	46%	47%
West	A350-900_G2	D	ICAOB_EX	90%	54%	53%
East	A350-XWB	D	ICAOA_EX	2%	36%	50%
East	A350-XWB	D	ICAOB_EX	98%	64%	50%
West	A350-XWB	D	ICAOA_EX	10%	46%	47%
West	A350-XWB	D	ICAOB_EX	90%	54%	53%
East	A350-XWB_G2	D	ICAOA_EX	2%	36%	50%
East	A350-XWB_G2	D	ICAOB_EX	98%	64%	50%
West	A350-XWB_G2	D	ICAOA_EX	10%	46%	47%
West	A350-XWB_G2	D	ICAOB_EX	90%	54%	53%
East	A380-841	D	ICAOA_EX	30%	27%	13%
East	A380-841	D	ICAOB_EX	70%	73%	88%
West	A380-841	D	ICAOA_EX	46%	55%	76%
West	A380-841	D	ICAOB_EX	54%	45%	24%
East	A380-841_G2	D	ICAOA_EX	30%	27%	13%
East	A380-841_G2	D	ICAOB_EX	70%	73%	88%
West	A380-841_G2	D	ICAOA_EX	46%	55%	76%
West	A380-841_G2	D	ICAOB_EX	54%	45%	24%
East	A380-861	D	ICAOA_EX	27%	38%	0%
East	A380-861	D	ICAOB_EX	73%	62%	100%
West	A380-861	D	ICAOA_EX	40%	43%	50%
West	A380-861	D	ICAOB_EX	60%	57%	50%
East	A380-861_G2	D	ICAOA_EX	27%	38%	0%
East	A380-861_G2	D	ICAOB_EX	73%	62%	100%
West	A380-861_G2	D	ICAOA_EX	40%	43%	50%
West	A380-861_G2	D	ICAOB_EX	60%	57%	50%
East	EMB190	D	ICAOAE	11%	33%	0%

Table D.2 (continued) INM Altitude Profile Selection

Direction	Aircraft INM ID	Operation (A Arrival, D Departure)	INM Profile	Day	Evening	Night
East	EMB190	D	ICAOBE	28%	25%	20%
East	EMB190	D	STD_EXT	61%	42%	80%
West	EMB190	D	ICAOAE	21%	42%	0%
West	EMB190	D	ICAOBE	42%	35%	50%
West	EMB190	D	STD_EXT	38%	23%	50%
East	EMB190_G2	D	ICAOAE	11%	33%	0%
East	EMB190_G2	D	ICAOBE	28%	25%	20%
East	EMB190_G2	D	STD_EXT	61%	42%	80%
West	EMB190_G2	D	ICAOAE	21%	42%	0%
West	EMB190_G2	D	ICAOBE	42%	35%	50%
West	EMB190_G2	D	STD_EXT	38%	23%	50%
East	EMB195	D	ICAOAE	11%	33%	0%
East	EMB195	D	ICAOBE	28%	25%	20%
East	EMB195	D	STD_EXT	61%	42%	80%
West	EMB195	D	ICAOAE	21%	42%	0%
West	EMB195	D	ICAOBE	42%	35%	50%
West	EMB195	D	STD_EXT	38%	23%	50%
East	EMB195_G2	D	ICAOAE	11%	33%	0%
East	EMB195_G2	D	ICAOBE	28%	25%	20%
East	EMB195_G2	D	STD_EXT	61%	42%	80%
West	EMB195_G2	D	ICAOAE	21%	42%	0%
West	EMB195_G2	D	ICAOBE	42%	35%	50%
West	EMB195_G2	D	STD_EXT	38%	23%	50%
East	NEO319	D	ICAOA_EX	61%	56%	52%
East	NEO319	D	ICAOB_EX	39%	44%	48%
West	NEO319	D	ICAOA_EX	59%	56%	55%
West	NEO319	D	ICAOB_EX	41%	44%	45%
East	NEO319_G2	D	ICAOA_EX	61%	56%	52%
East	NEO319_G2	D	ICAOB_EX	39%	44%	48%
West	NEO319_G2	D	ICAOA_EX	59%	56%	55%
West	NEO319_G2	D	ICAOB_EX	41%	44%	45%
East	NEO320	D	ICAOA_EX	28%	36%	41%

Table D.2 (continued) INM Altitude Profile Selection

Direction	Aircraft INM ID	Operation (A Arrival, D Departure)	INM Profile	Day	Evening	Night
East	NEO320	D	ICAOB_EX	72%	64%	59%
West	NEO320	D	ICAOA_EX	39%	48%	59%
West	NEO320	D	ICAOB_EX	61%	52%	41%
East	NEO320_G2	D	ICAOA_EX	28%	36%	41%
East	NEO320_G2	D	ICAOB_EX	72%	64%	59%
West	NEO320_G2	D	ICAOA_EX	39%	48%	59%
West	NEO320_G2	D	ICAOB_EX	61%	52%	41%
East	NEO321	D	ICAOA_EX	46%	50%	54%
East	NEO321	D	ICAOB_EX	54%	50%	46%
West	NEO321	D	ICAOA_EX	58%	62%	65%
West	NEO321	D	ICAOB_EX	42%	38%	35%
East	NEO321_G2	D	ICAOA_EX	46%	50%	54%
East	NEO321_G2	D	ICAOB_EX	54%	50%	46%
West	NEO321_G2	D	ICAOA_EX	58%	62%	65%
West	NEO321_G2	D	ICAOB_EX	42%	38%	35%

Departures in this modelling set have an unrestricted climb beyond 5,500’ AAL.

Table D.3 below shows the INM types which had the Stagelengths increased to account for the selected stagelength differences found in the 2011 INM 7.0d Evaluation data. For example, a city-pair stagelength of five for a 7773ER is adjusted to eight in the final modelling operational data.

Table D.3 Stagelength Adjustments

SL Adjustments			
Aircraft INM ID	**SL Adjustment**	**Aircraft INM ID**	**SL Adjustment**
7478	3	A350-800	2
7478_G2	3	A350-800_G2	2
7773ER	3	A350-900	2
7773ER_G2	3	A350-900_G2	2
7778X	3	A350-1000	2
7778X_G2	3	A350-1000_G2	2
7779X	3	A350-XWB	2
7779X_G2	3	A350-XWB_G2	2
A320-232	3	A380-841	3
NEO320	3	A380-841_G2	3
NEO320_G2	3		

D.1.3 Modelling Details

In general all of the modelling for years 2030 and 2040 developed results for the following standard metrics:

- LDEN – (Lden) 24 hour metric with day equal to 0700 to 1900, evening equal to 1900 to 2300 and night equal to 2300 to 0700. Day, evening and night operations are weighted by 1, 3.16[10] and 10 respectfully. This metric represents an annual average day;

- 16hr Leq – (Leq) 16 hour metric with equal to 0700 to 2300. Day equal to 0700 to 1900, evening equal to 1900 to 2300 and night equal to 2300 to 0700. Day, evening and night operations are weighted by 1, 1 and 0 respectfully (night operations are excluded). This metric represents an average day between June 16 and Sept 15th (92-day summer period);

- 8hr LeqN – (LeqN) 8 hour night metric with night equal to 2300 to 0700. Day, evening and night operations are weighted by 0, 0 and 1 respectfully. This metric represents an annual average 8 hour night; and

- 6.5hr LeqN – (LN65) 6.5 hour night metric with night equal to 2330 to 0600. Day, evening and night operations are weighted by 0, 0 and 1 respectfully. This metric represents an annual average 6.5 hour night.

For 2030, which is the primary evaluation year, the following supplemental metrics were also modelled:

[10] A operational weighting of 3.16 results in a noise level weighting of 5 decibels (dB)

- 2.5hr LeqN – (LN25) 2.5 hour night metric with night equal to 0430 to 0700. Day, evening and night operations are weighted by 0, 0 and 1 respectfully. This metric represents an annual average 2.5 hour night;
- 1.5hr LeqN – (LN15) 1.5 hour night metric with night equal to 0430 to 0600. Day, evening and night operations are weighted by 0, 0 and 1 respectfully. This metric represents an annual average 1.5 hour night;
- N60 – (LN15_N60) Number of Events above a 60 Lmax. This was calculated the 1.5 hour night 0430 to 0600;
- N60 – (LN25_N60) Number of Events above a 60 Lmax. This was calculated the 2.5 hour night 0430 to 0700;
- N60 – (LeqN_N60) Number of Events above a 60 Lmax. This was calculated the 8 hour night 2300 to 0700;
- N65 – (Leq_N65) Number of Events above a 65 Lmax. This can be applied to any modelled time frame but was calculated the 16 hour daytime 0700 to 2300; and
- N70 – (Leq_N70) Number of Events above a 70 Lmax. This can be applied to any modelled time frame but was calculated the 16 hour daytime 0700 to 2300.

Weather Data

The following values were used for all model runs.

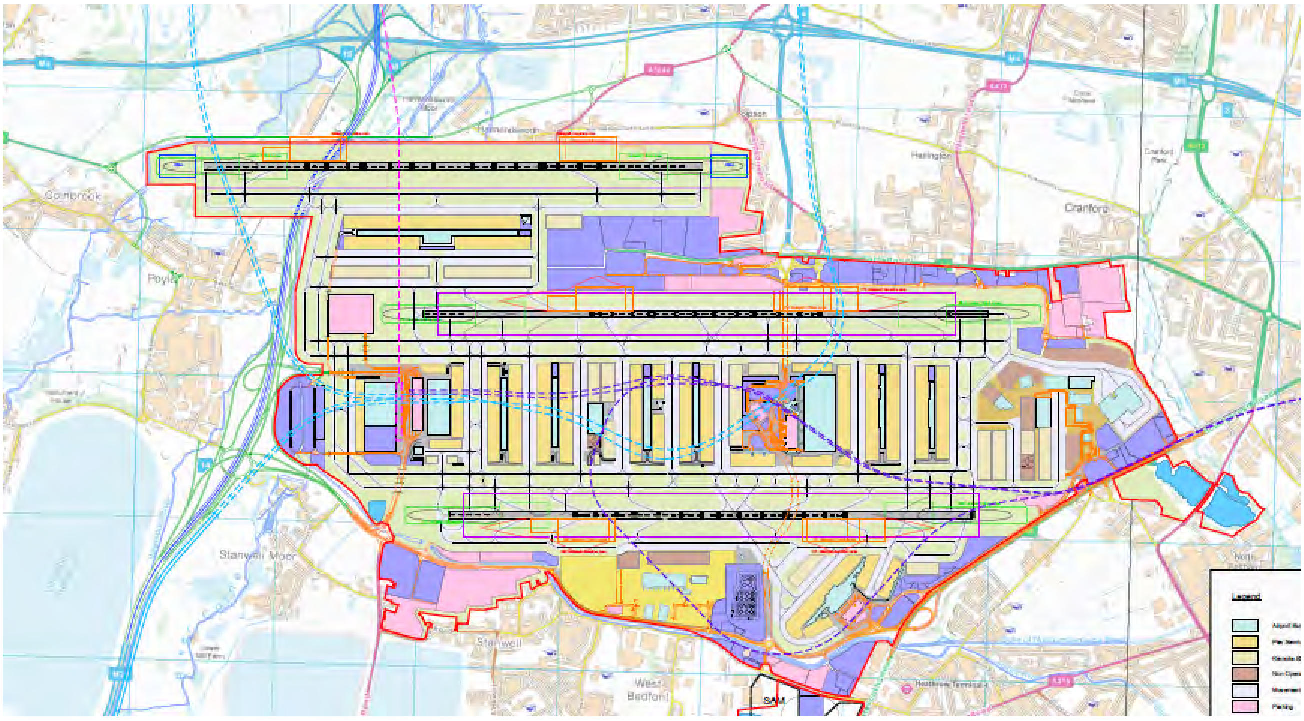
- Temperature = 14.8 C;
- Pressure = 759.97 mm-Hg;
- Humidity = 70.0 %; and
- Headwind = 14.8 km/h.

Runway Layout

The modelling focused on two runway layouts:

- Two Runway Existing; and
- Three Runway Northwest 3500m.

Figure D.3 3 Runway North West Layout (note this is indicative for simplicity and the masterplan boundary does not include the variations made around Harmondsworth).



The three runway layout includes extended displaced landing thresholds resulting in 2,800m of landing distance on each runway. Displaced thresholds were only applied to runways that are longer than 2800m. For example, a 3,500m runway has a 700 m arrival displaced threshold on each end.

Table D.4 Runway Lengths and Displaced Landing Thresholds

Runway	2 Runway Layout		3 Runway Layout	
	Length	Displaced Landing Threshold	Length (m)	Displaced Landing Threshold
09N – 27N (New Runway)	-	-	3500m	700m
09L – 27R	3902m	315m	3962m	1162m
09R – 27L	3658m	310m	3660m	862m

Operational Conditions Modelling

For the 2R layout:

- 2030 - 480,000 operations per year; and
- 2040 - 480,000 operations per year.

For the 3 Runway layout:

- 2030 - 570,000 operations per year; and
- 2040 - 740,000 operations per year.

The future runway studies used the east – west split and adjustment from the busy day schedule as defined in Table D.5. Runway use before 6am is distributed equally between the runways. Table D.5 displays the scale factors used for each metric and time period. The East – West split is based on the prior five years.

Table D.5 Operational Scaling Factors

Metric	Modal Splits		Conversion from 'busy day' schedule		
	East	West	Day	Evening	Night
$L_{Aeq, 16hr}$	0.18	0.82	357/365	362/365	--
L_{DEN}	0.3	0.7	351/365	365/365	--
L_{DEN} (2300-0600)	0.5	0.5	--	--	305/365
L_{DEN} (0600-0700)	0.3	0.7	--	--	305/365
L_{EQN} (2300-0600)	0.5	0.5	--	--	305/365
L_{EQN} (0600-0700)	0.3	0.7	--	--	305/365
N65	0.5	0.5	--	--	305/365
N15	0.5	0.5	--	--	305/365
LN25 (0430-0600)	0.5	0.5	--	--	305/365
LN25 (0600-0700)	0.3	0.7	--	--	305/365

Aircraft Noise Emission Dataset – INM Aircraft Types

The INM version 7.0d aircraft database contains 164 different civil aircraft/engine combinations. This version includes several new types which are part of the 2030 Heathrow forecasts, such as the Boeing 787, 747-800 and the 777300ER. This version also includes four new Embraer types in service (E170, E175, E190 and the E195). All of the modelling sets were completed using INM 7.0d.

The schedule types were matched to either an INM type or the appropriate substitution used for this modelling set. The NEO, A350 and 777Max families of aircraft are used in the modelling with substitutions and adjusted NPD curves.   The INM 7.0d modelling for these cases includes new manufacturer's data for the Boeing 787-8, 747-800, 777300ER, EMB190 and EMB170.

The Sustainable Aviation Noise Roadmap (SANR) along with ERCD information on how future aircraft were adjusted in ANCON was used to form the basis of the adjustments in the INM aircraft types. The SANR suggests a noise reduction target of 0.1 dB per year / 1 dB per decade to 0.3 dB per year / 3 dB per decade.

2030 INM Types

For the A350 family, ERCD use -4.1/-4.2 (dep) and -0.1/-0.4 (arr) for the adjustment from the A330 to the A358 and A359 respectively and then -1.8 and + 1.6 for the A351 (based on their noise database). A conservative approach has been adopted by taking the lowest yearly adjustments to noise emissions from the SANR of 0.1dB per/year for the A358, A359 and A351/X. So, across the 20 years from the A330 to the A350 gives an improvement of 2 dB cumulatively across the certification points which are slightly lower in general than the ERCD figures.

The 7XX is a generic Code F replacement. There is some debate over whether this should be a 748 or 777-9X (400 seat variant). There are less than 200 orders (globally) currently for the 748 (wikipedia.org). It is considered unlikely that there would be no 748 aircraft in 2030, but they are likely to be the minority of movements of this size of aircraft. Evidence today suggests that 747-400 replacements are largely being taken up by 777-300ER. This would suggest that the future might see 777-X taking this 400 seat ground. A380 aircraft would be left at the 450-500+ sector. For the 7XX instead of creating a substitution type, movements for this aircraft code have been split between the 7478 and the 777-9X (20% 748, 80% 777-9X (see 77W for noise level assumptions). It should be noted that since the 748 is of a higher noise level than 777-9X this is considered conservative.

The only current technology 777 variant left in the schedule is the 777-300ER (the 772 is generally being seen as replaced with the 788). BA has recently ordered some of these aircraft which could be expected to fly for the next 20 years (and other carriers have orders in place). However, while optimistic, Heathrow attracts a quieter fleet and it is considered reasonable to replace with the 777-8X variation.

It is considered reasonable to apply the SANR (0.1 dB/year) to the 777-300ER over the 15 years between coming into service in 2004 and the planned service of 777-X variants in 2020. Therefore a reduction of 1.5 dB against the 777-300ER is a reasonable assumption. Considering that reductions will come on the departure side mostly, the 77W to be replaced with 777-8X with a noise reduction of -1, -0.5 (relative to the 777-300ER). The 777-9X is assumed to have the same noise characteristics as the 777-300ER.

For surrogate types the assumption is to focus noise reductions in the Flyover and Lateral area, with some nominal benefit to Approach noise. Table 3 displays the 2030 INM type, its substitution type and adjustments to the NPD curves.

Table D.6 2030 INM Aircraft Types

	2030 Modelling						G1 Adjustments from Standard INM Types	
From Schedule	**INM Type Imminent (G1)**		**INM Type/ Substitution**		**Arrival Profile / %NEO**		**Arr. NPD Adj**	**Dep. NPD Adj**
351	A350-1000	100%	A330-343	sub	3.2		0.0	-2.0
35X	A350-XWB	100%	A330-343	sub	3.2		0.0	-2.0
358	A350-800	100%	A330-343	sub	3.2		-0.5	-1.0
359	A350-900	100%	A330-343	sub	3.2		-0.5	-1.0
388	A380-841	100%	A380-841		3.2		0.0	0.0
748	7478	100%	7478		3.2		0.0	0.0
778	7778X	100%	7773ER	sub	3.2		-0.5	-1.0
779	7779X	100%	7773ER	sub	3.2		0.0	0.0
788	7878R	100%	7878R		3.2		0.0	0.0
789	7878R	100%	7878R	sub	3.2		0.0	0.0
7XX	7779X (80%)	7478 (20%)			3.2		0.0	0.0
7ZZ	7773ER	100%	7773ER	sub	3.2		0.0	0.0
E90	EMB190	100%	EMB190		3.2		0.0	0.0
E95	EMB195	100%	EMB195		3.2		0.0	0.0
319	A319-131	100%	A319-131		3.2		0.0	0.0
320	A320-232	100%	A320-232		3.2		0.0	0.0
321	A321-232	100%	A321-232		3.2		0.0	0.0
N19	NEO319	100%	A319-131	sub	3.2	90	-3.0	-4.0
N20	NEO320	100%	A320-232	sub	3.2	90	-3.0	-4.0
N21	NEO321	100%	A321-232	sub	3.2	90	-3.0	-4.0
351	A350-1000	100%	A330-343	sub	3.2		0.0	-2.0

2040 INM Types

The 2040 INM model types use some of the 2030 types with the addition of a percentage of Future Generation (generation 2) of these aircraft types. Entry into service of Future/Generation 2 (G2) aircraft has been considered around 2035 (20-30 years after the Imminent/Generation 1 equivalent). In all cases the entry into service is at least 15 years after the start of what is considered to be the 'future' generation and so, reflecting the SANR, a conservative sound level reduction of cumulative 1.5 dB has been applied (0.1 dBA per year). As with 2030 assumptions it is considered that most of the sound level reductions will accrue at Flyover rather than Approach with -1.0 dBA being applied to departures and -0.5 dBA being applied to arrivals.

For the A320 Family Generation 2 (G2), consider each variant to be introduced approximately 15 years after the Generation 1 (G1) NEO, an overall improvement of approximately 1.5 dB could be expected.

For the A350 Generation 2 (G2), it is considered that the ‘future’ variant would be likely to be introduced approximately 15 years after the end of the ‘imminent’ period (Generation 1, G1), therefore an overall improvement of approximately 1.5 dB could be expected.

For the A380 Generation 2 (G2), consider each variant to be introduced approximately 15 years after the Generation 1 (G1) type, an overall improvement of approximately 1.5 dB could be expected.

The 7ZZ is a generic placeholder for a twin aisle Code E size aircraft. The A35X has been adopted as the surrogate for this aircraft with assumptions as previously detailed for the for the G2 variant.

This 7XX is a generic Code F replacement. It is considered unlikely that there would be a ‘Future’/G2 variant of the 7XX family by 2040 but the split of B748/777-9X would change from 20/80 to 15/85, reflecting move towards twin engine fleet.

For the 7878, it is considered that there would be a Generation 2 variant of the 787 operating by 2040 with an overall sound level reduction of 1.5 dB. It is considered that there will be G2 version of the 777-X operating in sufficient numbers by 2040 to warrant attention.

It is also considered that these G2 aircraft types are likely to be introduced around 2035 and that adoption into the fleet would be at around 20% by 2040.

Table D.7 2040 INM Aircraft Types

2040 Modelling							G1 Adjustments from Standard INM Types	
From Schedule	INM Type Imminent (G1)		INM Type / Substitution		Arrival Profile / %NEO		Arr. NPD Adj	Dep. NPD Adj
351	A350-1000	80%	A350-1000_G2	20%	3.5		-0.5	-1.0
358	A350-800	80%	A350-800_G2	20%	3.5		-0.5	-1.0
359	A350-900	80%	A350-900_G2	20%	3.5		-0.5	-1.0
388	A380-841	80%	A380-841_G2	20%	3.5		-0.5	-1.0
778	7778X	80%	7778X_G2	20%	3.5		-0.5	-1.0
779	7779X	100%			3.5		0	0
748	748	100%			3.5		0	0
788	7878R	80%	7878R_G2	20%	3.5		-0.5	-1.0
789	7878R	80%	7878R_G2	20%	3.5		-0.5	-1.0
7XX			7779X (85%)	7478 (15%)	3.5		0	0
7ZZ	7773ER	100%			3.5		0	0
E90	EMB190	80%	EMB190_G2	20%	3.5		-0.5	-1.0
E95	EMB195	80%	EMB195_G2	20%	3.5		-0.5	-1.0
N19	NEO319	80%	NEO319_G2	20%	3.5	100	-0.5	-1.0
N20	NEO320	80%	NEO320_G2	20%	3.5	100	-0.5	-1.0
N21	NEO321	80%	NEO321_G2	20%	3.5	100	-0.5	-1.0

Flight Tracks

Flight tracks for each of the runway layout and airspace alternatives were modelled. No dispersion was modelled on these tracks as current trials indicate concentration of tracks over a 300m spread. These were added to the INM study and operations were assigned to each one from the schedule. Flight tracks with no dispersion simulate precision RNAV departures and arrivals to be used in the future airspace.

Three airspace alternatives were developed for this analysis to be used with the 3 Runway future cases only. The airspace alternatives are:

- **Option N**: Minimum number of NEW people overflown - Adopt routes that are as similar to today as possible. Existing people may be exposed more than today;
- **Option T**: Minimum number of TOTAL people overflown - Fly over least densely populated areas (including some valued open spaces) – could affect many new people;

- **Option R**: Respite - More people are overflown but impacts are potentially reduced. Initial consultation feedback indicates value in "respite" over minimizing number communities overflown.

Modes

There are four available operating modes in each direction that when operated together can provide a degree of relief for those close to the airport from arriving and departing aircraft.

Table D.8 Runways and Modes

Runway	MDL-WEST	MLD-WEST	DLM-WEST	LDM-WEST	MDL-EAST	MLD-EAST	DLM-EAST	LDM-EAST
New	Mixed	Mixed	Depart	Land	Mixed	Mixed	Depart	Land
North	Depart	Land	Land	Depart	Depart	Land	Land	Depart
South	Land	Depart	Mixed	Mixed	Land	Depart	Mixed	Mixed

Start of Take-off Roll

The analysis used the average between the first two taxiways only for Long Haul aircraft (7478 and 380, 777 variants) that needed the full runway length for take-off. For all other aircraft the start of take-off roll was adjusted to reflect the average between the first several entrance taxiways (yellow circle).

Figure D.4 Start of Take-off Roll Position (Runway 27L)

The following table lists the adjustment in meters from the end of the runway for the start of take-off roll for most aircraft.

Table D.9 Start of Take-off Roll Distances (3 Runway Option)

Runway End	SOTR (Short Haul)	SOTR (Long Haul)
27 New	191m	55m
09 New	191m	55m
27R	154m	66m
09L	69m	9m
27L	110m	32m
09R	94m	0m

For the 2 Runway cases the distances are different due to no changes to the locations of the taxiways or runways.

Table D.10 Start of Take-off Roll Distances (2 Runway Option)

Runway End	SOTR (Short Haul)	SOTR (Long Haul)
09L	303m	0m
09R	94m	0m
27L	69m	0m
27R	151m	0m

D.2 ANCON Modelling

ANCON modelling has been undertaken by the Civil Aviation Authority's (CAA) Environmental Research and Consultancy Department (ERCD). The modelling has been based on the INM models developed using the methodology described in Section D.1. These models have been used by ERCD as a basis of their ANCON modelling.

A description of the ANCON modelling process is provided in **Appendix I**.

D.3 Ground Noise Modelling

D.3.1 3D Noise Model

In order to assess current and future levels of noise exposure from airside ground noise sources and road traffic noise, it has been necessary to develop 3D noise models of a 2R and 3R Heathrow and the surrounding area.

To develop the 3D models, the following datasets have been utilised:

- OS MasterMap Digital Mapping data;
- OS 10m Digital Terrain Model (DTM) data;
- Heathrow 3RNW Masterplan v3.9 (R3500-XX-GA-904-000082);
- 2013 CACI post-code based population data;
- OS Address Layer 2 dataset; and
- Civils 3D outputs of the proposed changes in carriageway elevations.

Terrain

In order to develop the terrain model, the OS 10m DTN has been processed alongside the OS MasterMap data to attribute heights to features such as carriageway edges and land boundaries. This process established the terrain model for 2R.

In order to develop the terrain model for 3R, the terrain has been modified in the vicinity of new or realigned carriageways based on the outputs from Civils3D. This has been particularly important in considering the proposed M25 tunnel and the elevated section of the realigned A4 to the north of Sipson.

For the 3R model, the runway elevation has been assumed as 24m AOD.

Buildings

For ground-based noise sources, buildings both screen and reflect noise. In addition, the noise experience can vary significantly from one side of a building to another. Buildings have therefore been incorporated into the 3D noise models using the buildings and structures features from the OS MasterMap dataset. In order to differentiate noise-sensitive uses, GIS has been used to join the buildings to the AL2 dataset. This process has allowed the number of dwellings per building to be established and the height of the building to be estimated subject to a minimum height of 8m.

For all buildings within the airport boundary, these have been assumed as being 12m high.

Population Exposure Assessment

The 3D models have considered the spatial location of the population and sensitive uses based on current-day information. Using the AL2 dataset, the location of sensitive uses such as schools, hospitals, community centres and places of worship have been identified. Using the CACI data, an estimation of the population per household has been made. No provision has been made for forecasting population beyond 2013 in the ground noise models. This is because the consideration of population increases requires a spatial aspect and would require some understanding of where exactly new dwellings are to be built.

The approach taken to the assessment of population exposure reflects that adopted for the analysis of noise level grids and strategic noise maps. This process has involved classifying a noise grid into noise level bands and intersecting building objects with this classification to derive noise exposure. This approach differs to that used in other ground noise assessments and has been adopted to reflect the approaches used for the analysis of road traffic noise.

D.3.2 Airside Ground Noise Modelling

The modelling airside ground noise has taken into consideration the following sources of noise:

- Taxiing aircraft;
- Aircraft at Stand including APU running; and
- Aircraft within holdzones.

Noise modelling has been undertaken using the following datasets:

- 2R and 3R forecast 2030 and 2040 schedules;
- Outputs from TAAM aircraft ground movement modelling; and
- Information relating to ground emissions from commercial aircraft.

Modelled Aircraft Types and Emissions

The modelling has considered three assumed aircraft types. Each aircraft type has been selected principally due to its size and the height of the aircraft's engines and APU. The dimensions of the aircraft and source heights are an important consideration in the context of physical mitigation. The higher the sources, the less likely mitigation will be effective. This means that a noise barrier may perform better for smaller aircraft than it does for larger aircraft.

The aircraft assumptions have been based on the aircraft's ICAO design groups and codes. These are:

- Twin-engine Code C aircraft (i.e. Airbus A320 and Boeing 737);
- Twin-engine Code E aircraft (i.e. Boeing 777 and Airbus A330); and
- Four-engine Code E/F aircraft (i.e. Airbus A380 and Boeing 747).

In general, there is little correlation linking aircraft taxi emissions to aircraft size however, for the purposes of modelling, and based on data availability, a proxy aircraft has been adopted to model emissions as summarised in Table D.11 below. The data adopted considers measured taxi and APU noise emissions, directivity patterns and the spectra nature of the noise source. This has been based on measured and published data by researchers and aircraft manufacturers.

Table D.11 Aircraft Noise Emission Data

Modelled Aircraft	APU		Taxi / Hold	
	L_{WA}	Height (m)	L_{WA}	Height (m)
2C (e.g. Airbus A319/320)	118	4.0	128	2.0
2E (e.g. Boeing 777)	118	6.0	132	3.5
4E/F (e.g. Airbus A380)	123	7.5	132	4.0

Aircraft Taxi Movements and Taxiway Usage

Aircraft taxi movements have been obtained from the schedules against each modelled aircraft type.

For departures, the runway allocations within the schedules have been used along with the stand allocations within the TAAM datasets to process the number and taxi route of the aircraft. Likewise, for arrivals, the TAAM data has been used to determine at which point how each modelled aircraft category is likely to leave each runway with the runway schedules used to determine which apron and stand the movement will be headed to.

The emissions model has averaged the movements based on a number of factors, notably:

- Modal split; and
- The available operating modes – i.e. DLM, LDM etc.

The modelled modal split has been 80%W/20%E for $L_{Aeq, 16hr}$ and L_{den}, and 50%W/50%E for L_{night}. All ground movement activity has been averaged equally across all runways.

For short-term noise modelling and in order to identify mitigation during events, a single hourly value has been calculated assuming the worst-case mode for a particular receptor.

Taxi Speeds

Taxi speeds have been derived from an analysis of the TAAM dataset. Using taxi route distances calculated from the masterplan, the time taken for aircraft to traverse each route has been determined. Based on this analysis, a standard assumption has been applied to the modelling and a free-flowing average taxi speed of 20 kmh^{-1} has been assumed for arrivals and departures in both the 2R and 3R models.

Aircraft Holding and Hold Zones

In 2030 and 2040 for a 2R and 3R Heathrow, it is anticipated that Collaborative Decision Making (CDM) would be implemented. CDM, as outlined in Heathrow’s Mitigation Strategy, seeks to reduce aircraft holding on taxiways and hold points by instead holding aircraft at stand.

CDM has been assumed to apply for 2R and 3R cases in 2030 and 2040. To replicate this, sections of taxiway have been modelled as 'hold zones' to synthesis queuing prior to departure.

Within the hold zone, three hold points have been modelled with aircraft stationary for 90 seconds at each point. Between these hold points, the speed of taxi has been assumed as 5 kmh^{-1}. As no noise emission data is available for aircraft holding, it has been assumed that the aircraft will continue to generate noise at the same levels during taxiing. This assumption is considered somewhat conservative.

These assumptions reflect the approach within the air emission modelling.

D.3.4 Surface Access Road Traffic Noise

The modelling of surface access road traffic noise has been aligned with the modelling of road traffic air emissions. A road centreline dataset used for the air emission modelled has been adapted and attributed with traffic noise emission data as required by the 'Calculation of Road Traffic Noise' (CRTN). The road traffic emission data has been based on 24-hour AADT traffic flows and compositions scaled to 18-hour AAWT as required by the CRTN. Traffic flows and compositions have been taken from traffic model outputs provided by AECOM.

For the purposes of developing the traffic noise emission dataset, the following assumptions have been applied:

- Vehicles of HGV2 class or heavier are classified as HGVs for the purposes of modelling noise emissions using the CRTN methodology;
- Road surfaces and road surface texture depths have been assumed as 'impervious' and 2mm; and
- Traffic speeds have been assumed as 'free flowing' from the road traffic model dataset.

Further adaptations that have been made to the road centreline datasets include consideration of whether or not the road is located on or below a bridge, and distinction in the direction of traffic flow.

Study Area

The study area adopted for the assessment of road traffic noise has mirrored those selected for the Air Quality assessment. The global study area for the calculation of road traffic noise has been undertaken across the Ordnance Survey grid from (502000, 172000) to (512000, 181000).

D.3.5 Population Exposure Assessment

The assessment of population exposure to ground noise has been undertaken using a technique consistent with the processes adopted in the analysis of strategic noise maps under the Environmental Noise (England) Regulations. The process involves the classification of noise level grids into 1 dB intervals, which are then intersected with building population polygon dataset. The highest classified value interesting the building polygon is used and assigned to the dwelling for the purposes of population exposure assessment. The same approach has been adopted for the assessment of overall noise exposure levels and for the assessment of changes in exposure.

D.3.6 Assessment Scenarios

A number of assessment scenarios have been developed to help demonstrate the following:

- Impacts before and after mitigation; and
- Overall levels of average noise exposure.

Airside Ground Noise

For airside ground noise, it has been necessary to demonstrate the effectiveness of mitigation through the analysis of short term metrics where the effects of measures such as perimeter barriers will be most apparent. In addition, it has been necessary to consider the overall levels of average noise exposure from airside ground noise.

The following assessment scenarios have therefore been developed:

- Short term event cases with and without mitigation measures for 3R including:
  - Taxiing aircraft in terms of hourly $L_{Aeq,\ 1hr}$ levels;
  - APU running in terms of worst case $L_{Aeq,\ T}$ event levels during an APU run; and
  - Potential stand selection strategies.
- Long-term noise exposure levels in terms of $L_{Aeq,\ 16hr}$, $L_{night\ (8\text{-}hour)}$ and L_{den} in 2030 and 2040 for:
  - 3R with mitigation;
  - 3R without physical mitigation (i.e. bunding and perimeters screens); and
  - 2R.

Road Traffic Noise

- For road traffic noise, six scenarios have been considered:
- 2R 2030 and 2040;
- 3R 2030 and 2040 without mitigation;
- 3R 2030 and 2040 with mitigation; and
- The Airports Commission SAF requires the identification of road subject to a potential increase of 25% in road traffic volumes. Since Heathrow's 3R masterplan include new and realigned carriages, potential noise level changes of at least 1 dB(A) have been identified. This level of change is equivalent to a 25% change in road traffic flow, and

Appendix E
Air Noise Data

E.1 INM and ANCON Comparison

The CAA were commissioned to develop noise contours using their ANCON model based on the INM models developed as described in **Appendix D**. The INM models were provided directly to ERCD to use in ANCON. A comparison of the results between ANCON and INM is presented in the following sections. A graphical comparison in the form of noise contours is provided in the figures below for Option T 'total people'.

Figure E.1 Comparison of 2030 LAeq, 16hr contours (INM – Magenta / ANCON – Blue)

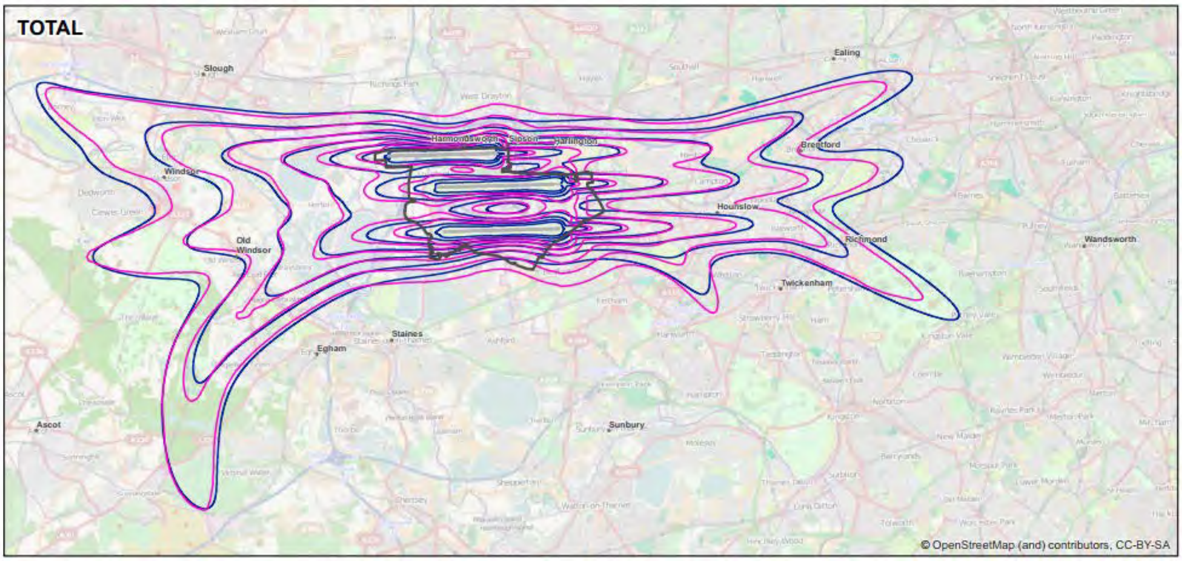


Figure E.2 Comparison of 2030 Lden contours (INM – Magenta / ANCON – Blue)

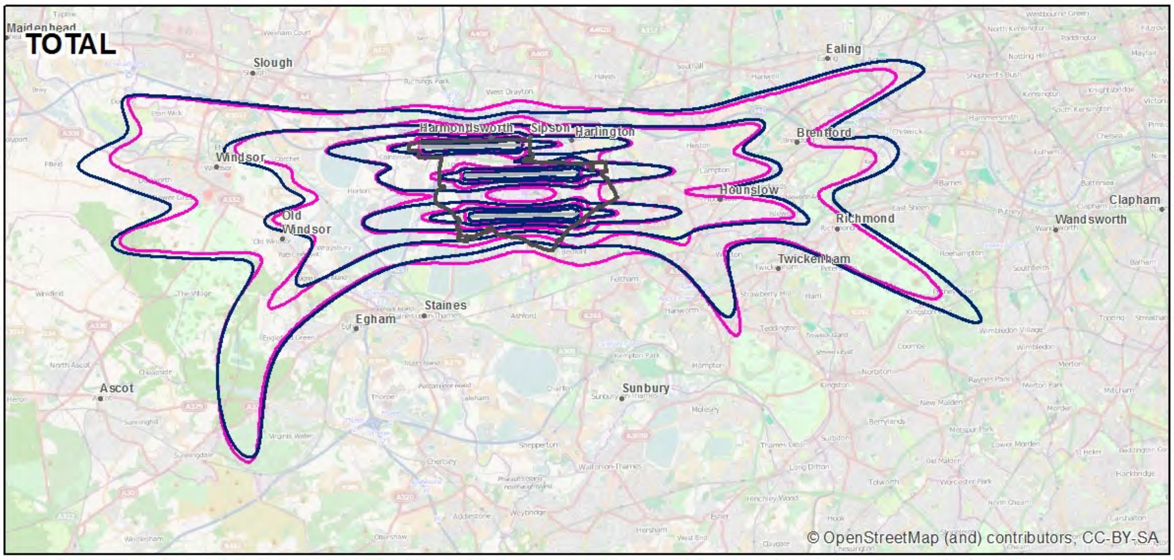


Figure E.3 Comparison of 2030 Lnight, 8-hour contours (INM – Magenta / ANCON – Blue)

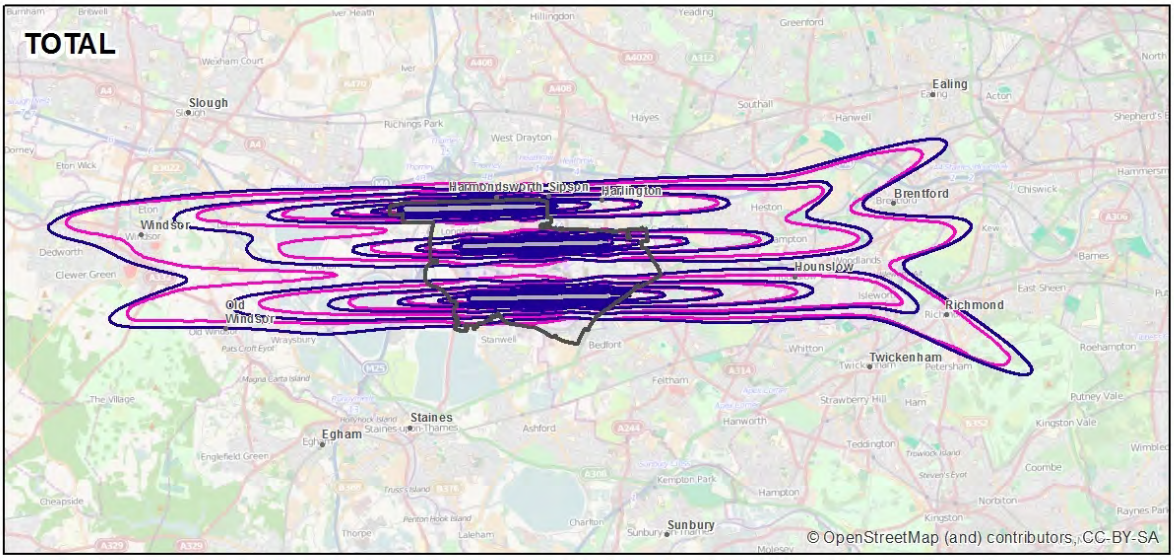
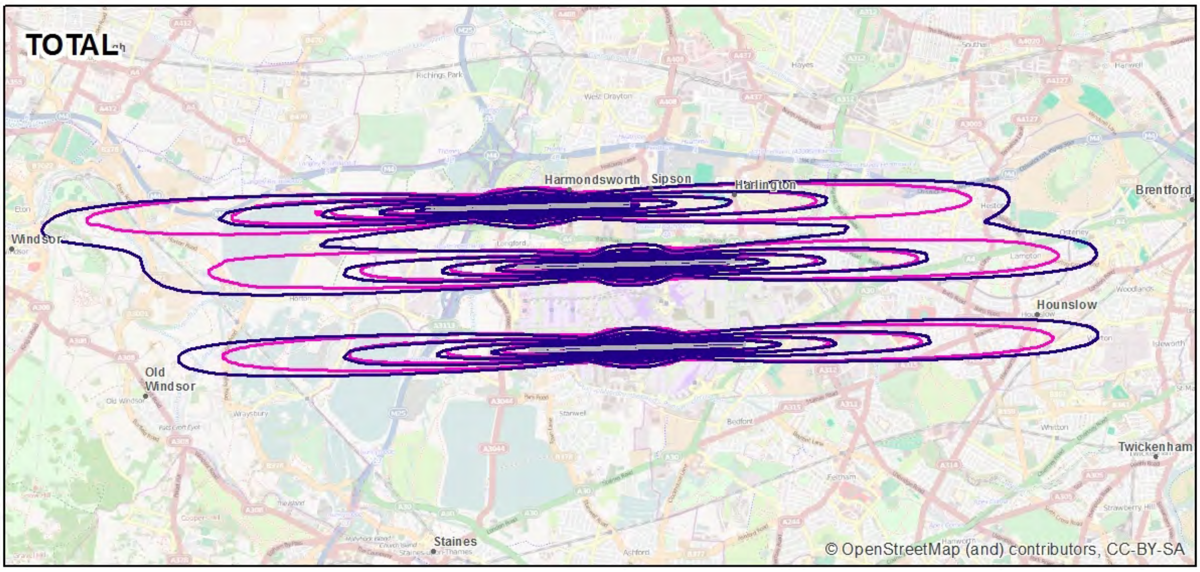


Figure E.4 Comparison of 2030 Lnight, 6.5-hour contours (INM – Magenta / ANCON – Blue)



In general the results indicate that the INM and ANCON modelling results are within ±1dB for all the key noise metrics. A similar analysis of the 2040 results indicates a greater alignment than for the 2030 results. At the higher noise contour bands the INM model generally produces larger contours. At lower noise levels such as 54 dB $L_{Aeq,16hr}$ and 55 dB L_{den} the ANCON contours are slightly larger. The minimising number of newly overflown people option has the most significant degree of difference at the 54 dB $L_{Aeq,16hr}$ level. The degree of alignment is better to the west of the airport (which is dominated by westerly departures) than to the east (which is dominated by westerly arrivals).

The differences between the modelled outputs have been discussed and reviewed with the CAA's Environmental Research and Consultancy Department (ERCD). Based on these discussions, the following conclusions have been reached regarding the differences between the INM and ANCON model outputs:

- There is a very close agreement between modelling approaches and outputs;
- Review of the implementation of each model suggests that the most likely source of difference is in the assumptions about operational procedures:
  - There is a high degree of alignment between the departure procedures adopted in INM and ANCON modelling. Therefore given the degree of alignment of contours to the west it is concluded a high degree of alignment of noise assumptions as well;
  - Arrivals profiles for the INM future 2030 and 2040 are assumed to be based on PBN technologies and therefore highly accurate in terms of vertical and horizontal alignment. The INM modelling has assumed that the vertical profile will accurately follow the stated descent rate (3.2 degrees in 2030 and 3.5 in 2040) from a height of 6,000ft (approximately 20nmi from the airport) all the way to the runway. ANCON assumes an average descent profile based on today's operation modified to the relevant future descent until approximately 4 nmi from the airport. This is likely to mean that at distances of around 6nmi from the airport aircraft would be lower than in the INM model. As a result aircraft will be noisier at these ranges.
  - There are also likely to be some differences between the operating procedure implemented in ANCON and INM. These are likely to be the major factor for the differences in the contours at the 54 dB L_{Aeq} level (considering the broader agreement at higher noise level contours).
- Based on the above it is concluded that the assumptions regarding future fleet noise level in the INM modelling are broadly consistent with those assumed by ERCD in the ANCON model.
- Differences in the night-time metrics are in the +/-1 dB range and are caused by ANCON contours for the two most northern runway joining together at low noise levels, where the INM contours do not. The contours are non-the-less considered to be in close agreement;
- The population differences are very sensitive to small changes when extended over London.

The ERCD ANCON results were not available for the May 2014 submission. Since the May 2014 submission, Heathrow has received results from ERCD.

E.2 Air Noise Exposure Statistics – Comparison to Current Day

E.2.1 INM Modelled Outputs – 'Taking Britain Further'

The following INM modelled noise exposure outputs were used to support Heathrow's May 2014 submission 'Taking Britain Further'. Within the publication, Table 5.11 presents the percentage reduction in population exposed to aircraft noise based on 2011 'baseline' population data. These results are reproduced in full below for each airspace option.

Table E.4 INM Model Outputs – $L_{Aeq, 16hr}$ - Populations

Metric and Contour $L_{Aeq, 16hr}$	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	478000	261100	279800	299250	294750	262650	336050	354200	408500
> 57 dB	248550	140850	163350	170650	170700	138700	196400	204200	241000
> 60 dB	124400	66800	77900	79850	80200	67950	105150	107900	136150
> 63 dB	58400	25800	26700	26650	26900	26000	36500	36550	54850
> 66 dB	21900	6900	10350	10300	10600	7400	15850	15900	19550
> 69 dB	5500	1650	1050	1050	1050	2350	3950	3850	4150
> 72 dB	1292	10	0	0	0	20	620	620	500

Table E.5 INM Model Outputs – $L_{Aeq,\ 16hr}$ - Households

Metric and Contour $L_{Aeq,\ 16hr}$	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	187850	99950	104050	113250	110000	100400	124850	133650	155000
> 57 dB	93900	50600	57850	60650	61100	49750	70150	73400	89300
> 60 dB	43350	22950	27050	27750	27850	23550	37000	38000	47700
> 63 dB	20300	8700	9600	9600	9650	8800	13000	13000	18950
> 66 dB	7250	2400	3950	3950	4100	2600	5950	6000	7150
> 69 dB	1900	500	450	450	450	800	1550	1500	1600
> 72 dB	300	0	0	0	0	0	240	240	180

Table E.6 INM Model Outputs – $L_{Aeq, 16hr}$ – Areas (km²)

Metric and Contour $L_{Aeq, 16hr}$	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	170.3	106.0	139.0	142.3	133.9	107.0	164.7	167.5	161.9
> 57 dB	100.8	62.7	86.1	88.1	83.1	63.3	102.0	104.6	98.9
> 60 dB	57.7	38.0	52.6	53.0	51.4	38.8	64.0	64.7	61.9
> 63 dB	35.5	24.0	32.8	32.8	32.9	24.9	40.2	40.2	39.8
> 66 dB	23.0	13.3	19.3	19.3	19.3	14.1	25.6	25.6	25.6
> 69 dB	12.6	7.2	9.8	9.8	9.8	7.8	14.1	14.1	14.1
> 72 dB	6.6	4.2	5.8	5.8	5.8	4.6	7.8	7.8	7.8

Table E.7 INM Model Outputs – L_{den} - Populations

Metric and Contour L_{den}	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 55 dB	634450	314950	330850	350000	342050	315500	397900	430600	408500
> 60 dB	218600	108650	124200	134050	132700	107850	162950	171000	170200
> 65 dB	63250	23250	24700	24450	25600	23000	36750	36650	38550
> 70 dB	10950	2500	1150	1150	1150	2900	4200	4100	4150
> 75 dB	1150	0	0	0	0	0	0	0	0

Table E.8 INM Model Outputs – L_{den} - Households

Metric and Contour	2011 Baseline	2030				2040			
L_{den}	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 55 dB	258900	121800	124550	134050	129700	121800	150150	165300	155000
> 60 dB	82950	38150	43200	46950	46400	37900	58050	61150	60800
> 65 dB	21650	7700	8800	8700	9100	7650	12800	12800	13400
> 70 dB	3450	750	450	450	450	900	1600	1600	1600
> 75 dB	350	0	0	0	0	0	0	0	0

Table E.9 INM Model Outputs – L_{den} – Areas (km^2)

Metric and Contour $L_{Aeq, 16hr}$	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	192.1	116.7	151.2	154.7	145.9	116.5	181.4	184.8	176.7
> 57 dB	80.3	48.6	67.5	68.6	66.8	48.5	81.7	83.1	80.1
> 60 dB	34.4	20.7	29.3	29.3	29.4	20.9	36.7	36.7	36.8
> 63 dB	13.3	7.4	10.3	10.3	10.3	7.7	14.7	14.7	14.7
> 66 dB	4.7	3.2	4.5	4.5	4.5	3.4	5.9	5.9	5.9
> 69 dB	192.1	116.7	151.2	154.7	145.9	116.5	181.4	184.8	176.7
> 72 dB	80.3	48.6	67.5	68.6	66.8	48.5	81.7	83.1	80.1

Table E.10 INM Model Outputs – $L_{Aeq,\,8hr}$ (night-time) - Populations

Metric and Contour $L_{Aeq,\,8hr}$ (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 48 dB	453450	201100	181450	206050	176500	204000	207400	247800	209000
> 51 dB	229050	91050	93250	103100	94250	88400	128900	140500	129900
> 54 dB	119300	40300	27300	26950	27050	39400	43150	44200	43500
> 57 dB	53850	12150	4600	4150	4600	11750	8650	8550	8750
> 60 dB	21600	2400	450	450	450	2400	700	600	700
> 63 dB	5150	50	50	50	50	50	100	100	100
> 66 dB	1950	0	0	0	0	0	0	0	0
> 69 dB	10	0	0	0	0	0	0	0	0
> 72 dB	n/a	0	0	0	0	0	0	0	0

Table E.11 INM Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 48 dB	186800	76900	66550	77800	64400	78150	77600	95300	79100
> 51 dB	88800	31800	31900	35650	32300	30700	44850	49500	45200
> 54 dB	43150	13350	9150	8950	9100	13000	14700	15000	14800
> 57 dB	18050	3700	1550	1400	1550	3600	2900	2850	2950
> 60 dB	6850	700	200	200	200	700	250	250	250
> 63 dB	1550	50	50	50	50	0	50	50	50
> 66 dB	550	0	0	0	0	0	0	0	0
> 69 dB	0	0	0	0	0	0	0	0	0
> 72 dB	0	0	0	0	0	0	0	0	0

Table E.12 INM Model Outputs – $L_{Aeq, 8hr}$ (night-time) – Areas (km[2])

Metric and Contour $L_{Aeq, 16hr}$	2011 Baseline	2030				2040			
	2R 2011	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	117.9	69.0	76.9	81.2	75.9	69.3	90.5	96.0	88.9
> 57 dB	74.1	35.9	40.6	42.4	40.9	35.2	54.6	57.5	54.7
> 60 dB	43.2	17.1	18.4	18.3	18.4	16.9	25.7	25.8	25.8
> 63 dB	21.6	8.6	8.7	8.7	8.7	8.6	12.4	12.4	12.4
> 66 dB	11.3	4.5	4.6	4.6	4.6	4.5	6.4	6.4	6.4
> 69 dB	6.0	2.5	2.6	2.6	2.6	2.5	3.7	3.7	3.7
> 72 dB	3.3	1.4	1.7	1.7	1.7	1.4	2.4	2.4	2.4

Table E.13 INM Model Outputs – N70 16-hour day - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 20	n/a	223350	247850	249200	274200	207450	236350	235400	256150
> 50	203450	169700	184400	184600	176750	154000	176400	173650	179300
> 100	114500	71100	92250	102150	93900	66100	123550	128100	121050
> 200	76300	41650	39600	39300	39400	40000	44450	45450	44000
> 300	16300	8050	5300	5350	5200	8450	20850	21000	20300
> 400	1150	0	1000	1100	1200	0	3600	3550	4350
> 500	100	0	0	0	0	0	740	760	790

Table E.14 INM Model Outputs – N70 16-hour day - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 20	n/a	84700	92600	93150	103650	78000	87200	86800	95200
> 50	75950	63750	67100	67750	63950	56900	63700	62900	65150
> 100	40750	24150	31850	35550	32350	22300	43400	44800	42000
> 200	26700	14050	13850	13750	13800	13500	15300	15650	15150
> 300	5400	2700	2250	2250	2200	2850	7800	7850	7650
> 400	450	0	400	400	450	0	1550	1500	1850
> 500	40	0	0	0	0	0	270	280	290

Table E.16 INM Model Outputs – N60 8-hour night - Populations

Metric and Contour N60 (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 25	270700	120050	30300	93400	37950	103250	103750	160300	108950
> 50	0	0	0	0	0	0	100	100	100

Table E.17 INM Model Outputs – N60 8-hour day - Households

Metric and Contour N60 (night-time)	2011 Baseline	2030				2040			
	2R	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 25	111750	48600	9750	37050	12350	41500	36000	60850	38100
> 50	0	0	0	0	0	0	50	50	50

Table E.18 INM Model Outputs – Option T 'Minimise Total People' - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,450	314,950	330,850	397,900	-319,500	-303,600	-236,550	15,900	67,050	-50%	-48%	-37%
$L_{Aeq,\ 16h}$ (69)	5,500	1,650	1,050	3,950	-3,850	-4,450	-1,550	-600	2,900	-70%	-81%	-28%
$L_{Aeq,\ 16hr}$ (57)	248,550	140,850	163,350	196,400	-107,700	-85,200	-52,150	22,500	33,050	-43%	-34%	-21%
$L_{Aeq,\ 16hr}$ (54)	478,000	261,100	279,800	336,050	-216,900	-198,200	-141,950	18,700	56,250	-45%	-41%	-30%
LAeq, 8hr night (50)	292,050	130,100	117,950	158,850	-161,950	-174,100	-133,200	-12,150	40,900	-55%	-60%	-46%
LAeq, 8hr night (48)	453,450	201,100	181,450	207,400	-252,350	-272,000	-246,050	-19,650	25,950	-56%	-60%	-54%

Table E.19 INM Model Outputs – Option N ‘Minimum New People’ - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on ‘Base Year’)				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,450	314,950	350,000	430,600	-319,500	-284,450	-203,850	35,050	80,600	-50%	-45%	-32%
$L_{Aeq, 16h}$ (69)	5,500	1,650	1,050	3,850	-3,850	-4,450	-1,650	-600	2,800	-70%	-81%	-30%
$L_{Aeq, 16hr}$ (57)	248,550	140,850	170,650	204,200	-107,700	-77,900	-44,350	29,800	33,550	-43%	-31%	-18%
$L_{Aeq, 16hr}$ (54)	478,000	261,100	299,250	354,200	-216,900	-178,750	-123,800	38,150	54,950	-45%	-37%	-26%
LAeq, 8hr night (50)	292,050	130,100	127,500	174,600	-161,950	-164,550	-117,450	-2,600	47,100	-55%	-56%	-40%
LAeq, 8hr night (48)	453,450	201,100	206,050	247,800	-252,350	-247,400	-205,650	4,950	41,750	-56%	-55%	-45%

Table E.20 INM Model Outputs – Option R 'Maximum Respite' - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,450	314,950	350,000	430,600	-319,500	-284,450	-203,850	35,050	80,600	-50%	-45%	-32%
$L_{Aeq,\ 16h}$ (69)	5,500	1,650	1,050	3,850	-3,850	-4,450	-1,650	-600	2,800	-70%	-81%	-30%
$L_{Aeq,\ 16hr}$ (57)	248,550	140,850	170,650	204,200	-107,700	-77,900	-44,350	29,800	33,550	-43%	-31%	-18%
$L_{Aeq,\ 16hr}$ (54)	478,000	261,100	299,250	354,200	-216,900	-178,750	-123,800	38,150	54,950	-45%	-37%	-26%
LAeq, 8hr night (50)	292,050	130,100	120,950	156,600	-161,950	-171,100	-135,450	-9,150	35,650	-55%	-59%	-46%
LAeq, 8hr night (48)	453,450	201,100	176,500	209,000	-252,350	-276,950	-244,450	-24,600	32,500	-56%	-61%	-54%

E.2.2 ANCON Outputs – As used for ‘Noise Scorecard’

The following ANCON modelled noise exposure outputs have been used to inform the analysis presented in Section 6.1. Like the INM results, the outputs are based on comparison to baseline conditions and therefore use current day populations. .

Table E.21 ANCON Model Outputs – $L_{Aeq, 16hr}$ - Populations

Metric and Contour $L_{Aeq, 16hr}$	2012 Baseline	2030				2040			
	2R ERCD Report 1301	2R do-minimum Figure E5	3R Option T Figure E6	3R Option N Figure E7	3R Option R Figure E8	2R do-minimum Figure E9	3R Option T Figure E10	3R Option N Figure E11	3R Option R Figure E12
> 54 dB	586,050	373350	297600	387700	319800	322400	345950	457950	364600
> 57 dB	237350	169500	170350	184950	173550	152800	187800	202900	192800
> 60 dB	105800	74300	86700	87600	88150	69150	107450	112250	109200
> 63 dB	42000	22550	21100	20950	21500	19450	30700	30550	31600
> 66 dB	12850	4400	4650	4650	4850	4100	7850	7850	8300
> 69 dB	3200	950	200	250	200	350	600	600	600
> 72 dB	200	10	0	0	0	10	0	0	0

Table E.22 ANCON Model Outputs – $L_{Aeq, 16hr}$ - Households

Metric and Contour $L_{Aeq, 16hr}$	2012 Baseline	2030				2040			
	2R ERCD Report 1301	2R do-minimum Figure E5	3R Option T Figure E6	3R Option N Figure E7	3R Option R Figure E8	2R do-minimum Figure E9	3R Option T Figure E10	3R Option N Figure E11	3R Option R Figure E12
> 54 dB	248800	149300	112050	152950	122050	126800	131250	182100	139650
> 57 dB	98600	62800	60750	67150	62050	55550	67750	74600	69800
> 60 dB	42150	25350	29850	30250	30250	23400	37050	38800	37650
> 63 dB	16500	7500	7600	7550	7750	6400	10800	10750	11050
> 66 dB	4850	1500	1900	1900	2000	1400	3050	3050	3250
> 69 dB	1200	300	100	100	100	100	250	250	250
> 72 dB	100	0	0	0	0	0	0	0	0

Table E.23 ANCON Model Outputs – $L_{Aeq, 16hr}$ – Areas (km^2)

Metric and Contour $L_{Aeq, 16hr}$	2012 Baseline	2030				2040			
	2R ERCD Report 1301	2R do-minimum Figure E5	3R Option T Figure E6	3R Option N Figure E7	3R Option R Figure E8	2R do-minimum Figure E9	3R Option T Figure E10	3R Option N Figure E11	3R Option R Figure E12
> 54 dB	199.6	123.9	146.6	156.0	140.7	117.3	165.9	176.3	161.3
> 57 dB	106.7	69.5	87.8	91.7	85.0	66.1	99.1	103.4	95.8
> 60 dB	58.7	38.6	51.2	51.7	50.3	37.0	60.0	60.8	58.6
> 63 dB	34.3	21.3	28.0	28.0	28.1	20.3	33.4	33.4	33.2
> 66 dB	20.5	10.4	13.2	13.2	13.2	9.7	16.2	16.1	16.3
> 69 dB	10.0	5.5	6.7	6.7	6.7	5.1	7.9	7.9	7.9
> 72 dB	5.3	3.1	3.8	3.8	3.8	2.8	4.4	4.4	4.4

Table E.24 ANCON Model Outputs – L_{den} - Populations

Metric and Contour L_{den}	2012 Baseline	2030				2040			
	2R ERCD Report 1305	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	725000	446350	428100	460350	361650	375050	408450	525450	399050
> 60 dB	179300	129600	166750	148800	146250	123050	157100	164700	162650
> 65 dB	44200	21250	23750	19650	20000	18450	30950	31200	32200
> 70 dB	5500	1900	500	450	400	1450	850	850	850
> 75 dB	100	0	0	0	0	0	0	0	0

Table E.25 ANCON Model Outputs – L_{den} - Households

Metric and Contour L_{den}	2012 Baseline	2030				2040			
	2R ERCD Report 1305	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	312500	180100	170450	182600	138550	148050	156600	209650	152750
> 60 dB	74500	45700	61050	52300	51350	43050	55600	58700	57800
> 65 dB	17300	6900	8800	7000	7100	5900	10700	10750	11100
> 70 dB	2000	550	200	150	150	450	350	350	350
> 75 dB	<100	0	0	0	0	0	0	0	0

Table E.26 ANCON Model Outputs – L_{den} – Areas (km^2)

Metric and Contour L_{den}	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	216.9	136.1	160.9	170.4	154.2	125.8	180.4	190.3	173.6
> 60 dB	80.4	53.6	68.8	70.3	68.6	50.2	77.7	79.5	76.9
> 65 dB	31.8	17.9	23.8	23.8	23.9	16.7	30.4	30.3	30.4
> 70 dB	10.9	5.8	7.0	7.0	7.0	5.3	8.4	8.4	8.4
> 75 dB	3.9	2.3	2.9	2.9	2.9	2.1	3.3	3.3	3.3

Table E.27 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	Not Currently Available	220750	203150	234650	194650	199100	207900	240650	206250
> 51 dB		122650	115900	125500	118700	112200	139450	146300	141000
> 54 dB		48300	34550	34500	34500	43200	49250	50550	49950
> 57 dB		13300	5100	5050	5100	10900	9200	9200	9100
> 60 dB		2500	450	450	450	2400	600	600	600
> 63 dB		200	100	100	100	0	50	50	50
> 66 dB		10	0	0	0	0	0	0	0
> 69 dB		0	0	0	0	0	0	0	0
> 72 dB		0	0	0	0	0	0	0	0

Table E.28 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	Not Currently Available	84850	75550	89750	72100	75850	77600	92200	77450
> 51 dB		43700	40250	43850	41250	39150	48850	51600	49400
> 54 dB		16050	11700	11700	11650	14300	16650	17050	16900
> 57 dB		4100	1700	1700	1700	3300	3050	3050	3050
> 60 dB		700	200	200	200	700	250	250	250
> 63 dB		50	50	50	50	0	50	50	50
> 66 dB		0	0	0	0	0	0	0	0
> 69 dB		0	0	0	0	0	0	0	0
> 72 dB		0	0	0	0	0	0	0	0

Table E.29 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) – Areas (km^2)

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	Not Currently Available	76.2	86.0	91.1	84.5	69.3	90.3	95.0	89.2
> 51 dB		44.1	48.8	50.7	48.9	40.5	57.5	59.4	57.5
> 54 dB		18.9	20.4	20.4	20.4	17.6	25.8	25.9	25.9
> 57 dB		8.7	9.0	9.0	9.0	8.1	11.2	11.2	11.2
> 60 dB		4.5	4.5	4.5	4.5	4.1	5.4	5.4	5.4
> 63 dB		2.4	2.5	2.5	2.5	2.2	2.9	2.9	2.9
> 66 dB		1.4	1.7	1.7	1.7	1.3	1.9	1.9	1.9
> 69 dB		0.9	1.2	1.2	1.2	0.8	1.3	1.3	1.3
> 72 dB		0.5	0.8	0.8	0.8	0.5	0.8	0.9	0.8

Table E.30 ANCON Model Outputs – N70 16-hour day - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E29	3R Option T Figure E30	3R Option N Figure E31	3R Option R Figure E32	2R do-minimum Figure E33	3R Option T Figure E34	3R Option N Figure E35	3R Option R Figure E36
> 20	Not Currently Available	223350	247850	249200	274200	207450	236350	235400	256150
> 50		169700	184400	184600	176750	154000	176400	173650	179300
> 100		71100	92250	102150	93900	66100	123550	128100	121050
> 200		41650	39600	39300	39400	40000	44450	45450	44000
> 300		8050	5300	5350	5200	8450	20850	21000	20300
> 400		0	1000	1100	1200	0	3600	3550	4350
> 500		0	0	0	0	0	740	760	790

Table E.31 ANCON Model Outputs – N70 16-hour day - Households

Metric and Contour	2012 Baseline	2030				2040			
$L_{Aeq, 8hr}$ (night-time)	2R ERCD Report 1305	2R do-minimum Figure E29	3R Option T Figure E30	3R Option N Figure E31	3R Option R Figure E32	2R do-minimum Figure E33	3R Option T Figure E34	3R Option N Figure E35	3R Option R Figure E36
> 20	Not Currently Available	84700	92600	93150	103650	78000	87200	86800	95200
> 50		63750	67100	67750	63950	56900	63700	62900	65150
> 100		24150	31850	35550	32350	22300	43400	44800	42000
> 200		14050	13850	13750	13800	13500	15300	15650	15150
> 300		2700	2250	2250	2200	2850	7800	7850	7650
> 400		0	400	400	450	0	1550	1500	1850
> 500		0	0	0	0	0	270	280	290

Table E.32 ANCON Model Outputs – N70 16-hour day – Areas (km^2)

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E29	3R Option T Figure E30	3R Option N Figure E31	3R Option R Figure E32	2R do-minimum Figure E33	3R Option T Figure E34	3R Option N Figure E35	3R Option R Figure E36
> 20	Not Currently Available	92.4	135.2	134.5	137.4	91.6	137.1	136.8	138.0
> 50		65.6	91.2	89.4	85.8	60.2	91.7	92.7	91.0
> 100		39.7	56.0	57.9	53.0	37.3	68.7	68.6	62.7
> 200		24.9	33.1	33.1	32.9	24.5	37.0	37.1	36.9
> 500		1.2	1.1	1.1	1.1	1.2	5.0	5.0	5.0

Table E.33 ANCON Model Outputs – N60 8-hour night - Populations

Metric and Contour N60 (night-time)	2012 Baseline 2R	2030 2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2040 2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	Not Currently Available	120050	30300	93400	37950	103250	103750	160300	108950
> 50		0	0	0	0	0	100	100	100

Table E.34 ANCON Model Outputs – N60 8-hour day - Households

Metric and Contour N60 (night-time)	2012 Baseline 2R	2030 2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2040 2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	Not Currently Available	48600	9750	37050	12350	41500	36000	60850	38100
> 50		0	0	0	0	0	50	50	50

Table E.35 ANCON Model Outputs – N60 8-hour day – Areas (km^2)

Metric and Contour N60 (night-time)	2012 Baseline	2030				2040			
	2R	2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	Not Currently Available	32.3	15.2	25.8	16.0	30.5	42.0	50.9	41.7
> 50		0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3

Table E.36 ANCON Model Outputs – Option T 'Minimise Total People' - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2012 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	446,350	428,100	408,450	-278,650	-296,900	-316,550	-18,250	-19,650	-38%	-41%	-44%
$L_{Aeq, 16h}$ (69)	3,200	950	200	600	-2,250	-3,000	-2,600	-750	400	-70%	-94%	-81%
$L_{Aeq, 16hr}$ (57)	237,050	169,500	170,350	187,800	-67,550	-66,700	-49,250	850	17,450	-28%	-28%	-21%
$L_{Aeq, 16hr}$ (54)	586,050	373,350	297,600	345,950	-212,700	-288,450	-240,100	-75,750	48,350	-36%	-49%	-41%

Table E.37 ANCON Model Outputs – Option N 'Minimum New People' - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2012 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	446,350	460,350	525,450	-278,650	-264,650	-199,550	14,000	65,100	-38%	-37%	-28%
$L_{Aeq, 16h}$ (69)	3,200	950	250	600	-2,250	-2,950	-2,600	-700	350	-70%	-92%	-81%
$L_{Aeq, 16hr}$ (57)	237,050	169,500	184,950	202,900	-67,550	-52,100	-34,150	15,450	17,950	-28%	-22%	-14%
$L_{Aeq, 16hr}$ (54)	586,050	373,350	387,700	457,950	-212,700	-198,350	-128,100	14,350	70,250	-36%	-34%	-22%

Table E.38 ANCON Model Outputs – Option R 'Maximum Respite' - % Population Comparisons to Baseline Year

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2012 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	446,350	361,650	399,050	-278,650	-363,350	-325,950	-84,700	37,400	-38%	-50%	-45%
$L_{Aeq, 16h}$ (69)	3,200	950	200	600	-2,250	-3,000	-2,600	-750	400	-70%	-94%	-81%
$L_{Aeq, 16hr}$ (57)	237,050	169,500	173,550	192,800	-67,550	-63,500	-44,250	4,050	19,250	-28%	-27%	-19%
$L_{Aeq, 16hr}$ (54)	586,050	373,350	319,800	364,600	-212,700	-266,250	-221,450	-53,550	44,800	-36%	-45%	-38%

E.3 Noise Exposure against Forecast Populations

The following assessments take into account forecast changes in populations as provided by CACI. The levels of noise exposure (i.e. the noise exposure itself) that underpin these results is identical to that used to present the results outlined in D.2. However in section of the Appendix, forecast populations have been used instead of baseline populations. This assessment therefore considers population growth and forecast populations in 2030 and 2040.

E.3.1 INM Noise Exposure Forecasts – Assuming Population Growth

The following results tables are based on INM modelling and present population and household noise exposure in 2030 and 2040 assuming population growth.

Table E.39 INM Model Outputs – $L_{Aeq,\ 16hr}$ - Populations

Metric and Contour $L_{Aeq,\ 16hr}$	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	313500	335250	359450	353350	260800	428250	452100	462250
> 57 dB	169400	196300	205200	205250	113700	251350	261450	262200
> 60 dB	80500	93750	96050	96500	50700	134600	138200	138600
> 63 dB	31050	32100	32050	32400	15100	46800	46850	47350
> 66 dB	8250	12450	12400	12750	3100	20400	20450	20500
> 69 dB	2000	1300	1300	1300	50	5050	4950	5300
> 72 dB	10	0	0	0	0	800	800	800

Table E.40 INM Model Outputs – $L_{Aeq, 16hr}$ - Households

Metric and Contour $L_{Aeq, 16hr}$	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 54 dB	125500	130250	142200	137800	136800	169450	181800	184950
> 57 dB	63800	72800	76400	76900	68200	95950	100450	100750
> 60 dB	29000	34100	34950	35050	32300	50550	52000	51950
> 63 dB	10950	12050	12000	12150	12050	17650	17650	17750
> 66 dB	3050	4950	4950	5100	3550	8100	8100	8100
> 69 dB	650	550	550	550	1100	2100	2050	2200
> 72 dB	0	0	0	0	10	330	330	330

Table E.41 INM Model Outputs – L_{den} - Populations

Metric and Contour L_{den}	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 55 dB	376900	395400	419350	409650	401350	505400	546450	520150
> 60 dB	130850	149350	161250	159650	138500	208700	219100	218150
> 65 dB	28050	29750	29450	30850	29600	47200	47150	49550
> 70 dB	3000	1350	1350	1350	3700	5400	5300	5350
> 75 dB	0	0	0	0	0	0	0	0

Table E.42 INM Model Outputs – L_{den} - Households

Metric and Contour L_{den}	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 55 dB	152300	155500	167800	162300	165150	203100	223200	210150
> 60 dB	48150	54450	59200	58500	52100	79500	83800	83300
> 65 dB	9750	11050	10950	11400	10500	17500	17500	18300
> 70 dB	950	550	550	550	1200	2200	2150	2200
> 75 dB	0	0	0	0	0	0	0	0

Table E.43 INM Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 48 dB	241700	218100	247700	247700	260800	264800	316150	267200
> 51 dB	109800	112500	124450	124450	113700	165750	180700	167000
> 54 dB	48600	32950	32550	32550	50700	55600	56950	56050
> 57 dB	14650	5550	5050	5050	15100	11200	11050	11300
> 60 dB	2900	550	550	550	3100	900	750	900
> 63 dB	100	50	50	50	50	150	150	150
> 66 dB	0	0	0	0	0	0	0	0
> 69 dB	0	0	0	0	0	0	0	0
> 72 dB	0	0	0	0	0	0	0	0

Table E.44 INM Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 48 dB	96800	83850	98000	81250	106700	105800	129800	108000
> 51 dB	40300	40350	45150	40900	42400	61750	68250	62300
> 54 dB	16950	11550	11350	11500	18000	20250	20700	20400
> 57 dB	4700	1950	1750	1950	4950	4000	3900	4050
> 60 dB	900	250	250	250	950	350	300	350
> 63 dB	50	50	50	50	50	50	50	50
> 66 dB	0	0	0	0	0	0	0	0
> 69 dB	0	0	0	0	0	0	0	0
> 72 dB	0	0	0	0	0	0	0	0

Table E.45 INM Model Outputs – N70 16-hour day - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 50	130050	162550	167450	168350	n/a	n/a	n/a	n/a
> 100	78000	98250	99300	99500	n/a	n/a	n/a	n/a
> 200	49400	40950	40600	40800	n/a	n/a	n/a	n/a
> 300	8750	6900	6900	6850	n/a	n/a	n/a	n/a
> 400	0	500	350	350	n/a	n/a	n/a	n/a
> 500	0	30	30	30	n/a	n/a	n/a	n/a

Table E.46 INM Model Outputs – N70 16-hour day - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 20	48150	60150	62100	62350	n/a	n/a	n/a	n/a
> 50	28100	35700	36100	36200	n/a	n/a	n/a	n/a
> 100	17450	14900	14750	14850	n/a	n/a	n/a	n/a
> 200	2950	2950	2950	2950	n/a	n/a	n/a	n/a
> 300	0	200	150	150	n/a	n/a	n/a	n/a
> 400	0	10	10	10	n/a	n/a	n/a	n/a
> 500	48150	60150	62100	62350	n/a	n/a	n/a	n/a

Table E.47 INM Model Outputs – N60 8-hour night - Populations

Metric and Contour N60 (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 25	64300	12200	38050	13850	n/a	n/a	n/a	n/a
> 50	0	0	0	0	n/a	n/a	n/a	n/a

Table E.48 INM Model Outputs – N60 8-hour day - Households

Metric and Contour N60 (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
> 25	26100	4400	15950	4950	n/a	n/a	n/a	n/a
> 50	0	0	0	0	n/a	n/a	n/a	n/a

Table E.49 INM Model Outputs – Option T ‘Minimise Total People’ - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on ‘Base Year’)				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,000	376,900	395,400	505,400	-257,100	-238,600	-128,600	18,500	110,000	-41%	-38%	-20%
$L_{Aeq,\ 16h}$ (69)	5,000	2,000	1,300	5,050	-3,000	-3,700	50	-700	3,750	-60%	-74%	1%
$L_{Aeq,\ 16hr}$ (57)	249,000	169,400	196,300	251,350	-79,600	-52,700	2,350	26,900	55,050	-32%	-21%	1%
$L_{Aeq,\ 16hr}$ (54)	478,000	313,500	335,250	428,250	-164,500	-142,750	-49,750	21,750	93,000	-34%	-30%	-10%
LAeq, 8hr night (50)	453,440	241,700	218,100	264,800	-211,740	-235,340	-188,640	-23,600	46,700	-47%	-52%	-42%
LAeq, 8hr night (48)	634,000	376,900	395,400	505,400	-257,100	-238,600	-128,600	18,500	110,000	-41%	-38%	-20%

Table E.50 INM Model Outputs – Option N 'Minimum New People' - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,000	376,900	419,350	546,450	-257,100	-214,650	-87,550	42,450	127,100	-41%	-34%	-14%
$L_{Aeq,\ 16h}$ (69)	5,000	2,000	1,300	4,950	-3,000	-3,700	-50	-700	3,650	-60%	-74%	-1%
$L_{Aeq,\ 16hr}$ (57)	249,000	169,400	205,200	261,450	-79,600	-43,800	12,450	35,800	56,250	-32%	-18%	5%
$L_{Aeq,\ 16hr}$ (54)	478,000	313,500	359,450	452,100	-164,500	-118,550	-25,900	45,950	92,650	-34%	-25%	-5%
LAeq, 8hr night (50)	453,440	241,700	247,700	316,150	-211,740	-205,740	-137,290	6,000	68,450	-47%	-45%	-30%
LAeq, 8hr night (48)	634,000	376,900	419,350	546,450	-257,100	-214,650	-87,550	42,450	127,100	-41%	-34%	-14%

Table E.51 INM Model Outputs – Option R 'Maximum Respite' - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	634,000	376,900	409,650	520,150	-257,100	-224,350	-113,850	32,750	110,500	-41%	-35%	-18%
$L_{Aeq, 16h}$ (69)	5,000	2,000	1,300	5,300	-3,000	-3,700	300	-700	4,000	-60%	-74%	6%
$L_{Aeq, 16hr}$ (57)	249,000	169,400	205,250	262,200	-79,600	-43,750	13,200	35,850	56,950	-32%	-18%	5%
$L_{Aeq, 16hr}$ (54)	478,000	313,500	353,350	462,250	-164,500	-124,650	-15,750	39,850	108,900	-34%	-26%	-3%
LAeq, 8hr night (50)	453,440	241,700	247,700	267,200	-211,740	-205,740	-186,240	6,000	19,500	-47%	-45%	-41%
LAeq, 8hr night (48)	634,000	376,900	409,650	520,150	-257,100	-224,350	-113,850	32,750	110,500	-41%	-35%	-18%

E.3.2 ANCON Noise Exposure Forecasts – Assuming Population Growth

The following results tables are based on ANCON modelling and present population and household noise exposure in 2030 and 2040 assuming population growth.

Table E.52 ANCON Model Outputs – $L_{Aeq, 16hr}$ - Populations

Metric and Contour $L_{Aeq, 16hr}$	2030				2040			
	2R do-minimum Figure E5	3R Option T Figure E6	3R Option N Figure E7	3R Option R Figure E8	2R do-minimum Figure E9	3R Option T Figure E10	3R Option N Figure E11	3R Option R Figure E12
> 54 dB	438600	355700	455700	382800	405600	439250	568950	463800
> 57 dB	203900	204700	222350	208600	195800	240150	259450	246500
> 60 dB	89500	104350	105450	106100	88850	137700	143900	140050
> 63 dB	27100	25400	25200	25850	24950	39400	39200	40550
> 66 dB	5250	5550	5550	5800	5250	10000	10000	10600
> 69 dB	1150	250	300	250	450	800	800	800
> 72 dB	10	0	0	0	10	0	0	0

Table E.53 ANCON Model Outputs – $L_{Aeq, 16hr}$ - Households

Metric and Contour $L_{Aeq, 16hr}$	2030				2040			
	2R do-minimum Figure E5	3R Option T Figure E6	3R Option N Figure E7	3R Option R Figure E8	2R do-minimum Figure E9	3R Option T Figure E10	3R Option N Figure E11	3R Option R Figure E12
> 54 dB	182000	139900	186650	152650	169150	177450	238850	189150
> 57 dB	79150	76500	84600	78150	76150	92600	102000	95300
> 60 dB	32050	37600	38100	38100	32200	50700	53200	51600
> 63 dB	9450	9500	9450	9700	8800	14750	14650	15100
> 66 dB	1850	2350	2350	2450	1900	4100	4100	4350
> 69 dB	350	100	100	100	150	350	350	350
> 72 dB	0	0	0	0	0	0	0	0

Table E.54 ANCON Model Outputs – $L_{Aeq, 16hr}$ – Areas (km^2)

Metric and Contour $L_{Aeq, 16hr}$	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
	Figure E5	Figure E6	Figure E7	Figure E8	Figure E9	Figure E10	Figure E11	Figure E12
> 54 dB	123.9	146.6	156.0	140.7	117.3	165.9	176.3	161.3
> 57 dB	69.5	87.8	91.7	85.0	66.1	99.1	103.4	95.8
> 60 dB	38.6	51.2	51.7	50.3	37.0	60.0	60.8	58.6
> 63 dB	21.3	28.0	28.0	28.1	20.3	33.4	33.4	33.2
> 66 dB	10.4	13.2	13.2	13.2	9.7	16.2	16.1	16.3
> 69 dB	5.5	6.7	6.7	6.7	5.1	7.9	7.9	7.9
> 72 dB	3.1	3.8	3.8	3.8	2.8	4.4	4.4	4.4

Table E.55 ANCON Model Outputs – L_{den} - Populations

Metric and Contour L_{den}	2030				2040			
	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	522500	428100	540200	432550	468450	408450	653000	507450
> 60 dB	156050	166750	179100	176000	158050	157100	211000	208400
> 65 dB	25600	23750	23650	24100	23700	30950	40100	41450
> 70 dB	2250	500	550	500	1850	850	1100	1100
> 75 dB	0	0	0	0	0	0	0	0

Table E.56 ANCON Model Outputs – L_{den} - Households

Metric and Contour L_{den}	2030				2040			
	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	218750	170450	222500	173200	195850	156600	275250	206950
> 60 dB	57800	61050	66000	64800	59250	55600	80500	79250
> 65 dB	8750	8800	8800	8900	8150	10700	14700	15200
> 70 dB	700	200	200	200	600	350	450	450
> 75 dB	0	0	0	0	0	0	0	0

Table E.57 ANCON Model Outputs – L_{den} – Areas (km^2)

Metric and Contour L_{den}	2030				2040			
	2R do-minimum Figure E13	3R Option T Figure E14	3R Option N Figure E15	3R Option R Figure E16	2R do-minimum Figure E17	3R Option T Figure E18	3R Option N Figure E19	3R Option R Figure E20
> 55 dB	136.1	160.9	170.4	154.2	125.8	180.4	190.3	173.6
> 60 dB	53.6	68.8	70.3	68.6	50.2	77.7	79.5	76.9
> 65 dB	17.9	23.8	23.8	23.9	16.7	30.4	30.3	30.4
> 70 dB	5.8	7.0	7.0	7.0	5.3	8.4	8.4	8.4
> 75 dB	2.3	2.9	2.9	2.9	2.1	3.3	3.3	3.3

Table E.58 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	265000	243600	281700	233800	254700	265500	307150	263650
> 51 dB	147850	139700	151300	143050	144300	179100	187950	181150
> 54 dB	58300	41700	41700	41650	55650	63400	65050	64300
> 57 dB	16050	6150	6100	6150	14050	11900	11850	11750
> 60 dB	3000	550	550	550	3100	750	750	750
> 63 dB	250	150	150	150	0	50	50	50
> 66 dB	10	0	0	0	0	0	0	0
> 69 dB	0	0	0	0	0	0	0	0
> 72 dB	0	0	0	0	0	0	0	0

Table E.59 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	106650	94850	112800	90800	103700	105850	125650	105800
> 51 dB	55350	50900	55500	52200	54050	67200	71100	68000
> 54 dB	20350	14800	14800	14750	19750	22950	23500	23300
> 57 dB	5200	2200	2150	2200	4600	4250	4200	4200
> 60 dB	900	250	250	250	950	300	300	300
> 63 dB	100	50	50	50	0	50	50	50
> 66 dB	0	0	0	0	0	0	0	0
> 69 dB	0	0	0	0	0	0	0	0
> 72 dB	0	0	0	0	0	0	0	0

Table E.60 ANCON Model Outputs – $L_{Aeq, 8hr}$ (night-time) – Areas (km^2)

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum Figure E21	3R Option T Figure E22	3R Option N Figure E23	3R Option R Figure E24	2R do-minimum Figure E25	3R Option T Figure E26	3R Option N Figure E27	3R Option R Figure E28
> 48 dB	76.2	86.0	91.1	84.5	69.3	90.3	95.0	89.2
> 51 dB	44.1	48.8	50.7	48.9	40.5	57.5	59.4	57.5
> 54 dB	18.9	20.4	20.4	20.4	17.6	25.8	25.9	25.9
> 57 dB	8.7	9.0	9.0	9.0	8.1	11.2	11.2	11.2
> 60 dB	4.5	4.5	4.5	4.5	4.1	5.4	5.4	5.4
> 63 dB	2.4	2.5	2.5	2.5	2.2	2.9	2.9	2.9
> 66 dB	1.4	1.7	1.7	1.7	1.3	1.9	1.9	1.9
> 69 dB	0.9	1.2	1.2	1.2	0.8	1.3	1.3	1.3
> 72 dB	0.5	0.8	0.8	0.8	0.5	0.8	0.9	0.8

Table E.61 ANCON Model Outputs – N70 16-hour day - Populations

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum Figure E29	3R Option T Figure E30	3R Option N Figure E31	3R Option R Figure E32	2R do-minimum Figure E33	3R Option T Figure E34	3R Option N Figure E35	3R Option R Figure E36
> 20	541800	849800	798400	900450	579600	851950	839300	836650
> 50	231150	236100	236150	215700	210750	242250	230750	231200
> 100	87050	110950	122900	112950	84900	158200	164100	155150
> 200	51400	47700	47350	47450	51350	57150	58400	56500
> 300	10100	6350	6450	6200	10850	26800	26950	26050
> 400	0	1150	1300	1450	0	4550	4500	5500
> 500	0	0	0	0	0	940	950	990

Table E.62 ANCON Model Outputs – N70 16-hour day - Households

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
	Figure E29	Figure E30	Figure E31	Figure E32	Figure E33	Figure E34	Figure E35	Figure E36
> 20	222400	346750	324100	367700	242050	350800	345000	347250
> 50	91700	90400	91650	81850	83450	93750	89800	89750
> 100	31000	40100	44800	40750	30650	59350	61400	57600
> 200	18200	17450	17300	17350	18550	20950	21400	20700
> 300	3550	2750	2800	2750	3900	10600	10700	10450
> 400	0	450	500	550	0	2050	2000	2450
> 500	0	0	0	0	0	360	370	380

Table E.63 ANCON Model Outputs – N70 16-hour day – Areas (km^2)

Metric and Contour $L_{Aeq, 8hr}$ (night-time)	2030				2040			
	2R do-minimum	3R Option T	3R Option N	3R Option R	2R do-minimum	3R Option T	3R Option N	3R Option R
	Figure E29	Figure E30	Figure E31	Figure E32	Figure E33	Figure E34	Figure E35	Figure E36
> 20	92.4	135.2	134.5	137.4	91.6	137.1	136.8	138.0
> 50	65.6	91.2	89.4	85.8	60.2	91.7	92.7	91.0
> 100	39.7	56.0	57.9	53.0	37.3	68.7	68.6	62.7
> 200	24.9	33.1	33.1	32.9	24.5	37.0	37.1	36.9
> 500	1.2	1.1	1.1	1.1	1.2	5.0	5.0	5.0

Table E.64 ANCON Model Outputs – N60 8-hour night - Populations

Metric and Contour N60 (night-time)	2030				2040			
	2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	221000	55750	215300	78350	205300	174450	292150	181450
> 50	0	0	0	0	0	150	150	150

Table E.65 ANCON Model Outputs – N60 8-hour day - Households

Metric and Contour N60 (night-time)	2030				2040			
	2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	88650	18800	85150	27200	83000	66000	119850	69050
> 50	0	0	0	0	0	50	50	50

Table E.66 ANCON Model Outputs – N60 8-hour day – Areas (km²)

Metric and Contour N60 (night-time)	2030				2040			
	2R do-minimum Figure E37	3R Option T Figure E38	3R Option N Figure E39	3R Option R Figure E40	2R do-minimum Figure E41	3R Option T Figure E42	3R Option N Figure E43	3R Option R Figure E44
> 25	32.3	15.2	25.8	16.0	30.5	42.0	50.9	41.7
> 50	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3

Table E.67 INM Model Outputs – Option T 'Minimise Total People' - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2012 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	522,500	428,100	408,450	-202,500	-296,900	-316,550	-94,400	-19,650	-28%	-41%	-44%
$L_{Aeq,\ 16h}$ (69)	3,200	1,150	250	800	-2,050	-2,950	-2,400	-900	550	-64%	-92%	-75%
$L_{Aeq,\ 16hr}$ (57)	237,350	203,900	204,700	240,150	-33,450	-32,650	2,800	800	35,450	-14%	-14%	1%
$L_{Aeq,\ 16hr}$ (54)	586,050	438,600	355,700	439,250	-147,450	-230,350	-146,800	-82,900	83,550	-25%	-39%	-25%

Table E.68 INM Model Outputs – Option N 'Minimum New People' - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on 'Base Year')				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	522,500	540,200	653,000	-202,500	-184,800	-72,000	17,700	112,800	-28%	-25%	-10%
$L_{Aeq,\ 16h}$ (69)	3,200	1,150	300	800	-2,050	-2,900	-2,400	-850	500	-64%	-91%	-75%
$L_{Aeq,\ 16hr}$ (57)	237,350	203,900	222,350	259,450	-33,450	-15,000	22,100	18,450	37,100	-14%	-6%	9%
$L_{Aeq,\ 16hr}$ (54)	586,050	438,600	455,700	568,950	-147,450	-130,350	-17,100	17,100	113,250	-25%	-22%	-3%

Table E.69 INM Model Outputs – Option R ‘Maximum Respite’ - % Population Comparisons to Baseline Year assuming Population Growth

Metric and Contour Boundary	Total Population (Based on ‘Base Year’)				Difference					Percentage Difference Relative to 2011		
	2011 Base	2R 2030	3R 2030	3R 3040	2R 2030 v Base	3R 2030 v Base	3R 2040 v Base	3R 2040 v 2R 2030	3R 2040 v 3R 2030	2R 2030	3R 2030	3R 2040
L_{den} (55)	725,000	522,500	432,550	507,450	-202,500	-292,450	-217,550	-89,950	74,900	-28%	-40%	-30%
$L_{Aeq,\ 16h}$ (69)	3,200	1,150	250	800	-2,050	-2,950	-2,400	-900	550	-64%	-92%	-75%
$L_{Aeq,\ 16hr}$ (57)	237,350	203,900	208,600	246,500	-33,450	-28,750	9,150	4,700	37,900	-14%	-12%	4%
$L_{Aeq,\ 16hr}$ (54)	586,050	438,600	382,800	463,800	-147,450	-203,250	-122,250	-55,800	81,000	-25%	-35%	-21%

E.4 Noise Exposure Changes

The following table presents a summary of noise level changes and the population associated with these changes for various airspace options and comparisons.

Table E.70 Noise Exposure Changes – 57 dB $L_{Aeq, 16hr}$ – INM Model Outputs

Airspace Option	Comparison	Change relative to 57 dB $L_{Aeq, 16hr}$	Population		
			Significant Adverse Change	No Change	Significant Improvement
-	2030 2R verse Baseline	Still in	0	98,850	41,700
		Newly in	0	250	0
		Newly excluded	0	64,450	43,500
Option T	2030 3R verse Baseline	Still in	7,000	72,350	64,150
		Newly in	17,900	1,950	0
		Newly excluded	0	17,500	85,650
	2030 3R verse 2030 2R	Still in	6,700	124,500	350
		Newly in	28,300	10,800	
		Newly excluded	0	5,550	1,950

Table E.70 (continued) Noise Exposure Changes – 57 dB $L_{Aeq, 16hr}$– INM Model Outputs

Airspace Option	Comparison	Change relative to 57 dB $L_{Aeq, 16hr}$	Population		
			Significant Adverse Change	No Change	Significant Improvement
Option N	2030 3R verse Baseline	Still in	7,050	83,050	60,250
		Newly in	18,150	2,100	0
		Newly excluded	0	38,150	58,050
	2030 3R verse 2030 2R	Still in	7,500	125,800	350
		Newly in	26,900	10,100	0
		Newly excluded	0	5,350	150
Option R	2030 3R verse Baseline	Still in	6,900	79,500	60,000
		Newly in	21,500	2,850	0
		Newly excluded	0	26,750	73,500
	2030 3R verse 2030 2R	Still in	6,700	124,600	350
		Newly in	28,300	10,800	0
		Newly excluded	0	5,550	1,950

Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon134.mxd

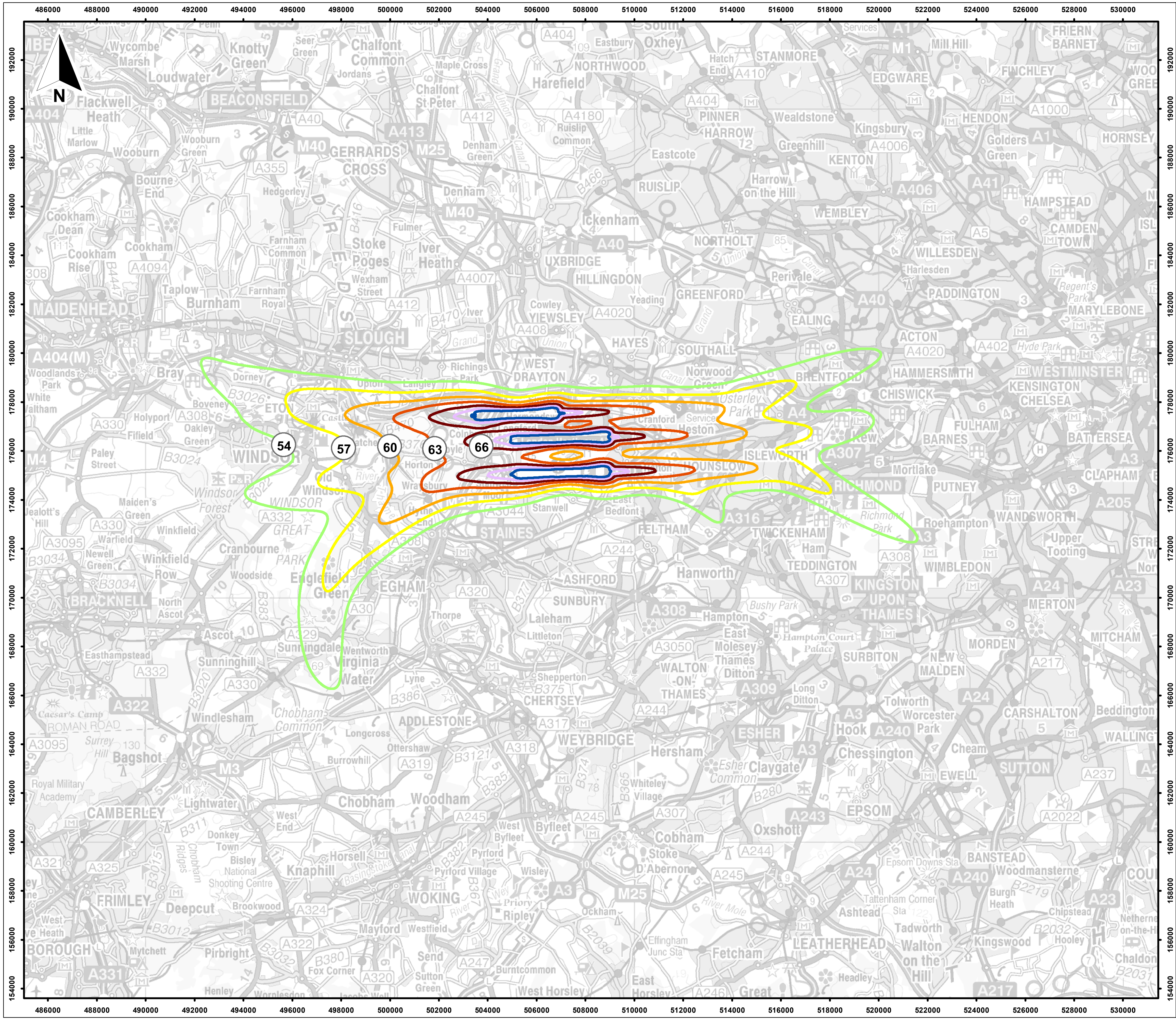
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E5
2R 2030 'do-minimum'
$L_{Aeq,16hr}$

June 2014
35310-Lon134 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon153.mxd

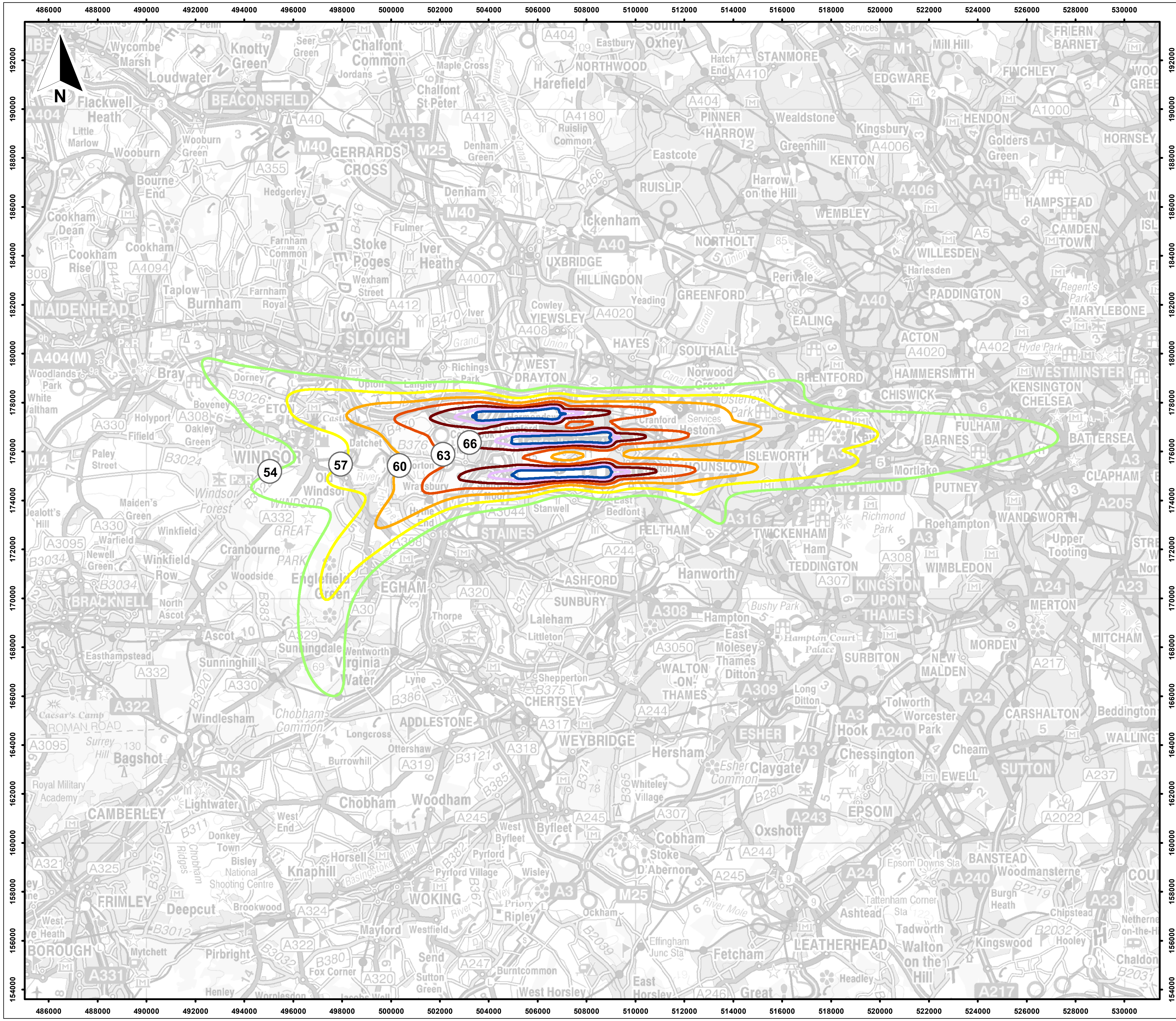
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E6
3R 2030 Option T
$L_{Aeq,16hr}$

June 2014
35310-Lon153 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon142.mxd

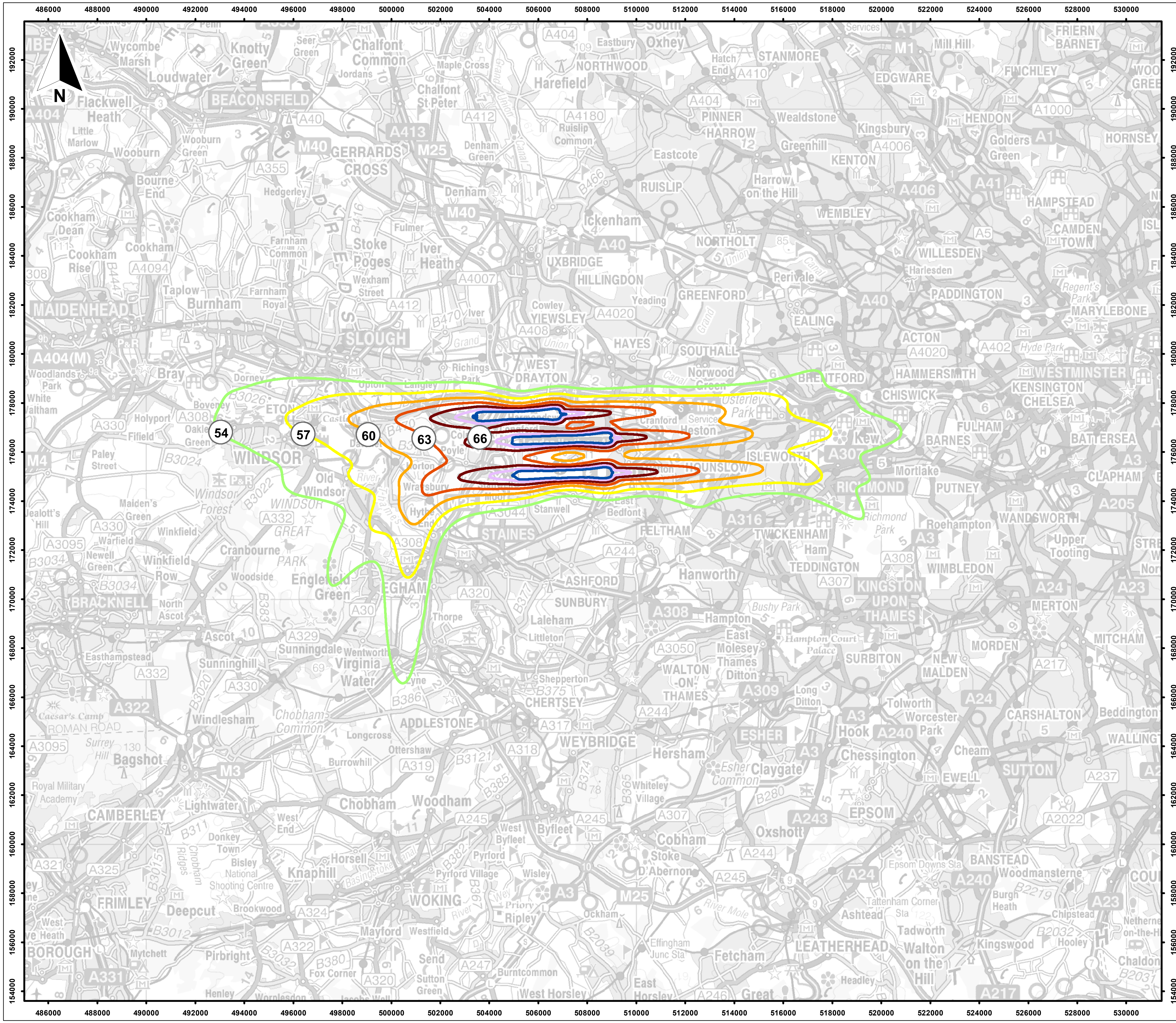
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E7
3R 2030 Option N
$L_{Aeq,16hr}$

June 2014
35310-Lon142 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon148.mxd

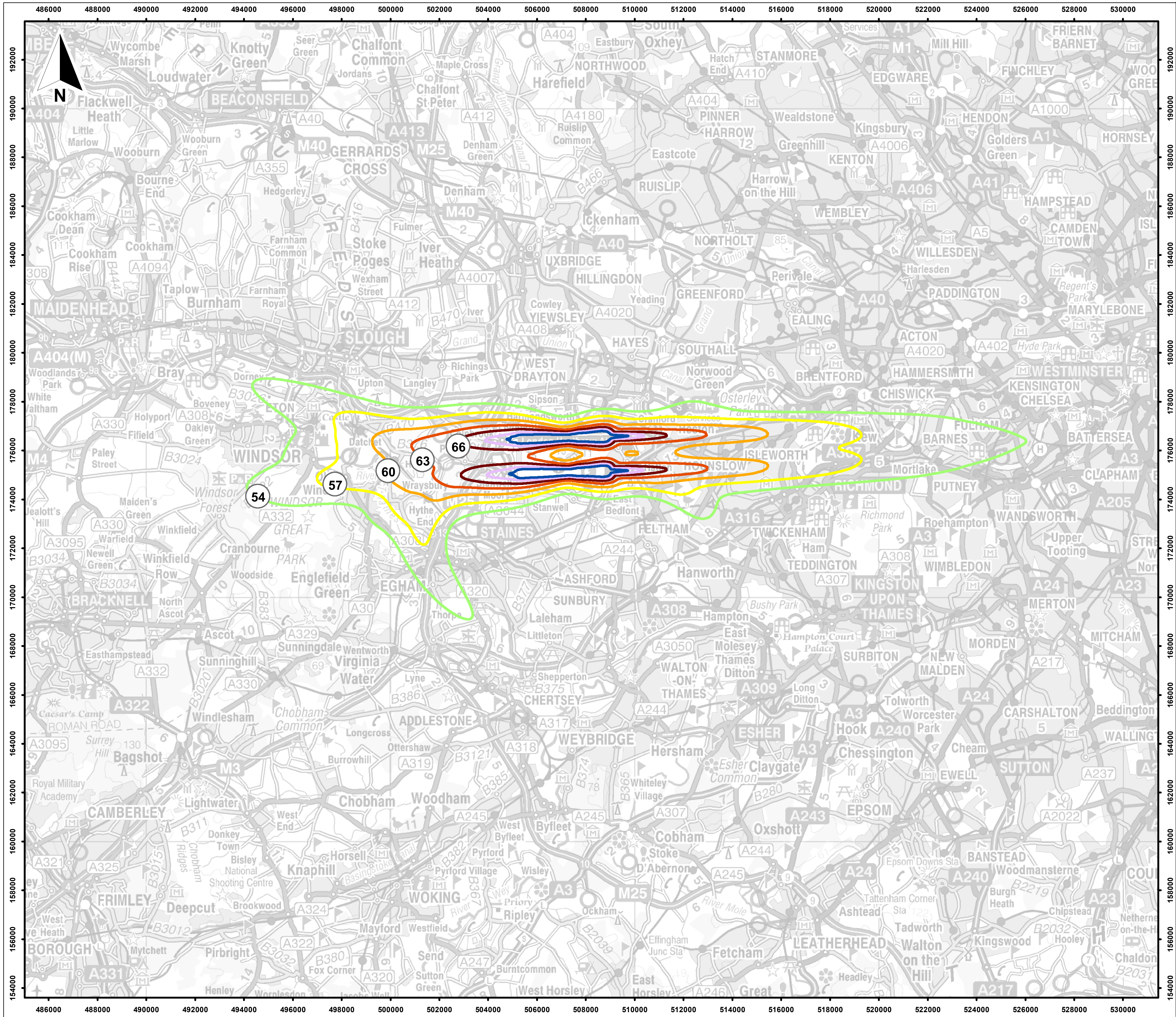
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E8
3R 2030 Option R
$L_{Aeq,16hr}$

June 2014
35310-Lon148 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon137.mxd

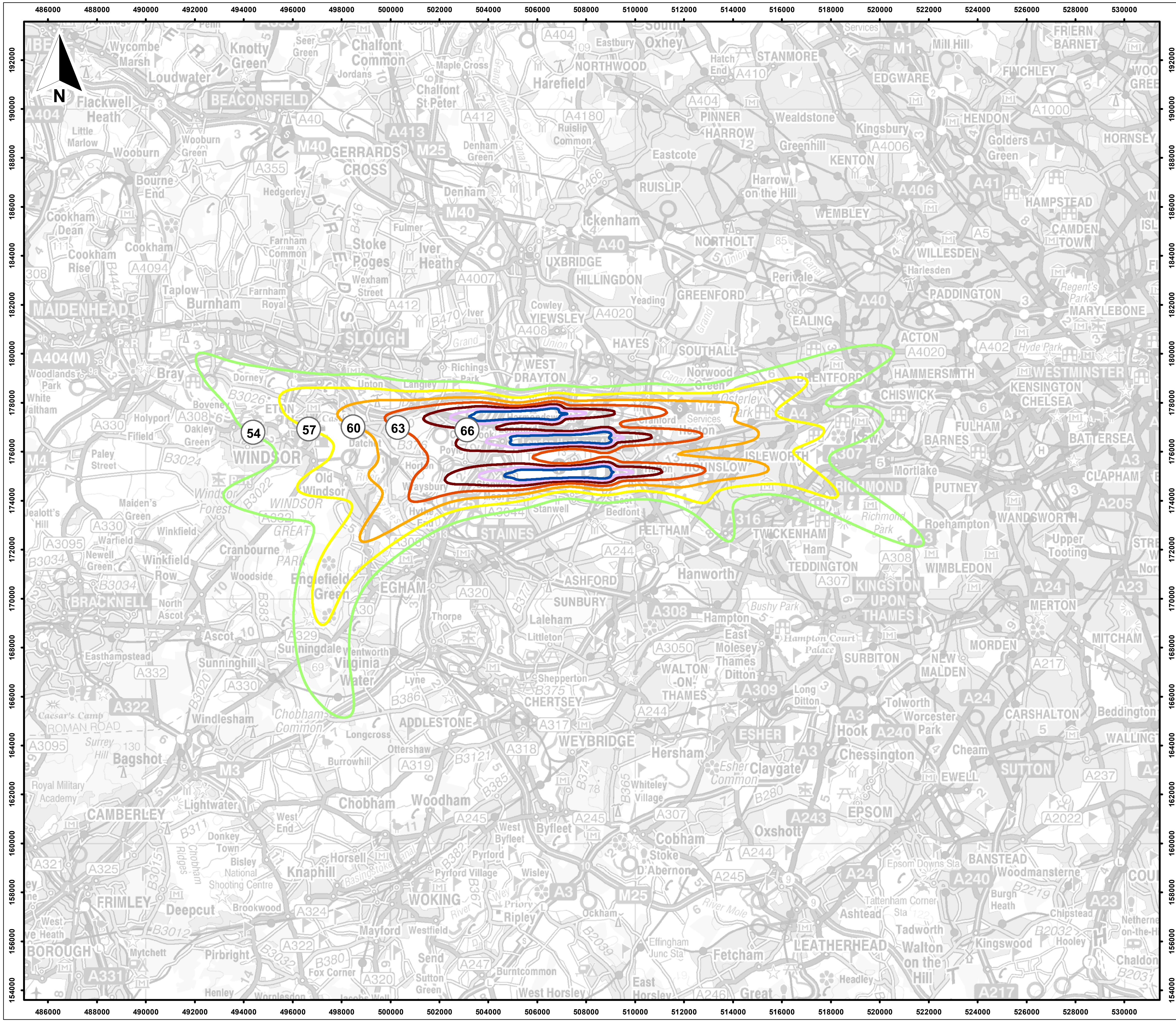
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E9
2R 2040 'do-minimum'
$L_{Aeq,16hr}$

June 2014
35310-Lon137 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon156.mxd

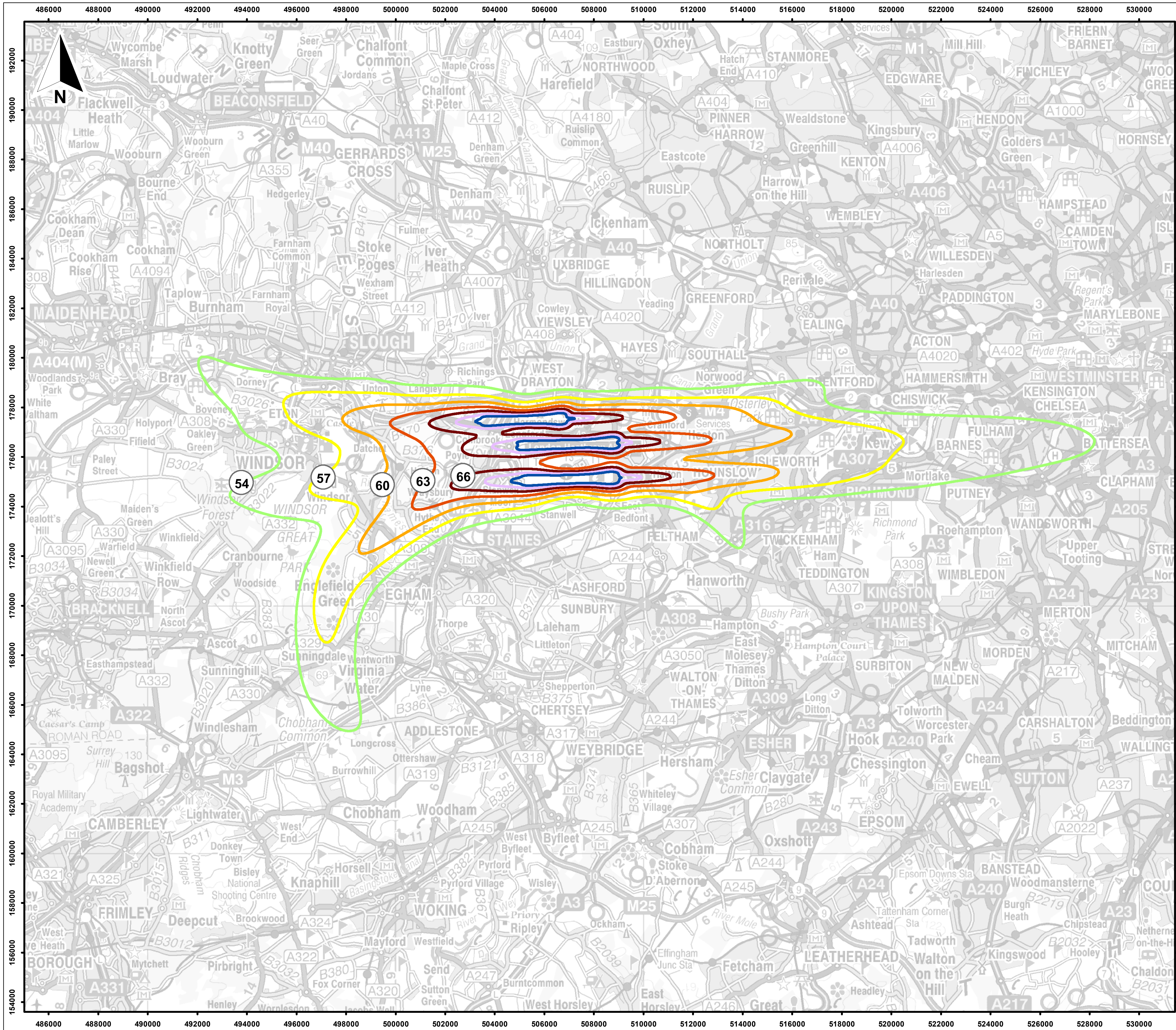
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E10
3R 2040 Option T
$L_{Aeq,16hr}$

June 2014
35310-Lon156 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon145.mxd

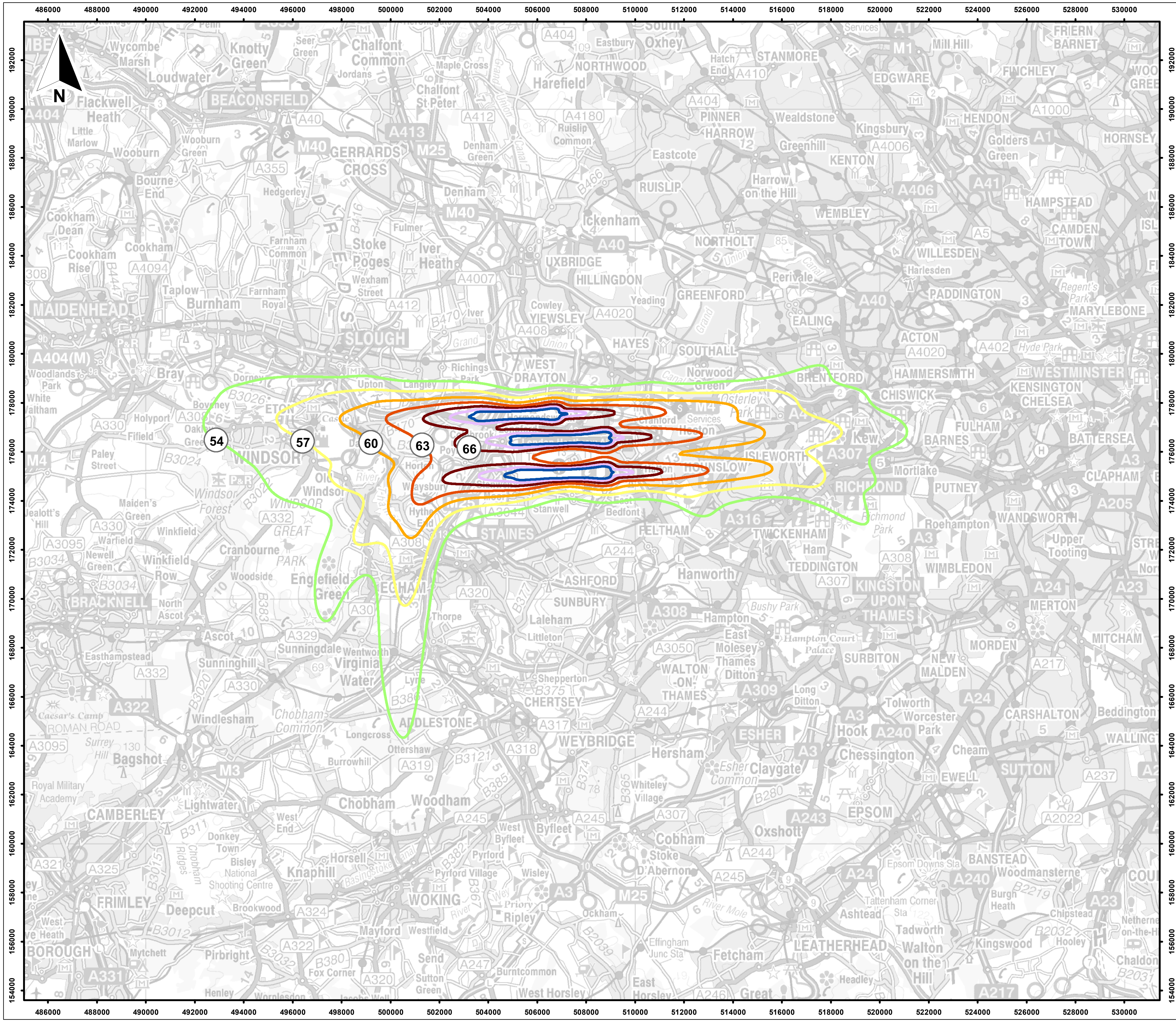
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E11
3R 2040 Option N
$L_{Aeq,16hr}$

June 2014
35310-Lon145 montg

amec



Key:

Noise Level (dB)

- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon150.mxd

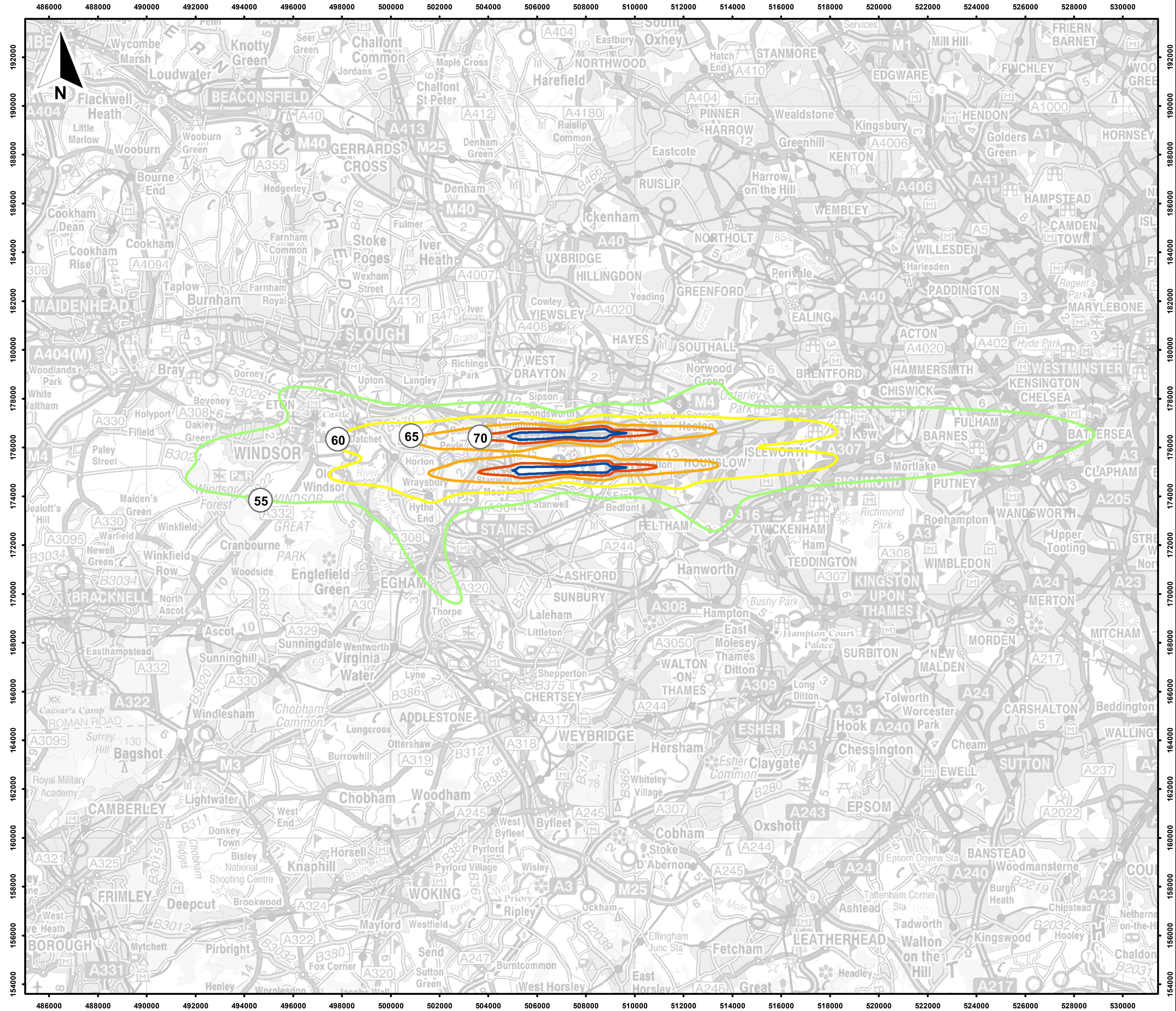
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E12
3R 2040 Option R
$L_{Aeq,16hr}$

June 2014
35310-Lon150 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon135.mxd

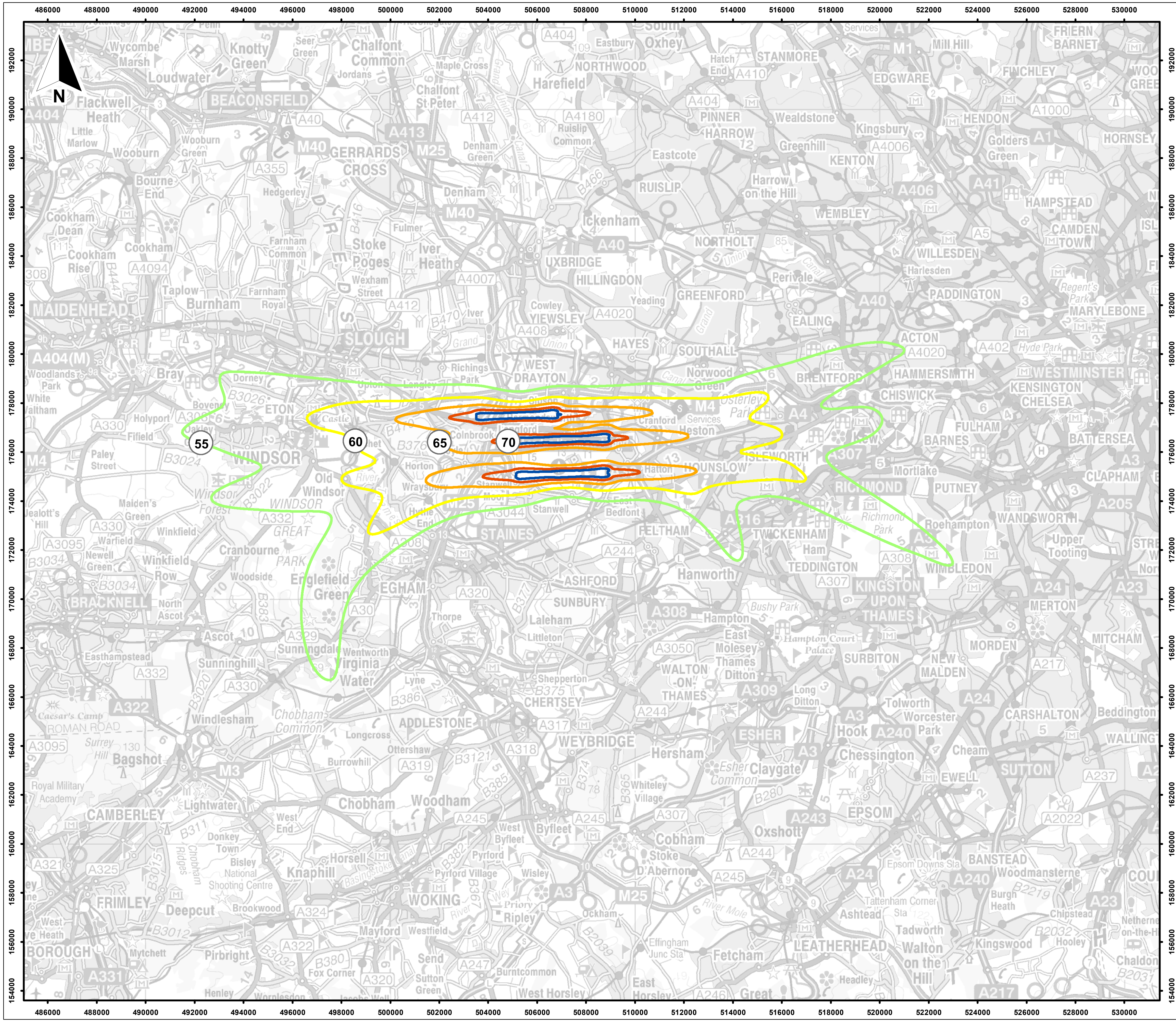
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E13
2R 2030 'do-minimum'
L_{den}

June 2014
35310-Lon135 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon154.mxd

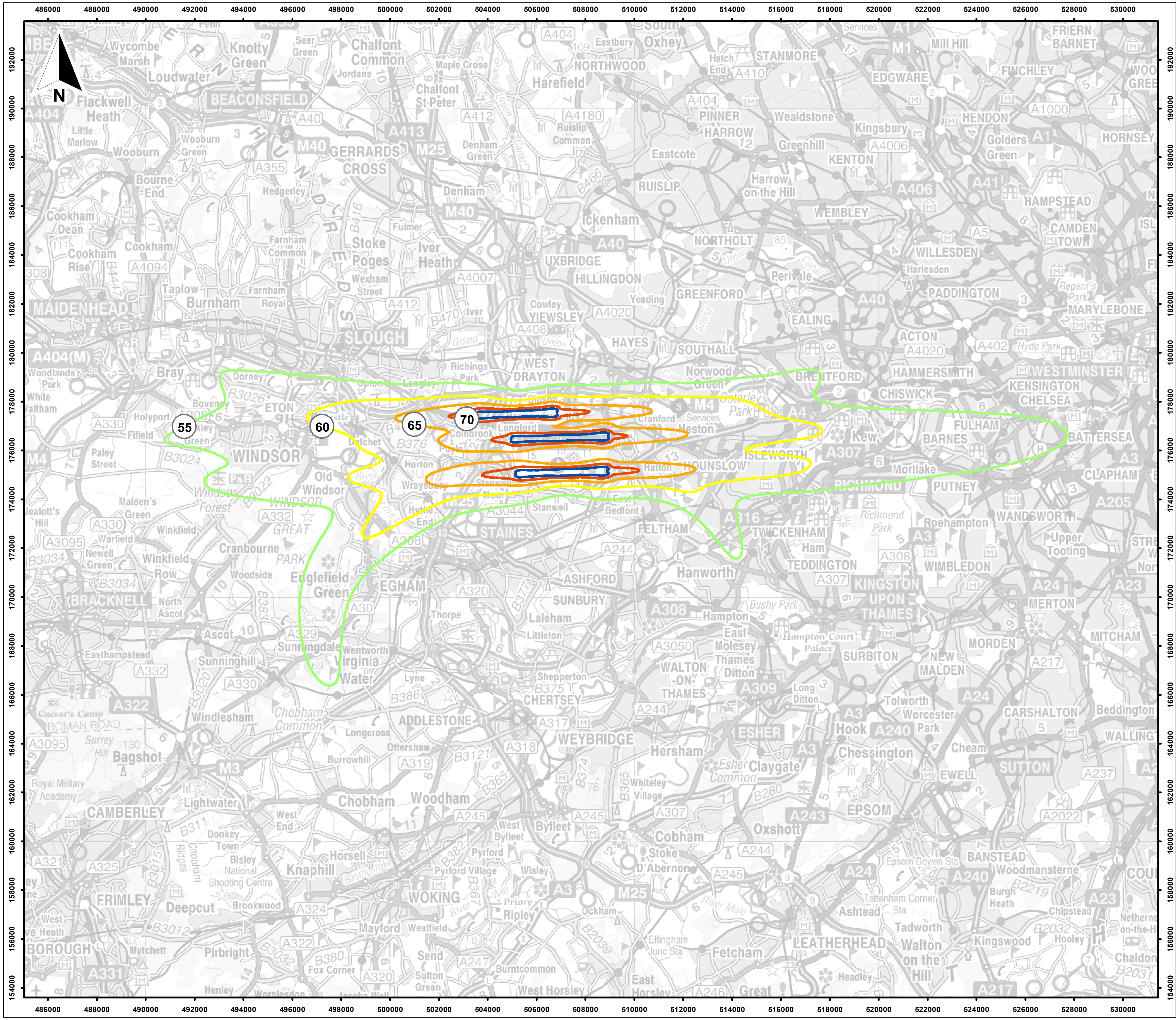
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E14
3R 2030 Option T
L_{den}

June 2014
35310-Lon154 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon143.mxd

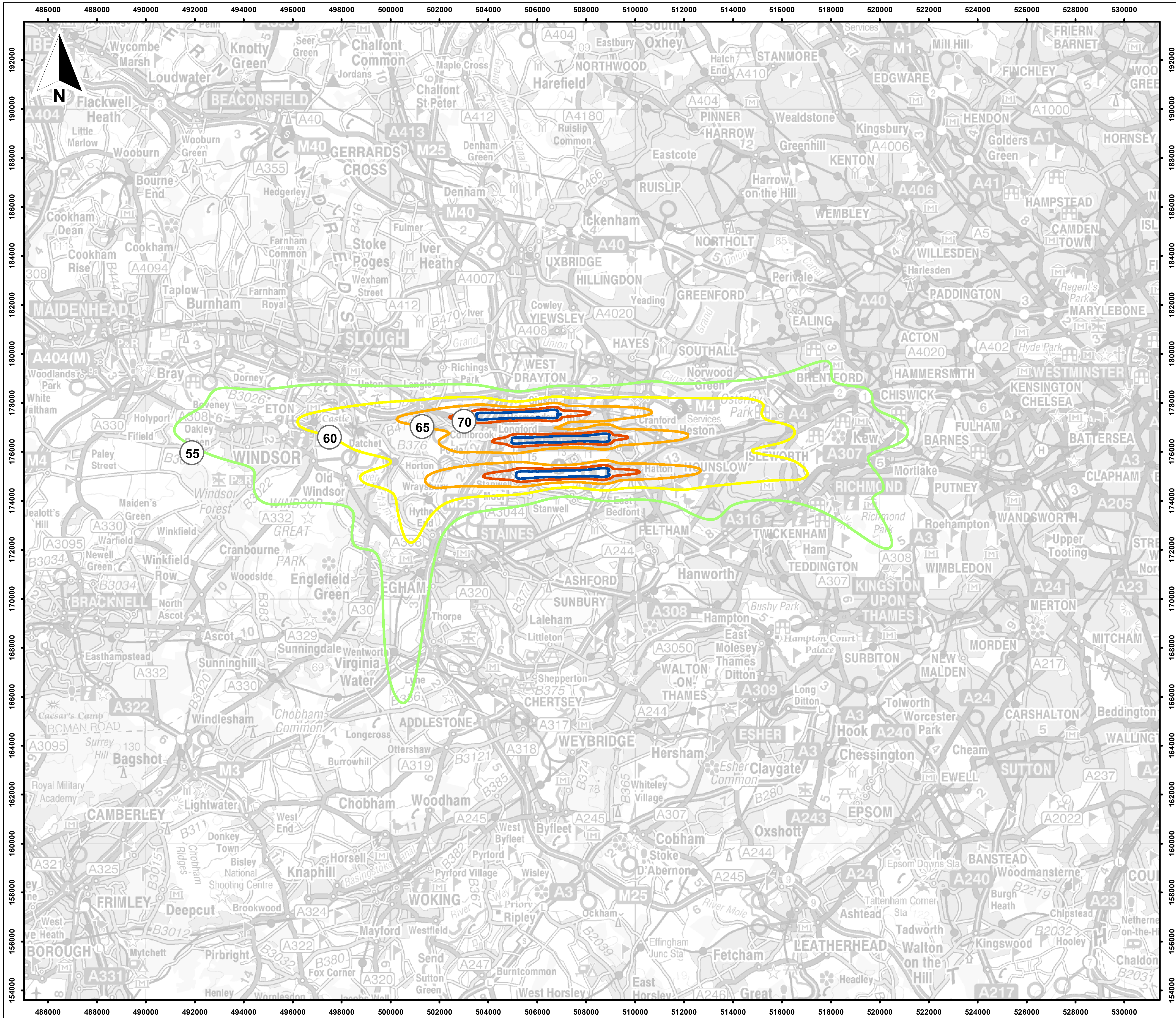
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E15
3R 2030 Option N
L_{den}

June 2014
35310-Lon143 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon149.mxd

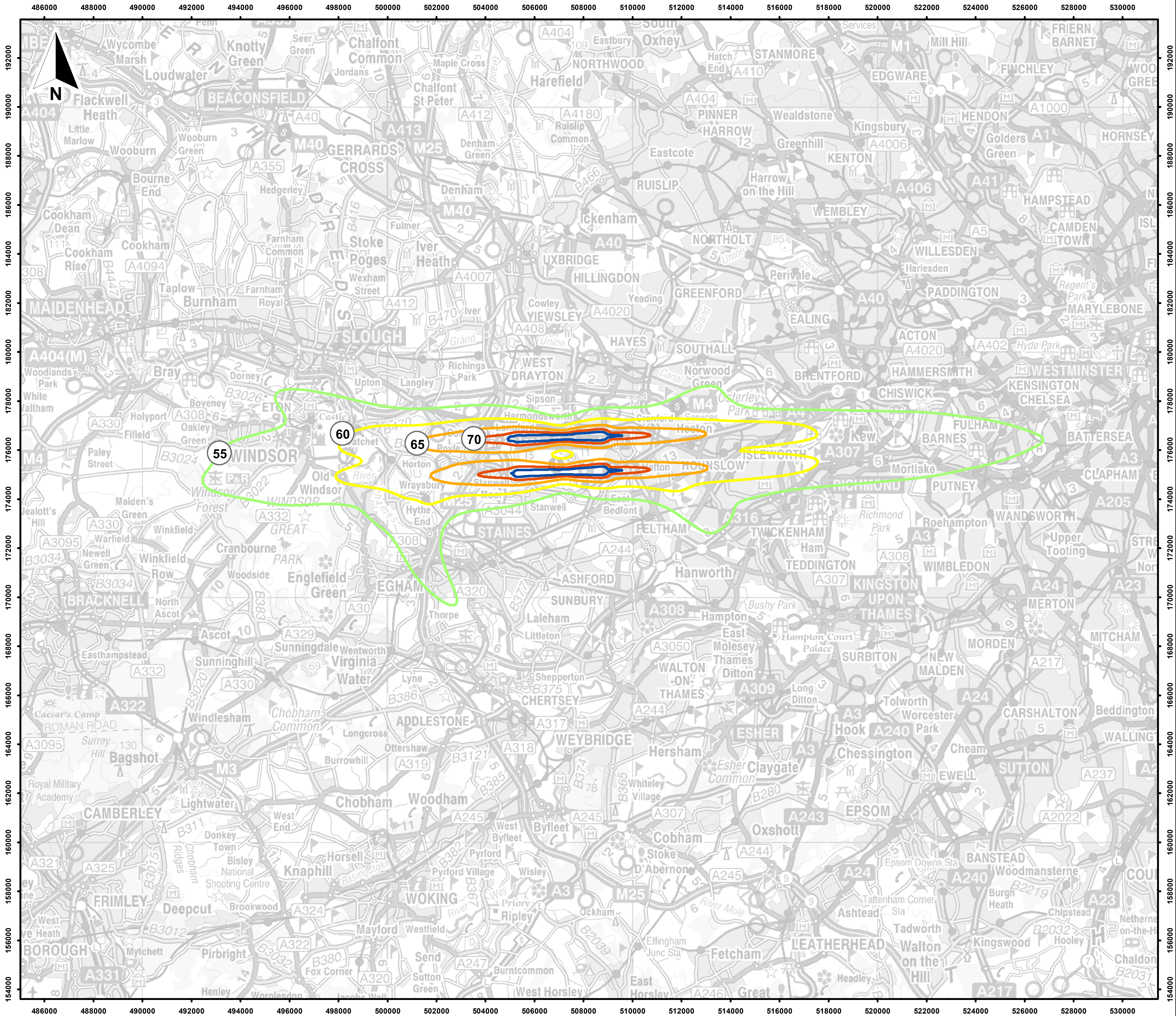
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E16
3R 2030 Option R
L_{den}

June 2014
35310-Lon149 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

Scale: 1:150,000 @ A3

0 2,500 5,000 Metres

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon138.mxd

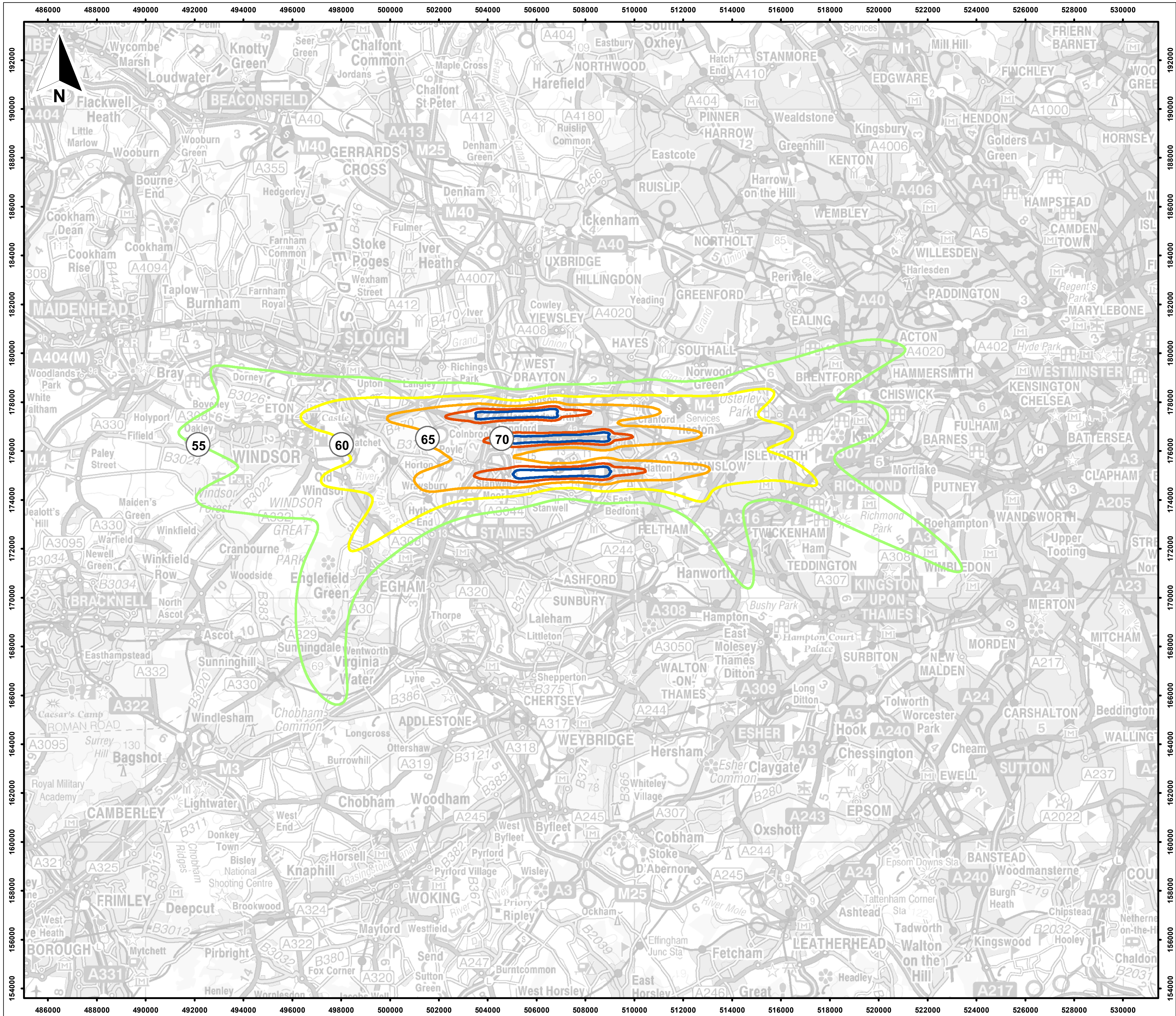
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E17
2R 2040 'do-minimum'
L_{den}

June 2014
35310-Lon138 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon158.mxd

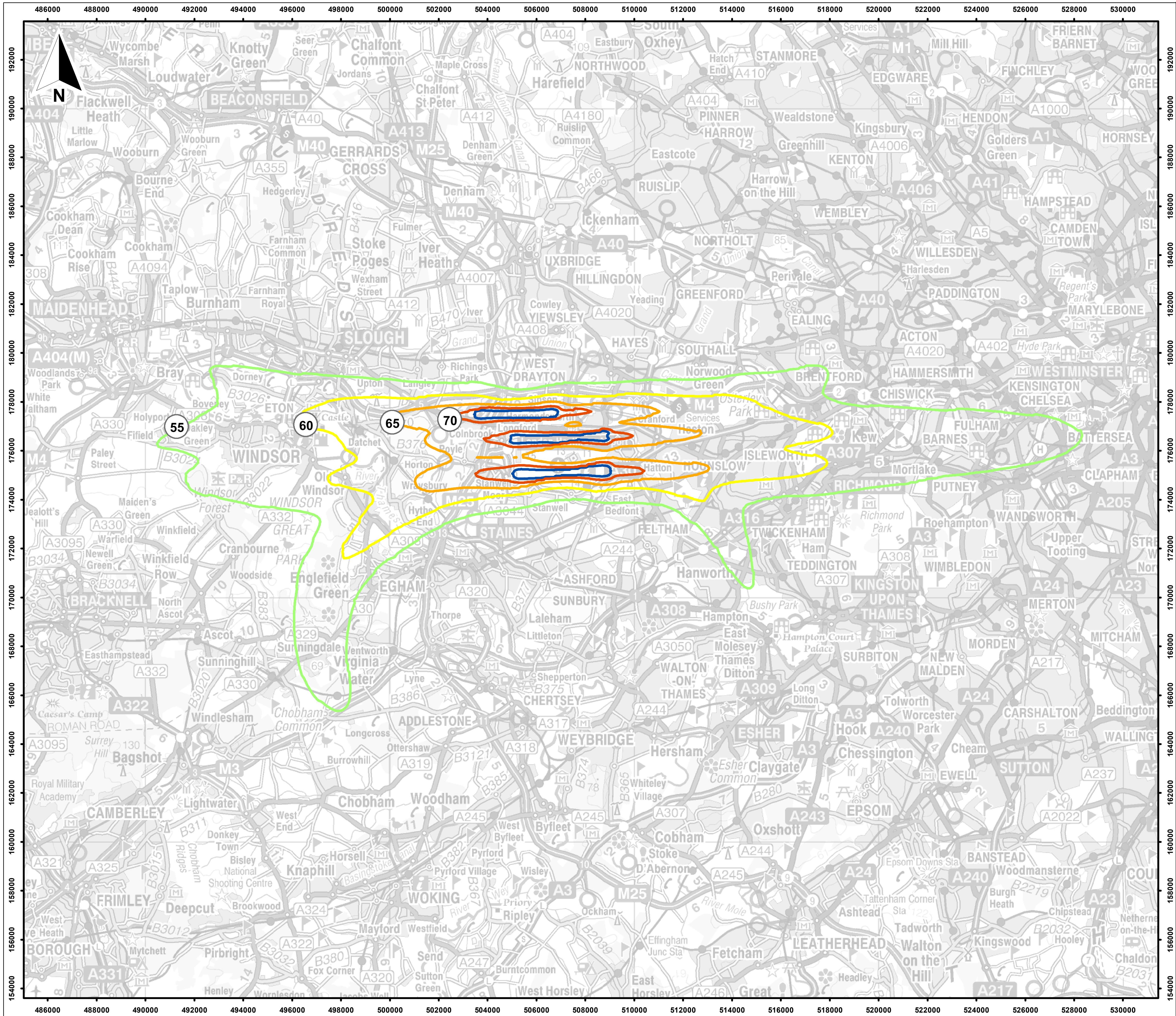
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E18
3R 2040 Option T
L_{den}

June 2014
35310-Lon158 montg

amec



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

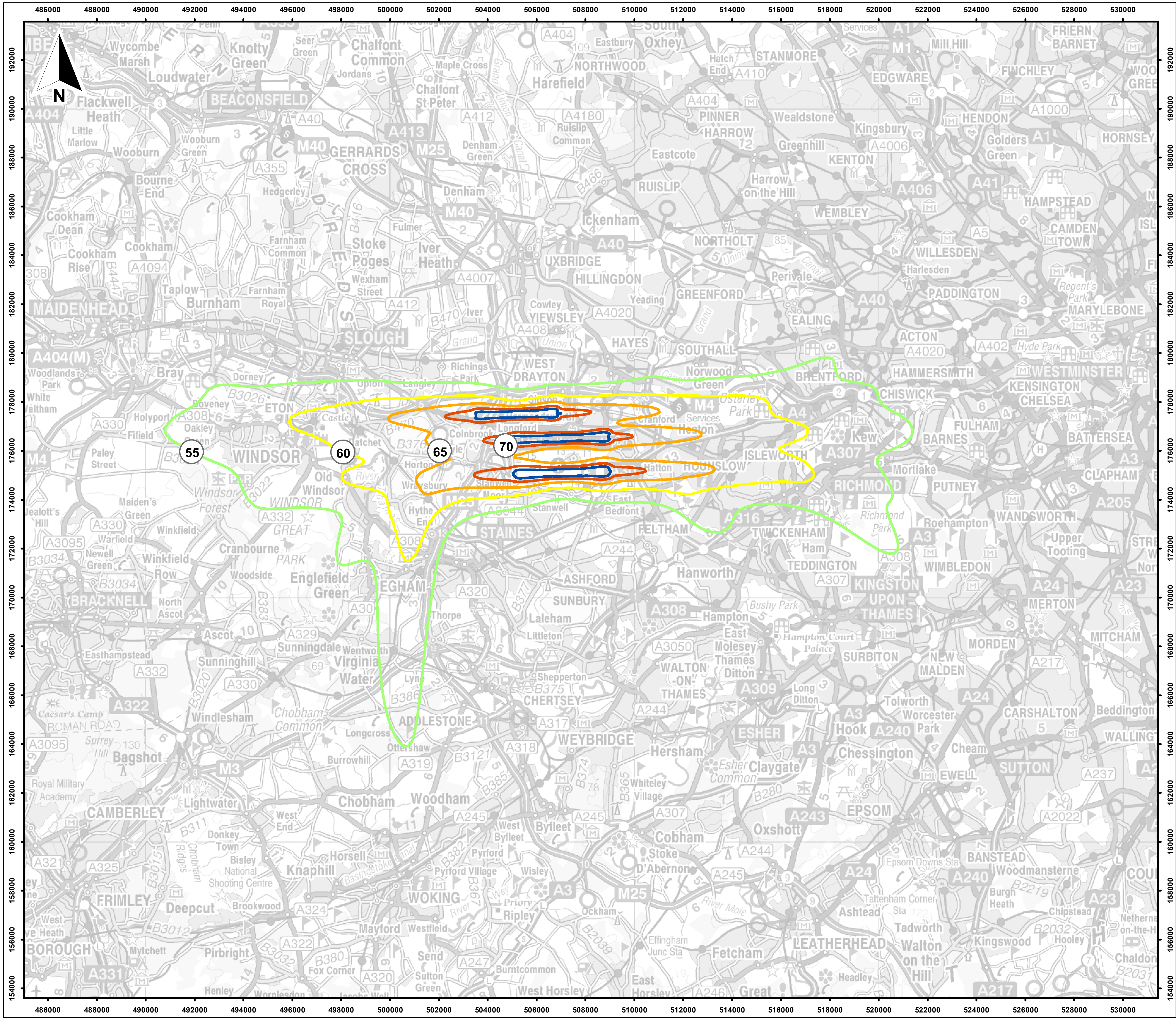
H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon146.mxd

Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E19
3R 2040 Option N
L_{den}

June 2014
35310-Lon146 montg



Key:

Noise Level (dB)

- > 55
- > 60
- > 65
- > 70
- > 75

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon151.mxd

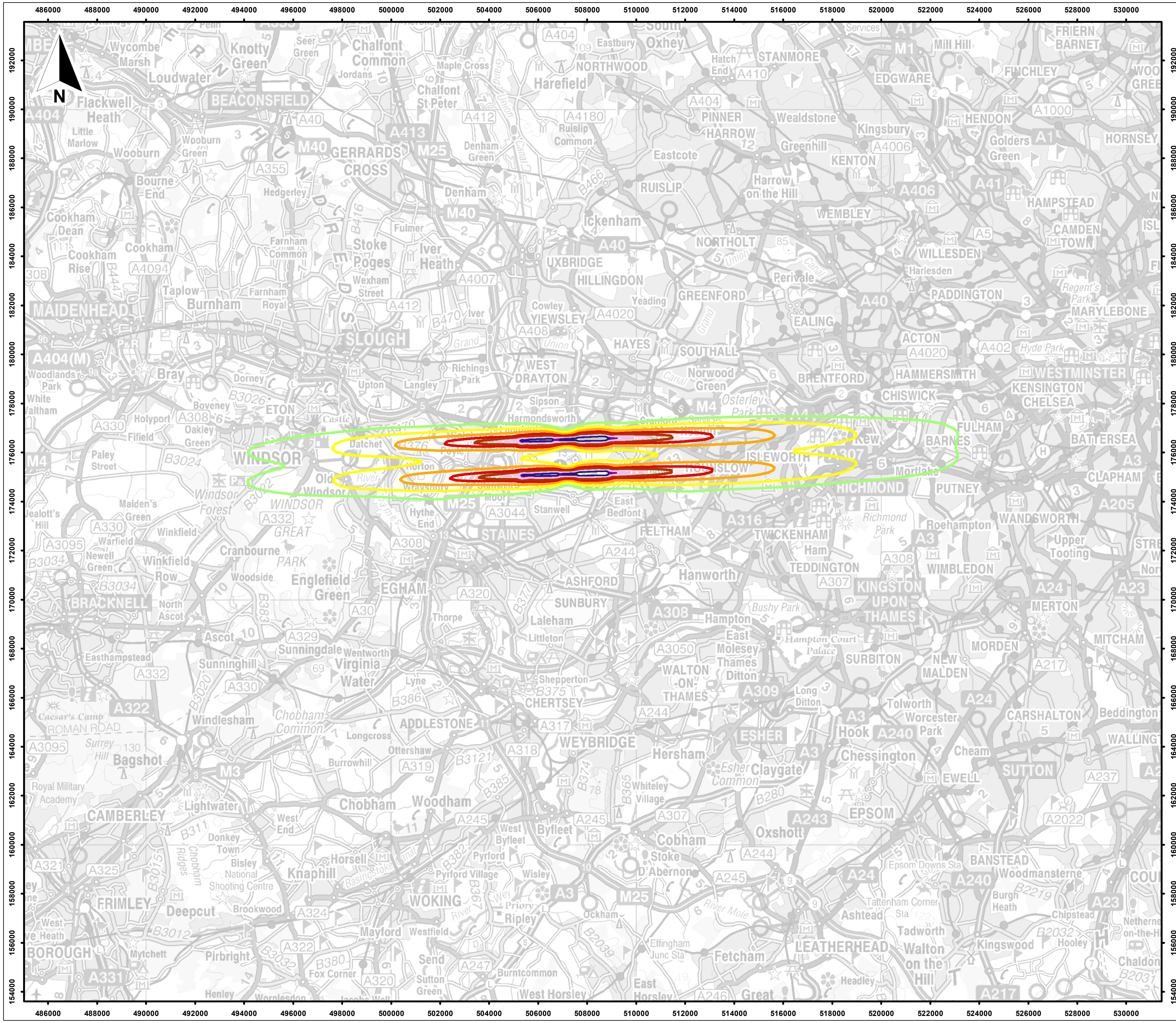
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E20
3R 2040 Option R
L_{den}

June 2014
35310-Lon151 montg

amec



Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon162.mxd

Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E21
2R 2030 'do-minimum' $L_{Aeq,8hr}$ (night)

June 2014
35310-Lon160 montg

amec

Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon166.mxd

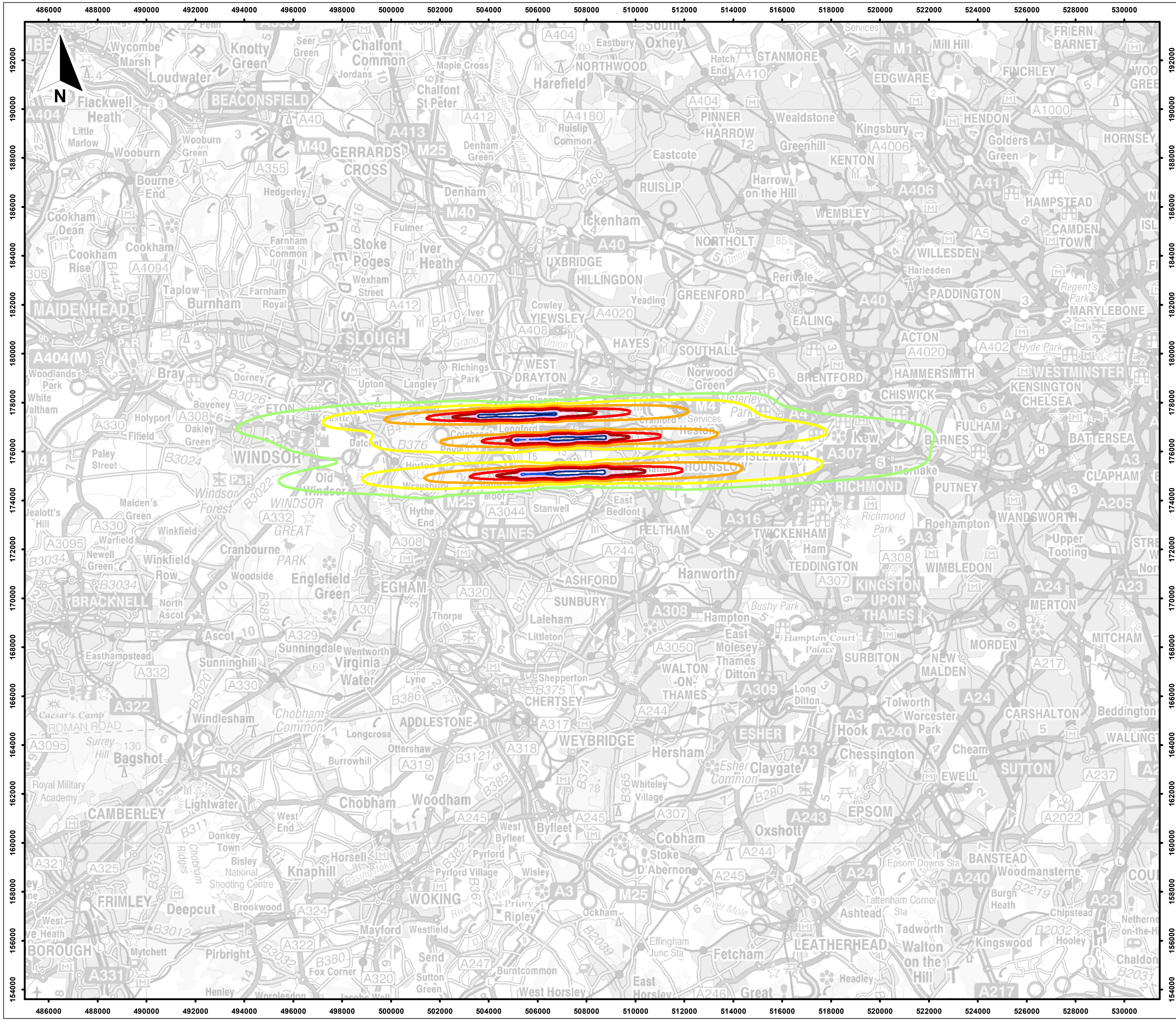
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E22
3R 2030 Option T $L_{Aeq,8hr}$ (night)

June 2014
35310-Lon166 montg

amec



Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon162.mxd

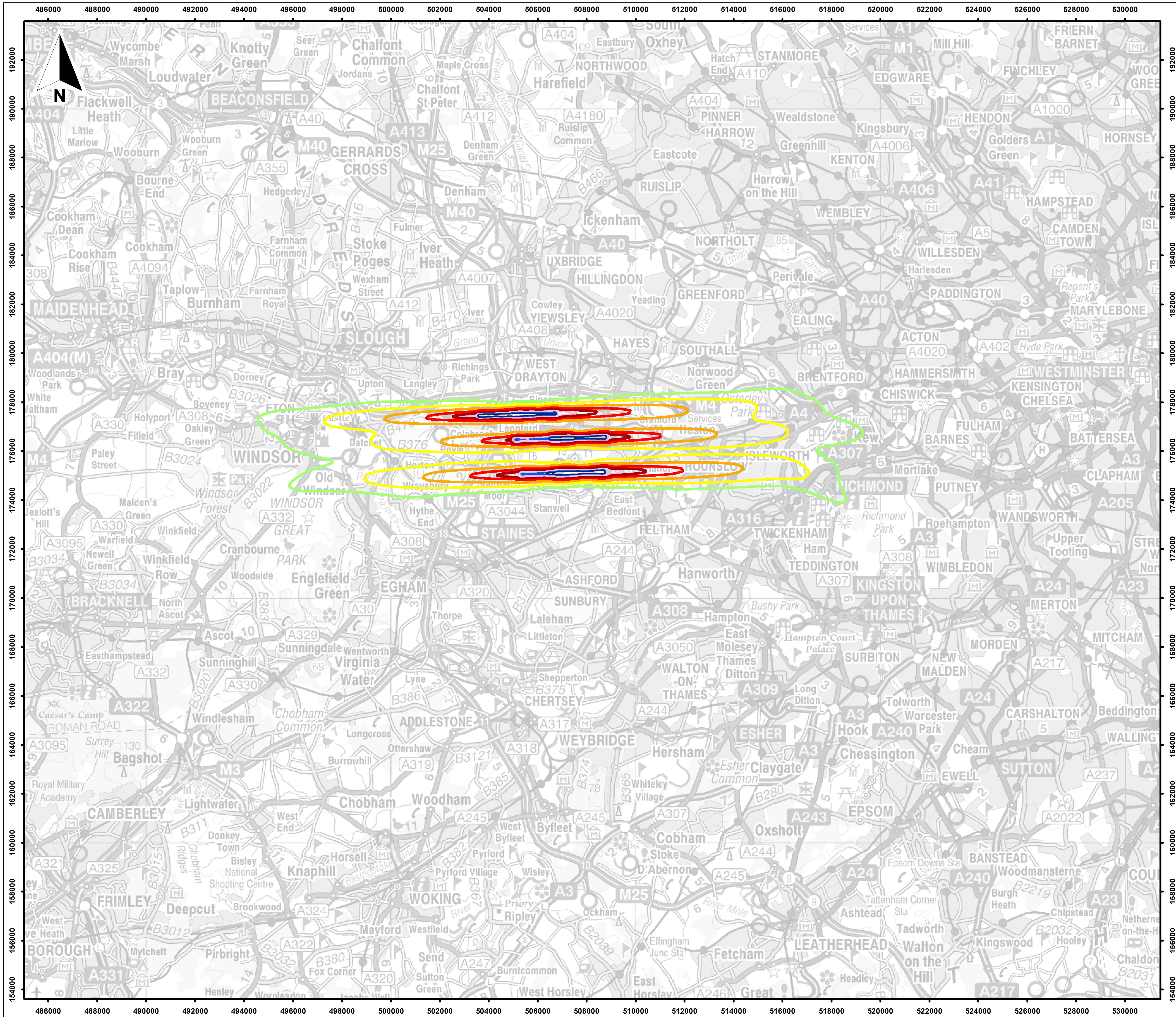
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E23
3R 2030 Option N
$L_{Aeq,8hr}$ (night)

June 2014
35310-Lon162 montg

amec



Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon164.mxd

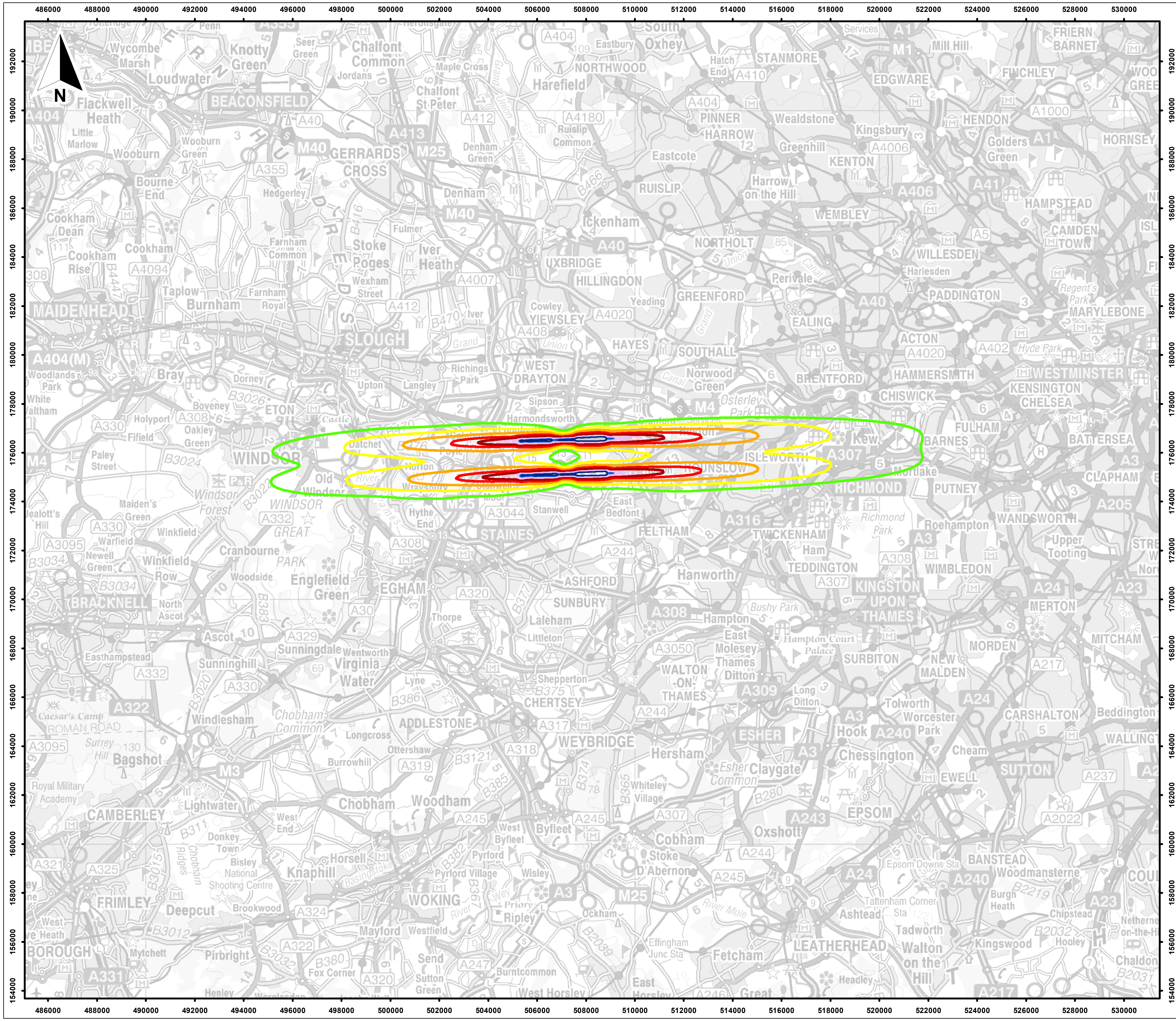
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E24
3R 2030 Option R $L_{Aeq,16hr}$ (night)

June 2014
35310-Lon164 montg

amec



Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon161.mxd

Heathrow

Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E25

2R 2040 'do-minimum' $L_{Aeq,8hr}$ (night)

June 2014

35310-Lon161 montg

amec

Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon167.mxd

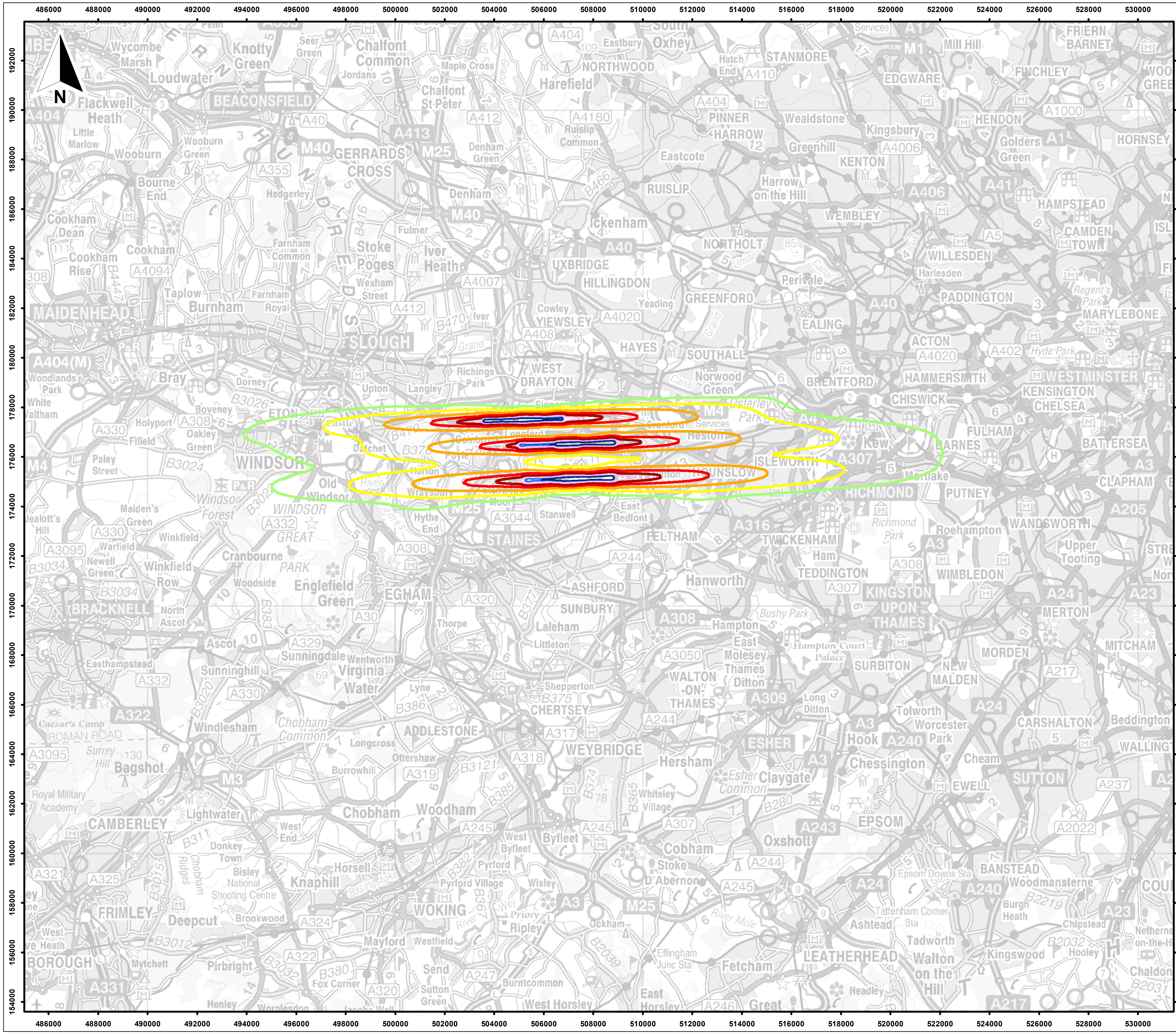
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E26
3R 2040 Option T $L_{Aeq,16hr}$ (night)

June 2014
35310-Lon167 montg

amec



Contains Ordnance Survey data. © Crown Copyright and database right (2013)

Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon163.mxd

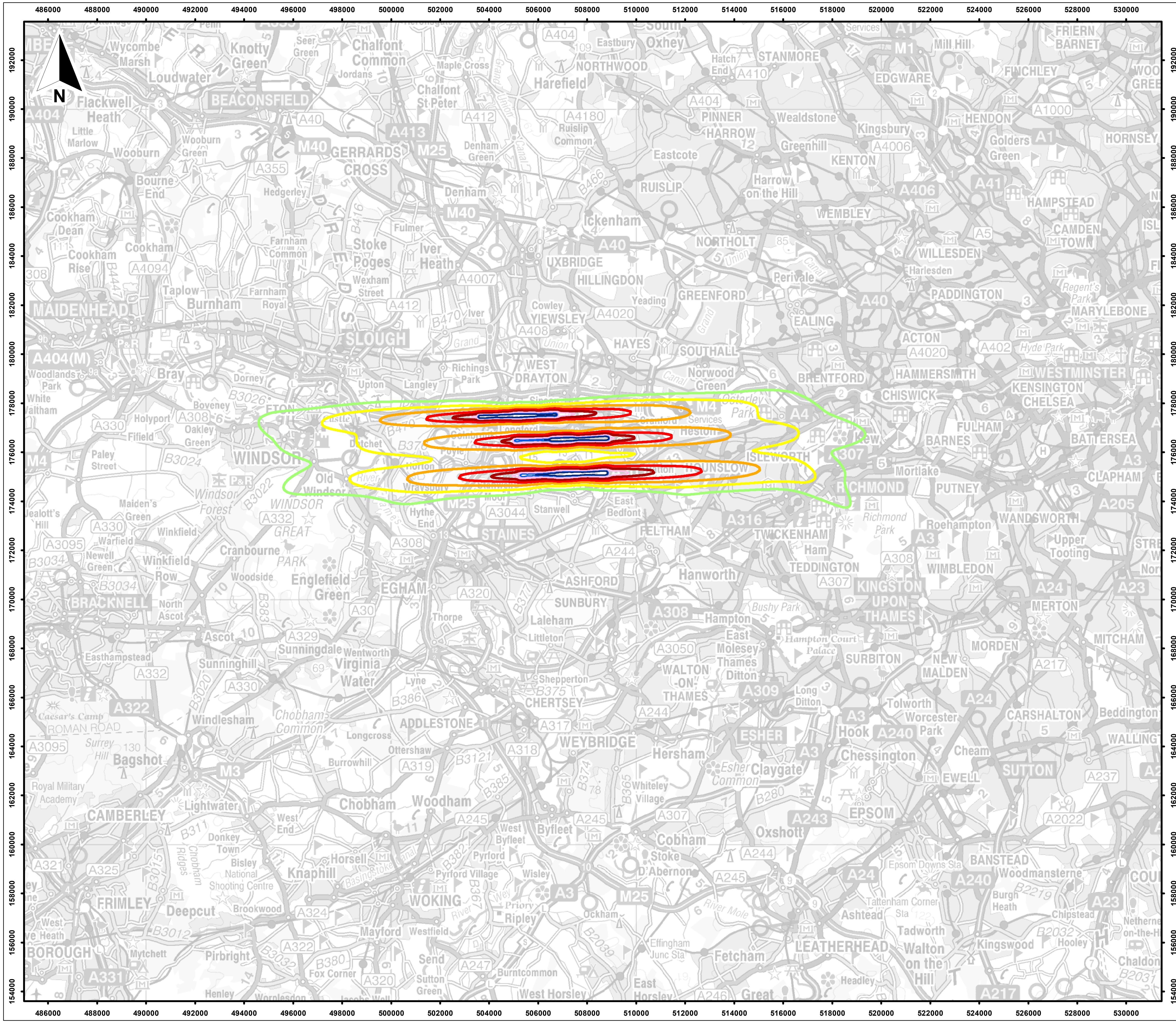
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E27
3R 2040 Option N
$L_{Aeq,8hr}$ (night)

June 2014
35310-Lon163 montg

amec



Key:

Noise Level (dB)

- > 48
- > 51
- > 54
- > 57
- > 60
- > 63
- > 66
- > 69
- > 72

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon165.mxd

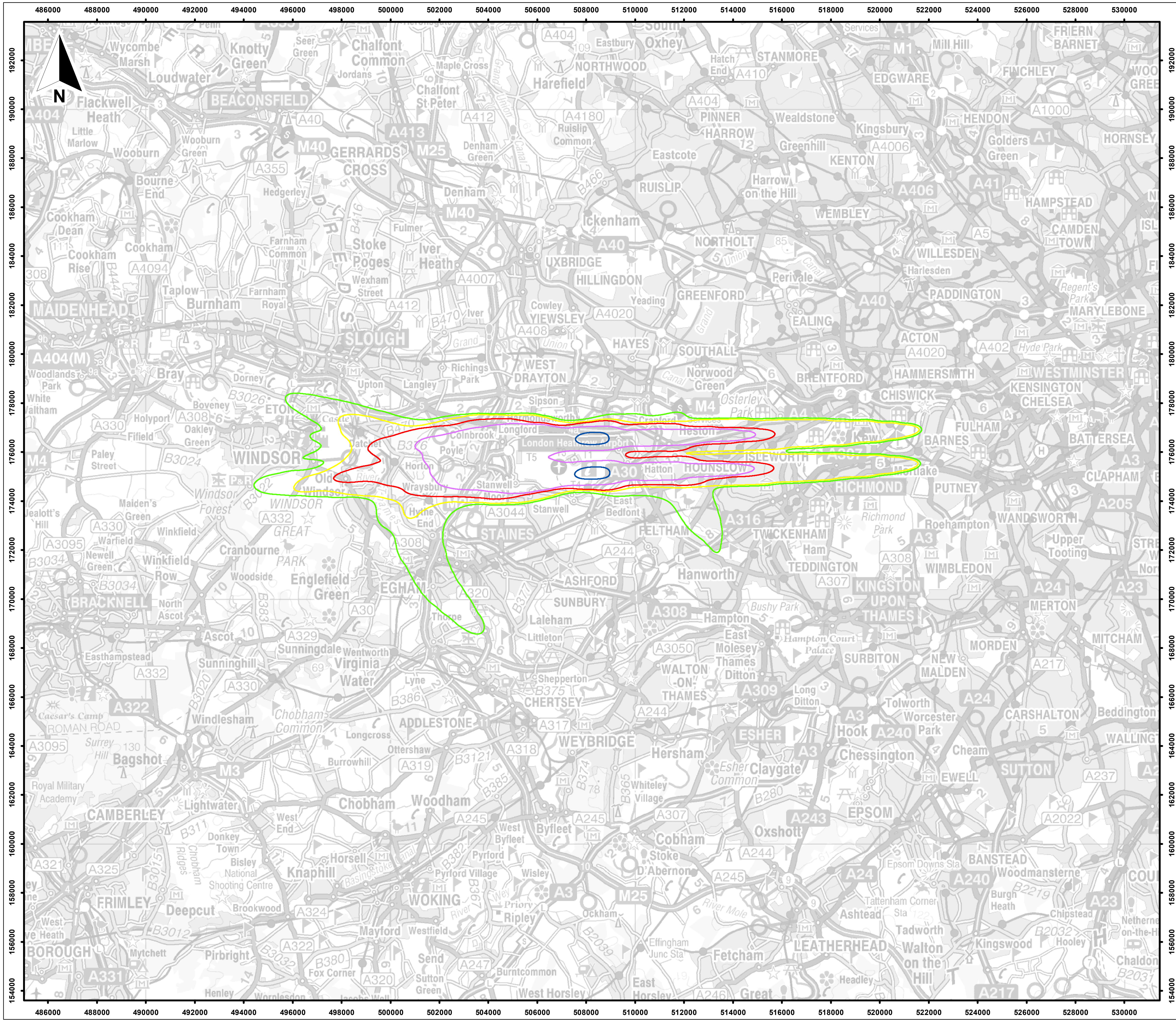
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E28
3R 2040 Option R $L_{Aeq,8hr}$(night)

June 2014
35310-Lon165 montg

amec



Key:

Noise Level (dB)

- > 20 (green)
- > 50 (yellow)
- > 100 (red)
- > 200 (violet)
- > 500 (blue)

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon176.mxd

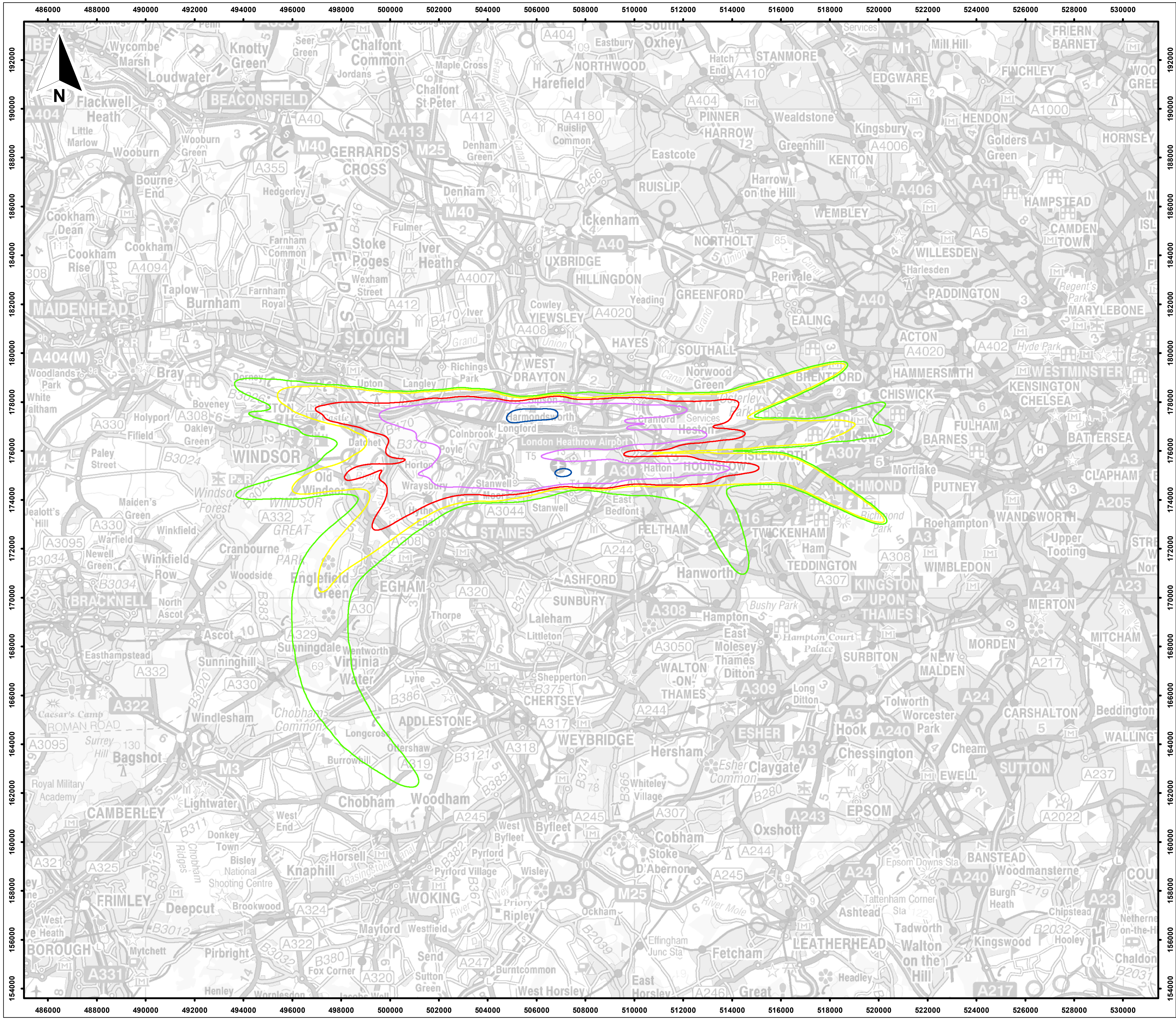
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E29
2R 2030 'do-minimum'
N70 (16-hour day)

June 2014
35310-Lon176 montg

amec



Key:

Noise Level (dB)

- > 20
- > 50
- > 100
- > 200
- > 500

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon182.mxd

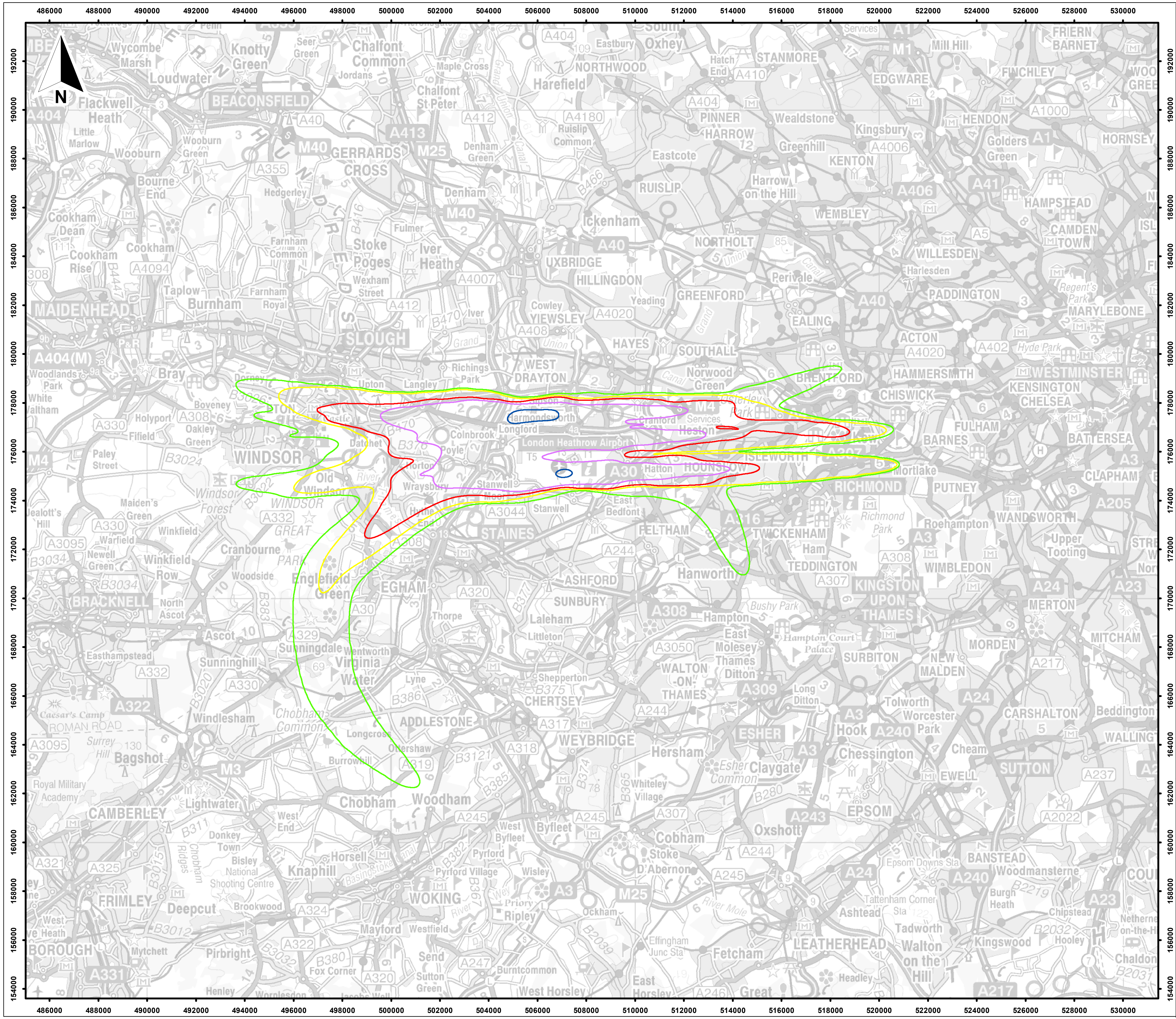
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E30
3R 2030 Option T
N70 (16-hour day)

June 2014
35310-Lon182 montg

amec



Key:

Noise Level (dB)

- > 20 (green)
- > 50 (yellow)
- > 100 (red)
- > 200 (violet)
- > 500 (blue)

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon178.mxd

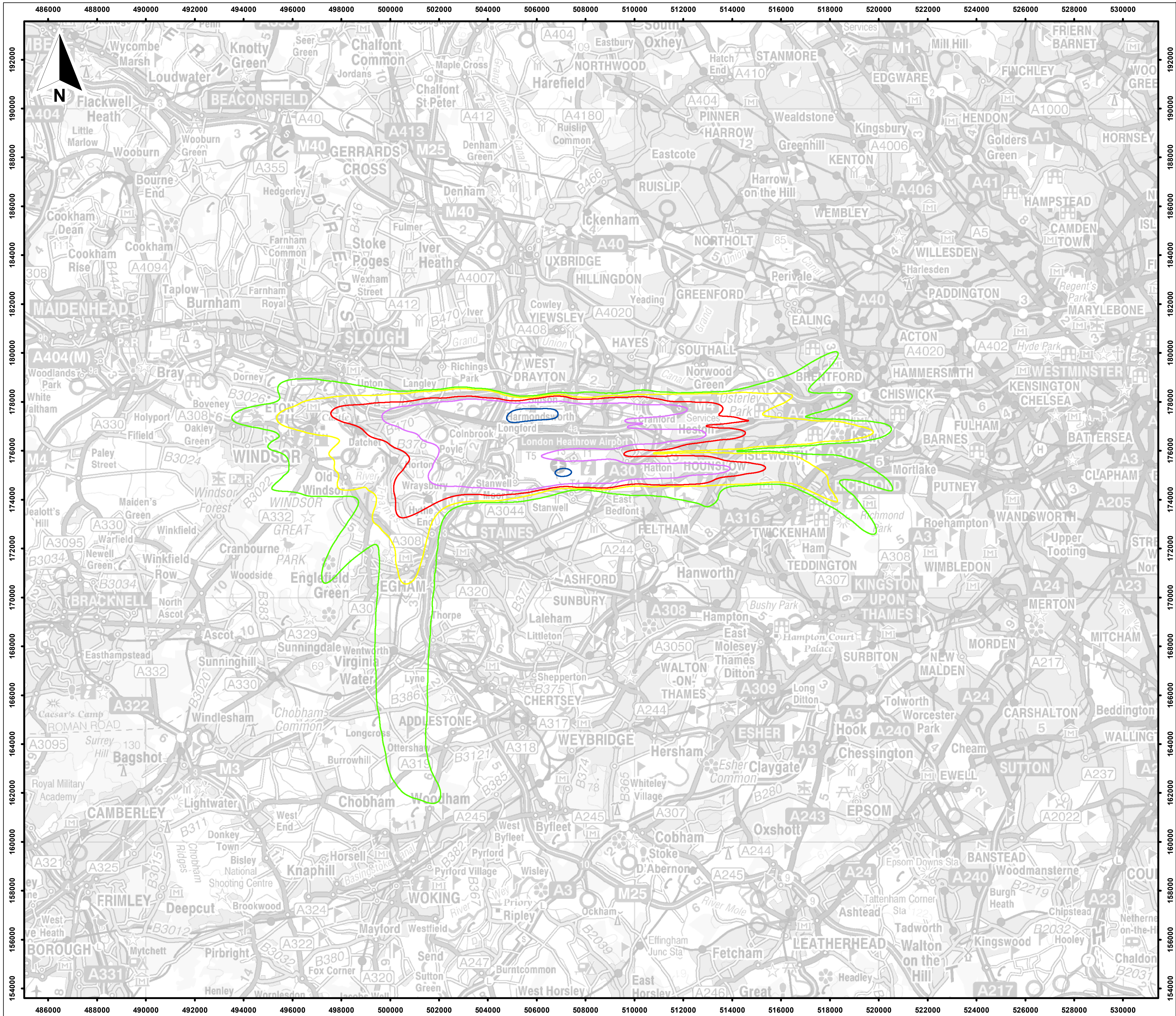
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E31
3R 2030 Option N
N70 (16-hour day)

June 2014
35310-Lon178 montg

amec



Key:

Noise Level (dB)

- \> 20
- \> 50
- \> 100
- \> 200
- \> 500

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon180.mxd

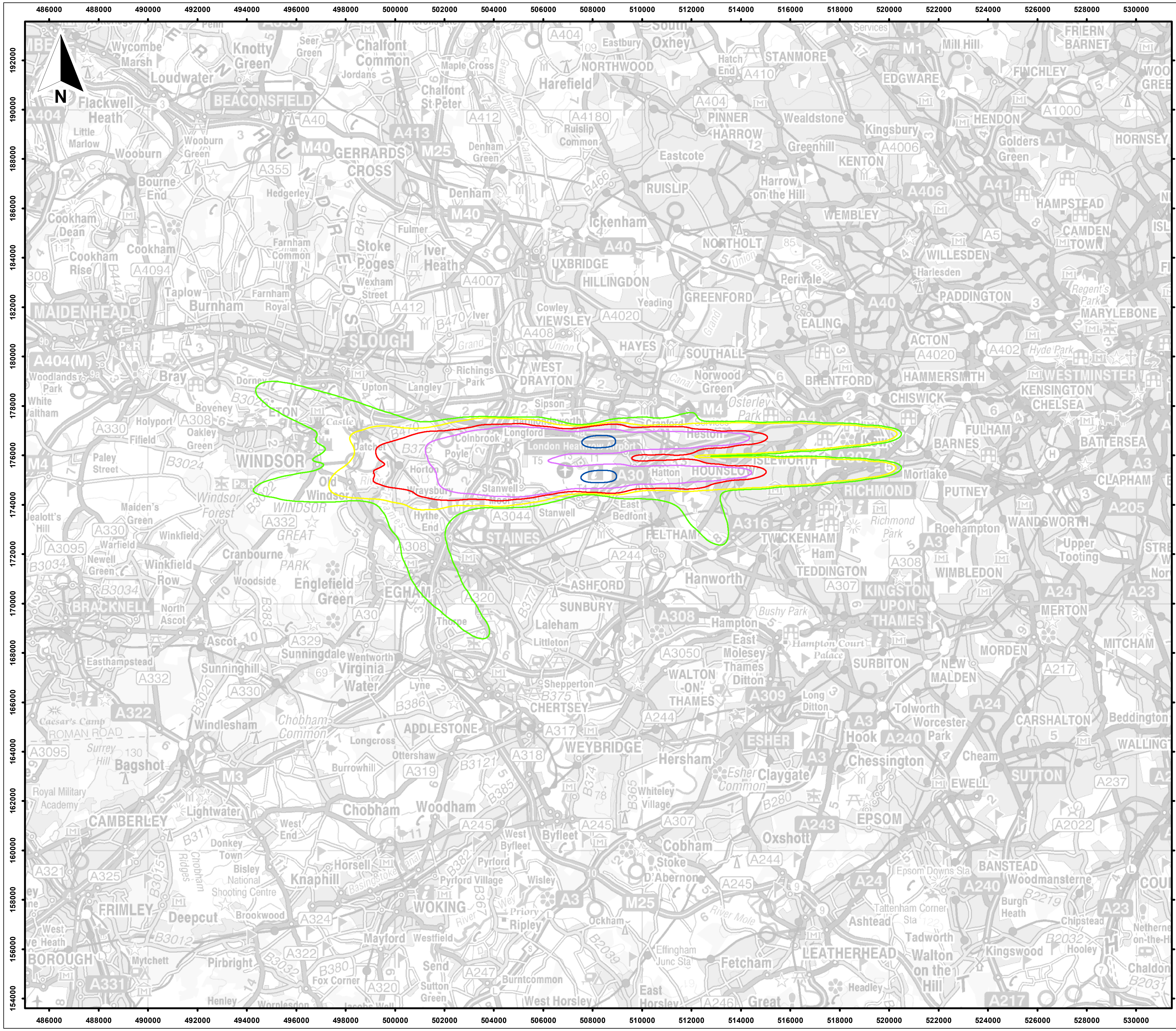
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E32
3R 2030 Option R
N70 (16-hour day)

June 2014
35310-Lon180 montg

amec



Key:

Noise Level (dB)

- > 20 (green)
- > 50 (yellow)
- > 100 (red)
- > 200 (pink)
- > 500 (blue)

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal \Drawings\GIS\Figures\35310-Lon177.mxd

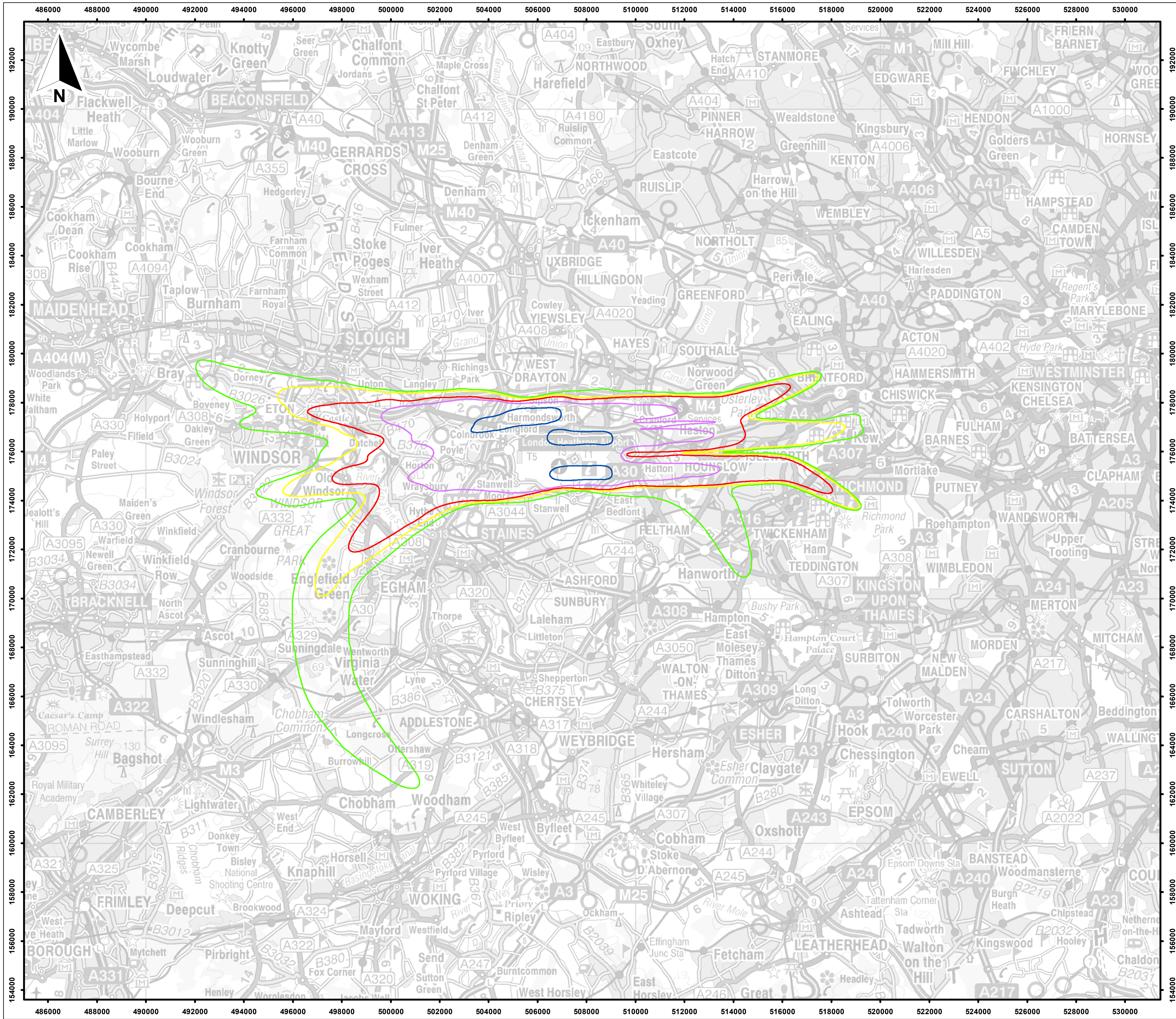
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E33
2R 2040 'do-minimum'
N70 (16-hour day)

June 2014
35310-Lon177 montg

amec



Key:

Noise Level (dB)

- > 20
- > 50
- > 100
- > 200
- > 500

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon183.mxd

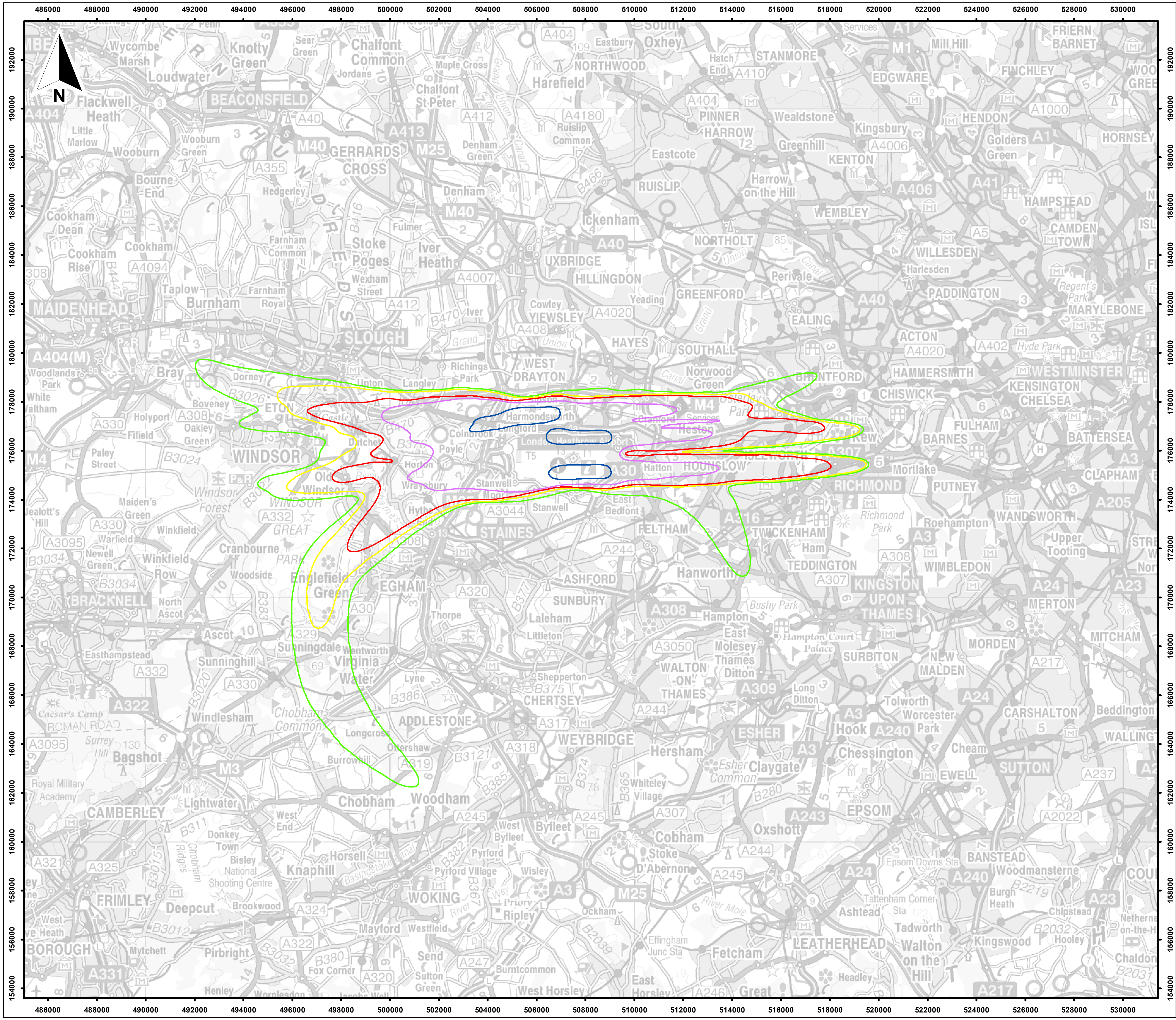
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E34
3R 2040 Option T
N70 (16-hour day)

June 2014
35310-Lon183 montg

amec



Key:

Noise Level (dB)

- > 20
- > 50
- > 100
- > 200
- > 500

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon179.mxd

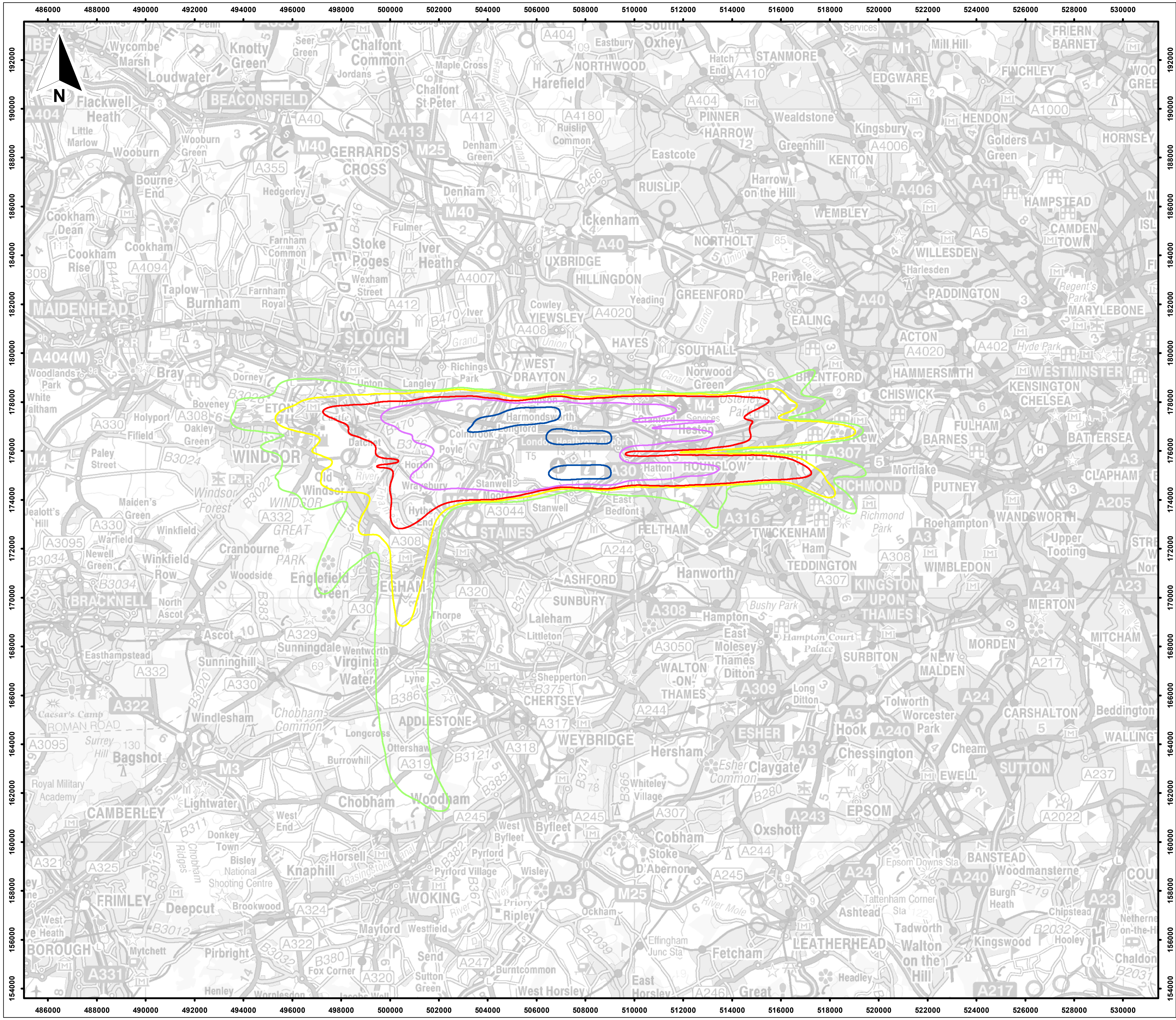
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E35
3R 2040 Option N
N70 (16-hour day)

June 2014
35310-Lon179 montg

amec



Key:

Noise Level (dB)

- > 20
- > 50
- > 100
- > 200
- > 500

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon181.mxd

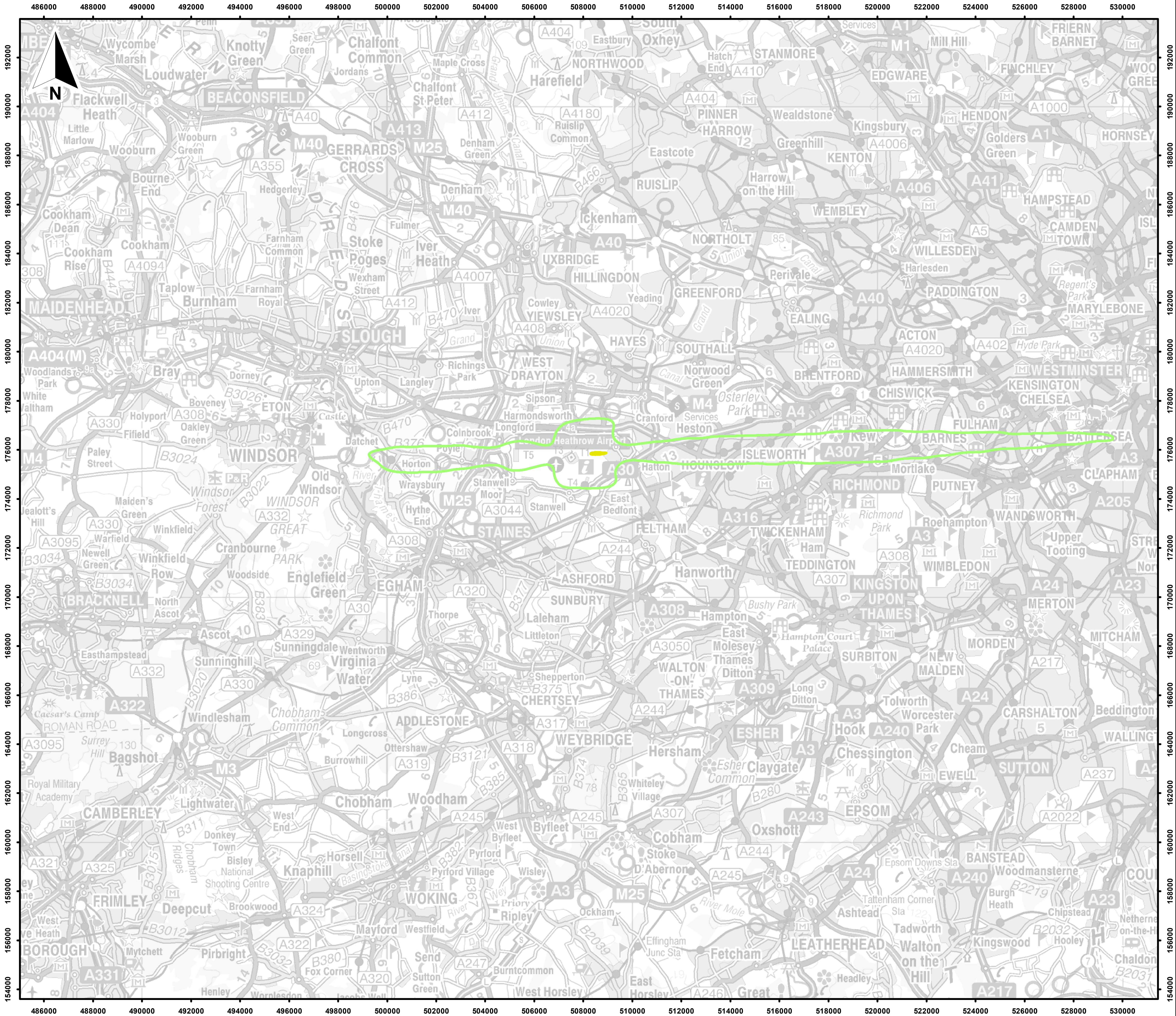
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E36
3R 2040 Option R
N70 (16-hour day)

June 2014
35310-Lon181 montg

amec



Key:

Noise Level (dB)

25

50

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\2R_2030_N60_8h.mxd

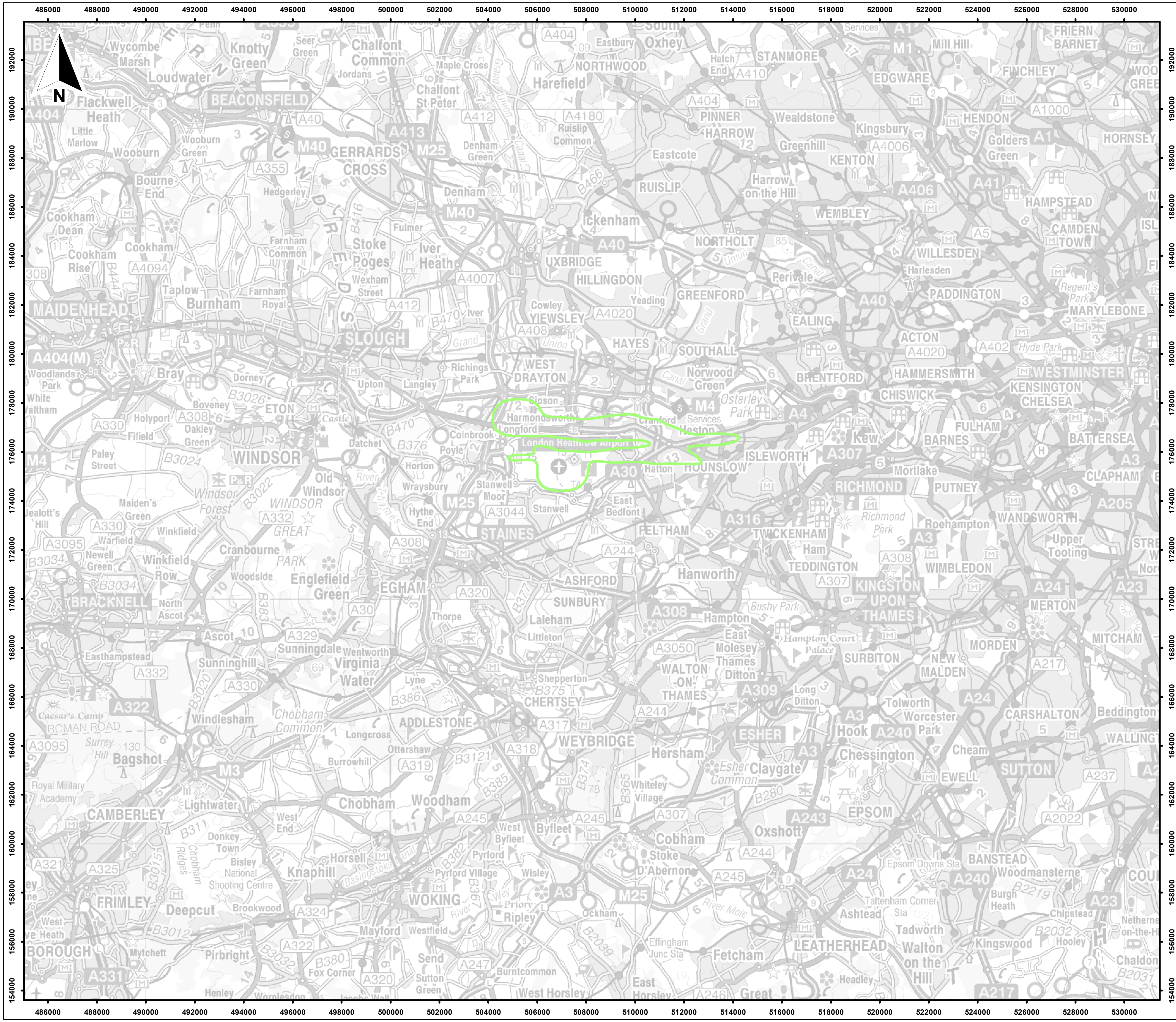
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure E37
2R 2030 'do-minimum'
N60 (8-hour night)

June 2014
35310-Lon168 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon174.mxd

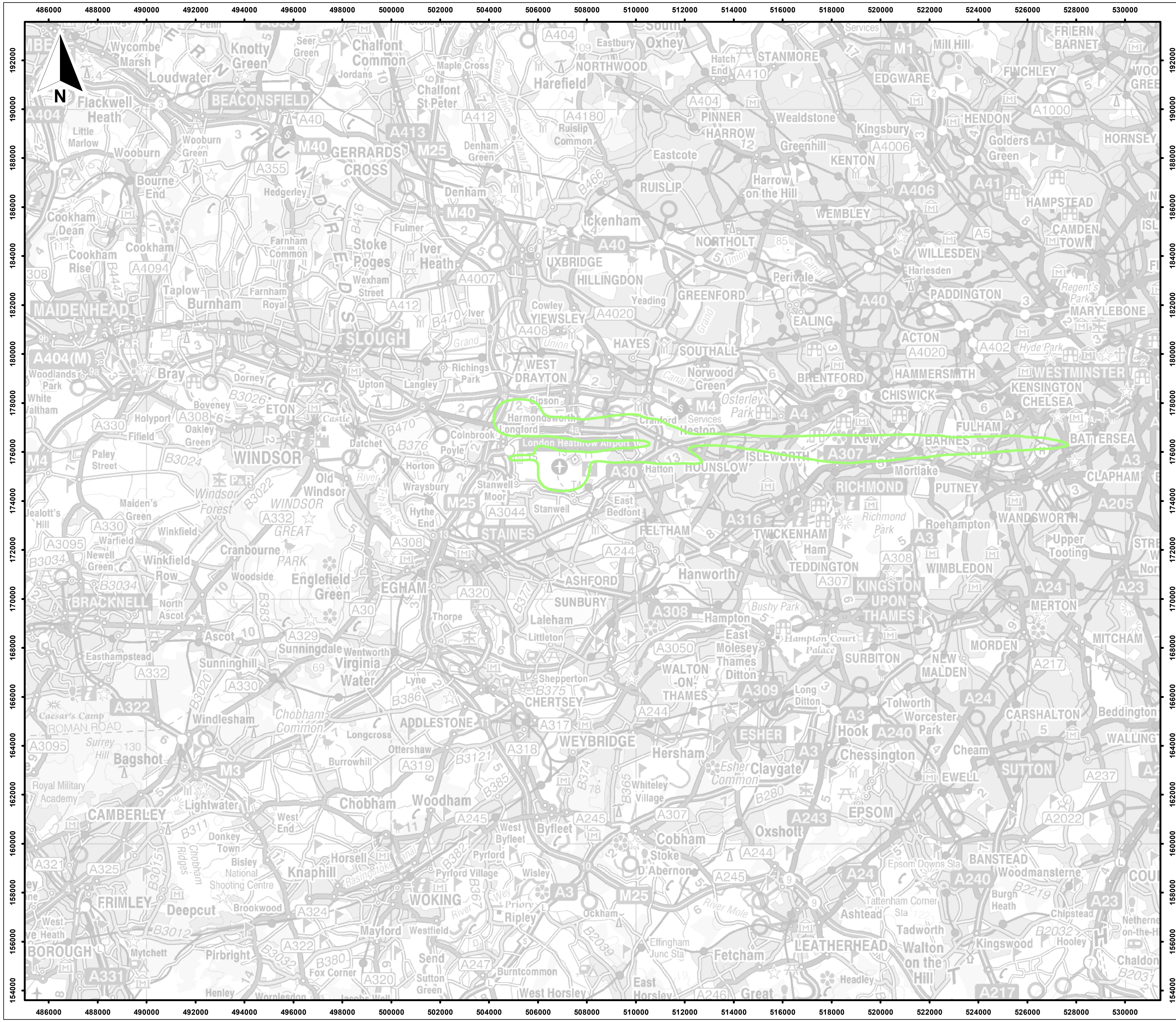
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E38
3R 2030 Option T
N60 (8-hour night)

June 2014
35310-Lon174 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon170.mxd

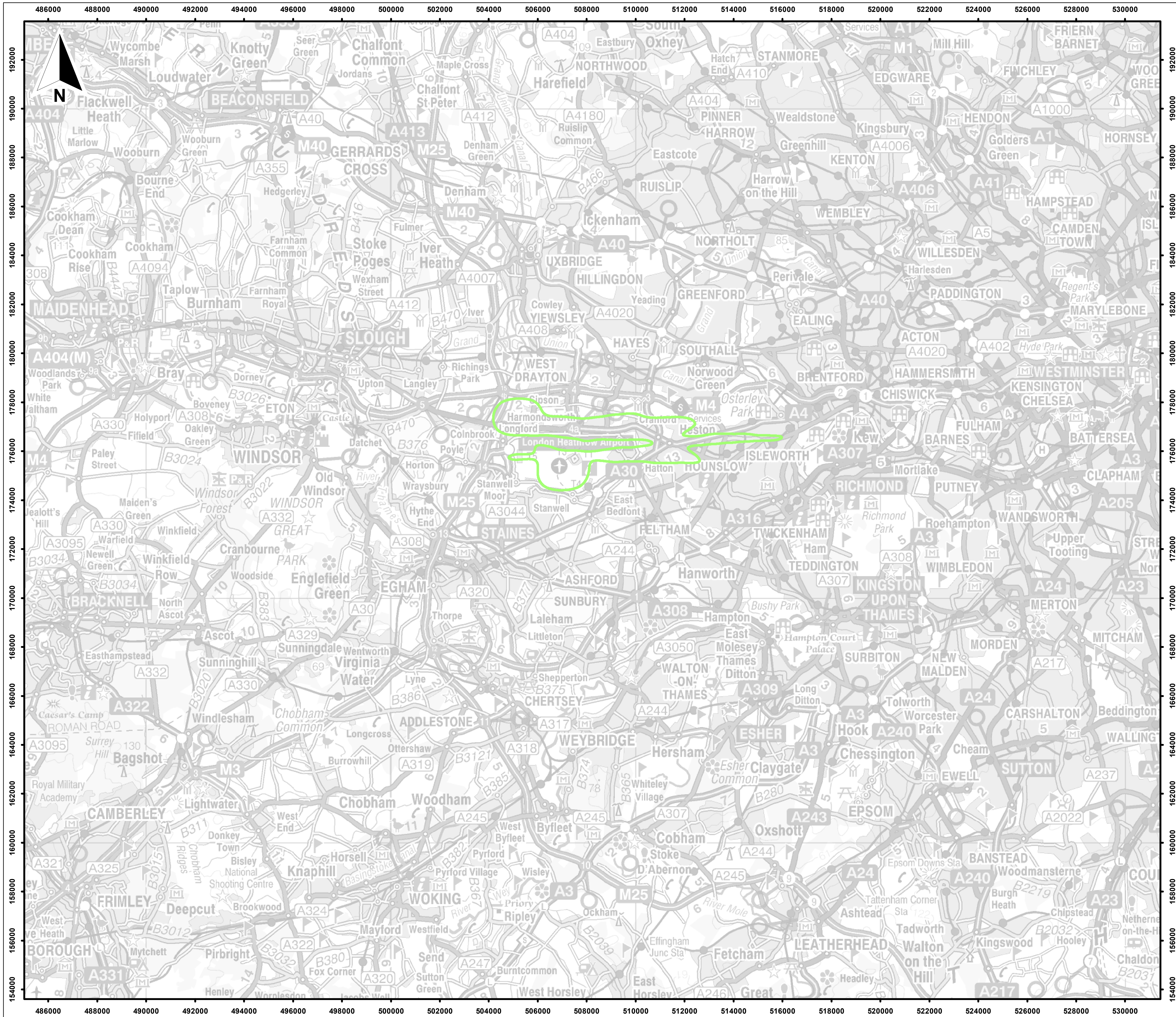
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E39
3R 2030 Option N
N60 (8-hour night)

June 2014
35310-Lon170 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon172.mxd

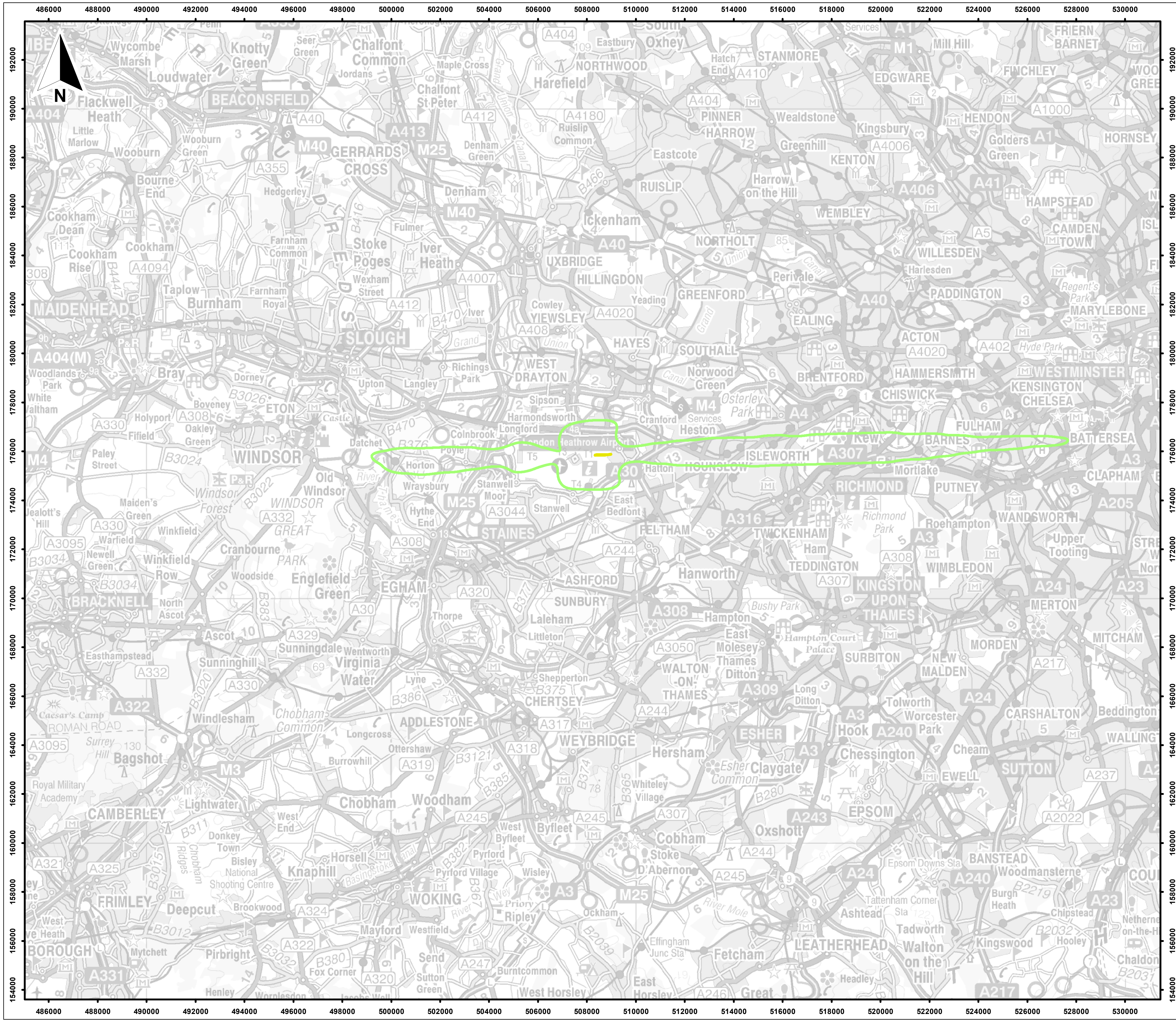
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E40
3R 2030 Option R
N60 (8-hour night)

June 2014
35310-Lon172 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon169.mxd

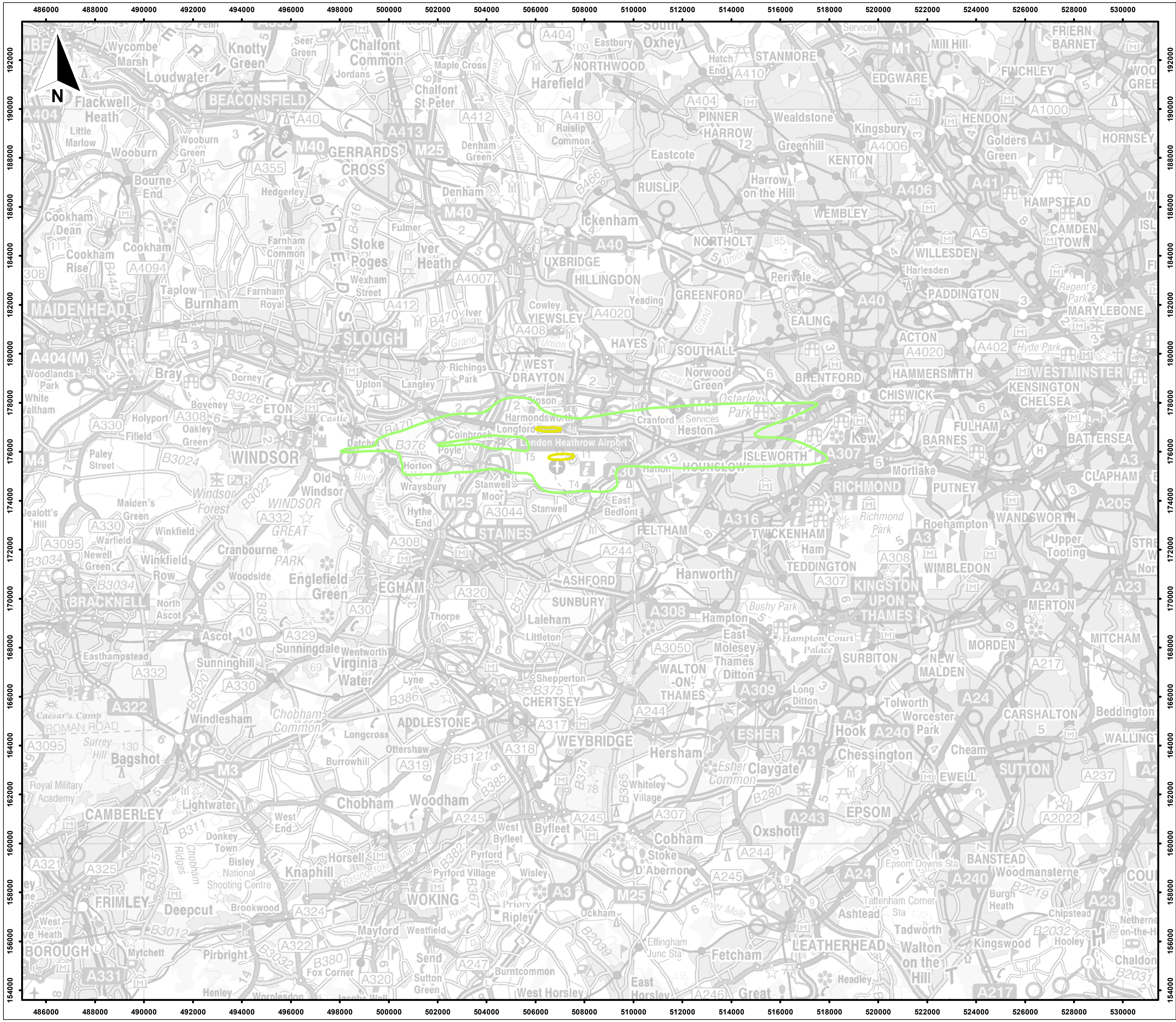
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E41
2R 2040 'do-minimum'
N60 (8-hour night)

June 2014
35310-Lon169 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:125,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon175.mxd

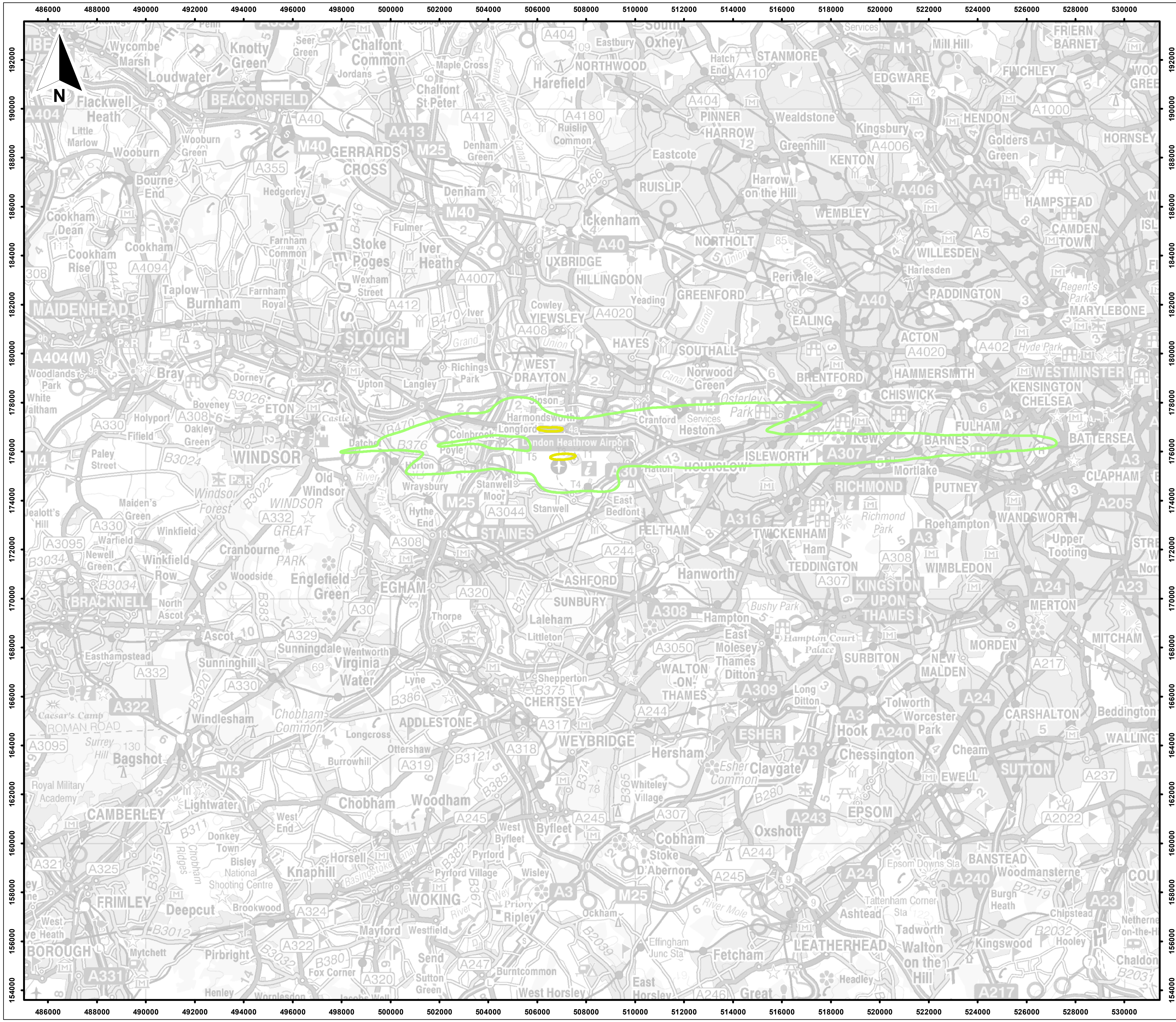
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E42
3R 2040 Option T
N60 (8-hour night)

June 2014
35310-Lon175 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon171.mxd

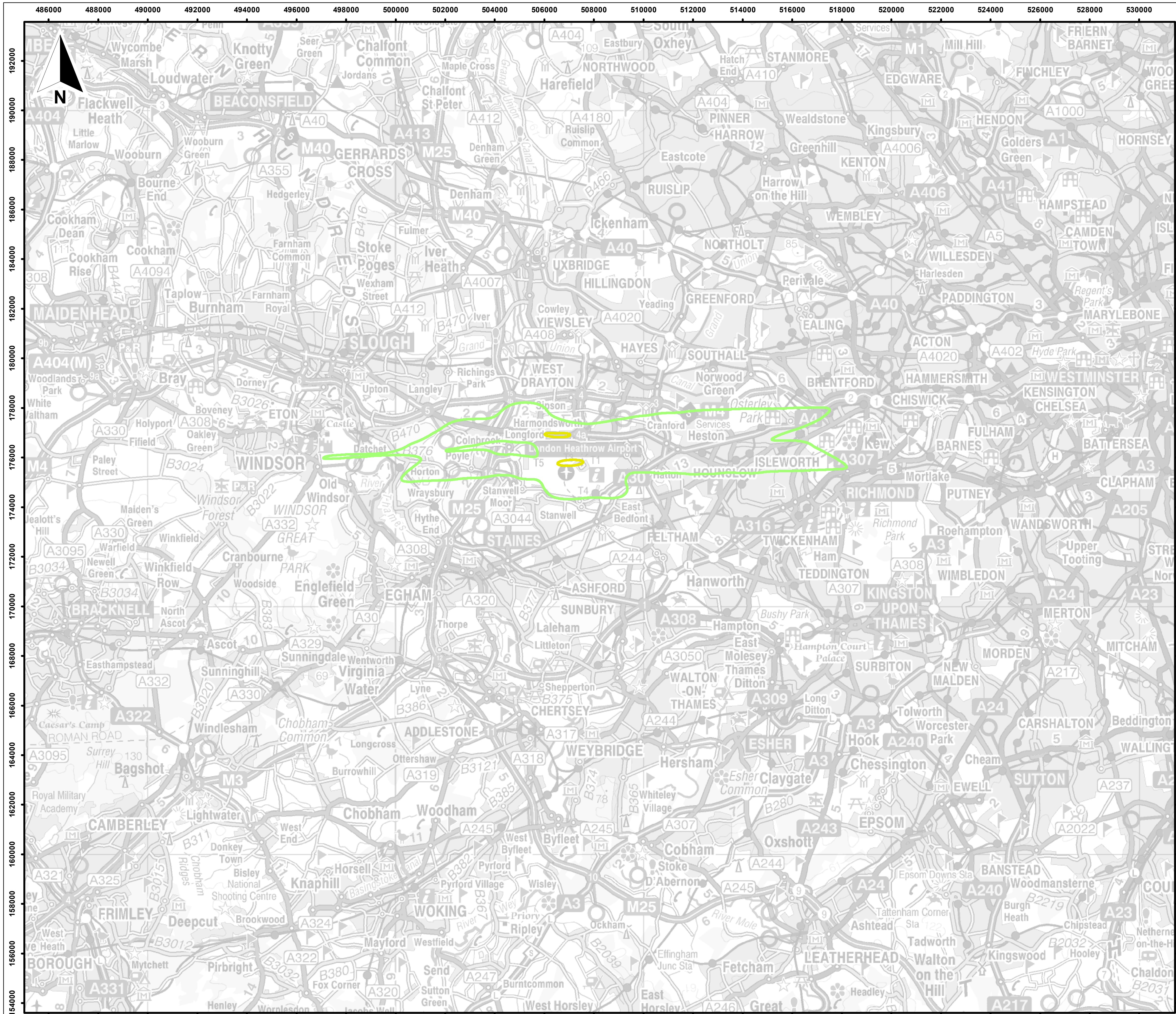
Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E43
3R 2040 Option N
N60 (8-hour night)

June 2014
35310-Lon171 montg

amec



Key:

Noise Level (dB)

- 25
- 50

0 2,500 5,000 Metres

Scale: 1:150,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon173.mxd

Heathrow
Making every journey better

Heathrow's North-West Runway Air and Ground Noise Assessment

Figure E44
3R 2040 Option R
N60 (8-hour night)

June 2014
35310-Lon173 montg

amec

Appendix F
Ground Noise Assessments

F.1 Aircraft Ground Noise

F.1.1 Noise event levels before mitigation

Locations with the largest potential for change in airside ground noise exposure due to 3R are to the north of the existing airport boundary in Harmondsworth and Sipson, to the north-west in Poyle and to the south-west in Stanwell and Stanwell Moor.

These changes will be apparent due to the extension of the airport boundary and the insertion of airside activities into new areas of the airfield. In the case of Sipson, Harmondsworth and Poyle, the taxiway infrastructure and aprons associated with Terminal 6 and the third runway will result in noise from aircraft on the taxiway and from aircraft and activities on the aprons become more apparent. In the case of Stanwell Moor and Stanwell, increases in airside ground noise will be mainly due to extensions to taxiway to the west of Terminal 5.

At all other locations, there is unlikely to be a material change in airside ground noise since all other infrastructure and the level of activity remains relatively consistent in comparison to 2R.

Noise from Taxiing Aircraft

Table F.1 presents noise levels in terms of L_{Aeq} event noise levels over the duration of single aircraft taxiing event at community locations in the vicinity of the extended airport boundary. Table F.1 shows that at locations such as Harmondsworth, noise levels during aircraft taxiing can exceed 65 dB in the absence of mitigation. At Sipson and Poyle, noise event levels also have the potential to exceed 65 dB. At Stanwell and Stanwell Moor, noise from aircraft taxiing events can be as high as 65-70 dB L_{Aeq}.

Table F.1 shows that with the construction of perimeter bunding and fencing at boundary with Sipson and Harmondsworth has the potential to reduce noise during aircraft taxiing by 5-7 dB(A). These measures are likely to reduce single noise event levels to less than 60 dB(A). At Poyle, a 3-5 dB reduction in noise event levels taxiing events can also be provided by means of perimeter barriers. At Stanwell and Stanwell Moor, perimeter boundaries will help reduce noise event levels from aircraft taxiing to around 60 – 65 dB, a 2 dB reduction.

Table F.1 Aircraft Taxiing– Noise Mitigation Reductions

Community / Locality	Representative Receptor Point	Modelled Event Noise Level, dB		
		Without Mitigation, dB	With Mitigation, dB	Approximate Noise Reductions, dB
Poyle	The Hawthorns	64 - 68	63 - 65	3
Poyle	Fawsley Close	61 - 66	60 - 61	5
Harmondsworth	Harmondsworth Lane	60 - 66	60 - 62	4
Sipson	Vincent Close	60 - 65	56 - 60	5
Sipson	Bomer Close	62 - 68	56 - 61	7
Stanwell	Gibson Place	59 - 65	58 - 61	4
Stanwell	Russell Drive	64 - 69	62 - 64	5
Stanwell Moor	Horton Road	61 - 65	61 - 63	2
Stanwell Moor	Flintlock Close	63 - 66	63 - 64	2

Noise from Aircraft during Holding

Table F.2 shows that hourly noise levels from aircraft holding and taxiing within runway-end holdzones can exceed 70 dB in Sipson without mitigation. Similar levels could also occur to the north of Poyle. At Stanwell Moor and Stanwell, noise from aircraft holding at the southern runway end would be around 60 dB however this is consistent with current levels of exposure.

Table F.2 demonstrates that at Sipson, the construction of perimeter fencing can help reduce noise from aircraft holding by 5-7 dB at the selected receptors resulting noise levels of less than 65 dB $L_{Aeq,\ 1hr}$ during 09R departures. In Poyle, perimeter fencing results in a 5 dB reduction in noise levels. At the selected locations in Stanwell and Stanwell Moor, the introduction of perimeter fencing will have little impact on noise exposure.

The results also demonstrate that for the locations that would be most exposed to noise from aircraft within the holdzones, the proposed physical mitigation will help reduce the level of noise during these events. For locations at distances much further from the holdzones, the performance of the physical mitigation is much reduced.

Table F.2 Aircraft Holding– Noise Mitigation Reductions

Community / Locality	Representative Receptor Point	Modelled Event Noise Level, dB		
		Without Mitigation, dB	With Mitigation, dB	Approximate Noise Reductions, dB
Poyle	The Hawthorns	63 - 68	62 – 63	4
Poyle	Fawsley Close	63 – 68	63 – 65	4
Harmondsworth	Harmondsworth Lane	54 – 62	54 – 62	0
Sipson	Vincent Close	63 – 69	59 – 64	5
Sipson	Bomer Close	66 – 72	62 – 65	7
Stanwell	Gibson Place	58 – 61	58 – 61	0
Stanwell	Russell Drive55 - 60	59 – 61	59 – 61	0
Stanwell Moor	Horton Road	56 – 60	56 – 58	2
Stanwell Moor	Flintlock Close	55 – 60	55 – 58	2

Noise from APUs and Aircraft at Stand

A calculation of instantaneous L_{Aeq} noise levels at community locations in the vicinity of the extended airport boundary from aircraft on stand at the proposed Terminal 6 has shown that noise from a single APU is expected to be less than 55 dB L_{Aeq} in the absence of any mitigation.

APUs are elevated sources which means that the performance of mitigation measures such as barriers and perimeter bunding is somewhat diminished unless they are of a significant height and width. The calculations have shown that for Harmondsworth and Poyle, the insertion of perimeter mounds are unlikely to have any effect on noise levels during APU running. For Sipson, it reduction of up to 3 dB may be expected from the worst stand locations at Terminal 6.

A mitigation measure that has been considered involves strategic stand use, as described in Section 4.5. This involves the deliberate and planned use of stands that are screened from sensitive receptors by the Terminal building. This measure will be most effective for receptors at Harmondsworth and Sipson that are immediate to the northern Terminal 6 aprons. The measure involves, where possible, using the southern Terminal 6 apron during noise sensitive periods such as the night.

Table F.3 presents noise levels at the selected receptors from APU running at various sections of the proposed Terminal 6 apron as illustrated in Figure F.1.

Figure F.1 Segmented Terminal 6 Apron

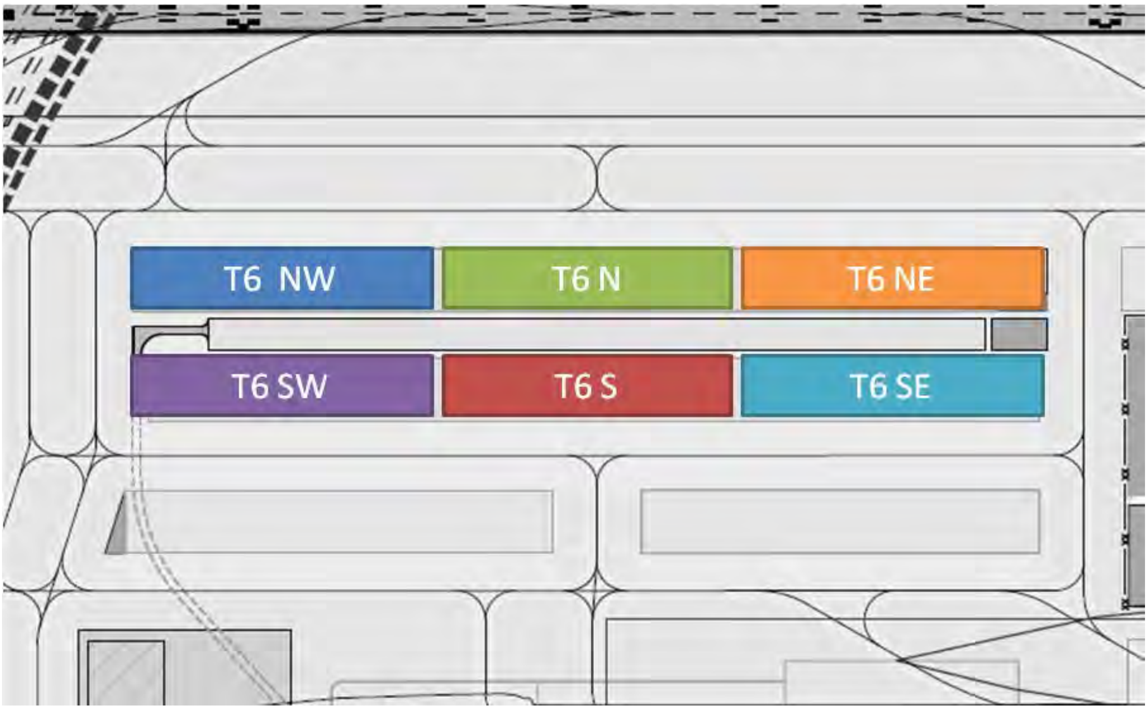


Table F.3 shows that should stands be used strategically this can reduce noise from airside activity and APUs by as much as 15 dB at receptors. The results are most apparent for Harmondsworth which would be most sensitive to noise from APU running from Terminal 6

Table F.3 Noise Levels from APU Use and Stand Selection

Community / Locality	Representative Receptor Point	Maximum APU Event Level (L_{Aeq}) for Apron Location						
		NW	N	NE	SW	S	SE	Max Benefit
Poyle	The Hawthorns	34	30	29	35	34	32	**6**
Poyle	Fawsley Close	37	35	34	38	35	33	**5**
Harmondsworth	Harmondsworth Lane	41	45	51	36	46	43	**15**
Sipson	Vincent Close	38	41	44	37	40	42	**7**
Sipson	Bomer Close	39	42	45	36	42	43	**9**

Audibility

With reference to the baseline noise measurements presented in **Appendix B**, some conclusions can be made with regard to the potential audibility of aircraft ground noise from the various sources of aircraft noise outlined above.

- For Sipson, Harmondsworth and Poyle, aircraft ground noise will be audible during both daytime and night-time periods;
- At Stanwell Moor and Stanwell, there is unlikely to be a marked change in the audibility of aircraft ground noise due to the development. The noise would be most audible at night but unlikely to be above current levels of exposure.

F.1.2 Assessment of Noise Exposure

Figure F2, Figure F3 and Figure F4 present noise exposure maps for 3R 2040 for the $L_{Aeq, 16hr}$, L_{den} and L_{night} metrics.

An analysis of calculated noise exposure results shows that for locations outside of the 3R boundary, the difference in noise exposure levels between 3R 2030 and 3R 2040 are less than 1 dB, and in majority of cases, less than 0.5 dB. It is therefore considered that the contribution of airside ground noise to the overall ambient noise climate will be similar between 2030 and 2040 despite the increase in airport movements over this period.

Figures F5-F7 present noise exposure difference maps comparing 2R in 2040 with 3R in 2040 for these metrics. The figures show that the greatest change in noise exposure will occur to the north and north-west of the current 2R boundary and at locations around the extended proposed 3R boundary. The largest increases in airside ground noise exposure will occur in Harmondsworth where increases in excess 9 dB in noise exposure are predicted with overall levels of exposure of 54-60 dB $L_{Aeq, 16hr}$ and 40-50 dB L_{night}.

Similar increases are calculated in Poyle however as demonstrated by the contours, around half of the community is exposed above the 54 dB $L_{Aeq, 16hr}$, 55 dB L_{den} and 45 dB L_{night} exposure thresholds.

At Stanwell Moor and Stanwell, changes in airside ground noise at residential dwellings will be no more than 3 dB. In the majority of cases, changes will be limited to 1 dB with most residential dwellings exposed to noise levels of less than 40 dB L_{night} and 54 dB $L_{Aeq, 16hr}$.

In Sipson, properties will experience on average a 10 dB increase in airside ground noise exposure. Some properties at the boundary will see increases of at least 10 dB. Despite this, and through the inclusion of the perimeter mitigation, $L_{Aeq, 16hr}$ noise exposure will be 63 dB or less for the majority of retained residential dwellings.

The figure shows a number of changes in aircraft noise exposure across the airfield. These are due to changes in the use of taxiways, and the demolition and construction of new buildings. It should be noted that in modelling noise, no consideration has been given to structures that may be built within the 3R masterplan ancillary areas. Any buildings or structures placed in these areas will also help reduce noise from airside operations.

Table F.4 presents a comparison of airside ground noise population exposure between 2R 2030/40 and 3R 2040 for the $L_{Aeq, 16hr}$, L_{den} and L_{night} measures.

Table F.4 Airside Ground Noise Population Exposure Statistics (2R 2030/40 vs 3R 2040 with mitigation)

$L_{Aeq, 16hr}$	2R	3R		L_{den}	2R	3R		L_{night}	2R	3R	
≥ 54	1000	4000	+3000	≥ 55	1800	5100	+3300	≥ 45	2600	4450	+1850
≥ 57	400	1600	+1200	≥ 60	300	1100	+800	≥ 50	400	900	+500
≥ 60	150	700	+550	≥ 65	20	140	+120	≥ 55	50	70	+20
≥ 63	20	200	+180	≥ 70	0	0	0	≥ 60	0	0	0
≥ 66	5	5	0	≥ 75	0	0	0	≥ 65	0	0	0
≥ 69	0	0	0					≥ 70	0	0	0

Table F.4 shows that with the introduction of a third runway, population noise exposure to the key metrics will increase in all bands. The increases in exposure are principally due to the increased boundary of the airport. This has the effect of introducing airside ground noise exposure to populations within Sipson and Poyle to the above noise exposure threshold values.

At the higher noise level bands, there remains nobody exposed to airside ground noise levels above 69 dB $L_{Aeq, 16hr}$. A 180 people are introduced to levels of exposure above 63 dB $L_{Aeq, 16hr}$.

Effect of Mitigation on Noise Exposure

Table F.5 provides a comparison of 3R 2040 ground noise exposure levels with and without physical mitigation measures. The table shows the physical mitigation alone has the effect of removing around 300 people from exposure levels above 63 dB $L_{Aeq, 16hr}$ and almost completely removes everybody from being exposed to levels above 66 dB and 69 dB $L_{Aeq, 16hr}$. The population removed from these bands are on the whole located within Sipson.

Table F.5 Airside Ground Noise Population Exposure Statistics (2040 with and without mitigation)

$L_{Aeq, 16hr}$	No Mit	Mit		L_{den}	No Mit	Mit		L_{night}	No Mit	Mit	
≥ 54	4300	4000	-300	≥ 55	5500	5100	-400	≥ 45	4800	4450	-350
≥ 57	2000	1600	-400	≥ 60	1500	1100	-400	≥ 50	1300	900	-400
≥ 60	1100	700	-400	≥ 65	400	140	-260	≥ 55	300	70	-230
≥ 63	500	200	-300	≥ 70	100	0	-100	≥ 60	0	0	0
≥ 66	200	<5	-200	≥ 75	0	0	0	≥ 65	0	0	0
≥ 69	100	0	-100					≥ 70	0	0	0

F.1.3 Conclusions

The results of the aircraft ground noise assessment demonstrate that:

- There will be an increase in noise exposure to aircraft ground noise as a result of a third runway at Heathrow. This is due to the increase in the airport's boundary and the location of the airfields taxiways with respect to Sipson and Poyle;
- The main increase in exposure will be at locations around the extended boundary. For all other locations around Heathrow's current 2R boundary, aircraft ground noise will be comparable to current day;
- The physical mitigation provided within the masterplan will help reduce noise exposure, particularly for those exposed to the highest levels of noise; and
- Stand use strategies will help reduce noise from airside activity and these measures should be encouraged during the particularly sensitive periods such as the night where noise from aircraft ground activities would be most prevalent.

F.2 Road Traffic Noise

F.2.1 Road traffic noise changes before mitigation

The difference contours presented in Figure F8 show that noise exposure levels to road traffic noise will change as a result of 3R in the absence of mitigation. There are decreases within 3R boundary where the existing A4 will be removed and increases where the A4 becomes realigned to the north of Harmondsworth and runs to the east of Sipson.

At Harmondsworth, the realignment of the A4 could result in road traffic noise increasing by up to 10 dB. At Sipson, without mitigation increases in road traffic noise are likely to be around 3-5 dB to the north of the village. However there are decreases in road traffic noise through the village as a result of the re-diversion of traffic.

Increases in road traffic noise of around 3-10 dB would also be apparent at some dwellings to the west of Harlington. Along the A4 from the Henlys Roundabout to the airport's northern tunnel would increase by around 1-3 dB due to increased road traffic along this route.

Increases in road traffic noise would be apparent between Colnbrook and Poyle due to the new link road between the A4 and Bath Road. At these locations, increases could be more than 10 dB due to this new link.

To the south of the airport, increases in road traffic are likely to occur to the north of Stanwell Moor as a result of the re-diversion of airport traffic to Terminal 5 and realignment of the Southern Perimeter Road. Without mitigation, increases of 3-5 dB are possible as a result.

The majority of all other road traffic noise changes are a result of changes to the airfield itself and the construction and demolition of buildings.

F.2.2 Road Traffic Noise Changes after Mitigation

Figure F9 presents a noise difference map comparing road traffic noise for3R 2030 with mitigation against 3R 2030 without mitigation. This figure demonstrates the effectiveness of the road traffic noise mitigation. It can be seen that:

- Between Colnbrook and Poyle, roadside barriers mitigate traffic noise by 5-10 dB;
- At Harmondsworth, Sipson and Harlington, roadside barriers provide a 3-5 dB reduction in road traffic noise;
- Between Henly's Roundabout and the airport, low noise surfacing helps reduce road traffic noise by 1-3 dB; and
- Reductions of between 1-10 dB occur in Stanwell Moor due to roadside barriers.

When taking into consideration the performance the mitigation, the impacts of road traffic noise at these locations are reduced. Figure F10 shows noise level changes comparing 2R 2030 with 3R 2030 including road traffic noise mitigation measures.

The figure shows that:

- between Colnbrook and Poyle, road traffic noise may increase by 5-10 dB for the majority of dwellings in this location.
- To the north of Harmondsworth, the roadside noise barriers result in the majority of properties being exposed to noise level increases of less than 1 dB.
- To the north of Sipson, roadside barriers result in a 1-3 dB reduction in road traffic noise on the northern facades of the properties.

- To the west of Harlington, road traffic noise increases are reduced to 1-3 dB through roadside noise barriers.
- Between Henly's Roundabout and the airport, low noise surfacing reduces road traffic noise by 1-3 dB;
- In Stanwell, residential dwellings will observe increases of up to 5 dB in road traffic noise due to traffic re-diversion and the realignment of the Southern Perimeter Road.

F.2.3 Assessment of Noise Exposure

Figure F11 presents a road traffic noise map for 2030 which incorporates mitigation. The realignment of the A4 can be clearly seen in the noise map. The map shows that where the A4 is realigned between Colnbrook and Poyle, there are a number of residential dwellings that would be exposed to road traffic noise levels of above 55 dB $L_{Aeq, 16hr}$ that previously would not have. The results indicate that there are no dwellings that would be exposed to levels above the Noise Insulation Regulations (NIR) threshold of 68 dB $L_{Aeq, 18hr}$. This would however require further, more detailed consideration at a later date.

To the north of Harmondsworth, the realignment of the A4 results in properties to the north of Harmondsworth becoming exposed to levels of road traffic noise above 60 dB $L_{A10, 18hr}$. The realignment between Sipson and Harlington has a limited effect due to the existing dominance of the M4 spur and the M4. For both of these locations, there are no dwellings that would become exposed to noise levels of more than 68 dB $L_{A10, 18hr}$.

At Stanwell Moor, in the vicinity of the realigned Southern Perimeter Road, noise would remain relatively consistent with future levels under 2R. This is due to the dominance of the M25.

Noise exposure has been assessed across the study area to provide a comparison of 2R 2030 against 3R 2030 with and without the physical and road surface mitigation outlined in Section 4.

Table 7.4 **Road Traffic Noise Population Exposure Statistics (2030 2R v 2030 3R)**

$L_{A10, 18hr}$	2R 2030	3R 2030 no mitigation	3R 2030 with mitigation
≥ 57 (equivalent to 55 dB $L_{Aeq, 16hr}$)	73600	67000	66500
≥ 60	57500	52400	52200
≥ 63	45900	42000	41600
≥ 68 (NIR threshold excluding change)	24100	22700	22400
≥ 70	14300	13700	13200
≥ 75	1300	1000	1000

The table shows that across the study area, road traffic noise exposure decreases as a result of 3R. These are small improvements in the overall population noise exposure comparing 3R 2030 with and without mitigation.

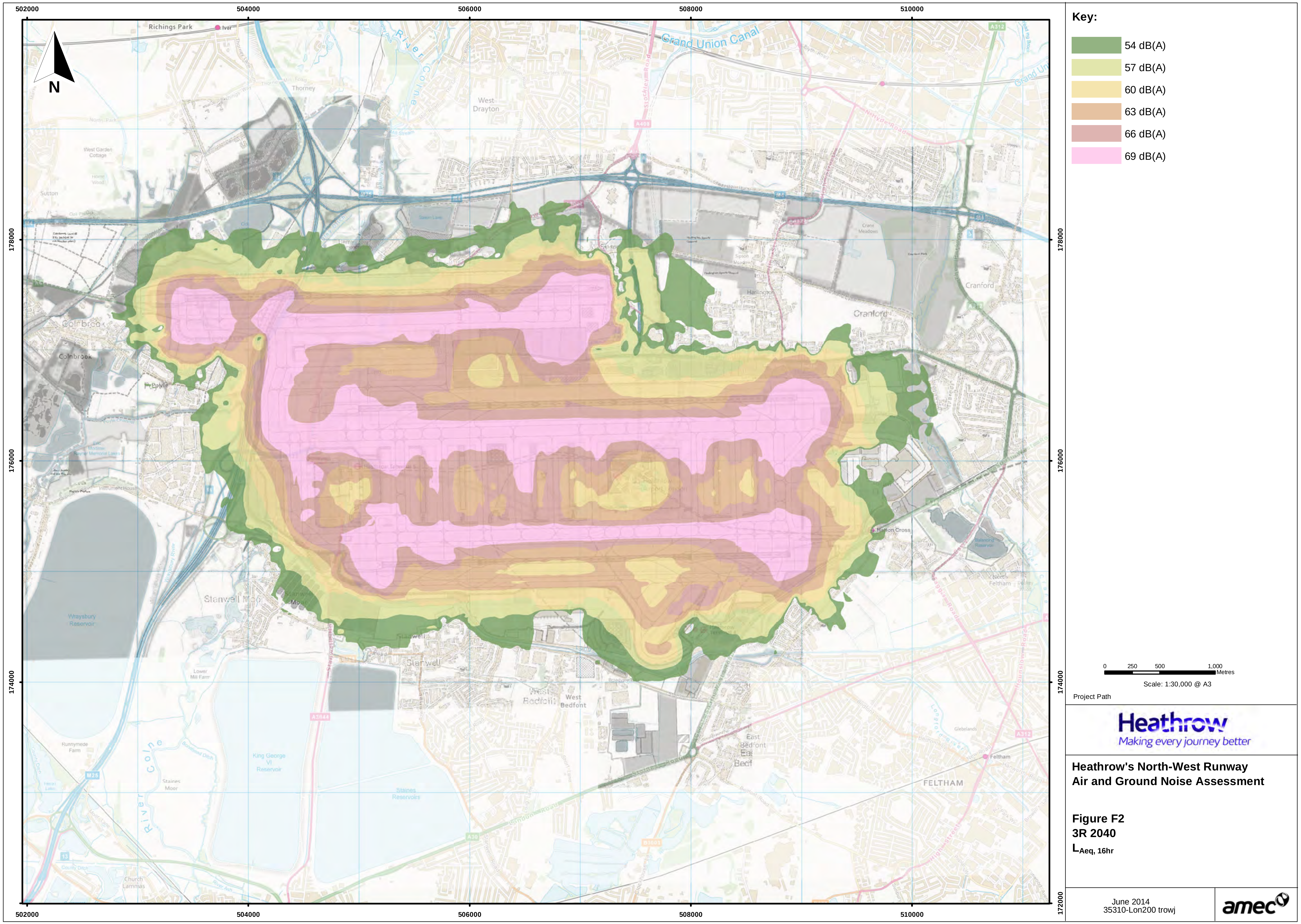
Indicative NIR Assessment

An indicative assessment has been undertaken against the eligibility criterion for noise insulation under the Noise Insulation Regulations 1975 (as outlined in **Appendix A**).The assessment has identified a number of properties that may be eligible for noise insulation under these Regulations. These are located in 2 locations:

- Between Colnbrook and Poyle at the junction of a new road linking the realigned A4 with Park Street; and
- To the very north of Sipson

It is estimated that around 100 residential dwellings will experience increases of 1 dB in road traffic noise as a result of the development and would be exposed to noise above the eligibility threshold of 68 dB $L_{A10, 18hr}$. Of these dwellings, it is estimated that around 40 would experience these increases as a direct result of new or realigned carriageway. On this basis and with reference to the eligibility criterion, around 40 would be eligible.

It is reminded that this is a high level assessment and more detailed assessment would be required in the future to full establish the number of exact location of dwellings that are eligible under the Regulations.



Key:
54 dB(A)
57 dB(A)
60 dB(A)
63 dB(A)
66 dB(A)
69 dB(A)
Scale: 1:30,000 @ A3
Project Path
Heathrow
Making every journey better
Heathrow's North-West Runway
Air and Ground Noise Assessment
Figure F2
3R 2040
$L_{Aeq,\ 16hr}$
June 2014
35310-Lon200 trowj
amec

Key:

- > 55 dB(A)
- > 60 dB(A)
- > 65 dB(A)
- > 70 dB(A)
- > 75 dB(A)

0 250 500 1,000 Metres

Scale: 1:30,000 @ A3

Project Path

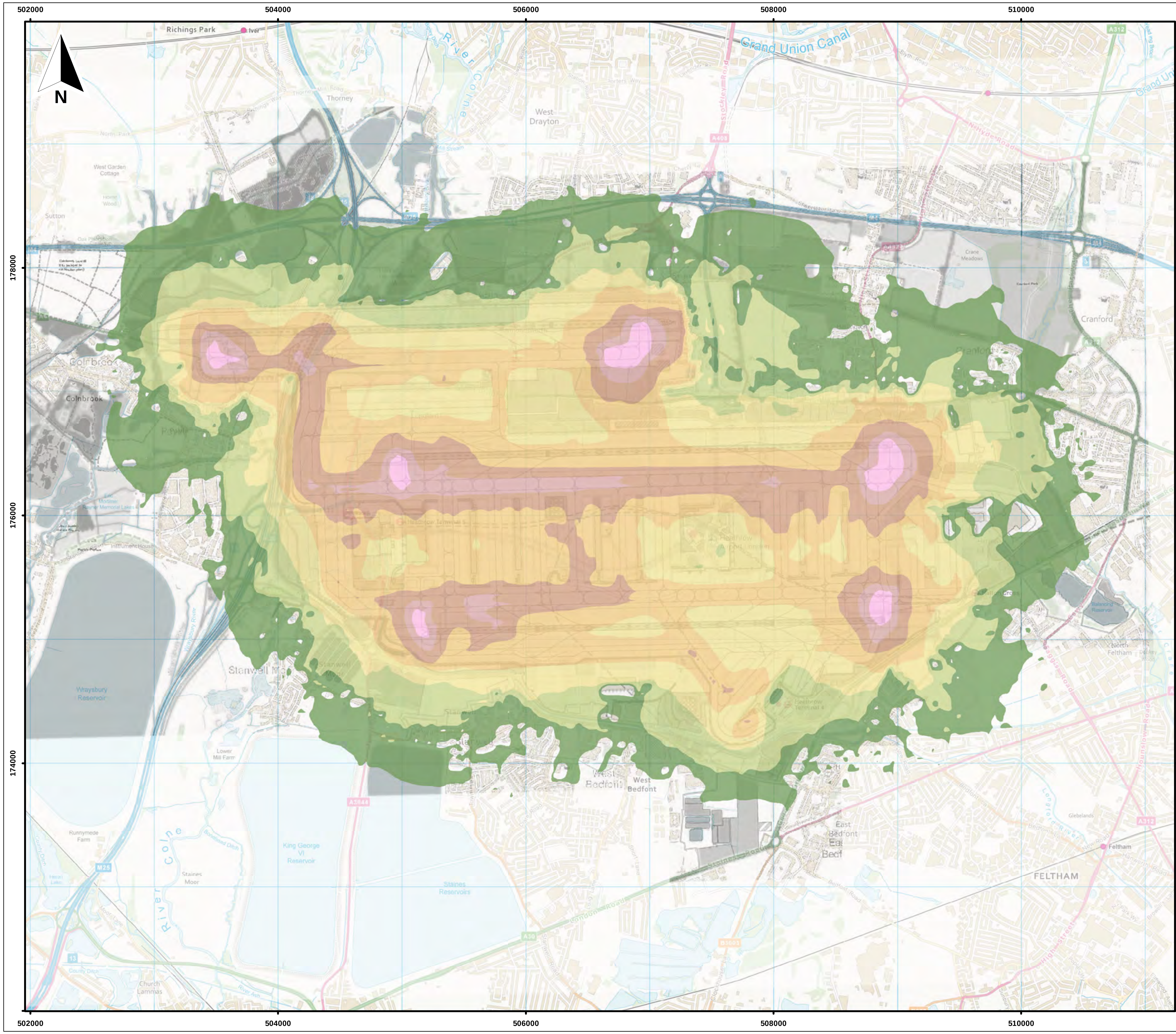
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F3
3R 2040
L_{den}

June 2014
35310-Lon201 trowj

amec



Key:

- > 40 dB(A)
- > 45 dB(A)
- > 50 dB(A)
- > 55 dB(A)
- > 60 dB(A)
- > 65 dB(A)
- > 70 dB(A)

Project Path

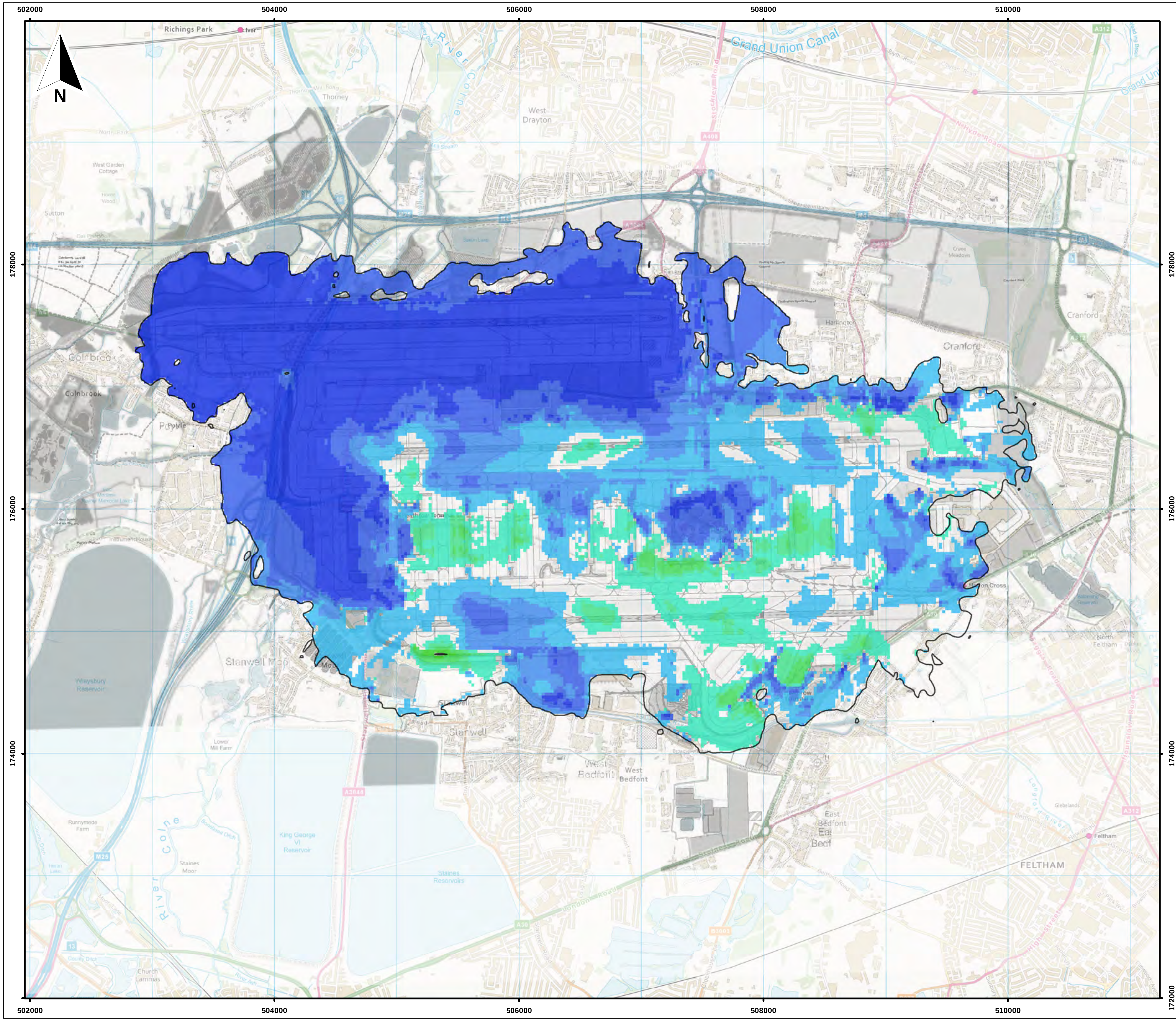
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F3
3R 2040
L_{night}

June 2014
35310-Lon202 trowj

amec



Key:

- 54 dB(A)
- > 10 dB decrease
- 5 - 10 dB decrease
- 3 - 5 dB decrease
- 1 - 3 dB decrease
- less than 1 dB change
- 1 - 3 dB increase
- 3 - 5 dB increase
- 5 - 10 dB increase
- > 10 dB increase

0 250 500 1,000 Metres

Scale: 1:30,000 @ A3

Project Path

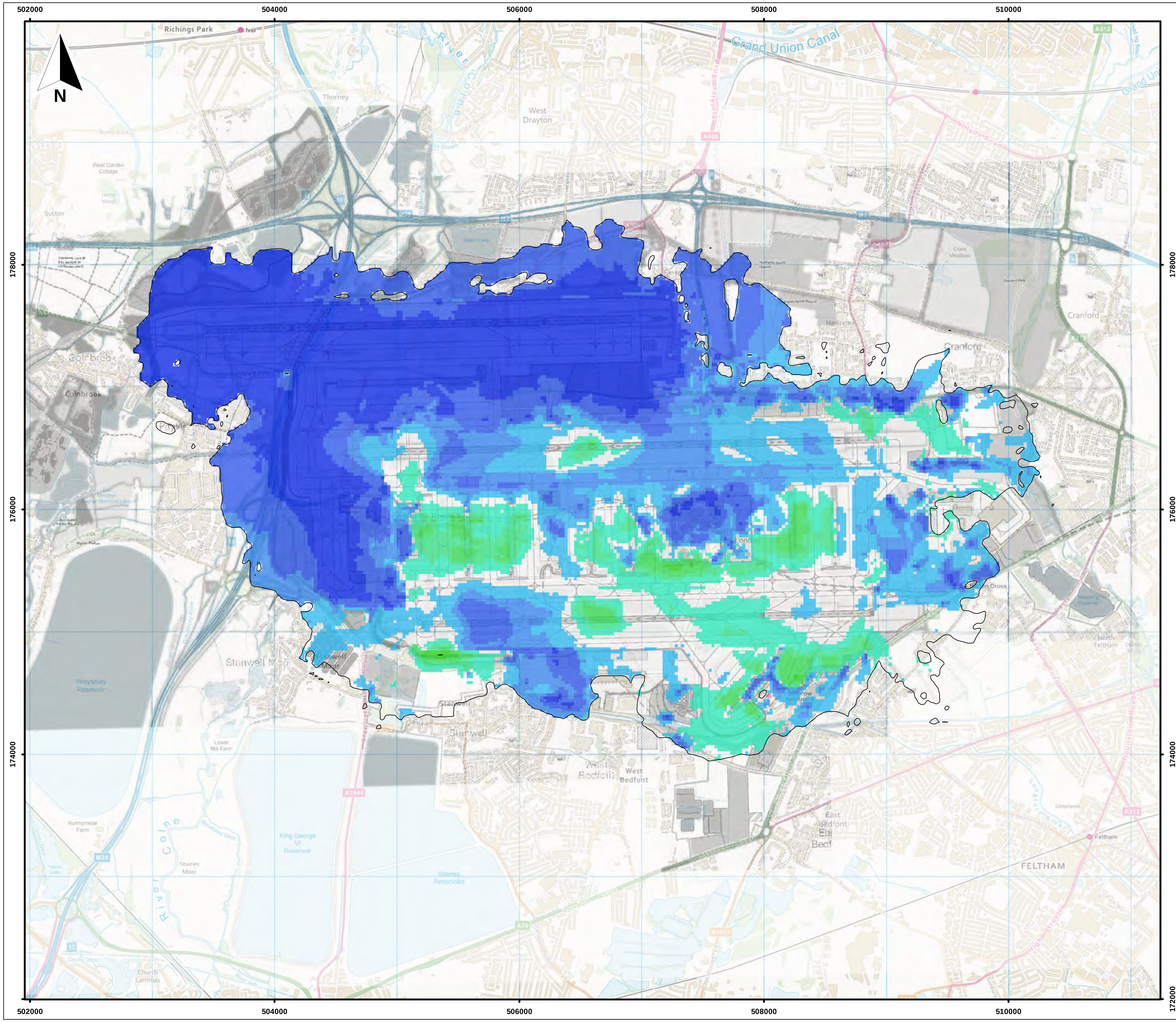
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F5
3R 2040 verse 2R 2040
Noise Exposure Difference Map
$L_{Aeq,\ 16hr}$

June 2014
35310-Lon203 trowj

amec



Key:

	55 dB(A)
	> 10 dB decrease
	5 - 10 dB decrease
	3 - 5 dB decrease
	1 - 3 dB decrease
	less than 1 dB change
	1 - 3 dB increase
	3 - 5 dB increase
	5 - 10 dB increase
	> 10 dB increase

0 250 500 1,000 Metres

Scale: 1:30,000 @ A3

Project Path

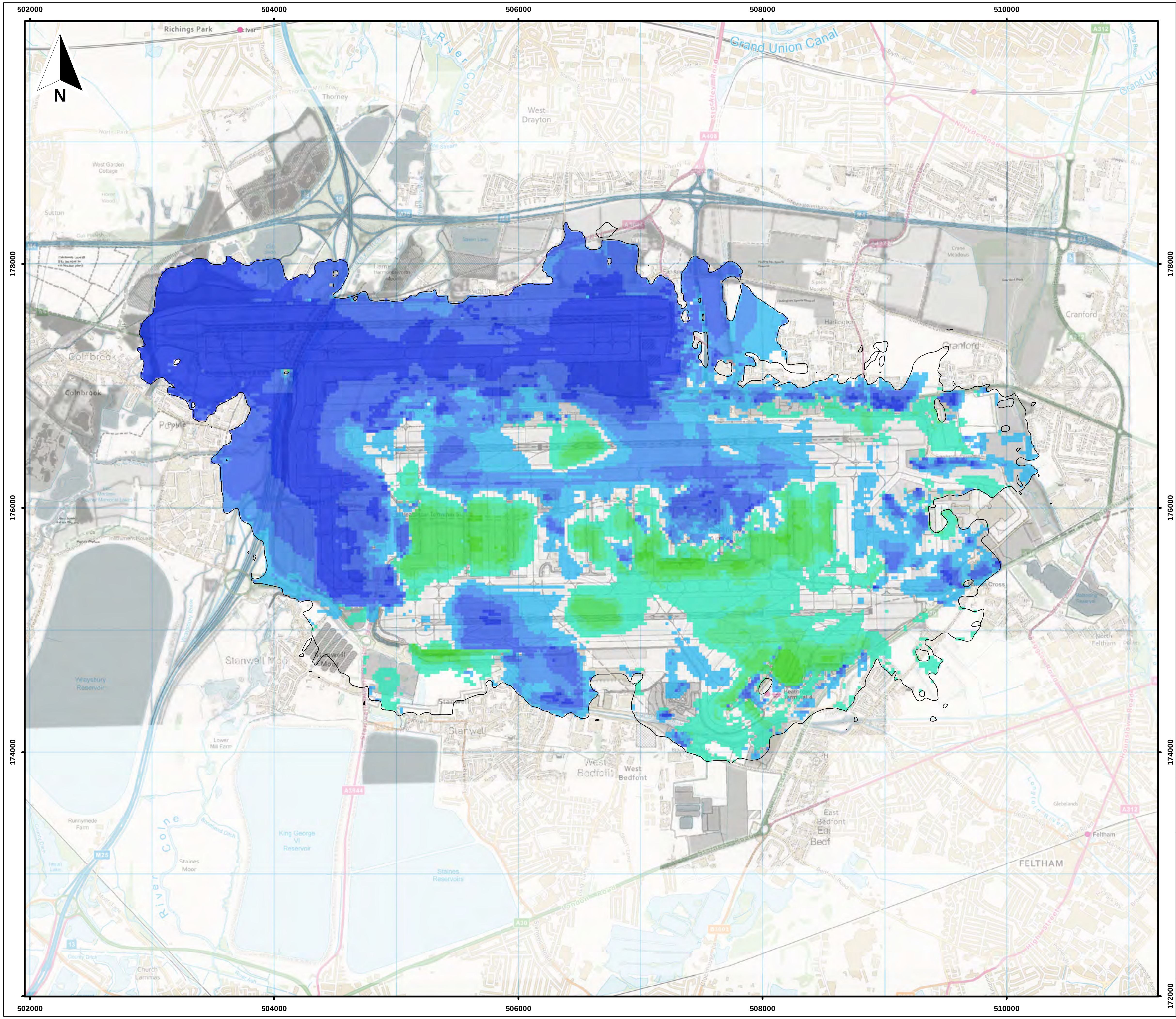
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F6
3R 2040 verse 2R 2040
Noise Exposure Difference Map
L_{den}

June 2014
35310-Lon204 trowj

amec



Key:

- 45 dB(A)
- > 10 dB decrease
- 5 - 10 dB decrease
- 3 - 5 dB decrease
- 1 - 3 dB decrease
- less than 1 dB change
- 1 - 3 dB increase
- 3 - 5 dB increase
- 5 - 10 dB increase
- > 10 dB increase

0 250 500 1,000 Metres

Scale: 1:30,000 @ A3

Project Path

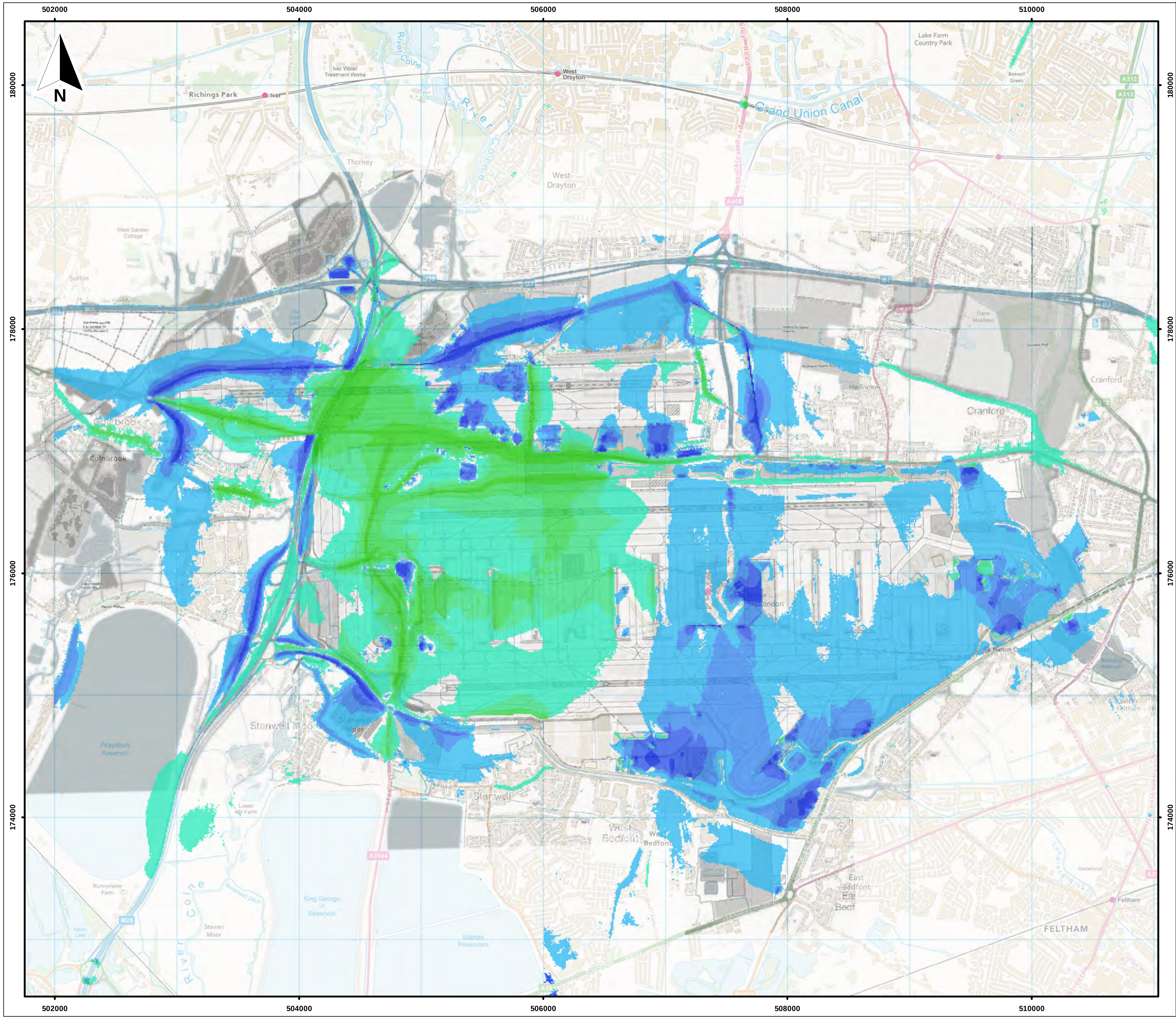
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F7
3R 2040 verse 2R 2040
Noise Exposure Difference Map
L_{night}

June 2014
35310-Lon205 trowj

amec



Key:

- > 10 dB decrease
- 5 - 10 dB decrease
- 3 - 5 dB decrease
- 1 - 3 dB decrease
- less than 1 dB change
- 1 - 3 dB increase
- 3 - 5 dB increase
- 5 - 10 dB increase
- > 10 dB increase

0 250 500 1,000 1,500 Metres

Scale: 1:30,000 @ A3

Project Path

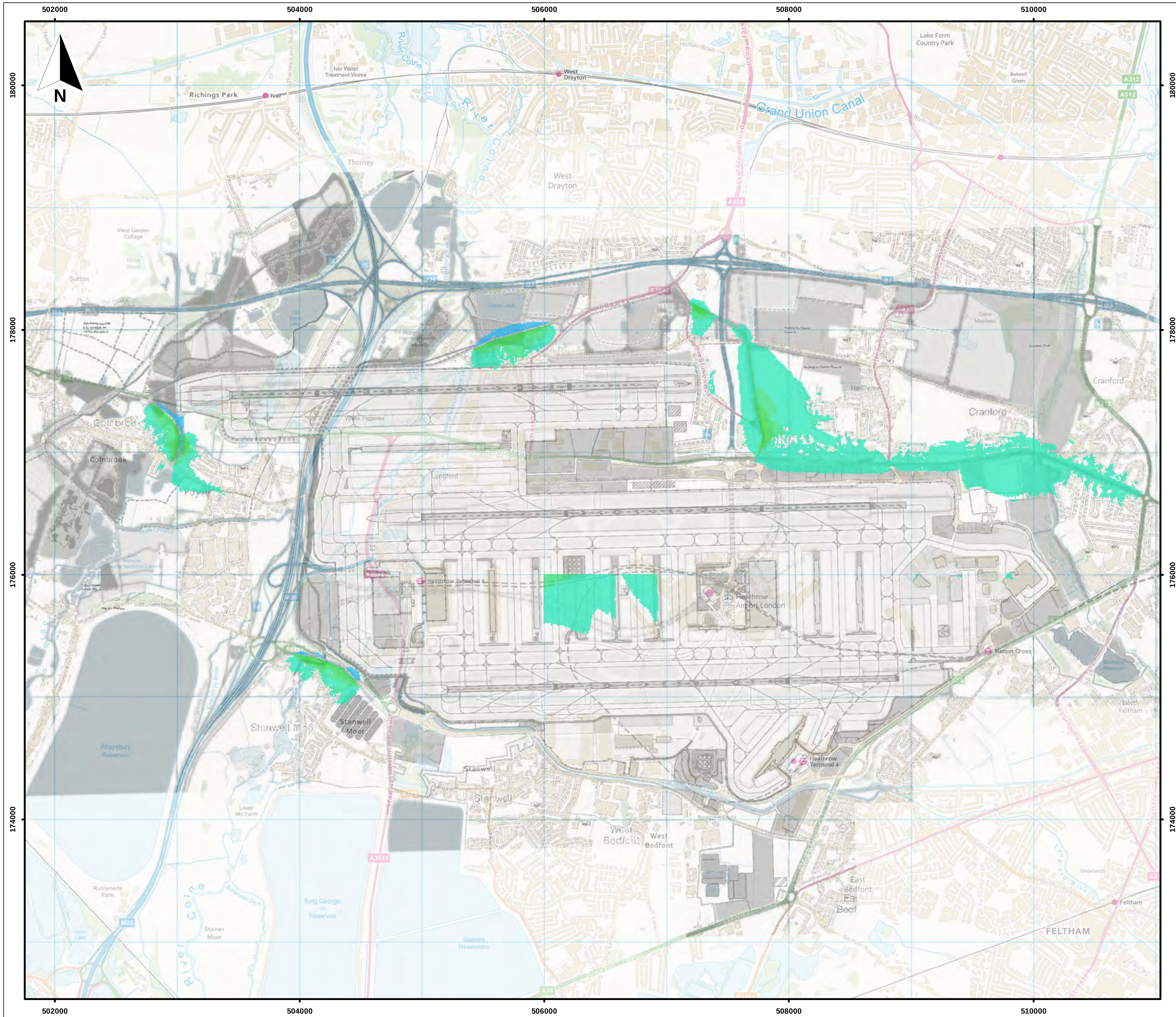
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F7
3R 2030 without Mitigation verse 2R 2030
Noise Exposure Difference Map
$L_{A10, 18hr}$

June 2014
35310-Lon206 trowj

amec



Key:

RTN_MIT.asc

<VALUE>

- > 10 dB decrease
- 5 - 10 dB decrease
- 3 - 5 dB decrease
- 1 - 3 dB decrease
- less than 1 dB change
- 1 - 3 dB increase
- 3 - 5 dB increase
- 5 - 10 dB increase
- > 10 dB increase

0 250 500 1,000 1,500 Metres

Scale: 1:30,000 @ A3

Project Path

Heathrow
Making every journey better

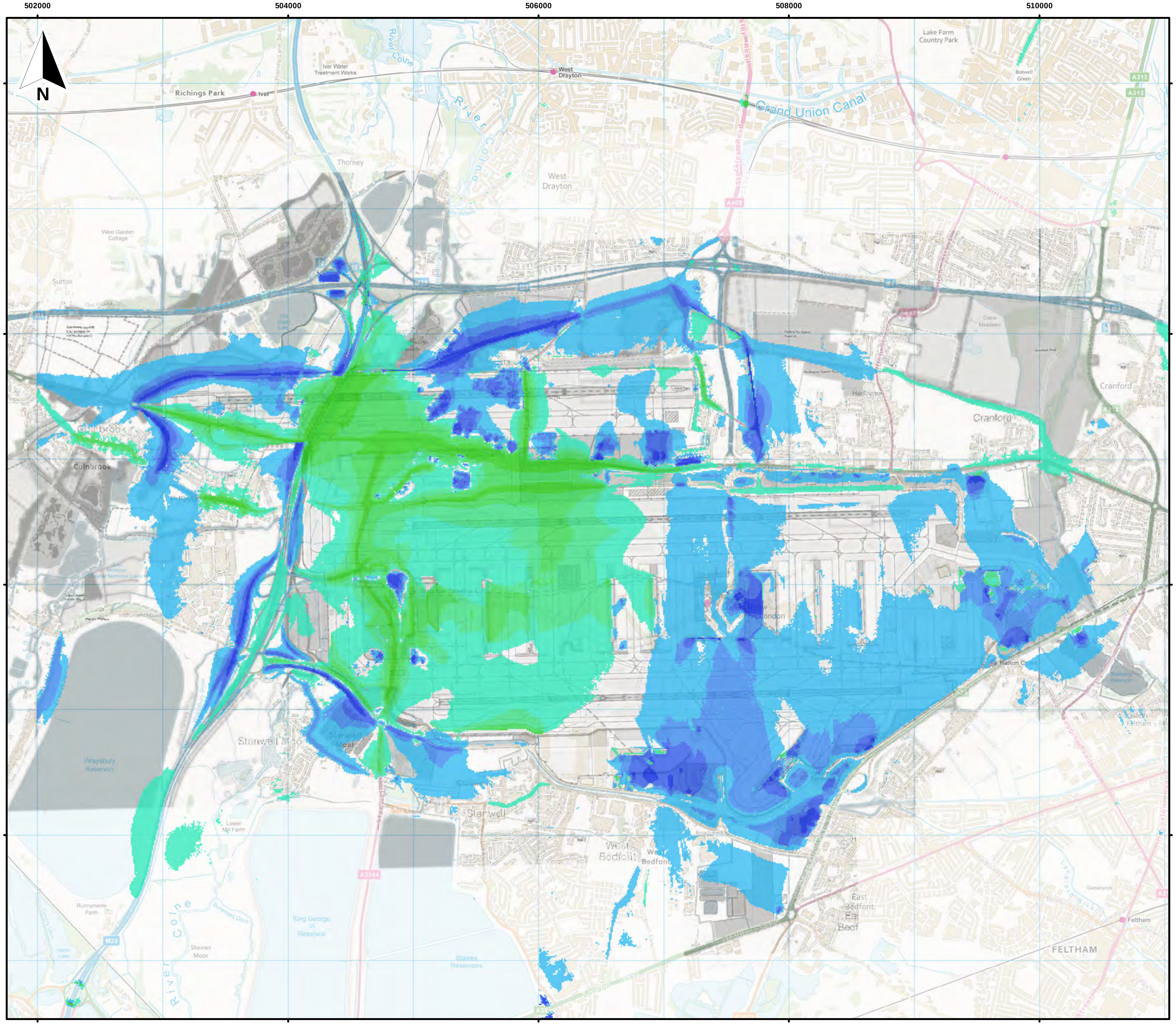
Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F9
Performance of Road Traffic Noise Mitigation

Noise Exposure Change
$L_{A10,\ 18hr}$

June 2014
35310-Lon207 trowj

amec



Key:

- > 10 dB decrease
- 5 - 10 dB decrease
- 3 - 5 dB decrease
- 1 - 3 dB decrease
- less than 1 dB change
- 1 - 3 dB increase
- 3 - 5 dB increase
- 5 - 10 dB increase
- > 10 dB increase

Project Path

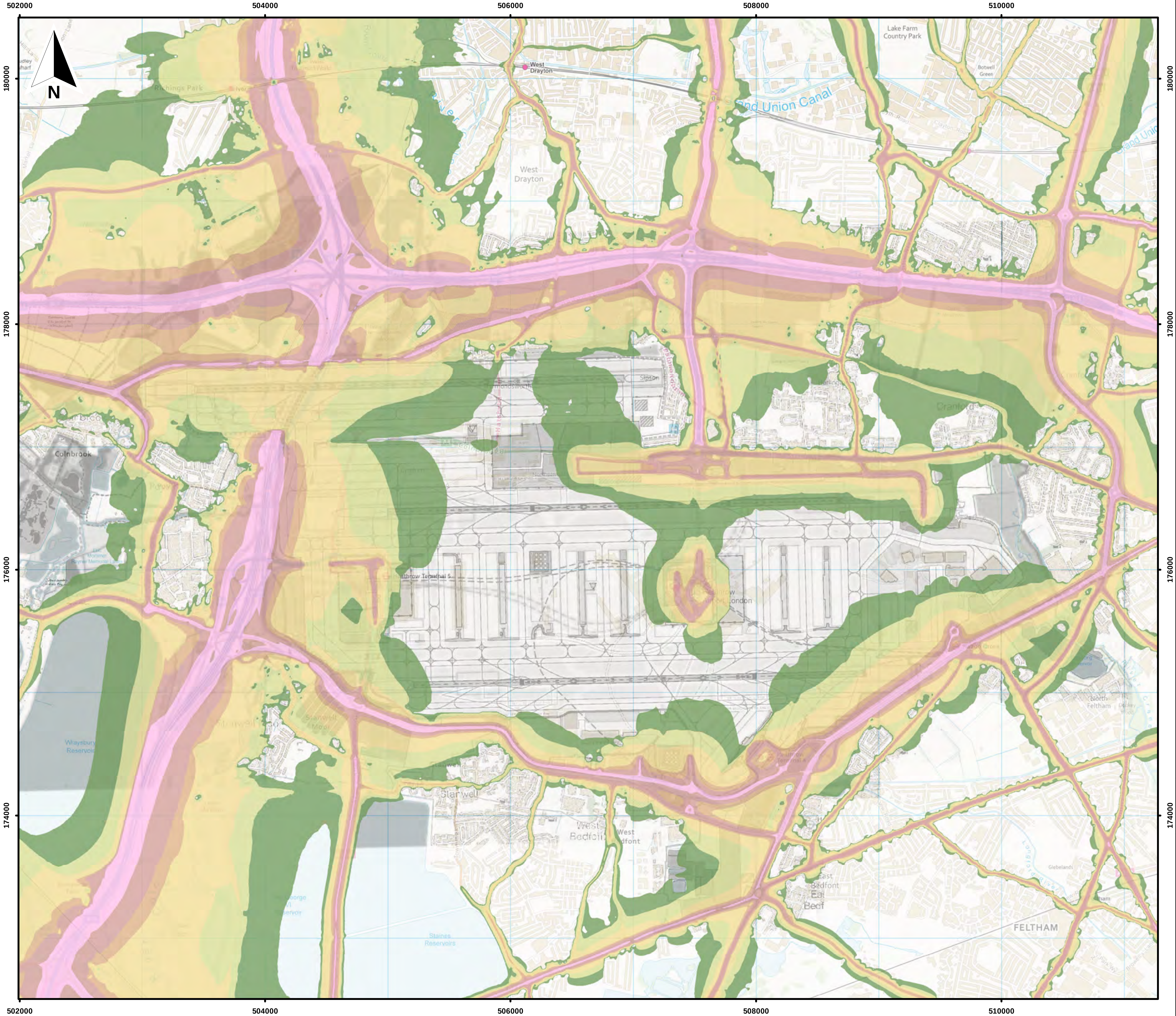
Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F10
3R 2030 with Mitigation verses 2R 2030
Noise Exposure Change
$L_{A10, 18hr}$

June 2014
35310-Lon208 trowj

amec



Key:

- 57 dB LA10, 18hr / 55 dB LAeq, 16hr
- 60 dB LA10, 18hr
- 63 dB LA10, 18hr
- 68 dB LA10, 18hr (NIR)
- 70 dB LA10, 18hr
- 75 dB LA10, 18hr

0 250 500 1,000 1,500 Metres

Scale: 1:30,000 @ A3

Project Path

Heathrow
Making every journey better

Heathrow's North-West Runway
Air and Ground Noise Assessment

Figure F11
3R 2030 with Mitigation
Road Traffic Noise Levels
$L_{A10, 18hr}$

June 2014
35310-Lon209 trowj

amec

Appendix G
Example Respite Calculation

An assessment of respite is presented in Section 5. A high level methodology for the calculation of respite is provided in Section 5.4. This Appendix presents a worked methodology for the calculation of respite. This calculation has facilitated the results of the respite assessment presented in Section 6.

Example Method

A study area for respite is defined as follows:

Respite occurs within a distance of 15 nmi from the airport which represents the area in which the vast majority of complaints are received

All arrival and departure routes are buffered by 500m to reflect what could reasonably be considered to be direct overflight (NB. This reflects a scenario incorporating PBN where there is overflight accuracy in the region of 300m)

A population postcode point is selected

A count in undertaken of the number of corridors that overfly the postcode point for both easterly and westerly operations

To establish the amount of respite, the number of modes is converted into the following percentages for easterly and westerly operations

- 0 modes =100% respite
- 1 mode = 75% respite
- 2 modes = 50% respite
- 3 modes = 25% respite
- 4 modes = 0% respite

The respite over the total year is calculated by taking into account the overall modal split i.e. (30% x easterly respite) + (70% x westerly respite).

The table below provides an example of this calculation.

	Easterly Modes Overflown					Westerly Modes Overflown					Easterly	Westerly	Overall
Location	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**			
1			✔			✔					50%	100%	85%
2					✔			✔			0%	50%	35%

Appendix H
Airspace Options and Modes

H.1 Airspace Options and Modes

This appendix provides a series of figures and illustrations of the potential modes of the three airspace options discussed and outlined in Section 4.4 of this document. The following figures should be interpreted using following key.

Key	
	Option Landing Corridor
	Option Departure Corridor
	Existing Track

In addition to the potential airspace routes, the figures present current flight tracks.

H.2 Option T – Minimising Total People

Figure H.1 – Option T – Minimise Total People – Westerly MLD

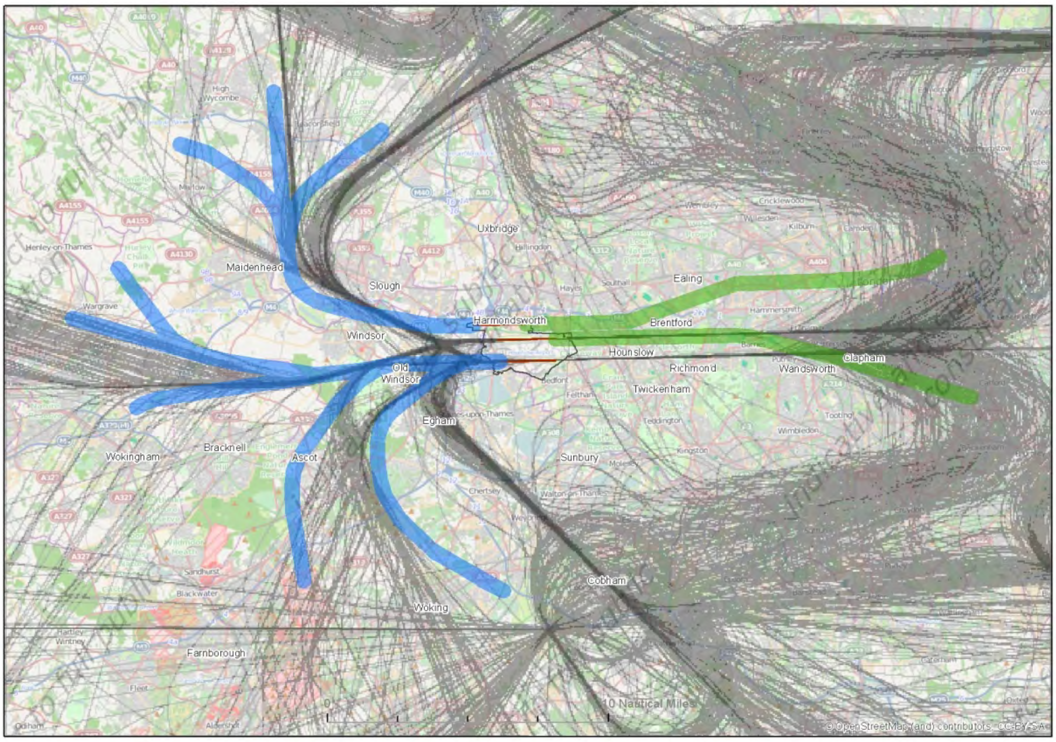


Figure H.2 – Option T – Minimise Total People – Westerly MDL

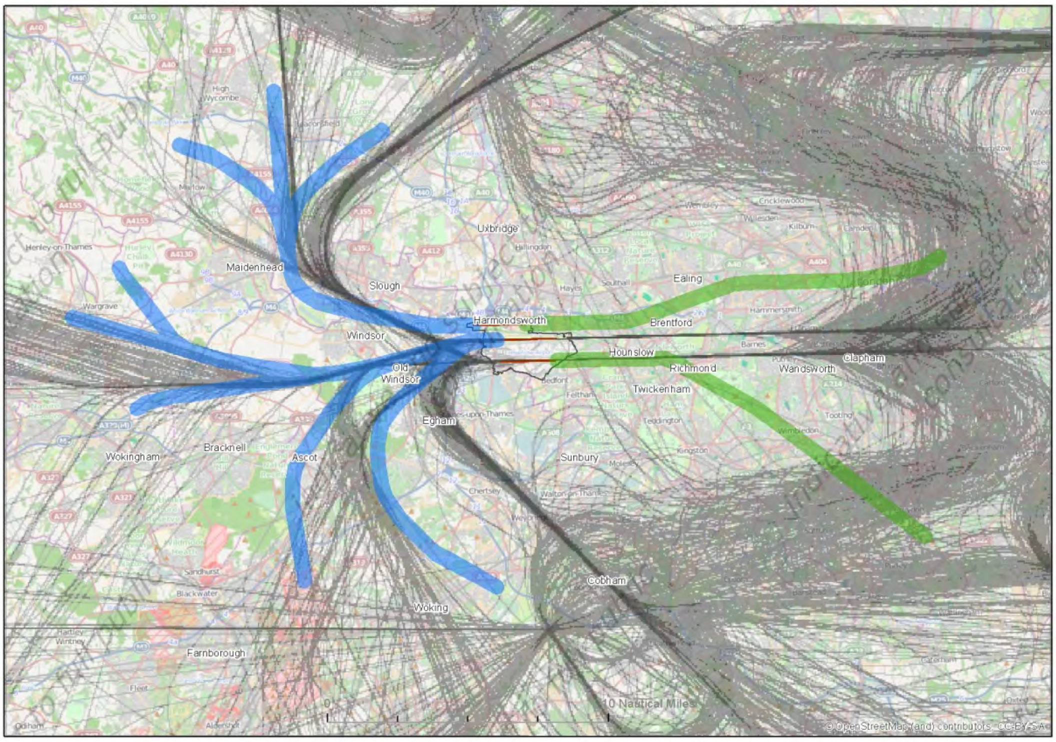


Figure H.3 – Option T – Minimise Total People – Westerly LDM

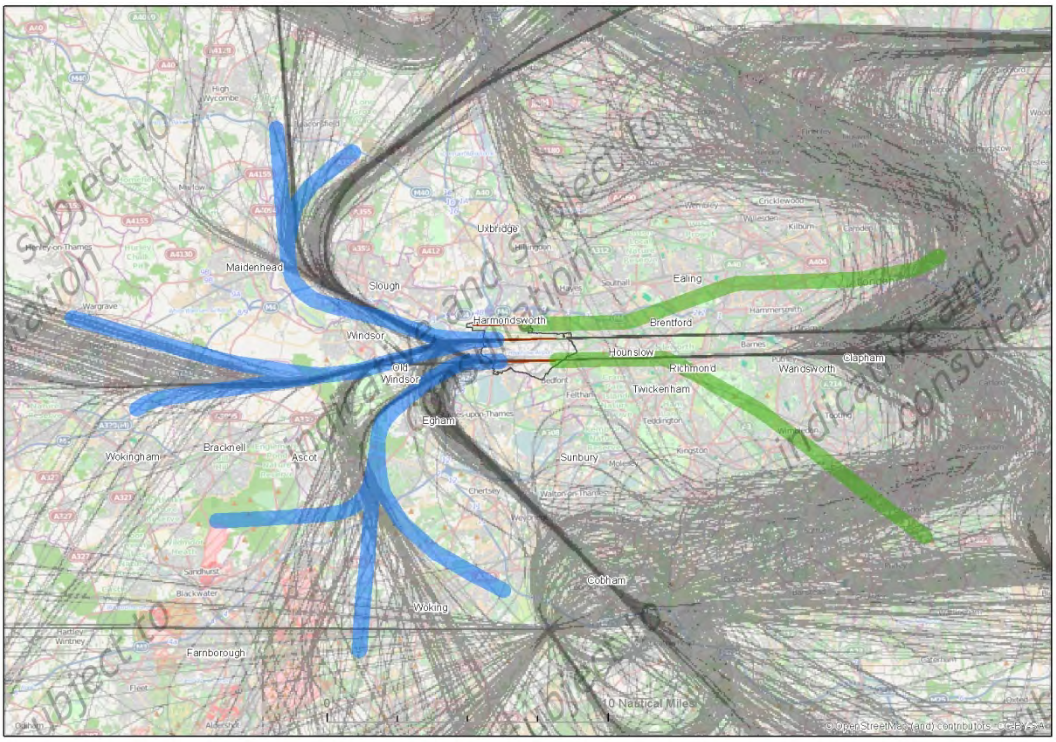


Figure H.4 – Option T – Minimise Total People – Westerly DLM

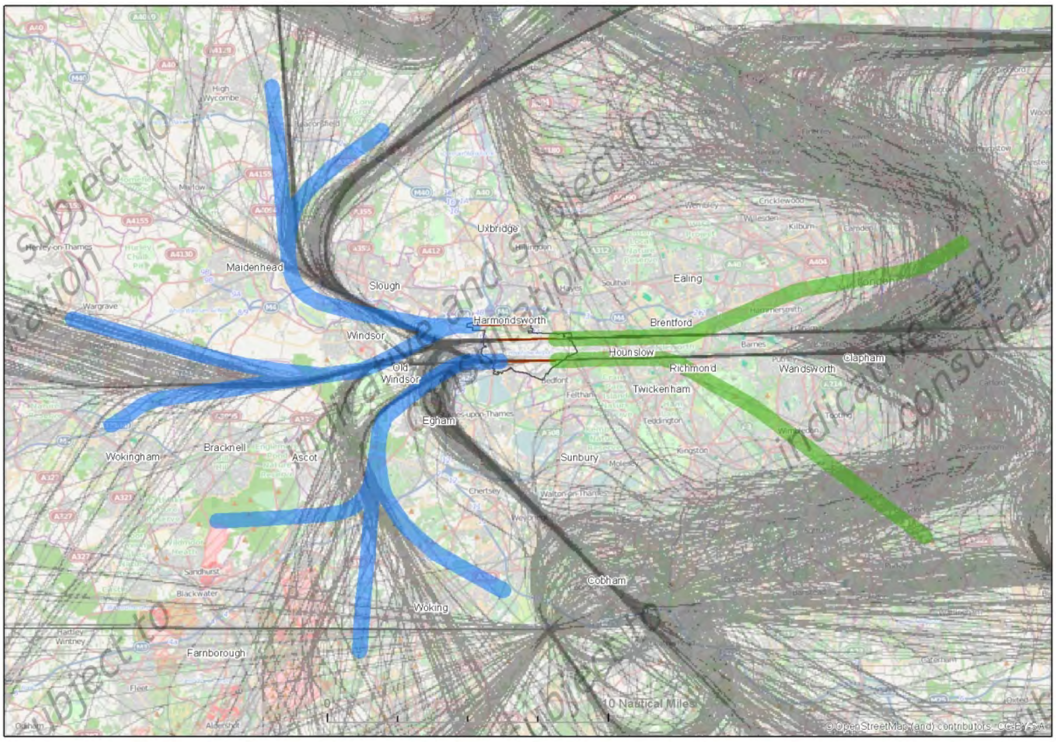


Figure H.5 – Option T – Minimise Total People – Easterly MLD

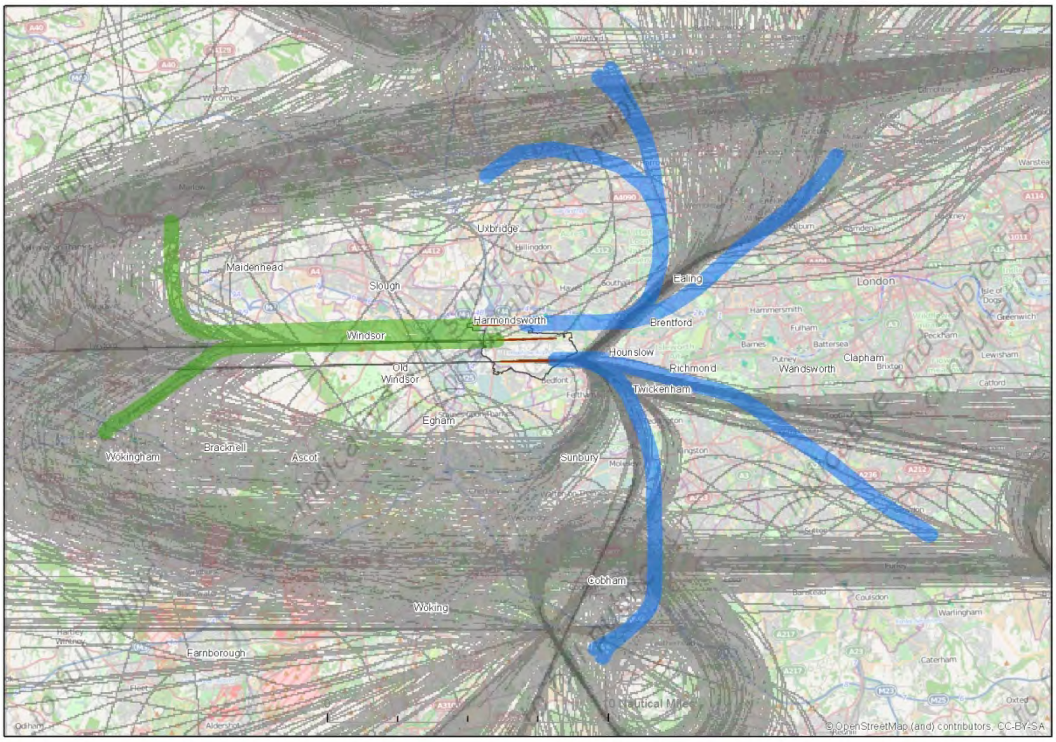


Figure H.6 – Option T – Minimise Total People – Easterly MDL

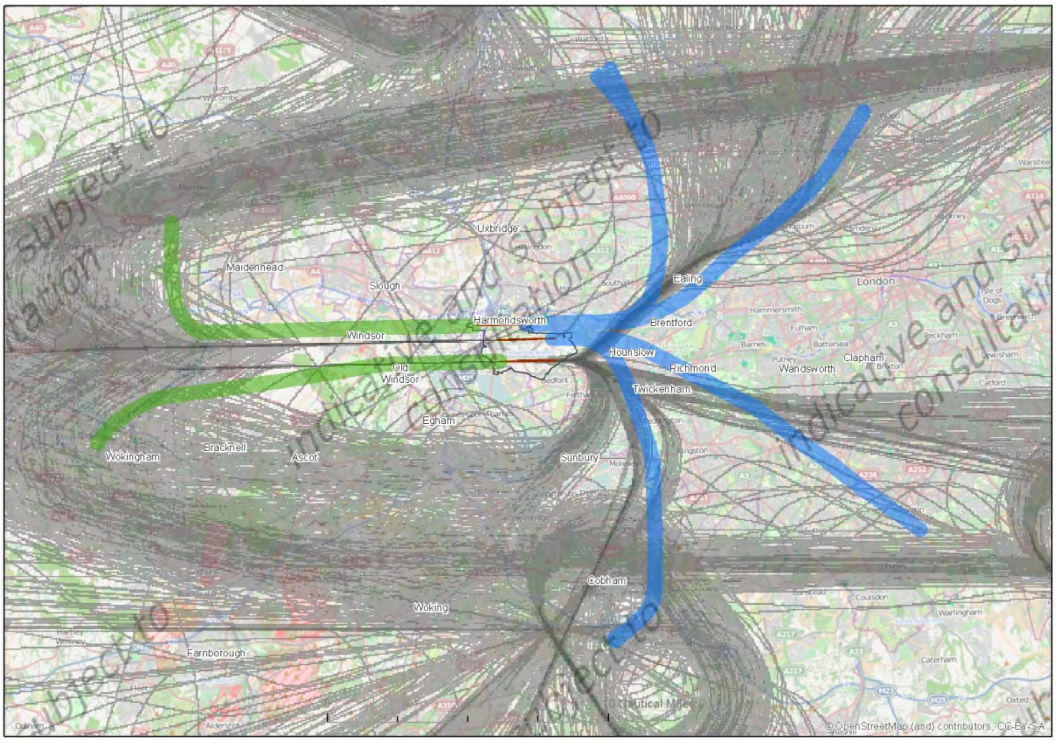


Figure H.7 – Option T – Minimise Total People – Easterly LDM

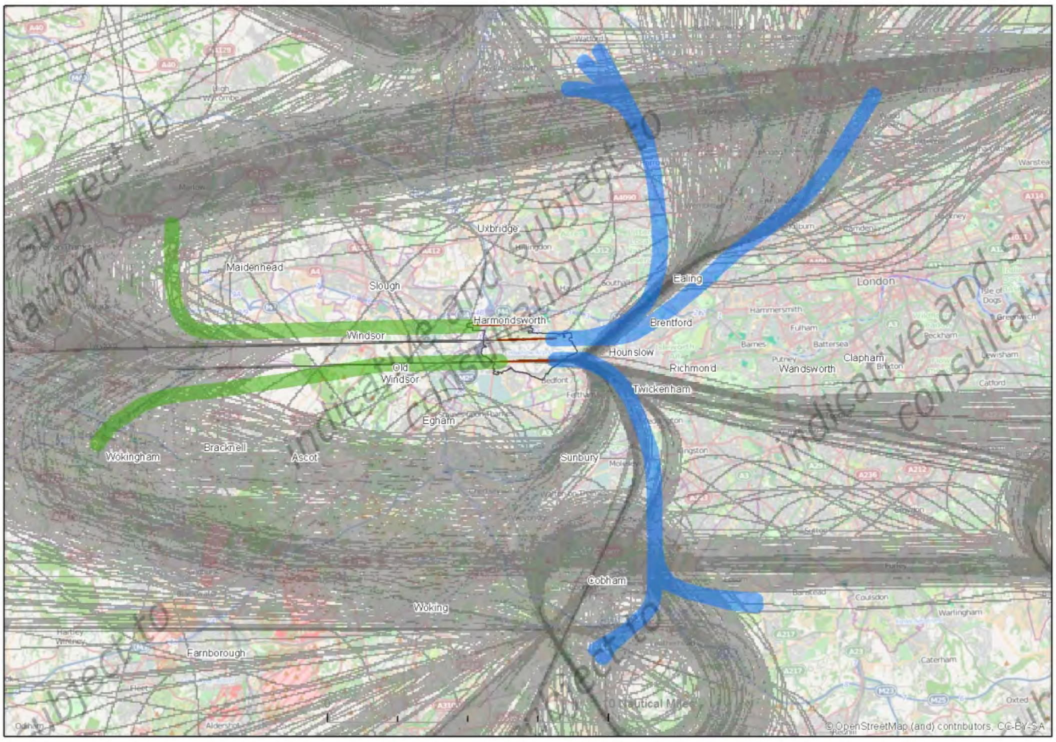
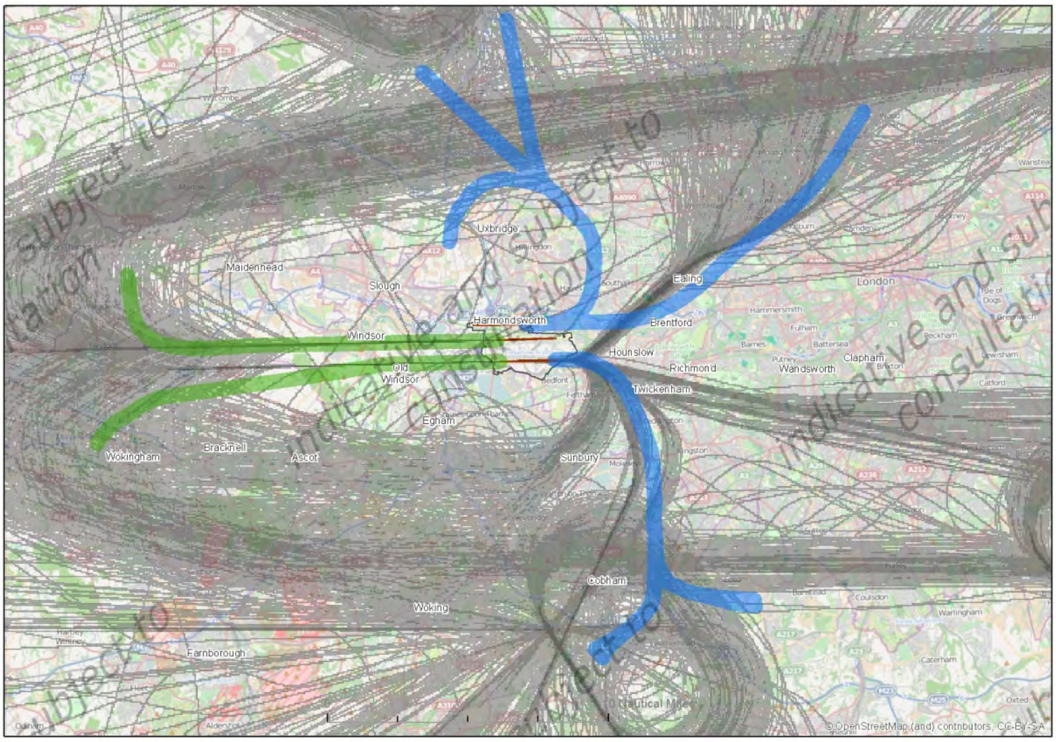


Figure H.8 – Option T – Minimise Total People – Easterly DLM



H.3 Option N – Minimising New People

Figure H.9 – Option N – Minimise New People – Westerly MLD

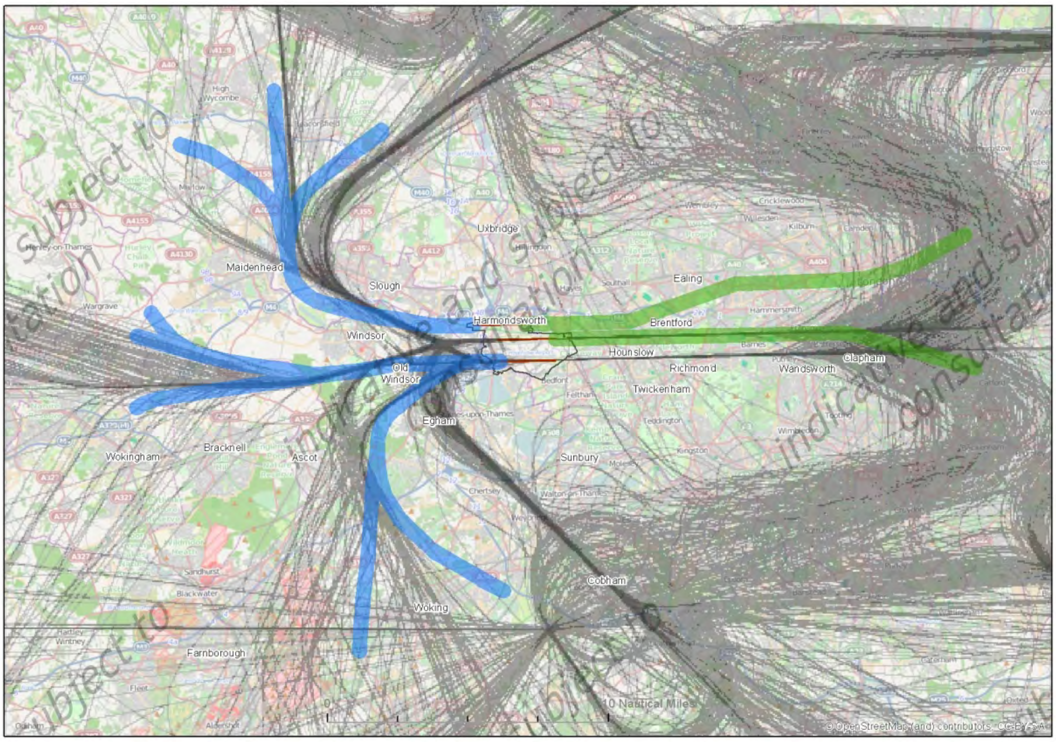


Figure H.10 – Option N – Minimise New People – Westerly MDL

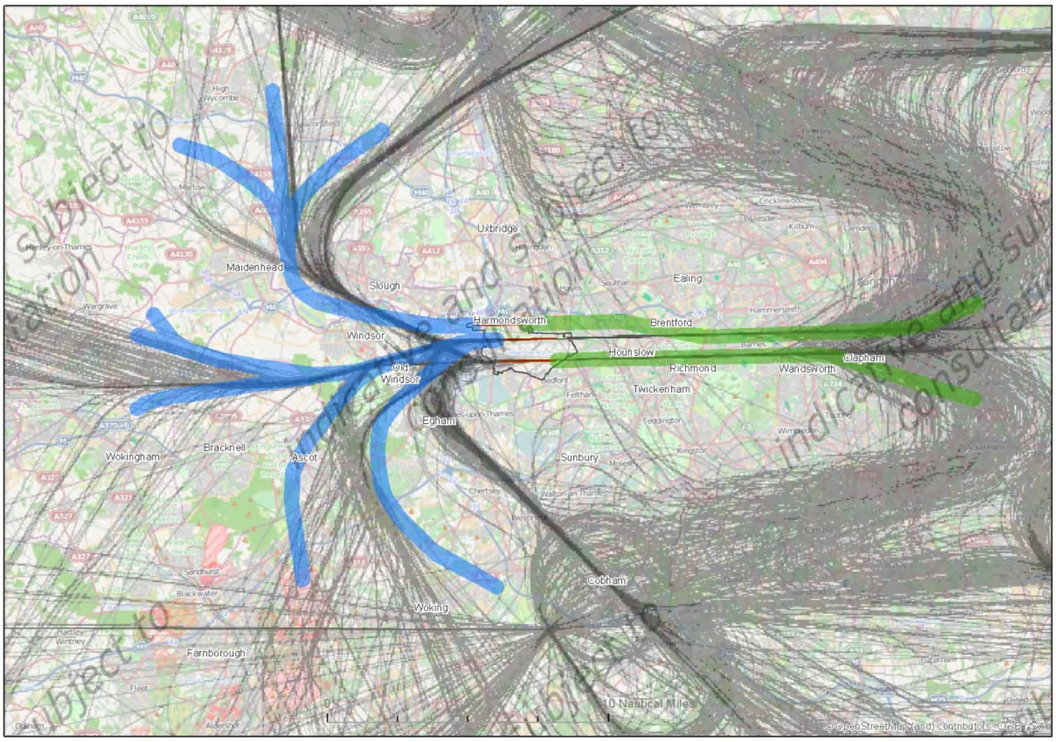


Figure H.11 – Option N – Minimise New People – Westerly LDM

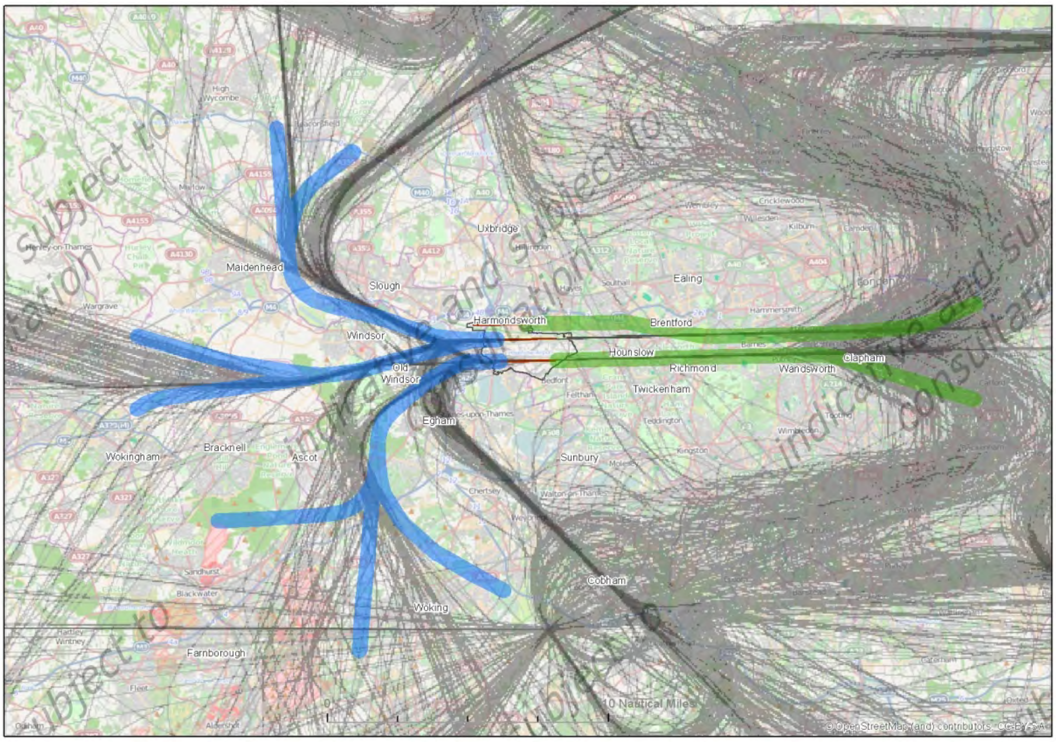


Figure H.12 – Option N – Minimise New People – Westerly DLM

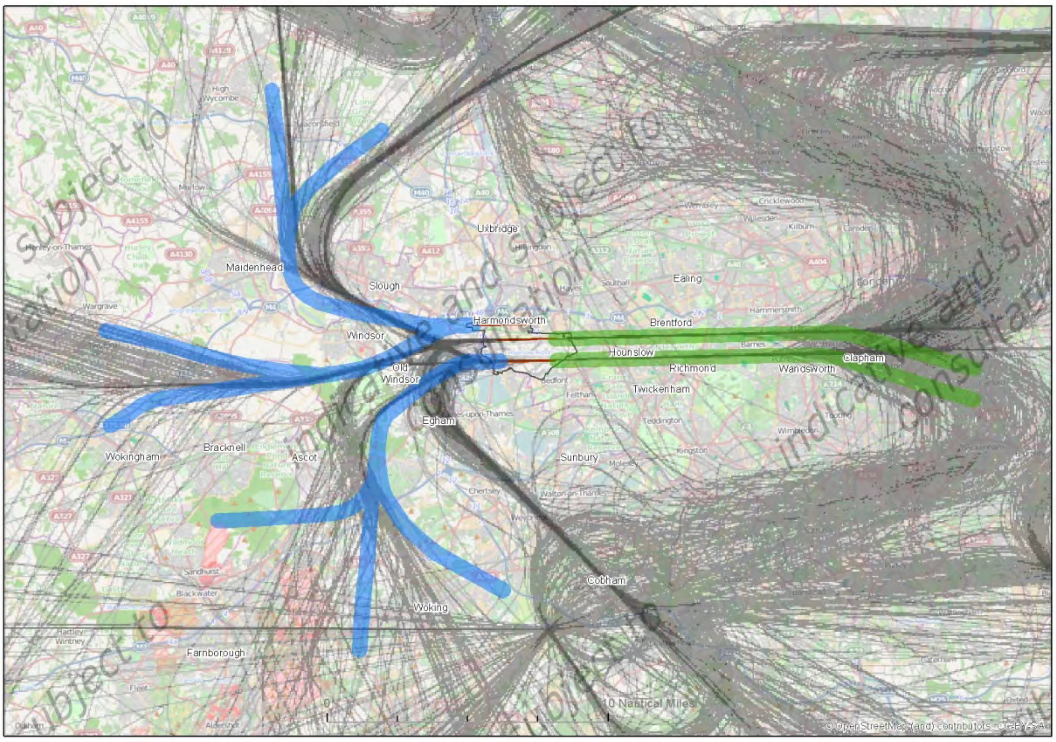


Figure H.13 – Option N – Minimise New People – Easterly MLD

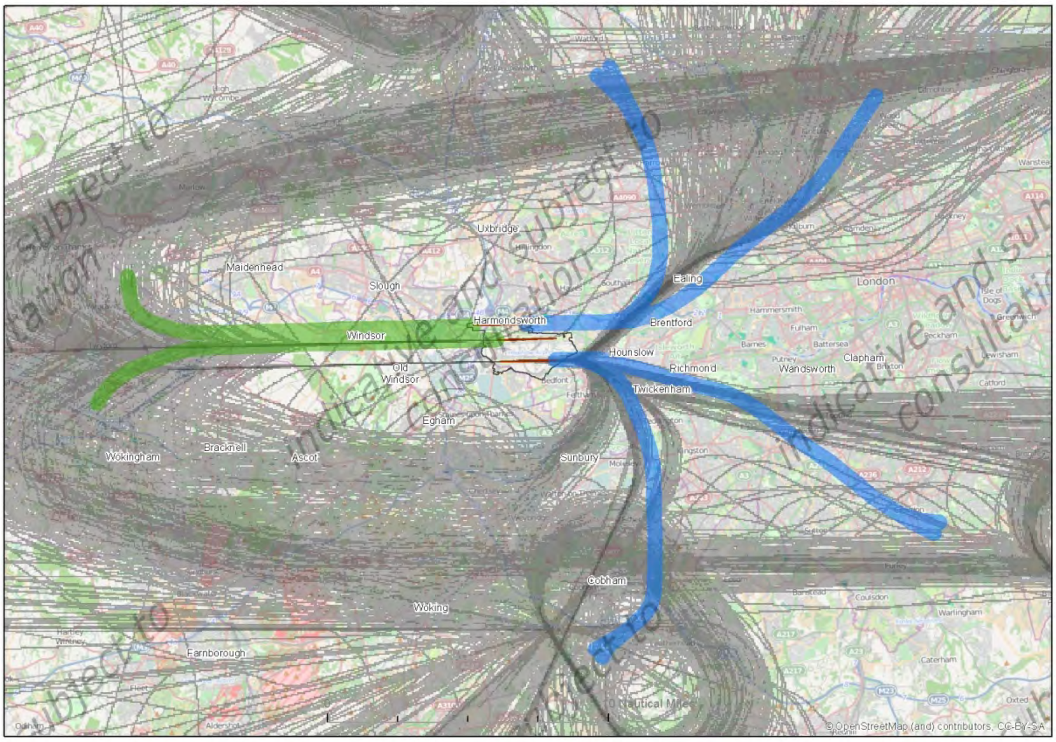


Figure H.14 – Option N – Minimise New People – Easterly MDL

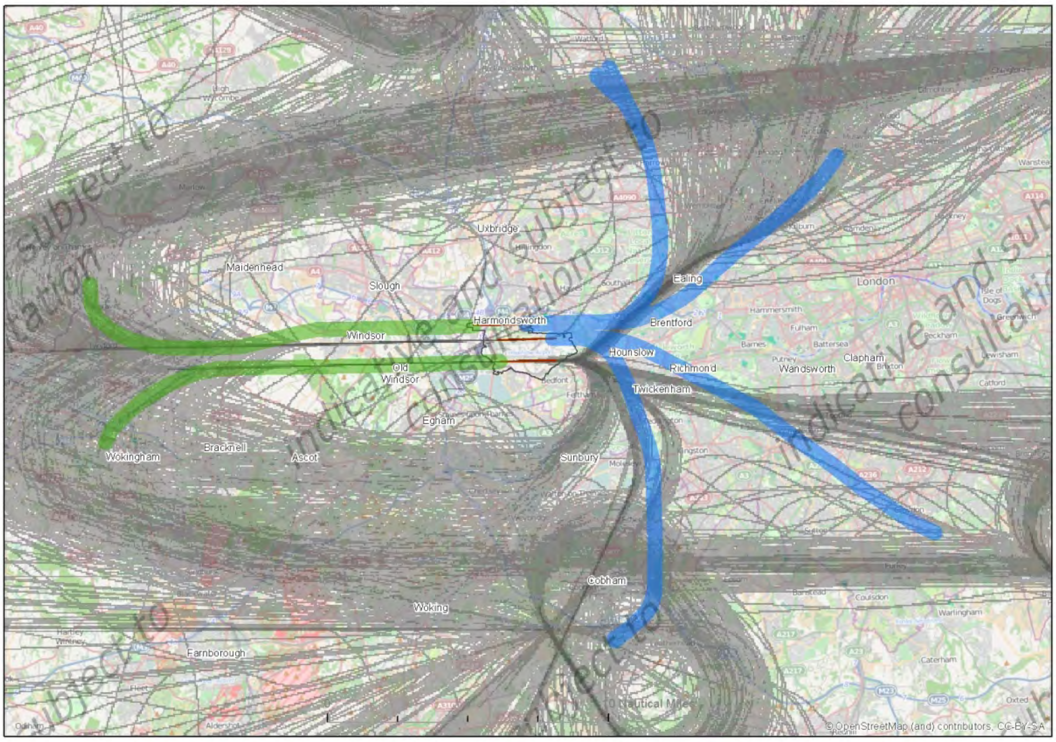


Figure H.15 – Option N – Minimise New People – Easterly LDM

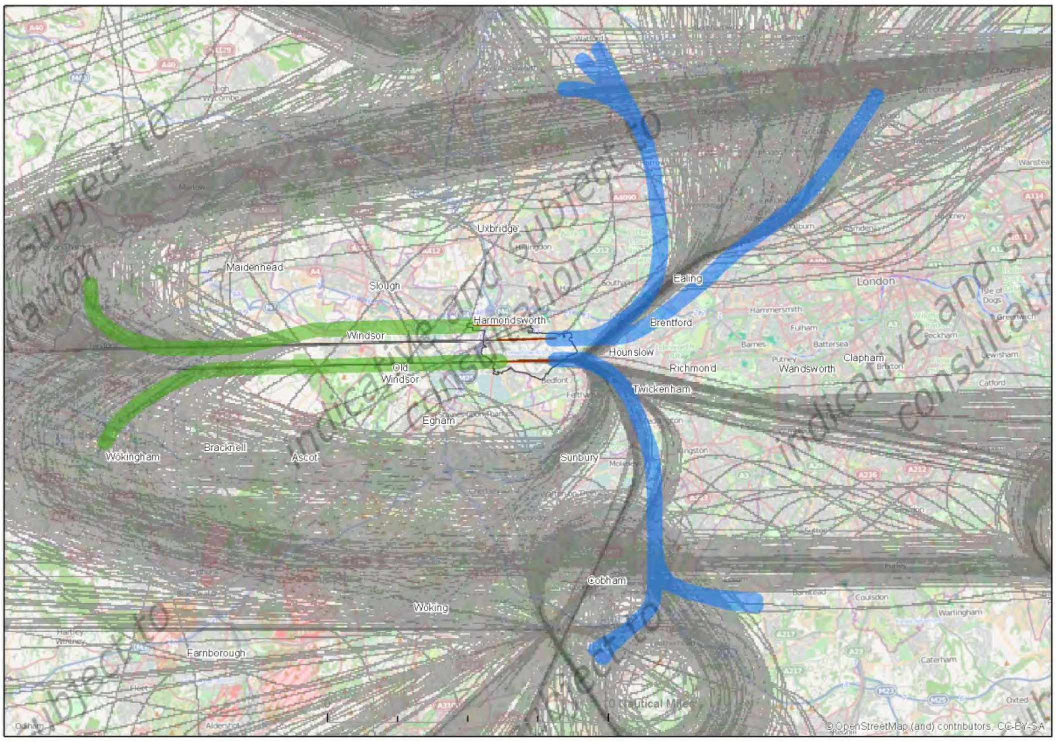
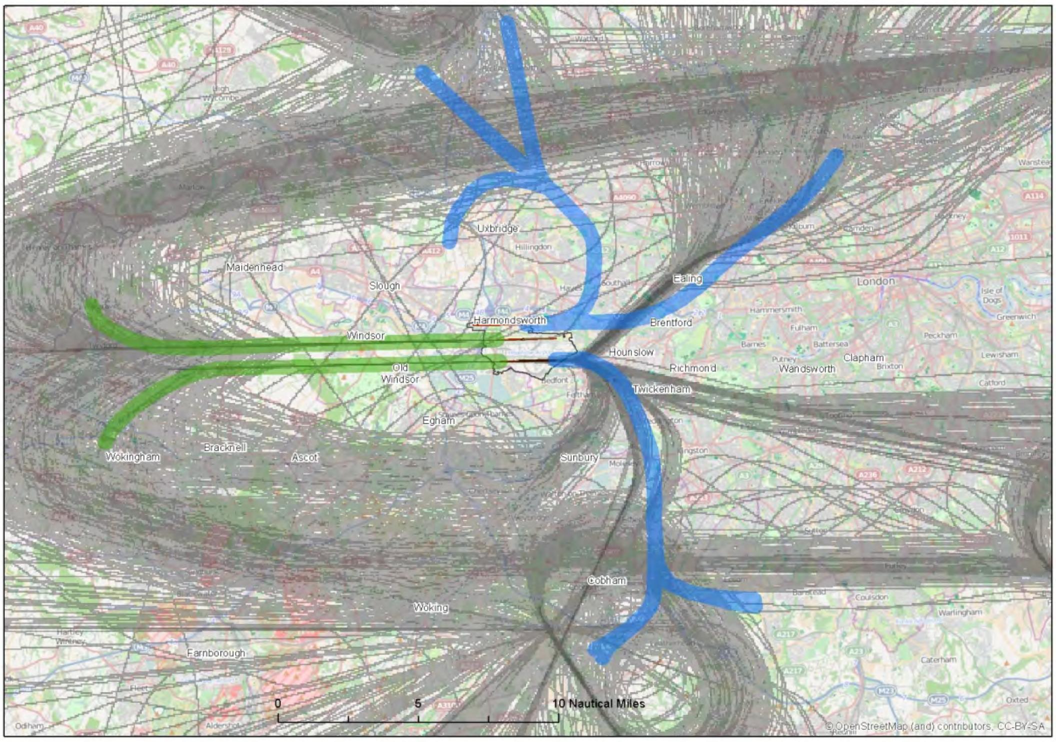


Figure H.16 – Option N – Minimise New People – Easterly DLM



H.4 Option R – Maximise Respite

Figure H.17 – Option R – Maximise Respite – Westerly MDL 1

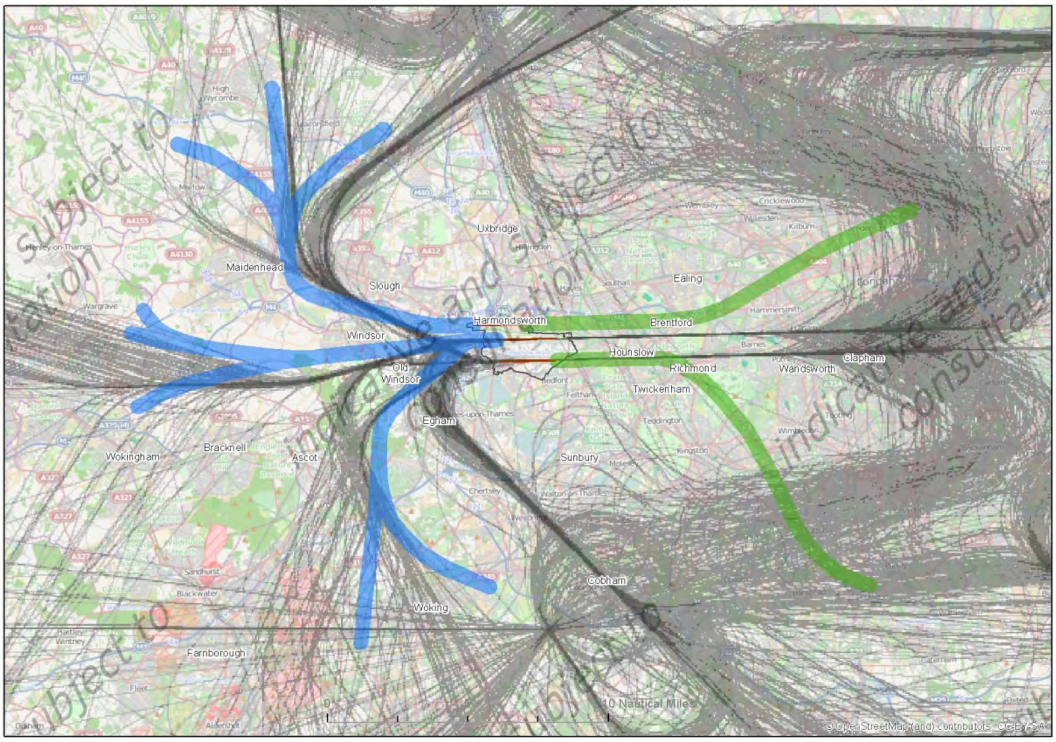


Figure H.18 – Option R – Maximise Respite – Westerly MDL 2

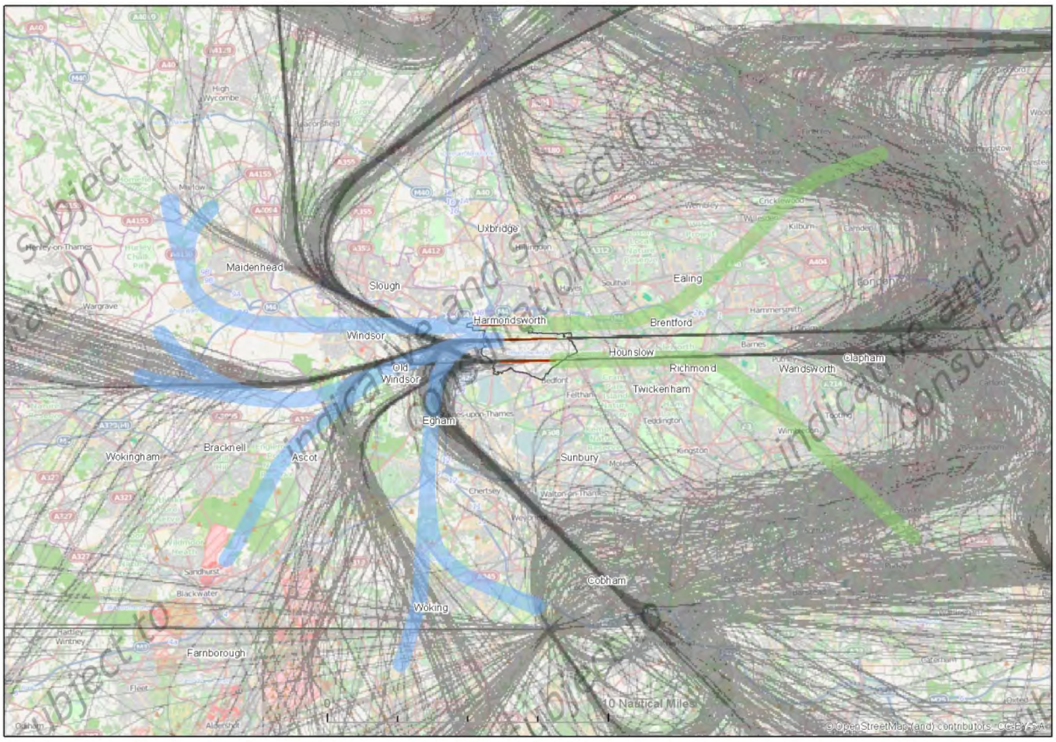


Figure H.19 – Option R – Maximise Respite – Westerly MLD 1

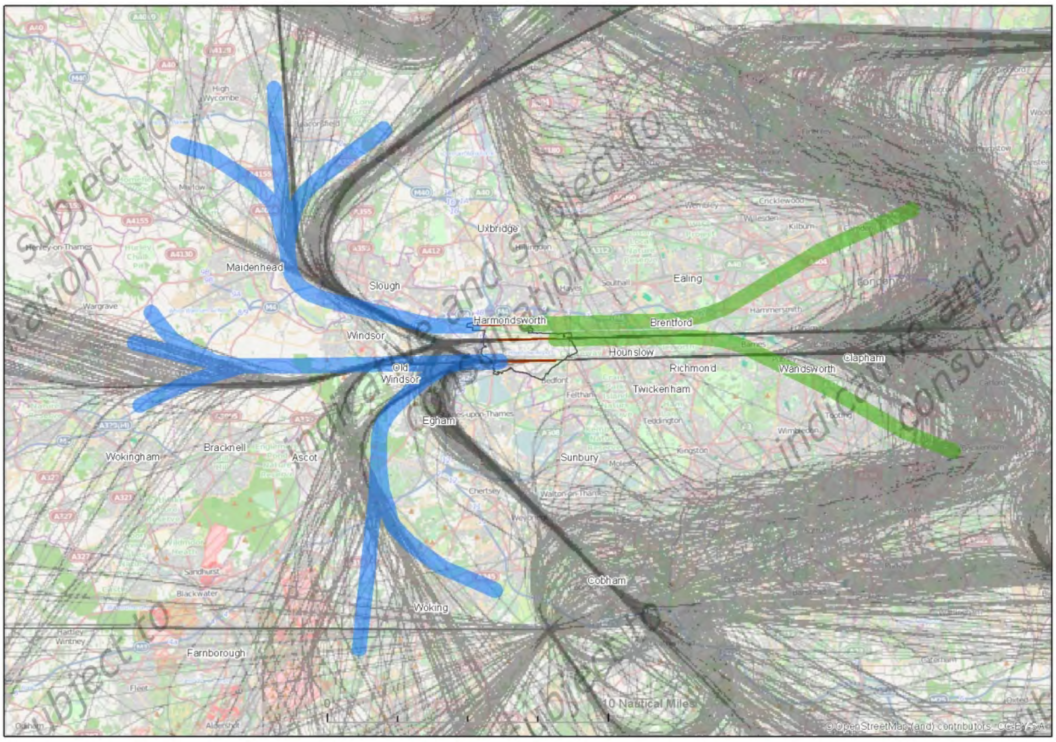


Figure H.20 – Option R – Maximise Respite – Westerly MLD 2

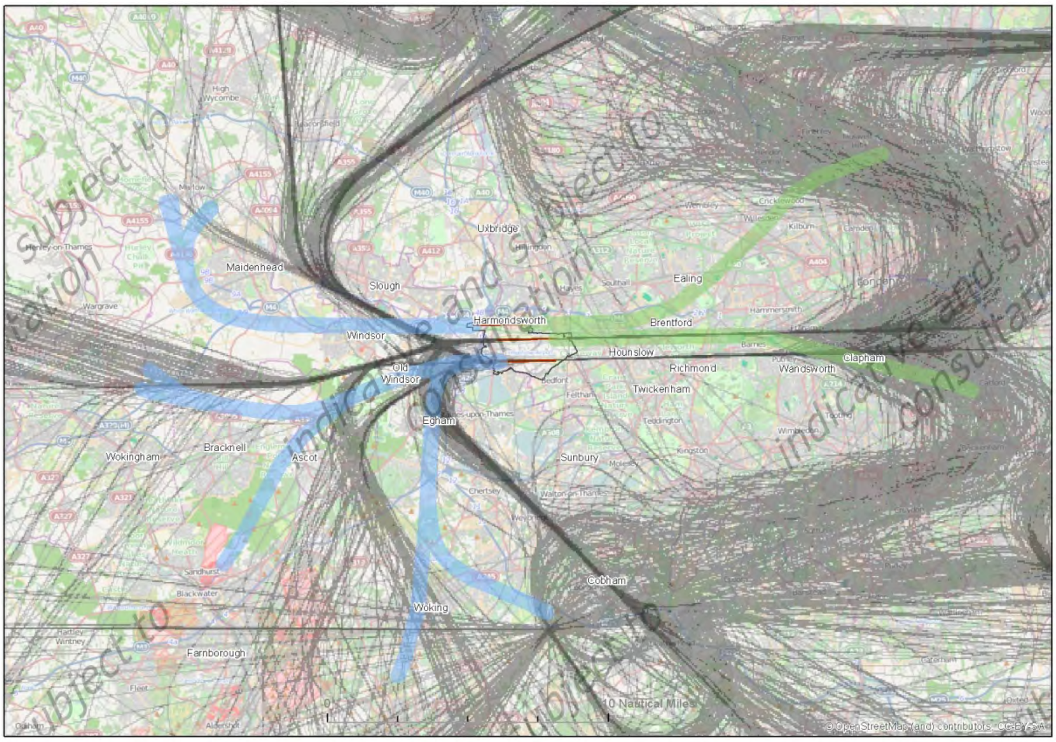


Figure H.21 – Option R – Maximise Respite – Westerly LDM 1

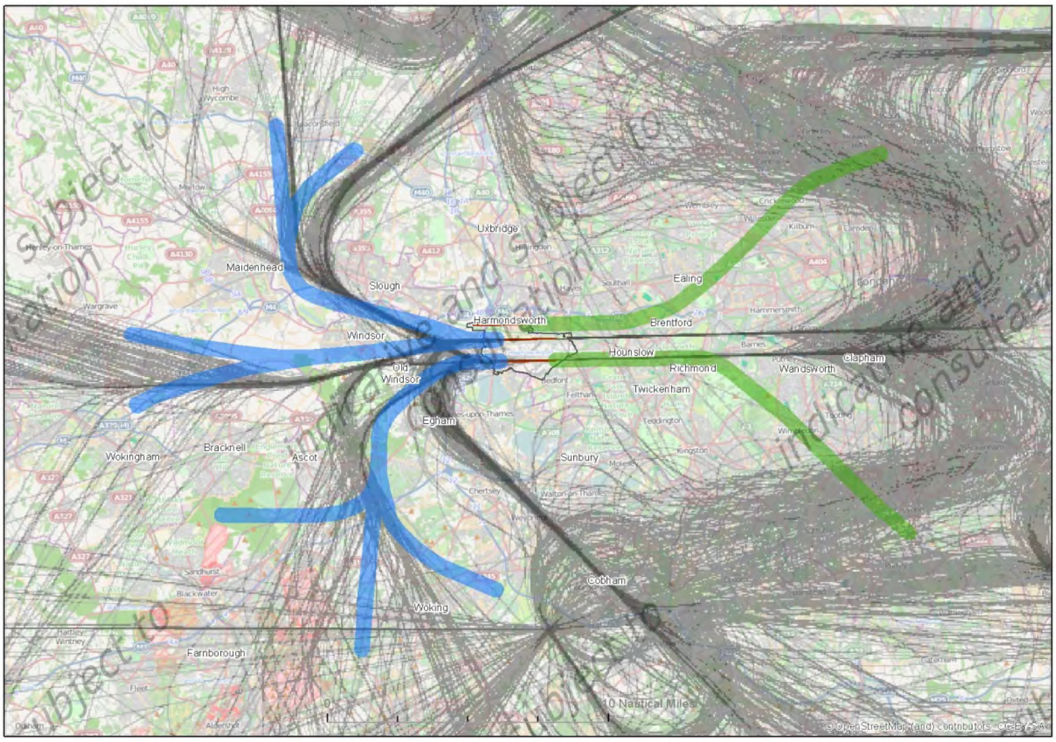


Figure H.22 – Option R – Maximise Respite – Westerly LDM 2

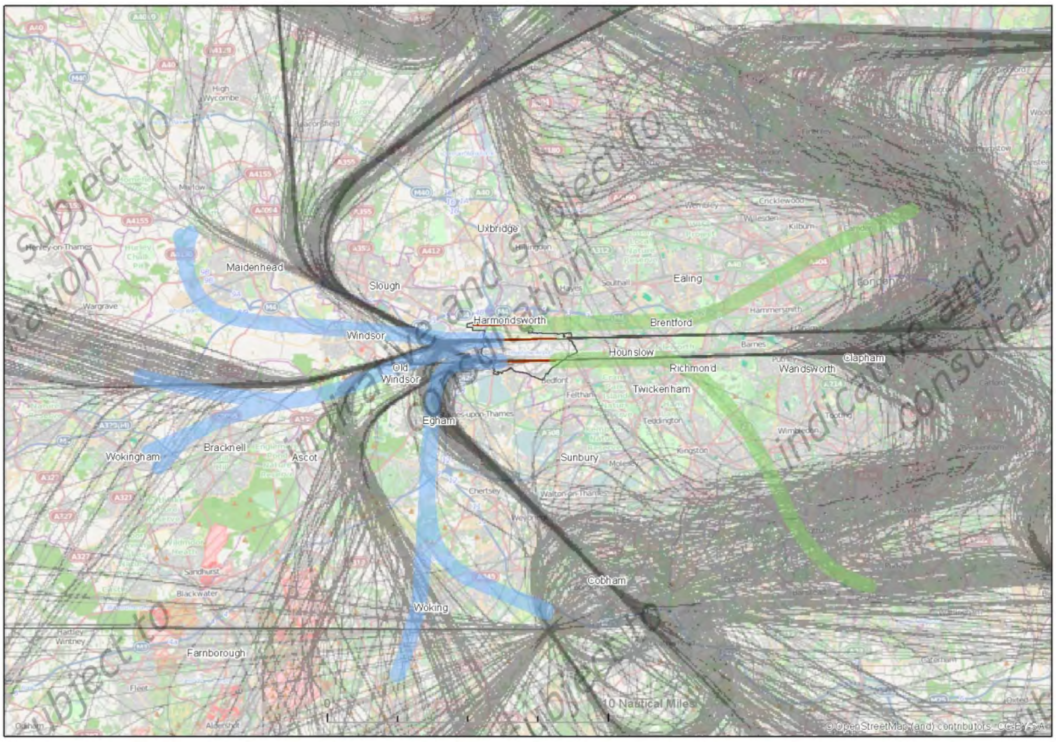


Figure H.23 – Option R – Maximise Respite – Westerly DLM1

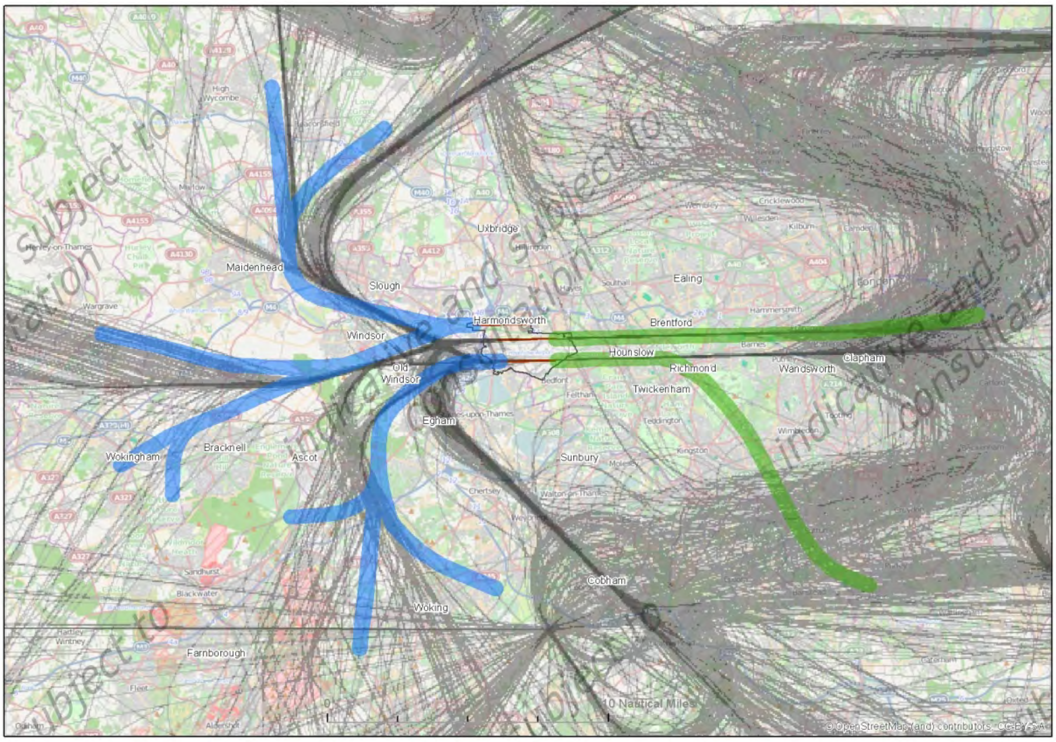


Figure H.24 – Option R – Maximise Respite – Westerly DLM2

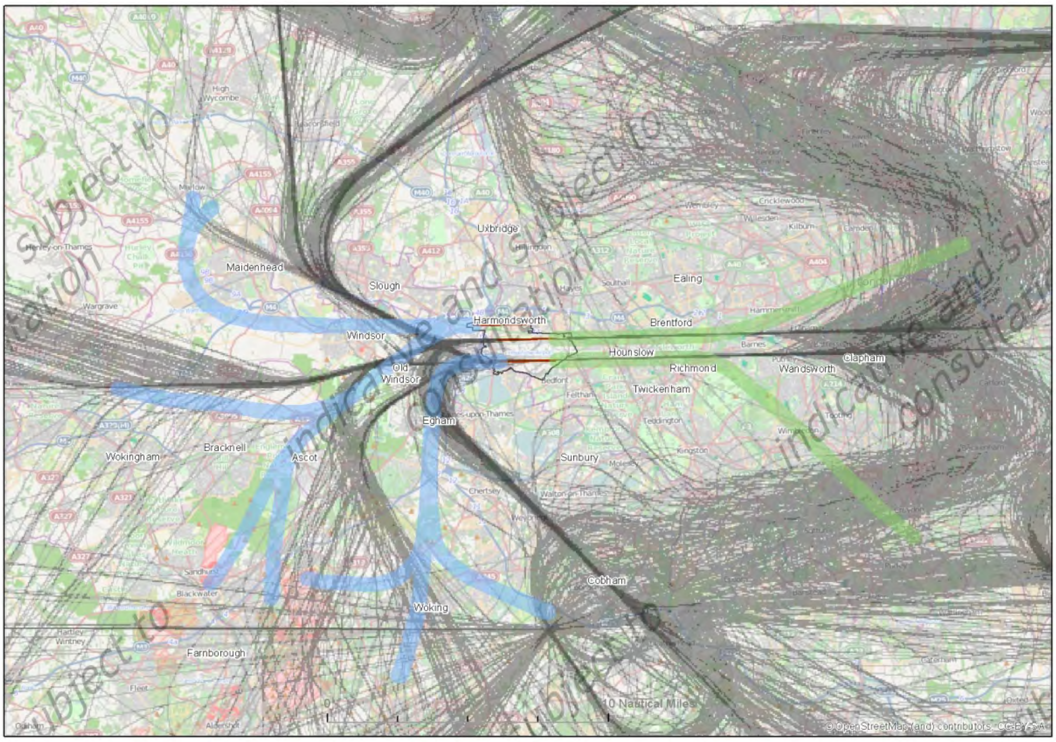


Figure H.25 – Option R – Maximise Respite – Easterly MDL 1

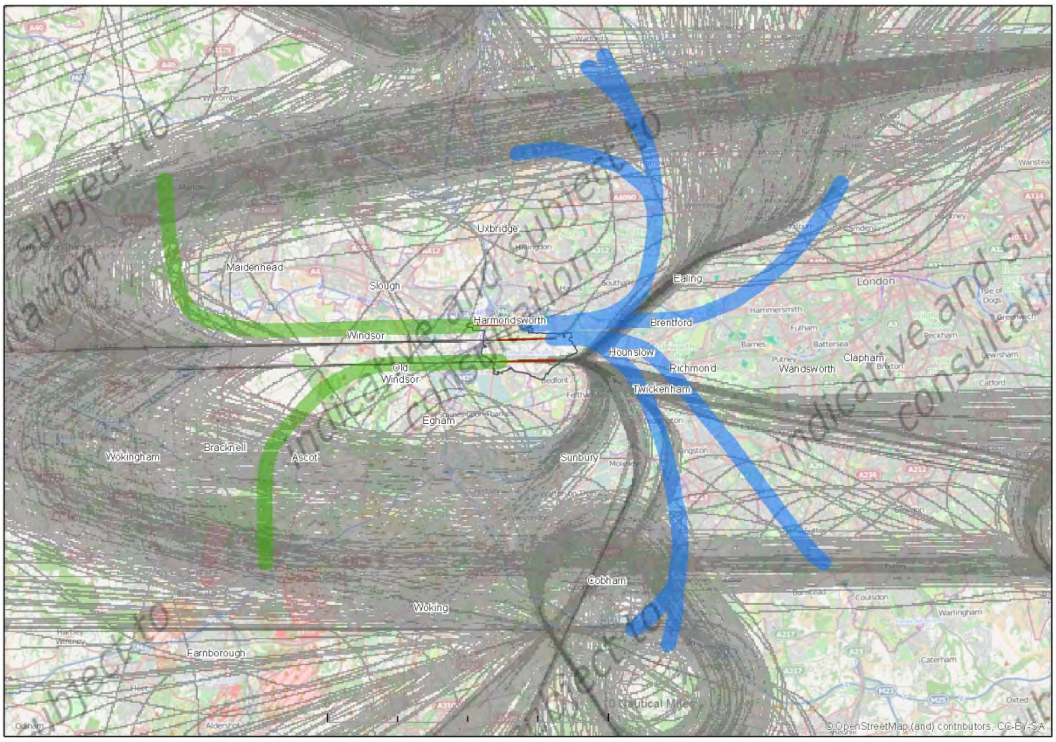


Figure H.26 – Option R – Maximise Respite – Easterly MDL 2

Figure H.27 – Option R – Maximise Respite – Easterly MLD 1

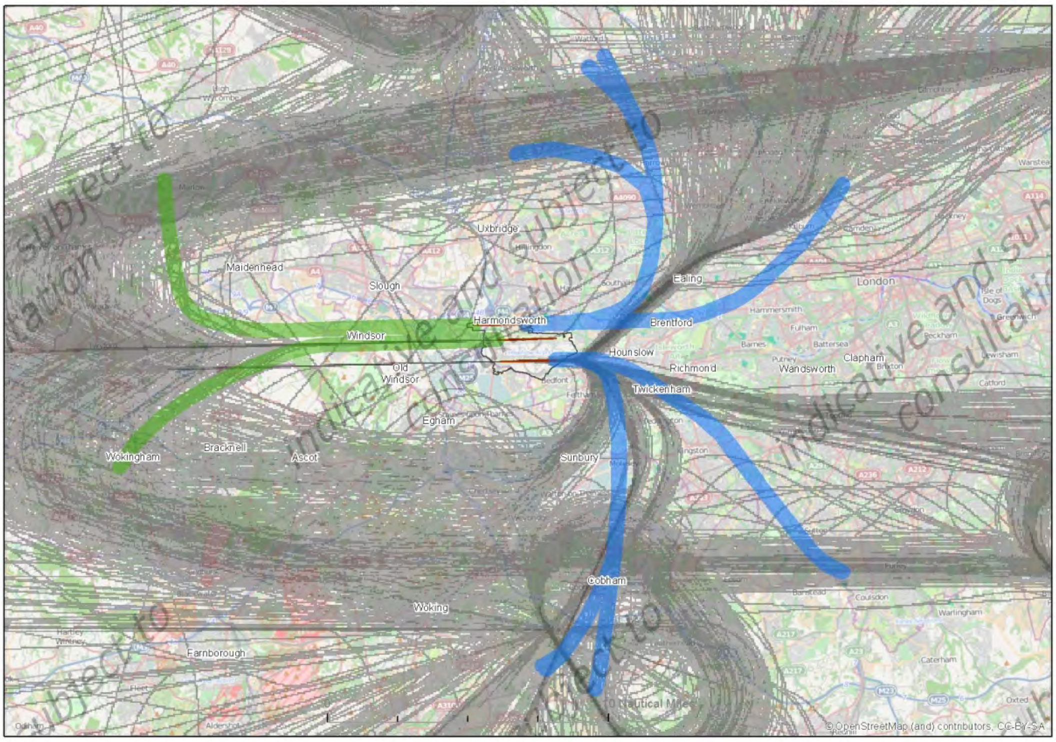


Figure H.28 – Option R – Maximise Respite – Easterly MLD 2

Figure H.29 – Option R – Maximise Respite – Easterly LDM 1

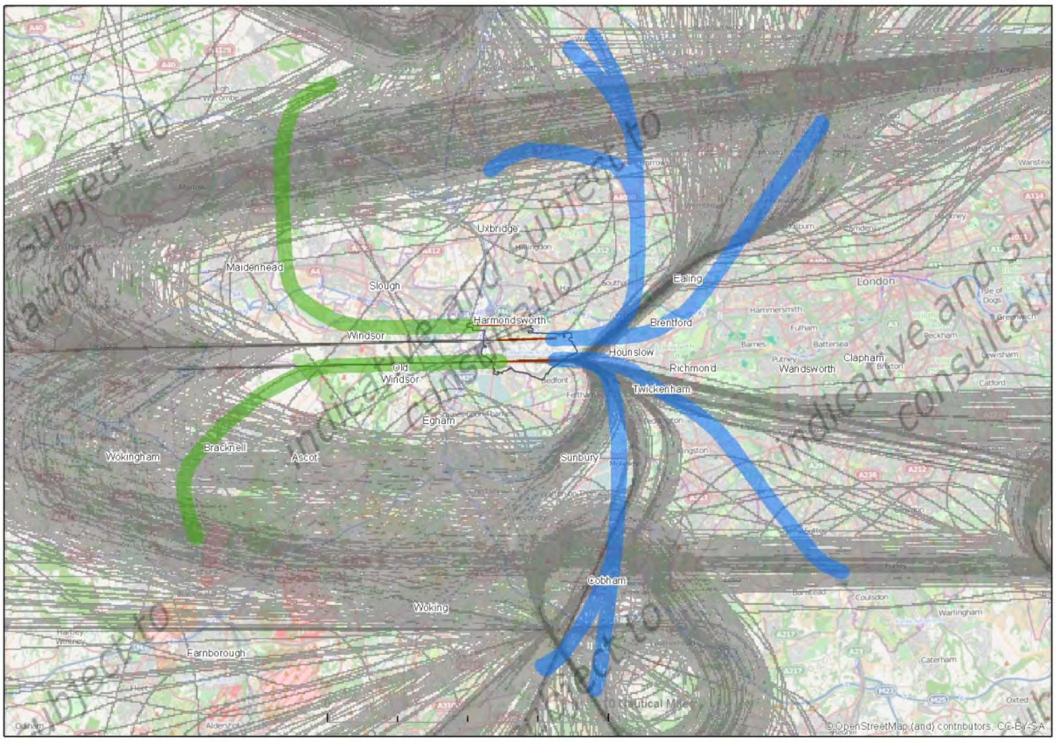


Figure H.30 – Option R – Maximise Respite – Easterly LDM 2

Figure H.31 – Option R – Maximise Respite – Easterly DLM 1

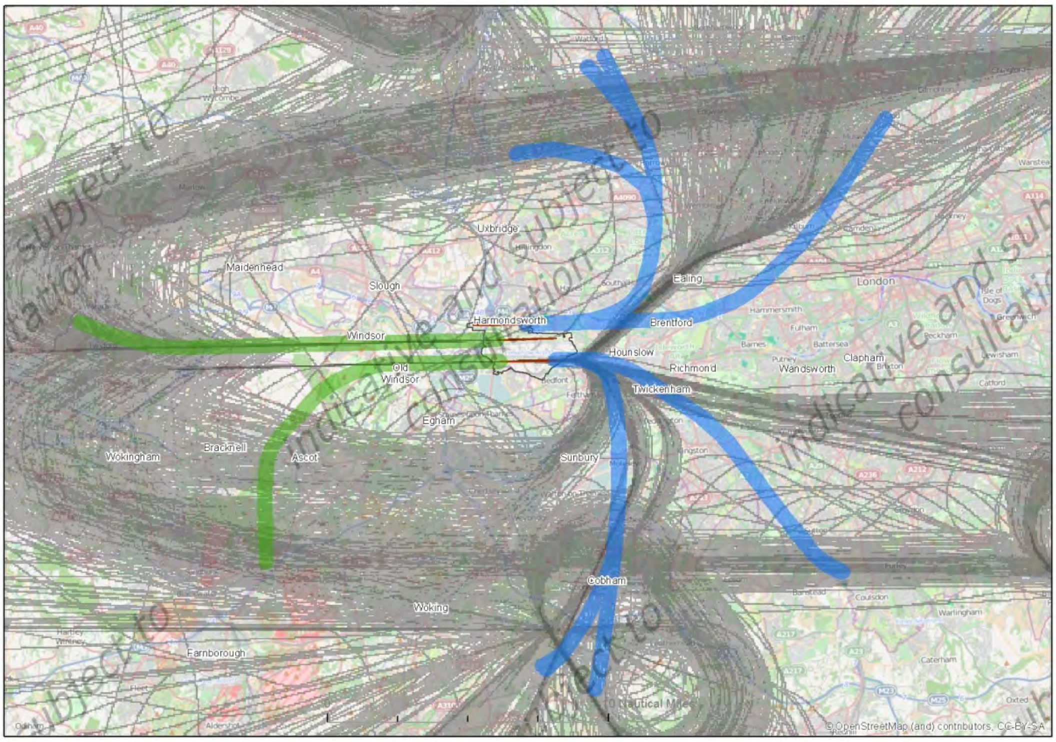
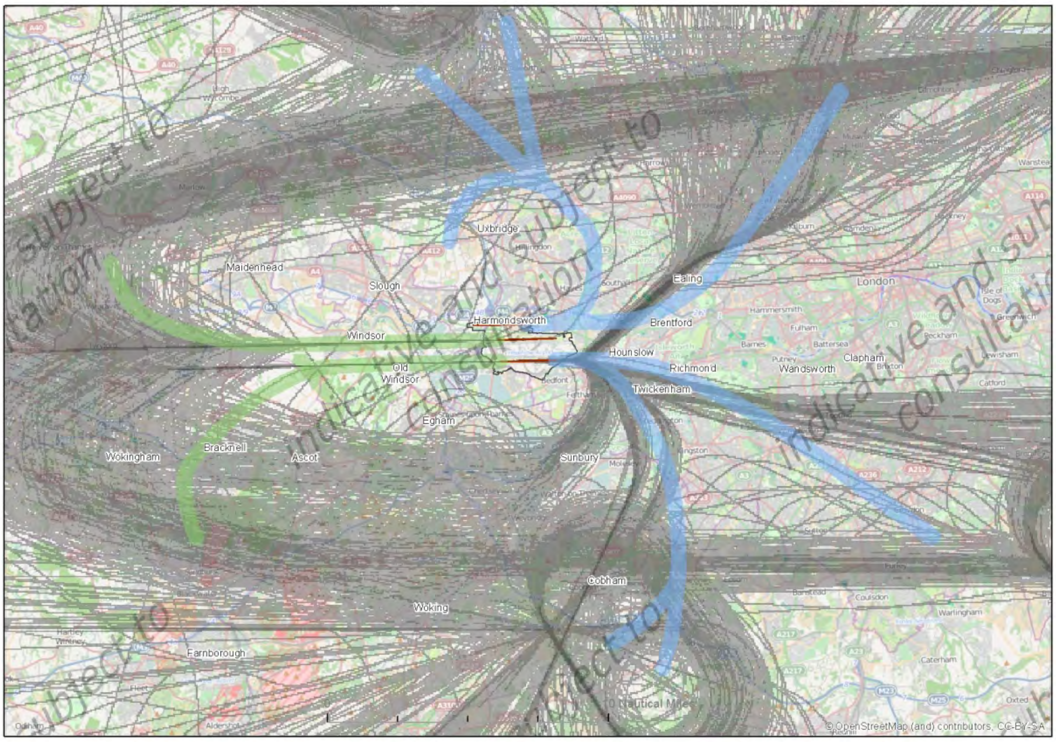


Figure H.32 – Option R – Maximise Respite – Easterly DLM 2



Appendix I
ERCD ANCON Modelling Technical Note

Civil Aviation Authority
Environmental Research and Consultancy Department

Aviation Noise Modelling: Heathrow R3 Options

Issued: 13 June 2014

Introduction

The Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority (CAA) was commissioned by AMEC Environment & Infrastructure UK Ltd (hereafter referred to as "AMEC") to model forecast noise exposure contours for a series of Heathrow airport scenarios.

This document presents the methodology relating to the calculation of these noise contours. In undertaking this work, account was taken of the information presented in the Airports Commission Appraisal Framework[1] on the modelling of aviation noise.

A glossary of technical terms is provided in Appendix A.

Scenarios

AMEC provided annual and summer average aircraft movement numbers by aircraft type, time period (day, evening and night), runway and route for each scenario.

The scenarios requested are summarised below:

- Run 1 – Heathrow 2030 fleet, 2-runway configuration, 480,000 movements per year.
- Run 2 – Heathrow 2030 fleet, 3-runway configuration, 570,000 movements per year, route option N, aimed at minimising the number of people newly affected by noise.
- Run 3 – Heathrow 2030 fleet, 3-runway configuration, 570,000 movements per year, route option R, aimed at providing the maximum level of respite.
- Run 4 – Heathrow 2030 fleet, 3-runway configuration, 570,000 movements per year, route option T, aimed at minimising the total number of people affected by noise.
- Run 5 – Heathrow 2040 fleet, 2-runway configuration, 480,000 movements per year.
- Run 6 – Heathrow 2040 fleet, 3-runway configuration, 740,000 movements per year, route option N, aimed at minimising the number of people newly affected by noise.

[1] Airports Commission: Appraisal Framework, April 2014

- Run 7 – Heathrow 2040 fleet, 3-runway configuration, 740,000 movements per year, route option R, aimed at providing the maximum level of respite.
- Run 8 – Heathrow 2040 fleet, 3-runway configuration, 740,000 movements per year, route option T, aimed at minimising the total number of people affected by noise.

The ANCON noise model

The noise contours were calculated using the UK Civil Aircraft Noise Contour model ANCON (version 2.3). The ANCON model is developed and maintained by ERCD on behalf of the Department for Transport (DfT) and is used for the production of historic and forecast contours for Heathrow, Gatwick and Stansted airports, and a number of regional airports in the UK.

ANCON is fully compliant with the latest European guidance on noise modelling, ECAC.CEAC Doc 29 (3rd edition), published in December 2005[2]. This guidance document represents internationally agreed best practice as implemented in modern aircraft noise models.

Methodology

Aviation noise was calculated for both takeoff and landing operations, accounting for engine and airframe noise. The contours show ‘air noise’, which comprises the noise from aircraft whilst flying in the air and when on the runway during the take-off and landing roll. Noise from ground-based activities such as aircraft taxiing and engine testing (‘ground noise’) is not considered.

Routes and profiles

Information on runway, route and landing threshold geometry was provided by AMEC for each scenario. At AMEC’s request, lateral dispersion was not modelled for the arrival and departure tracks.

ANCON uses average vertical departure and arrival profiles for each modelled aircraft type, which are based on the actual profiles flown by the respective aircraft. These average profiles are calculated from radar data. Models for future aircraft types use the profiles for their respective surrogate aircraft models (see Appendix B for further information).

[2] European Civil Aviation Conference. Report on Standard Method of Computing Noise Contours around Civil Airports ECAC.CEAC Doc 29, 3rd edition, Volumes 1 & 2, December 2005

AMEC requested that arrival profiles adhere to a 3.2˚ approach angle for the 2030 scenarios, and a 3.5˚ angle for the 2040 scenarios. To achieve this, the average profiles, which reflect the current 3.0˚ ILS glideslope, were adjusted to account for the higher approach angles.

Most aircraft approach operations exhibit periods of level flight prior to joining the ILS glideslope on final approach at a distance of around 10 to 12 km from the landing threshold (i.e. over Richmond and Chiswick for westerly arrivals). These are reflected in the ANCON profiles accordingly.

It is understood that AMEC has undertaken its own noise modelling using approach profiles which assume no periods of level flight. This will have the effect of reducing predicted approach noise levels at affected locations that are at least around 10 to 12 km from the runway threshold, compared with the results produced using ANCON.

Aircraft models

Existing aircraft were modelled using the latest (2012) ANCON noise database for operations at Heathrow Airport. This database is reviewed and updated annually and reflects the operational noise performance of each aircraft type at Heathrow.

The estimated noise performance of the imminent and future next generation aircraft types was developed based on available manufacturers' data and current industry knowledge. The process and rationale used for this is summarised in Appendix B.

Noise metrics

Noise exposure contours were calculated for the metrics listed below, as specified in the Appraisal Framework. The N65 metric is not specified in the Appraisal Framework, but was requested by AMEC in addition:

- $L_{Aeq,16h}$ metric calculated for average summer day movements over the 16-hour daytime period between 07:00 and 23:00. Contours from 54 to 72 dB were produced in 3 dB steps.
- $L_{Aeq,8h}$ metric calculated for average summer night movements over the 8-hour night-time period between 23:00 and 07:00. Contours from 48 to 72 dB were produced, where relevant, in 3 dB steps.

- L_{den} metric calculated for the annual average daily movements over the 24-hour period, with weightings of 5 dB for evening (19:00 - 23:00) and 10 dB for night-time (23:00 - 07:00). Contours from 55 to 75 dB were produced in 5 dB steps.
- N70 ‘number above’ metric describes the number of noise events (N) exceeding an outdoor maximum noise level of 70 dB L_{Amax}, calculated for the average summer day movements over the 16-hour period between 07:00 and 23:00. Contours of N greater than 20, 50, 100, 200 and 500 events were produced where relevant.
- N65, the same as N70 but with the threshold set at 65 dB L_{Amax}.
- N60, similar to the N70 metric, but calculated for the average summer night movements over the 8-hour period between 23:00 and 07:00. Contours of N greater than 25 and 50 events were plotted where relevant.

The areas, populations and numbers of households enclosed by the contours were calculated. The population and household estimates were calculated using forecast population data for 2030 and 2040 provided by AMEC.

Any people or households located within the new expanded airport boundary for the three-runway scenarios were not included in the population or household estimates.

APPENDIX A

Glossary of Technical Terms

ANCON	The UK civil aircraft noise contour model, developed and maintained by ERCD.
CAD	Computer Aided Design.
dB	Decibel units describing sound level or changes of sound level.
dBA	Units of sound level on the A-weighted scale, which incorporates a frequency weighting approximating the characteristics of human hearing.
DfT	Department for Transport (UK Government).
ECAC	European Civil Aviation Conference.
ERCD	Environmental Research and Consultancy Department of the Civil Aviation Authority.
ILS	Instrument Landing System; a ground-based system that provides precision guidance to an aircraft approaching and landing on a runway.
$L_{Aeq,16h}$	Equivalent sound level of aircraft noise in dBA, often called 'equivalent continuous sound level'. For conventional historical contours this is based on the daily average movements that take place within the 16-hour period (0700-2300 local time) over the 92-day summer period from 16 June to 15 September inclusive.
$L_{Aeq,8h}$	Equivalent sound level of aircraft noise in dBA often called 'equivalent continuous sound level'. This is based on the daily average movements that take place within the 8-hour period (2300-0700 local time) over the 92-day summer period from 16 June to 15 September inclusive.
L_{den}	Equivalent sound level of aircraft noise in dBA for the 24-hour annual average period with 5 dB weightings for $L_{evening}$ and 10 dB weightings for L_{night}.
N70 & N60	'Number above' contours describe the number of noise events (N) exceeding an outdoor maximum noise level of 70 dBA Lmax for N70 (based on an average summer's 16-hour day), and 60 dBA Lmax for N60 (based on an average summer's 8-hour night).
NPPF	National Planning Policy Framework.
NPSE	Noise Policy Statement for England.
TfL	Transport for London

APPENDIX B

Future Aircraft Types for Forecasting

Introduction

The requirement to forecast aircraft noise exposure to 2050 necessitates the definition of future aircraft types and their associated noise characteristics.

Historical trends clearly show that each generation of aircraft are quieter than their predecessor, significantly so in some cases. This is a reflection of the introduction of new technologies, of which some are aimed purely at reducing aircraft noise, whilst others are, for example, aimed at reducing fuel burn.

This changing of noise performance over time necessitates the need to take into account how the aircraft fleet will change.

Methodology

For each future aeroplane type, an explicit ‘surrogate’ has been chosen; a similar aircraft type whose certificated noise levels are known. For a given future type, the noise model data for this surrogate aircraft are then adjusted based on the differences between the future type’s predicted certification data and the surrogate aircraft’s known data.

The same approach has been used as in previous assessments such as the noise study undertaken in support of the Department for Transport’s (DfT) Consultation: Adding Capacity at Heathrow Airport, which formed part of the Project for the Sustainable Development of Heathrow (PSDH)[3].

Future aircraft types

The assumptions on the noise characteristics of the future aircraft types presented in this assessment are based on the latest available data. They update the assumptions used in the previous ERCD studies and are aligned to the guidance in The SA Noise Road-Map[4]. There are two categories of future aircraft:

[3] ERCD Report 0705, Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport, November 2007. www.caa.co.uk/ERCDreport0705

[4] The SA Noise Road-Map, A Blueprint for Managing Noise from Aviation Sources to 2050. 2013, Sustainable Aviation.

- *Imminent* aircraft types incorporating Generation 1 technology with significant fuel burn and noise benefits. These have recently entered, or are currently offered for sale to the market, and include all-new aircraft as well as re-engined aircraft.
- *Future* aircraft types incorporating Generation 2 technology, which aim to achieve the noise goals set out in Flightpath 2050[5]. These types are envisaged to eventually replace the Imminent Generation 1 aircraft.

In the former case, the noise characteristics are well-defined. In the latter case, the assumptions are based on expected technological advances and underlying trends as well as the entry into service (EIS) date of the Generation 2 aircraft type relative to Generation 1 predecessors.

Use has been made of the Sustainable Aviation assumption of a 0.1 dB/year baseline rate of improvement from the Generation 1 introduction dates (assuming no technology step-changes or major configurational changes).

Descriptions of the basic characteristics of the Imminent (Generation 1) and Future (Generation 2) types are given in The SA Noise Road-Map. **Tables B1 and B2** below identify the new types, presenting the surrogate types and corresponding adjustments used to model them.

[5] Flightpath 2050, Europe's Vision for Aviation. 2011, European Commission.

Table B1: Generation 1 *Imminent* aircraft types and modelling assumptions

Aircraft category	Aircraft type	New ANCON model	ANCON model surrogate	Adjustment, dB	
				Departure	Arrival
Airbus single-aisle	A319 NEO	EA319NEO	A319V	-2.6	-1.9
Airbus single-aisle	A320 NEO	EA320NEO	A320V	-2.6	-2.2
Airbus single-aisle	A321 NEO	EA321NEO	A321V	-2.7	-1.0
Airbus twin-aisle	A350-800	EA358	EA33	-4.1	0.1
Airbus twin-aisle	A350-900	EA359	EA33	-4.2	0.4
Airbus twin-aisle	A350-1000	EA3510	EA33	-1.8	1.6
Airbus very large	A380-900	EA389	EA38	0.0	0.0
Boeing single-aisle	B737-700 MAX	B7377MAX	B736	-3.5	-1.0
Boeing single-aisle	B737-800 MAX	B7378MAX	B738	-3.9	-0.4
Boeing single-aisle	B737-900 MAX	B7379MAX	B738	-2.7	-0.1
Boeing twin-aisle	B787-8	B788	B763G	-4.3	-2.3
Boeing twin-aisle	B787-9	B789	B763G	-2.3	-1.1
Boeing twin-aisle	B787-10	B7810	B763G	-1.0	-0.3
Boeing very large	B747-8	B748	B744G	-4.65	-2.9
Generic regional jet	E170 NEO	ERJ170NEO	ERJ170	-6.5	-2.8
Generic regional jet	E190 NEO	ERJ190NEO	ERJ170	-4.6	-0.3

Table B2: Generation 2 *Future* aircraft types and modelling assumptions

Aircraft category	Aircraft type	New ANCON model	ANCON model surrogate	Adjustment, dB	
				Departure	Arrival
Airbus single-aisle	A319 NEO G2	EA319N2	EA319NEO	-0.7	-0.2
Airbus single-aisle	A320 NEO G2	EA320N2	EA320NEO	-0.7	-0.2
Airbus single-aisle	A321 NEO G2	EA321N2	EA321NEO	-0.7	-0.2
Airbus twin-aisle	A350-800 G2	EA358N2	EA358	-1.7	-0.4
Airbus twin-aisle	A350-900 G2	EA359N2	EA359	-2.1	-0.4
Airbus twin-aisle	A350-1000 G2	EA3510N2	EA3510	-2.0	-0.4
Airbus very large	A380-800 NEO G2	EA38NEO	EA38	-1.0	0.0
Airbus very large	A380-900 NEO G2	EA389NEO	EA389	-1.0	0.0
Boeing single-aisle	B737-700 MAX G2	B7377N2	B7377MAX	-0.7	-0.1
Boeing single-aisle	B737-800 MAX G2	B7378N2	B7378MAX	-0.6	-0.1
Boeing single-aisle	B737-900 MAX G2	B7379N2	B7379MAX	-0.6	-0.1
Boeing twin-aisle	B787-8 G2	B788N2	B788	-1.9	-0.4
Boeing twin-aisle	B787-9 G2	B789N2	B789	-2.2	-0.4
Boeing twin-aisle	B787-10 G2	B7810N2	B7810	-1.9	-0.4
Boeing very large	B747-8 G2	B748N2	B748	-2.3	-0.5
Generic regional jet	E170 NEO G2	ERJ170N2	ERJ170NEO	-1.4	-0.3
Generic regional jet	E190 NEO G2	ERJ190N2	ERJ190NEO	-1.4	-0.3

Appendix J
Noise Exposure Change Figures

Figure J.1 – Option T – Minimise Total – $L_{Aeq,\,16hr}$ Noise Exposure Change 3R 2030 vs 2R 2011

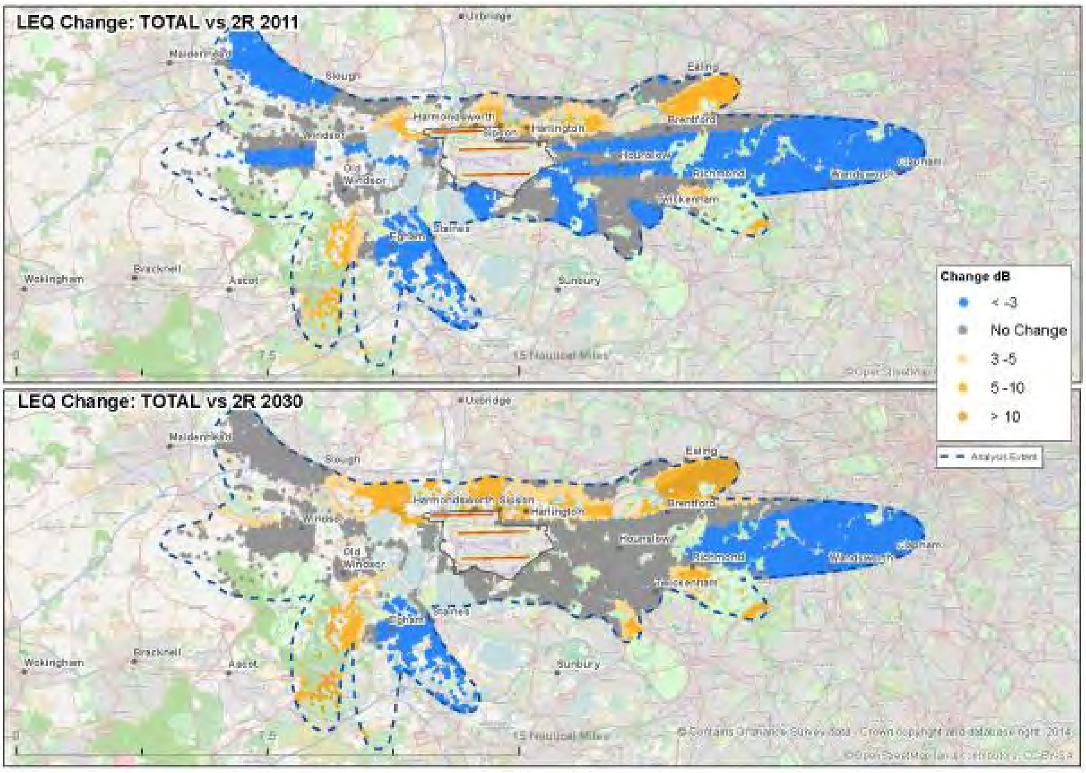


Figure J.2 – Option T – Minimise Total – L_{den} Noise Exposure Change 3R 2030 vs 2R 2011

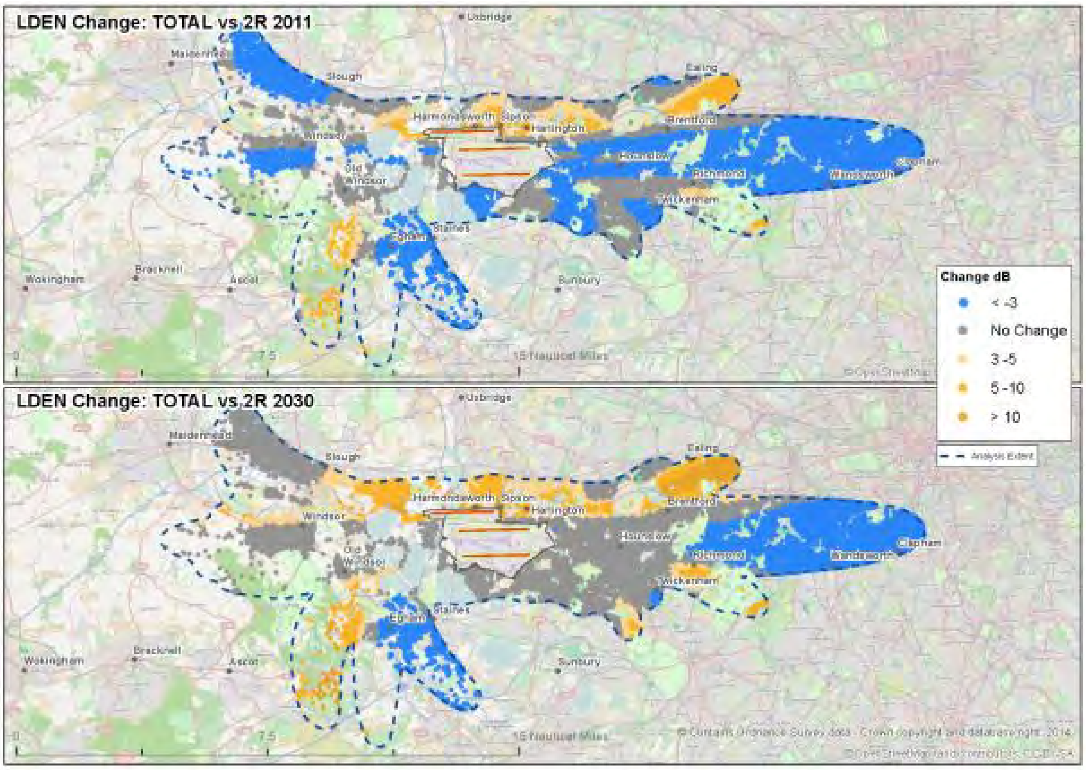


Figure J.3 – Option T – Minimise Total – $L_{Aeq,\ 8hr\ (night)}$ Noise Exposure Change 3R 2030 vs 2R 2011

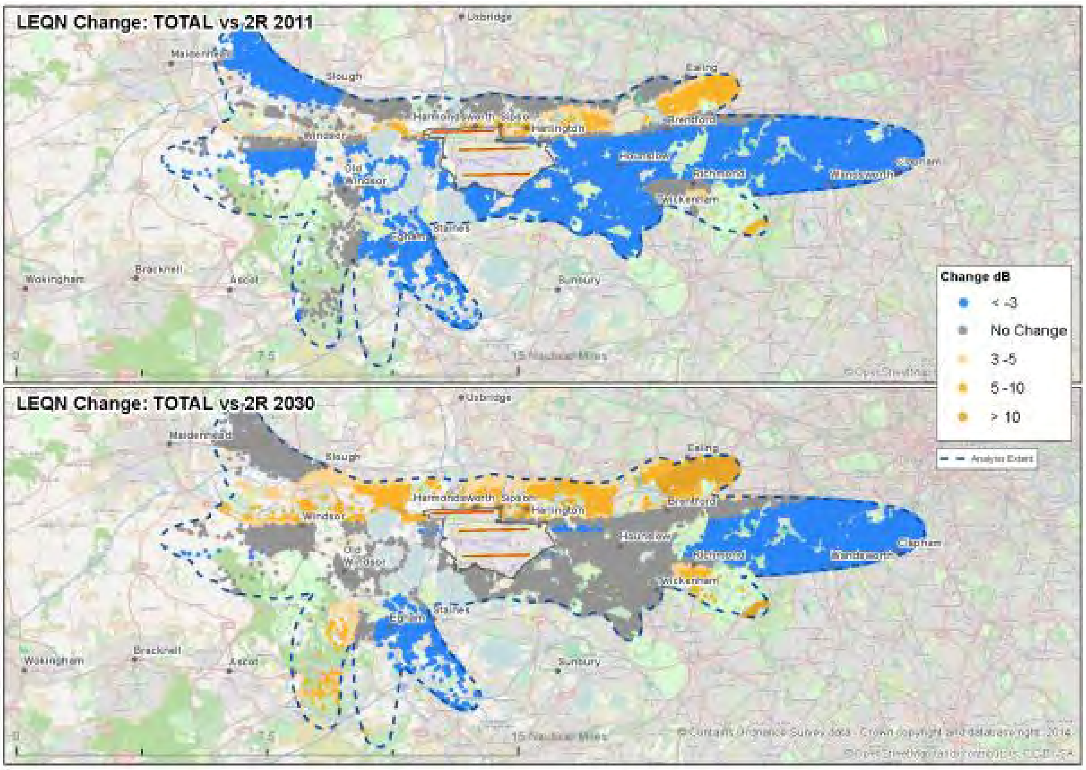


Figure J.4 – Option T – Minimise Total – Overview of Population Exposure Changes

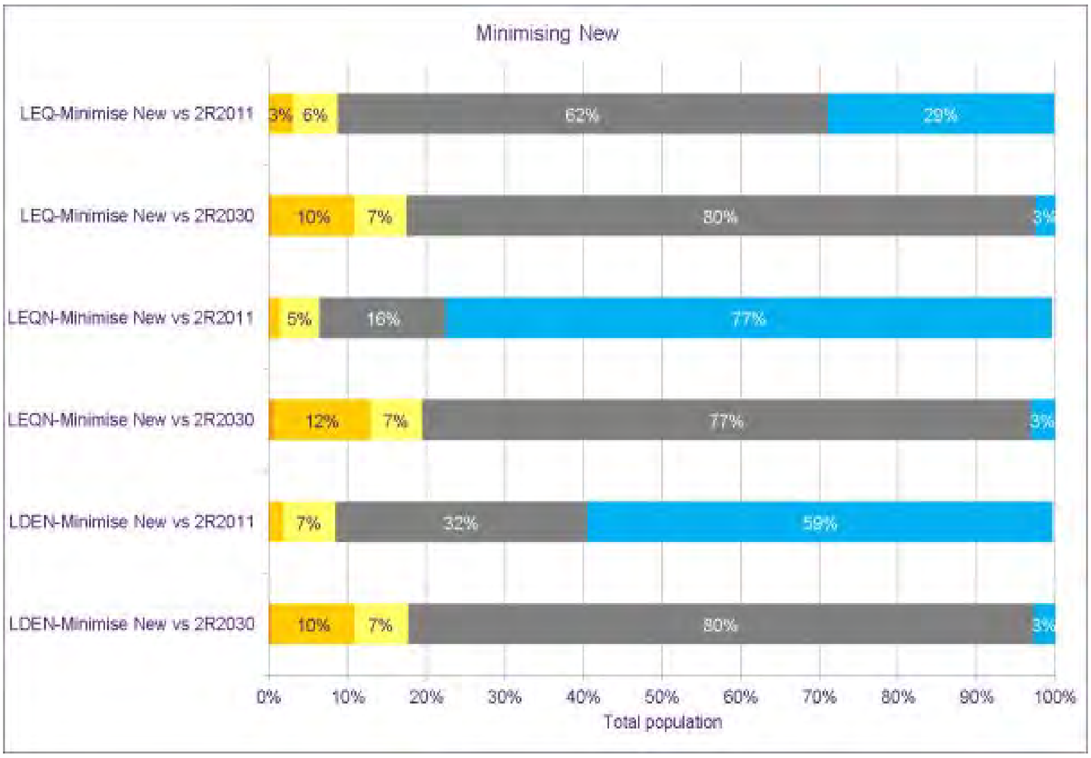


Figure J.5 – Option N – Minimise New – $L_{Aeq, 16hr}$ Noise Exposure Change 3R 2030 vs 2R 2011

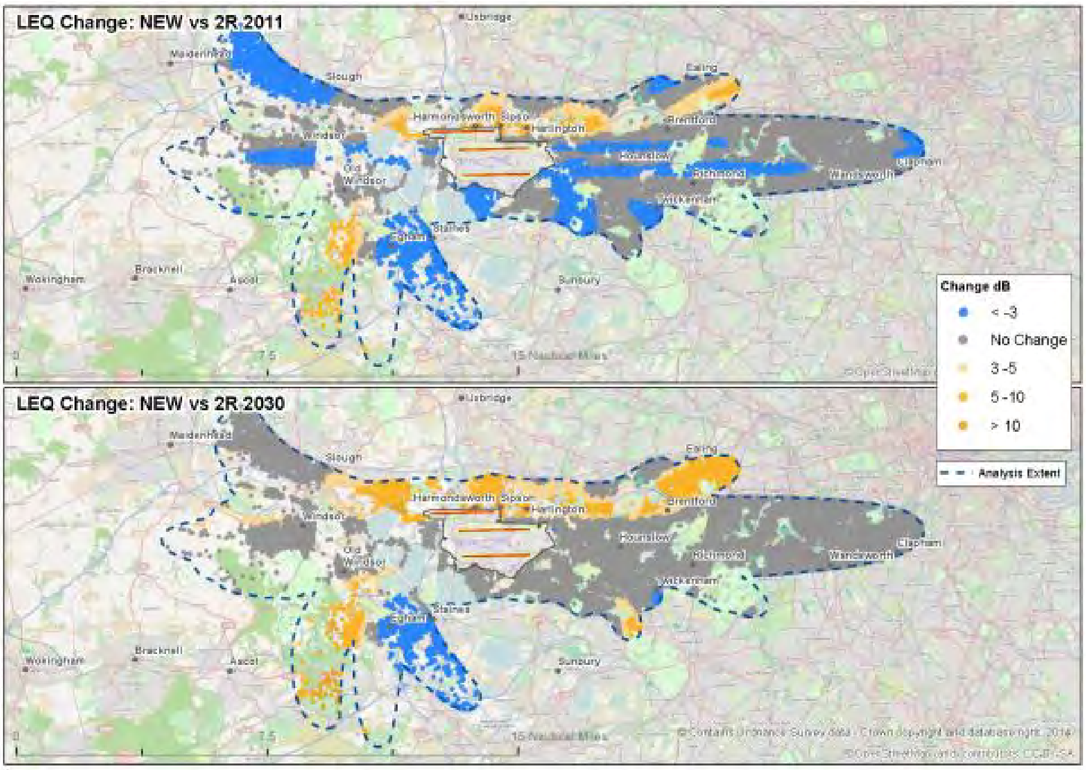


Figure J.6 – Option N – Minimise New – L_{den} Noise Exposure Change 3R 2030 vs 2R 2011

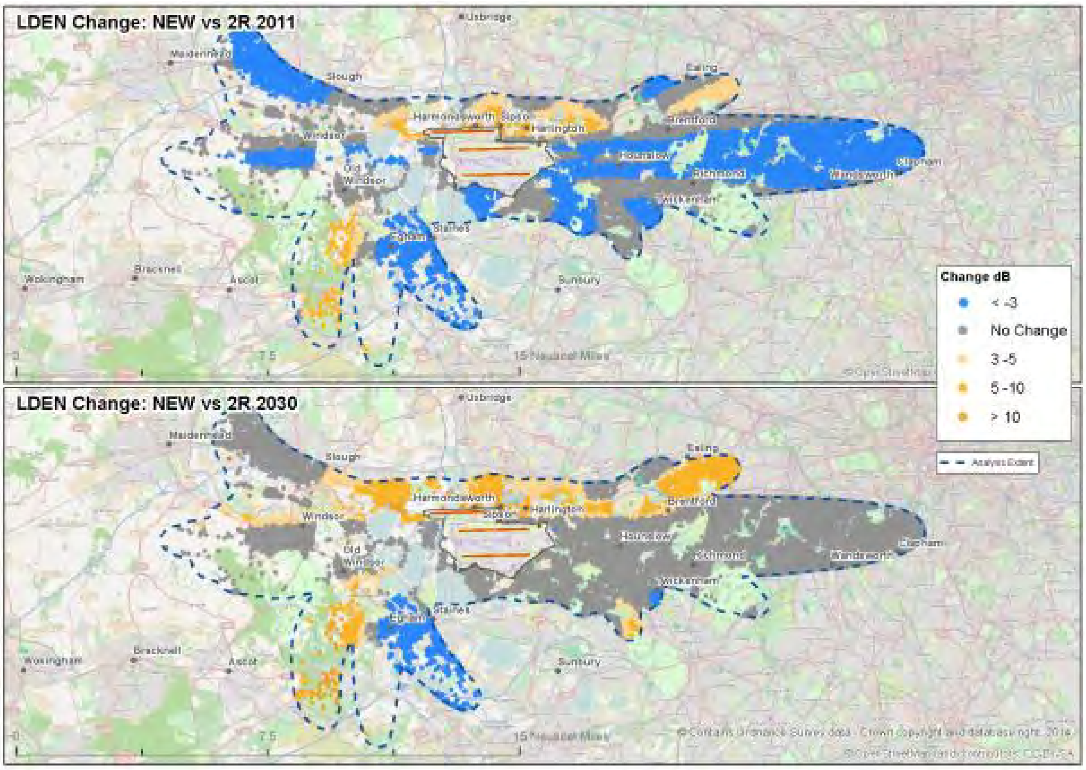


Figure J.7 – Option N – Minimise New – $L_{Aeq,\ 8hr\ (night)}$ Noise Exposure Change 3R 2030 vs 2R 2011

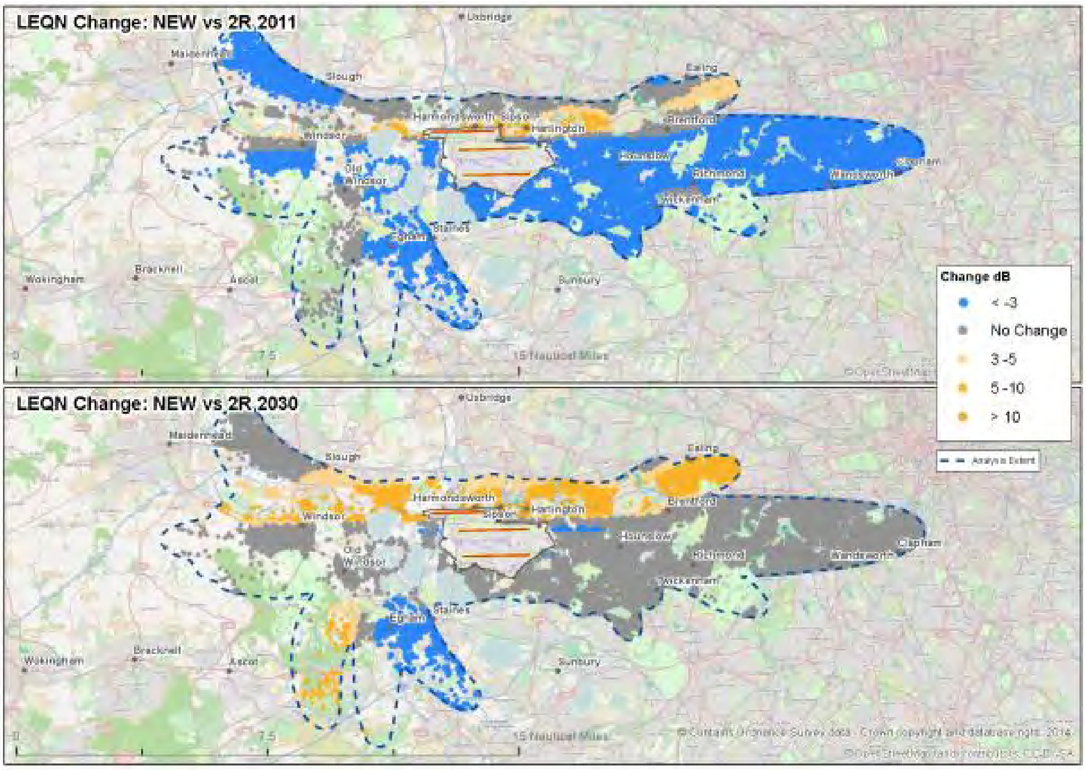


Figure J.8 – Option N – Minimise New – Overview of Population Exposure Changes

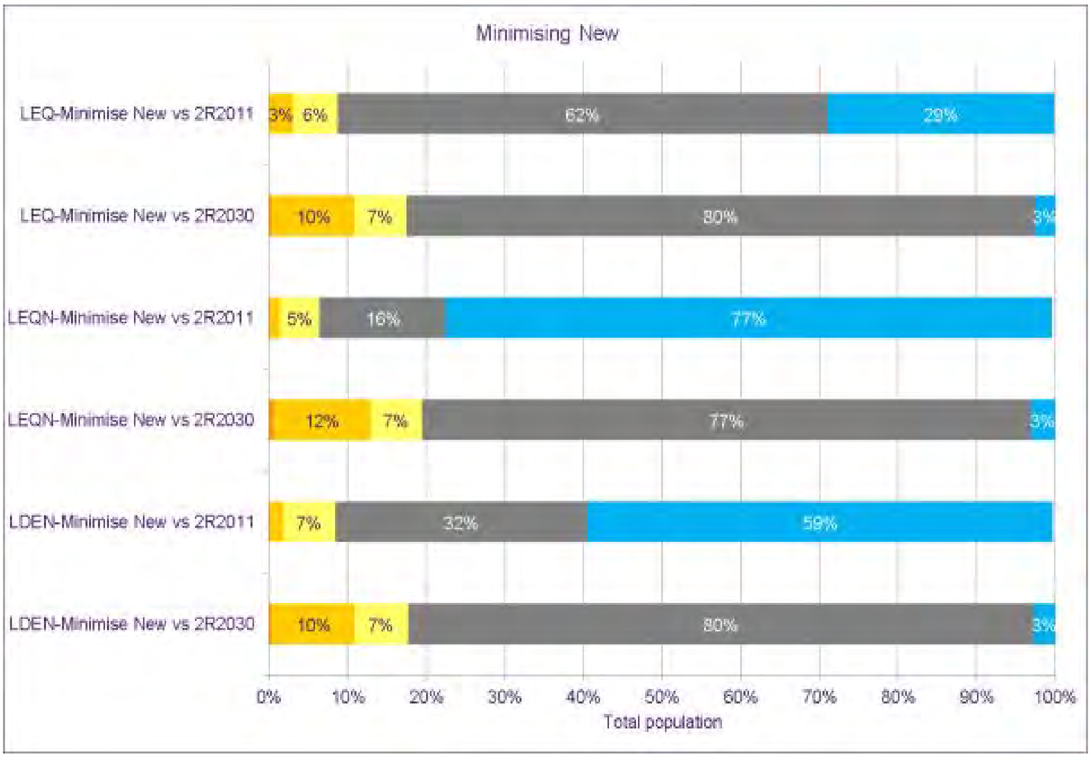


Figure J.9 – Option R – Maximise Respite – $L_{Aeq,\ 16hr}$ Noise Exposure Change 3R 2030 vs 2R 2011

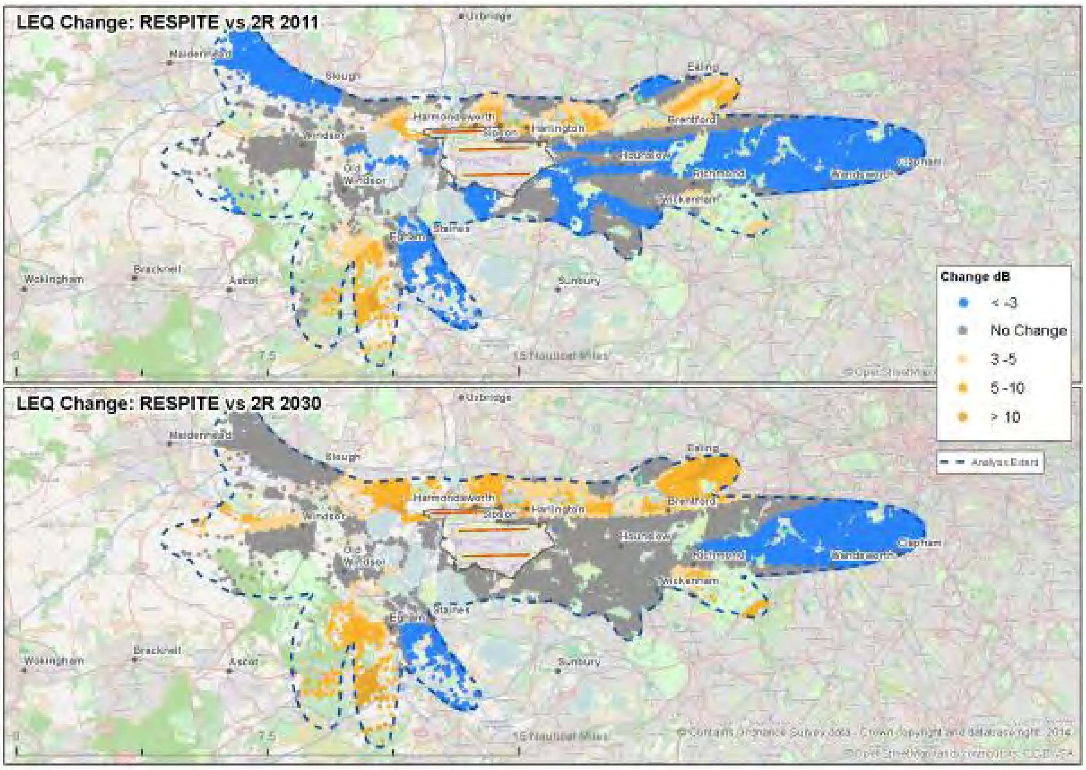


Figure J.10 – Option R – Maximise Respite – L_{den} Noise Exposure Change 3R 2030 vs 2R 2011

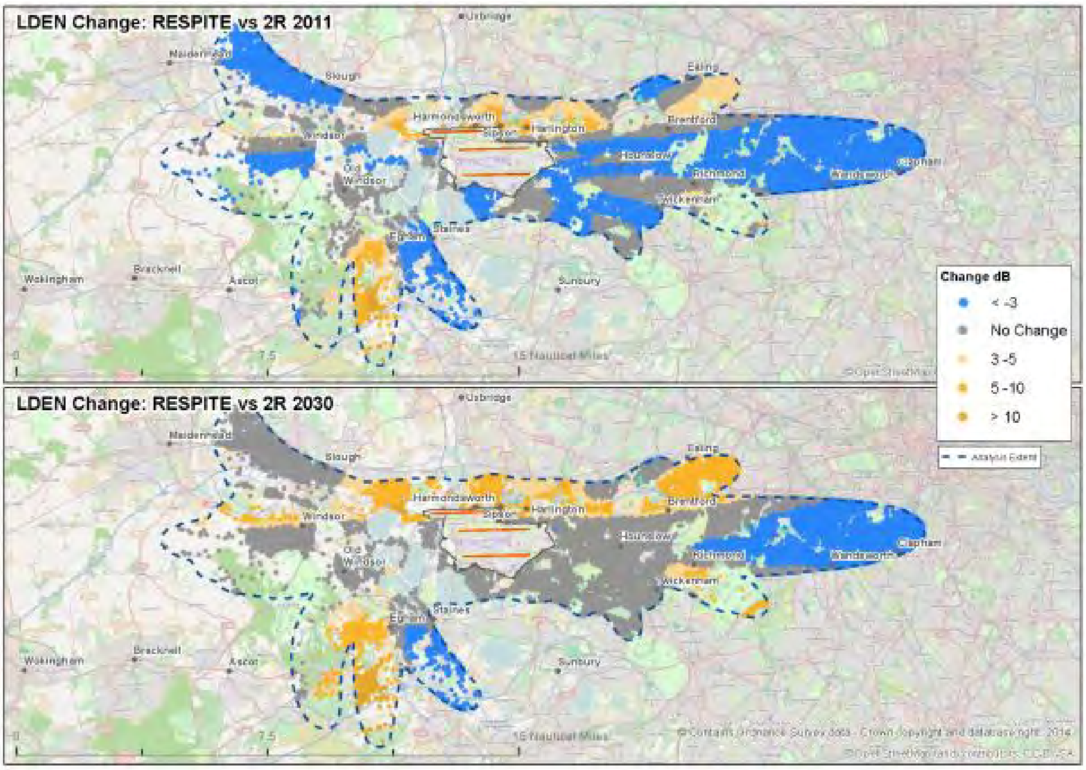


Figure J.11 – Option R – Maximise Respite – $L_{Aeq,\ 8hr\ (night)}$ Noise Exposure Change 3R 2030 vs 2R 2011

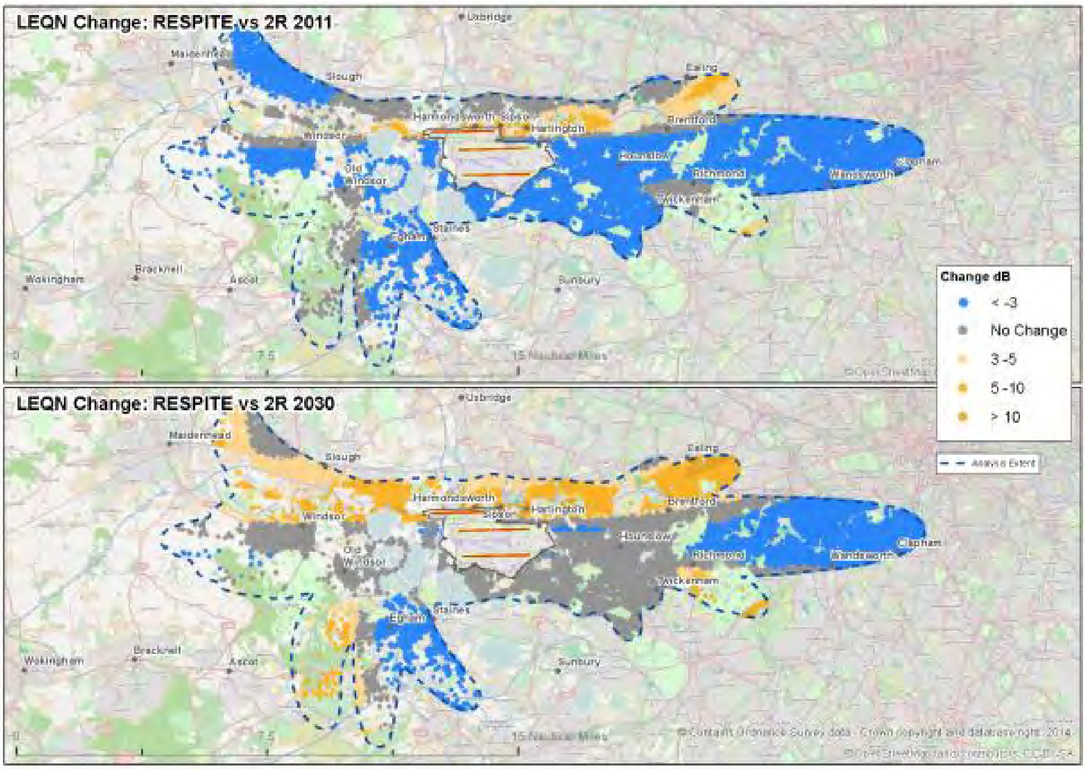
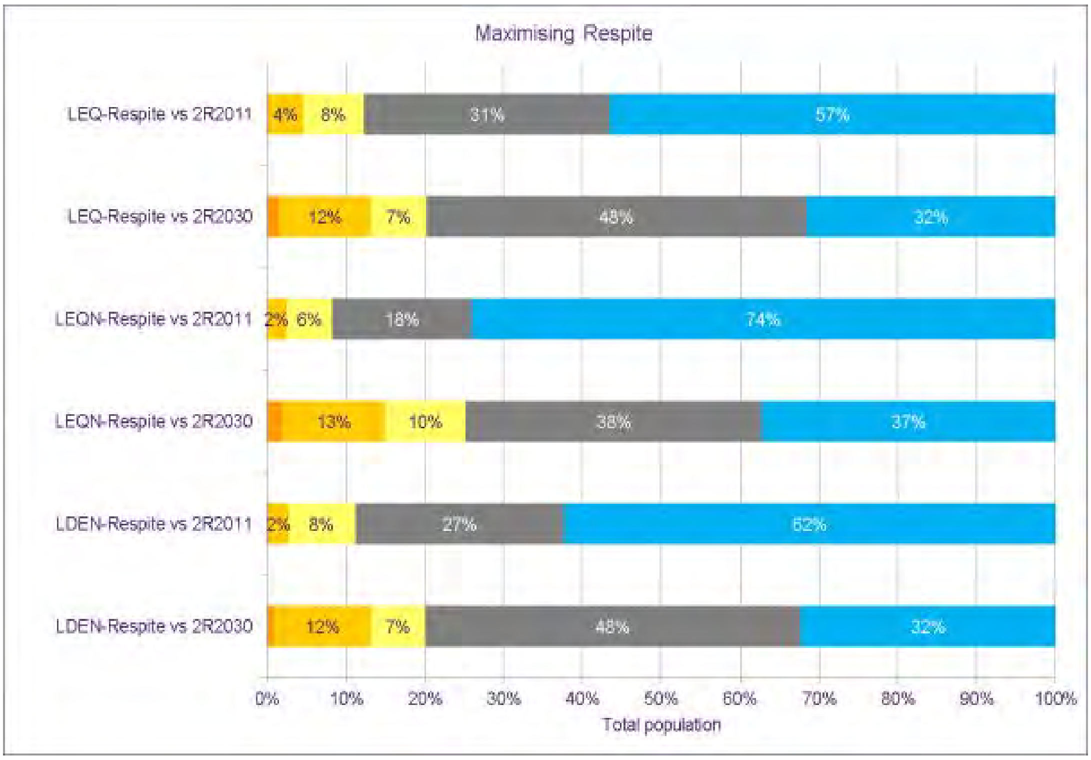


Figure J.12 – Option R – Maximise Respite – Overview of Population Exposure Changes



Appendix K
Respite Figures

Figure K.1 Spatial Analysis of the proportion of respite received during westerly operations for Option N

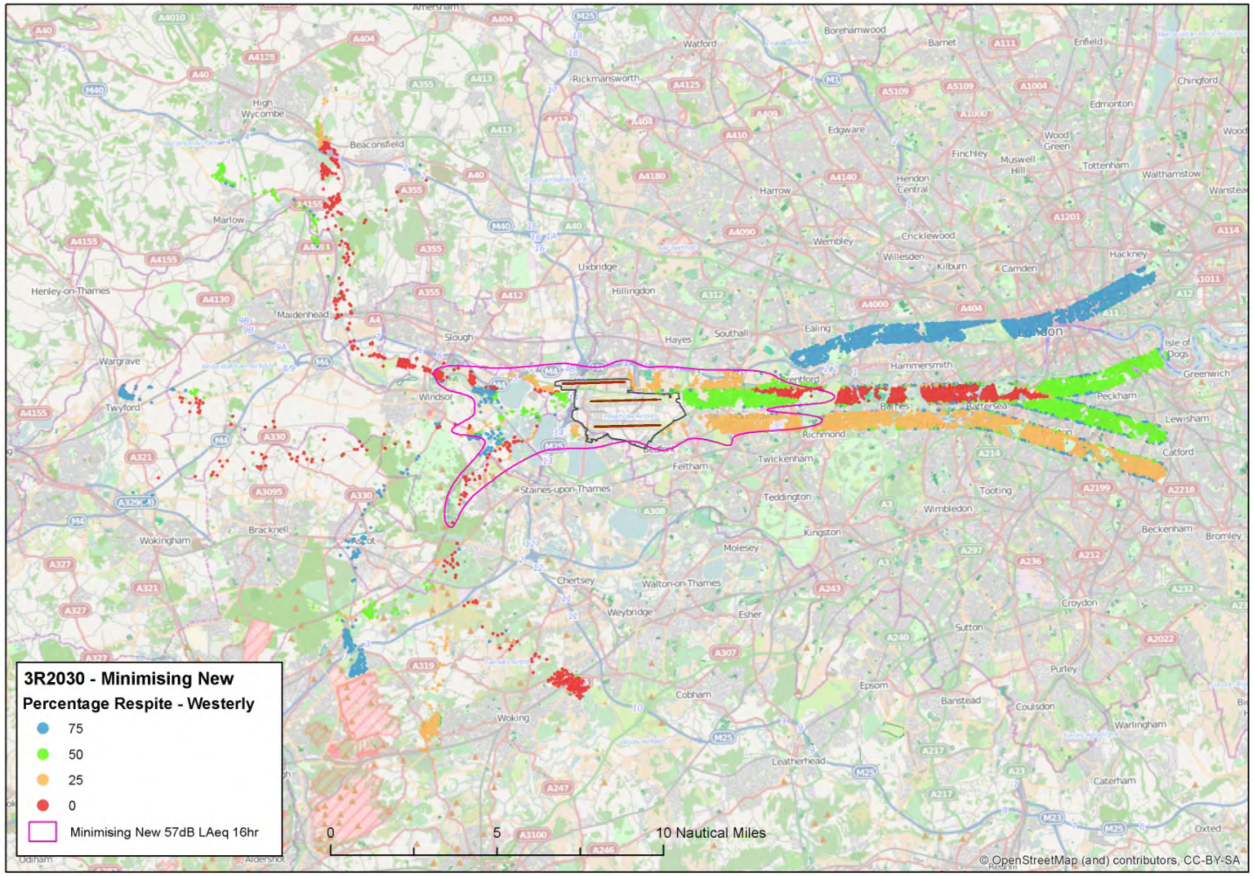


Figure K.2 Spatial Analysis of the proportion of respite received during easterly operations for Option N

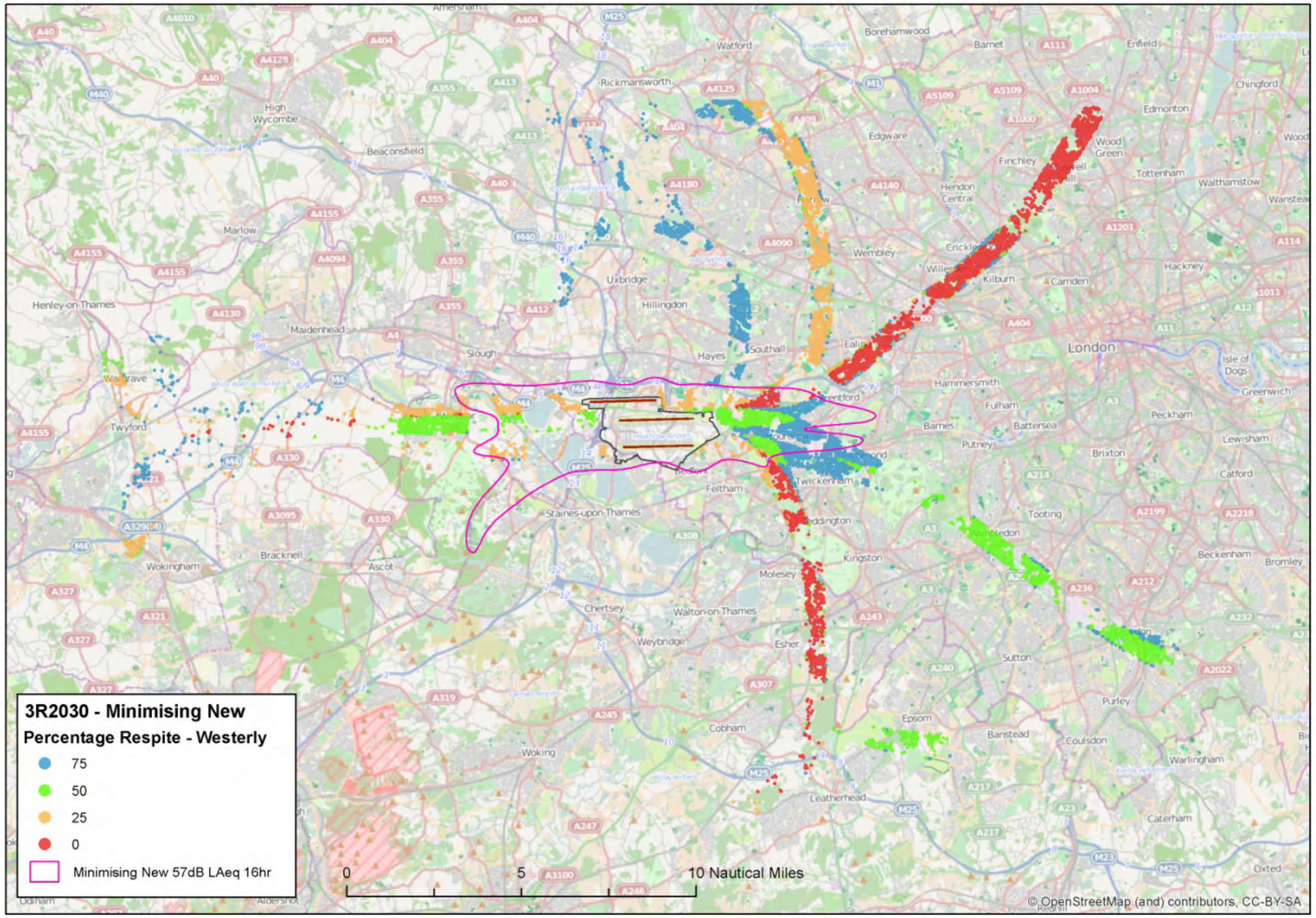


Figure K.3 Spatial analysis of the number of modes for which areas are overflown in total for Option N

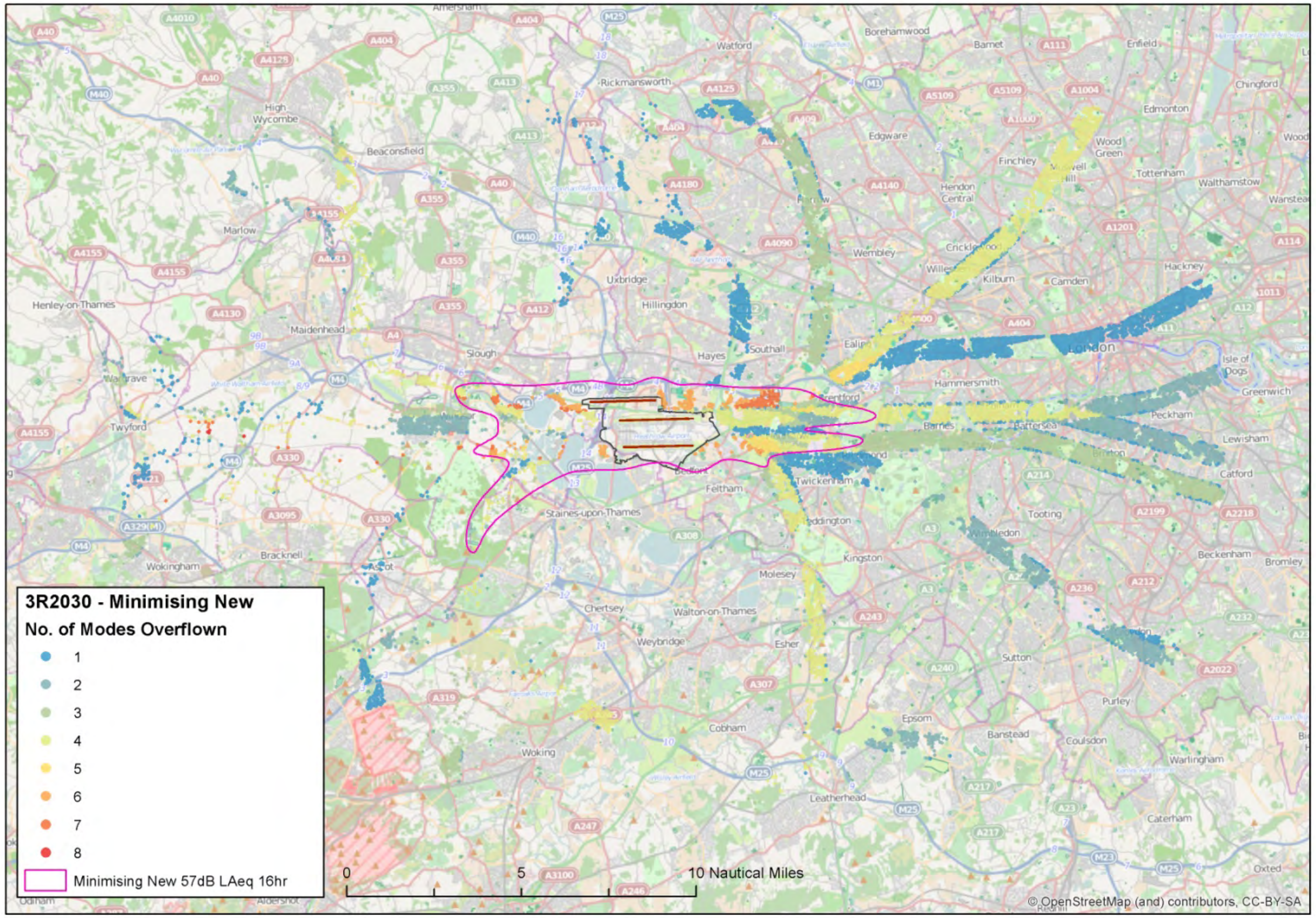


Figure K.4 **Spatial analysis indicating the number of days per year for which areas are overflown in total for Option N**

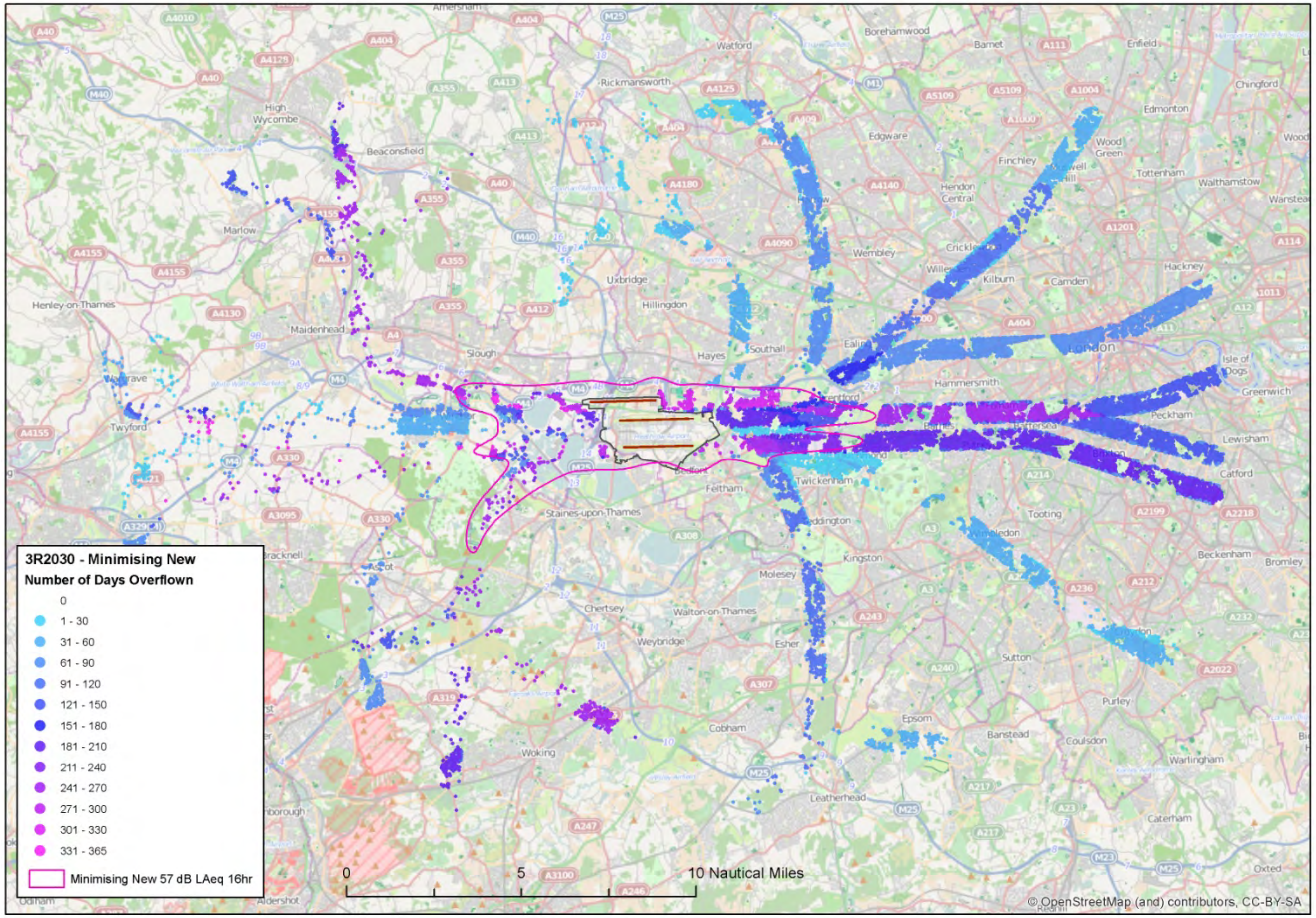


Figure K.5 Spatial Analysis of the proportion of respite received during westerly operations for Option T

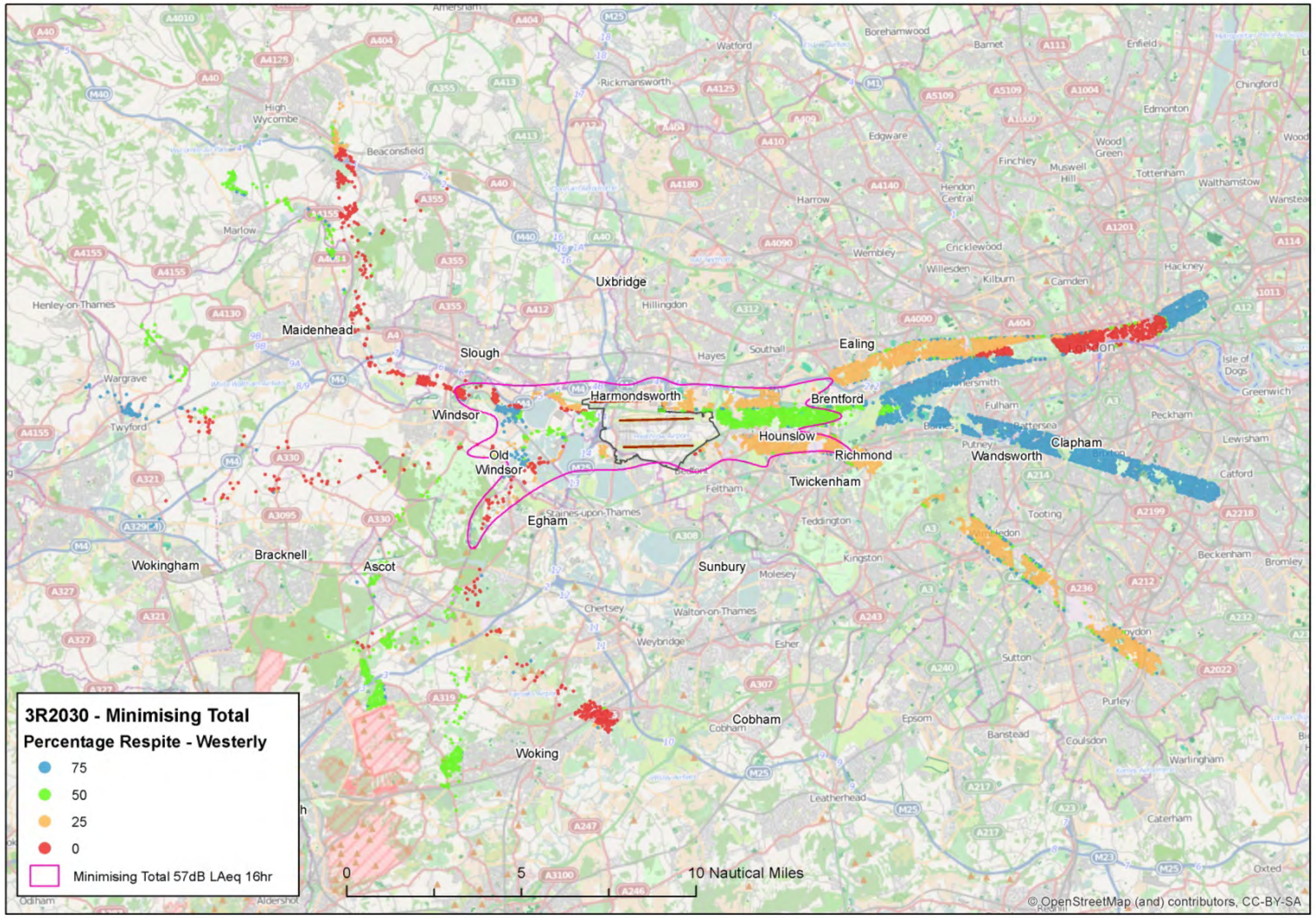


Figure K.6 Spatial Analysis of the proportion of respite received during easterly operations for Option T

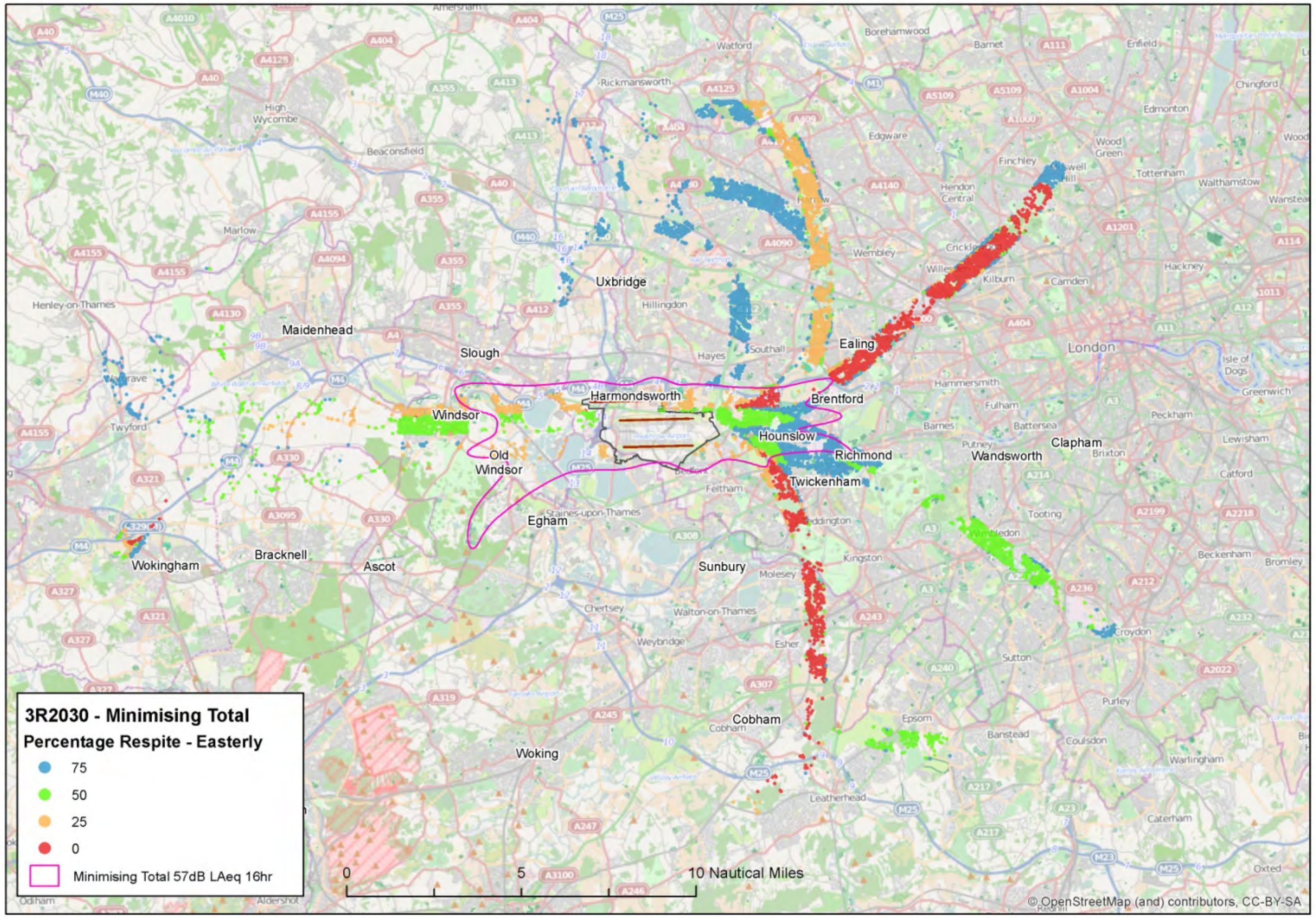


Figure K.7 Spatial analysis of the number of modes for which areas are overflown in total for Option T

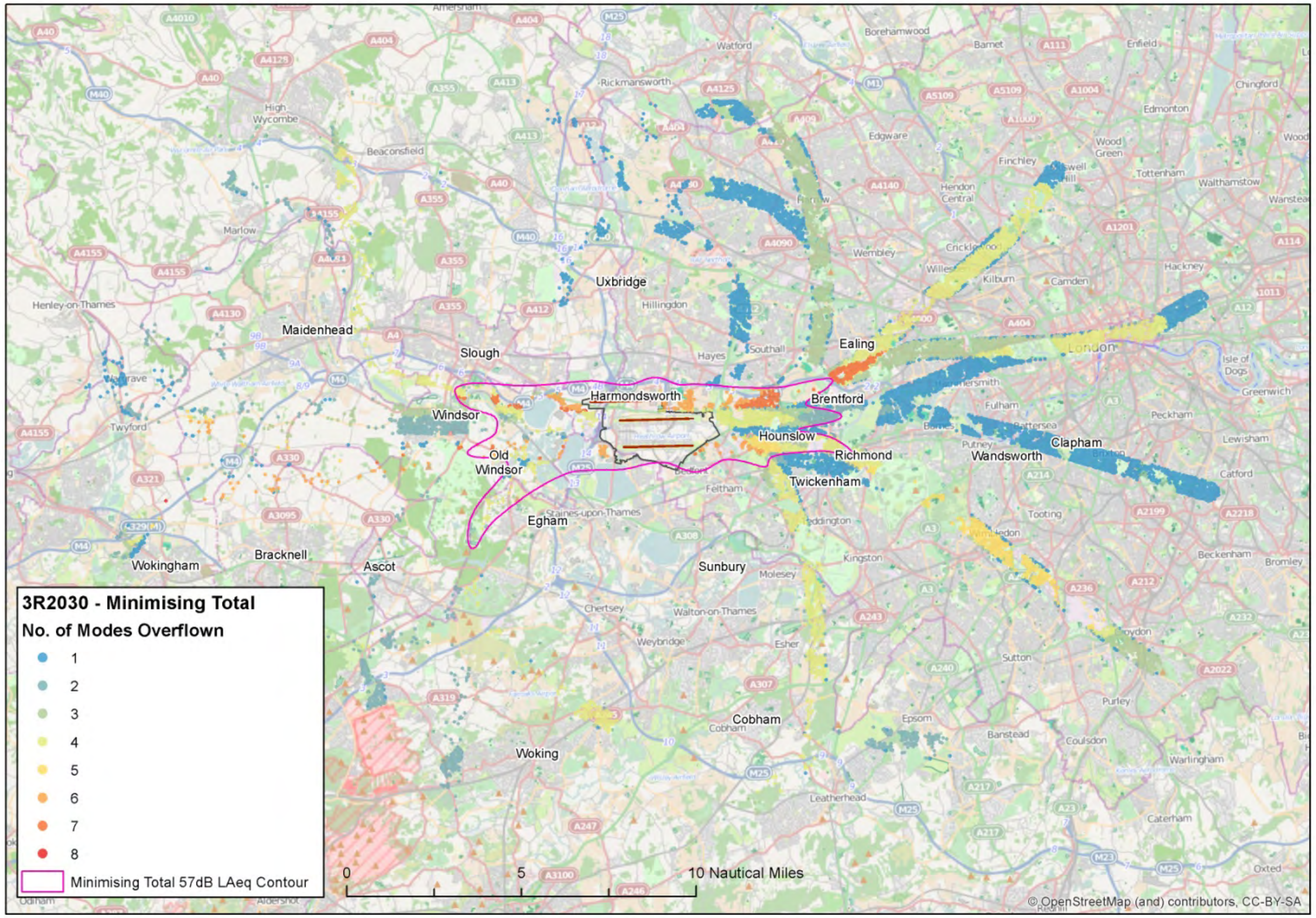


Figure K.8 Spatial analysis indicating the number of days per year for which areas are overflown in total for Option T

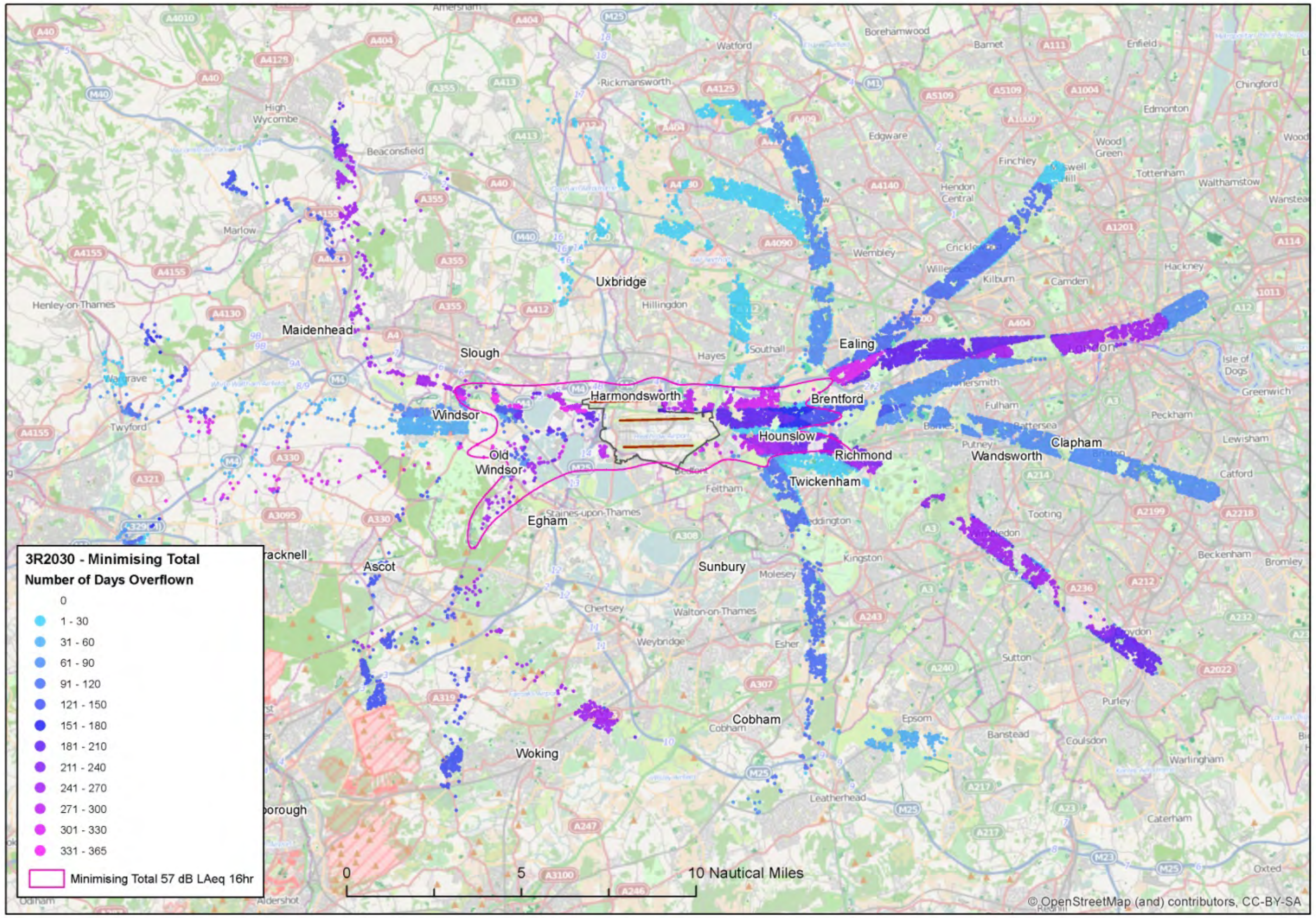


Figure K.9 Spatial Analysis of the proportion of respite received during westerly operations for Option R

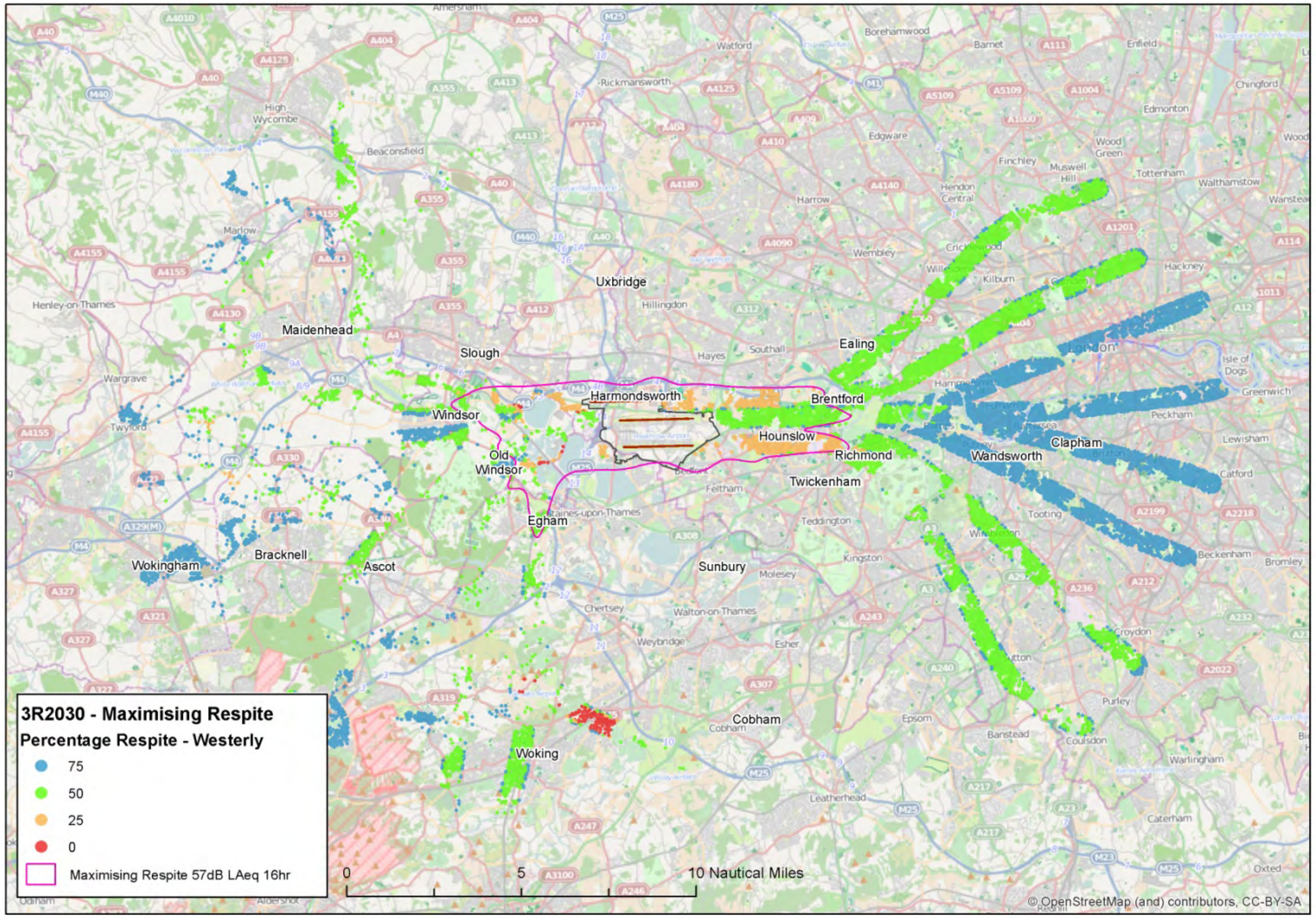


Figure K.10 Spatial Analysis of the proportion of respite received during easterly operations for Option R

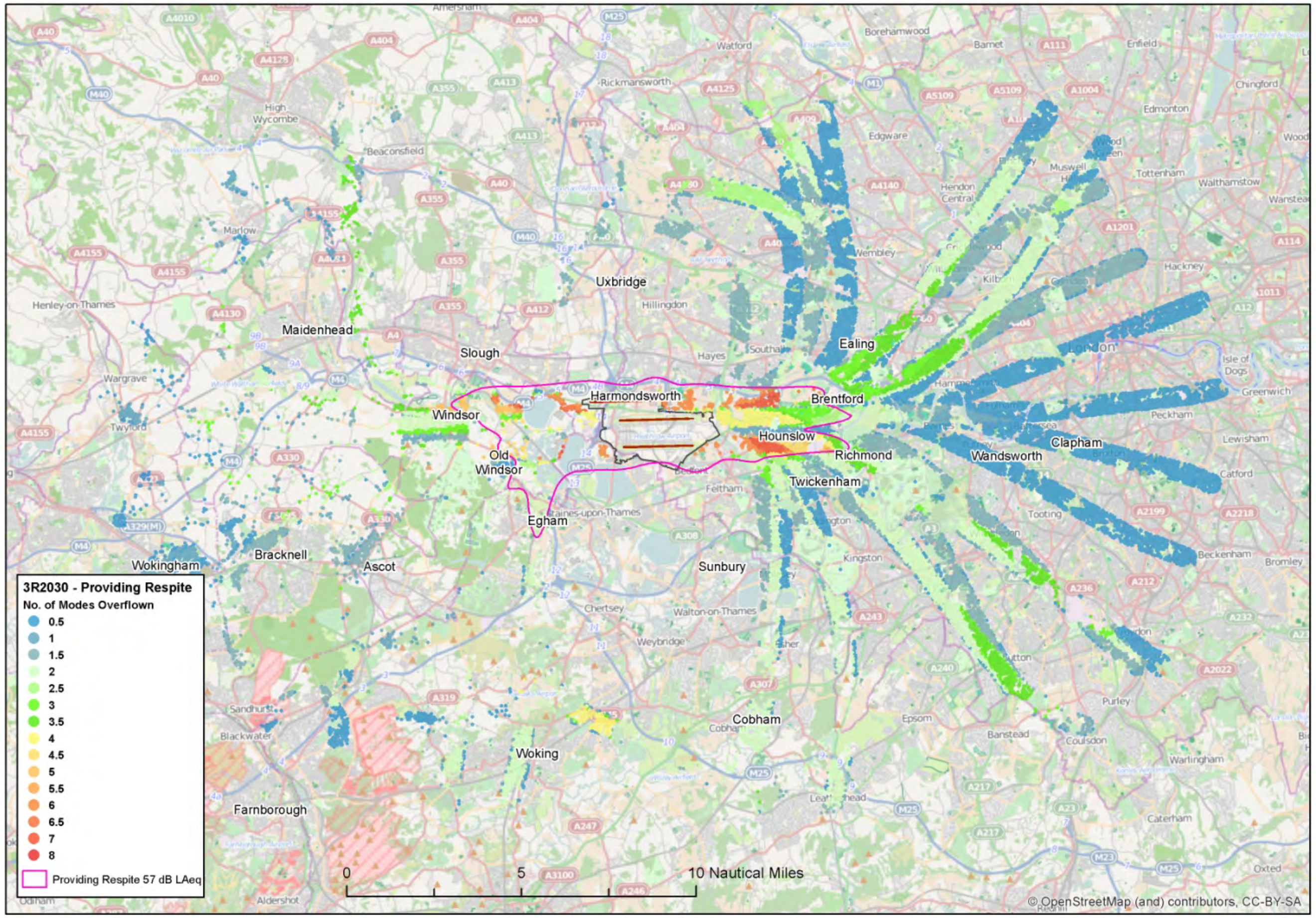

Uxbridge
Maidenhead
Slough
Ealing
Harmondsworth
Brentford
Windsor
Hounslow
Clapham
Old Windsor
Richmond
Wandsworth
Twickenham
Egham
Bracknell
Wokingham
Ascot
Sunbury
Cobham
Woking
Farnborough
3R2030 - Providing Respite
No. of Modes Overflown
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
8
Providing Respite 57 dB LAeq
0
5
10 Nautical Miles
© OpenStreetMap (and) contributors, CC-BY-SA

Figure K.11 Spatial analysis of the number of modes for which areas are overflown in total for Option R

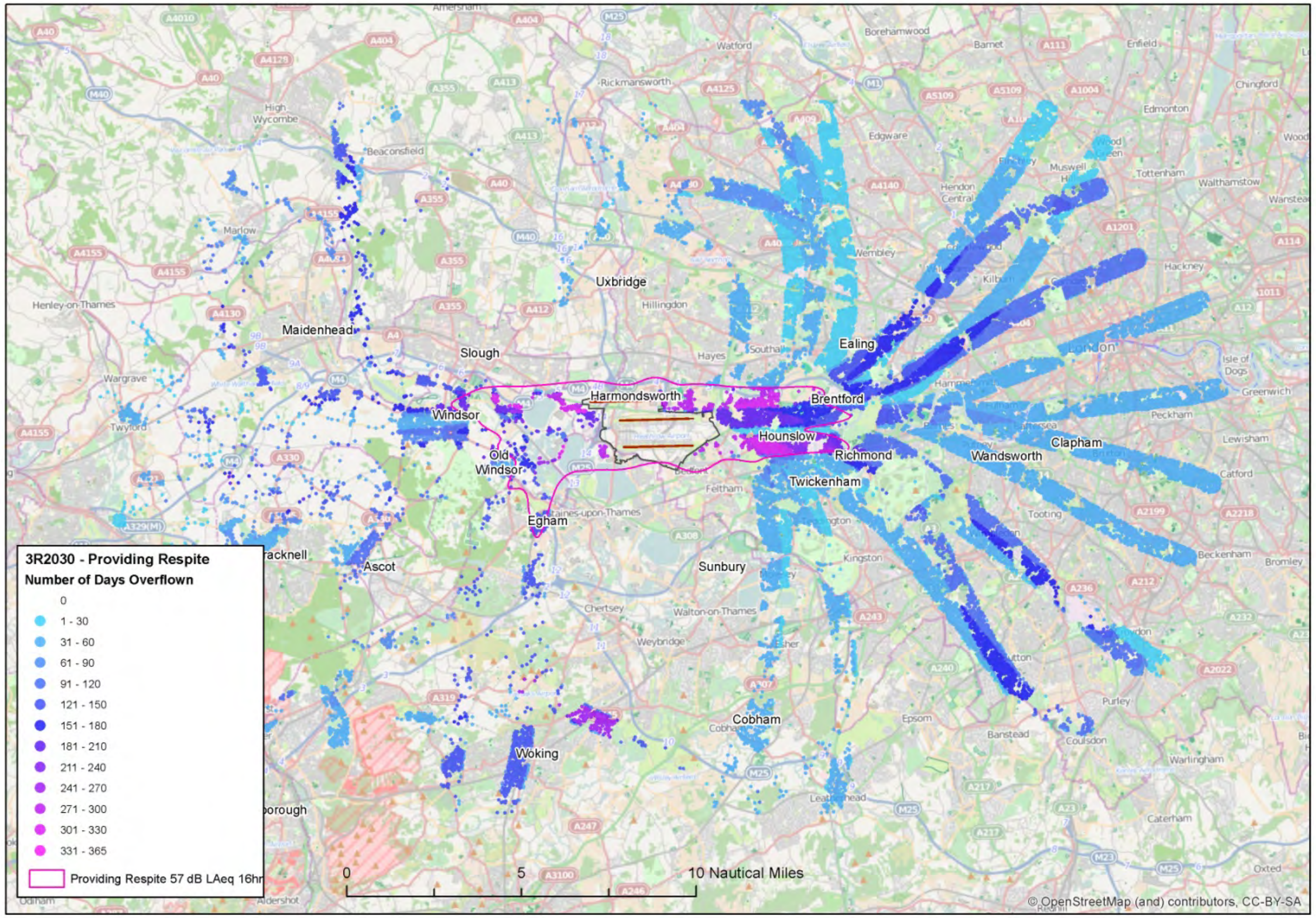


Figure K.12 Spatial analysis indicating the number of days per year for which areas are overflown in total for Option R