Community Noise Information Report - Draft Chertsey

19th October 2017 – 16th October 2018

Introduction

At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor in the Castle End area of Chertsey between 19th October 2017 and the 17th October 2018. This report presents an analysis of operational and noise data over this period.

The report is structured using a template developed by Anderson Acoustics working with members of the Heathrow Community Noise Forum (HCNF) Working Group for Monitoring & Verification. It is set out as:

- **Section 2 – Key Findings** are presented.
- **Section 3 – Background & Methodology** provides an overview of how the airport operates, noise and how the data (both operations and noise) have been analysed.
- **Section 4 – Flight track data** presents analysis of the flight tracks and operations above Chertsey including routes, proximity, spatial distribution, height and aircraft types. As flight track data has been collected for many years in the airport's noise and track-keeping (NTK) system, analysis has compared the noise monitoring period with an equivalent period in 2013/14.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise events and overall community noise levels as measured at the noise monitor. Noise data is analysed only for the monitoring period. Comparison with a historic period is not possible as monitoring has not taken place at the same location previously.
- **Section 6 – Noise Modelling** This section presents noise levels derived from noise modelling. Aircraft noise models have been generated for easterly and westerly days for the summer periods of both 2013 and 2017 using AEDT. Previous reports have been based on Heathrow's verified noise model using INM. This software has recently been superseded by AEDT.
- **Section 7 – Appendices** presents large scale versions of all of noise modelling results and provides greater detail on noise terminology around how sound is described, how aircraft noise is measured and how differences of sound level relate to human perception.

It should be noted that this report is intended to describe noise exposure rather than the impact of that exposure - we cannot judge how each individual will respond. The report describes exposure and differences therein (as applicable) of aircraft using a variety of both operations and noise related metrics.

Whilst this report is a comprehensive analysis, it is not intended to be exhaustive. Should there be any questions or comments arising from the data presented herein, these should be addressed to the HCNF for additional analysis.

Key Findings

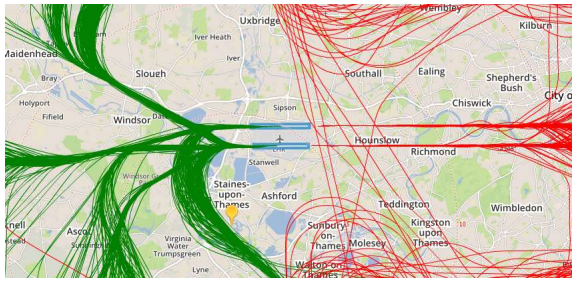
Operations and the community
The noise monitor in Chertsey is predominantly overflown by westerly departures. It is located close to the centre line of the DET departure route. Aircraft departing to the east of the airport on the CPT route will also pass over the monitor, however, at a higher altitude.
The proportion of aircraft following the westerly DET and easterly CPT route has remained generally constant over the last five years.
There has, on average, been no change in the number of daily movements through the westerly gate between 2013 and 2018. The easterly gate has seen an increase in traffic of about 15% over the same period. This increase mostly occurred in the hours 10:00-12:00 and 16:00-19:00.
Aircraft passing through the gate on westerly operations are more concentrated in 2018 compared to 2013, however the main centre of concentration has moved to the west away from the noise monitor. The concentration of aircraft through the easterly gate has not changed however the position of the swathe has moved north closer to the noise monitor.
The average height of aircraft through the westerly and easterly gate has reduced by around 100 and 200ft respectively.
There has been a reduction in the proportion of small twin engine through both gates in favour of larger aircraft. There has also been a large increase in the use of B787 through both gates since 2013.

Noise levels in the community based on measurement at Chertsey monitor	Difference in community noise levels between 2013 and 2017 based on noise modelling
Approximately 85% of noise events measured at Chertsey are associated with aircraft flying the DET route on westerly operations. The remaining events are generally from aircraft flying the CPT route on easterly operations.	On westerly operations, there was a decrease in average daytime noise levels of up to 1dB whilst the number of events exceeding 65dB increased by up to 25 per day.
On days of full westerly and easterly operations, there are, on average, 140 and 50 noise events recorded per day respectively.	The average level during the night period on westerly operations decreased in 2017 compared to 2013 by up to 3dB while the number of events exceeding 60dB decreased by an average of to 4 per night.
The average L_{AMax} for all aircraft noise events measured at Chertsey is 69dB and would typically last for 28 seconds.	On easterly operations, there was almost no change in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017 however the modelling indicates an increase of up to 25 daytime N65 events.
The A320 is responsible for the largest number of noise events (23%) followed by the B777 (20%).	There was a decrease in average night-time aircraft noise on easterly operations of less than one decibel and a decrease in N60 of less than 2 from 2013 to 2017.
The B747 is the loudest aircraft that passes overhead at Chertsey followed by the A380 and A340. These are the only quad engine aircraft operating at Heathrow.	
Noise events occur most frequently between 21:00 and 23:00, during which up to 14 aircraft events are recorded each hour. This is also a period when the proportion of louder (>70dB LAmax) events occur due to a higher proportion of larger aircraft using the DET route.	

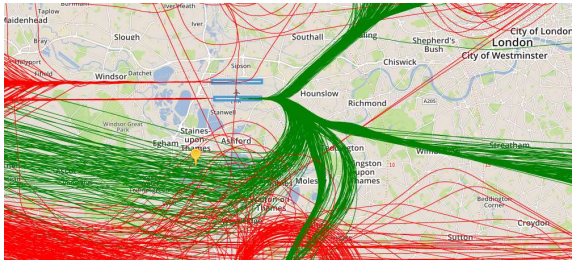
Understanding how wind direction affects aircraft operations

Wind direction and operating direction

- The direction aircraft land and take-off from Heathrow depends on the direction of the wind. For safety reasons, aircraft take-off and land into the wind.
- When the wind blows from the west, aircraft arrive from the east, over central London, and take off to the west. This is called westerly operations. Conversely, when the wind blows from the east, aircraft arrive from the west over Berkshire and take off to the east. This is called easterly operations.
- The figures below show flight tracks for a typical day of easterly and westerly operations. Arrivals are shown red, departures green. The position of the noise monitor is indicated by the yellow pin drop.



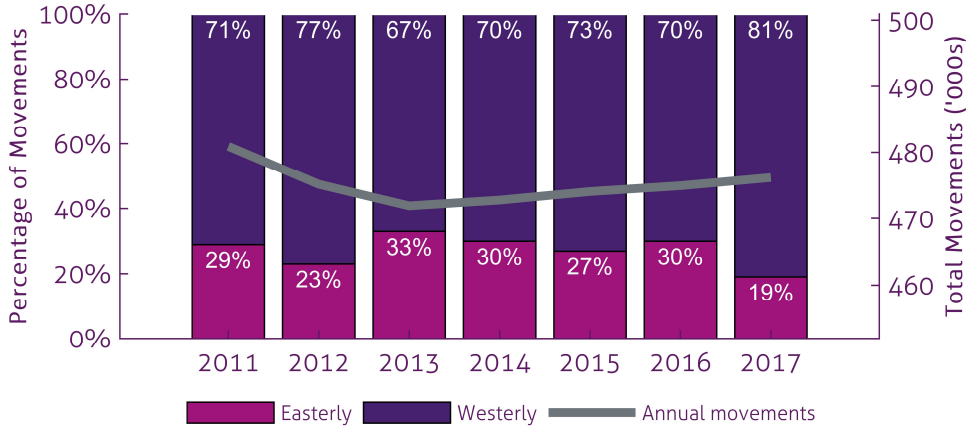
Flight tracks on a westerly day (1st October 2018)



Flight tracks on an easterly day (28th September 2018)

The proportion of easterly/westerly operations

- Around Heathrow, the prevailing wind direction is from the west.
- Heathrow also operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5kts or more. This was implemented to protect more densely populated areas to the east of the airport.
- As a result, the airport is typically on westerly operations for about 70-75% of the year.
- The figure below presents the **annual** proportion of easterly and westerly operations for the last 7 full years.

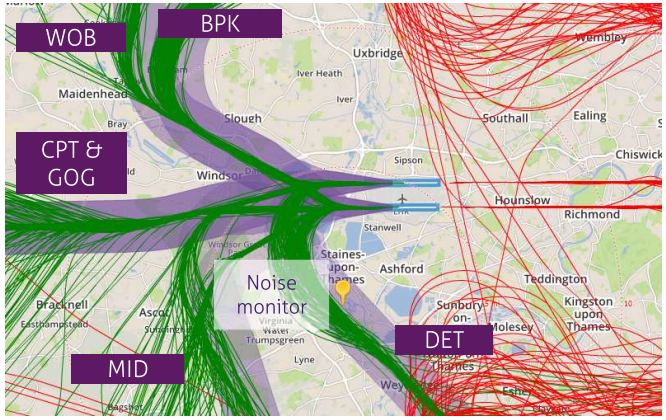


Note: Further information about operations at Heathrow can be found at http://www.heathrow.com/noise/heathrow-operations

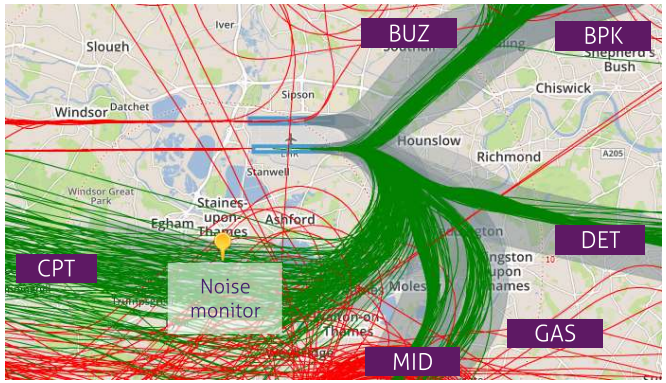
Understanding where aircraft fly near to Chertsey

- The images to the right presents a typical day of westerly operations (top) and easterly operations (bottom) with arrival tracks shown in red and departures in green.
- Aircraft departing the airport follow one of six pre-defined routes (NPRs), typically based upon their destination. These are represented by the purple and grey corridors.
- Chertsey is predominantly overflown by westerly departures. It is located close to the centre line of the DET westerly noise preferential route (NPR). In reality, most aircraft take this corner wide so the position of the noise monitor is to the eastern edge of the swathe.
- During easterly operations the area can be overflown by aircraft departing following the CPT route. On average, these aircraft will have reached an altitude of 6,000ft.

Arrival and departure tracks on westerly operations (NPRs shaded in purple)



Arrival and departure tracks on easterly operations (NPRs shaded in grey)

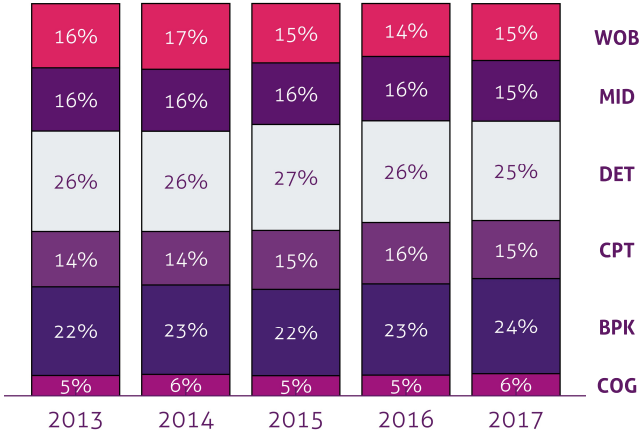


DET and GOG are the new names for the DVR and SAM routes respectively. Throughout this document they are referred to as DET and GOG

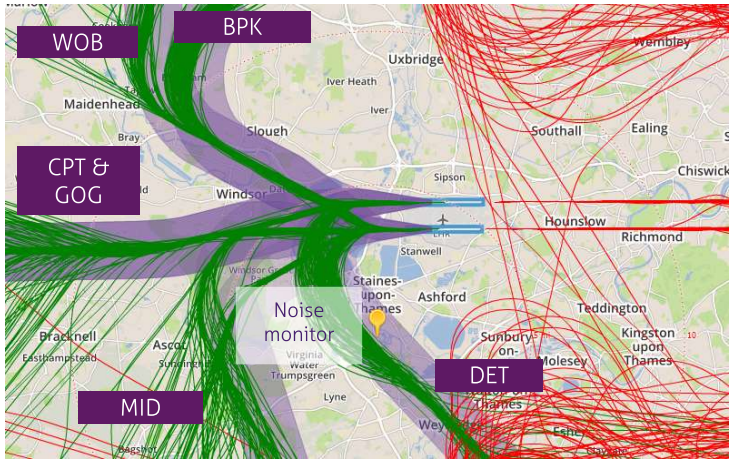
Understanding where aircraft fly on westerly operations

- The top figure shows the proportions of **annual** route usage by westerly operations for each year from 2013-2017.
- In 2017, 25% of aircraft departing on westerly operations followed DET, the route most pertinent to residents in Chertsey.
- There are small fluctuations from year to year, but route usage has remained broadly consistent over the five year period.
- The westerly departure routes and typical tracks are shown again in the bottom right image.

Annual departure route use during westerly operations



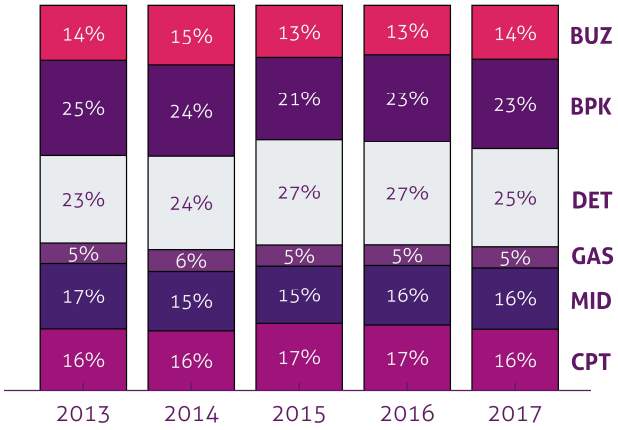
Arrival and departure tracks on westerly operations (NPRs shaded in purple)



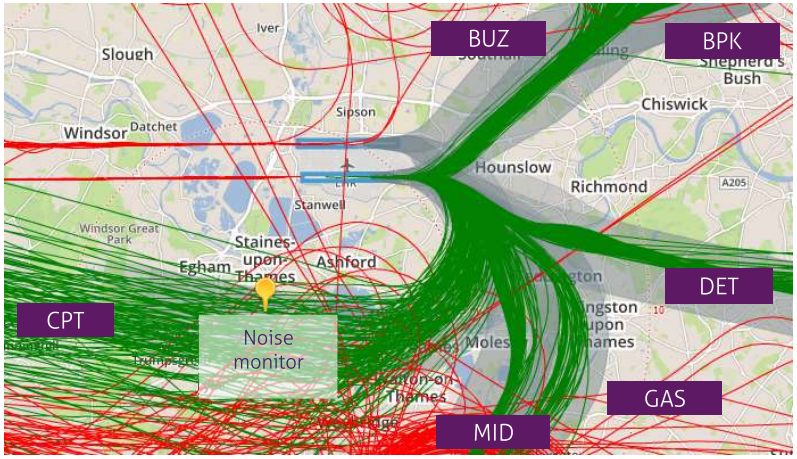
Understanding where aircraft fly on easterly operations.

- The top figure shows the proportions of **annual** route usage by westerly operations for each year from 2013-2017.
- In 2017, 16% of easterly departures followed the CPT route, the easterly route of most relevance to residents of Chertsey.
- There are small fluctuations from year to year, but route usage has remained broadly consistent over the five year period.
- The easterly departure routes and typical tracks are shown again in the bottom right image.

Annual departure route use during easterly operations



Arrival and departure tracks on easterly operations (NPRs shaded in grey)



Understanding operational and gate data.

Operational data.

- The following operational data were provided for the period 19th October 2017– 16th October 2018 and the same period for the five previous years:
  - Easterly/westerly movements - % of movements in easterly/westerly direction.
  - Daily logs - Number of flights operating from Heathrow per day by runway used
  - Heathrow flight-by-flight data - Aircraft type, departure route, runway.
- Since this period in 2012/13 coincides with the Operation Freedoms trials, the analysis period has been truncated to 1st March to 16th October to ensure a fair comparison between dates.

Gate analysis.

- To investigate the heights, distribution and concentration of aircraft, the Noise and Track Keeping (NTK) system's "gate analysis" function was used to provide data on where aircraft have flown relative to the noise monitor.
- Two 'gates' were drawn over Chertsey centred on the temporary noise monitor; one to capture movements while the airport is on westerly operations (westerly gate) and one for easterly operations (easterly gate).

- The westerly gate is approximately perpendicular to the westerly DET route and is 4.5km wide, centered on the noise monitor. The easterly gate (EG) is 10km wide and perpendicular to the easterly CPT route. Both gates extend to a height of 20,000ft.
- The heights and positions of each aircraft passing through the gate were extracted from ANOMS, Heathrow's NTK system. The following data were extracted:
  - Aircraft deviation from the centre of the gate
  - Aircraft height at gate
  - Time that the aircraft penetrated the gate
  - Departure route flown – 'standard instrument departure route' (SID)
  - Aircraft type
  - Runway used

Can the data be trusted?

- Through the Heathrow Community Noise Forum (HCNF), an independent study was carried out, investigating the accuracy of flight track data of Heathrow systems.
- The results confirming the integrity of the data and models are presented in the following report: http://www.heathrow.com/file_source/HeathrowNoise/Static/NLR_HCNF_20160125.pdf

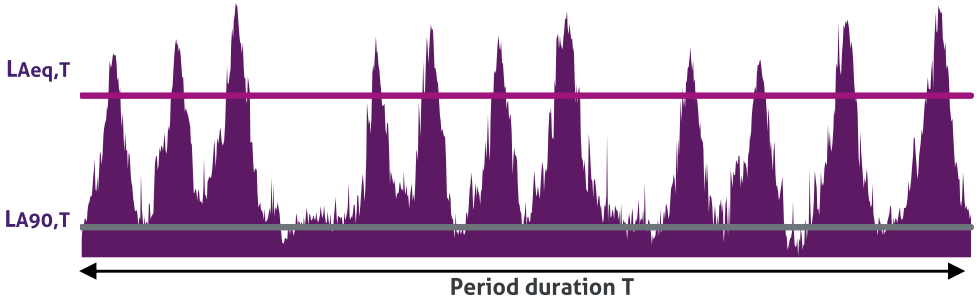
Understanding measured noise data.

Measured noise data:

- A Bruel & Kjaer 3639-A, Type 1 integrating sound level meter was set to measure total ambient and background noise levels over hour periods in addition to individual noise events which, where possible, are linked to aircraft operations.
- Measured data is passed into Heathrow's NTK System without modification – no data has been excluded due to adverse weather conditions.
- For this report, noise data has been provided by Heathrow for the period 19th October 2017 – 17th October 2018. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

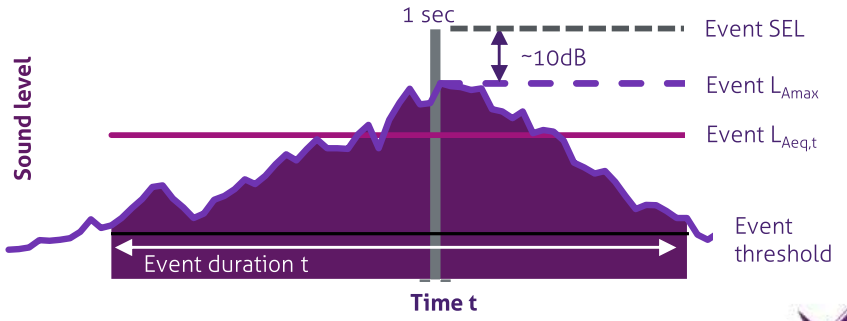
Ambient and background noise levels:

- The figure below illustrates how sound levels can vary over a time period T where aircraft events are experienced. The following metrics are typically used to describe the overall noise environment – $L_{Aeq,T,}$ and $L_{A90,T:}$ These are described as follows:
  - $L_{Aeq,T}$ – the total sound level across period T from all sources;
  - $L_{A90,T}$ - the sound level exceeded for 90% of the time across period T from all sources, this is often regarded as a measure of the background noise;
  - The NTK system provides these metrics in 1hr periods ie T=1hr.



Noise events:

- When the measured noise level exceeds a pre-determined threshold, a noise event is recorded.
- For ALL noise events, three descriptors are provided:
  - L_{Amax} - the maximum A-weighted sound pressure level during the event
  - SEL (sound exposure level or singe event level) - the sound level of a one second burst of steady sound level that contains the same A-weighted sound energy as the whole event; and
  - Duration – the length of time (t) in seconds that the event exceeds the event detection threshold set on the sound level meter. The threshold is set dependent on local background noise conditions and can vary between monitor locations.
- For noise events linked to an aircraft operation the following data is also provided :
  - Aircraft type
  - Runway
  - Route
  - Position at time of L_{Amax}
  - Position at point of closest approach.
- The figure below illustrates the sound metrics associated with an aircraft noise event. The difference between L_{Amax} and SEL is typically around 10dB.

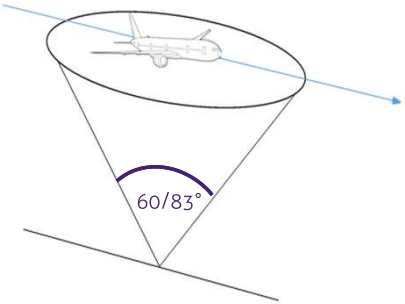


Analysing noise levels from aircraft in this area.

To undertake analysis of measured aircraft noise events, two perspectives are considered.

- Firstly, noise in the community. Aircraft overhead will generally have a higher noise level than those further away. However, noise from aircraft further away still contributes to the noise environment. So when describing noise from aircraft in an area all aircraft noise events should be considered.
- Secondly, if considering relative noise levels of aircraft it is best practice to restrict analysis to aircraft deemed 'overhead' to enable like for like comparison. This ensures that flights that are quieter purely as a result of being further away do not artificially reduce the analysed noise levels from that aircraft type.
- There is no consensus as to what constitutes an overhead flight. In February 2017 the CAA published guidance (CAP 1498) recommending the use of an imaginary cone over the receiver with an apex of 60 or 83 degrees. This is illustrated in the figure below.

Flights are considered overhead if the aircraft pass within cone above the noise monitor

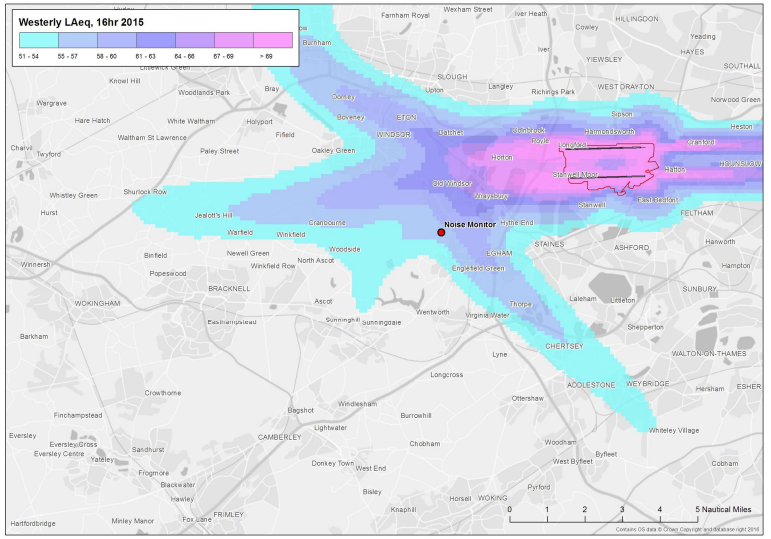


- This community information report will, where applicable, present results for overhead flights determined by CAA guidance as well as all registered aircraft noise events.

Noise Modelling

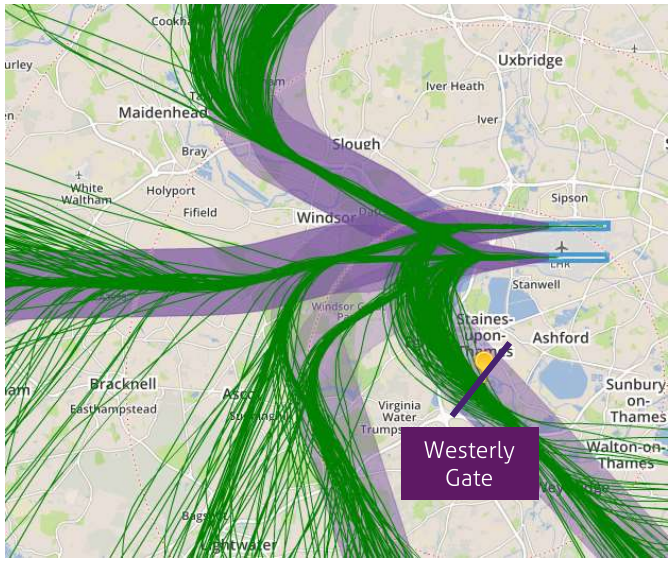
- Aircraft noise modelling has been used to provide an understanding of differences in the noise environment between 2013 and 2017 over the wider geographic area.
- Differences in daytime and night time levels for an **average day and night of easterly and westerly operations** across the summer periods of 2013 and 2017 have been derived using the Heathrow AEDT model.

Example contours generated by aircraft noise modelling



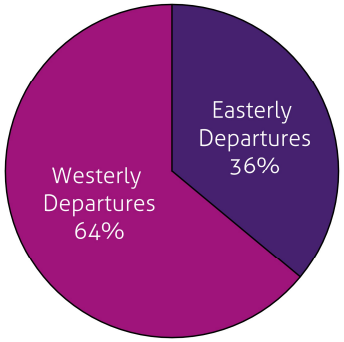
Overview of flight track data – Westerly Gate

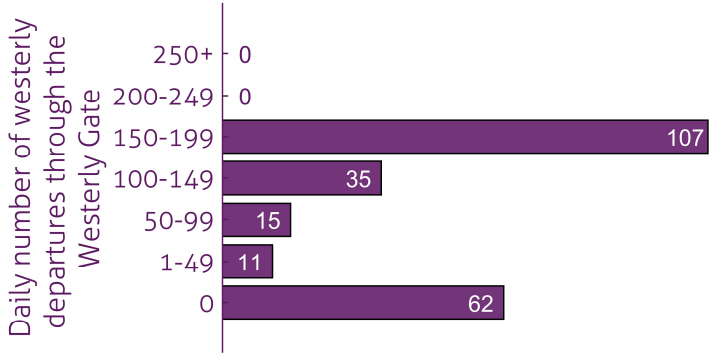
1st March – 16th October 2018 (dates truncated to avoid comparison with Operation Freedoms Trial)



Example day of departing aircraft tracks in the vicinity of Chertsey during westerly operations & the westerly gate (width 4.5km)

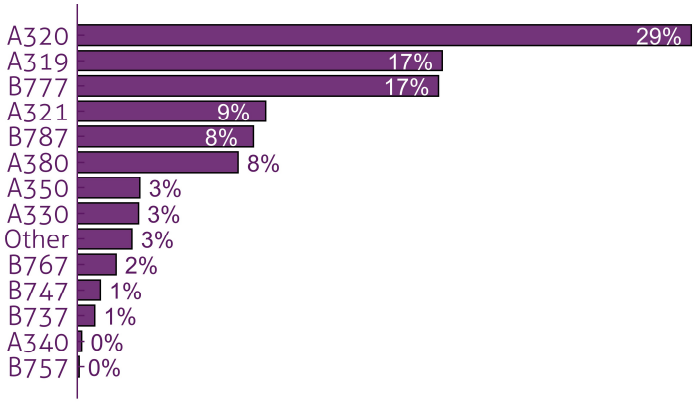
Total 152,980 departures from Heathrow



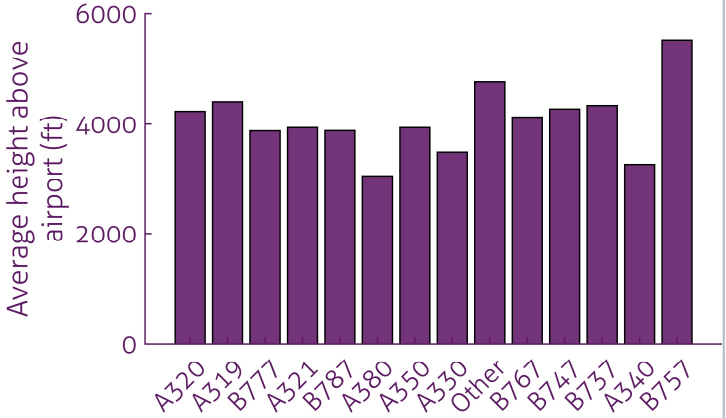


Number of westerly departures per day passing through the westerly gate (230 days in total)

Proportion of departing aircraft types passing through the westerly gate

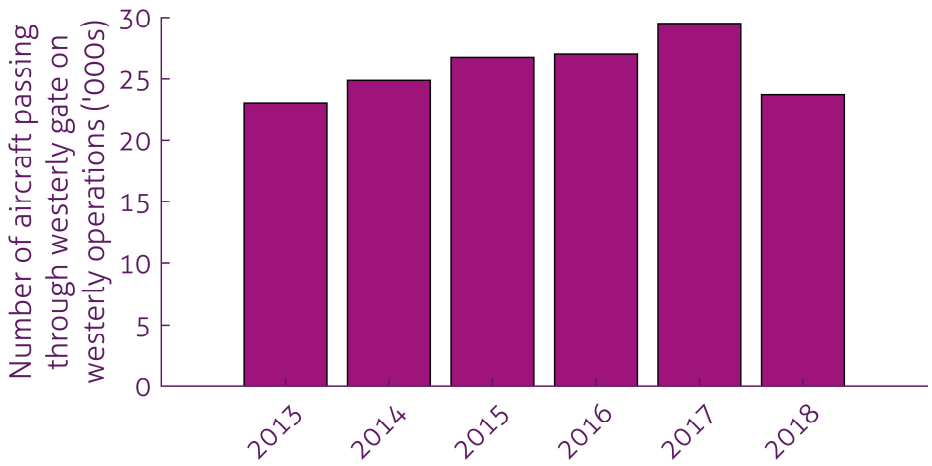


Average height of departing aircraft as they pass through the westerly gate



Is the number of flights over the area different in 2018 to 2013?

- The figure to the right shows the total number of departures that passed through the westerly gate in the period from 1st March to 16th October from 2013 to 2018.
- Annually, between 23,000 and 30,000 departures penetrated the westerly gate of which the majority are departures on the DET route.
- Year to year changes can be attributed to fluctuations in the proportion of westerly operations (determined by wind direction), total number of movements and the proportion of aircraft flying each departure route.
- The table indicates that the proportion of westerly operations in 2013 was 62%, in 2018 64%.
- On a full day of westerly operations;
  - There was no change in the number of departures through the westerly gate in the 2018 period compared to 2013.
  - There was a small increase in the proportion of these aircraft that are deemed to be overhead (as indicated by the numbers in parentheses).
  - There is, on average, less than one arrival that passes through the gate on westerly operations.



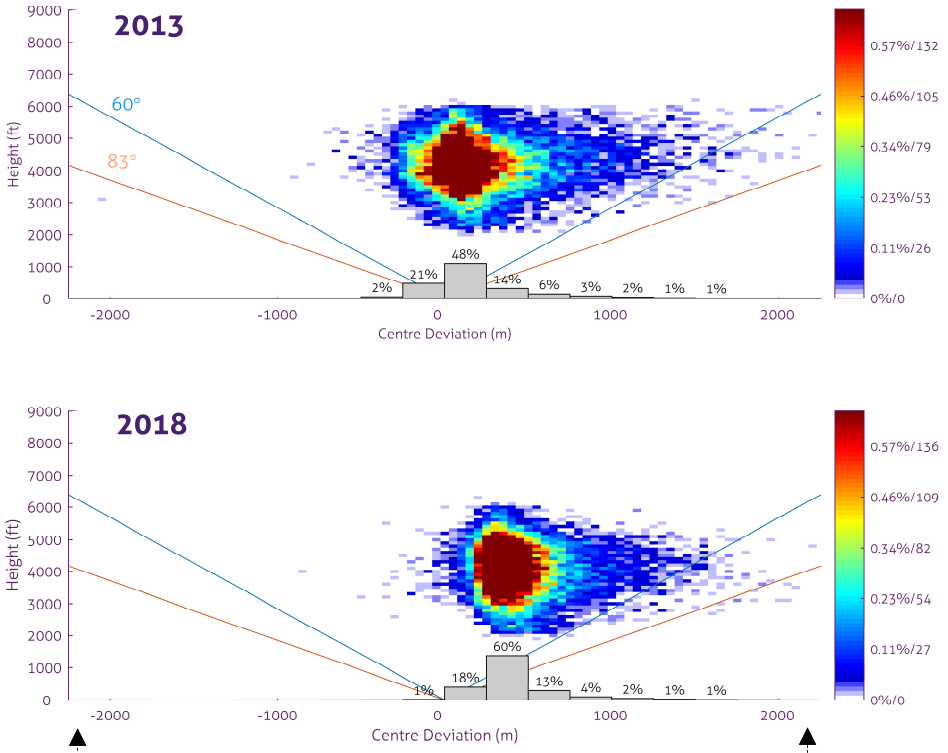
	2013	2018	Change	Change (%)
Proportion of westerly operations (all Heathrow flights)	62%	64%	+2%	N/A
Average number of westerly departures passing through the westerly gate during days of 100% westerly operations.	162 (142)*	162 (147) *	+0 (+5)*	+0% (+4%)*
Average number of westerly arrivals passing through the westerly gate during days of 100% westerly operations.	1	1	-	-

* Figures in parentheses indicate the number of flights passing through the 60° overhead cone.

Note: Wherever this section of the report refers to *2018*, it should be noted that this is specifically the measurement period from 1st March to 16th October 2018. Similarly, 2013 specifically refers to the period from 1st March to 16th October 2013.

Is the concentration of westerly operations different between 2013 and 2018?

- The figures to the right are heat maps showing the 2D concentrations of departing aircraft as they pass through the westerly gate during the 2013 (the upper figure) and 2018 (the lower figure) monitoring period in addition to the concentration at different distances from the centre along the length of the gate shows by the grey bars.
- The scale presents colours for the proportion of aircraft in each grid square (pixel). For example a "red" indicates 0.57% of the movements passing through a grid square in the gate in both figures (it should be noted that the number of movements this represents may differ between the figures – in 2013, 132 flights represent 0.57%, in 2018 this figure was 136).
- The gate has been designed to be perpendicular to the route closest to the noise monitor; DET.
- The figures show the width of the swathe is narrower in 2018 compared to 2013 suggesting the flight path is slightly more concentrated.
- Furthermore, the whole swathe has moved, on average, about 250m to the west away from the noise monitor at Chertsey.

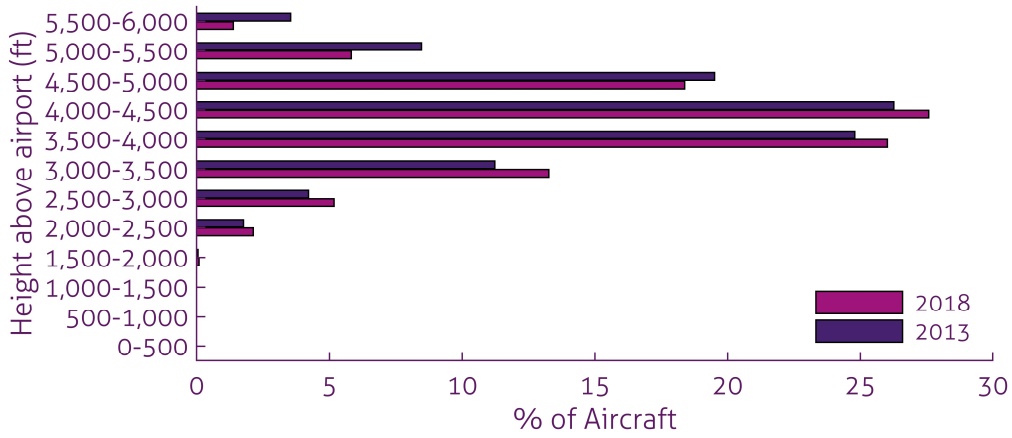


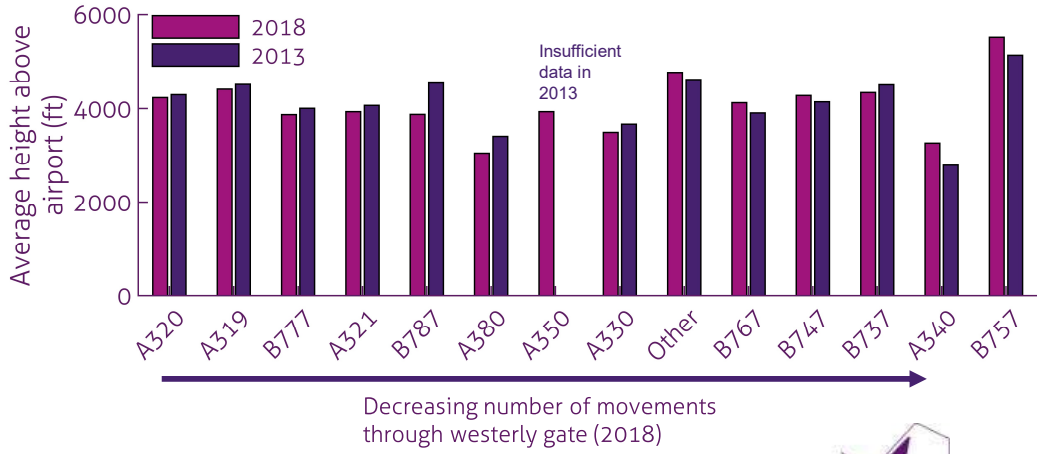
Note: The "heat maps" have been normalised to account for differences between the number of westerly departures in each of the monitoring periods. This allows the concentrations in each graph to be compared. This method does not account for any changes in daily number of movements passing through the gate - these changes are presented on Page 14. The maps are divided into grid squares, 50m horizontally by 60ft vertically.

Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft on the DET route as they passed through the westerly gate in the 2013 and 2018 periods.
- **This indicates that aircraft above Chertsey were, on average, approximately 100ft lower in the 2018 period compared to 2013.**
- The figures present the distribution of these aircraft height through the westerly gate comparing 2013 with 2018 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that although in both years the greatest proportion of aircraft passed through the gate between 4,000ft and 4,500ft, in 2018 a greater proportion of aircraft passed through gate at lower altitudes compared to 2013.
- The lower figure shows that the height of aircraft varies with type. The B757 is the highest aircraft type (although, in this case, the sample size is small) while the A380 and A340 are the lowest.
- Most aircraft types flew slightly lower in 2018 compared to 2013 with the exception of the B767, B747, A340 and B757.

	2013	2018	Difference
Average height of departures through westerly gate on DET	4,150ft	4,040ft	-110ft

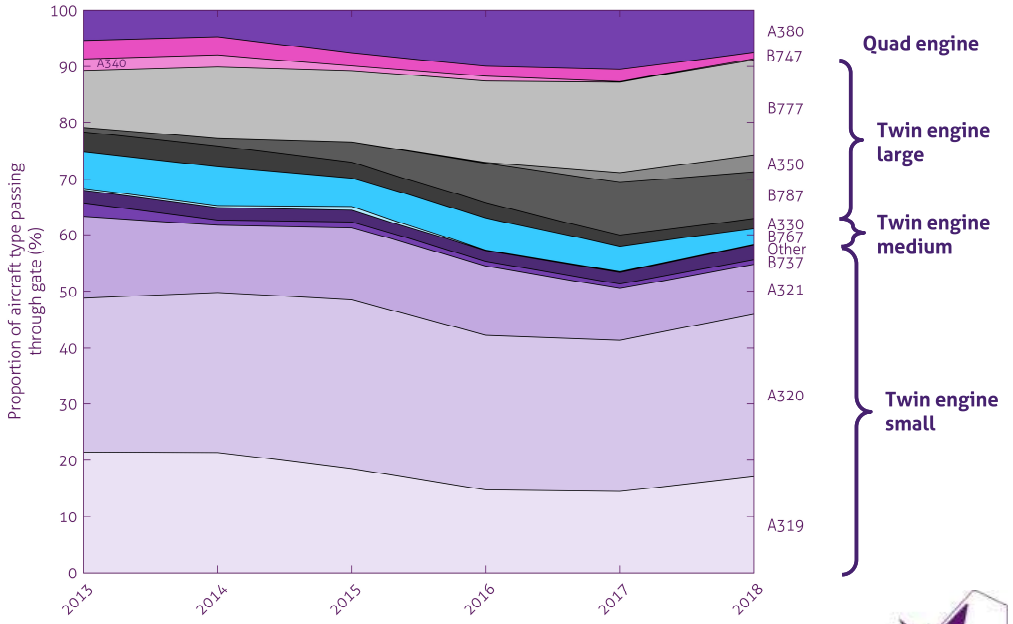




Is the fleet mix different between 2013 and 2018?

- The table to the right presents the mix of departing aircraft that passed through the westerly gate and overall at Heathrow in the 2013 and 2018 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - quad (four) engine aircraft (including B747, A340),
  - twin engine large aircraft (B777, A350, B787)
  - twin engine medium aircraft (B767, A330) and
  - twin engine small aircraft (B737, A320 family).
- The analysis on page 14 indicates that, on average, the number of departing aircraft flying through the westerly gate has not changed on days of full westerly operations between 2013 and 2018.
- The analysis on this page indicates that there was an increase in the proportion of A380 operations departing through the westerly gate from 5.5% in 2013 to 7.6% in 2018. The proportion of the other 4 engine (quad) aircraft types reduced. The proportion of large twin aircraft increased significantly, whilst the proportion of small and medium twin aircraft reduced.
- The figure provides a more detailed picture of how the fleet mix has changed across the period. The aircraft categories used in this report are distinguished by the different colour schemes.
- In general, there has been shift towards larger aircraft on the DET. The figure indicates this is due to an increase in use of the B787 and B777.

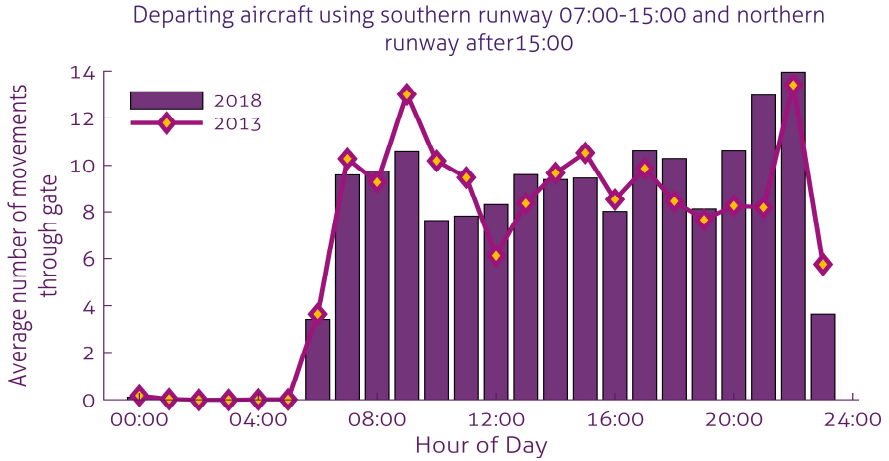
Fleet mix				
Category	Westerly gate		All LHR	
	2013	2018	2013	2018
A380	5.5%	7.6%	3.8%	3.5%
Quad engine	5.3%	1.3%	9.8%	5.2%
Twin engine large	17.4%	31.1%	17.4%	26.8%
Twin engine medium	4.1%	2.6%	2.9%	3.9%
Twin engine small	67.6%	57.5%	66.1%	60.6%

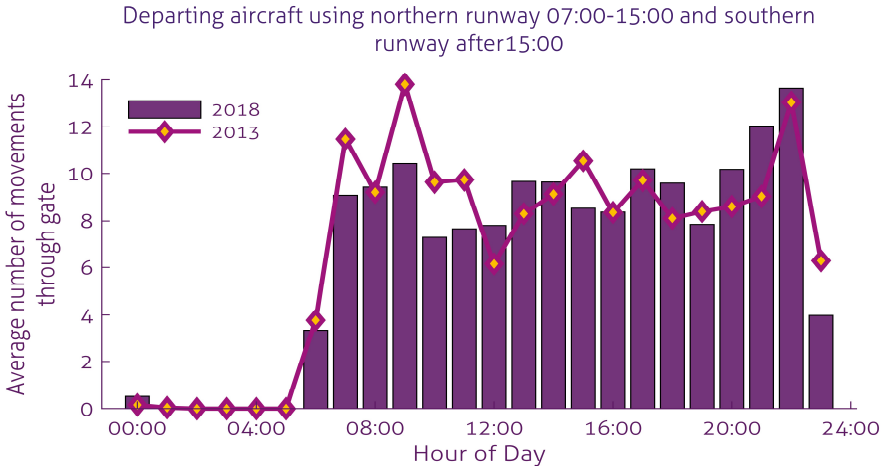


* Days of 100% westerly operations only

Does the number of flights over the area vary across the day? Is there a difference between 2013 and 2018?

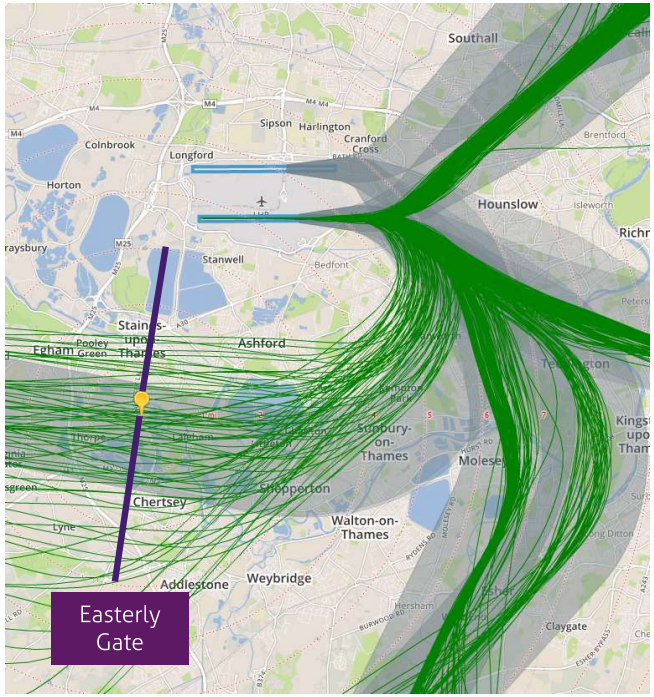
- The figures to the right present the average number of departures through the westerly gate per hour in 2013 and 2018 during days of 100% westerly operations.
- The figure demonstrates the impact of runway alternation on flights through the gate. The upper image shows the movements on days where aircraft are departing the southern runway in the hours 07:00-15:00 and the northern runway after 15:00. The lower image shows the movements on days where aircraft are departing the northern runway in the hours 07:00-15:00 and the southern runway after 15:00.
- The figures show that during daytime hours (07:00-23:00) between 8 and 14 aircraft pass through the gate per hour.
- The busiest hours are between 21:00 and 23:00.
- In terms of average movements through the gate, Chertsey is not affected by the runway alternation on westerly operations.
- Previous analysis on Page 14 has shown that there were the same number of daily flights through the gate in 2018 compared to 2013, however these figures suggest the distribution of flights during the day has changed. In general, 2018 saw a decrease in the number flights during the morning hours (06:00-12:00) and an increase in the evening hours (17:00-23:00).
- Of the total 230 days in the 2018 monitoring period, 109 days (47%) were 100% westerly operations and 54 days (23%) were on 100% easterly operations.





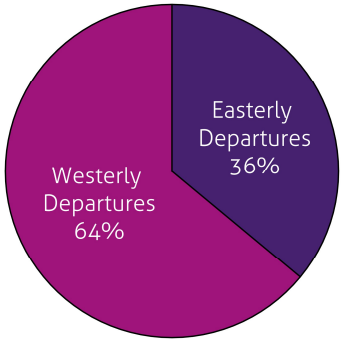
Overview of flight track data – Easterly Gate

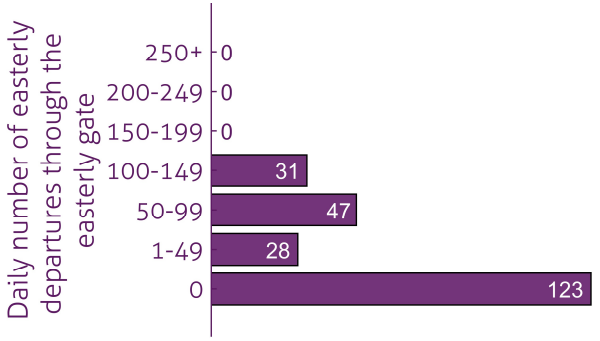
1st March – 16th October 2018 (dates truncated to avoid comparison with Operation Freedoms Trial)



Example day of departing aircraft tracks in the vicinity of Chertsey during easterly operations & the easterly gate (width 10km)

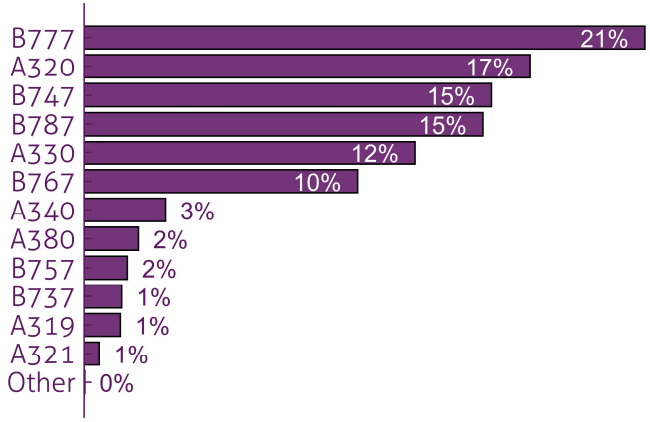
Total 152,980 departures from Heathrow



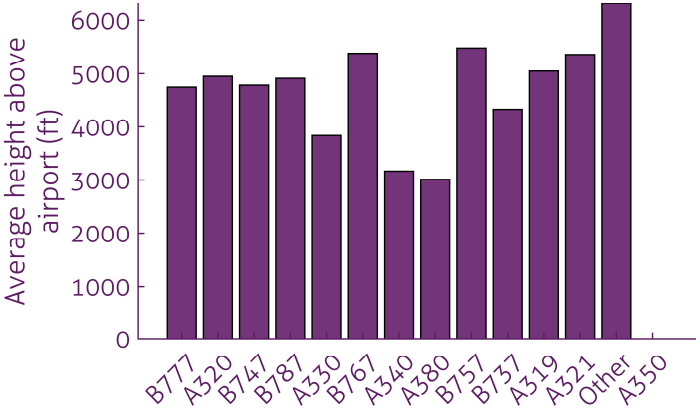


Number of easterly departures per day passing through the easterly gate (230 days in total)

Proportion of departing aircraft types passing through the easterly gate

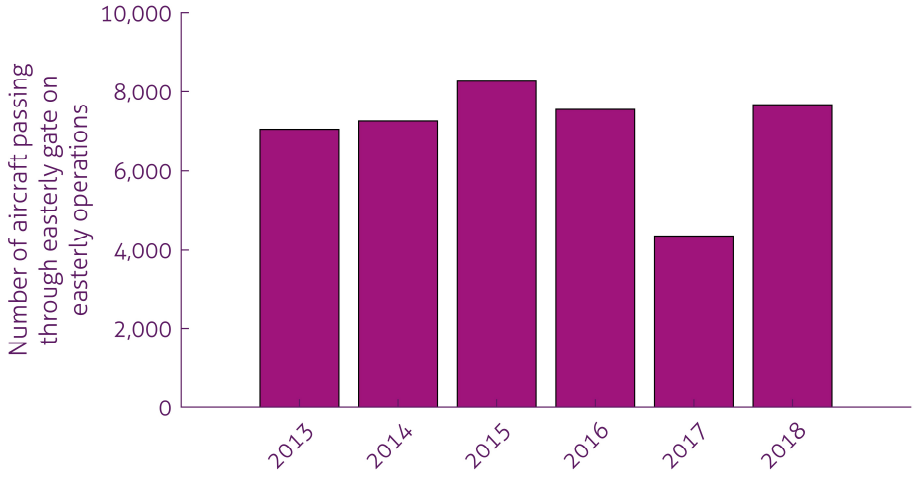


Average height of departing aircraft as they pass through the easterly gate



Is the number of flights over the area different in 2018 compared to 2013?

- The figure to the right shows the total number of departures that passed through the easterly gate in the periods from 1st March – 16th October from 2013 to 2018.
- In each period, between 4,300 and 8,300 departures penetrated the easterly gate of which the majority are following the Compton route from the southern runway.
- Year to year changes can be attributed to fluctuations in the proportion of easterly operations (determined by wind direction), total number of movements and the proportion of aircraft flying each departure route.
- The table indicates that the proportion of easterly operations in 2013 was 38%, in 2018 76%.
- On a full day of easterly operations;
  - There was a 17% increase in departures through the easterly gate in the 2018 period compared to 2013.
  - The proportion of departures passing overhead at the monitor increased (as indicated by the numbers in parentheses).
  - The proportion of easterly arrivals increased by 13% however it should be noted that these, on average, pass through the gate at 8,000ft.



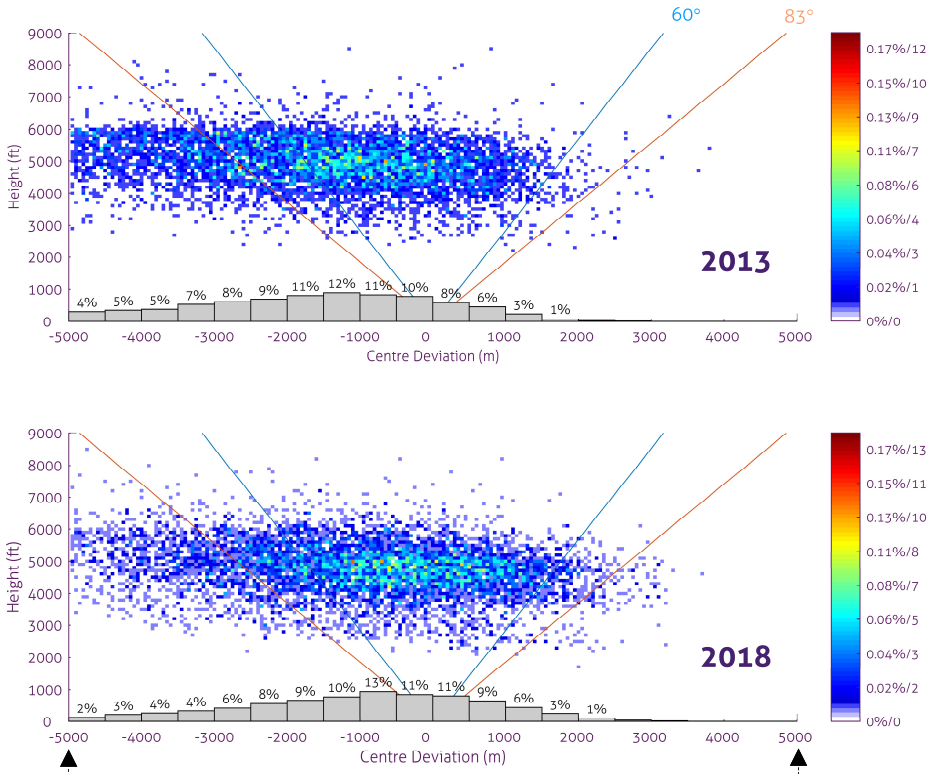
	2013	2018	Change	Change (%)
Proportion of easterly operations (all Heathrow flights)	38%	36%	-2%	N/A
Average number of easterly departures passing through the easterly gate during days of 100% easterly operations.	82 (24)*	96 (34) *	+14 (+10)*	+17% (+42%)*
Average number of easterly arrivals passing through the easterly gate during days of 100% easterly operations.	40 (8)*	45 (9) *	+5 (+1)*	+13% (+13%)*

* Figures in parentheses indicate the number of flights passing through the 60° overhead cone.

Note: Wherever this section of the report refers to *2018*, it should be noted that this is specifically the measurement period from 1st March – 16th October 2018. Similarly, 2013 specifically refers to the period from 1st March – 16th October 2013.

Is the concentration of easterly operations different between 2013 and 2018?

- The figures to the right are heat maps showing the 2D concentrations of departing aircraft as they pass through the easterly gate during the 2013 (the upper figure) and 2018 (the lower figure) monitoring period in addition to the concentration at different distances from the centre along the length of the gate shows by the grey bars.
- The scale presents colours for the proportion of aircraft in each grid square (pixel). For example a "red" indicates 0.17% of the movements passing through a grid square in the gate in both figures (it should be noted that the number of movements this represents may differ between the figures – in 2013, 12 flights represent 0.17%, in 2018 this figure was 13).
- The gate has been designed to be perpendicular to the Compton (CPT) route.
- The figures suggest the concentration of the swathe is similar in the two years although the position of main centre of swathe has moved north and is closer to the noise monitor at Chertsey in 2018.

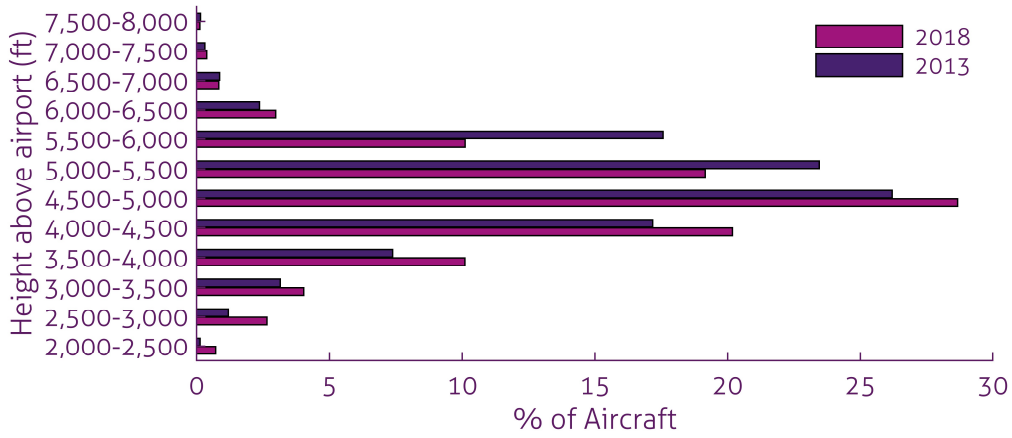


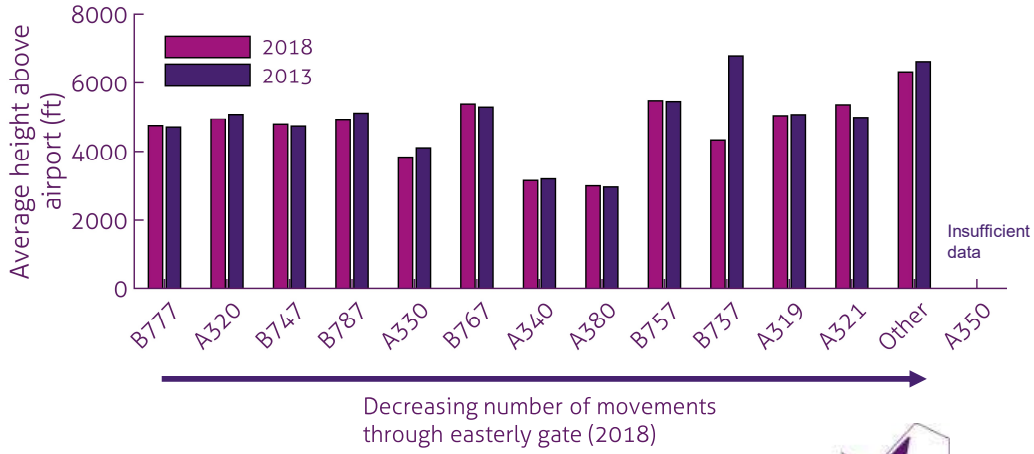
Note: The "heat maps" have been normalised to account for differences between the number of westerly departures in each of the monitoring periods. This allows the concentrations in each graph to be compared. This method does not account for any changes in daily number of movements passing through the gate - these changes are presented on Page 14. The maps are divided into grid squares, 50m horizontally by 60ft vertically.

Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft on the CPT route as they passed through the easterly gate in the 2013 and 2018 periods.
- **This indicates that, on easterly operations, aircraft above Chertsey were, on average, approximately 200ft lower in the 2018 period compared to 2013.**
- The figures present the distribution of these aircraft height through the easterly gate comparing 2013 with 2018 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows a clear shift in the distribution of altitudes of the aircraft through the gate to lower altitudes in 2018. More than 25% of aircraft passed through the gate between 4,500 and 5,000ft in both years.
- The lower figure shows that the height of aircraft varies with type. Most aircraft types pass through the gate, on average, between 4,700 and 5,500ft with the exception of the A330, A340 and A380 which are around 3,000ft.
- There are small changes (less than +/- 200ft) for individual aircraft types with the exception of the B737 which saw the average altitude through the gate decrease from 6,700 to 4,300ft (although this is likely to be an artefact of few movements).

	2013	2018	Difference
Average height of departures through easterly gate on CPT	4,880ft	4,690ft	-190ft



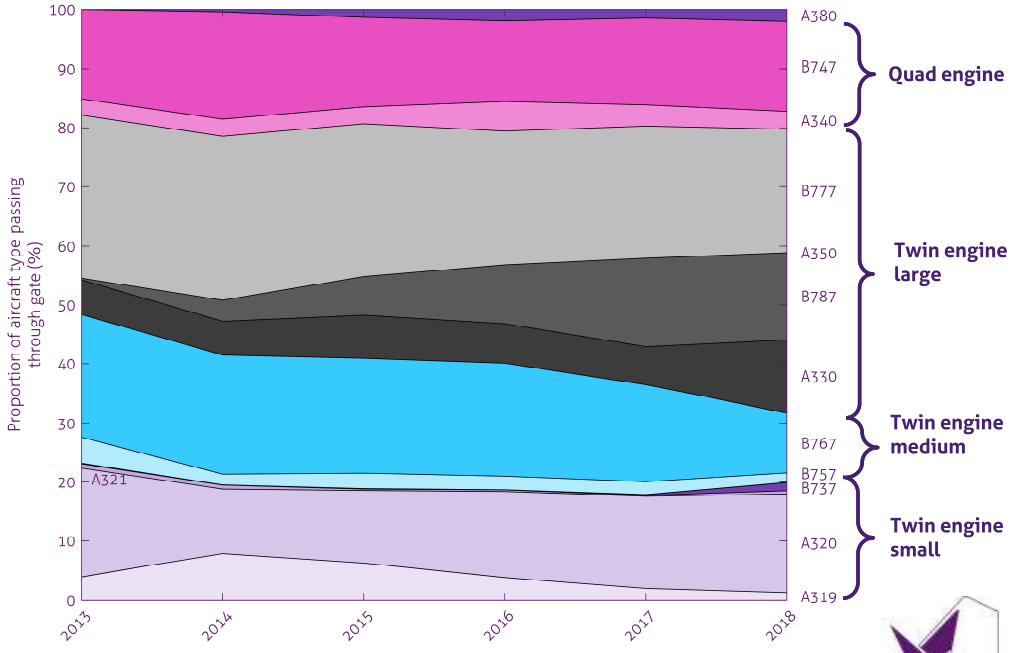


Is the fleet mix different between 2013 and 2018?

- The table to the right presents the mix of departing aircraft that passed through the easterly gate and overall at Heathrow in the 2013 and 2018 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - quad (four) engine aircraft (including B747, A340),
  - twin engine large aircraft (B777, A350, B787, A330)
  - twin engine medium aircraft (B767) and
  - twin engine small aircraft (B737, A320 family).
- Previous slides indicated that there has been a 17% increase in departing aircraft flying through the easterly gate on an average day of full easterly operations between 2013 and 2018.
- The analysis on this page indicates that there was an increase in the proportion of A380 operations from 0% in 2013 to 2% in 2018 although this is still less than average for Heathrow as a whole.
- In general, there is a greater proportion of larger aircraft operating passing through the easterly gate compared to all aircraft which operate at Heathrow.
- The figure provides a more detailed picture of how the fleet mix has changed across the period. The aircraft categories used in this report are distinguished by the different colour schemes.
- The most significant change has been the introduction and increase in use of the B787 Dreamliner which accounted for 15% of movements through the gate in 2018 compared to less than 1% in 2013.

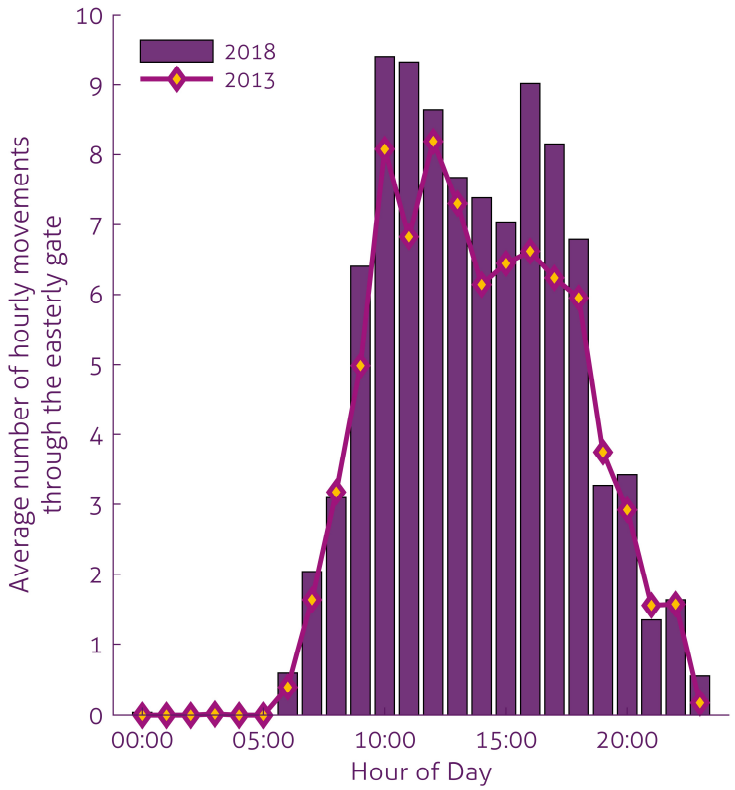
* Days of 100% easterly operations only

Fleet mix				
Category	Easterly gate		All LHR	
	2013	2018	2013	2018
A380	0.0%	2.0%	3.8%	3.5%
Quad engine	17.8%	18.2%	9.8%	5.2%
Twin engine large	33.8%	48.1%	17.4%	26.8%
Twin engine medium	20.7%	10.2%	2.9%	3.9%
Twin engine small	27.6%	21.5%	66.1%	60.6%



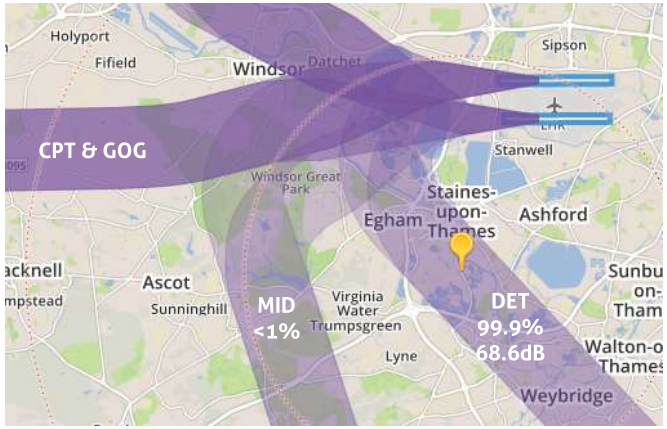
Does the number of flights over the area vary across the day? Is there a difference between 2013 and 2018?

- The figures to the right present the average number of departures through the easterly gate per hour in 2013 and 2018 during days of 100% easterly operations.
- The figure shows that the number of flights through the gate increases from 06:00 reaching a peak of around 9 flights per hour in the hours 10:00-12:00. this drops slightly before another peak between 16:00 and 18:00. After 18:00 the number of movements generally decrease until midnight.
- Previous analysis on Page 20 has shown that there were approximately 17% additional daily flights through the gate in 2018 compared to 2013. This figure shows that most of these additional movements occur between 10:00 and 12:00 and between 16:00 and 19:00.
- Of the total 230 days in the 2018 monitoring period, 54 days (23%) were on 100% easterly operations and 109 days (47%) were 100% westerly operations.



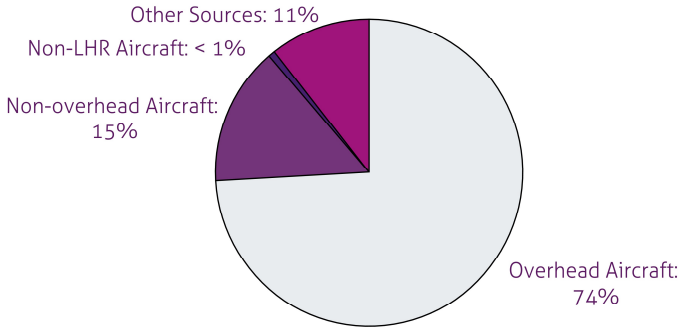
Overview of noise monitor data recorded at Chertsey

19th October 2017 – 16th October 2018



Monitor location, % noise events by route & average L_{Amax}

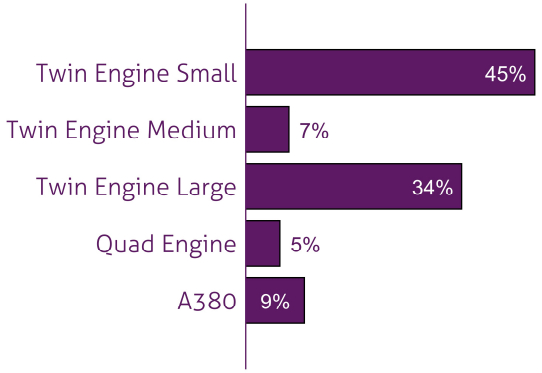
46,982 Measured Noise Events*



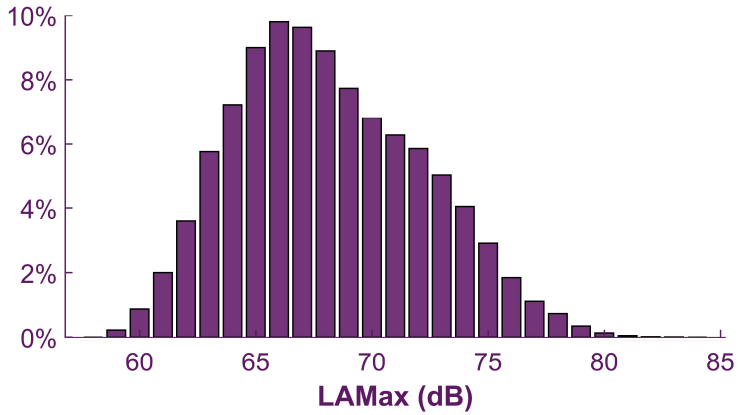
* From all noise sources

84%

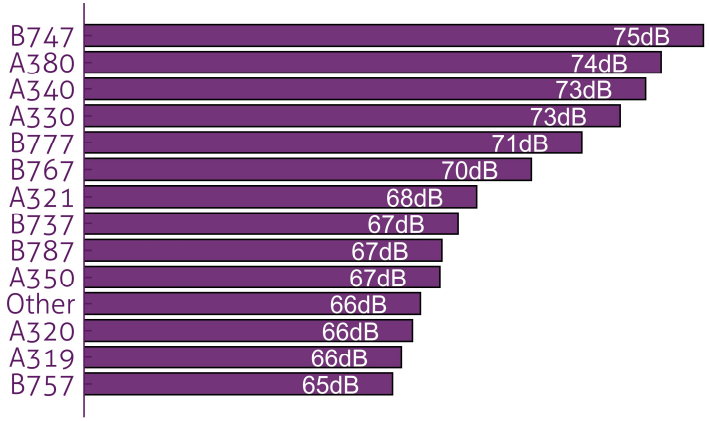
of aircraft noise events recorded when aircraft were within 60° cone over the noise monitor



Noise events by aircraft size



Overall distribution of maximum event noise level L_{Amax} - Heathrow aircraft



Average L_{Amax} by Aircraft Type*

*Overhead aircraft on westerly departures only

Noise monitoring overview.

Monitoring location, duration and setup

- A temporary noise monitor was installed in the Castle End area of Chertsey between 19/10/2017 and 16/10/2018.
- The monitor was set up to record noise events based on a threshold sound pressure level of 58.7 dBA being exceeded for more than 10 seconds.
- The location of the noise monitor is shown in the figure to the right. It is close to the centreline of the DET NPR on westerly operations.

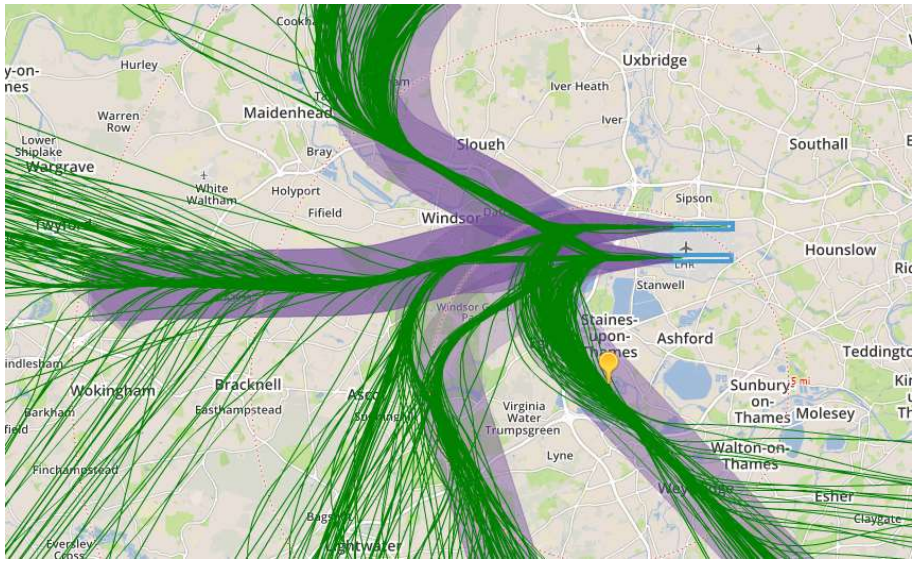
Noise event summary

- A total of 46,982 noise events were measured during the monitoring period. Of these around 89% were from aircraft using Heathrow and 11% were from non-aircraft sources.
- Almost 86% of the aircraft registering noise events at the noise monitor were using the DET westerly route, the vast majority of the remaining events were easterly departures on the CPT route.
- Overall, 84% of aircraft registering noise events were overhead (based on the 60° cone) - 91% of these were on the westerly DET route, the remaining 9% on the easterly CPT route.

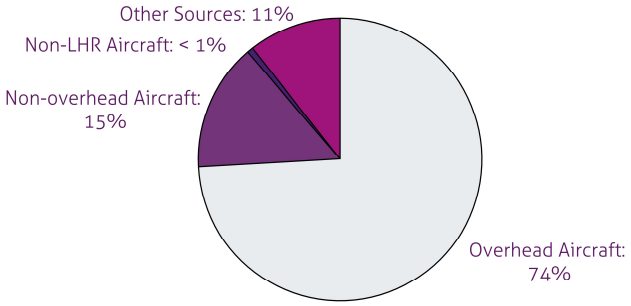
Percentage of aircraft noise events by route

Westerly				Eastery		Overhead
DET		Others		CPT		
27L	27R	27L	27R	09L	09R	
47	39	0	0	0	14	84

Noise preferential routes, monitor position and flight tracks on typical westerly day

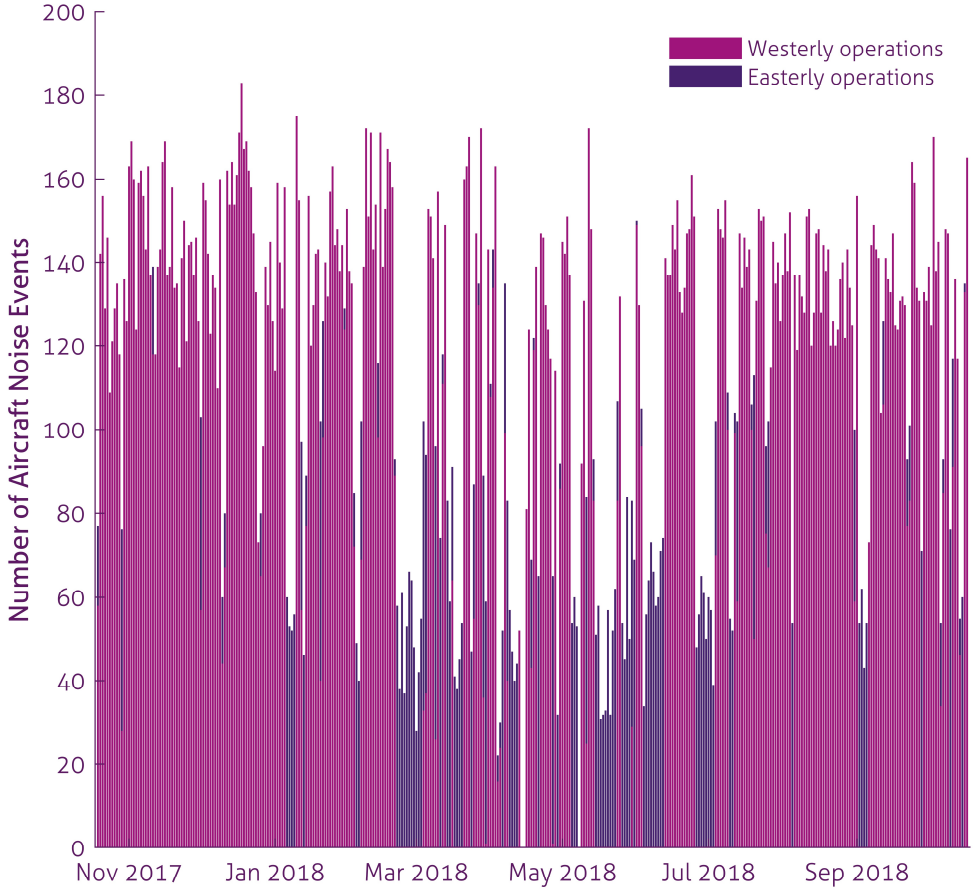


Measured noise event summary



Does the direction of operation affect the number of measured aircraft noise events?

- Noise events are predominantly captured at Chertsey mostly during periods of westerly operations by aircraft using the DET route. The remainder are generally easterly departures on the CPT route.
- During the monitoring period, 119 out of 363 days (33%) were 100% westerly operations and 42 days (12%) were 100% easterly operations. On the remaining days, the airport switched direction of operation during the day.
- During days of full westerly operations, there were, on average, 141 aircraft noise events triggered per day.
- During 100% easterly operations there was an average of 50 aircraft noise events – predominantly from departures following the Compton (CPT) route.
- On average, 84% of measured aircraft noise events were recorded by aircraft passing within the 60° overhead cone.
- Over the 363 days for which monitoring was taking place, 19% of days experienced 150 or more aircraft events whilst there were only two days that had less than 20 aircraft noise events.
- It is noted that an absence of aircraft noise events does not mean that aircraft would not necessarily be audible. There may be aircraft further away that are audible but have not triggered the noise event detection threshold.



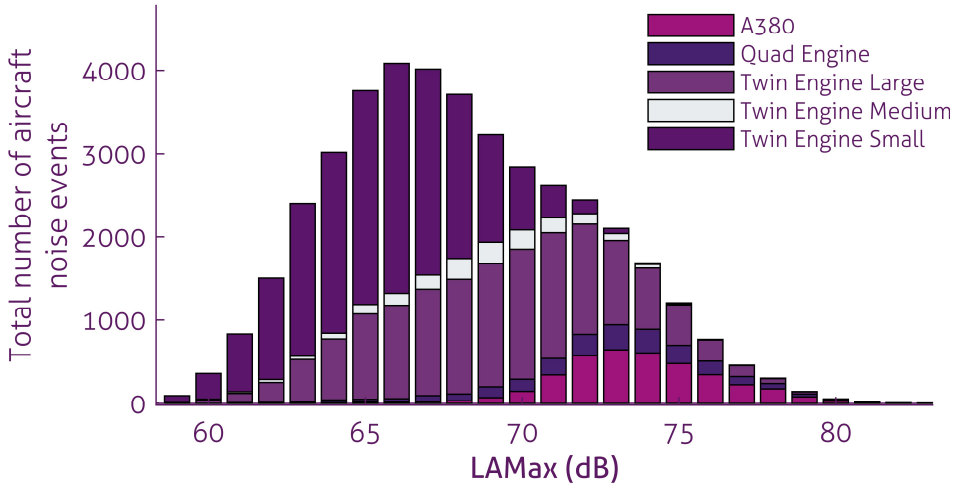
What was the range of L_{Amax} and SEL noise levels from aircraft events?

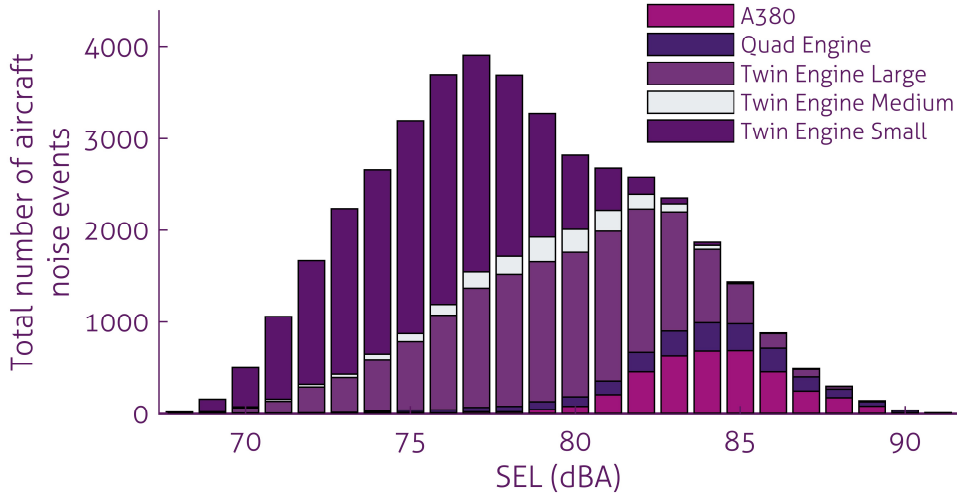
- The figures to the right present the range of L_{Amax} (top) and SEL (bottom) noise levels for all aircraft noise events measured at the Chertsey monitor during the monitoring period. An explanation of metrics is given on Page 10.
- The table below presents the average* L_{Amax} and SEL for each aircraft type group.
- The average L_{Amax} of all aircraft events is 68.6dB. The distribution of L_{Amax} is dependent on aircraft size with the larger aircraft generally recording louder events.

Aircraft group	Average L_{Amax}	Average SEL, dBA
A380	74.1	84.5
Quad engine	72.9	83.8
Twin engine large	69.8	79.9
Twin engine medium	68.2	78.7
Twin engine small	66.1	76.1

- As this analysis considers ALL events measured at this monitor regardless of distance or route these results cannot be used to compare the relative noise levels of aircraft types. An analysis of aircraft type noise levels is presented on Page 32.
- For non-aircraft related events, the mean L_{Amax} is 66.6dB reaching a maximum of 98dB.

* **Note: throughout this report, unless otherwise stated, the arithmetic mean is calculated.**

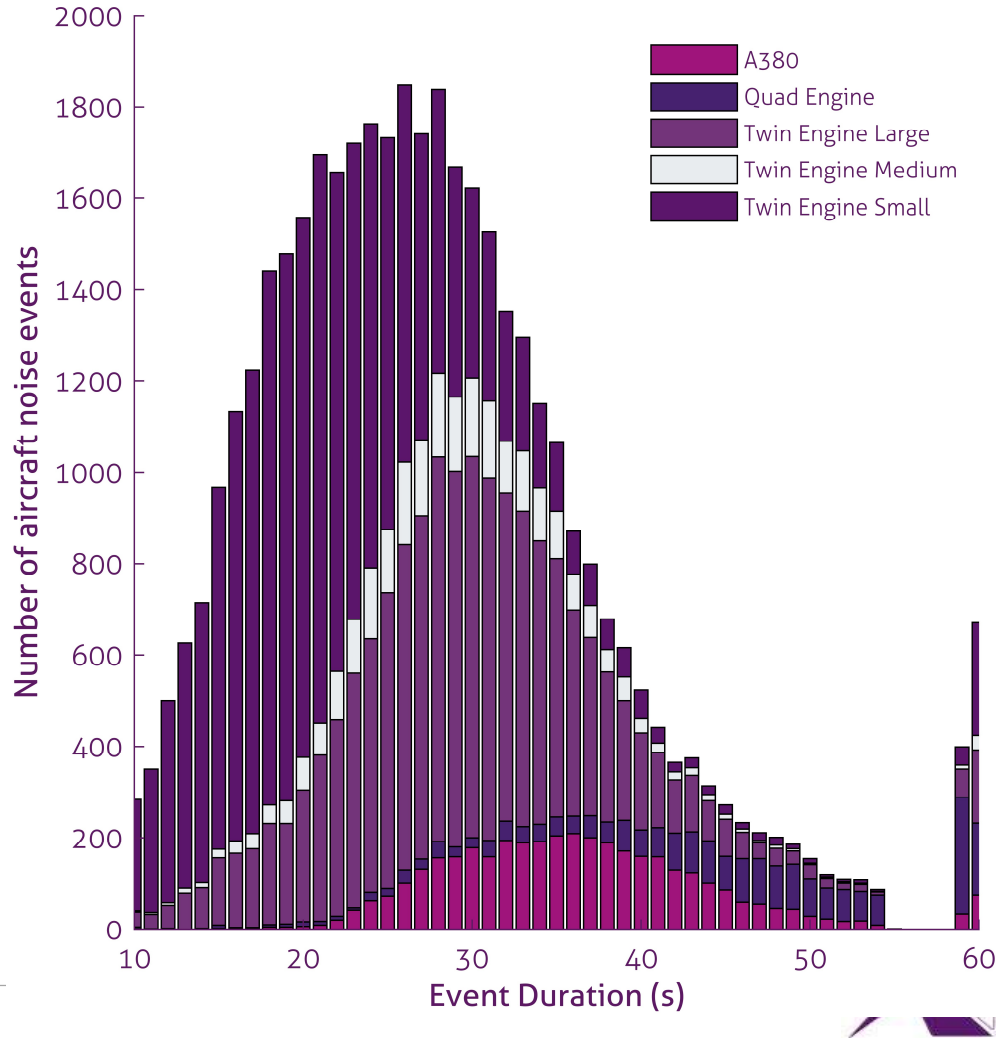




How does the duration of an aircraft event vary?

- The duration of an event (as defined for the purposes of this comparison only) is the time for which the noise level exceeds the event threshold level, which, in this case is 57.8dBA.
- In addition, events are only recorded if the duration is longer than 10s to prevent impulsive sounds which are not characteristic of aircraft noise being recorded or to prevent shorter duration transient events such as cars or lorries being captured.
- The average duration of **all measured aircraft events** was 28 seconds. The duration is largely dependent on the noise level of the event with the average event duration of the quad engine aircraft, predominantly B747-400s, being around 45 seconds while the duration of the smaller twin engine aircraft is 23 seconds.
- The >60 seconds category includes all events with durations more than 60 seconds, which are most likely to be due to one event combining with another (e.g. one of which may not necessarily be an aircraft event).

Aircraft group	Average noise event duration (seconds)
A380	36.2
Quad engine aircraft	45.0
Twin engine - large	29.8
Twin engine - medium	29.2
Twin engine - small	22.5



Which aircraft types account for the measured noise events?

- The table to the right shows the proportion of aircraft noise events recorded for each aircraft type overall, by route and whether the analysis shows it to be overhead at the noise monitor.
- The aircraft types listed are limited to the most common aircraft types operating at Heathrow. The remaining aircraft types are listed under 'Other'.
- As with the Heathrow Airport's traffic in general, the A320 family (A319, A320 & A321) dominate - accounting for 48% of all aircraft noise events detected by the monitor.
- The B777 (twin-engine large) series of aircraft account for around 20% of the measured aircraft noise events, of which the majority were using the DET route.
- 9% of the events were from the A380 almost solely when using westerly the DET route.
- On easterly operations the B747 was responsible for the single highest proportion of noise events – 3% of the total.
- The newest aircraft types in service, the B787 and A350 accounted for 9% and 2 % respectively of all recorded aircraft noise events. Again most of these were on the westerly DET route.

Aircraft Type	Total*	Route			Overhead**
		Westerly DET	Easterly CPT	Other	
A320	23	21	1	0	20
B777	20	17	3	0	17
A319	12	11	0	0	11
A380	9	9	0	0	7
B787	9	8	1	0	7
A321	8	8	0	0	7
A330	5	4	2	0	4
B747	5	2	3	0	3
B767	4	2	2	0	3
A350	2	2	0	0	2
A340	1	0	0	0	0
B737	1	0	0	0	1
Other	1	2	0	0	1
B757	0	0	0	0	0
Total* **	**100%**	**86%**	**14%**	**0%**	**84%**

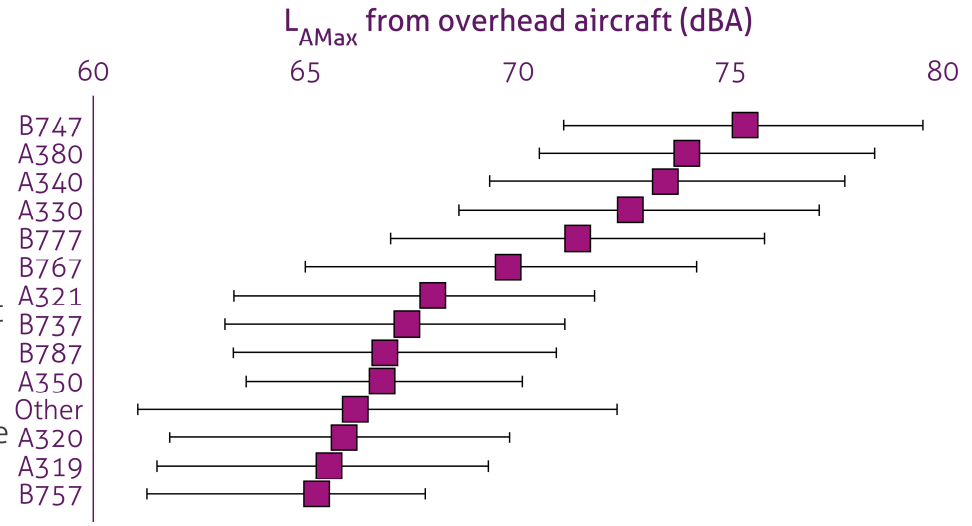
* Percentage based on 46,982 aircraft noise events recorded between 19th October 2017 and 16st October 2018.
** Defined as being with the 60 degree cone described on Page 11
***Totals may differ to sum of aircraft types due to rounding

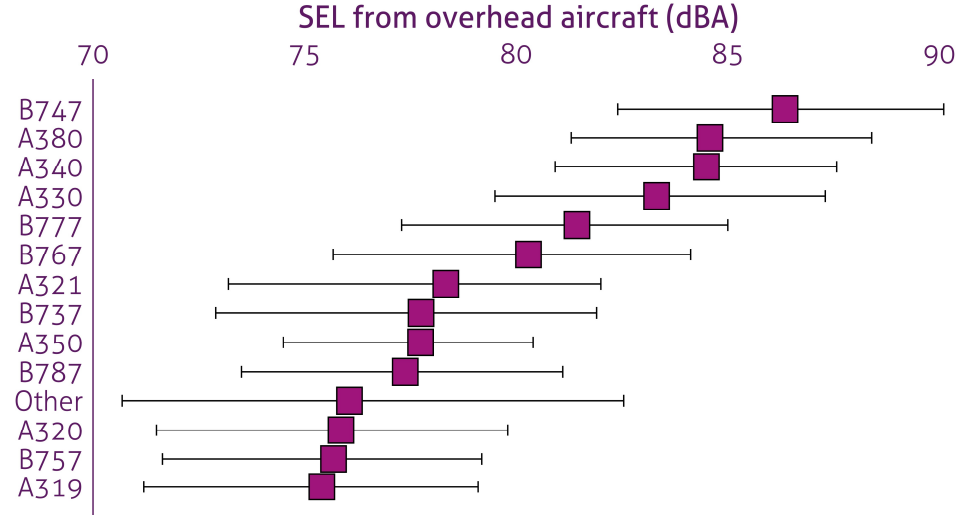
Comparison of average noise levels for different aircraft types

The plot in the top right show the average (arithmetic mean) L_{Amax} of each aircraft type in addition to the 5th and 95th percentile within the 60° **overhead** cone. The large majority of these were on the westerly DET route.

- The highest average measured noise level is from the B747, which at 78dB L_{Amax} was approx. 1dB louder than the next loudest aircraft types were the A380 and A340, both quad engine aircraft.
- It should be noted that there is a large range of levels for each aircraft type, typically between 6 and 12 decibels depending on the aircraft type.
- The B757 and two members of the A320 family, the A319 and A320, were, on average, the quietest aircraft types over the Chertsey monitor at approximately 65dB.
- The B787 and A350, the newest aircraft types in service (both in the medium twin engine category) generated average L_{Amax} levels of 67dB.

The plot in bottom right corner shows the average SEL of each aircraft type. The SEL takes into account of all energy within a noise event. The relationship of aircraft types is similar to that seen in the L_{Amax} plot with the A319 being the notable exception, which when measured using the SEL has the lowest noise level.

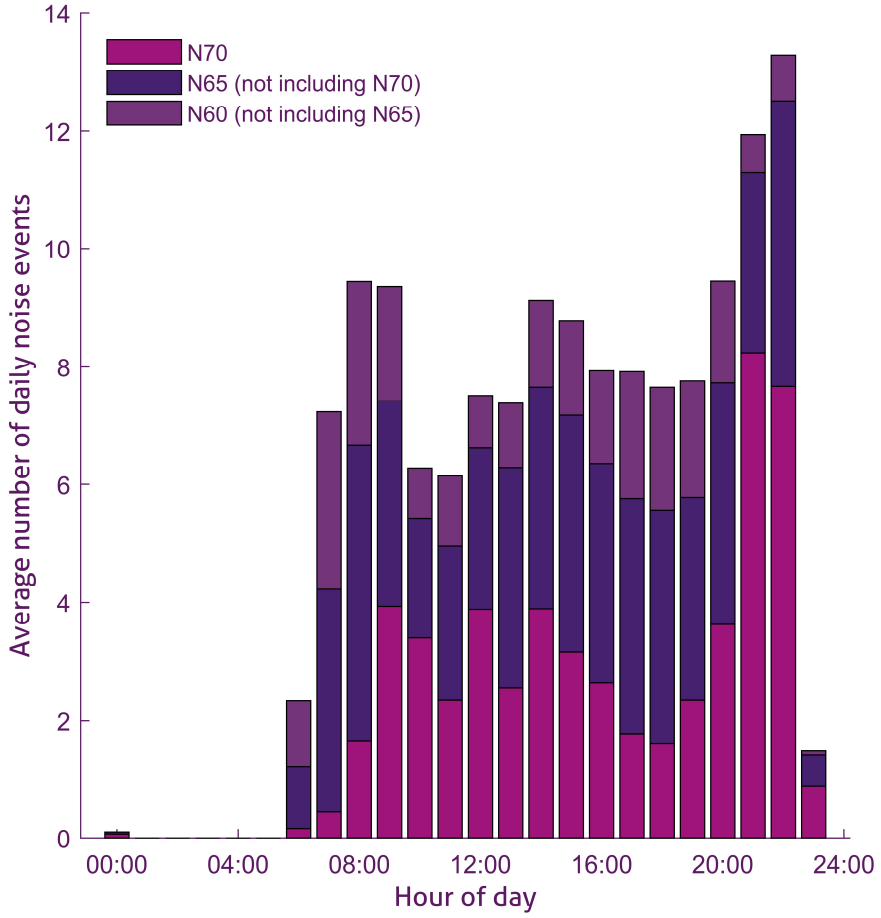




In accordance with CAA guidance, this analysis has used the 60 degree overhead cone.

How does the number of noise events vary across a day?

- It is recognised that the response to aircraft noise is related to more than average noise levels alone. The number of events and their individual levels are becoming increasingly recognised as a useful indicator of community response to aircraft noise.
- The N_{above} metrics describe the number of events in a period where the L_{Amax} exceeds a given value. For example, an $N65_{1hr}$ of 10 means that ten aircraft generated a maximum noise level greater than 65dBA in a single hour.
- The figure to the right shows the average hourly N60, N65 and N70 values across an **average 24hr day for days of 100% of westerly operations**.
- Between the hours of 07:00 and 21:00 there are typically, between 6 and 10 events being registered per hour. This rises to a maximum of approximately 14 events per hour between 21:00 and 23:00.
- On an average westerly day, the N65 during the 16h day period (07:00-23:00) was 137; the N60 during the 8h night (23:00-07:00) was less than 4.
- The N60 during the night period on westerly days was predominantly made up of scheduled departures in the 06:00-07:00 hour and late runners between 23:00 and 00:00.



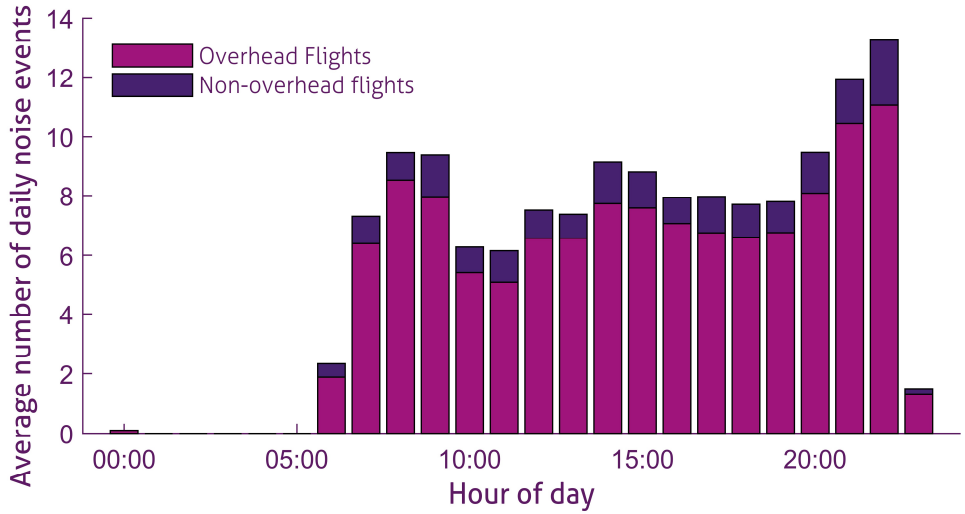
How does the number of aircraft noise events vary across a day?

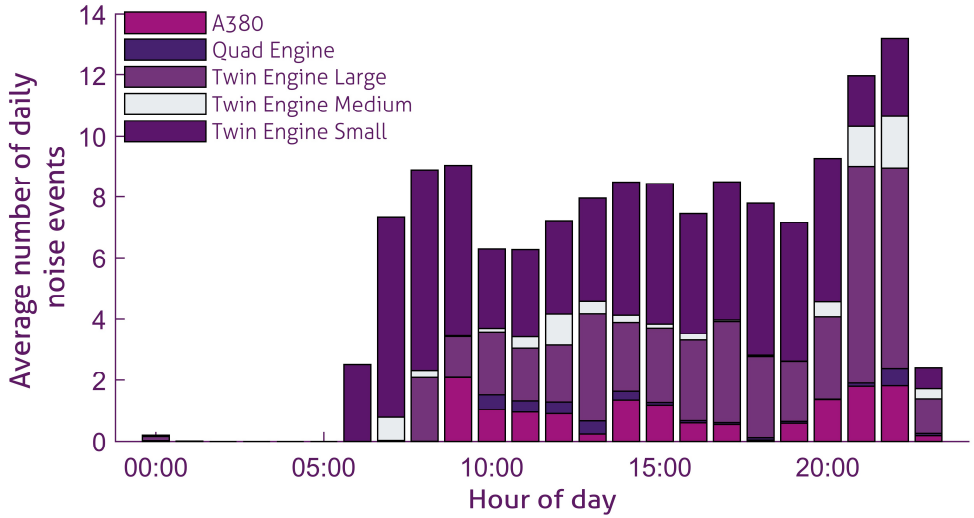
The top right figure shows the average number of noise events during each hour of the day for days of full westerly operations.

- During daytime hours, there were typically between 6 and 12 aircraft noise events per hour of which the majority were overhead (passing within the 60° cone above the monitor).
- The proportion of overhead aircraft remains approximately constant across the day.

The lower figure shows the same data broken down by aircraft size.

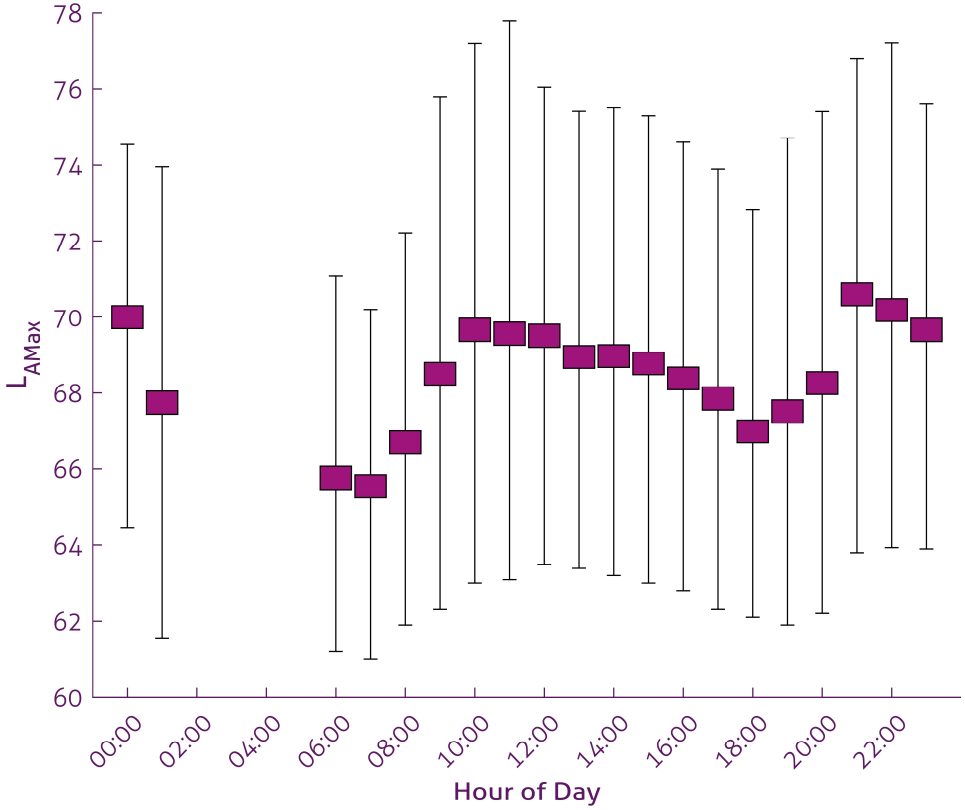
- Before 09:00, the vast majority of noise events were from small or medium sized aircraft; predominantly the A320 family.
- Small twin engine aircraft account for more than half the aircraft noise events throughout the day until 21:00 at which point the proportion of medium and large twin engine aircraft, and quad engine aircraft increases significantly.
- The number of the noisier, larger wide body aircraft increasing in the evening hours is reflected in the N_{above} plots on the previous slide (Page 33).





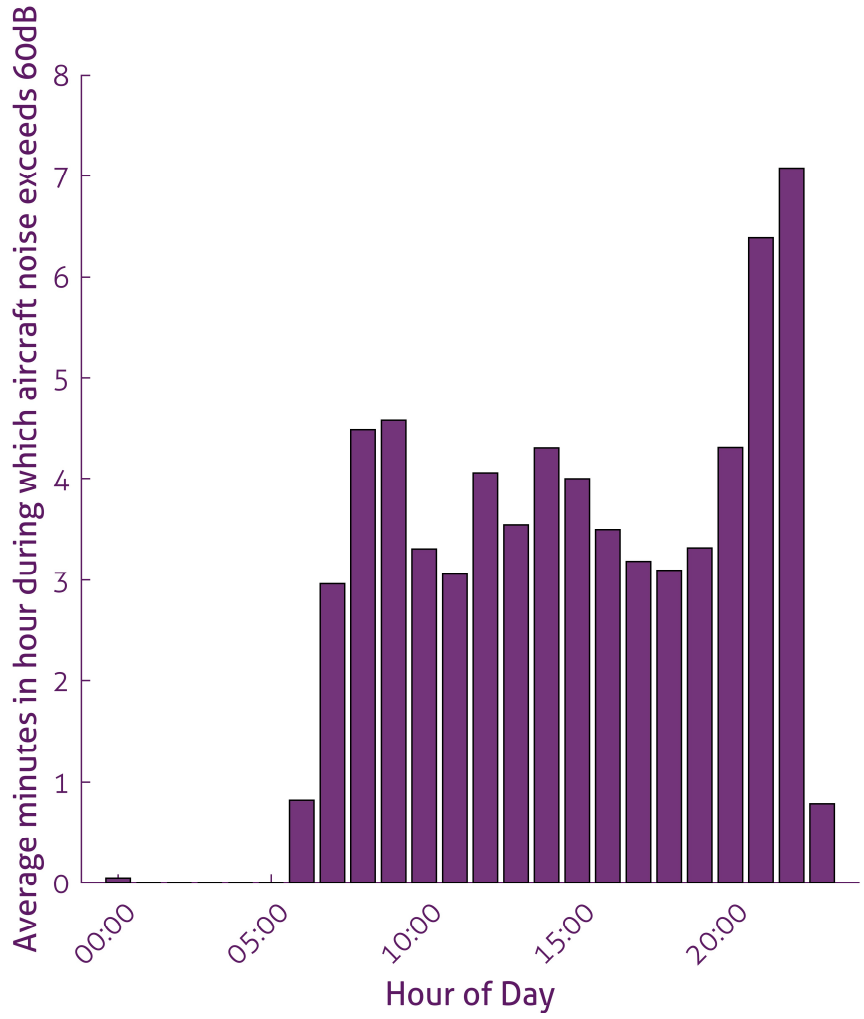
How does the L_{Amax} vary across a day?

- The figure to the right shows the average and range of L_{Amax} values of aircraft noise events for each hour of the day. The range represents the 5th and 95th percentile in each hour.
- In the morning period from 06:00 to 09:00, the average L_{Amax} is between 66 and 67dB. This increases to about 70dB from 09:00 to midday before reducing into the evening.
- A sharp increase is seen after 21:00 when average levels exceed 70dB due to the increased numbers of larger aircraft.
- In any given hour, the range of L_{Amax} is generally between 8 and 14dB.
- The early morning (00:00-02:00) data is an average of only around 22 aircraft events over the monitoring period of more than a year.



Average minutes in an hour during which aircraft noise exceeded monitor threshold

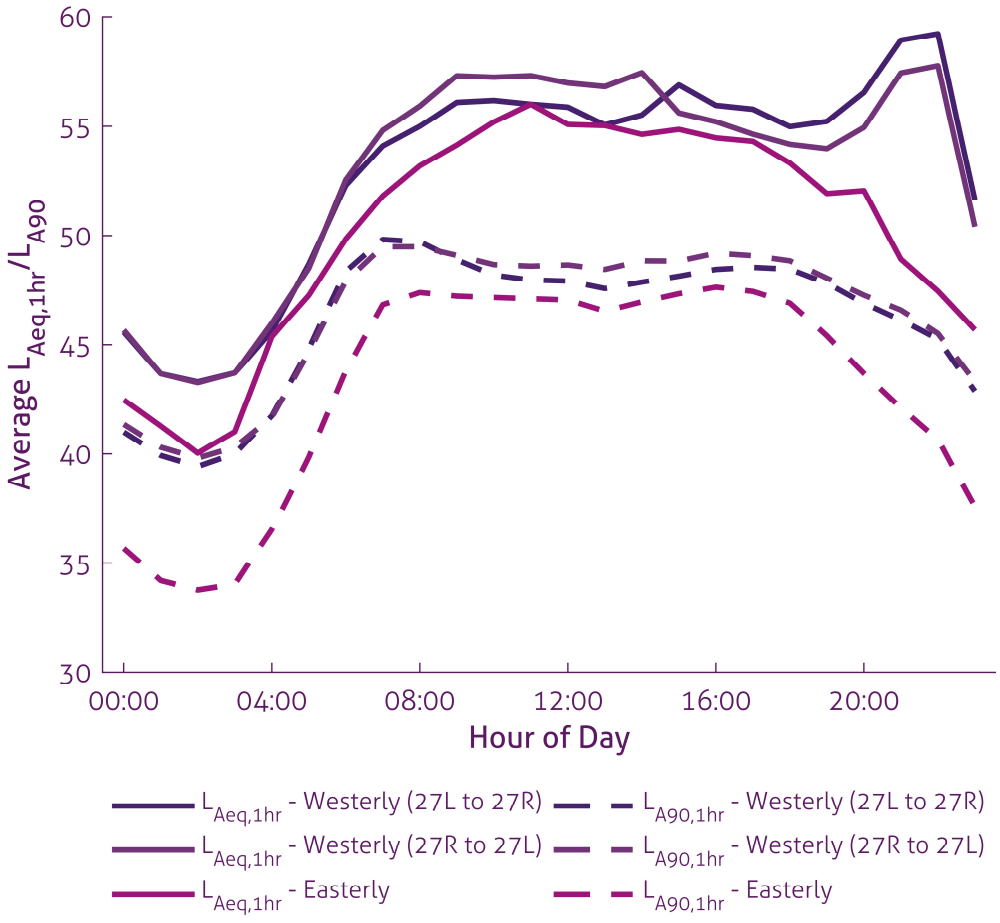
- The figure to the right shows the average number of minutes in each hour when the sound level within an aircraft noise event exceeding the measured noise event threshold - in this case 58.7dBA – on a day of full westerly operations. At this location this could be described as the amount of time (in minutes) that the aircraft noise level exceeds 58.7 dBA.
- It should be noted that individual aircraft events may be audible when the level is below that of the monitor threshold and therefore the total time the events are audible may be greater than given in the figure. This would be particularly the case during the night when background noise is lowest.
- The figure shows that on 100% westerly days aircraft noise exceeded the monitor threshold for a total of between 3 and 5 minutes in each hour between the hours of 7am and 9pm.
- Between 9pm and 11pm this increased to slightly more than 6 minutes. As with other analysis, this increase is because of the increase in movements by larger aircraft which generate longer events.



* Note: It is important not to compare the results on this page with other sites since the individual threshold can vary from monitor to monitor. The same noise event would register a longer duration if a lower threshold were to be used.

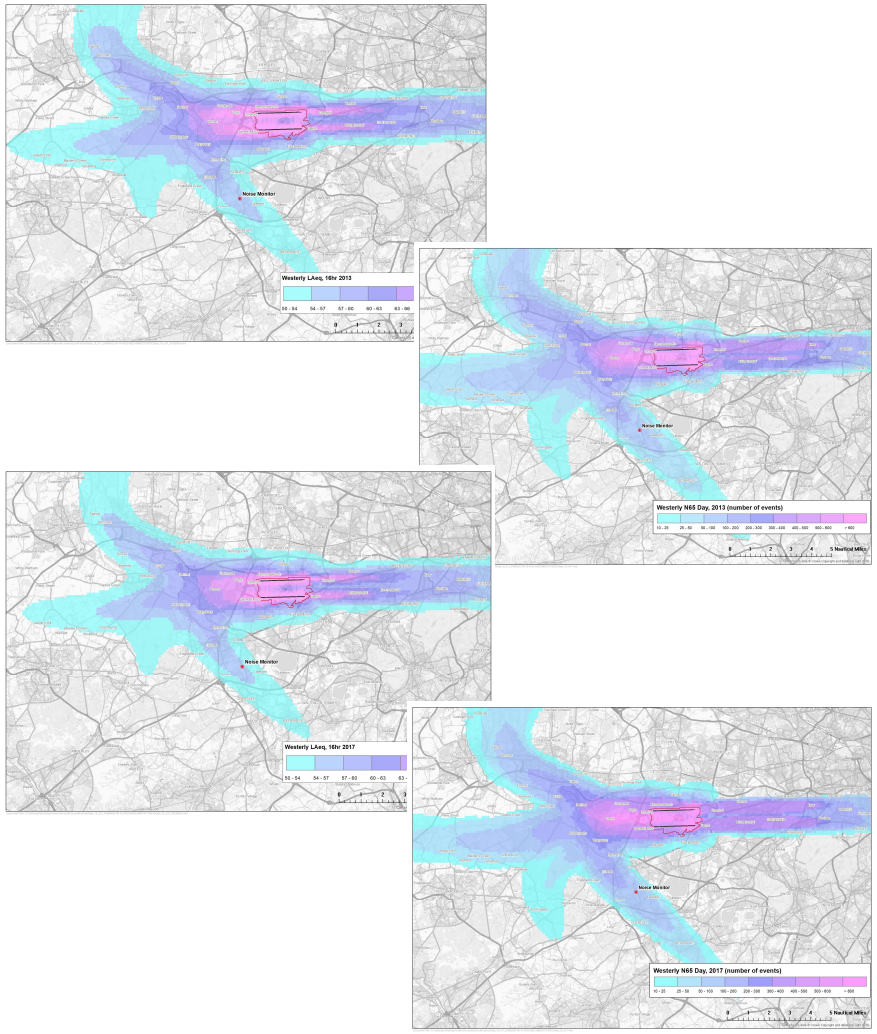
Do aircraft contribute to overall ambient noise levels?

- The figure to the right shows the average (arithmetic mean) hourly $L_{Aeq,1hr}$ and $L_{A90,1hr}$ on days where 100% of operations were either westerly or easterly. It also shows the effect of runway alternation on overall noise levels.
- It should be noted that these metrics describe the overall noise environment including all noise sources, not just aircraft noise.
- During days of full westerly operations between the hours of 07:00 and 21:00 average $L_{Aeq,1hr}$ values were around 2dB higher when compared with the same hour during a full easterly day. This difference starts to increase at 19:00 reaching a maximum of 10dB between 22:00 and 23:00.
- The contribution of aircraft noise to the noise environment is most discernible during the period 21:00 and 23:00 with $L_{Aeq,1hr}$ reaching 59dB on westerly operations at a time when background noise (as indicated by the L_{A90}) is reducing.
- On westerly operations, the $L_{Aeq,1hr}$ is approximately 1dB higher when the northern runway is in use.
- During the period the monitor was in place, the average daytime $L_{Aeq,16hr}$ between 07:00 and 23:00 was 57dB on westerly operations and 54dB on easterly operations from all noise sources.
- During the night, the average $L_{Aeq,8hr}$ between 23:00 and 07:00 was 49dB on westerly operations and 46dB on easterly operations.



Modelled long term average aircraft noise levels around the airport.

- While a noise monitor can provide an in-depth picture of the noise environment at a specific location, the data cannot be used to provide an understanding of the noise environment over a wider geographical area.
- The Heathrow AEDT model has been run using flight track data for **2013 and 2017** to investigate whether there are any differences in daytime ($L_{Aeq, 16hr}$ /N65) and nighttime ($L_{Aeq, 8hr}$ /N60) for an **average day and night of easterly and westerly operations** across the summer in each of these years.
- Note that these contours are specific to easterly and westerly operations and are not the same as the ERCD published annual contours which derive an overall average for the summer that combines westerly and easterly operations. The following maps only use days when there were either full easterly or westerly operations across that day.
- Daytime $L_{Aeq, 16hr}$ values are presented in bands >50 dB, > 54dB and then in 3 dB increments to 69 dB.
- Night-time $L_{Aeq, 8hr}$ values are presented in 5dB bands starting at >40 dB to 65 dB.
- These are longer terms metrics averaged over 16 and 8hrs and do not directly reflect the shorter term fluctuations between individual events.
- It should be noted that aircraft noise modelling to average levels around 50 dB carries increasing uncertainty in the result. In areas where aircraft noise levels are in this range it should be noted that many non aircraft noise sources may be of similar (or even higher) levels. Interpretation of the modelled results at this noise level should bear this mind.



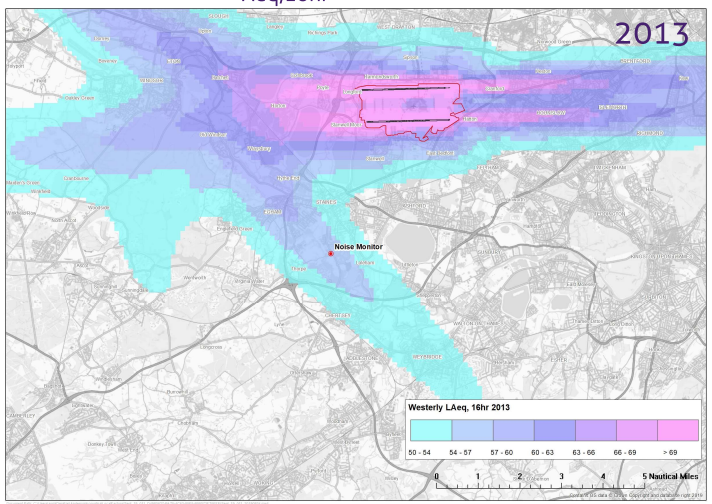
Average **daytime** aircraft noise levels – westerly operations

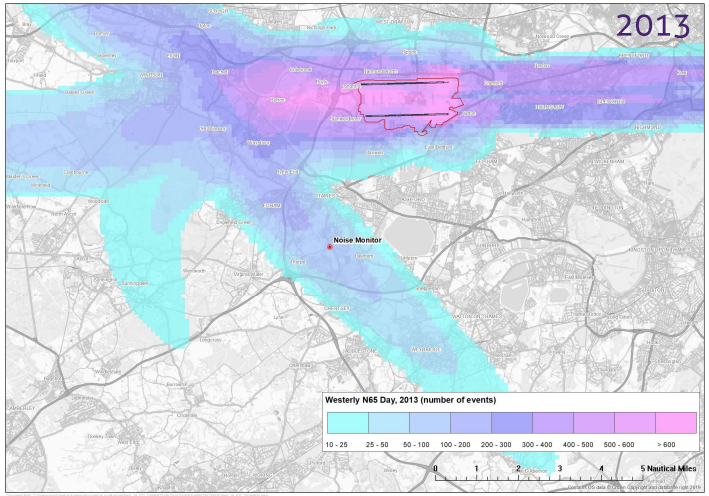
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq, 16hr}$ bands in the left column and N65 bands in the right column for **an average westerly summer day when the airport is on 100% westerly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dBA over the 16 hour day period between 7am and 11pm.

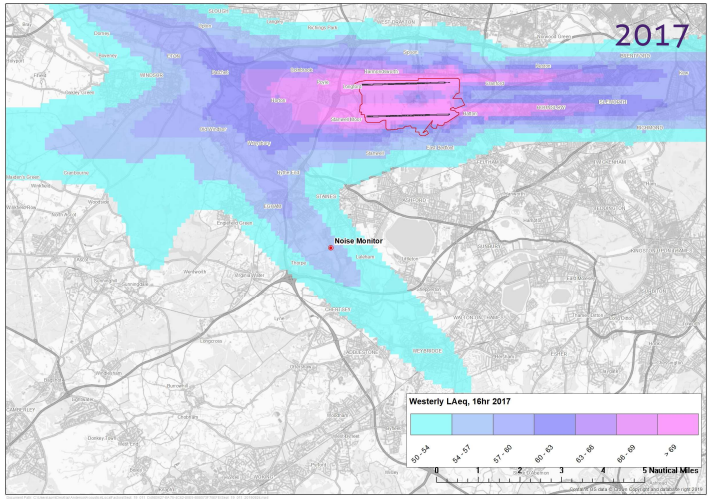
- Larger figures are shown in Appendix A.

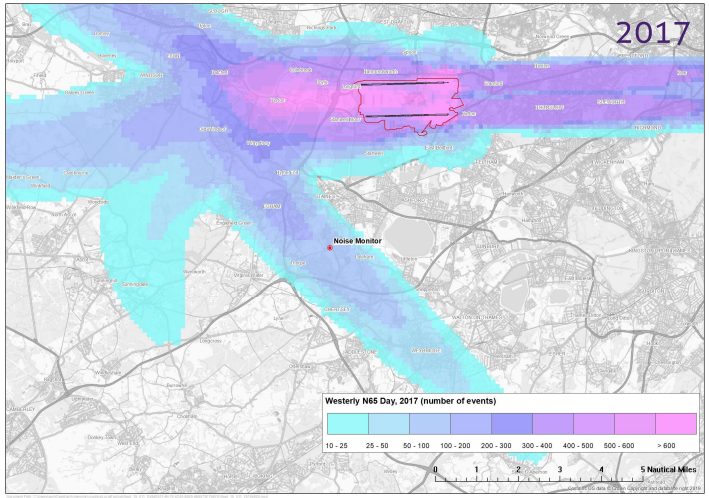
$L_{Aeq,16hr}$

N65, Daytime





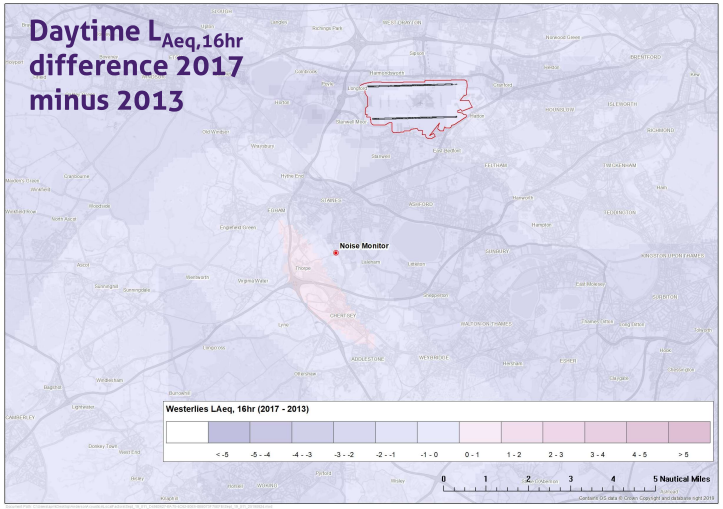


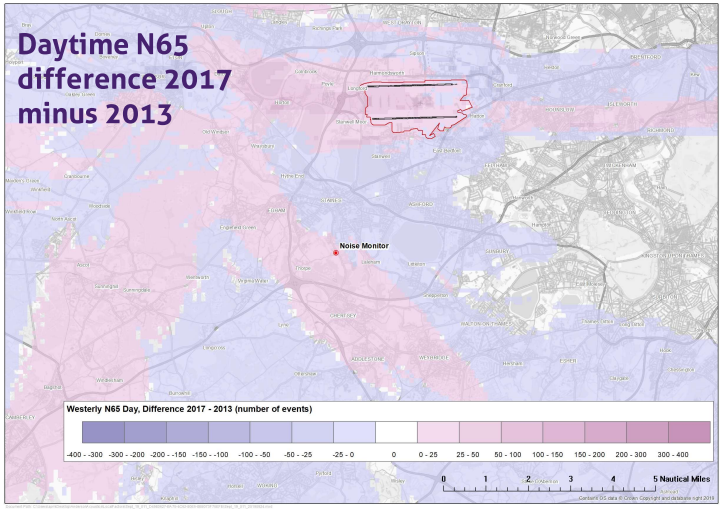


Differences in average **daytime** aircraft noise levels – westerly operations

- The difference in the modelled average $L_{Aeq,\ 16hr}$ and $N65_{16\ hr}$ contours around Heathrow between 2013 and 2017 are shown in the figures to the right. This is for **an average westerly summer day when the airport is on 100% westerly operations**
- The upper image shows the change in daytime $L_{Aeq,16hr}$ and the bottom image shows the change in daytime $N65_{16hr}$. Areas with a decrease in average exposure are shown in blue and those areas with an increase in average exposure shown in pink.
- At Chertsey, there was approximately a 1dB decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017 however the modelling also indicates an increase of up to 25 daytime N65 events.
- It should be noted that, all other variables remaining constant, a difference in 15% of noise events, would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a 100% increase would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.

- Larger figures are shown in Appendix A.



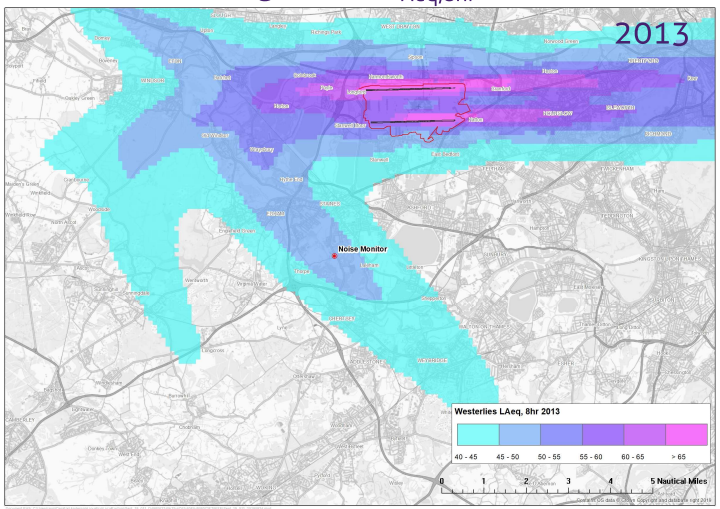


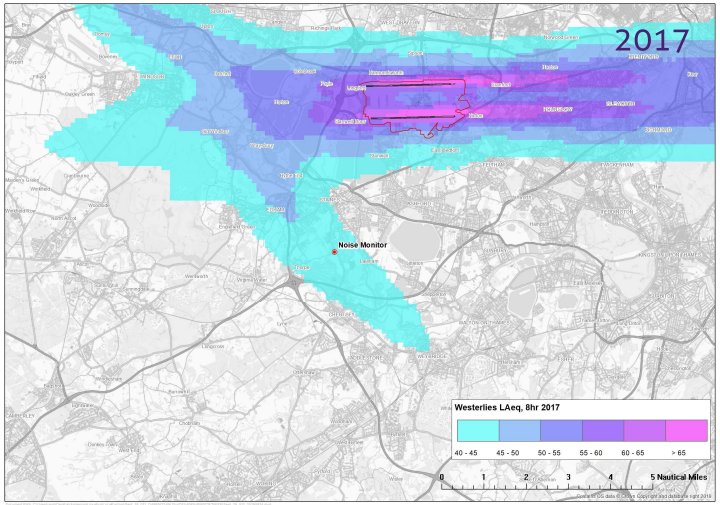
Average **night-time** aircraft noise levels – westerly operations

- The figures to the right show the 2013 and 2017 night-time $L_{Aeq, 8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average westerly summer night between 11pm and 7am when there are 100% westerly operations. Generated from **an average westerly summer day when the airport is on 100% westerly operations**
- The $L_{Aeq,8hr}$ contours are presented in 5dB intervals from >40 to > 65dB.
- The N60 is defined here as the number of aircraft noise events that exceed 60dBA over the 8 hour night period between 11pm and 7am.
- The figures to the right shows the average $N60_{8hr}$ values for 2013 and 2017 from 1 up to greater than 80 when the airport is on westerly operations.

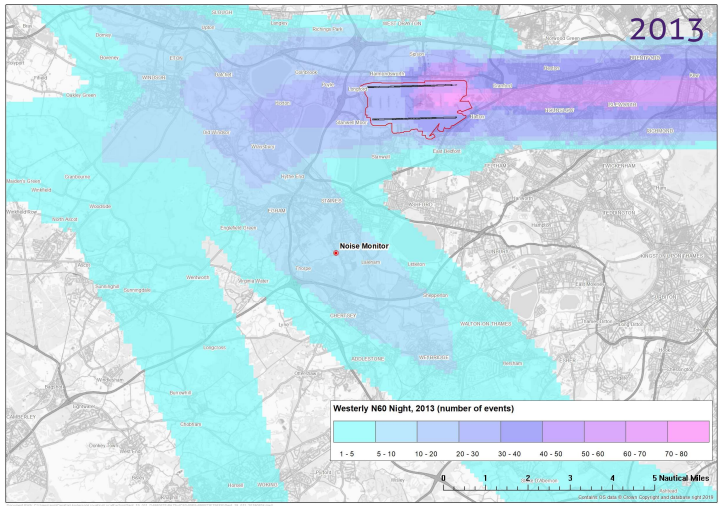
- Larger figures are shown in Appendix A.

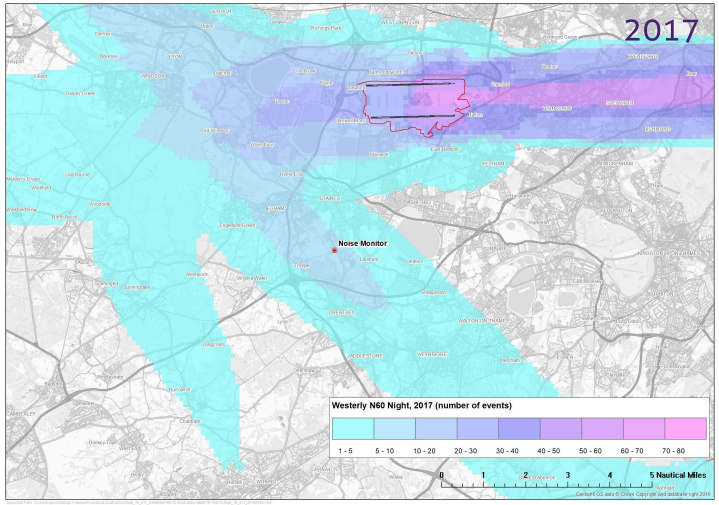
Night-time $L_{Aeq,8hr}$





N60, night-time

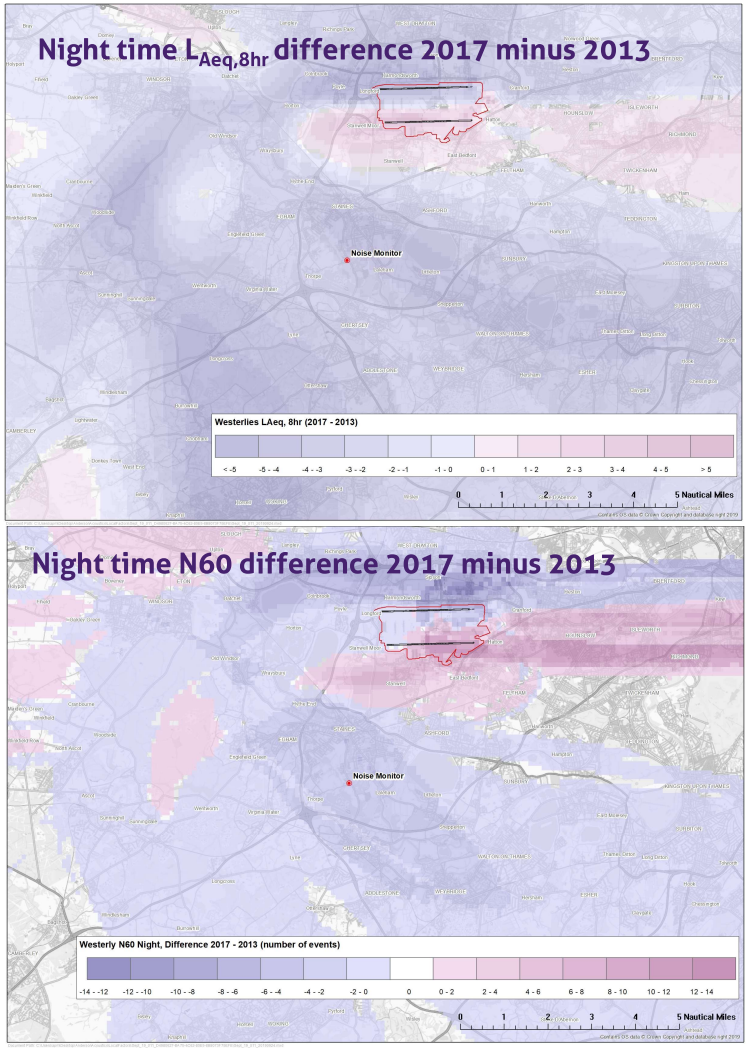




Differences in average **night-time** aircraft noise levels – westerly operations

- The difference in the modelled average $L_{Aeq, 8hr}$ (upper figure) and $N60_{(8\ hr)}$ (lower figure) values **on 100% westerly operations** around Heathrow between 2013 and 2017 are shown in the figures to the right.
- Areas with an average decrease are shown in blue and those areas with an average increase in pink.
- The results indicate an increase in average night-time aircraft noise $L_{Aeq,8hr}$ decreased by approximately 3 decibels and the N60 decreased by up to 4 at Chertsey from 2013 to 2017.

- Larger figures are shown in Appendix A.



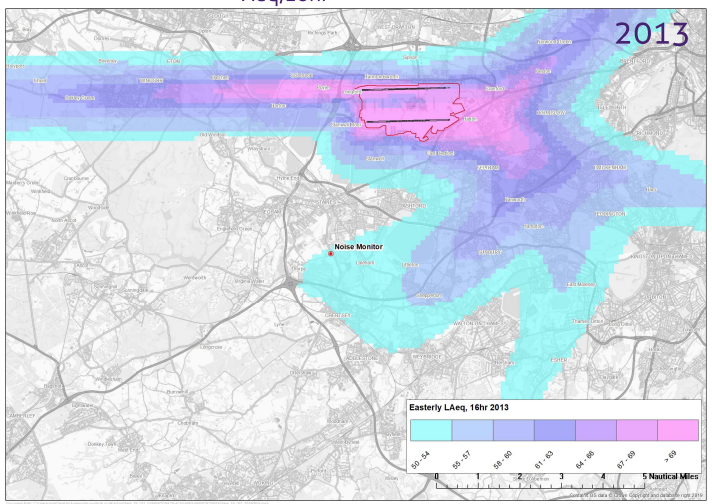
Average **daytime** aircraft noise levels – easterly operations

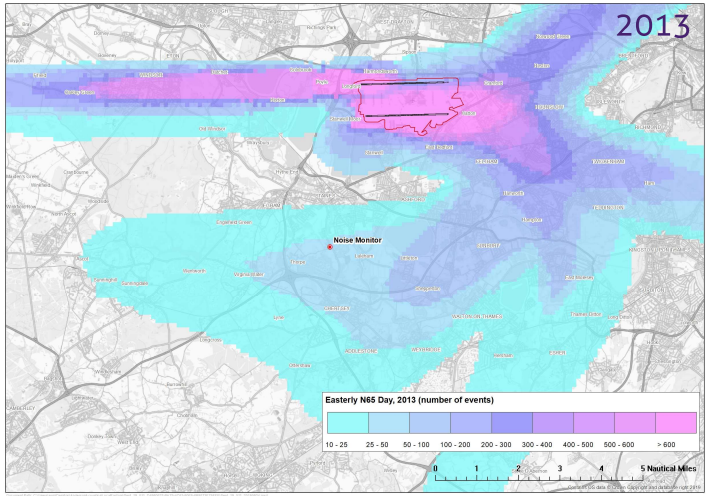
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq, 16hr}$ bands in the left column and N65 bands in the right column for **an average easterly summer day when the airport is on 100% easterly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dBA over the 16 hour day period between 7am and 11pm.

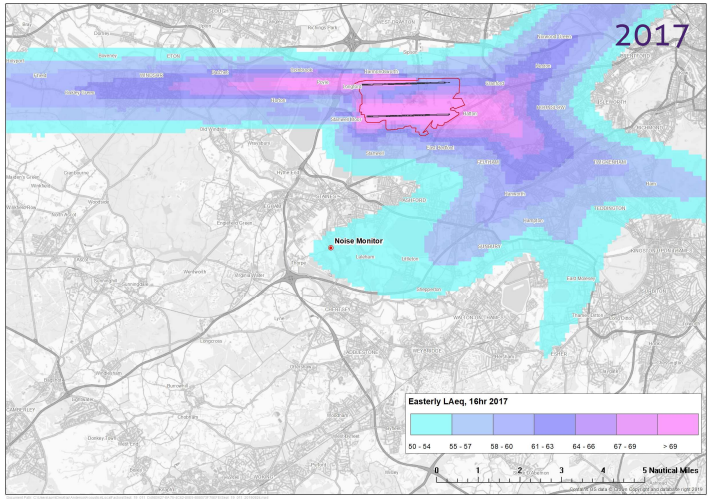
- Larger figures are shown in Appendix A.

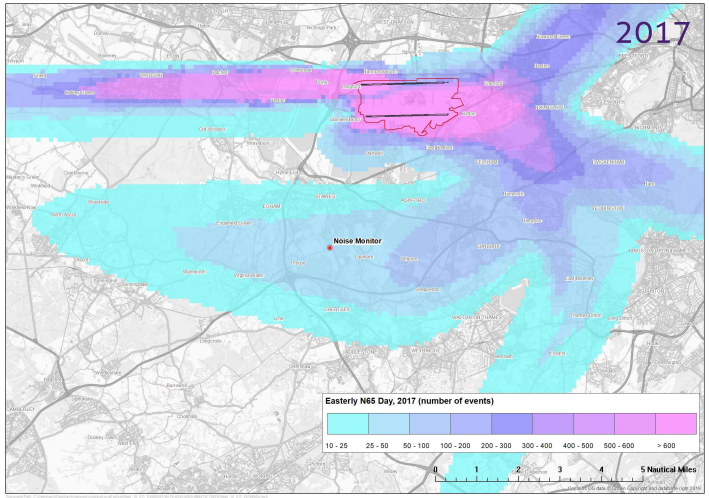
$L_{Aeq,16hr}$

N65, Daytime





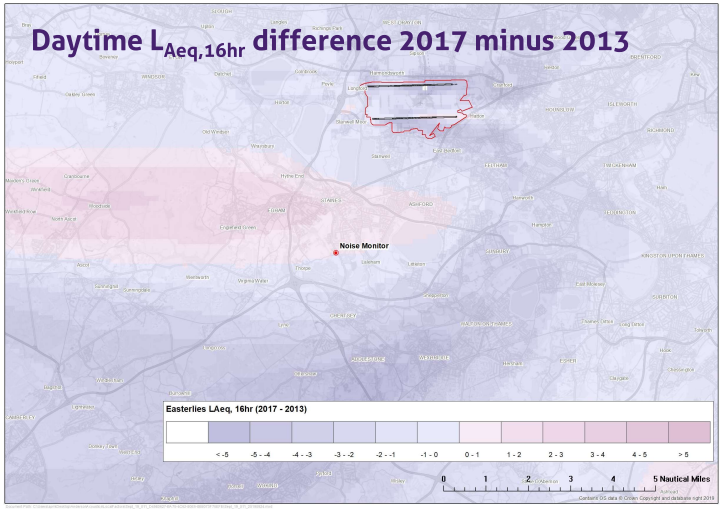


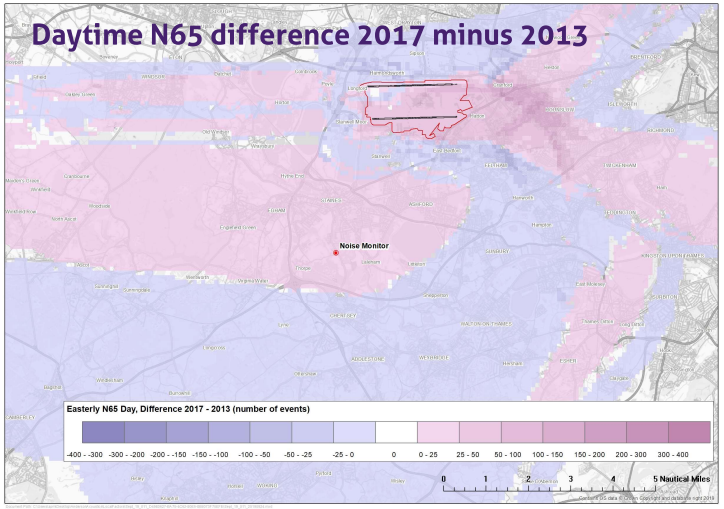


Differences in average **daytime** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq,\ 16hr}$ and $N65_{16\ hr}$ contours around Heathrow between 2013 and 2017 are shown in the figures to the right. This is for **an average easterly summer day when the airport is on 100% easterly operations**
- The upper image shows the change in daytime $L_{Aeq,16hr}$ and the bottom image shows the change in daytime $N65_{16hr}$. Areas with a decrease in average exposure are shown in blue and those areas with an increase in average exposure shown in pink.
- At Chertsey there was almost no change in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017 however the modelling indicates an increase of up to 25 daytime N65 events.
- It should be noted that, all other variables remaining constant, a difference in 15% of noise events, would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a 100% increase would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.

- Larger figures are shown in Appendix A.



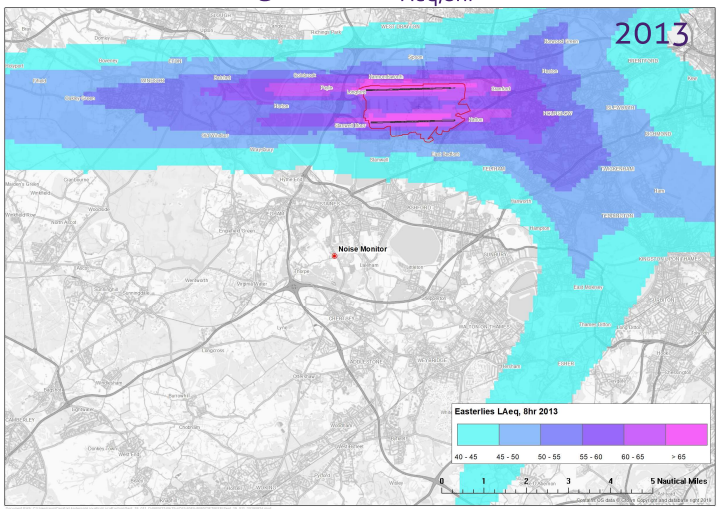


Average **night-time** aircraft noise levels – easterly operations

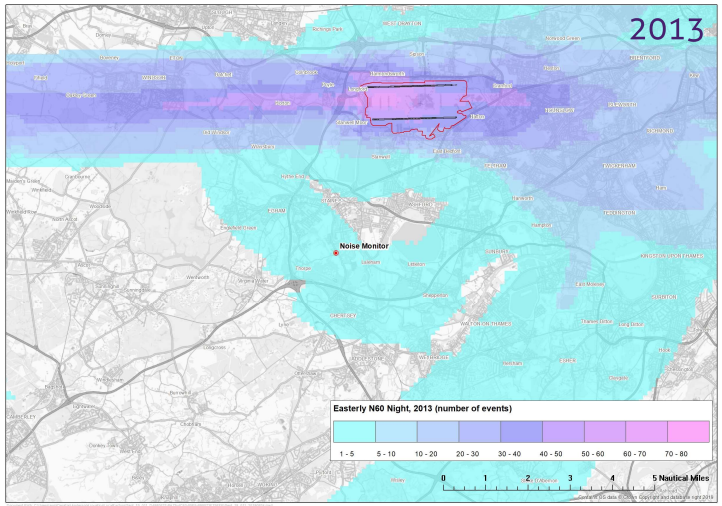
- The figures to the right show the 2013 and 2017 night-time $L_{Aeq, 8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average easterly summer night between 11pm and 7am when there are 100% easterly operations. Generated from **an average easterly summer day when the airport is on 100% easterly operations**
- The $L_{Aeq,8hr}$ contours are presented in 5dB intervals from >40 to > 65dB.
- The N60 is defined here as the number of aircraft noise events that exceed 60dBA over the 8 hour night period between 11pm and 7am.
- The figures to the right shows the average $N60_{8hr}$ values for 2011 and 2015 from 1 up to greater than 80 when the airport is on westerly operations.

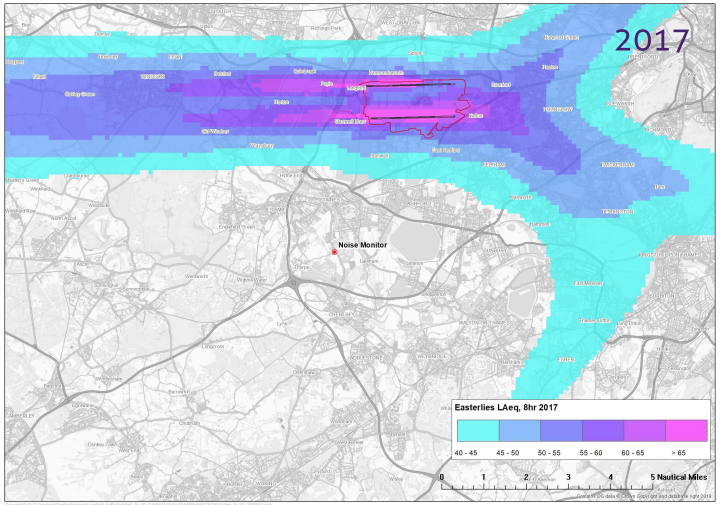
- Larger figures are shown in Appendix A.

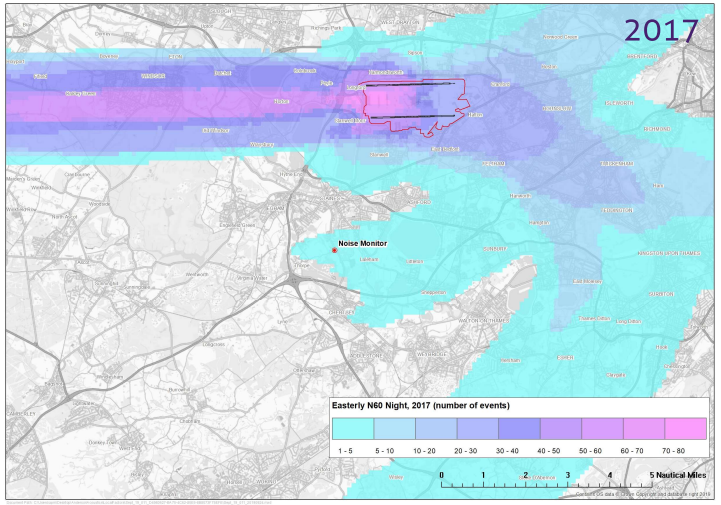
Night-time $L_{Aeq,8hr}$



N60, night-time



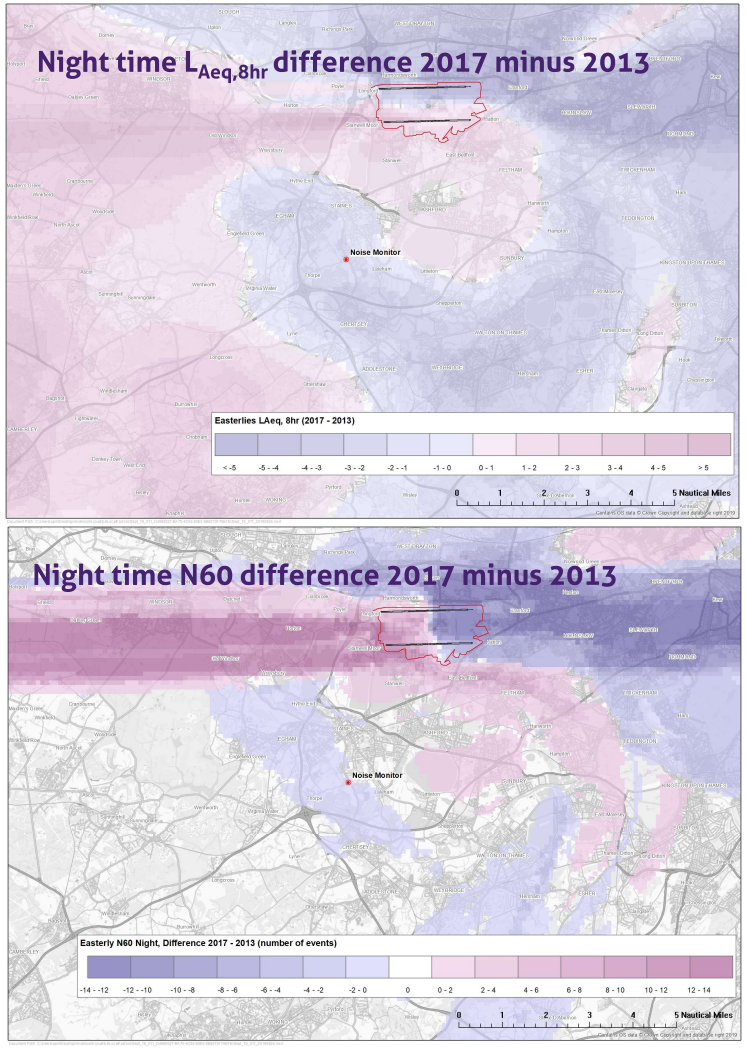




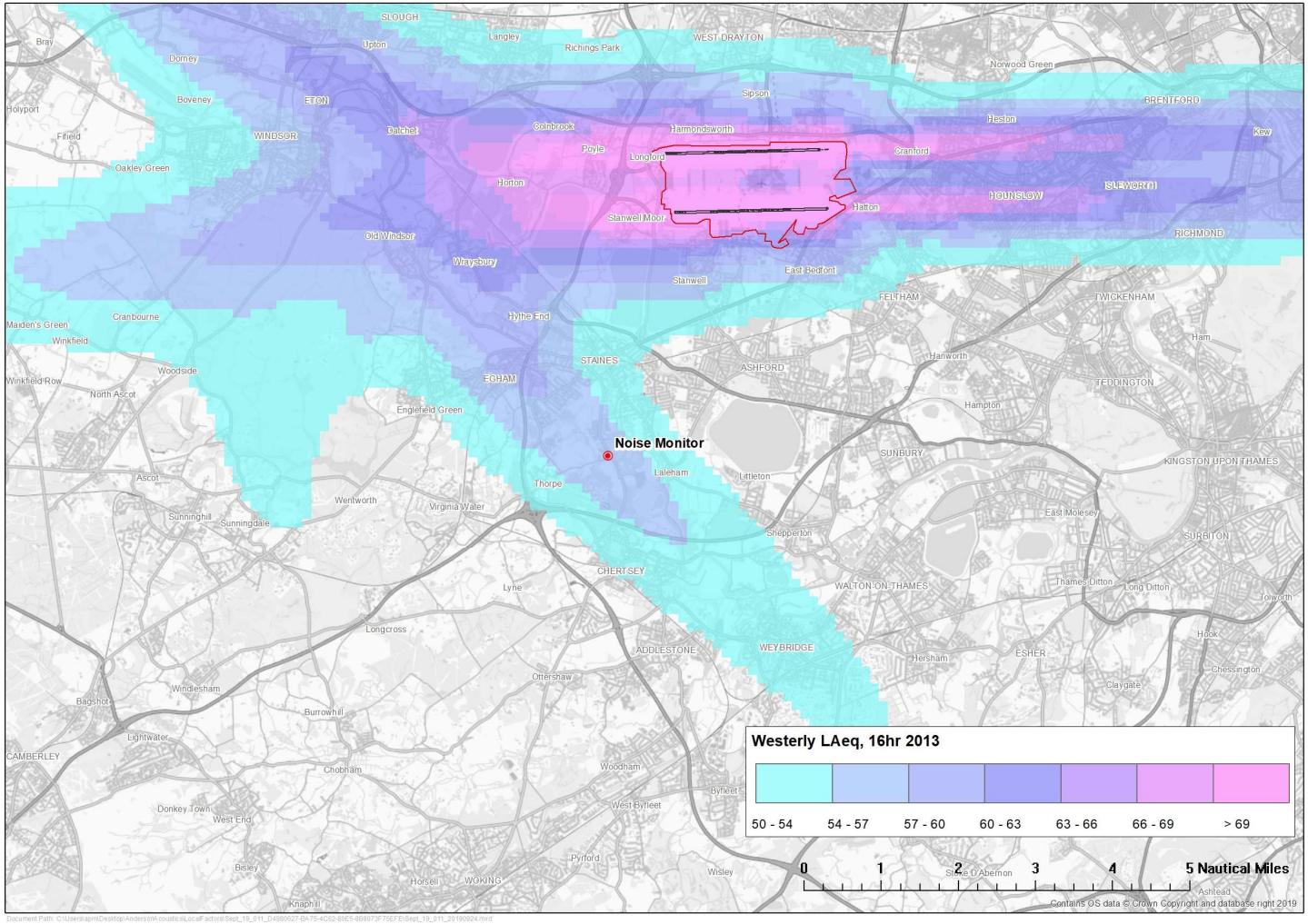
Differences in average **night-time** aircraft noise levels – easterly operations

- The difference in the modelled average $L_{Aeq, 8hr}$ (upper figure) and $N60_{(8\ hr)}$ (lower figure) values **on 100% easterly operations** around Heathrow between 2013 and 2017 are shown in the figures to the right.
- Areas with an average decrease are shown in blue and those areas with an average increase in pink.
- The results indicate an decrease in average night-time aircraft noise $L_{Aeq,8hr}$ of less than one decibel and a decrease in N60 of less than 2 at Chertsey from 2013 to 2017.

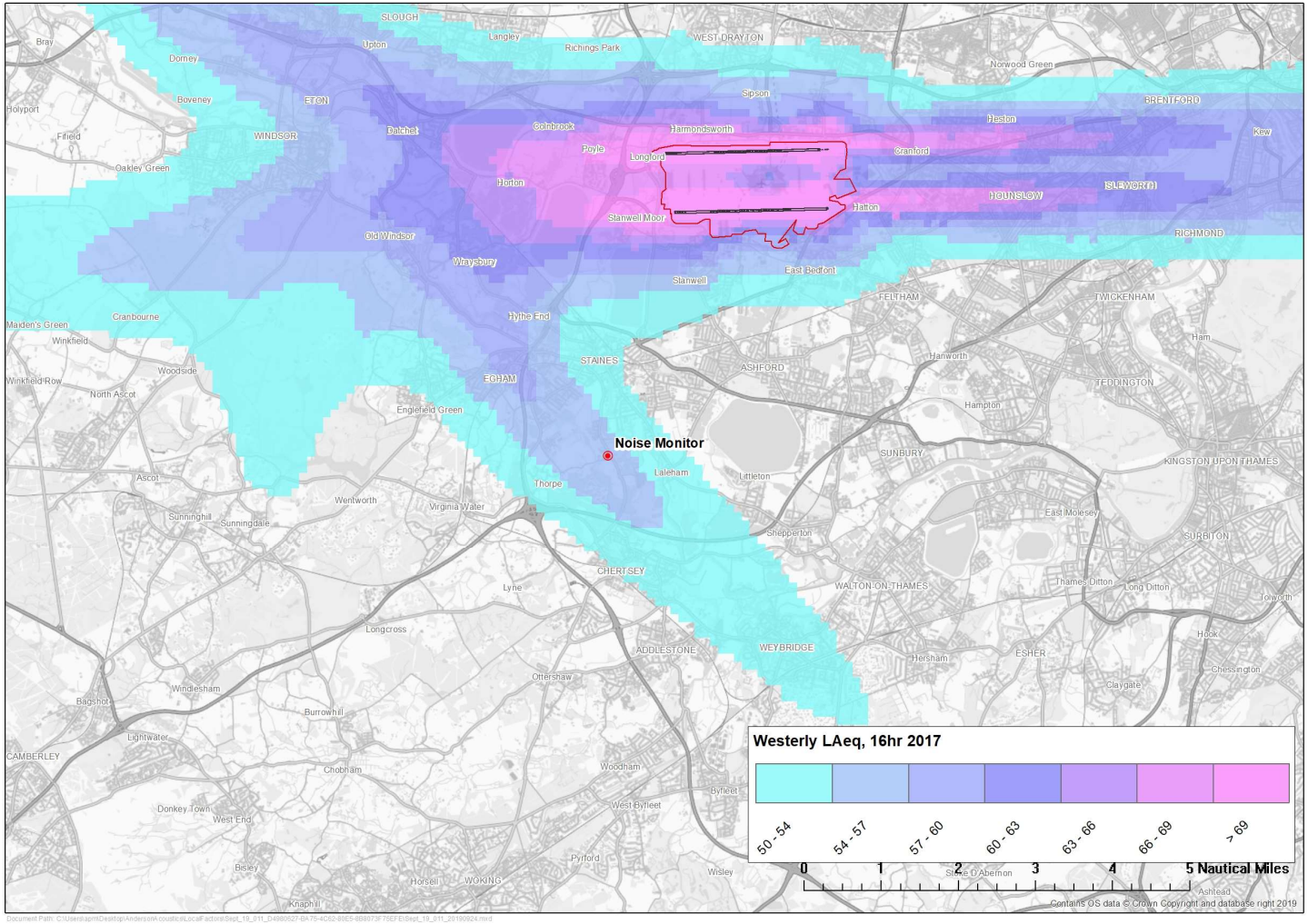
- Larger figures are shown in Appendix A.



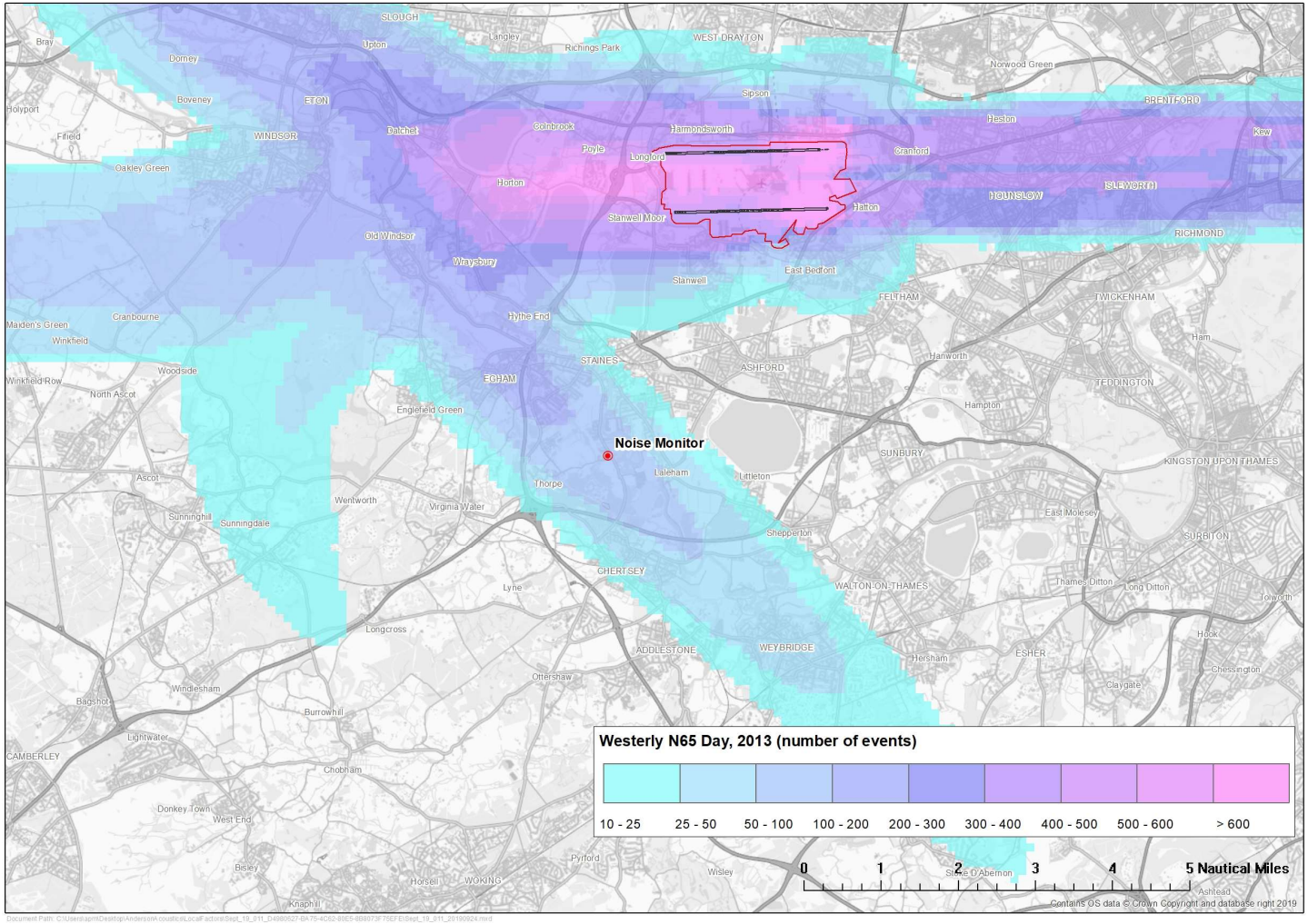
Appendix A: Average westerly day $L_{Aeq, 16hr}$ contours (2013)



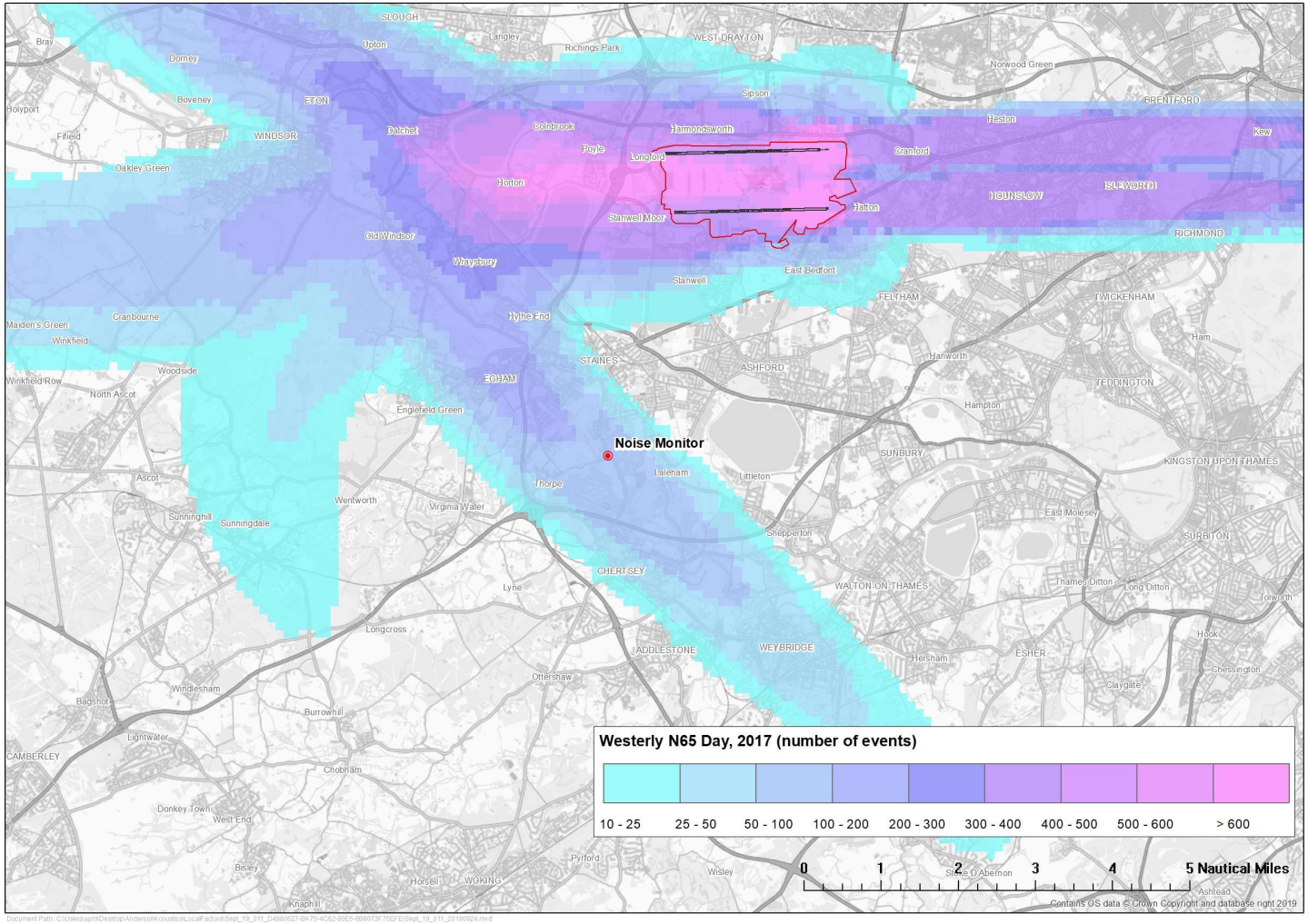
Appendix A: Average westerly day $L_{Aeq, 16hr}$ contours (2017)



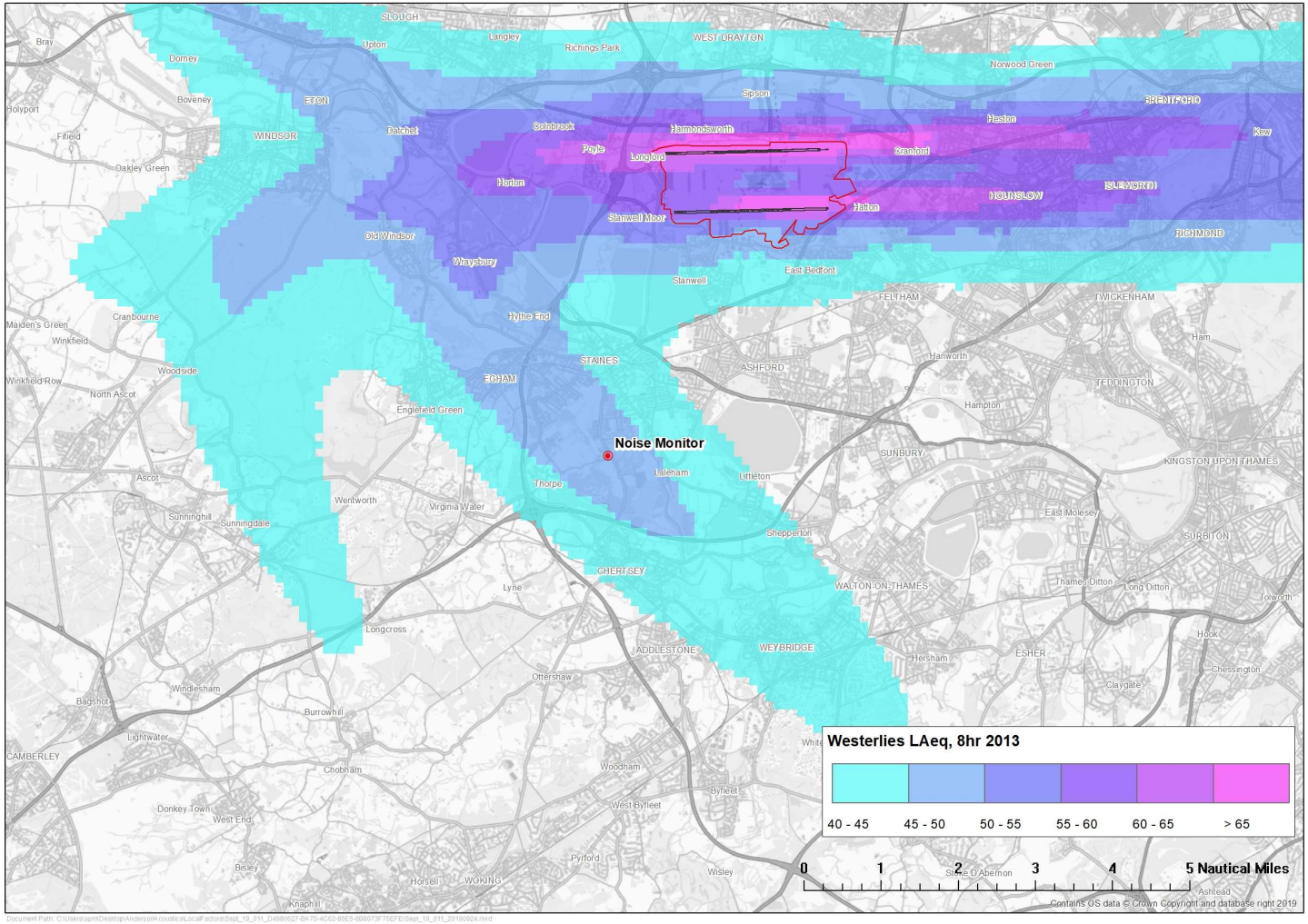
Appendix A: Average westerly day $N65_{16hr}$ contours (2013)



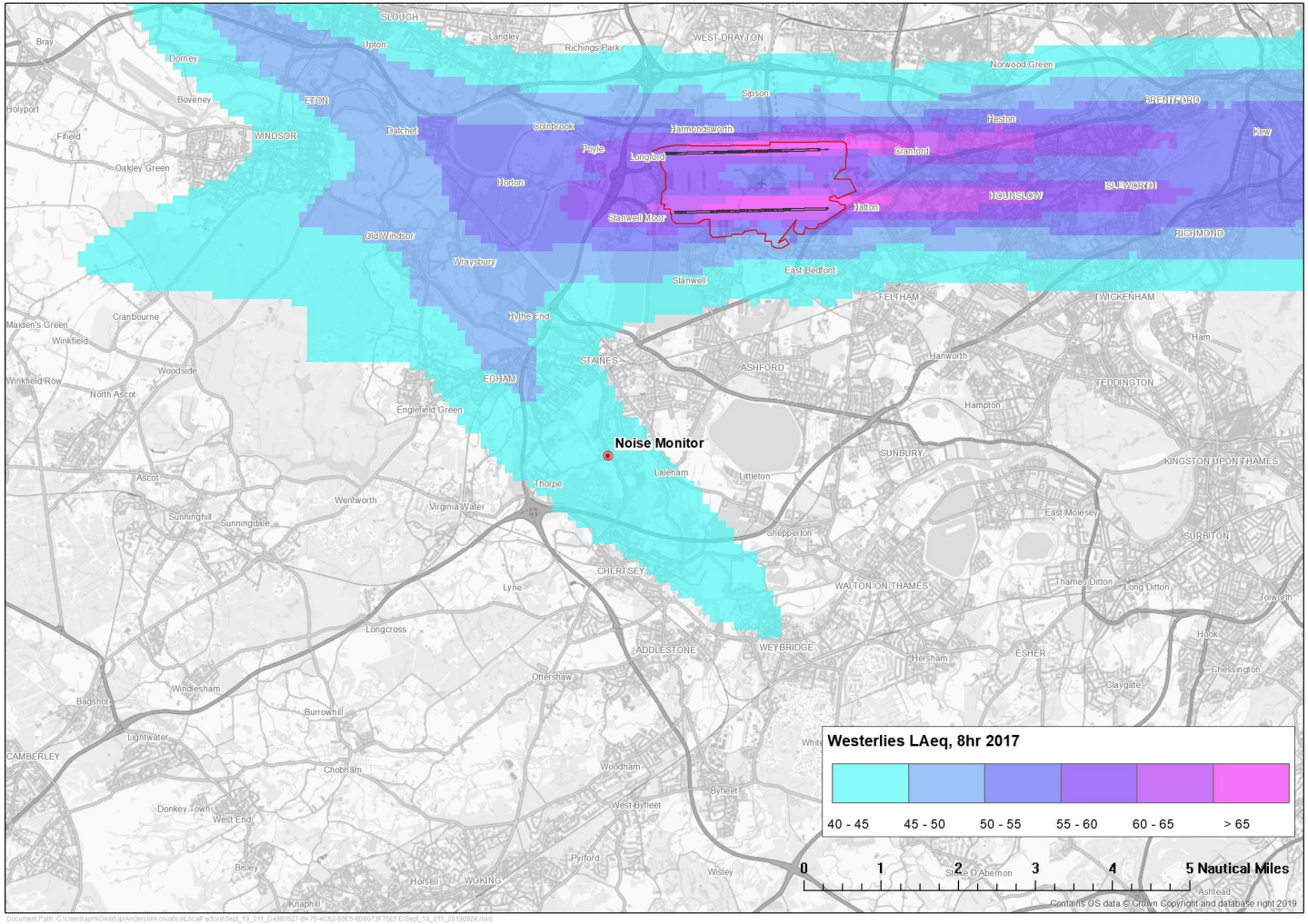
Appendix A: Average westerly day $N65_{16hr}$ contours (2017)



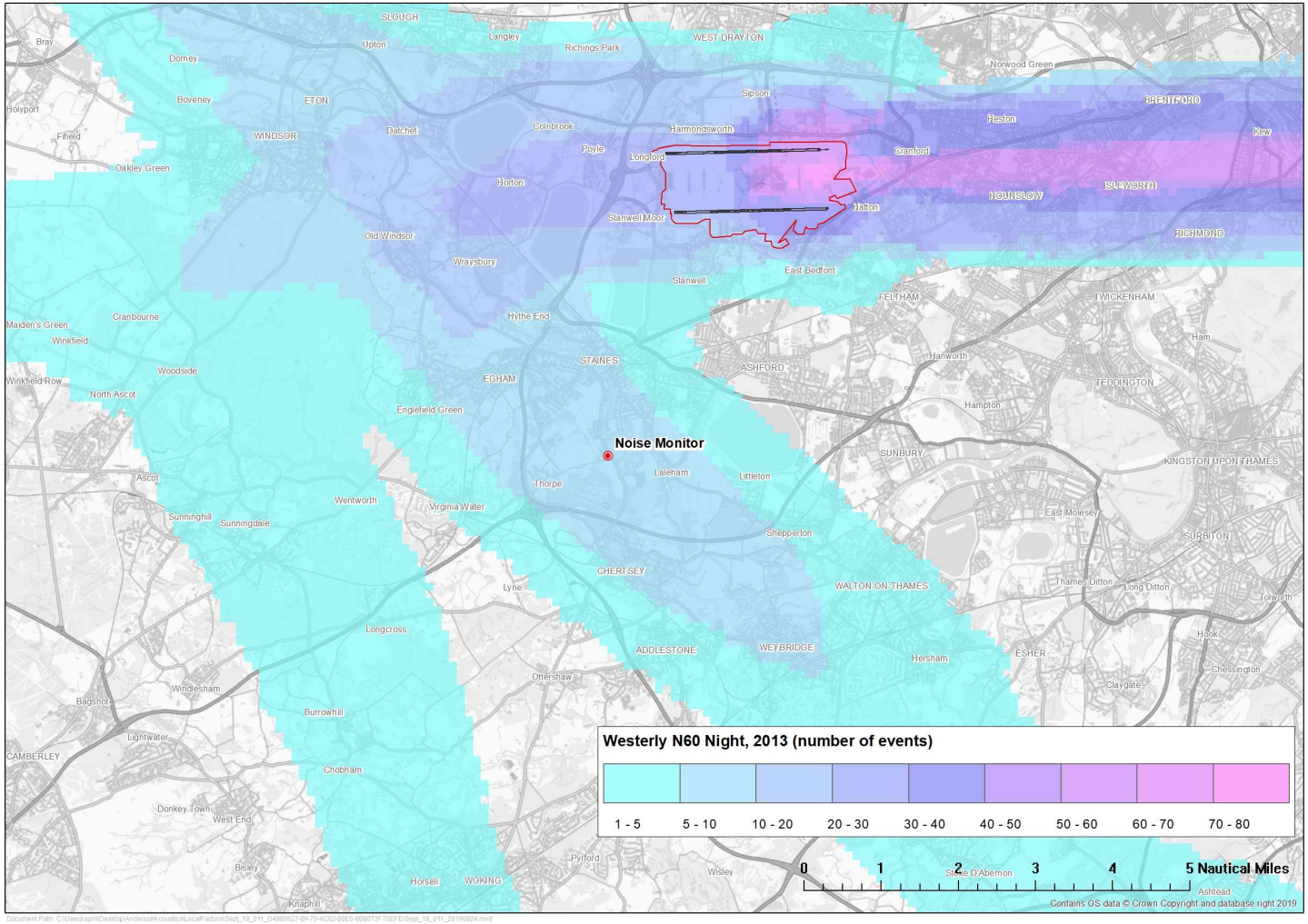
Appendix A: Average westerly night $L_{Aeq, 8hr}$ contours (2013)



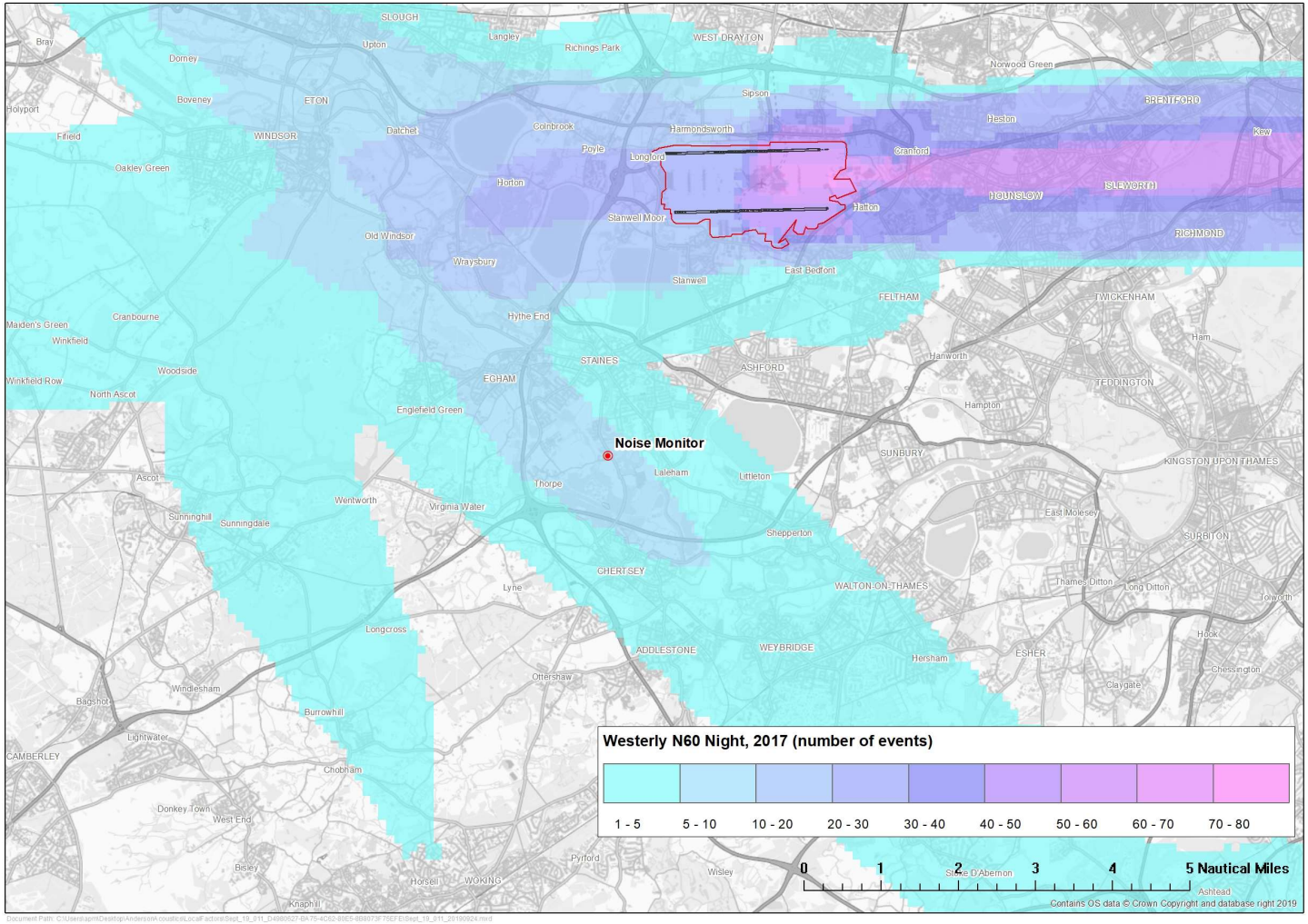
Appendix A: Average westerly night $L_{Aeq, 8hr}$ contours (2017)



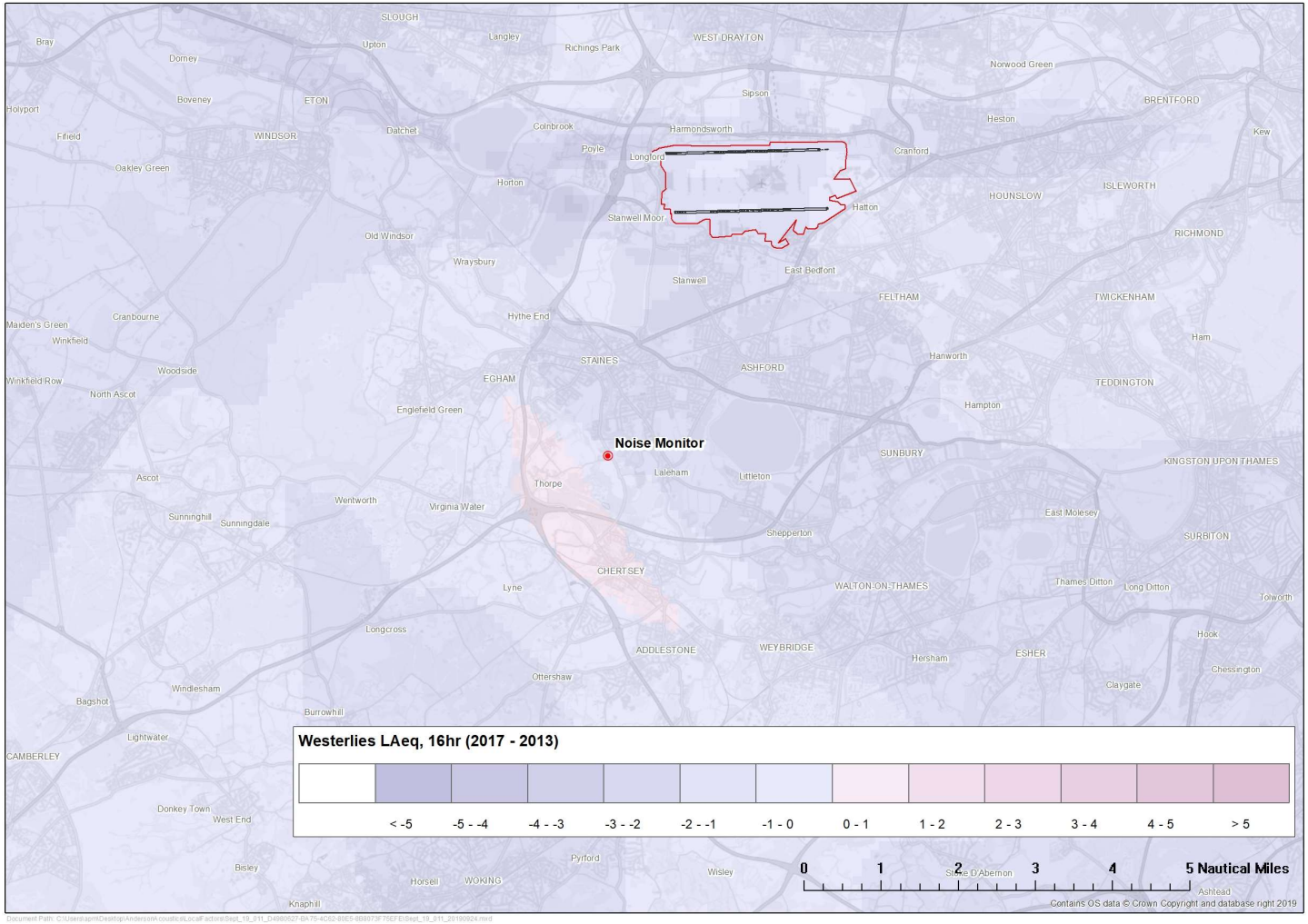
Appendix A: Average westerly night $N60_{8hr}$ contours (2013)



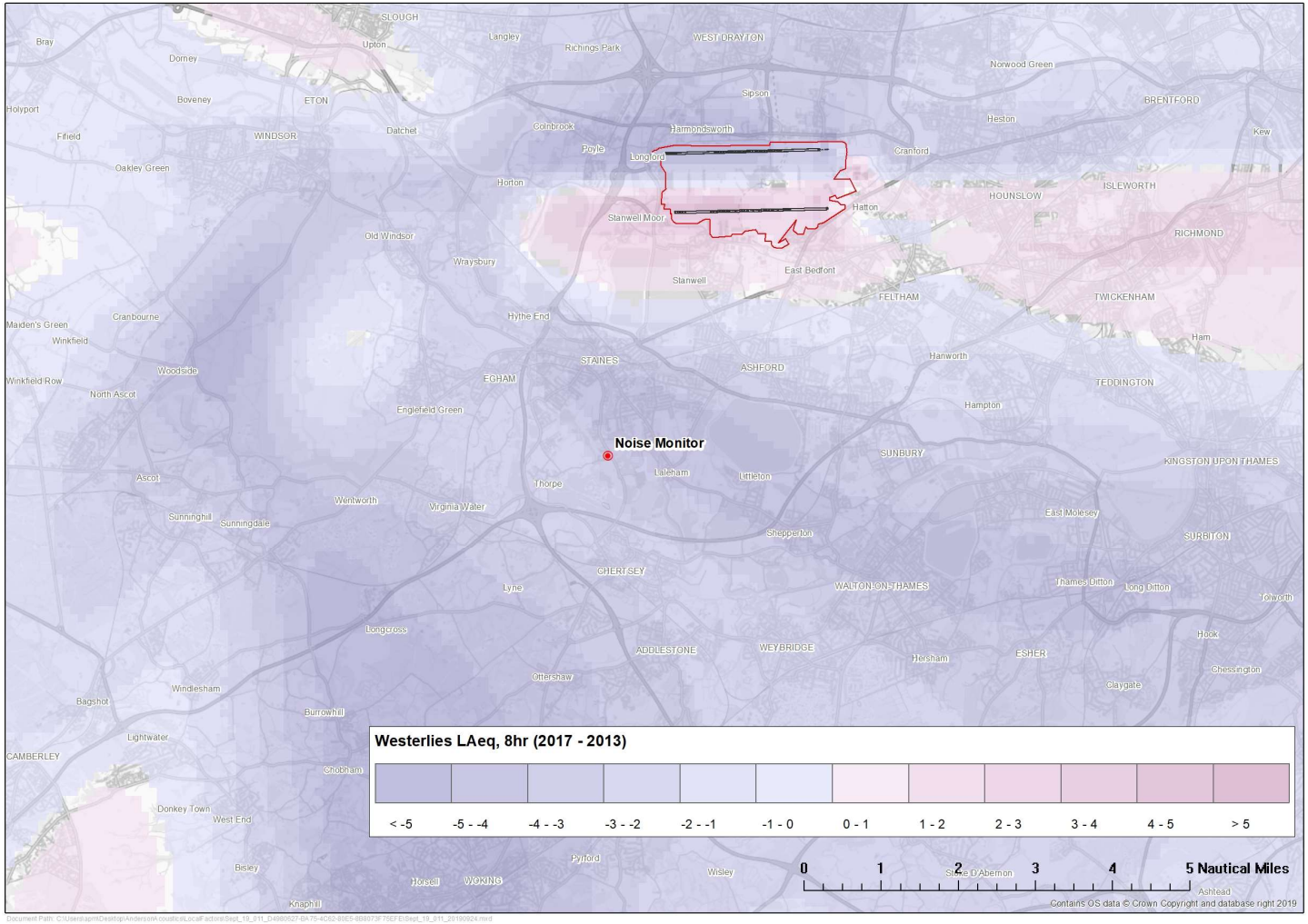
Appendix A: Average westerly night $N60_{8hr}$ contours (2017)



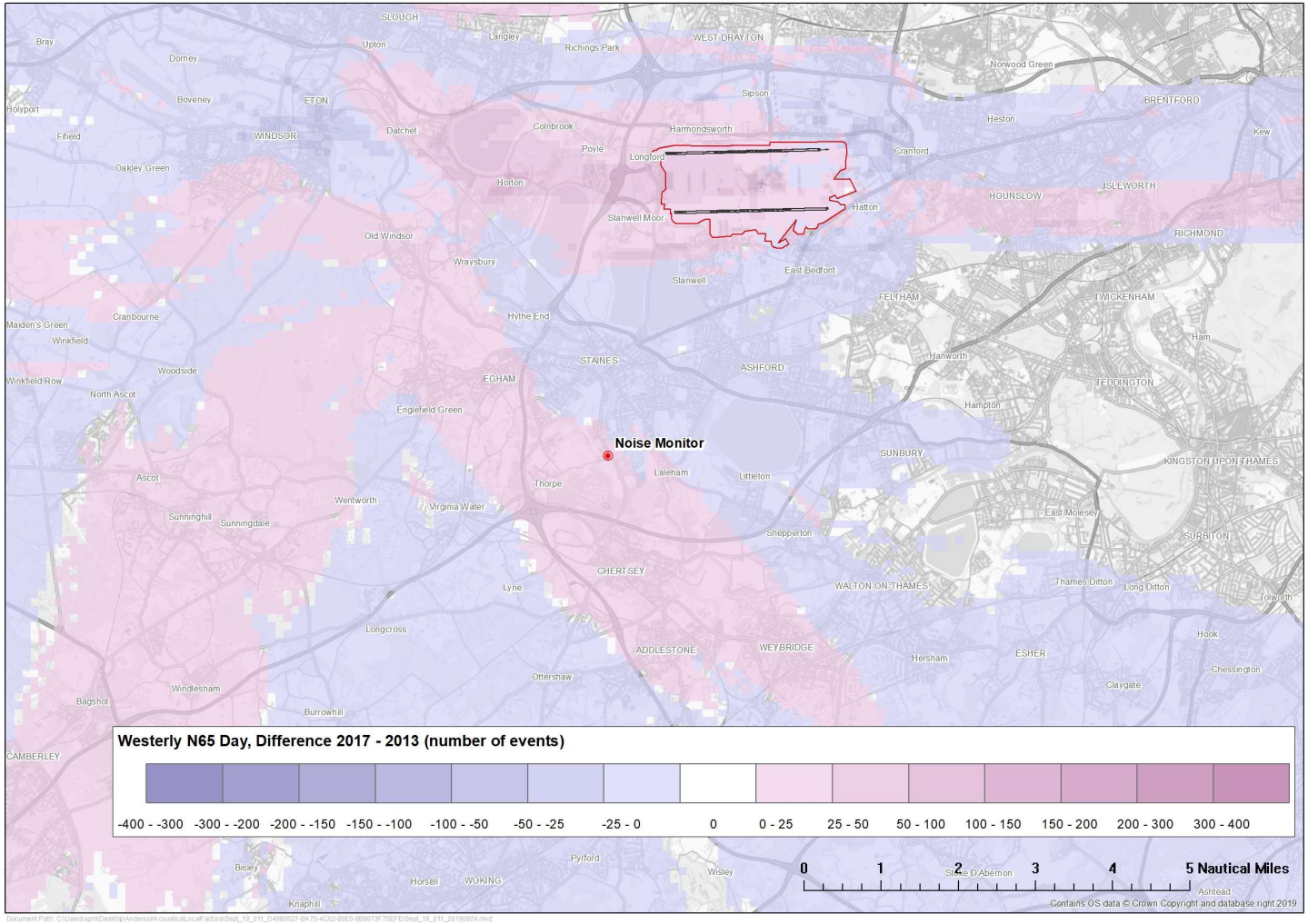
Appendix A: Average westerly day $L_{Aeq, 16hr}$ difference (2017 minus 2013)



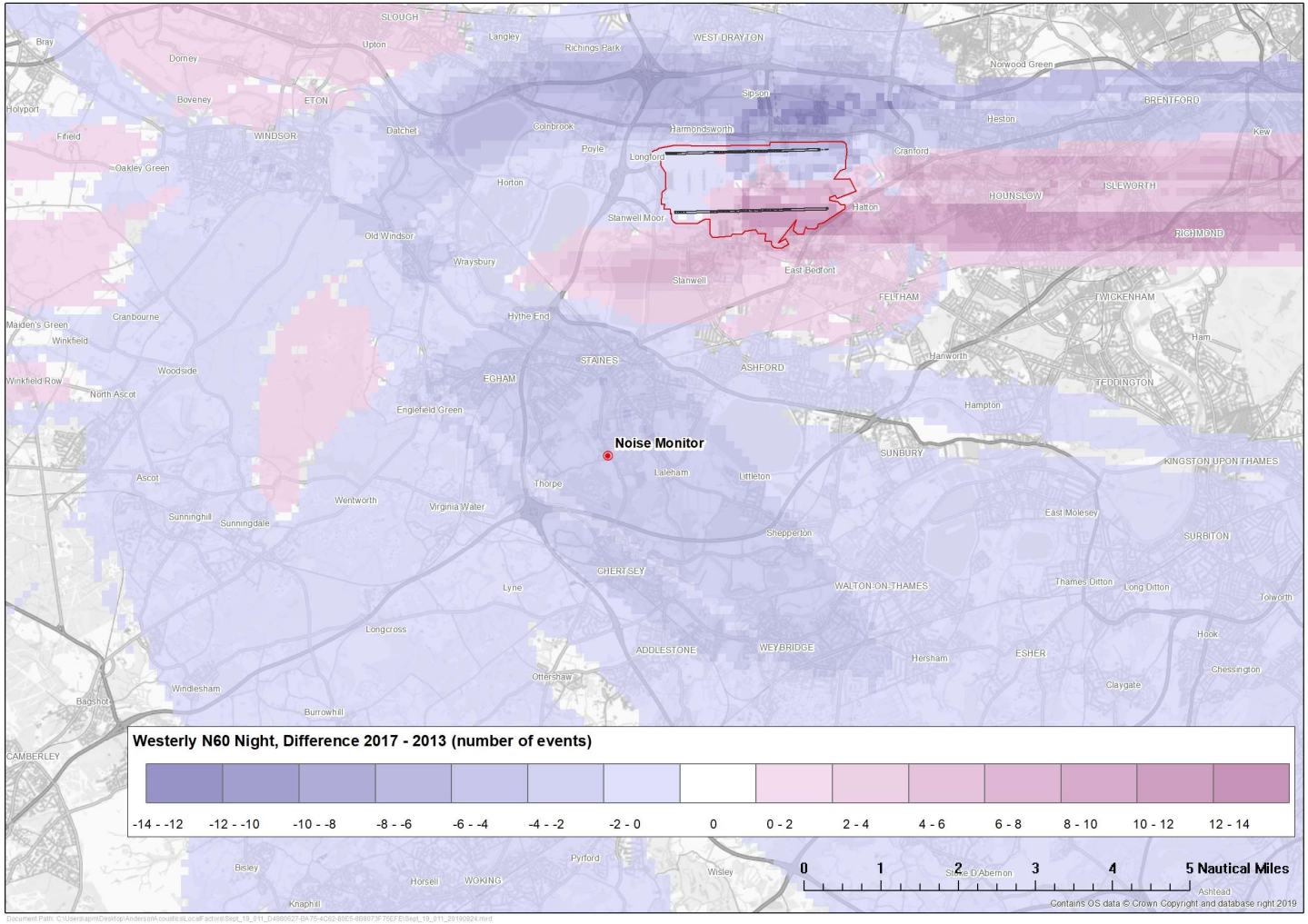
Appendix A: Average westerly night $L_{Aeq, 8hr}$ difference (2017 minus 2013)



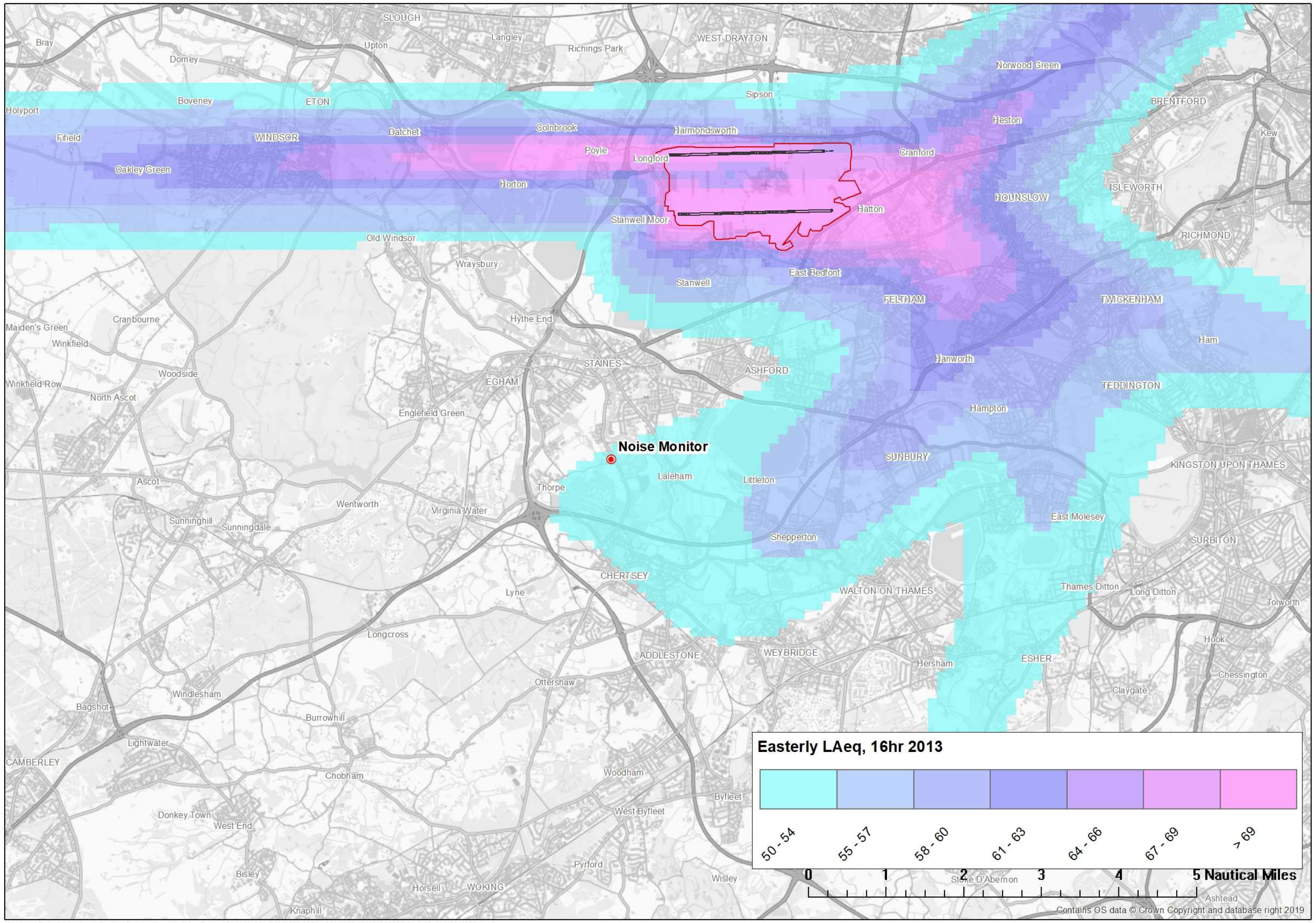
Appendix A: Average westerly day $N65_{16hr}$ difference (2017 minus 2013)



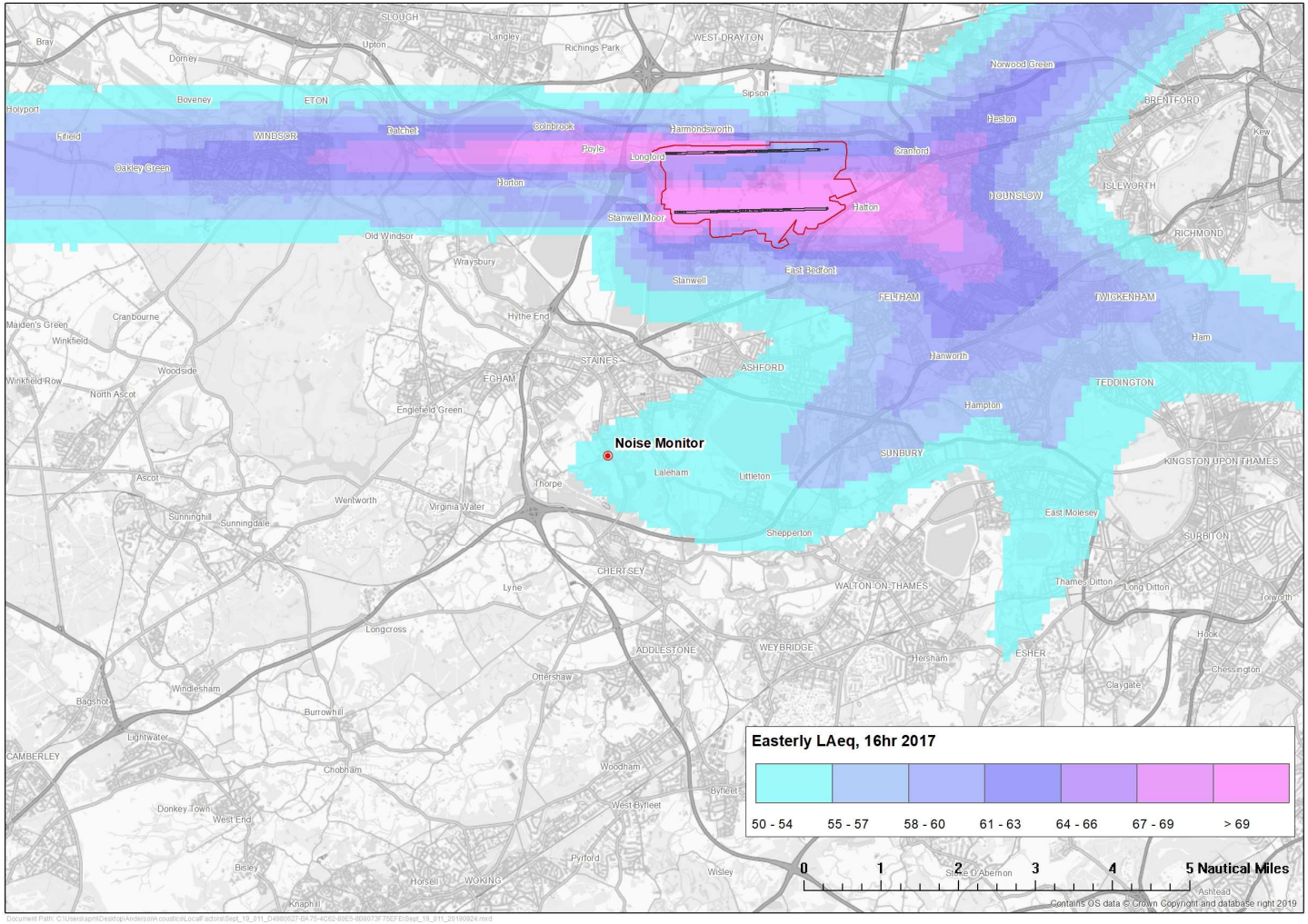
Appendix A: Average westerly night $N60_{8hr}$ difference (2017 minus 2013)



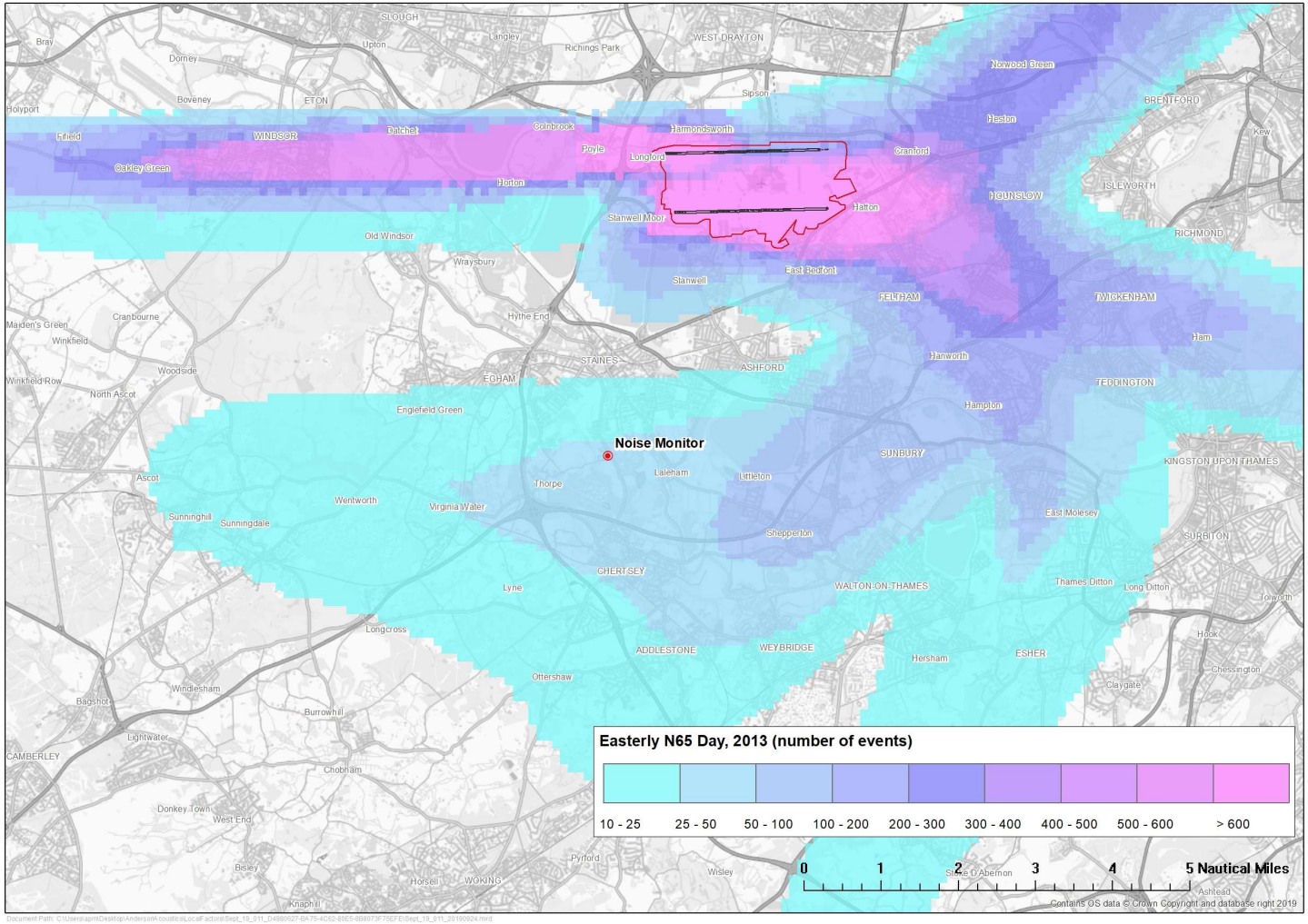
Appendix A: Average easterly day $L_{Aeq,\,16hr}$ contours (2013)



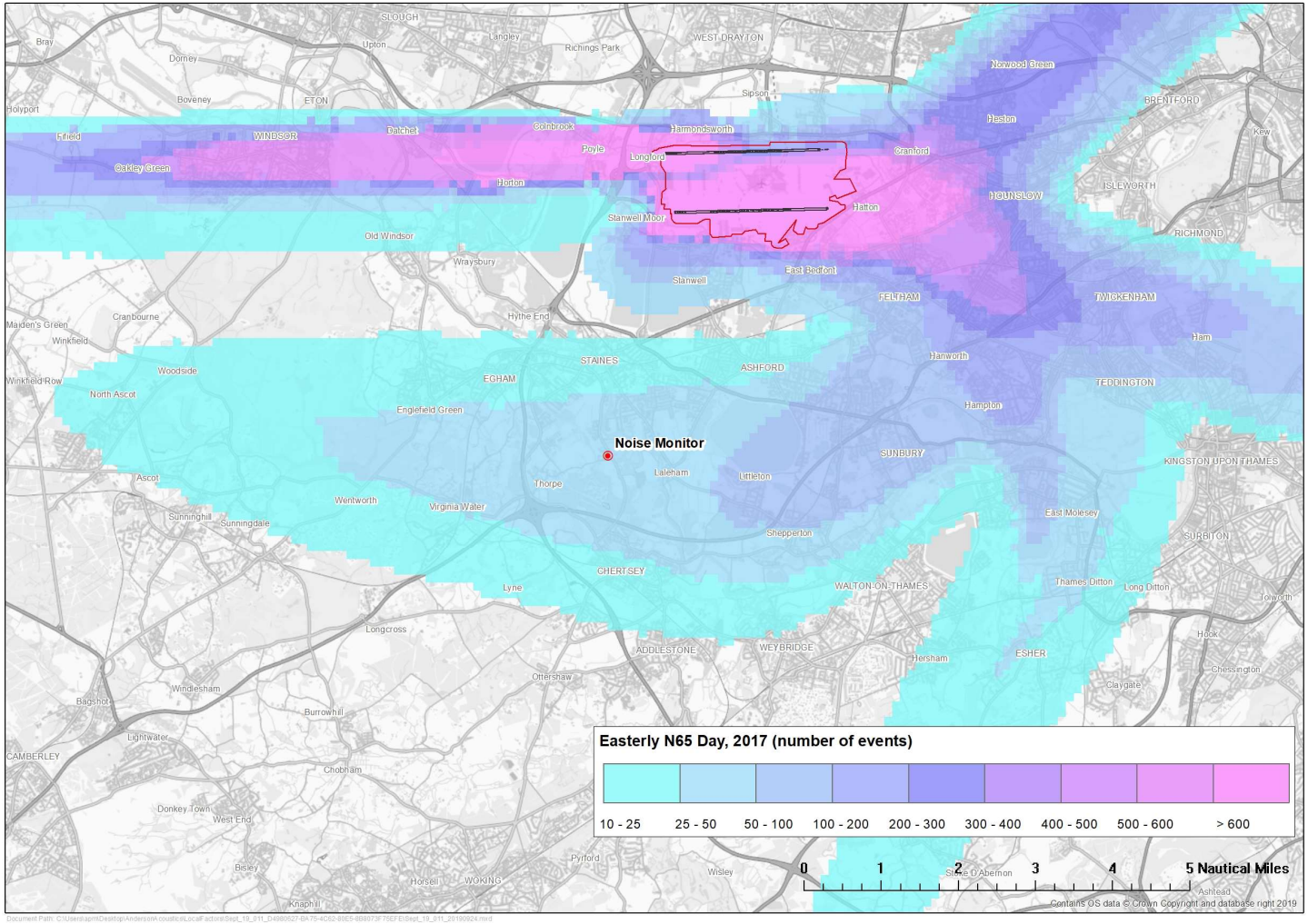
Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2017)



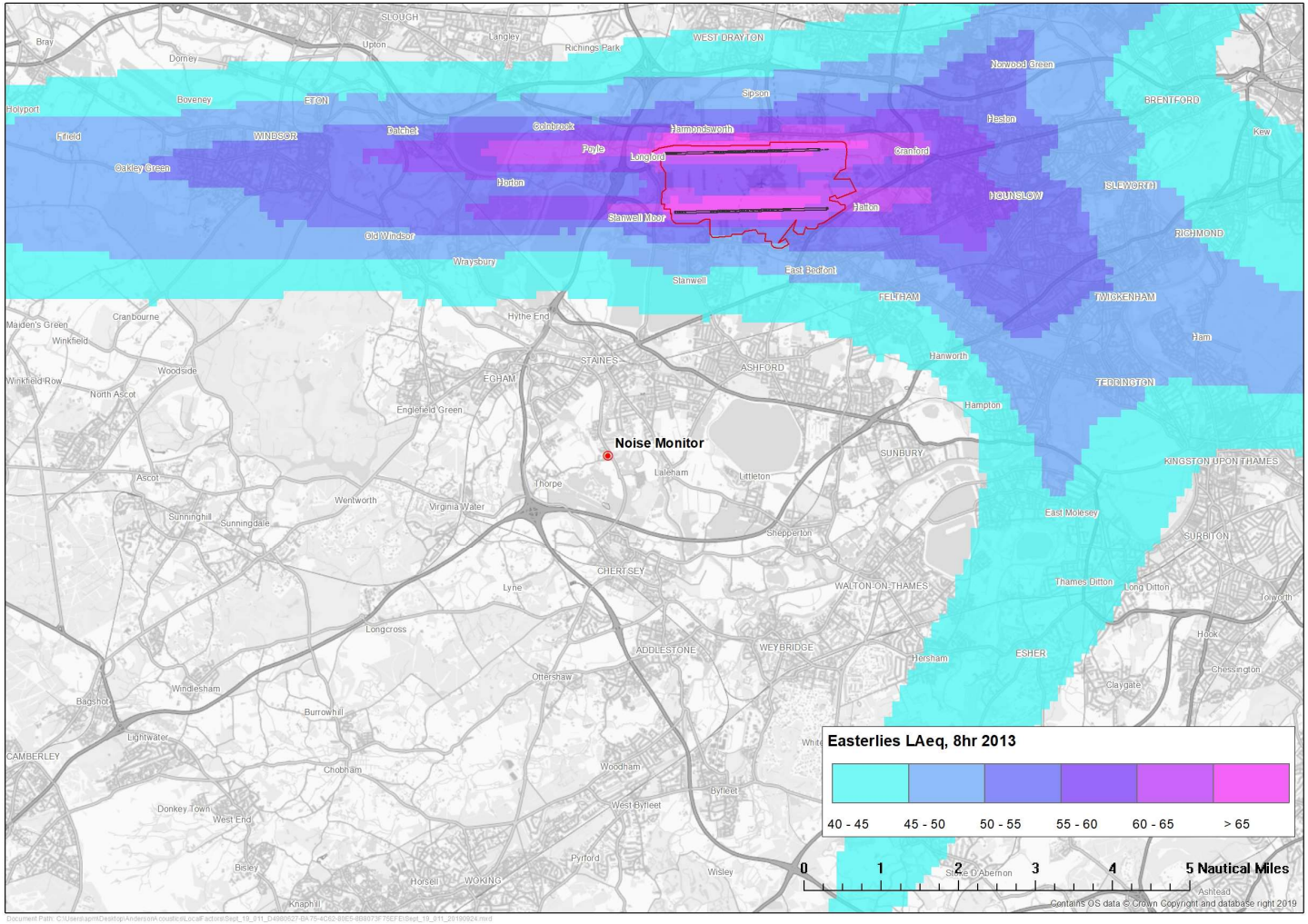
Appendix A: Average easterly day $N65_{16hr}$ contours (2013)



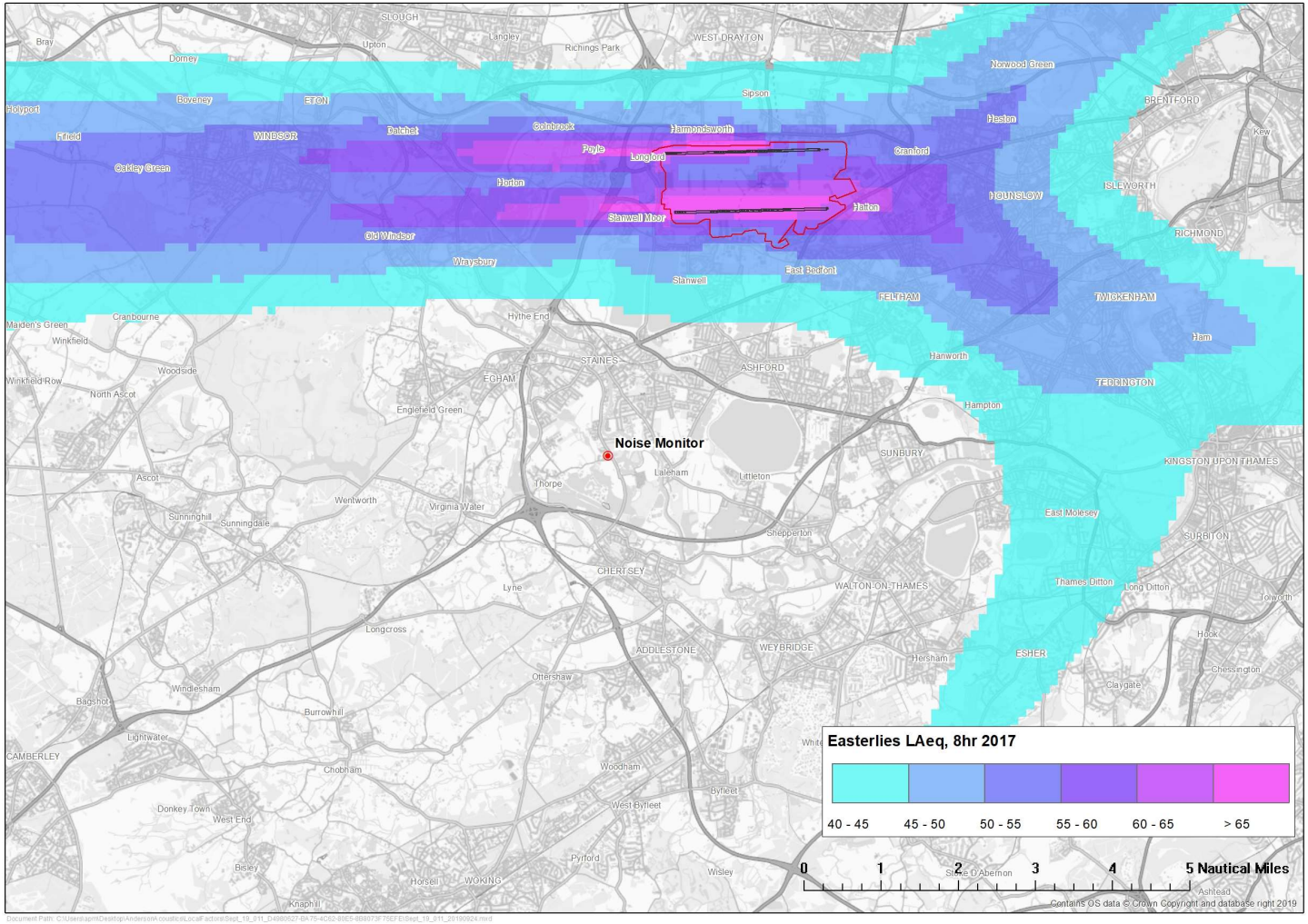
Appendix A: Average easterly day $N65_{16hr}$ contours (2017)



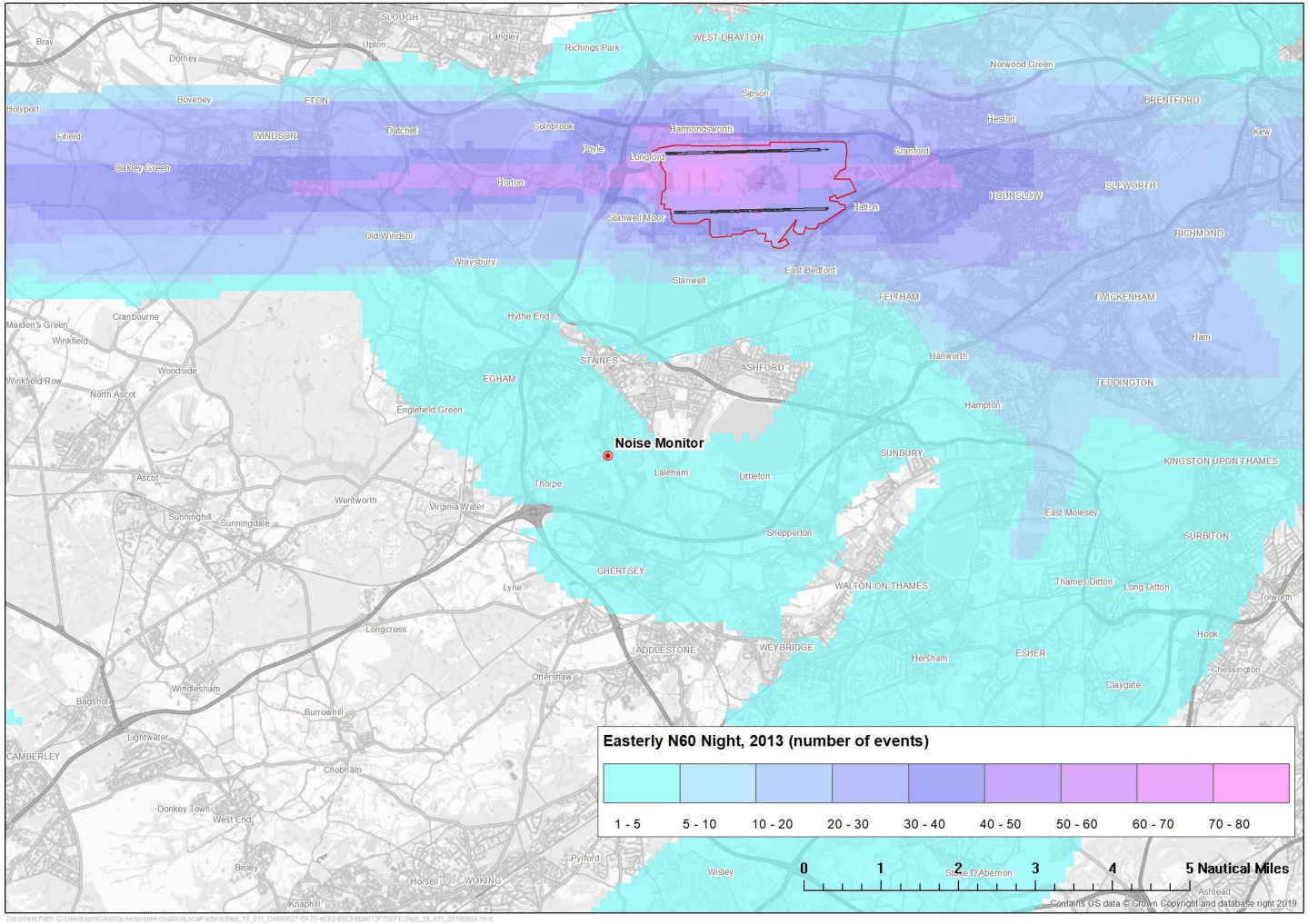
Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2013)



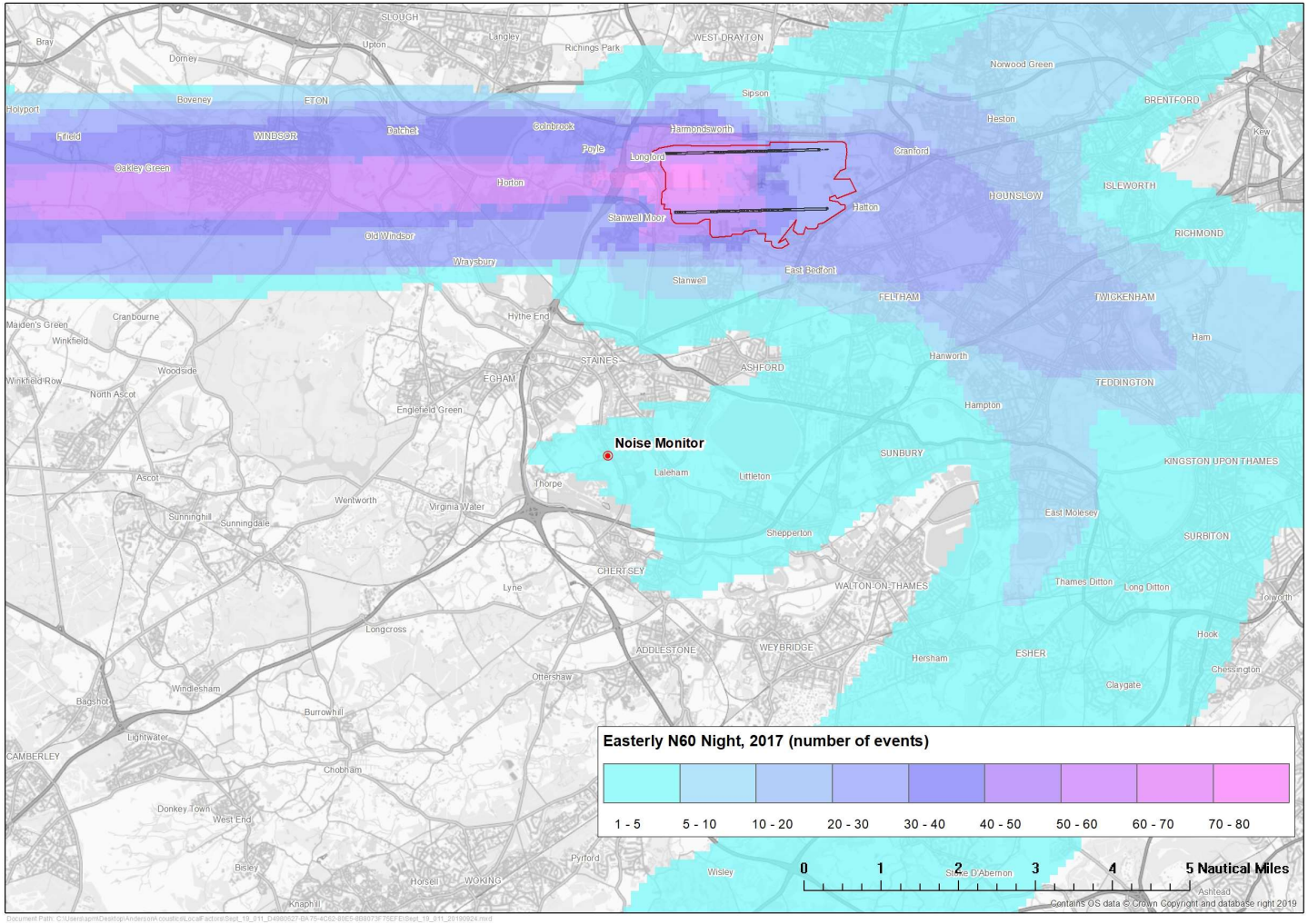
Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2017)



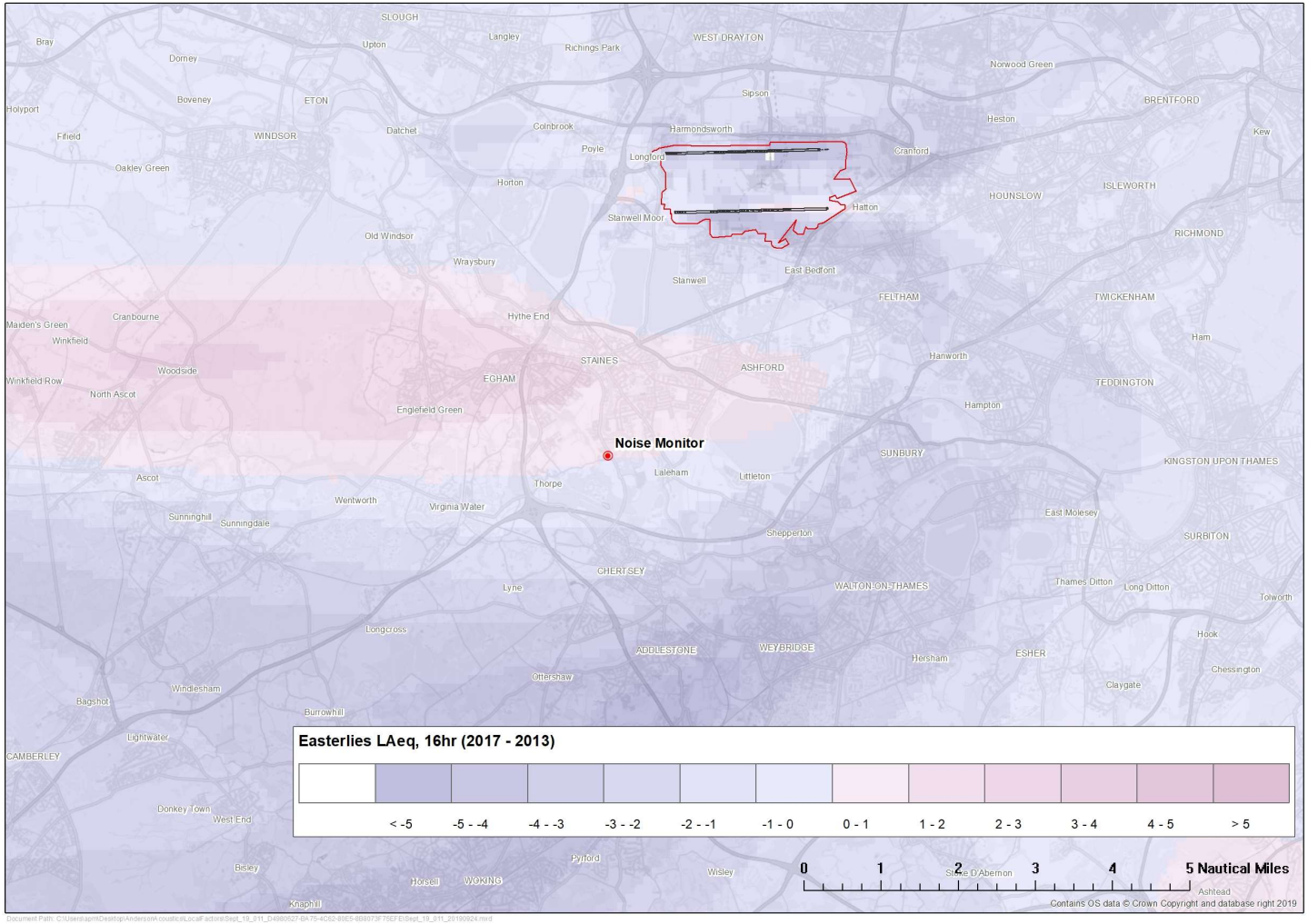
Appendix A: Average easterly night $N60_{8hr}$ contours (2013)



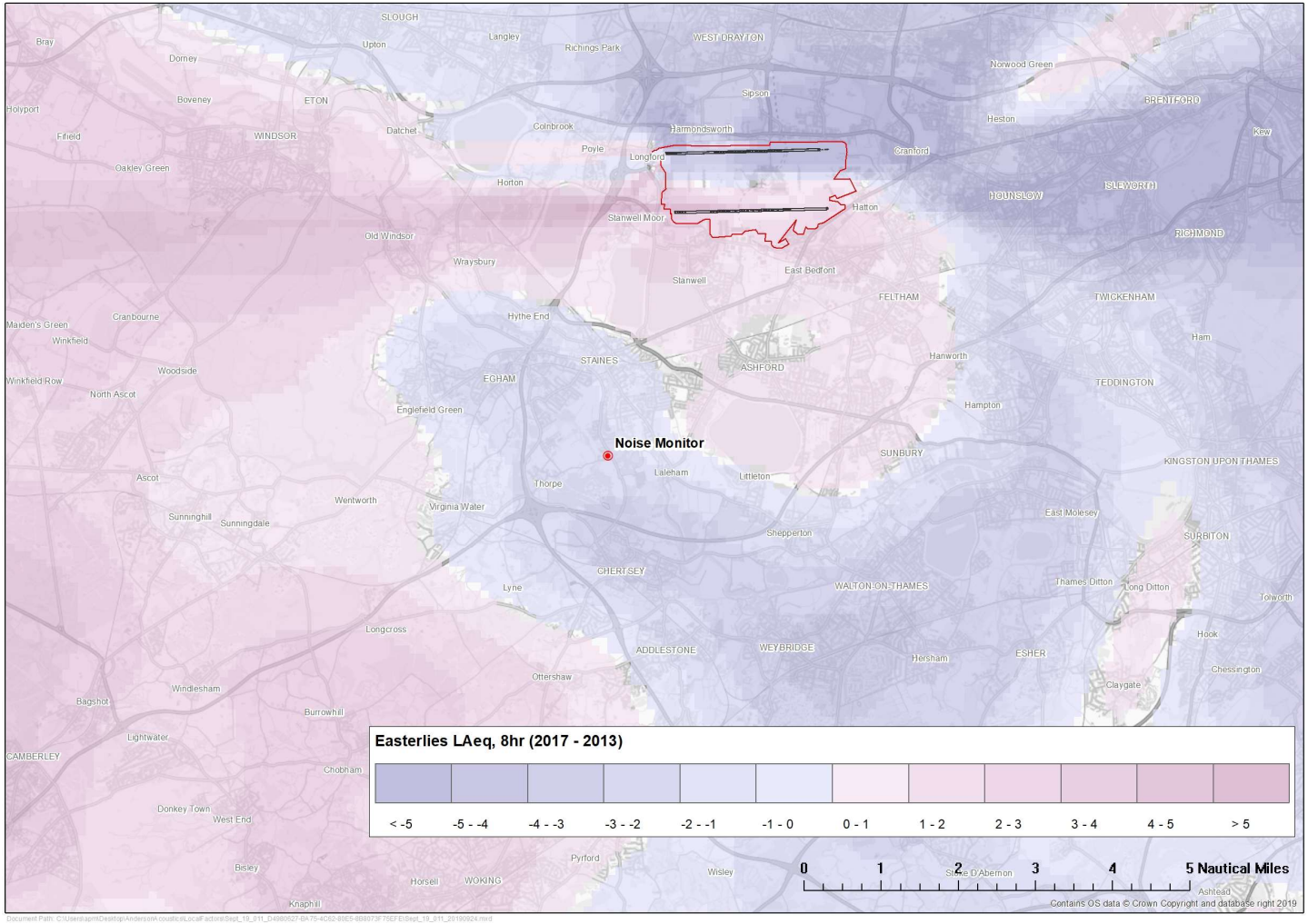
Appendix A: Average easterly night $N60_{8hr}$ contours (2017)



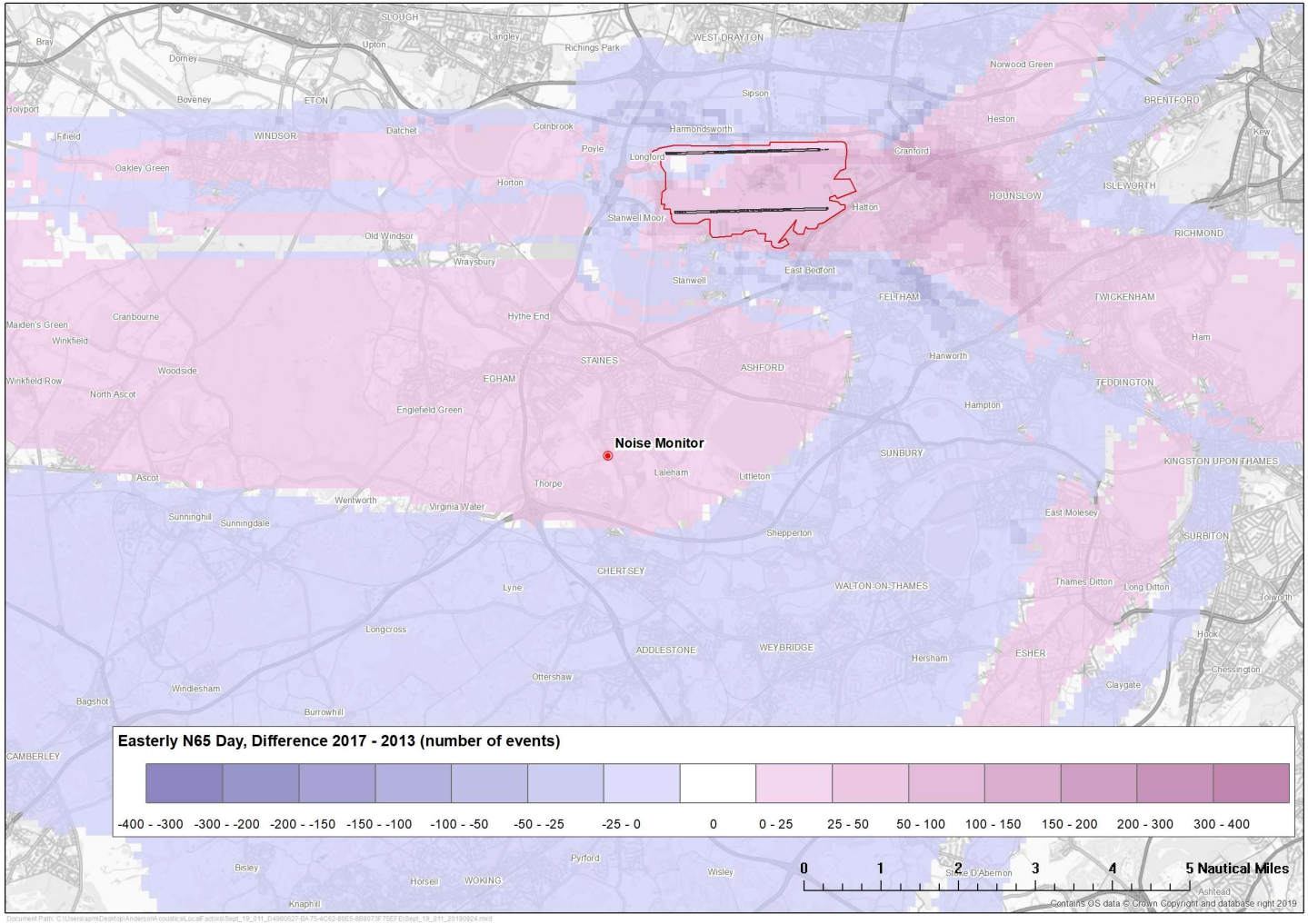
Appendix A: Average easterly day $L_{Aeq, 16hr}$ difference (2017 minus 2013)



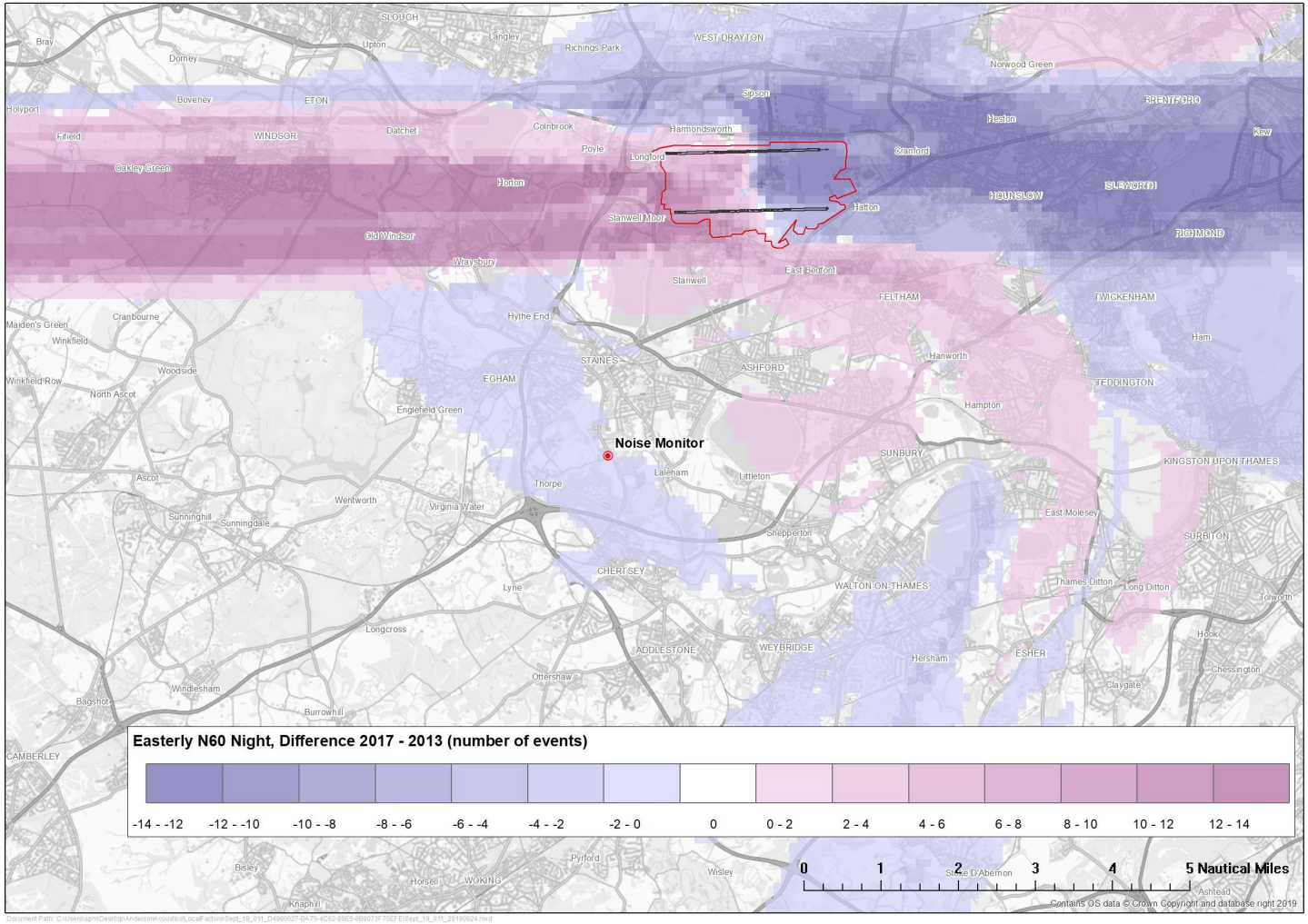
Appendix A: Average easterly night $L_{Aeq, 8hr}$ difference (2017 minus 2013)



Appendix A: Average easterly day $N65_{16hr}$ difference (2017 minus 2013)



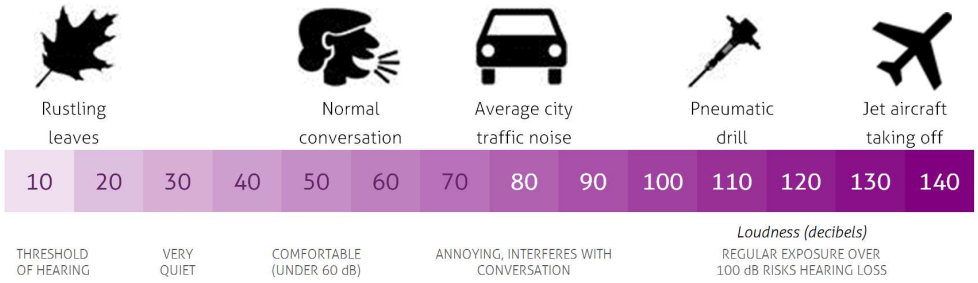
Appendix A: Average easterly night $N60_{8hr}$ difference (2017 minus 2013)



Appendix B: Noise Terminology

How is noise measured?

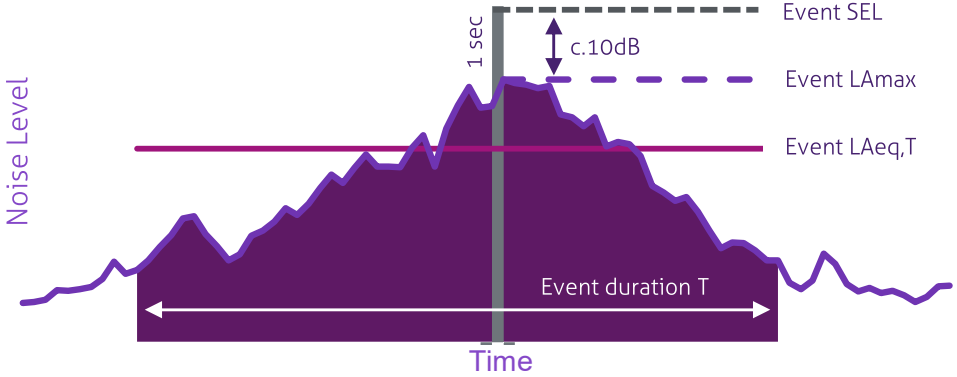
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Typical noise levels of everyday sounds are shown in the figure below.



The human ear is capable of detecting sound over a range of frequencies from around 20 Hz to 20 kHz, however its response varies depending on the frequency and is most sensitive to sounds in the mid frequency range of 1 kHz to 5 kHz. Instrumentation used to measure noise is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A weighting' and is represented as dB(A). All units in this report use this A-weighting.

How is aircraft noise measured?

As an aircraft passes over a location, noise levels slowly increase from ambient levels, reach a maximum and decrease back down to ambient levels. An example flyover is shown below.



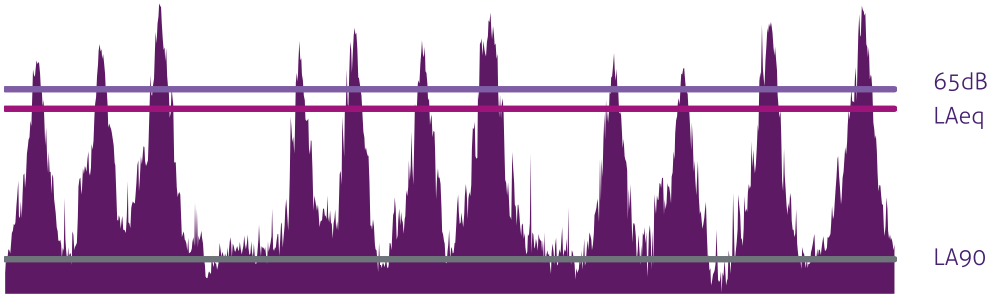
There are a number of metrics that can then be used to characterise a noise event all of which can be derived from modelling:

- The L_{Amax} is the highest sound pressure level during the event, it is an instant value, this is used typically with noise limits;
- The $L_{Aeq,t}$ is the continuous sound pressure level that would generate the same energy as that of the fluctuating noise level during the event of period T. It is in effect the average noise level over the time of the event;
- The SEL (sound exposure level or single event level), is the sound pressure that would arise for if all the energy of the event were to be delivered in 1 second.

Appendix B: Noise Terminology

How is long term noise exposure measured?

The L_{Amax} and SEL are useful at describing the noise level of individual events but how is aircraft noise exposure measured over time? The standard approach is based on long term averages such as the L_{Aeq} in the UK. The L_{Aeq} for a period of aircraft overflights is demonstrated in the figure below.



Although the L_{Aeq} plays a role in policy and planning assessment it does not adequately describe community experience. Supplementary noise metrics have been developed to better reflect community experience in simpler language. For example, the N65 describes the number of events which exceed 65dB which, in the above example, would be 11 over the period displayed.

The L_{A90} is a useful indicator of background noise in the absence of aircraft or other distinctive noise events. The L_{A90} is defined as the noise level which is exceeded for more 90% of monitored period and is demonstrated by the grey line in the figure above.

How does noise vary with distance?

As we move away from a sound source, the level we hear reduces since the sound energy is spread over a larger and larger area. If we assume a source emits sound equally in all directions, we can generate some rules regarding sound levels at different distances. For example, if the distance between a source and the receiver is doubled, the sound level will reduce by 6dB or if it is increase by a factor of 10 the level will reduce by 20dB.

Ratio of Distances	Level difference
1	0dB
1.25	2dB
1.5	3.5dB
2	6dB
5	14dB
10	20dB

Appendix B: Noise Terminology

How is noise level related to loudness?

Loudness is a subjective measure that describes the perceived strength of a sound. It is related to sound level but also related to other parameters such as frequency and duration. The table below provides an indication of the how the perceived loudness of a sound changes with an increase or decrease in sound level. For example, an increase of 10dB corresponds to a doubling of perceived loudness. It should be noted that the table below should only act as a guide to the relationship between level and perceived loudness – since loudness is a subjective measure, the same sound will not create the same loudness perception by all individuals

Level difference (dB)	Loudness Perception
+20dB	x 4
+10dB	x 2
+6dB	x 1.5
+3dB	x 1.2
±0dB	0
-3dB	÷ 1.2
-6dB	÷ 1.5
-10dB	÷ 2
-20dB	÷ 4

How does average noise level relate to number of events?

Average noise levels are determined by not only the level of individual aircraft events but also the frequency of which they occur. Due to the logarithmic nature in which noise is measured, a doubling of noise energy relates to a 3dB increase in average noise level. Therefore, if the number of events is doubled over a given time period (assuming the levels of the events are the same), the $L_{Aeq, T}$ will increase by 3dB. Further factors are shown in the table below.

Number of Events	Noise level difference
x4	+6dB
x2	+3dB
0	0
÷2	-3dB
÷4	-6dB