Environmental Research and Consultancy Department
Directorate of Airspace Policy
Civil Aviation Authority

ERCD REPORT 1201

Noise Exposure Contours for Heathrow Airport 2011

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Prepared by the Civil Aviation Authority on behalf of the Department for Transport, September 2012

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Summary

This report presents the year 2011 noise exposure contours for London Heathrow Airport. The 57 dBA Leq contour area for 2011 based on the actual runway modal split was calculated to be 108.8 km^2, 0.5% larger than in 2010. The population enclosed within the actual 57 dBA contour increased by 6% compared to 2010.

September 2012

The authors of this report are employed by the Civil Aviation Authority. The work reported herein was carried out on behalf of the Department for Transport.

Any views expressed are not necessarily those of the Secretary of State for Transport.

Population data used in this report are based on 2001 Census data (updated for 2011) supplied by CACI Information Services.

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Glossary

AIP Aeronautical Information Publication.

ANCON The UK civil aircraft noise contour model, developed and maintained by ERCD.

ATC Air Traffic Control.

CAA Civil Aviation Authority – the UK's independent specialist aviation regulator.

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).

ERCD Environmental Research and Consultancy Department of the Civil Aviation Authority.

ILS Instrument Landing System.

Leq 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.

NPD Noise-Power-Distance.

NPR Noise Preferential Route.

NTK Noise and Track Keeping monitoring system. The NTK system associates radar data from air traffic control radar with related data from both fixed (permanent) and mobile noise monitors at prescribed positions on the ground.

OS Ordnance Survey®, Great Britain's national mapping agency.

SEL The Sound Exposure Level generated by a single aircraft at the measurement point, measured in dBA. This noise metric accounts for the duration of the sound as well as its intensity.

SID Standard Instrument Departure.

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Executive Summary

This report presents noise exposure contours generated for London Heathrow Airport for the year 2011. The noise modelling used radar and noise data from the Heathrow Noise and Track Keeping System. Mean flight tracks and dispersions for each route, and average flight profiles of aircraft height, speed and thrust for each aircraft type, were calculated using these data.

Analysis of the 2011 summer traffic data for Heathrow revealed that average daily movements increased slightly from 2010, by 0.4%.

The results showed that the area of the 2011 ‘actual’ modal split (83% west / 17% east) 57 dBA Leq contour increased by 0.5% compared to 2010, to 108.8 km^2. This was due to the slight recovery of traffic levels in 2011, which included a higher frequency of movements by wide-body four-engine aircraft such as the Airbus A340-600 and Boeing 747-400. The population count within the 2011 actual 57 dBA contour increased by 6% compared to 2010.

Similarly, the area of the 2011 ‘standard’ modal split (77% west / 23% east) 57 dBA Leq contour increased by 0.8% to 107.1 km^2 and the corresponding population count was 6% higher.

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1 Introduction

1.1 Background

1.1.1 Each year the Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority (CAA) calculates the noise exposure around London Heathrow Airport on behalf of the Department for Transport (DfT). A computer model, ANCON, validated with noise measurements, is used to estimate the noise exposure. The model calculates the emission and propagation of noise from arriving and departing air traffic.

1.1.2 The noise exposure metric used is the Equivalent Continuous Sound Level, or Leq 16-hour (0700-2300 local time), which is calculated over the 92-day summer period from 16 June to 15 September. The background to the use of this index is explained in DORA Report 9023 (**Ref 1**).

1.1.3 Noise exposure is depicted in the form of noise contours, i.e. lines joining places of constant Leq, akin to the height contours shown on geographical maps or isobars on a weather chart. In the UK, Leq noise contours are normally plotted at levels from 57 to 72 dBA, in 3 dB steps.[1] The 57 dBA level denotes the approximate onset of significant community annoyance.

1.1.4 This report contains small-scale diagrams of the year 2011 Heathrow Leq contours overlaid onto Ordnance Survey® (OS) base maps. Diagrams in Adobe® PDF and AutoCAD DXF format are also available for download from the DfT website[2].

1.1.5 The objectives of this report are to explain the noise modelling methodology used to produce the year 2011 Leq contours for Heathrow Airport, to present the calculated noise contours and to assess the changes to the contours relative to the previous year (**Ref 2**).

[1] Aircraft noise contours are also produced on behalf of airports for the specific purpose of meeting the requirements of the Environmental Noise (England) Regulations 2006, which implemented Directive 2002/49/EC, Assessment and Management of Environmental Noise, in England. These are based on annual average values and require the use of different parameters (L_{day}, $L_{evening}$, L_{night}, $L_{eq,16hr}$ and L_{den} at 5 dB steps), so it is not possible to draw meaningful conclusions between the two types of contour maps. Further details about Directive 2002/49/EC are available on the Department for Environment, Food and Rural Affairs website at *www.defra.gov.uk* as well as ERCD Reports 0706, 0707 and 0708, which cover Heathrow, Gatwick and Stansted noise mapping respectively.

[2] www.dft.gov.uk

1.2 Heathrow Airport

1.2.1 Heathrow Airport is situated approximately 13 miles (21 km) west of the city of London. It is surrounded by suburban housing, business premises and mixed-use open land to the north and south, suburban housing and business premises to the east, and several large reservoirs, mixed-use open land, housing and business premises to the west (**Figure 1**).

1.2.2 Heathrow Airport has two runways: Runway 09L/27R to the north, which is 3,901 m long, and Runway 09R/27L to the south, which is 3,660 m long. The landing threshold[3] for Runway 09L is displaced by 306 m. The landing threshold for Runway 09R is also displaced, by 307 m. There are currently four passenger terminals.[4] The layout of the runways, taxiways and passenger terminals in 2011 is shown in **Figure 2**.[5]

1.2.3 In the 2011 calendar year, there were 481,000[6] aircraft movements (2010: 455,000) at Heathrow Airport, handling approximately 69.4 million passengers (2010: 65.9 million).[7]

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[3] The runway threshold marks the beginning of the runway available for landing aircraft. A *displaced* threshold is a runway threshold that is not located at the physical end of the runway. A displaced threshold is often employed to give arriving aircraft sufficient clearance over an obstacle.

[4] Terminal 2 closed for rebuilding work in November 2009 and is expected to re-open in 2014.

[5] UK AIP (10 Mar 11) AD 2-EGLL

[6] Air Transport Movements (ATMs) account for 477,000 of the total aircraft movements, thus the 480,000 ATM limit specified by the Terminal 5 Planning Condition A4 has not been exceeded.

[7] Source: CAA Regulatory Policy Group statistics (www.caa.co.uk)

2 Noise contour modelling methodology

2.1 ANCON noise model

2.1.1 Leq noise contours were calculated with the UK civil aircraft noise model ANCON (version 2.3), which is developed and maintained by ERCD on behalf of the DfT. A technical description of ANCON is provided in ERCD Report 0606 (**Ref 3**). The ANCON model is also used for the production of annual contours for Gatwick and Stansted airports, and a number of regional airports in the UK.

2.1.2 ANCON is fully compliant with the latest European guidance on noise modelling, ECAC.CEAC Doc 29 (3rd edition), published in December 2005 (**Ref 4**). This guidance document represents internationally agreed best practice as implemented in modern aircraft noise models.

2.2 Radar data

2.2.1 The noise modelling carried out by ERCD made extensive use of radar data extracted from Heathrow Airport's Noise and Track Keeping (NTK) system. Most large airports have NTK systems, which take data from Air Traffic Control (ATC) radars and combine them with flight information such as call sign, tail number, type and destination. Analyses of departure and arrival flight tracks, and flight profiles, were based on Heathrow 2011 summer radar data.

2.3 Flight tracks

2.3.1 Aircraft departing Heathrow are required to follow specific flight paths called Noise Preferential Routes (NPRs) unless directed otherwise by ATC. NPRs were designed to avoid the overflight of built-up areas where possible. They establish a path from the take-off runway to the main UK air traffic routes and form the first part of the Standard Instrument Departure routes (SIDs). The Heathrow SIDs are illustrated in **Figure 3**.

2.3.2 Associated with each NPR is a lateral swathe, which is defined by a pair of lines that diverge at 10 degrees from a point 2,000 m from start-of-roll, leading to a corridor extending 1.5 km either side of the nominal NPR centreline. Within this swathe the aircraft are considered to be flying on-track. The swathe takes account of various factors that affect track-keeping, including tolerances in navigational equipment, type and weight of aircraft, and weather conditions – particularly winds that may cause drifting when aircraft are turning. Aircraft reaching an altitude of 4,000 ft at any point along an NPR may be turned off the route by ATC onto more direct headings to their destinations – a practice known as 'vectoring'. ATC may also vector aircraft from NPRs below this altitude for safety reasons, including in certain weather conditions (for example, to avoid storms).

2.3.3 Departure and arrival flight tracks were modelled using samples of radar data extracted from the Heathrow NTK system over the 92-day summer period, 16 June to 15 September 2011. **Figure 4** shows a sample of radar flight tracks from a day in July 2011. ERCD used in-house radar analysis software to calculate mean departure flight tracks and associated lateral dispersions for each NPR/SID. Arrival tracks for Runways 27L, 27R, 09L and 09R were modelled using evenly spaced ‘spurs’ about the extended runway centrelines. The majority of arriving aircraft joined the centrelines at distances between 14 and 34 km from threshold when in westerly mode, and at distances between 11 and 32 km in easterly mode.

2.4 Flight profiles

2.4.1 For each ANCON aircraft type, average flight profiles of height, speed and thrust versus track distance (for departures and arrivals separately) were reviewed and updated where necessary, using 2011 summer radar data. The engine power settings required for the aircraft to follow the average height and speed profiles were calculated from data describing aircraft performance characteristics within each of the different aircraft type categories.

2.4.2 For 2011, only departure flight profiles were updated, as arrival noise measurement analysis suggested no changes of any significance to justify more detailed update. The updated departure flight profiles show an increase in the average height of aircraft below 1,000 ft for all aircraft types. The systematic change indicates this was not an operational effect and more detailed investigation showed that the effect is due to better radar coverage at low altitude, following a change of radar head feeding the NTK system, with the conclusion being that the previous extrapolation of radar data had underestimated aircraft height at low altitude. The increase in average aircraft height reduces the effect of ground absorption and thereby leads to increased noise (up to 0.8 dB) to the sides of the initial departure flight path, despite noise directly beneath the flight path decreasing slightly. The radar feed change does not impact arrival flight profiles, since flight at low altitude is constrained to follow the 3 degree ILS[8] glide path.

2.4.3 The application of reverse thrust following touchdown was modelled for all ANCON types where applicable.

2.5 Noise emissions

2.5.1 At Heathrow, the NTK system captures data from both fixed and mobile noise monitors around the airport. Noise event data for individual aircraft operations are

[8] Instrument Landing System

then matched to operational data provided by the airport. The Heathrow NTK system comprises twelve fixed monitors (positioned approximately 6.5 km from start-of-roll), together with a number of mobile monitors that can be deployed anywhere within the NTK radar coverage area.[9]

2.5.2 The noise data collected are screened by ERCD with reference to several criteria so that only high quality data are used in the analysis. First of all, noise data that lie outside a 'weather window' are discarded. This ensures that the data used are not affected by adverse meteorological conditions such as precipitation and strong winds. Secondly, the maximum noise level of the aircraft event must exceed the noise monitor threshold by at least 10 dB to avoid underestimates of the Sound Exposure Level (SEL).[10] Thirdly, only measurements obtained of aircraft operations that pass through a 60-degree inverted cone, centred at the noise monitor, are retained in order to minimise the effects of lateral attenuation[11] and lateral directivity[12].

2.5.3 The ANCON model calculates aircraft noise using a noise database expressing SEL as a function of engine power setting and slant distance to the receiver – the so-called 'Noise-Power-Distance' (NPD) relationship. The ANCON noise database is continually reviewed and updated with adjustments made when, and where, measurements show this to be necessary. Further information on the validation of the ANCON noise model can be found on the CAA website.[13]

2.6 Traffic distributions

2.6.1 The Leq contours are based on the daily average movements that take place during the 16-hour day (0700-2300 local time) over the 92-day period from 16 June to 15 September inclusive. The source of this information is the NTK system, which stores radar data supplemented by daily flight plans. Traffic statistics from NTK data were cross-checked with runway logs supplied by NATS[14] and very close agreement was found.

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[9] Further information on the noise monitors can be found in ERCD Report 1004 (**Ref 5**).

[10] The Sound Exposure Level of an aircraft noise event is the steady noise level, which over a period of *one second* contains the same sound energy as the whole event. It is equivalent to the Leq of the noise event normalised to one second.

[11] Lateral attenuation is the excess sound attenuation caused by the ground surface, which can be significant at low angles of elevation.

[12] Lateral directivity is the non-uniform directionality of sound radiated laterally about the roll axis of the aircraft – this is influenced to a large extent by the positioning of the engines.

[13] http://www.caa.co.uk/docs/68/Valid_ANCON.pdf

[14] NATS is the provider of air traffic control services to Heathrow Airport.

Traffic distribution by noise class

2.6.2 **Table 1** lists the average summer day movements[15] by eight noise classes of aircraft, ranked in ascending order of noise emission, i.e. from least to most noisy, in 2010 and 2011. As in 2010, short-haul ‘Chapter 3’ and ‘Chapter 4’[16] jet aircraft (Noise Class 3) formed the highest proportion of movements (68%). Their numbers were very slightly higher than in 2010. The numbers of wide-body twin-engine aircraft (Noise Class 4), which comprised 21% of the total traffic, were fractionally lower in 2011. However, there was a 4% increase in movements within Noise Class 5 (i.e. second generation wide-body three- or four-engine aircraft) in 2011. The numbers of aircraft in Noise Classes 1, 2, 6, and 8 were minimal, and there were no aircraft within Noise Class 7.

2.6.3 The average number of daily movements at Heathrow over the 2011 summer period was 0.4% higher than in 2010.

2.6.4 **Figure 5** illustrates the changing distribution of traffic among the eight noise classes over the period 1988 to 2011 inclusive. The shift towards Chapter 3 and 4 aircraft (i.e. Noise Classes 3-5) over the years can be seen, with short-haul jet aircraft (Noise Class 3) dominating the fleet mix.

Traffic distribution by ANCON aircraft type

2.6.5 A more detailed breakdown of the 2011 average summer day movements, indicating the ANCON types that fall into each noise class, is provided in **Table 2**. Within Noise Class 3, increases in movements of ANCON types such as the EA320V, ERJ and EA321V were offset by reductions of the B757E, EA320C and B733 (note: see **Table 2** for descriptions of ANCON types). Similarly, increases in Noise Class 4 ANCON types such as the B773G and B764 were offset by reductions in the movements of the EA33, B763R and B772G. The largest increase within Noise Class 5 was for the EA346, which was up by 4 movements per day. The numbers of B744P and B744R aircraft also increased slightly.

2.6.6 **Figure 6** illustrates the numbers of movements by ANCON aircraft type for the 2011 average summer day. It may be seen that the Airbus A319/A320/A321 aircraft family dominates the movements at Heathrow. In particular, the EA319V and EA320V are the most frequent aircraft with 208 and 199 daily movements respectively, together representing 32% of total movements.

2.6.7 There were on average 62 daily movements of the B744R ANCON type, the noise dominant type at Heathrow in terms of departure noise. This aircraft contributed the highest level of departure ‘noise energy’, which is a function of both aircraft noise level and movement numbers. Arrival noise was dominated by the short-haul Airbus aircraft family.

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[15] Includes departures and arrivals.

[16] Aircraft whose certificated noise levels are classified by the ICAO *Standards and Recommended Practices – Aircraft Noise: Annex 16 to the Convention on International Civil Aviation* into ‘Chapter 3’ and ‘Chapter 4’ types - these are typically characterised by modern, quieter, high-bypass turbofan aircraft.

Traffic distribution by SID route

2.6.8 **Figure 7** shows the distribution of aircraft departures by SID route for 2011. The percentage loadings on the SIDs were very similar to 2010, with the westerly WOB/BPK SIDs taking the highest proportion of traffic over the summer period (33%), followed by the westerly DVR/DET SIDs (21%).

2.7 Runway modal splits

2.7.1 In general, aircraft will take-off and land into a headwind to maximise lift during take-off and landing. The wind direction, which varies over the course of a year, will therefore have an important influence on the usage of runways[17]. The ratio of westerly (27L/27R) and easterly (09L/09R) operations is referred to as the *runway modal split*.

2.7.2 To remove the effect of year-on-year weather fluctuations on aircraft operations and to clarify underlying trends, two sets of contours have been produced for the year 2011:

(i) Contours using the 'actual' modal split over the Leq period; and

(ii) Contours assuming the 'standard' modal split over the Leq period, i.e. the long-term modal split calculated from the 20-year rolling average; for 2011, this is the 20-year period from 1992 to 2011. Use of the standard modal split enables year-on-year comparisons without the runway usage affecting the contour shape.

2.7.3 The actual and standard modal splits for 2011, together with the previous year, are summarised in the following table:

Heathrow runway modal splits for 2011 and 2010

Modal split scenario	% west (Runway 27L/27R)	% east (Runway 09L/09R)
Actual 2011	83%	17%
Actual 2010	83%	17%
Standard 2011	77%	23%
Standard 2010	76%	24%

[17] It should be noted that at Heathrow, a 'westerly preference' for aircraft operations is employed, which means that the airport will operate in westerly mode even if there is a light tailwind. This is done to reduce the use of easterly SIDs, which tend to overfly more populated areas compared to the westerly SIDs.

2.7.4 It can be seen that the 2011 actual modal split was the same as in 2010, with a 6% higher proportion of westerly operations compared to the standard modal split. The standard modal split for 2011 had 1% more westerly operations than in 2010. Historical runway modal splits at Heathrow for the past 20 years are illustrated in **Figure 8**.

2.7.5 At Heathrow, the runway modal split can have an important influence on the area of the 57 dBA Leq contour. In theory, the 57 dBA contour area would be maximised if (all other things being equal) the airport operated solely in westerly mode over the whole summer period. With a decreasing proportion of westerly movements (and hence an increasing proportion of easterly movements), the 57 dBA contour area would become smaller, reaching a theoretical minimum at a runway modal split of around 40% west / 60% east.

2.7.6 The effect of modal split on the contour area appears to be due to two factors: firstly, the interaction between the noise generated from the two separate runways at Heathrow, and secondly, operations in accordance with the 'Cranford Agreement',[18] which severely restricts departures from Runway 09L when the airport is operating in easterly mode.

2.7.7 Higher proportions of easterly movements at Heathrow would, in theory, help to reduce the 57 dBA contour area. It should, however, be noted that if the proportion of easterly movements were to rise above about 40%, the population count within the 57 dBA contour would start to increase sharply because of the relatively densely populated areas located to the east of the airport.

2.8 Topography

2.8.1 The topography around Heathrow Airport was modelled by accounting for terrain height. This was achieved by geometrical corrections for source-receiver distance and elevation angles. Other, more complex effects, such as lateral attenuation from uneven ground surfaces and noise screening/reflection effects due to topographical features, were not taken into account.

2.8.2 ERCD holds OS terrain height data[19] on a 200 m by 200 m grid for the whole of England. Interpolation was performed to generate height data at each of the calculation points on the receiver grid used by the ANCON noise model. The

[18] The 'Cranford Agreement' was a Government undertaking given at a meeting of the Cranford Residents' and District Amenities Association in 1952, that as far as practicable, the northern runway would not be used for take-offs to the east due to the proximity of Cranford to the east end of the runway. Following public consultation, a decision was made in 2009 by the Government to end the Cranford Agreement. This would allow for the more even spreading of noise around Heathrow. However, new taxiways would need to be built in order to implement the full alternation of easterly operations. The airport operator is expected to make a decision on applying for planning permission from the London Borough of Hillingdon for these works following completion of the 'Operational Freedoms' trial, which permits more flexible use of the runways in certain circumstances that can be applied to anticipate, prevent and mitigate disruption.

[19] Meridian™ 2

terrain heights in the vicinity of Heathrow Airport are depicted diagrammatically in **Figure 9**.

2.9 Population and 'Points of Interest' databases

2.9.1 Estimates were made of the numbers of people and households enclosed within the noise contours. The population data used in this report are a 2011 update of the 2001 Census supplied by CACI Limited[20]. The CACI population database contains data referenced at the postcode level. Population and household numbers associated with each postcode are assigned to a single co-ordinate located at the postcode's centroid. The population data points for the area around Heathrow Airport are illustrated in **Figure 10**.

2.9.2 Estimates have been made of the numbers of noise sensitive buildings situated within the contours, using the *InterestMap*™[21] 'Points of Interest' (2011) database. For the purposes of this study, the noise sensitive buildings that have been considered are schools, hospitals and places of worship.

[20] www.caci.co.uk

[21] InterestMap is distributed by Dotted Eyes Ltd and derived from Ordnance Survey Points of Interest data.

3 Noise contour results

3.1 Actual modal split contours

3.1.1 The Heathrow 2011 Leq noise contours generated with the actual 2011 summer period runway modal split (83% west / 17% east) are shown in **Figure 11**. The contours are plotted from 57 to 72 dBA at 3 dB intervals.

3.1.2 The cumulative areas, populations and households within the actual modal split contours are listed in the table below:

Heathrow 2011 actual modal split contours: area, population and household estimates

Leq contour level (dBA)	Area (km^2)	Population	Households
> 57	108.8	243,350	100,850
> 60	58.9	101,150	40,000
> 63	33.9	41,900	16,450
> 66	20.3	13,050	4,900
> 69	10.0	3,250	1,250
> 72	5.4	250	100

Note: Populations and households are given to the nearest 50.

3.1.3 Estimates of the cumulative numbers of noise sensitive buildings within the actual modal split contours are listed in the table below:

Heathrow 2011 actual modal split contours: noise sensitive building estimates

Leq contour level (dBA)	Schools	Hospitals	Places of worship
> 57	163	4	113
> 60	62	0	43
> 63	14	0	16
> 66	4	0	4
> 69	0	0	1
> 72	0	0	0

Note: Approximately half of the schools are nurseries.

3.2 Standard modal split contours

3.2.1 The Heathrow 2011 Leq noise contours generated with the standard 2011 summer period runway modal split (77% west / 23% east) are shown in **Figure 12**. The contours are plotted from 57 to 72 dBA at 3 dB intervals.

3.2.2 The cumulative areas, populations and households within the standard modal split contours are listed in the table below:

Heathrow 2011 standard modal split contours: area, population and household estimates

Leq contour level (dBA)	Area (km^2)	Population	Households
> 57	107.1	237,750	98,400
> 60	58.0	101,050	40,150
> 63	34.1	42,800	16,850
> 66	20.2	12,750	4,750
> 69	9.9	3,100	1,150
> 72	5.3	300	150

Note: Populations and households are given to the nearest 50.

3.2.3 Estimates of the cumulative numbers of noise sensitive buildings within the standard modal split contours are listed in the table below:

Heathrow 2011 standard modal split contours: noise sensitive building estimates

Leq contour level (dBA)	Schools	Hospitals	Places of worship
> 57	157	5	110
> 60	56	0	41
> 63	13	0	16
> 66	4	0	4
> 69	0	0	1
> 72	0	0	0

Note: Approximately half of the schools are nurseries.

4 Analysis of results

4.1 Actual modal split contours – comparison with 2010 contours

4.1.1 The Heathrow 2011 actual modal split Leq contours are compared against the 2010 actual Leq contours in **Figure 13**. The table below summarises the areas, populations and percentage changes from 2010 to 2011:

Heathrow actual modal split contours: areas and populations for 2010 and 2011

Leq (dBA)	2010 Area (km^2)	2011 Area (km^2)	Area change (%)	2010 Pop.	2011 Pop.	Pop. change (%)
> 57	108.3	108.8	+0.5%	228,700	243,350	+6%
> 60	59.0	58.9	-0.2%	95,300	101,150	+6%
> 63	33.8	33.9	+0.3%	38,550	41,900	+9%
> 66	20.1	20.3	+1.0%	12,250	13,050	+7%
> 69	9.8	10.0	+2.0%	2,800	3,250	+16%
> 72	5.3	5.4	+1.9%	200	250	+25%

Note: The 2010 and 2011 actual modal splits were both 83% west / 17% east.

4.1.2 Relative to 2010, the areas of most of the 2011 contours have increased by up to 2%. This can be attributed to the slight increase in movements, which included a rise in the number of aircraft within Noise Class 5 (i.e. wide-body four-engine aircraft such as the EA346 and B744R).

4.1.3 The 2011 population counts also increased at all contour levels. It should be noted that percentage changes in contour areas are not necessarily accompanied by similar changes in enclosed population because of the uneven distribution of populations around the airport.

4.2 Standard modal split contours – comparison with 2010 contours

4.2.1 The Heathrow 2011 standard modal split Leq contours are compared against the 2010 standard Leq contours in **Figure 14**. The table below summarises the areas, populations and percentage changes from 2010 to 2011:

Heathrow standard modal split contours: areas and populations for 2010 and 2011

Leq (dBA)	2010 Area (km^2)	2011 Area (km^2)	Area change (%)	2010 Pop.	2011 Pop.	Pop. change (%)
> 57	106.3	107.1	+0.8%	224,550	237,750	+6%
> 60	58.0	58.0	0.0%	95,350	101,050	+6%
> 63	33.9	34.1	+0.6%	38,350	42,800	+12%
> 66	20.1	20.2	+0.5%	11,500	12,750	+11%
> 69	9.7	9.9	+2.1%	2,700	3,100	+15%
> 72	5.3	5.3	0.0%	200	300	+50%

Note: The 2010 and 2011 standard modal splits were 76% west / 24% east and 77% west / 23% east respectively.

4.2.2 Relative to 2010, the areas of all the contours have increased by up to 2%. This can be attributed to the slight increase in movements, which included a rise in the number of aircraft within Noise Class 5 (i.e. wide-body four-engine aircraft such as the EA346 and B744R). The populations enclosed within these contour levels have also increased at all levels.

4.2.3 The standard contours normally provide a clearer indication than the actual contours of ‘fleet noise level’ changes from year to year because they minimise the effect of any difference between the ratios of westerly to easterly operations.

4.2.4 It can be seen from the results for the actual and standard contours that the runway modal split can affect the area enclosed by the contours (as explained in section 2.7.5). At the 57 dBA Leq level, the actual 2011 contour (modal split 83% west / 17% east) encloses an area of 108.8 km^2, whereas the 57 dBA Leq standard 2011 contour (modal split 77% west / 23% east) has an area 1.7 km^2 less at 107.1 km^2.

4.3 Noise contour historical trend

4.3.1 **Figure 15** shows how the 57 dBA Leq actual modal split contour has changed in area and population terms since 1988 by comparison with the total annual (365-day) aircraft movements. (Actual modal split data are used in this figure because standard modal split contours were not produced prior to 1995.)

Movements

4.3.2 Against the trend of a general decrease in contour area, the number of aircraft movements has risen steadily most years up until 2007, with a major trough occurring in 1991, the year of the First Gulf War. The annual movement figure for 2001 was slightly lower than the preceding year and reflected the disruption to traffic following the terrorist attacks on 11 September 2001. The total annual movement figure for 2005 was 2% higher than that for 2004 compared with the 1% decrease for the 16-hour average summer Leq day. Movements during the summer 2005 period were affected by three days of industrial action in August and possibly by the terrorist attacks in central London on 7 July 2005. A separate analysis showed that total movements in July and August of 2005 were less than those for the same months in 2004.

4.3.3 The total annual movements in 2006 were 0.2% lower than in 2005. Traffic levels during the summer 2006 Leq period were affected by new tighter security restrictions, which were introduced in mid-August 2006. Flights at Heathrow were also disrupted in December 2006 by heavy fog.

4.3.4 Annual traffic levels rose by 1% in 2007, but fell in 2008 by 0.6% – this may be attributed to the economic downturn and fluctuating oil price. (Note: over the summer period only, traffic levels increased by 0.5%). In 2009, traffic levels dropped further, by 3%, as the global recession continued to impact upon the aviation industry.

4.3.5 Aircraft movements fell in 2010 for the third year in a row, this time by 2%, as a result of adverse winter weather conditions, the volcanic ash crisis in April and industrial action in May. (However, it should be noted that over the summer period only, movements were up by 3%).

4.3.6 Annual traffic levels in 2011 staged a marked recovery from the falls seen in the previous three years, with an increase of 6% back to a level close to the last peak seen in 2007.

Areas and populations

4.3.7 The contour area figures give a better indication of the actual noise than the population figures because the latter are more susceptible to the runway modal split. This is particularly noticeable in 1995, which had an atypical modal split of 54% west / 46% east (compared with the 20-year average of 77% west / 23% east for that year). Also, percentage changes in contour areas are not necessarily accompanied by similar changes in enclosed population because the contours may be different in shape as well as size, and movement of contour lines from year to year, especially in or around relatively highly populated areas, can cause a disproportionate change in enclosed population. The recorded increase in enclosed population between 1998 and 1999 reflected demographic changes that occurred between the 1991 Census and the subsequent update.

4.3.8 The sharp rate of decline in contour area recorded in the late eighties and early nineties has diminished. The area reductions in 2000 and 2001 reflect reduced numbers of Concorde movements in those years (2.5 per day in 2000 and 0.1 per day in 2001). This followed the grounding of Concorde after the crash at Paris, Charles de Gaulle airport in July 2000. Concorde movements in 2002 and 2003 never reached the level of 1999. The dashed line on the figure shows what the 2003 areas and populations would have been had there been no movements by Concorde in the Leq period for that year. In October 2003 Concorde was retired from service so there were no movements by Concorde in 2004.

4.3.9 From 2004 to 2008, the 57 dBA contour area at Heathrow was relatively steady, within a range from 117 to 123 km^2. However, in 2009 the contour area fell below this range to 112.5 km^2, and dropped even further in 2010 to 108.3 km^2, the smallest area ever calculated for Heathrow. The 2011 area saw a marginal increase to 108.8 km^2 as traffic levels rose slightly over the summer period.

4.3.10 Between 2001 and 2009 the population count within the 57 dBA contour fluctuated between approximately 240,000 and 269,000. In 2010, the population count dropped below this range to its lowest ever value of 229,000. In line with the increase in contour area, the population increased to 243,000 in 2011.

5 Conclusions

5.1 Year 2011 average summer 16-hour day Leq noise exposure contours have been generated for Heathrow Airport using the ANCON noise model.

5.2 The results show that the actual modal split 57 dBA Leq contour area increased by 0.5% from 108.3 km^2 in 2010 to 108.8 km^2 in 2011. This can be attributed to a small recovery in traffic levels in 2011, which included increases in movements of wide-body four-engine aircraft such as the Airbus A340-600 and Boeing 747-400. The population count within the 2011 actual 57 dBA Leq contour increased by 6% compared to 2010.

5.3 The standard modal split 57 dBA Leq contour area also increased, from 106.3 km^2 in 2010 to 107.1 km^2 in 2011, a 0.8% rise. The population count within the 2011 standard 57 dBA Leq contour was higher by 6%.

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4 European Civil Aviation Conference
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Table 1 Heathrow 2010 and 2011 average summer day movements by noise class

Noise Class	Description	2010	2011	Percentage of total 2011 movements	Change
			<PROPELLER AIRCRAFT>		
1	Small propeller aircraft	0.1	**0.1**	< 0.1%	0.0 (*)
2	Large propeller aircraft	4.0	**1.6**	0.1%	-2.4 (*)
			<CHAPTER 3/4 JETS>		
3	Short-haul aircraft	853.3	**855.9**	67.5%	+2.6 (+0.3%)
4	Wide-body twin-engine aircraft	268.7	**268.3**	21.2%	-0.4 (-0.1%)
5	2nd generation wide-body 3,4-engine aircraft	137.6	**142.7**	11.2%	+5.1 (+3.7%)
			<LARGE CHAPTER 2/3 JETS>		
6	1st generation wide-body 3,4-engine aircraft	0.1	**< 0.1**	< 0.1%	0.0 (*)
			<2nd GENERATION TWIN JETS>		
7	Narrow-body twin-engine aircraft *(including Ch.2 and hushkitted versions)*	0.1	**0.0**	0.0%	-0.1 (*)
			<1st GENERATION JETS>		
8	Narrow-body 3,4-engine aircraft	0.1	**0.1**	< 0.1%	0.0 (*)
	TOTAL	1263.8	**1268.6**	100%	+4.8 (+0.4%)

* Percentage changes not shown due to low numbers and limited data resolution.

Note: Totals may not sum exactly due to rounding.

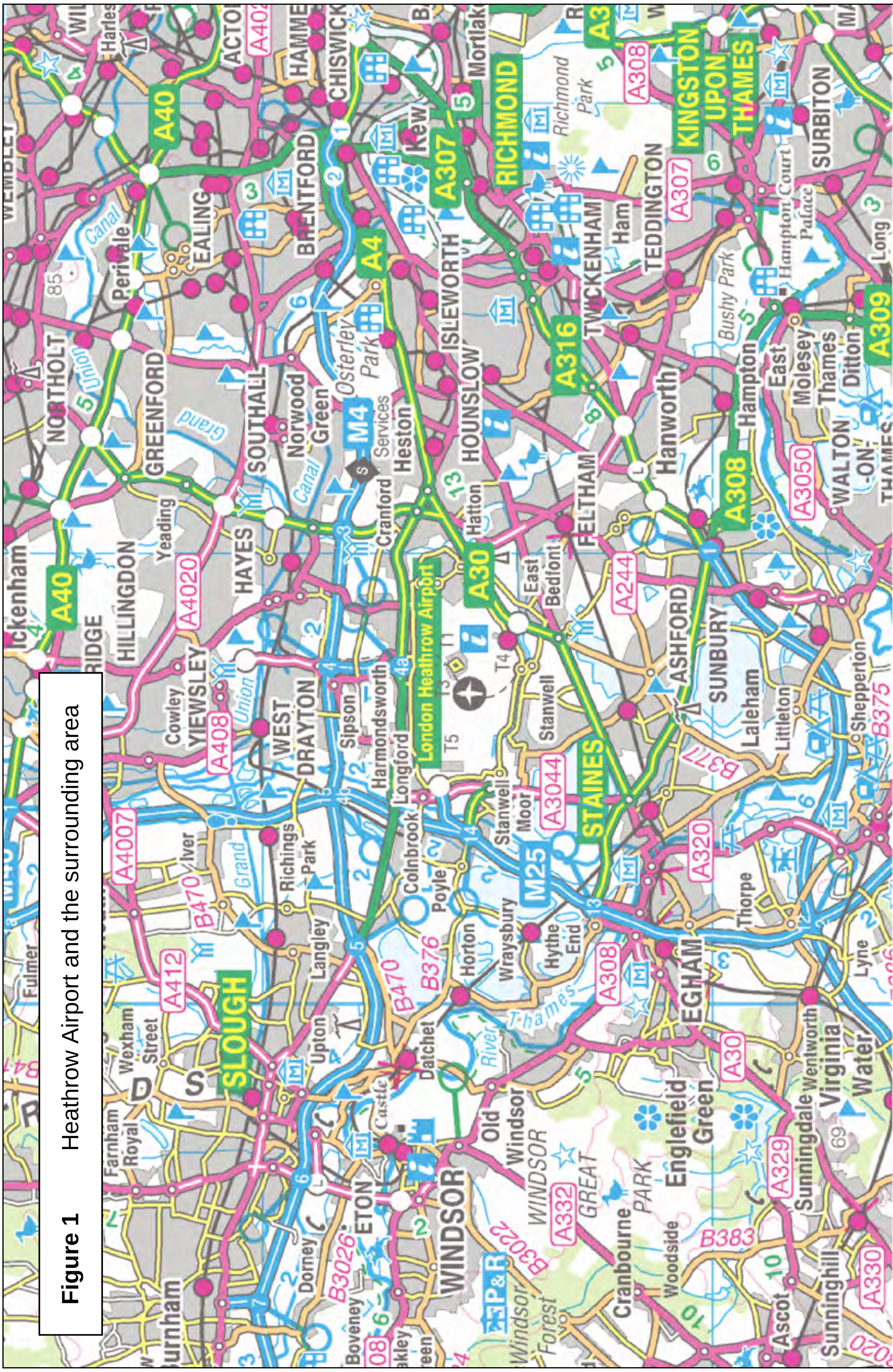
Table 2 Heathrow 2010 and 2011 average summer day movements by ANCON aircraft type

Aircraft type	Noise class	ANCON type	2010	2011	Change
Small twin-piston propeller	1	STP	0.0	**< 0.1**	0.0
Small twin-turboprop	1	STT	0.1	**0.1**	0.0
Large twin-turboprop	2	LTT	3.9	**1.6**	-2.3
Large four-engine propeller	2	L4P	0.1	**< 0.1**	0.0
Boeing 717	3	B717	0.0	**3.7**	+3.7
Boeing 737-300/400/500	3	B733	29.5	**20.4**	-9.1
Boeing 737-600/700	3	B736	18.3	**21.1**	+2.8
Boeing 737-800/900	3	B738	25.8	**23.9**	-1.9
Boeing 757-200 (RB211-535C engines)	3	B757C	1.1	**1.1**	0.0
Boeing 757-200 (RB211-535E4/E4B engines)	3	B757E	28.5	**17.6**	-10.9
Boeing 757-200 (PW2037/2040 engines)	3	B757P	1.0	**2.3**	+1.3
Boeing 757-300	3	B753	< 0.1	**0.7**	+0.7
BAe 146/Avro RJ	3	BA46	5.7	**6.6**	+0.9
Airbus A318	3	EA318	0.6	**2.5**	+1.9
Airbus A319 (CFM-56 engines)	3	EA319C	30.4	**32.9**	+2.5
Airbus A319 (IAE-V2500 engines)	3	EA319V	214.3	**208.2**	-6.1
Airbus A320 (CFM-56 engines)	3	EA320C	127.1	**117.7**	-9.4
Airbus A320 (IAE-V2500 engines)	3	EA320V	187.4	**199.4**	+12.0
Airbus A321 (CFM56 engines)	3	EA321C	41.9	**41.1**	-0.8
Airbus A321 (IAE-V2500 engines)	3	EA321V	92.9	**102.1**	+9.2
Executive Business Jet (Chapter 3)	3	EXE3	4.8	**4.2**	-0.6
Bombardier Regional Jet 100/200	3	CRJ	0.1	**0.2**	+0.1
Bombardier Regional Jet 700	3	CRJ700	1.6	**0.7**	-0.9
Bombardier Regional Jet 900	3	CRJ900	1.6	**2.9**	+1.3
Embraer ERJ 135/145	3	ERJ	19.0	**28.6**	+9.6
Embraer ERJ 170	3	ERJ170	0.2	**0.3**	+0.1
Embraer ERJ 190	3	ERJ190	0.1	**1.0**	+0.9
Fokker 100	3	FK10	6.9	**8.5**	+1.6
McDonnell Douglas MD80 series	3	MD80	10.8	**8.2**	-2.6
McDonnell Douglas MD90 series	3	MD90	3.7	**0.0**	-3.7
Boeing 767-200	4	B762	0.7	**0.2**	-0.5
Boeing 767-300 (GE CF6-80 engines)	4	B763G	14.2	**13.3**	-0.9
Boeing 767-300 (PW4000 engines)	4	B763P	11.2	**12.5**	+1.3
Boeing 767-300 (RR RB211 engines)	4	B763R	45.0	**41.6**	-3.4
Boeing 767-400	4	B764	9.7	**16.3**	+6.6
Boeing 777-200 (GE GE90 engines)	4	B772G	43.4	**40.1**	-3.3
Boeing 777-200 (PW PW4000 engines)	4	B772P	11.5	**9.7**	-1.8
Boeing 777-200 (RR Trent 800 engines)	4	B772R	50.3	**49.8**	-0.5
Boeing 777-300 (GE GE90 engines)	4	B773G	35.9	**43.3**	+7.4
Boeing 777-300 (RR Trent 800 engines)	4	B773R	1.6	**3.0**	+1.4
Airbus A300	4	EA30	4.3	**3.9**	-0.4
Airbus A310	4	EA31	1.6	**2.2**	+0.6
Airbus A330	4	EA33	39.3	**32.3**	-7.0
Airbus A340-200/300	5	EA34	17.9	**16.4**	-1.5
Airbus A340-600	5	EA346	28.7	**33.1**	+4.4
Airbus A380 (Engine Alliance GP7000 engines)	5	EA38GP	4.8	**4.0**	-0.8

Aircraft type	Noise class	ANCON type	2010	2011	Change
Airbus A380 (RR Trent 900 engines)	5	EA38R	4.0	**5.0**	+1.0
Boeing 747-400 (GE CF6-80F engines)	5	B744G	11.9	**11.5**	-0.4
Boeing 747-400 (PW PW4000 engines)	5	B744P	8.8	**10.2**	+1.4
Boeing 747-400 (RR RB211 engines)	5	B744R	61.2	**62.3**	+1.1
Boeing 747SP	5	B747SP	0.2	**0.2**	0.0
Boeing 747-100/200/300	6	B747	0.1	**< 0.1**	-0.1
Boeing 737-200 (Chapter 3)	7	B732	0.1	**0.0**	-0.1
Executive Business Jet (Chapter 2)	7	EXE2	0.0	**0.0**	0.0
Boeing 727 (Chapter 3)	8	B727	0.1	**0.1**	0.0
		TOTAL	1263.8	**1268.6**	+4.8 (+0.4%)

Note: Totals may not sum exactly due to rounding.

Figure 1 Heathrow Airport and the surrounding area



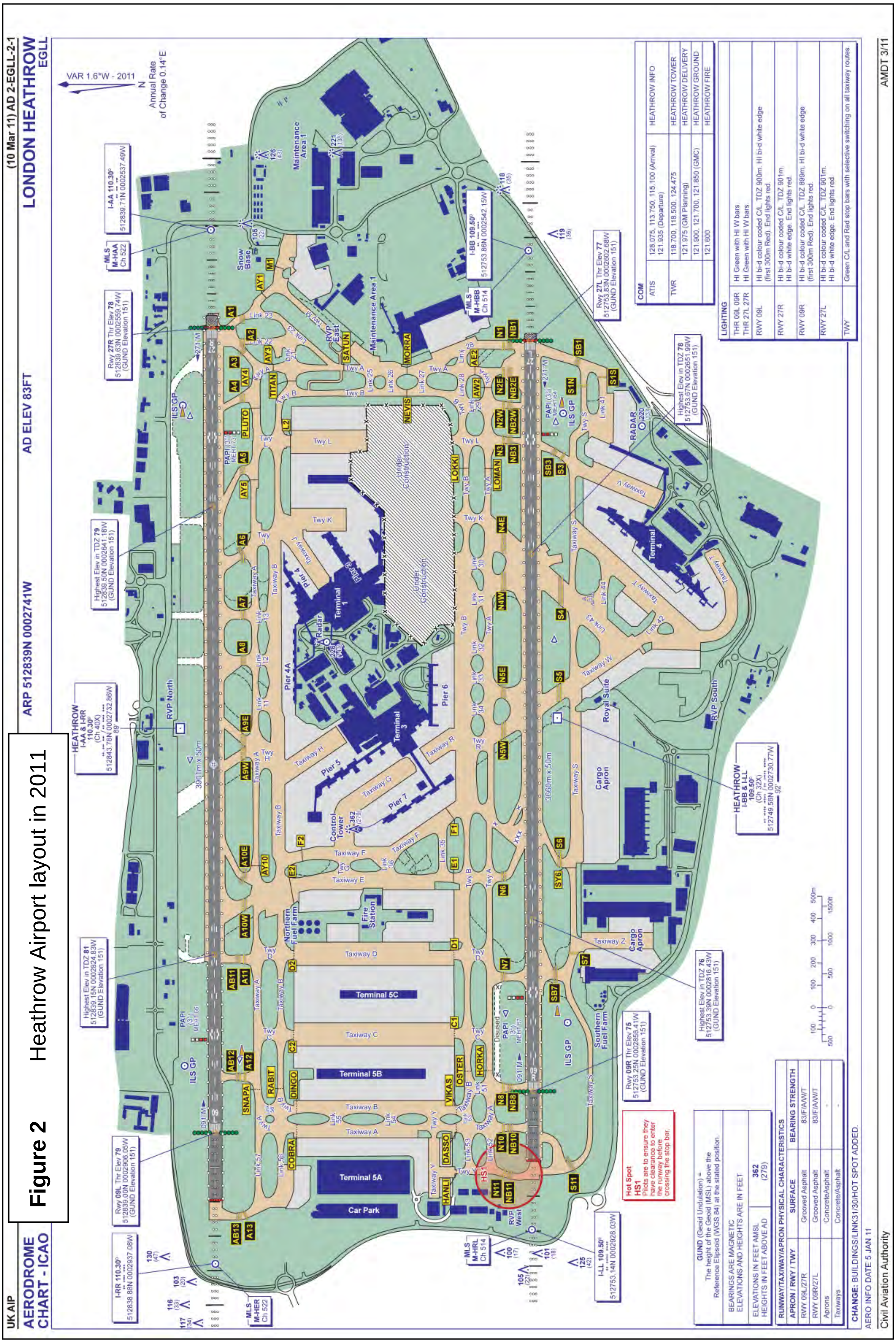


Figure 2 Heathrow Airport layout in 2011

Figure 3 Heathrow Standard Instrument Departure (SID) routes

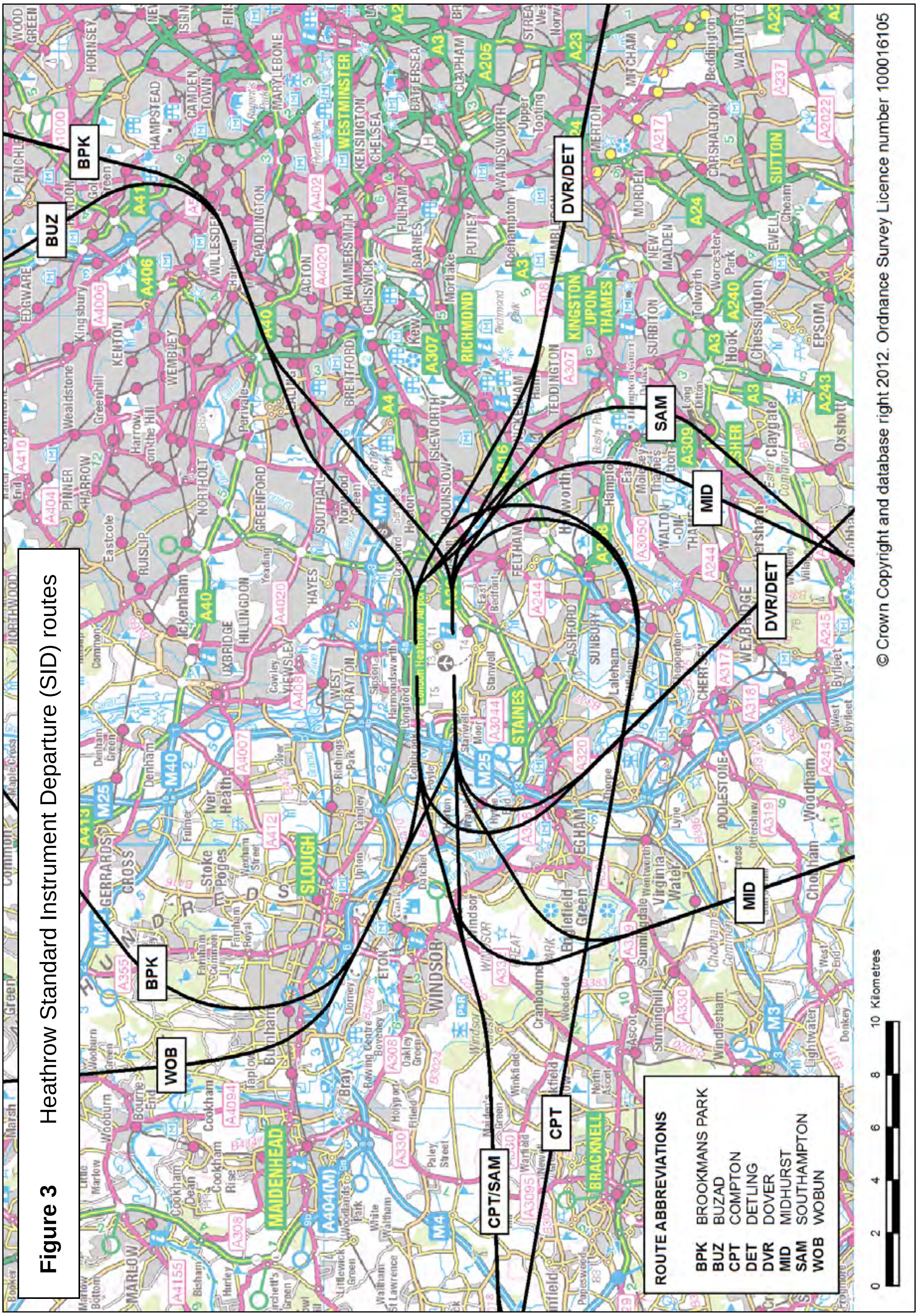


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Figure 4 Typical Heathrow radar flight tracks

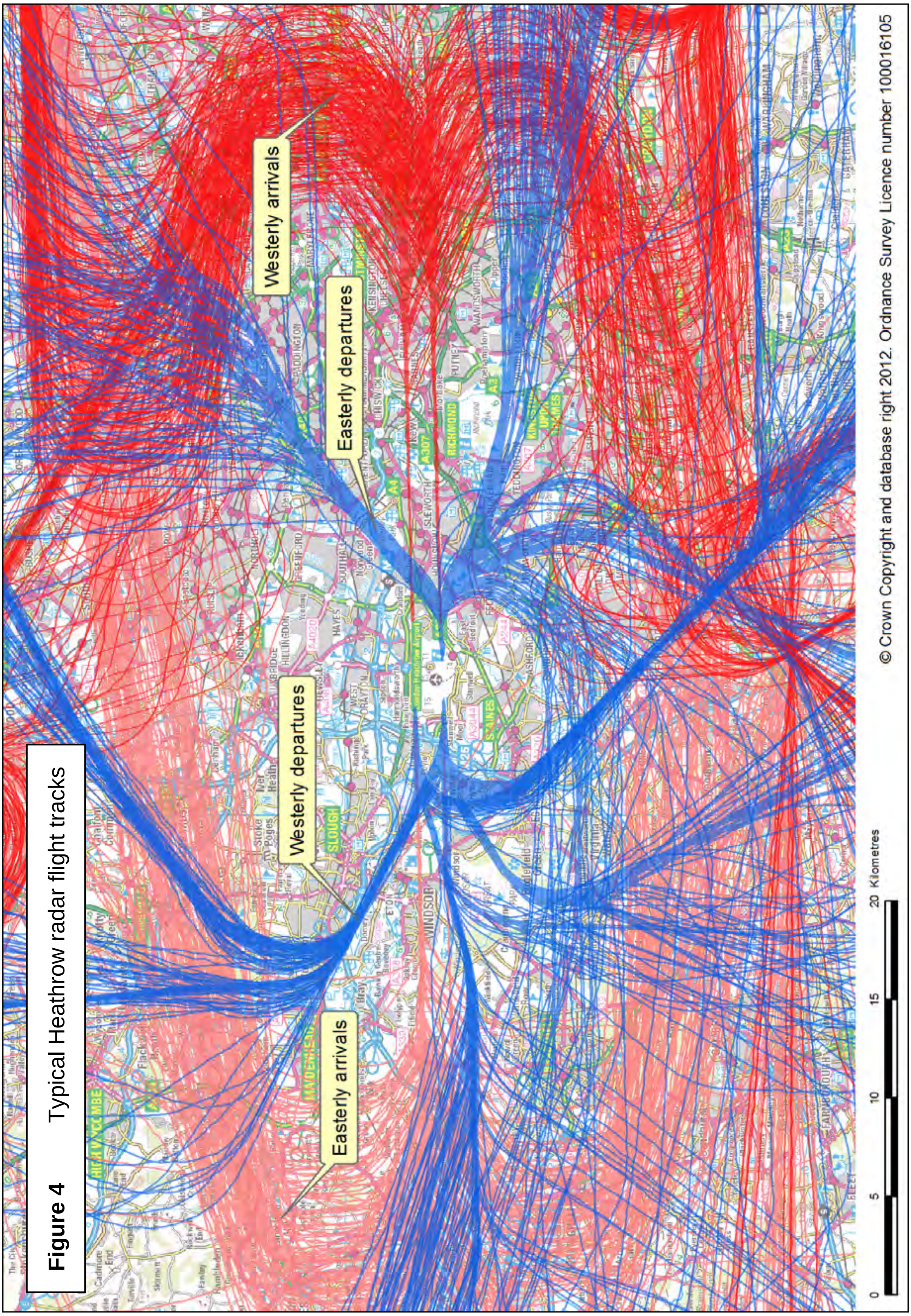
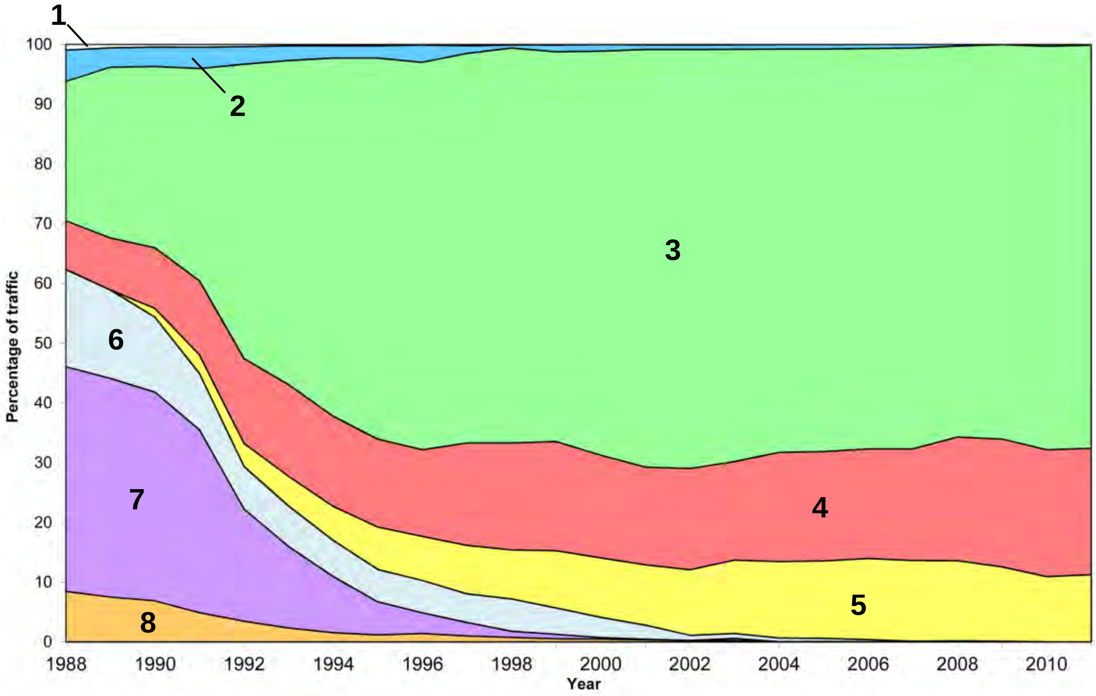


Figure 5 Heathrow noise class trend 1988-2011



Note: The percentages from 1990 onwards relate to the average 16-hour Leq day; before 1990 the percentages relate to the average 12-hour NNI day (0700-1900 local time). Also, the percentages before 1992 are based on departures only, from 1992 they relate to total movements.

Key to noise classes

Propeller aircraft

1 Small props, e.g. single/twin piston and turboprop light aircraft

2 Large props, e.g. 2- and 4-propeller transports, e.g. ATR-42, BAe ATP

Chapter 3/4 jets

3 Short-haul, e.g. Airbus A319, Boeing 737-300

4 Wide-body twins, e.g. Boeing 767, Boeing 777

5 2^{nd} generation wide-body 3,4-engine aircraft, e.g. Airbus A380, Boeing 747-400

Large Chapter 2/3 jets

6 1^{st} generation wide-body 3,4-engine aircraft, e.g. Boeing 747-200

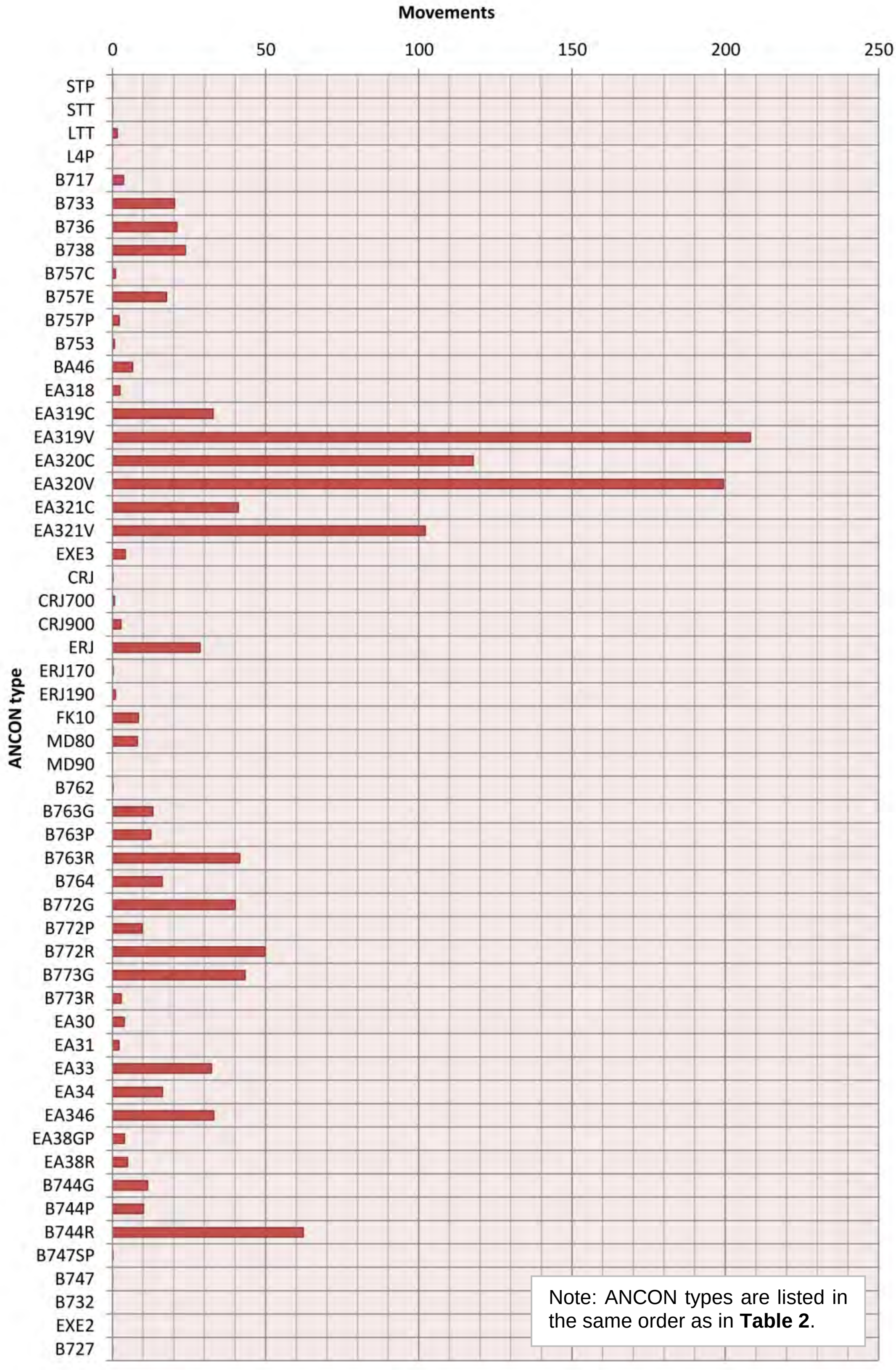
2^{nd} generation twin jets

7 Narrow body twins (including hushkitted versions), e.g. Boeing 737-200

1^{st} generation jets

8 Narrow body 3,4-engine aircraft (including hushkitted versions), e.g. Boeing 727

Figure 6 Heathrow 2011 average summer day movements by ANCON type



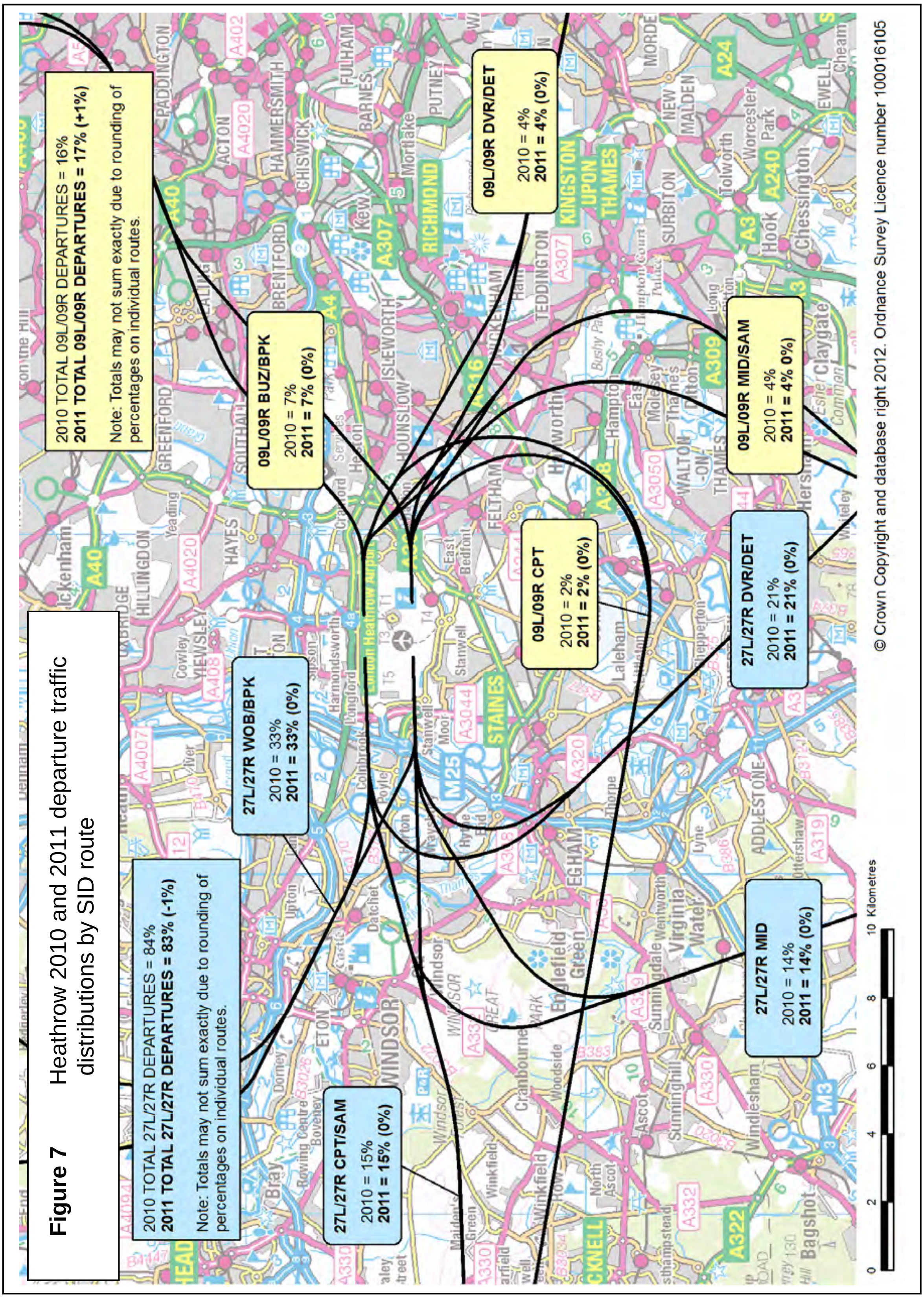


Figure 7 Heathrow 2010 and 2011 departure traffic distributions by SID route

Figure 8 Heathrow average summer day runway modal splits 1992-2011

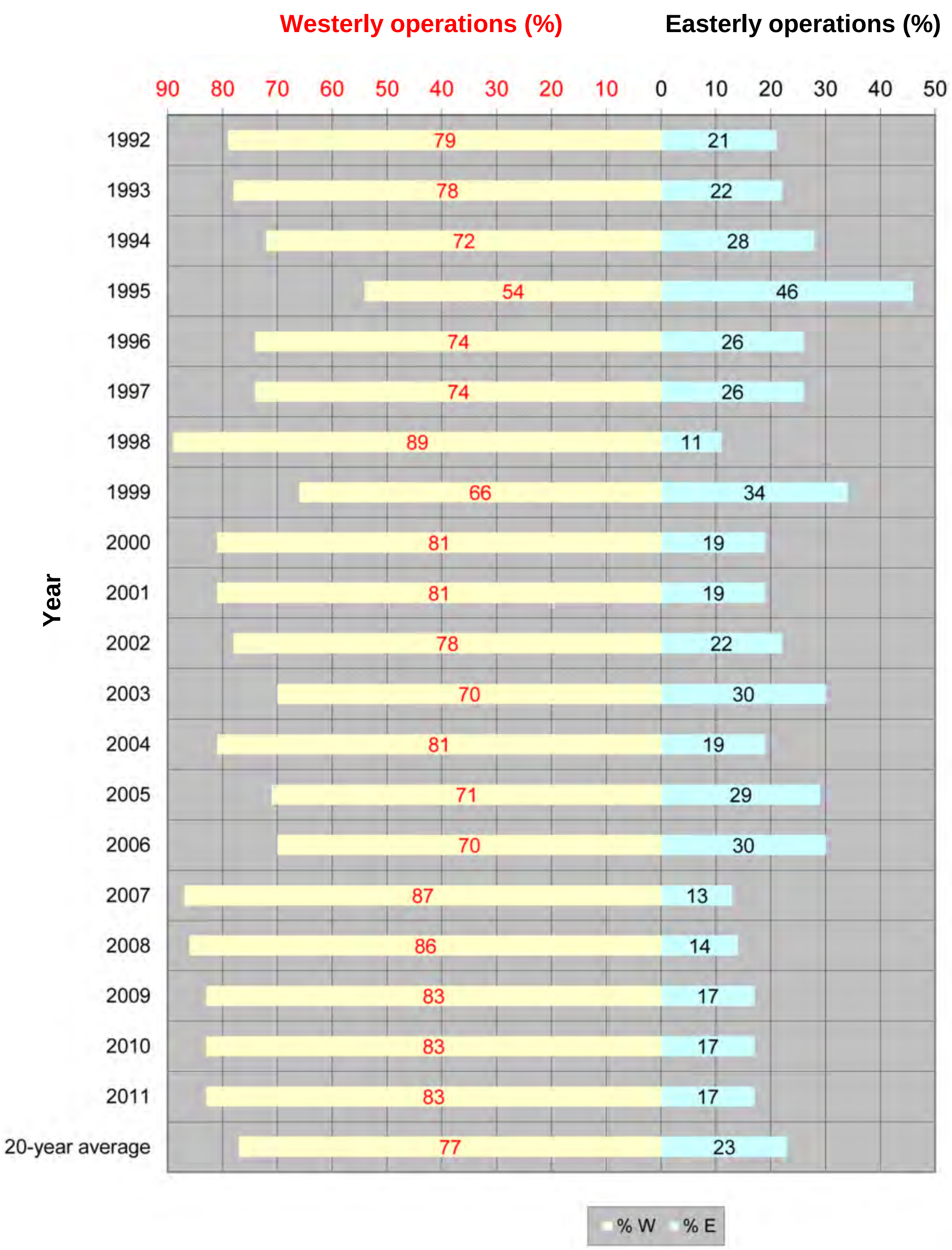
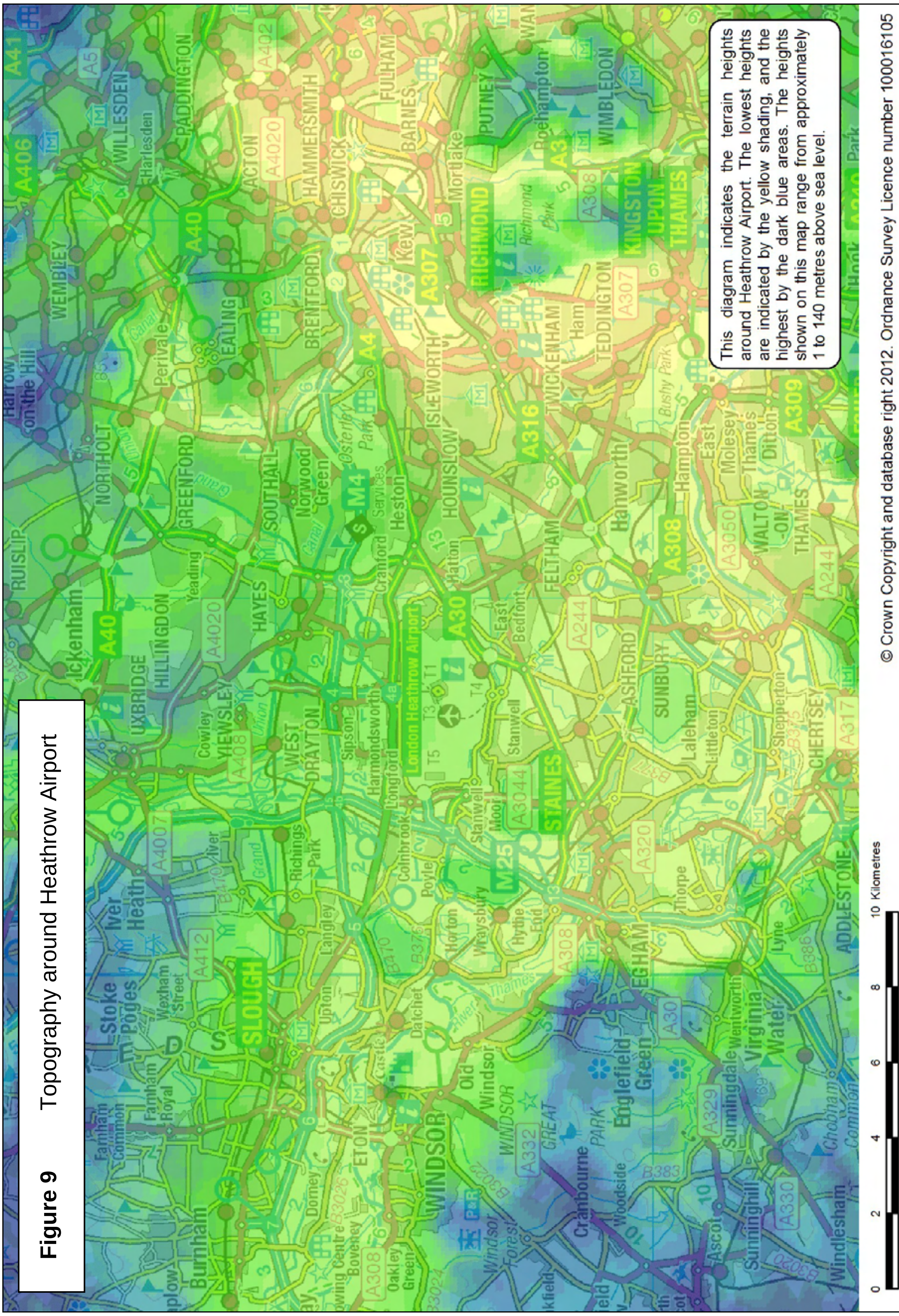


Figure 9 Topography around Heathrow Airport



This diagram indicates the terrain heights around Heathrow Airport. The lowest heights are indicated by the yellow shading, and the highest by the dark blue areas. The heights shown on this map range from approximately 1 to 140 metres above sea level.

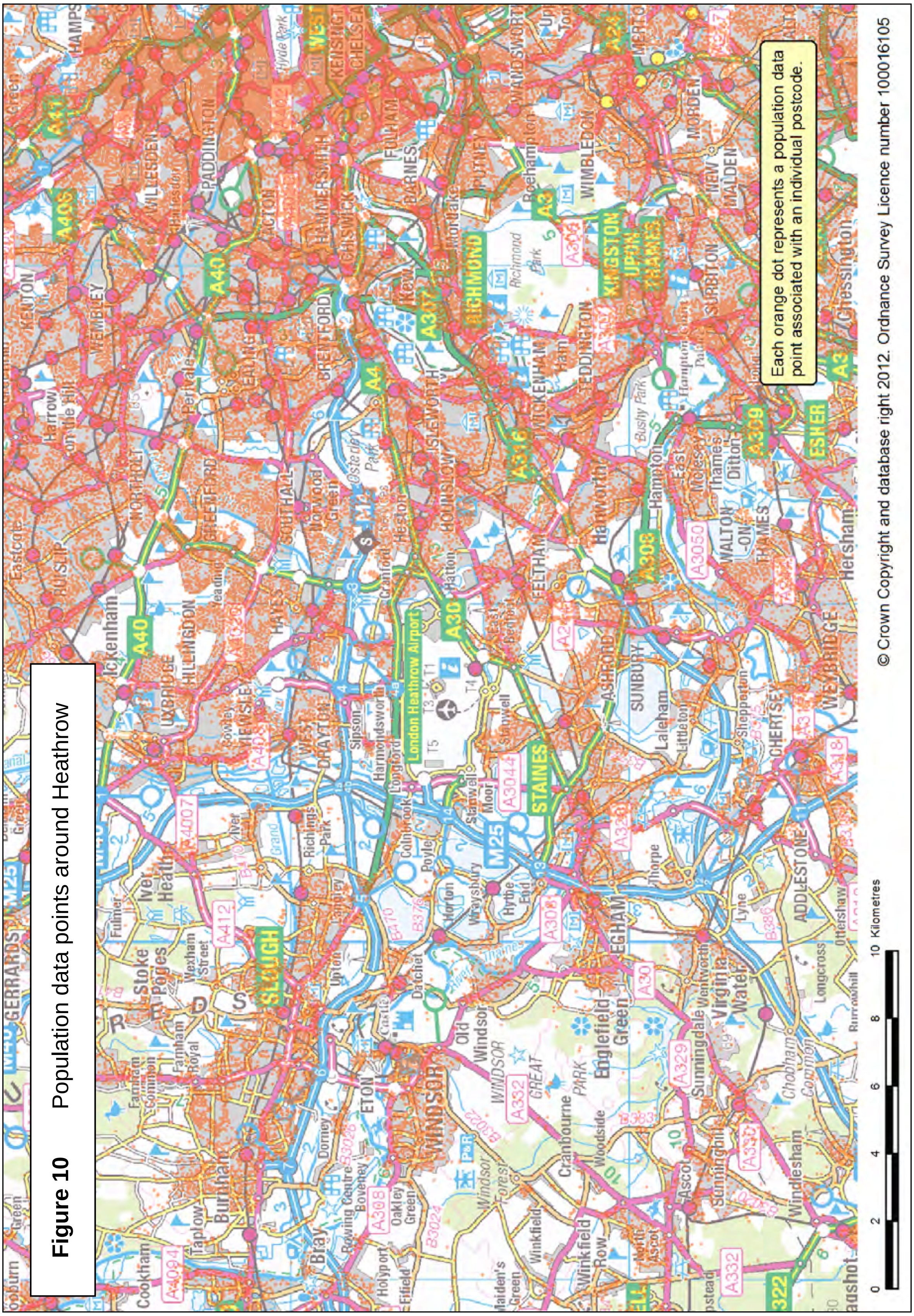


Figure 10 Population data points around Heathrow

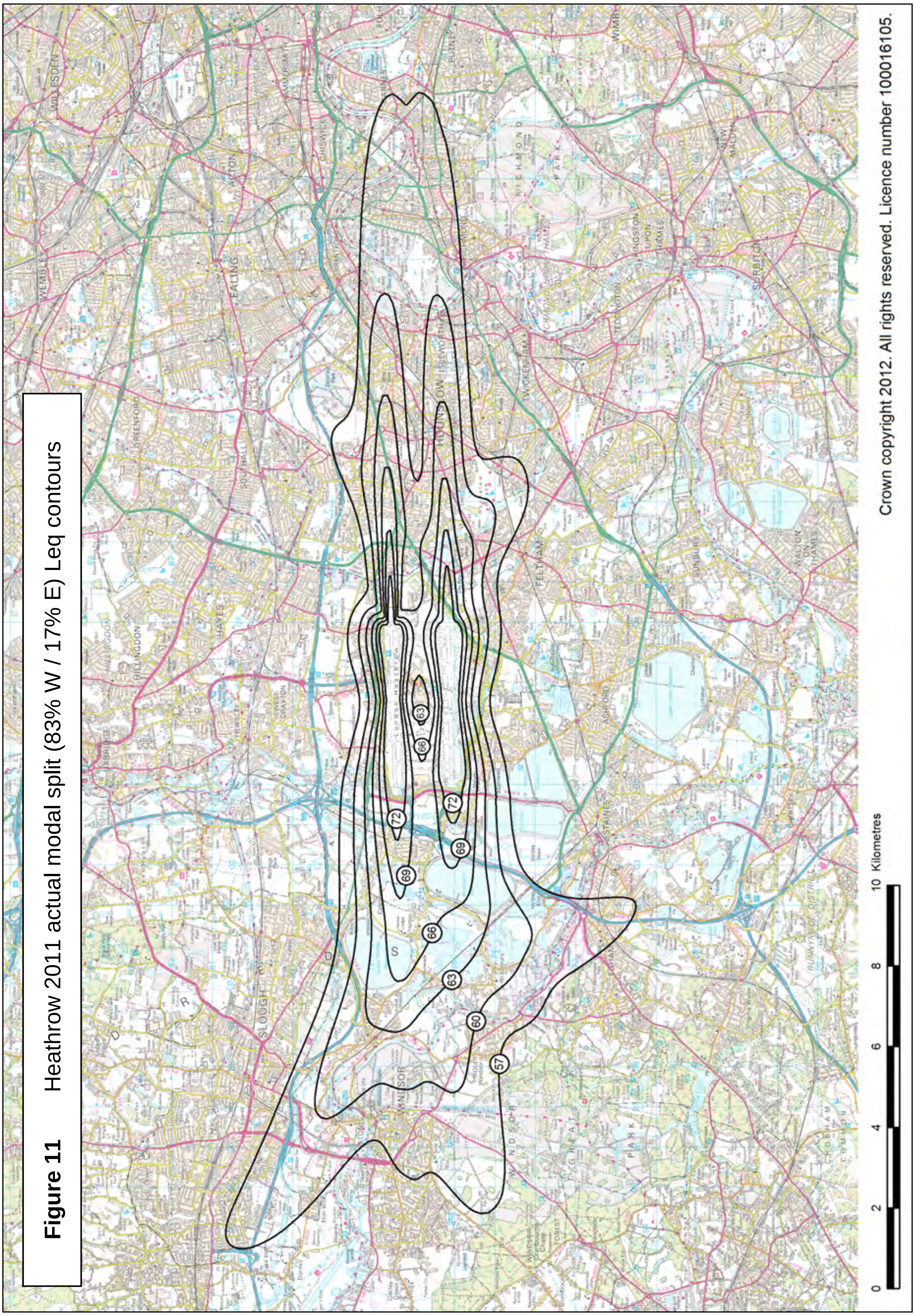
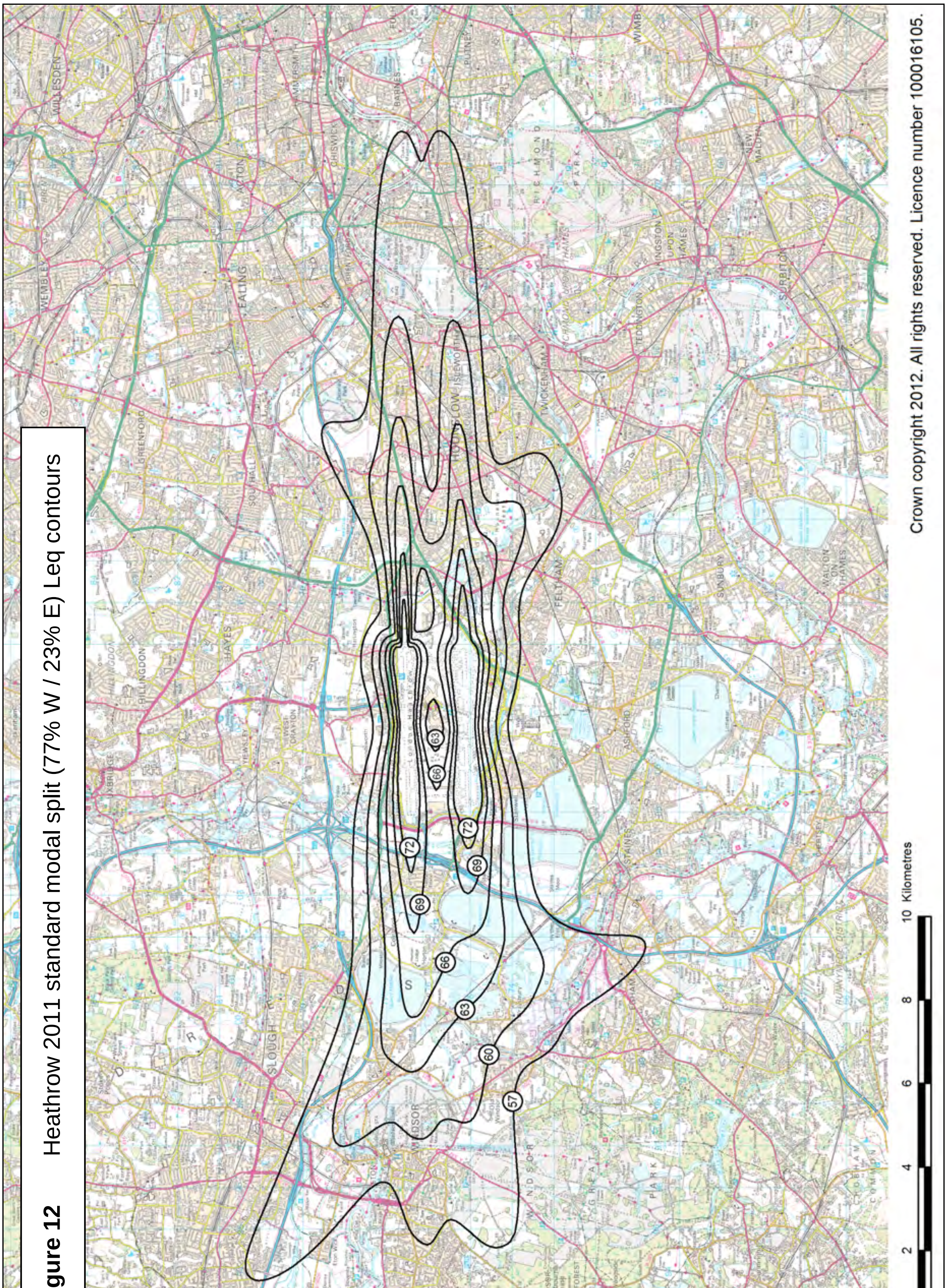


Figure 11 Heathrow 2011 actual modal split (83% W / 17% E) Leq contours

Figure 12 Heathrow 2011 standard modal split (77% W / 23% E) Leq contours



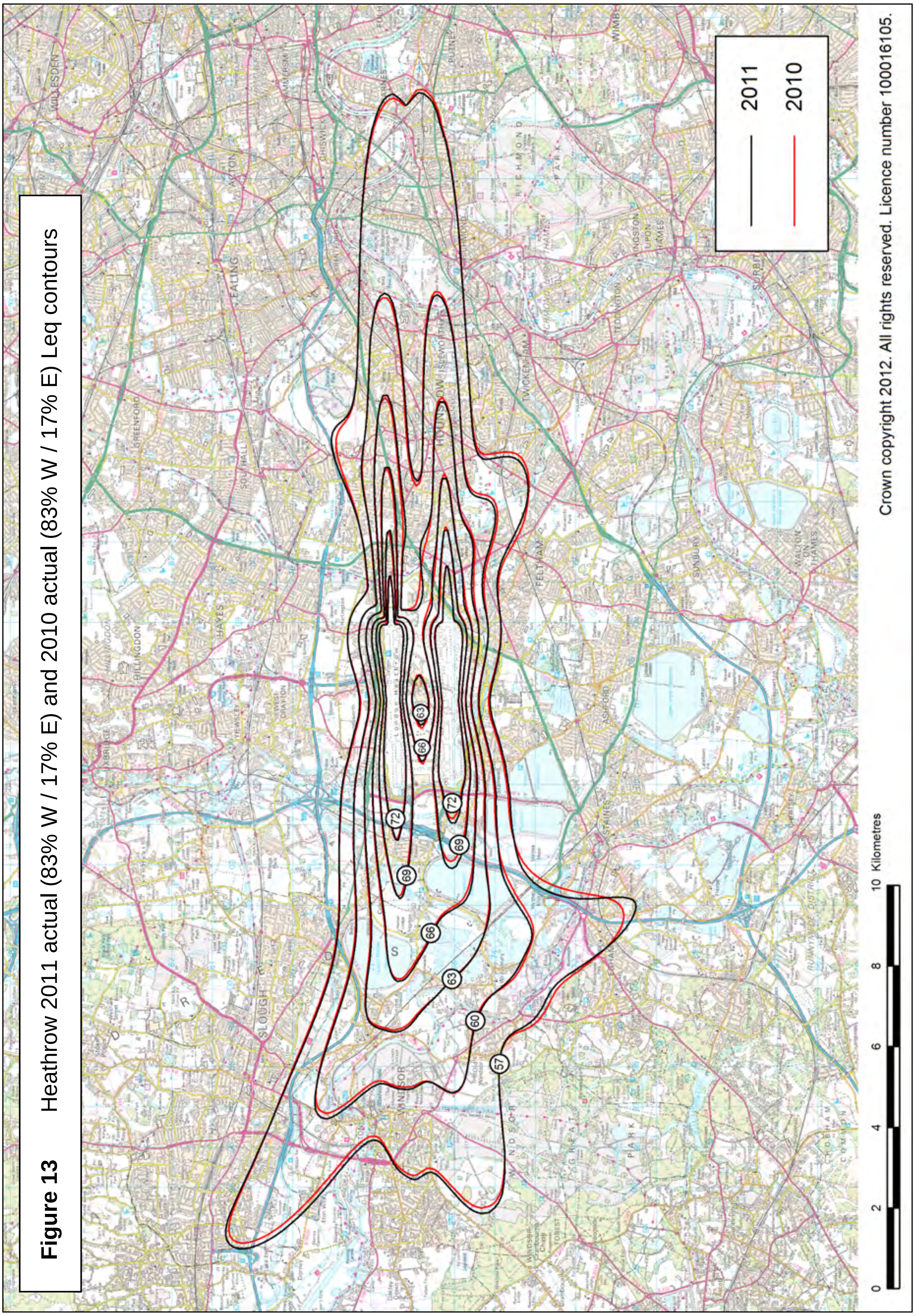


Figure 13 Heathrow 2011 actual (83% W / 17% E) and 2010 actual (83% W / 17% E) Leq contours

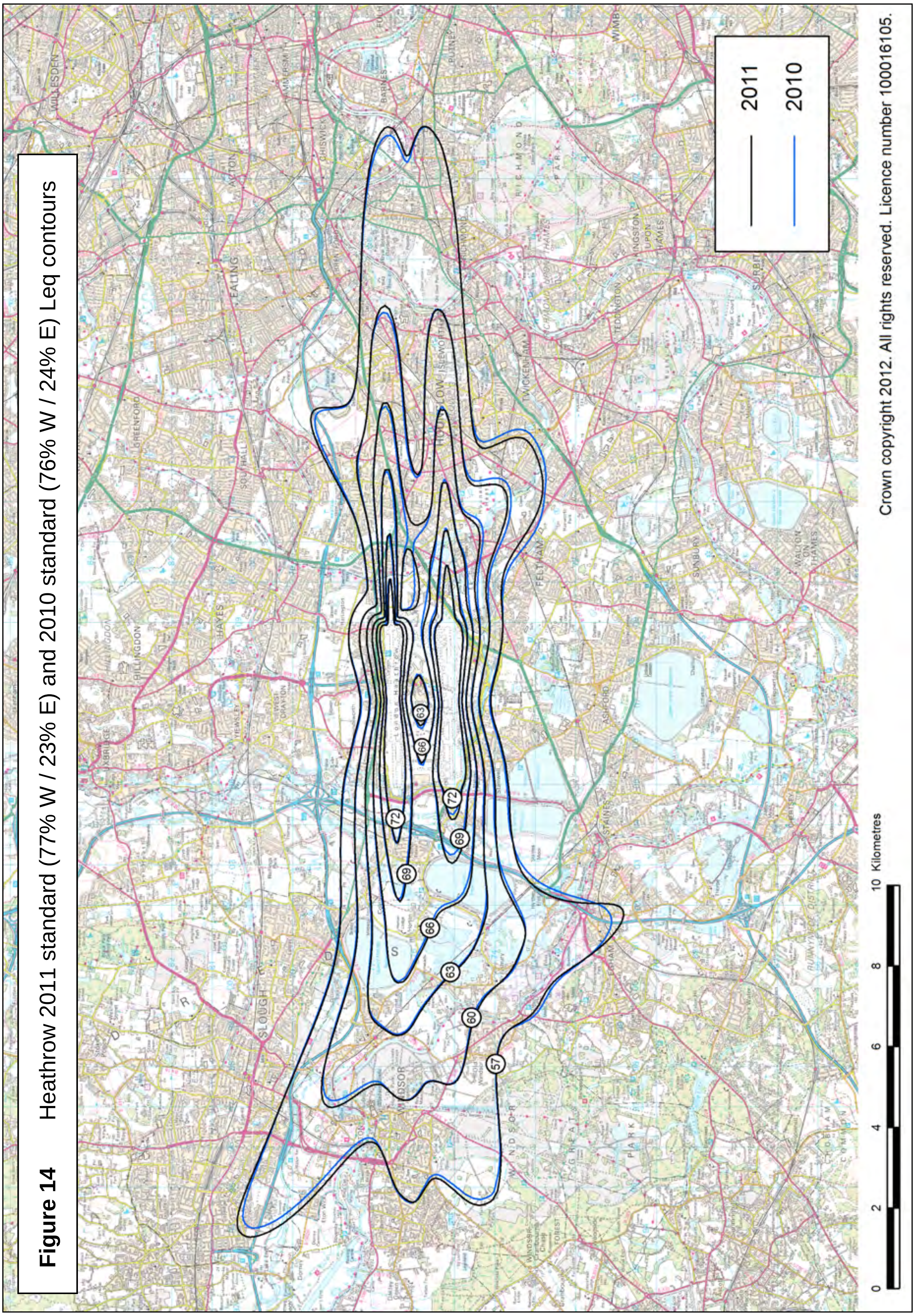


Figure 14 Heathrow 2011 standard (77% W / 23% E) and 2010 standard (76% W / 24% E) Leq contours

Figure 15 Heathrow traffic and noise contour area/population trend 1988-2011