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

ERCD Report 0803

Noise Exposure Contours for Stansted Airport 2007

D J Monkman
J Deeley
D Beaton
J McMahon
L E Edmonds

Prepared by the Civil Aviation Authority on behalf of the Department for Transport, London, July 2008

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Reference
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SUMMARY

This report describes the calculations of the aircraft noise exposure around London Stansted Airport for the year 2007 and compares both the input data and the resulting contours, together with the areas and populations within the contours, with those for 2006.

Prepared by the CAA on behalf of the Department for Transport, July 2008

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 in 2005 and 2006) supplied by CACI Information Services.

EXECUTIVE SUMMARY

For every year, the Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority estimates the noise exposures around the London Airports (Heathrow, Gatwick and Stansted) on behalf of the Department for Transport (DfT). The magnitude and extent of the aircraft noise around these airports are depicted on maps by *contours* of constant aircraft noise index (Leq) values. The contours are generated by a computer model validated with noise measurements, which calculates the emissions and propagation of noise from arriving and departing air traffic.

This report presents the results for London Stansted Airport for the year 2007 and compares both the air traffic information and the noise contours with those for 2006. As for 2006, the 2007 contours shown in this report take into account the topography around Stansted by accounting for terrain height in the modelling process.

Estimates of the populations within the 2006 contours are based on the 2001 census (updated by CACI in 2005), populations within the 2007 contours are also based on the 2001 census but updated by CACI in 2006.

The average daily aircraft movement rate during the Leq period was 2.3% higher in 2007 than in 2006. The actual modal split or runway direction in 2007 was 72% south-west / 28% north-east compared with 66% south-west / 34% north-east in 2006. The standard modal split (20 year average) in 2007 was 71% south-west / 29% north-east.

Relative to 2006, the total area within the actual 2007 terrain adjusted 57 dBA Leq (16-hour) contour increased from 29.3 square kilometres to 30.8 square kilometres, an increase of 5.1% and the population within this contour increased from 2,000 to 2,500, an increase of 25%.

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1 INTRODUCTION

1.1 The amount of aircraft noise experienced by people living around London (Stansted) Airport during the summer (mid June – mid September) of each year is estimated by the Environmental Research and Consultancy Department of the Civil Aviation Authority on behalf of the Department for Transport (DfT). The noise exposure measure is the Equivalent Continuous Sound Level, Leq (16-hour) in dBA. The background to the use of this index is explained in DORA Report 9023 (Ref 1). The method by which noise maps, or contours of Leq, are prepared using the ANCON Noise Model is described in DORA Report 9120, R&D Report 9842 and ERCD Report 0606[1] (Refs 2, 3 and 4).

1.2 This document contains small scale (1:150,000) diagrams of the 2007 Stansted Leq contours. Contours overlaid on Ordnance Survey (OS) digital maps, or in AutoCAD DXF format, are available for download from the Department for Transport website at www.dft.gov.uk. Additionally, printed contours overlaid on OS maps to scale 1:50,000 are available for purchase from the Department for Transport, Aviation Environmental Division, Zone 1/22, Great Minster House, 76 Marsham Street, London, SW1P 4DR, telephone 020 7944 4856, e-mail address aed@dft.gsi.gov.uk.

1.3 This report provides supporting information and compares both the aircraft operations and the resulting noise contours with those for 2006 (Ref 5).

1.4 New analyses of radar and noise data were undertaken in 2007, and the calculations incorporate revised mean tracks and associated dispersions for departing aircraft, together with revised 'spurs' to model the arrival flight track dispersion. Height/speed departure and arrival profiles have also been updated for each aircraft type where the data have shown this to be necessary.

1.5 To remove the effect of year-on-year weather fluctuations on aircraft operations in order to clarify underlying trends, two sets of contours for 2007 have been generated; (i) the '*actual'* modal split and (ii) the '*standard'* modal split. In 2007 the actual modal split (for the summer period 16 June – 15 September inclusive) was 72% south-west / 28% north-east compared to 66% south-west / 34% north-east in 2006. For 2006 the standard modal split was 72% south-west / 28% north-east (based on the 20 year Leq period average 1987 to 2006 inclusive); for 2007 the standard modal split was 71% south-west / 29% north-east (based on the 20 year Leq period average 1988 to 2007 inclusive). This report compares both actual and standard contours for 2006 and 2007.

1.6 As in 2006, the 2007 contours shown in this report take into account the topography around Stansted by accounting for terrain height in the modelling process. 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. ERCD holds terrain height data[2] obtained from Ordnance Survey on a 200m by 200m grid for England and Wales. Interpolation was performed to generate height data at each of the calculation points on the 100m by 50m receiver grid for use by the ANCON noise model.

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[1] ERCD Report 0606 will be published shortly.

[2] Meridian® 2 data revised 2007.

2 AIRCRAFT OPERATIONS

2.1 Flight Tracks

2.1.1 The 2007 calculations were based on updated mean tracks and track dispersions for all outbound routes from Runways 23 and 05 (see Figure 1 for route designations). These were determined from radar data (extracted from the airport's Noise and Track Keeping (NTK) monitoring system) for the summer of 2007.

2.1.2 Radar measurements of arrival tracks between the stacks and Runways 23 and 05 confirmed that the continued use of evenly spaced 'spurs' remained a realistic method for modelling the dispersion of arrival tracks about the extended runway centre lines. The 2007 measurements of arrivals on Runway 23 showed that, within the area of interest, 47% of aircraft approached from the western side of the airport and 53% from the eastern side of the airport. The comparable percentages for arrivals on Runway 05 were 93% from the western side and 7% from the eastern side of the airport. For Runway 23 the spur route segments joined the runway extended centre-line at distances ranging from 9 to 24 kilometres from threshold, for Runway 05 the distances ranged from 9 to 20 kilometres.

2.2 Flight Profiles and Noise Emissions

2.2.1 For 2007, the average flight profiles of height and speed versus track distance for each aircraft type were reviewed, and updated where necessary, for both departures and arrivals. For the 2007 calculations one additional aircraft type (the Airbus A340-200/-300) was added to the Stansted database. Noise event levels were then determined from a database expressing SEL[3] as a function of engine power setting and slant distance to the receiver – the so-called 'noise-power-distance (NPD)' relationship. The engine power settings required for the aircraft to follow the measured average height and speed profiles were calculated from data describing aircraft performance characteristics within each of the different aircraft type categories.

2.2.2 As for the aircraft flight track and profile data, the ANCON noise database is continuously reviewed and updated with adjustments made when, and where, measurements show this to be necessary. The Stansted NTK system comprises 8 fixed monitors (positioned approximately 6.5 kilometres from start of roll) together with a number of mobile monitors which are shared amongst the three London Airports and the CAA. These can be deployed anywhere within the NTK radar coverage area. More information about validating the CAA ANCON noise model can be found on the ERCD website at http://www.caa.co.uk/docs/68/Valid_ANCON.pdf. Following extensive noise measurements of departures from Stansted in 2007, at 4 and 5 kilometres from start of roll, the B737-800 and -900 aircraft have had their noise levels increased by about 0.5dB at distances ranging from 2 to 5 kilometres from start of roll.

2.2.3 Examination of the 2007 radar data indicated that, as in the preceding years, at distances greater than 10 kilometres to touchdown, the average aircraft heights for arrivals on Runway 05 were generally somewhat lower than on Runway 23. This follows the introduction of Continuous Descent Approach (CDA) procedures for Runway 23 arrivals via the Abbott stack from the 4 November 1999 and the extension to all Runway 23 arrivals in 2000 (section 2.21 paragraph 10, AD2-EGSS-1-11 of the UK AIP). Accordingly, for the 2007 calculations, separate Runway 23

[3] Sound Exposure Level in dBA; a measure of noise event level which accounts for both the duration and intensity of noise.

and 05 descent profiles were used to describe arrivals by all aircraft types at Stansted.

2.3 Traffic Distribution by Aircraft Type and Route

2.3.1 The aircraft movements conventionally used to determine Leq are the daily averages of those which take place in the 16-hour day, 0700-2300 local time, during the 92-day period 16 June to 15 September inclusive. Table 1, which displays the distribution of movements by aircraft type, shows that the 2007 average Leq 16-hour day movement rate was 2.3% higher than in 2006.

2.3.2 Table 2 compares the distribution of aircraft departures by route for 2006 and 2007. The percentages of use of each runway direction - the 'modal split' - for 2007 were 72% south-west / 28% north-east compared to 66% south-west / 34% north-east in 2006.

2.3.3 The table below lists the 'average summer day' movements by eight noise classes of aircraft (ranked in ascending order of noise emission, i.e. from least to most noisy) during 2006 and 2007. Table 1 and Figure 2 (at the end of the Report) state which specific aircraft types fall into which categories.

NOISE CLASS	AIRCRAFT	AVERAGE NUMBER 2006	AVERAGE NUMBER 2007	PERCENTAGE OF TOTAL 2007 MOVEMENTS	CHANGE AS PERCENTAGE OF TOTAL 2006 MOVEMENTS
	PROPELLER AIRCRAFT				
1	Small props	0.8	0.7	0.1	0.0
2	Large props	11.9	8.3	1.6	-0.7
	CHAPTER 3 JETS				
3	Short-haul	489.6	504.9	94.5	+2.9
4	Wide-body twins	8.2	9.0	1.7	+0.2
5	2nd gen wide body multis*	9.0	9.3	1.7	+0.1
	LARGE CHAPTER 2/3 JETS				
6	1st gen wide-body multis*	0.9	0.5	0.1	-0.1
	2 nd GENERATION TWIN JETS				
7	Narrow body twins (including Chapter 2 and hushkitted versions)	1.1	1.0	0.2	0.0
	1 st GENERATION JETS				
8	Narrow body multis (including hushkitted versions)	0.7	0.5	0.1	0.0
	TOTAL MOVEMENTS	522.2	534.2	100.0**	+2.3**

* Multi-engined (3 or 4) aircraft
** May not sum exactly due to rounding

2.3.4 Short haul Chapter 3 jets (noise class 3) showed the largest percentage increase in movements per average summer day rising from 489.6 in 2006 to 504.9 in 2007. Operations by Large props (noise class 2) showed the largest percentage reduction in 2007. It can be seen from Table 1 that, within noise class 3, movements by B737-300/400/500 continued to decrease whilst those by B737-800/900 and A319C continued to increase.

2.3.5 Figure 2 illustrates the changing distribution of traffic (both circuit and non-circuit prior to 2002) among these classes over the twenty years from 1988 to 2007[4] inclusive.

3 NOISE CONTOURS

3.1 'Actual' contours

3.1.1 The actual Leq contours for 2007 (i.e. those depicting actual terrain adjusted average mode Leq exposures), from 57 to 72 dBA in steps of 3dB, are overlaid on a background map in Figure 3. In Figure 4 three of these, for 57, 63 and 69 dBA Leq, are compared with the contours for 2006.

3.1.2 The total areas and populations[5] enclosed by each of the contours are listed below:

Leq LEVEL dBA	AREA SQ KM		PERCENTAGE CHANGE	POPULATION 000's		PERCENTAGE CHANGE
	2006 ACTUAL	2007 ACTUAL		2006 ACTUAL (2005 CACI data)	2007 ACTUAL (2006 CACI data)	
>57	29.3	30.8	+5.1	2.0	2.5	+25.0
>60	16.2	16.8	+3.7	1.0	1.0	0.0
>63	8.6	8.9	+3.5	0.3	0.3	*
>66	4.5	4.7	+4.4	<0.1	0.1	*
>69	2.3	2.5	+8.7	<0.1	<0.1	*
>72	1.3	1.4	+7.7	<0.1	<0.1	*

* Percentage changes not shown because of the relatively low numbers and limited resolution of the estimates. Also, percentage changes in contour areas and populations are not necessarily the same because the contours may differ in shape as well as size.

3.1.3 Relative to 2006, the areas within the 2007 actual Leq contours have all increased ranging from a 3.5% increase at 63 dBA Leq to an 8.7% increase at 69 dBA Leq. These increases in area are attributable to the 2.3% increase in traffic in 2007 and the increase in departure noise level of the B737-800, -900 as stated in paragraph 2.2.2. At 57 dBA Leq it is estimated that about half of the 5.1% increase is due to the increase in traffic whilst the other half is due to the increase in noise levels of the B737-800/900 aircraft (the most numerous aircraft types at Stansted in both 2006 and 2007 – see Table 1). Based on the 2006 CACI data, the population within the 2007 actual 57 dBA Leq contour increased by 25% (using the earlier 2005 CACI data would have yielded the same result). 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 line(s) from year to year, especially in or around relatively highly populated areas, can cause a disproportionate change in enclosed population.

3.1.4 It can be seen from Figure 4 that, despite the increase in traffic, the 2007 contours are generally very similar to those for 2006. The 2007 contours to the south-west of

[4] The 1990 to 2007 percentages shown in Figure 2 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.

[5] The population estimates shown in this Report are based on 2001 census data (updated by CACI Ltd in 2005 and 2006). Note also that area and population figures presented in this Report are cumulative.

the airport associated with departures on the Dover (DVR) and Clacton/Lydd (CLN/LYD) routes from Runway 23 (see Figure 1) have expanded very slightly as have those to the north east of the airport (associated with arrivals to Runway 23). These small movements in the contours reflect the 6% change in modal split between the two years. The 25% increase in population within the actual 57 dBA Leq contour is because in 2007 this contour encroached into Thaxted, a relatively highly populated area to the north east of the airport.

3.2 'Standard' contours

3.2.1 In Figure 5 the standard terrain adjusted 2007 contours (57, 63 and 69 dBA Leq) are compared with those for 2006. These show what the noise exposures would have been if the 2006 and 2007 modal splits had mirrored the 20-year rolling average. The 2006 standard contours were based on the 20 year average modal split from 1987 to 2006 inclusive of 72% south-west / 28% north-east; those for 2007 were based on the 20 year average modal split from 1988 to 2007 inclusive which was 71% south-west / 29% north-east. The associated areas and populations are displayed below:

Leq LEVEL dBA	AREA SQ KM		PERCENTAGE CHANGE	POPULATION 000's		PERCENTAGE CHANGE
	2006 STANDARD	2007 STANDARD		2006 STANDARD (2005 CACI data)	2007 STANDARD (2006 CACI data)	
>57	29.5	30.8	+4.4	2.2	2.3	+4.5
>60	16.2	16.8	+3.7	1.0	1.0	0.0
>63	8.6	8.9	+3.5	0.3	0.3	*
>66	4.5	4.7	+4.4	0.1	0.1	*
>69	2.4	2.5	+4.2	<0.1	<0.1	*
>72	1.3	1.4	+7.7	<0.1	<0.1	*

* Percentage changes not shown because of the relatively low numbers and limited resolution of the estimates.

3.2.2 Relative to 2006, the area within the standard 2007 57 dBA Leq contour increased by 4.4%. Based on the 2006 CACI data the population within the standard 2007 57 dBA Leq contour increased by 4.5% (using the earlier 2005 CACI population data would have yielded the same result).

3.2.3 The standard contours normally provide a clearer indication than the actual contours of 'fleet noise level' changes because they minimise the effect of any difference between the ratios of south-westerly to north-easterly operations for the two years. It can be seen from Figure 5 that the standard 2007 contours are very similar to those for 2006. The main change is the very slight widening of the 2007 57 dBA Leq contour to the south-west and, to a lesser extent, the north–east of the airport associated with departures from Runways 23 and 05. This is a consequence of the general increase in traffic and the slight increase in the departure noise of the B737-800/900 aircraft.

4 STANSTED TRAFFIC AND NOISE: HISTORICAL TRENDS

4.1 Figure 6 shows how the average mode 57 dBA Leq contours, based on actual modal splits[6], have changed since 1988 by comparison with the *total annual* aircraft movements.

4.2 Annual movements at Stansted rose steadily between 1990 and 2001 showing particularly rapid growth between 1997 and 1999. The number of movements in 2001 and 2002 were very similar but in 2003 the annual figure rose by 9.3% over the preceding year. The total annual movement figure for 2007 (208,500[7]) was 0.9% higher than that for 2006 (206,700).

4.3 Up to 1998, areas and populations within the 57 dBA Leq contours have generally risen in line with movements but in 1999, despite the high traffic growth, the area within the 57 dBA Leq contour fell by 19%. This decrease was attributable to fewer movements of older, noisier, Chapter 2 aircraft – in particular those by the BAC 1-11 which fell by 64% in that year.

4.4 Following the increase in traffic in 2007, the area within the actual 57 dBA Leq contour increased by 5.1% relative to 2006.

[6] Actual modal split data are used in this figure because contours based on standard modal split are a relatively recent innovation and data prior to 1995 are not available.

[7] Total annual movement figures rounded to nearest 100.

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DORA Report 9023, September 1990

2 Ollerhead J B
The CAA Aircraft Noise Contour Model: ANCON Version 1
DORA Report 9120, November 1992

3 Ollerhead J B, Rhodes D P, Viinikainen M S, Monkman D J, Woodley A C
The UK Civil Aircraft Noise Contour Model ANCON:
Improvements in Version 2
R&D Report 9842, June 1999

4 Rhodes D P, Monkman D J, Woodley A C
The CAA Aircraft Noise Contour Model: ANCON Version 2.3
ERCD Report 0606 (to be published shortly)

5 Monkman D J, Rhodes D P, Deeley J, Beaton D, McMahon J
Noise Exposure Contours for Stansted Airport 2006
ERCD Report 0703, June 2007

Table 1:

DISTRIBUTION OF STANSTED AVERAGE DAILY AIRCRAFT MOVEMENTS BY TYPE (0700-2300 LOCAL TIME, 16 JUNE-15 SEPTEMBER)

AIRCRAFT TYPE(S)	NOISE CLASS	AVERAGE NUMBER 2006	AVERAGE NUMBER 2007	PERCENTAGE OF TOTAL 2007 MOVEMENTS	CHANGE AS PERCENTAGE OF TOTAL 2006 MOVEMENTS
Small Props	1	0.8	0.7	0.1	0.0
Large Props	2	11.9	8.3	1.6	-0.7
B737-300, 400, 500	3	27.9	19.4	3.6	-1.6
B737-600, 700	3	40.0	41.2	7.7	+0.2
B737-800, 900	3	269.3	280.8	52.6	+2.2
B757E (RB211-535E4, E4B)	3	6.9	8.3	1.6	+0.3
B757P (Pratt & Whitney)	3	2.3	4.1	0.8	+0.3
BAe146	3	7.2	5.3	1.0	-0.4
A319C (CFM-56)	3	87.5	98.9	18.5	+2.2
A319V (IAE-V2500)	3	0.9	4.2	0.8	+0.6
A320C (CFM-56)	3	6.4	6.3	1.2	0.0
A320V (IAE-V2500)	3	2.0	3.4	0.6	+0.3
A321C (CFM56)	3	6.3	4.9	0.9	-0.3
A321V (IAE-V2500)	3	0.4	2.2	0.4	+0.3
Business Jet (Ch 3)	3	11.5	12.8	2.4	+0.2
Bombardier Regional Jet 100/200	3	0.1	0.2	0.0	0.0
Bombardier Regional Jet 700/900	3	0.1	0.0	0.0	0.0
Embraer EMB 135/145	3	1.8	2.2	0.4	+0.1
F100	3	10.7	5.7	1.1	-1.0
MD80	3	3.2	1.2	0.2	-0.4
MD90	3	5.1	3.8	0.7	-0.2
B767-200	4	3.2	4.3	0.8	+0.2
B767-300G (General Electric)	4	2.5	1.9	0.4	-0.1
B767-300P (Pratt and Whitney)	4	0.1	0.1	0.0	0.0
B777-200G (General Electric)	4	0.2	0.4	0.1	0.0
A300	4	1.8	2.1	0.4	+0.1
A310	4	0.3	0.2	0.0	0.0
A330	4	0.1	0.0	0.0	0.0
A340-200/300***	5	0.0	0.1	0.0	0.0
B747-400G (General Electric)	5	3.8	3.8	0.7	0.0
B747-400P (Pratt and Whitney)	5	0.2	0.2	0.0	0.0
B747SP	5	0.2	0.1	0.0	0.0
MD11	5	4.8	5.1	1.0	+0.1
B747-200, 300 (Ch 3)	6	0.9	0.5	0.1	-0.1
B737-200 (Ch3)	7	0.9	0.3	0.1	-0.1
DC9 (Ch 3)	7	0.2	0.6	0.1	+0.1
Business Jet (Ch 2)	7	0.0	0.1	0.0	0.0
B707, DC8*	8	0.1	0.2	0.0	0.0
B727 (Ch 3)	8	0.4	0.3	0.1	0.0
Tu154M*	8	0.2	0.0	0.0	0.0
TOTAL MOVEMENTS		522.2	534.2	100.0**	+2.3**

* In 2006 and 2007 all Chapter3 versions
** May not sum exactly due to rounding
*** New type for 2007

Table 2:

PERCENTAGE OF STANSTED AVERAGE DAILY AIRCRAFT DEPARTURES BY ROUTE*
(0700-2300 LOCAL TIME, 16 JUNE - 15 SEPTEMBER)

SOUTH WESTERLY DEPARTURE ROUTE	PERCENTAGE OF TOTAL DEPARTURES 2006	PERCENTAGE OF TOTAL DEPARTURES 2007	CHANGE (% OF TOTAL)
BUZ/BKY/CPT	33.4	36.6	+3.2
CLN	16.9	18.5	+1.6
DVR/LAM/LYD	15.7	16.9	+1.2
PERCENTAGE SOUTH WEST	66.0	72.0	+6.0
NORTH EASTERLY DEPARTURE ROUTE	PERCENTAGE OF TOTAL DEPARTURES 2006	PERCENTAGE OF TOTAL DEPARTURES 2007	CHANGE (% OF TOTAL)
BUZ/BKY/CPT	17.3	14.1	-3.2
CLN	8.8	7.2	-1.6
DVR/LAM/LYD	7.9	6.7	-1.2
PERCENTAGE NORTH EAST	34.0	28.0	-6.0

* See Figure 1

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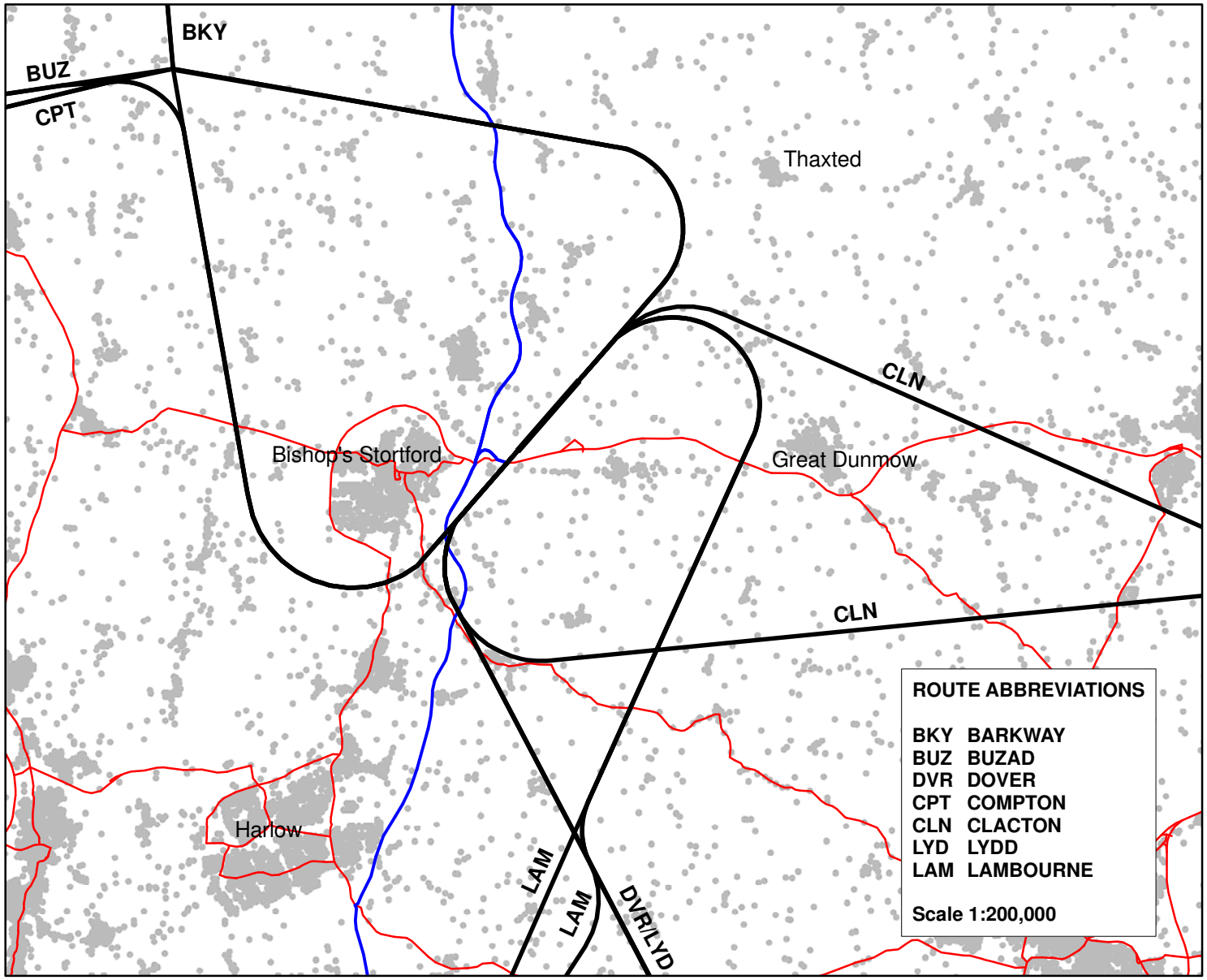
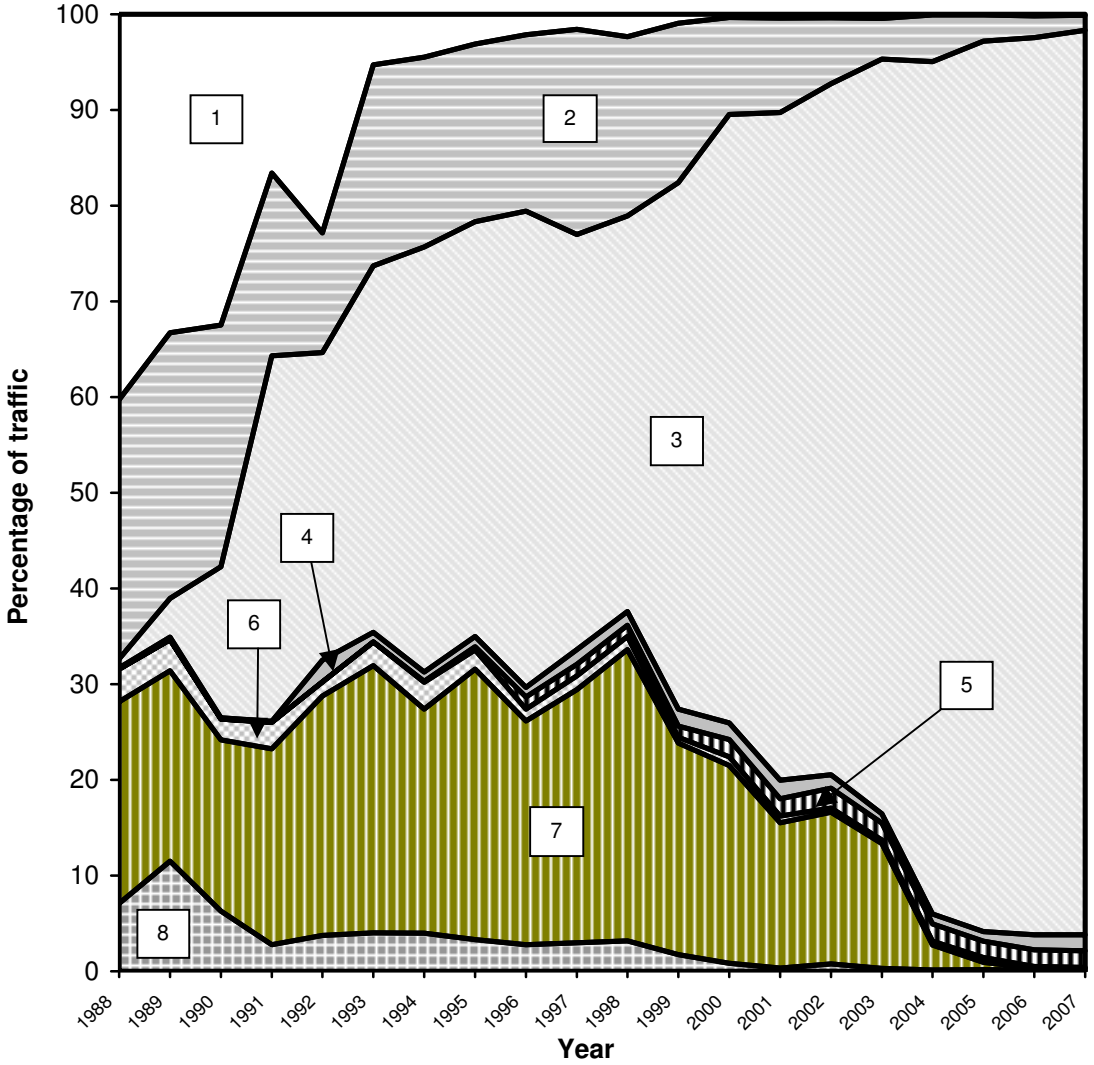


Figure 1: London Stansted Airport Standard Instrument Departure Routes



Propeller aircraft:

1 Small props: Single and twin pistons and turboprop light, business and commuter aircraft

2 Large props: 2- & 4-propeller transports; eg SF340 BAe-ATP, ATR42, F50, HS748, Saab 2000, Electra, Hercules, Viscount, Vanguard

Chapter 3 jets:

3 Short-haul: eg A320, BAe146, B717, B737-300, B757, F100, MD80, RJ50, re-engined narrow-bodies, some business jets

4 Wide-body twins: A300, A310, A330, B767, B777

5 2nd gen. wide-body multis*: A340, MD11, B747-400

Large Chapter 2/3 jets:

6 1st gen. wide-body multis* (Chapter 2 & 3): 'Classic' 747, Tristar, DC-10, An124, IL76, IL86

2nd generation twin jets:

7 Narrow body twins (including hushkitted versions): eg F28, BAC1-11, DC-9, B737-200, Tu134, other business jets

1st generation jets: (including hushkitted versions)

8 eg Trident, B707, DC-8, B727, IL62, Tu154

* Multi = 3- or 4- engined aircraft

Figure 2: Noise Class of Stansted aircraft 1988 - 2007

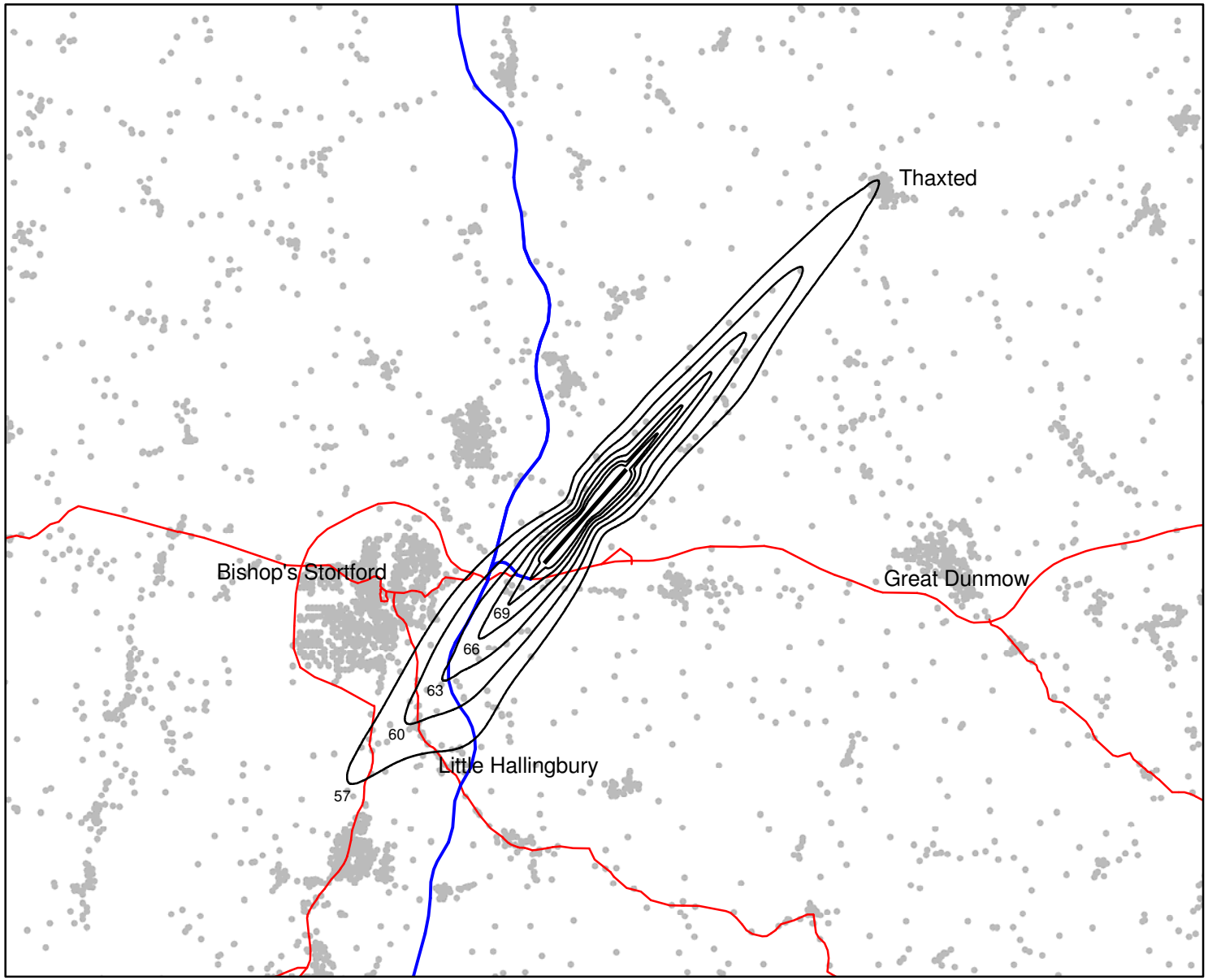


Figure 3: Stansted actual 2007 average mode (72% SW - 28% NE) terrain adjusted 16hr Leq on population map

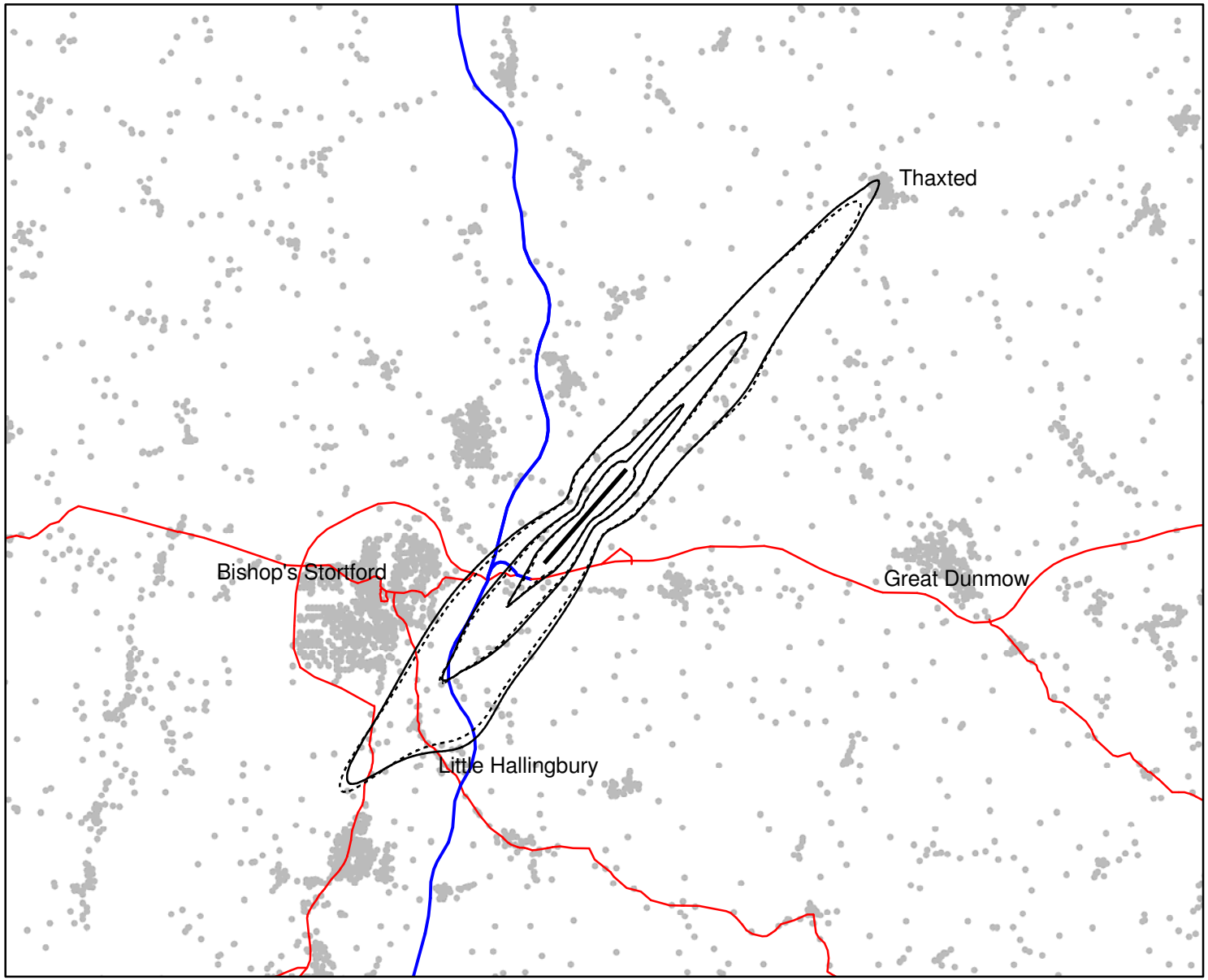


Figure 4: Stansted actual 57, 63 and 69 Leq contours - 2006 dotted (66% SW - 34% NE) - 2007 solid (72% SW - 28% NE)

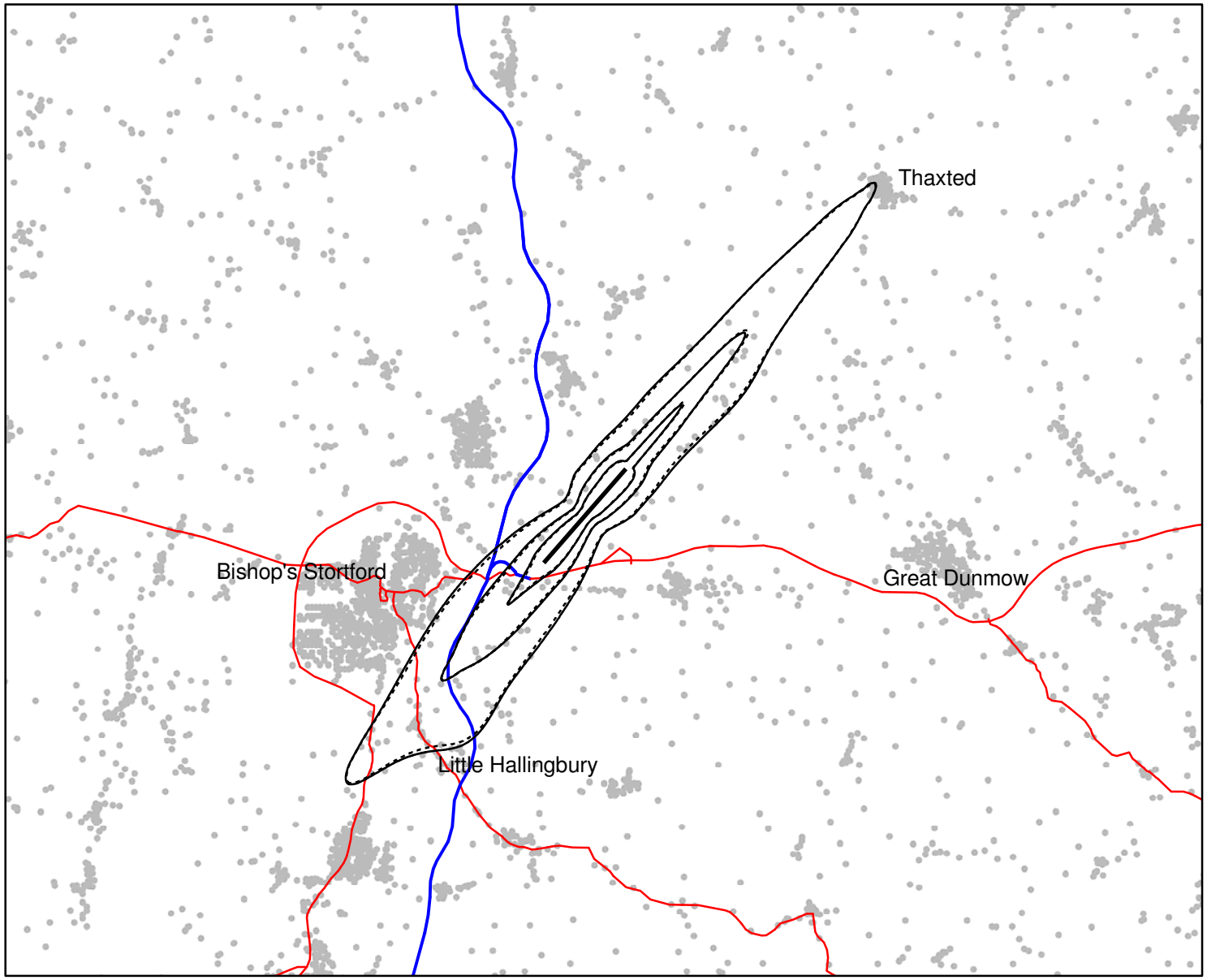


Figure 5: Stansted standard 57, 63 and 69 Leq contours - 2006 dotted (72% SW - 28% NE) - 2007 solid (71% SW - 29% NE)

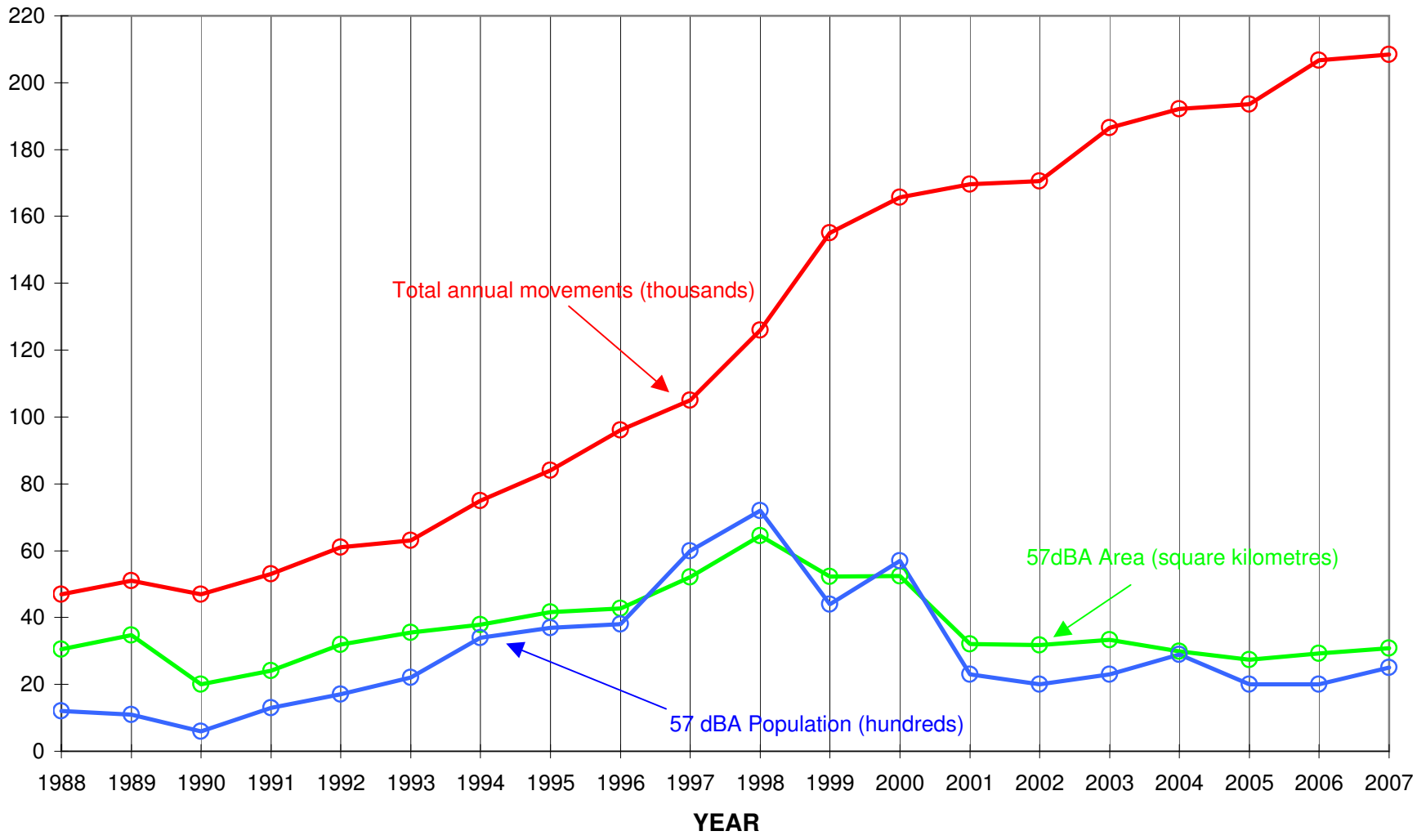


Figure 6: Stansted traffic and noise 1988 - 2007