Community Noise Information Report - Draft
Englefield Green - Air Force Memorial

18th September 2017 – 31st May 2018

Introduction

At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor at the Air Force Memorial site in Englefield Green between 18th September 2017 and the 31st May 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 Englefield Green 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. For a fair comparison, a subset of this data has been analysed in this report, removing the period coinciding with the Operational Freedoms Trial in 2012/13.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise event 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 This software has recently been superseded by AEDT.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 Heathrow Community Noise Forum (HCNF) for additional analysis.

Key Findings

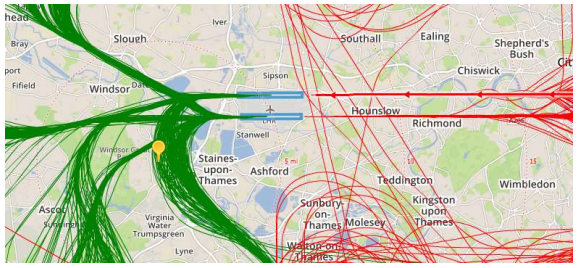
Operations and the community
The noise monitor in Englefield Green is predominantly overflown by westerly departures. It is located between the centre line of the MID departure route from the southern runway and the western edge of the DET route when aircraft depart from the northern runway. A number of aircraft departing to the east of the airport on the CPT route will pass over the monitor at a higher altitude.
The proportion of aircraft flying the westerly MID and DET and easterly CPT routes have not changed much over the last five years.
This report analysed movements through three 'gates' in space, each designed to monitor changes to the westerly DET, westerly MID and easterly CPT routes. It was found that the number of average daily movements through the gates on full westerly/easterly days had increased by 2%, 7% and 5% respectively.
Although the degree of concentration of each of the analysed routes has remained almost constant, the position of each one has moved closer to the noise monitor.
Through each of the gates, the average height of aircraft has reduced (2-4%) . The proportion of aircraft flying at the lowest altitudes has increased through both westerly gates.
There have been changes to the aircraft types operating at Heathrow over the last five years. The specific changes through each gate are detailed in this report.

Noise levels in the community based on measurement at Englefield Green monitor	Difference in community noise levels between 2013 and 2017 based on noise modelling
The noise environment at Englefield Green is dominated by aircraft whilst the airport is on westerly operations. Over 95% of aircraft noise events are recorded from aircraft on the westerly DET and MID routes.	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.
Over the course of the day, hourly ambient noise levels (from aircraft and other noise sources) are 4-10dB greater whilst on westerly compared to easterly operations. Hourly average noise levels are greatest between 21:00 and 23:00 during westerly operations.	The average level and number of events exceeding 60dB during night on westerly operations both decreased in 2017 compared to 2013.
On average, the number of noise events exceeding 65dB in the hours 07:00-23:00 on westerly operations (N65) was 150 while the number of noise events exceeding 60dB in the hours 23:00-07:00 (N60) was less than 5.	On easterly operations, the average daytime noise levels increased by up to 2dB in 2017 compared to 2013 however the $L_{Aeq,16hr}$ remains below 50dB.
The B747 generates the loudest noise events at the noise monitor followed by the A380. The A320 family (A319, A320 and A321) generate the quietest noise events.	The average level and number of events exceeding 60dB during night on easterly operations both decreased in 2017 compared to 2013.
The A320 is responsible for almost a third of aircraft noise events at Englefield Green followed by the B777 and A319. The largest aircraft, the A380 and the B747 are responsible for 9% and 5% of noise events respectively.	

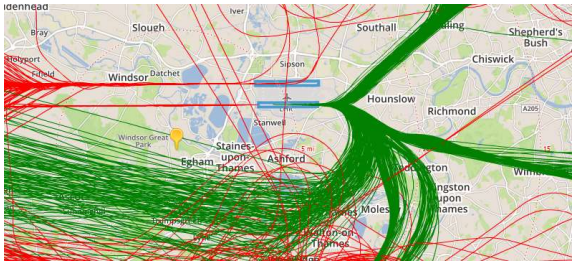
Understanding how wind direction affects aircraft operations.

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.



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



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

The proportion of easterly/westerly operations

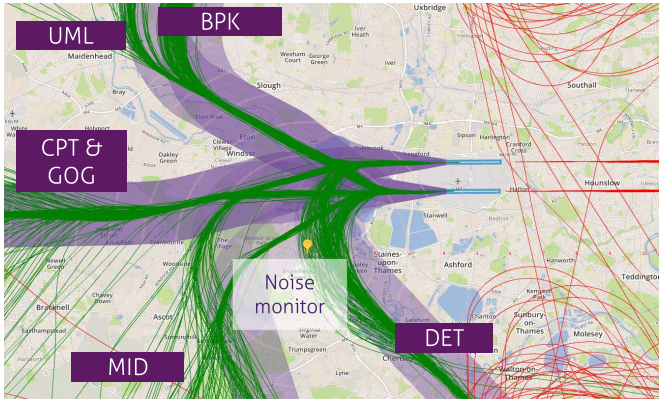
- Around Heathrow, the prevailing wind direction is from the west.
- Heathrow also operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5kts or more. This was implemented to protect more densely populated areas to the east of the airport.
- As a result, the airport is typically on westerly operations for about 70-75% of the year. During 2017, the proportion of westerly operations is uncharacteristically high at 81%.
- The figure below presents the **annual** proportion of easterly and westerly operations for the last 7 full years.
- The proportion of easterly and westerly operations **during the monitoring period** was 45% and 55% respectively. It should be noted this is different to the annual proportion for 2018.

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

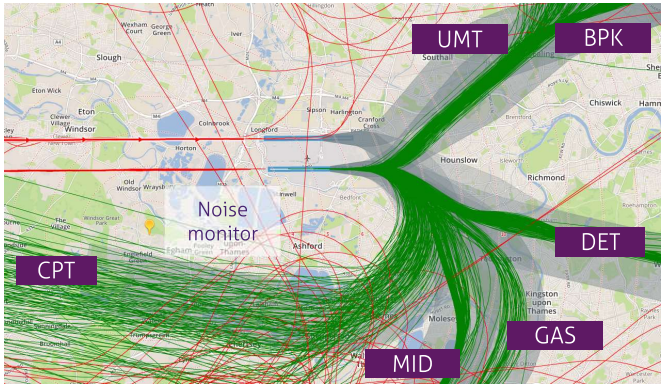
Understanding where aircraft fly near to Englefield Green.

- 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.
- Englefield Green is predominantly overflown by westerly departures. It is located between the centre line of the MID departure route (at which point aircraft are, on average, at an altitude of 3,000ft) from the southern runway and the western edge of the DET route (3,500ft) from the northern runway.
- 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)

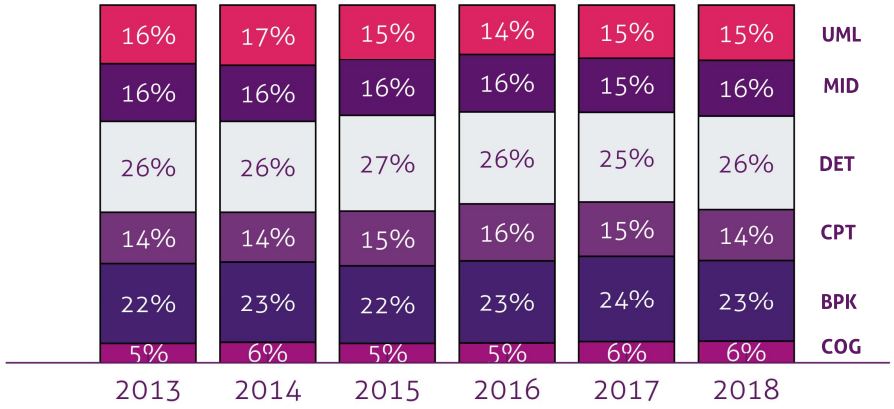


UML and UMT are the revised names for the westerly and easterly BUZ routes respectively.

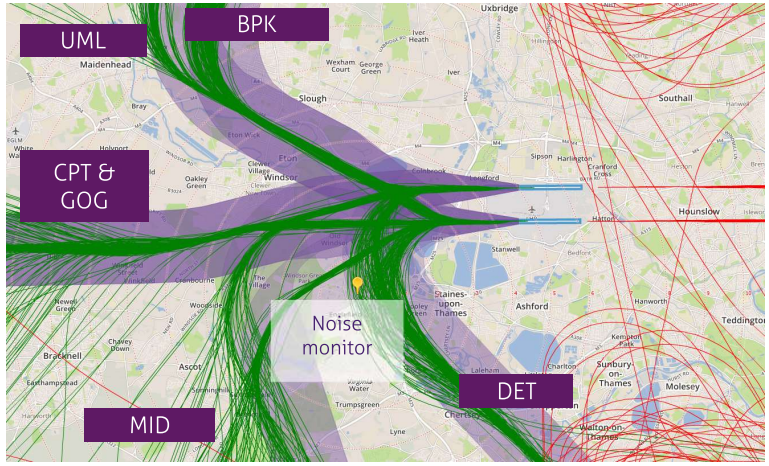
Understanding where aircraft fly on westerly operations.

- The figure below shows the proportions of **annual** route usage on westerly operations for each year from 2013-2017.
- In 2017, 15% of westerly departures followed the MID route and 25% the DET route, the routes most pertinent to Englefield Green.
- 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.
- The route usage during the monitoring period for the relevant westerly routes is shown on Page 13.

Annual departure route use during westerly operations



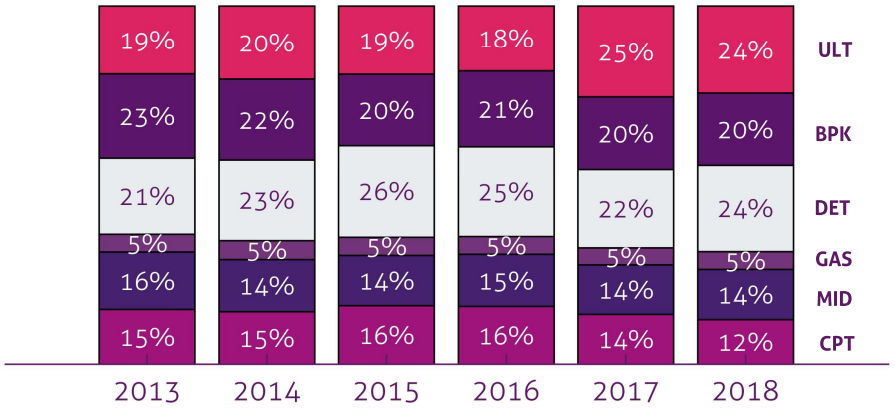
Arrival and departure tracks on westerly operations (NPRs shaded in purple)



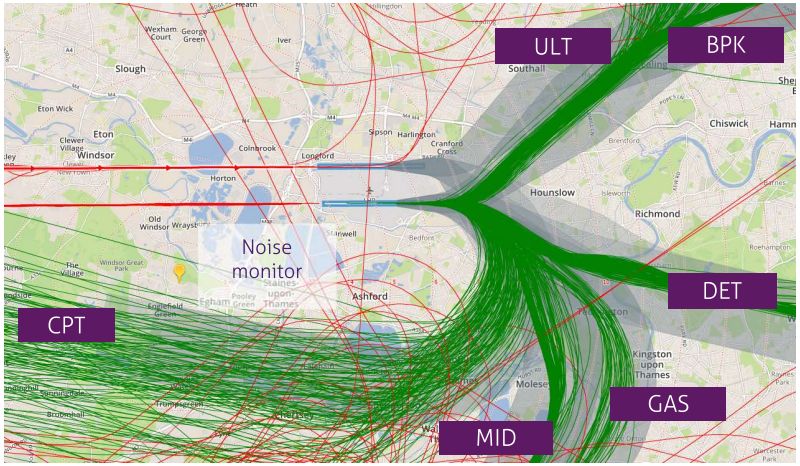
Understanding where aircraft fly on easterly operations.

- The figure below shows the proportions of **annual** route usage on easterly operations for each year from 2013-2017.
- In 2017, 15% of easterly departures followed the CPT route, the route most pertinent to Englefield Green.
- 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)



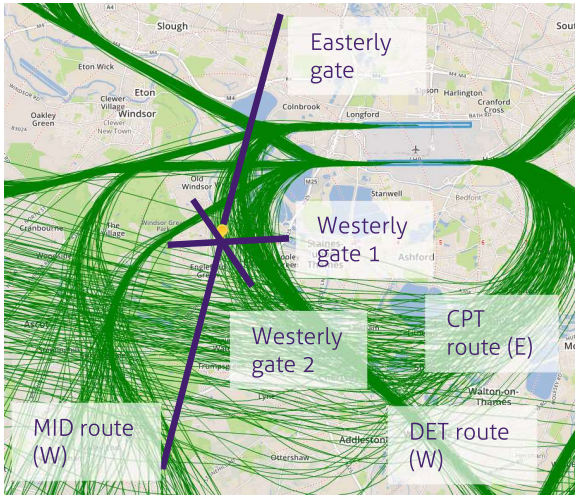
Understanding operational and gate data.

Operational data.

- The following operational data were provided for the period 1st March 2018– 31st May 2018 and the same period for the four 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.

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.
- Three 'gates' were drawn over Englefield Green centred on the temporary noise monitor; two to capture movements while the airport is on westerly operations (westerly gates 1 & 2) and one for easterly operations (easterly gate).



- The westerly gate 1 (WG1) is approximately perpendicular to the westerly DET route and westerly gate 2 (WG2) is approximately perpendicular to the westerly MID route off the southern runway. Both are 5km wide and centered on the noise monitor at the Air Force Memorial. The easterly gate (EG) is 17km wide and perpendicular to the easterly CPT route. All three 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

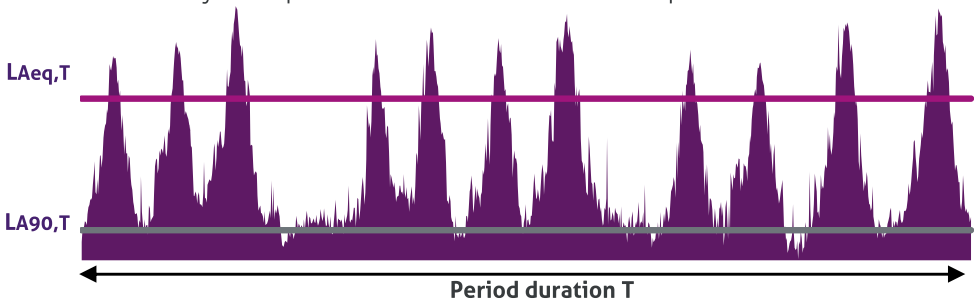
Understanding measured noise data.

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 1st March 2018– 31st May 2018. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

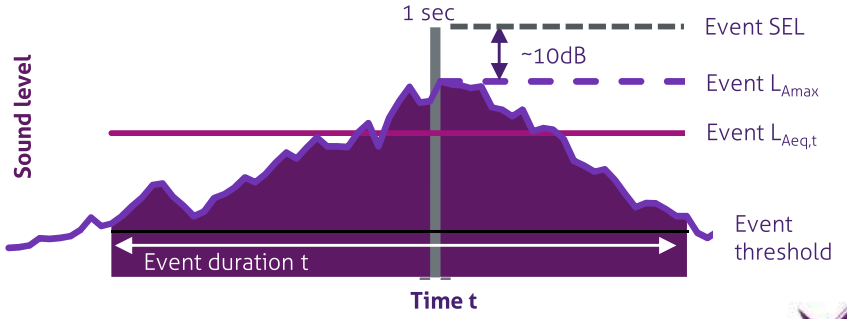
Ambient and background noise levels:

- 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 i.e. 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.

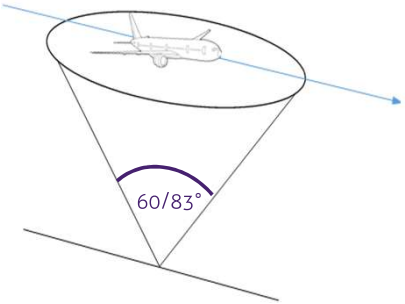


Analysing noise levels from aircraft in this area.

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

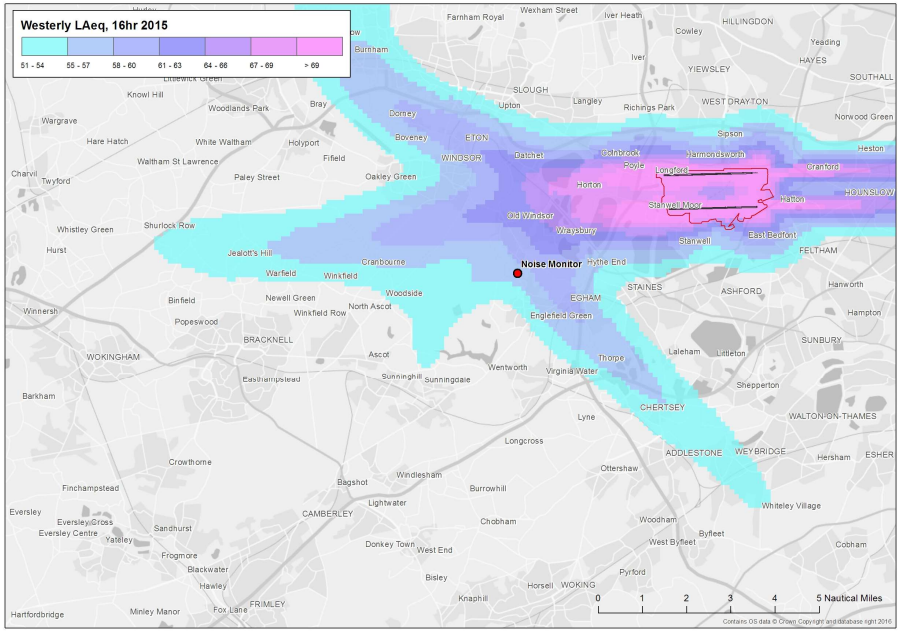


- This community information report will, where applicable, present results for overhead flights determined by CAA guidance as well as all registered aircraft noise events.

Noise Modelling

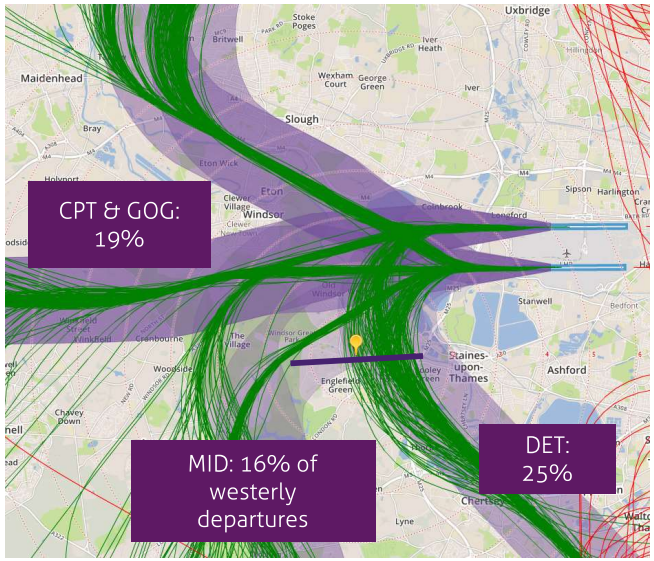
- Aircraft noise modelling has been used to provide an understanding of differences in the noise environment between 2013 and 2017 over the wider geographic area.
- Differences in daytime and night time levels for an **average day and night of westerly and easterly operations** across the summer of 2013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

Example contours generated by aircraft noise modelling



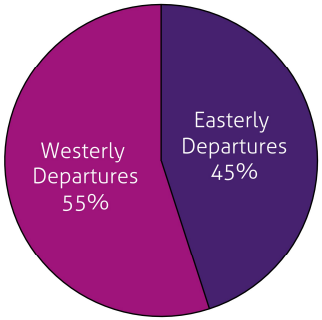
Overview of flight track data – Westerly Gate 1

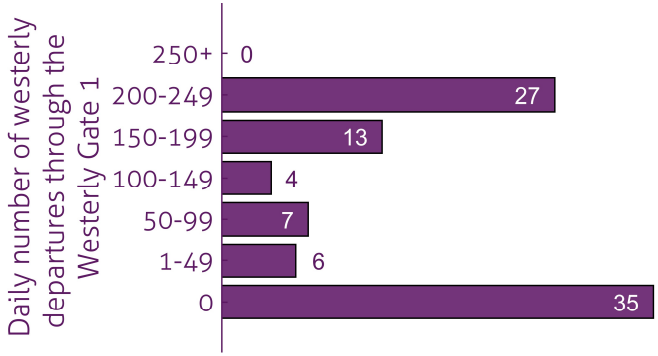
1st March 2018 - 31st May 2018 (dates to avoid Operational Freedoms Trials)



Example day of departing aircraft tracks in the vicinity of Englefield Green during westerly operations & westerly gate 1 (width 5km)

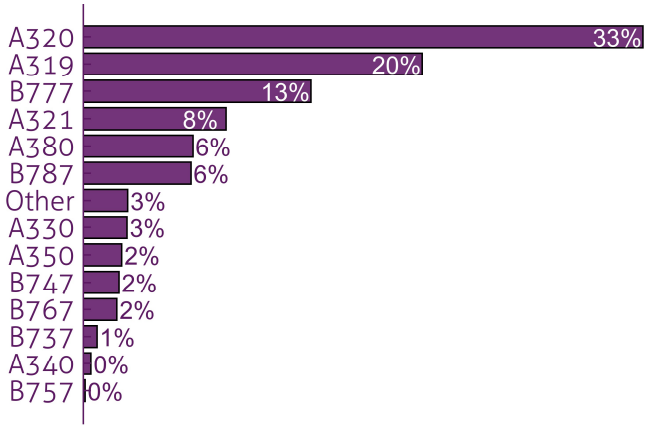
Total 60,293 departures from Heathrow



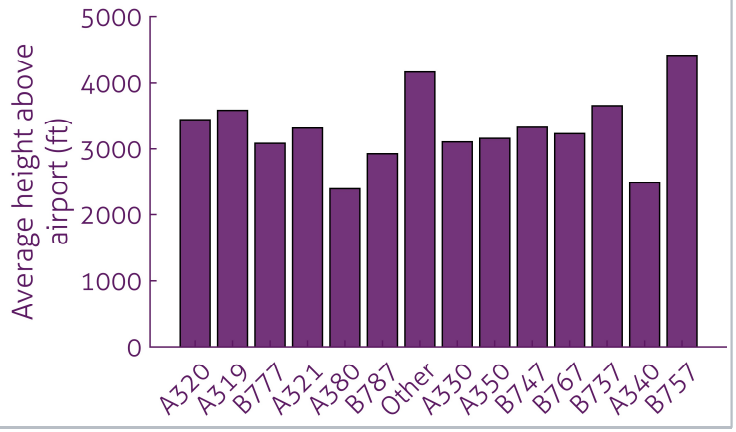


Number of westerly departures per day passing through the westerly gate (92 days in total)

Proportion of departing aircraft types passing through the westerly gate

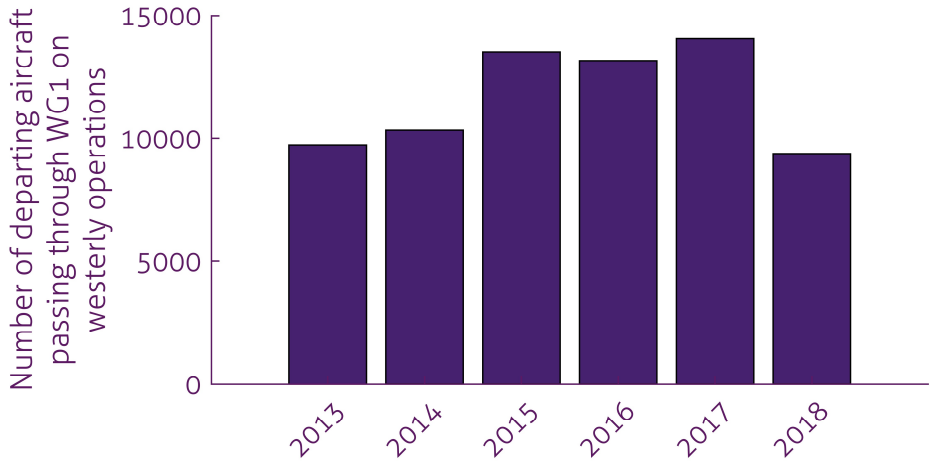


Average height of departing aircraft as they pass through the westerly gate



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

- The figure to the right shows the total number of westerly departures that passed WG1 in the period from 1st March to 31st May in the years from 2013 to 2018 (note that this period used in this section of the report is shorter than the duration the noise monitor was deployed for, this is to avoid comparing the movements in 2018 to a period in 2012/13 when the Operation Freedoms trials were taking place).
- During each period, between around 10,000 and 15,000 departures penetrated the WG1, the majority of which were are following 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 52%, in 2018 45%; these figures are lower than the long term average.
- On a full day of westerly operations;
  - There was a less than 1% increase in departures through WG1 on the DET route in the 2018 period compared to 2013.
  - However number of departures passing through 60° overhead cone increased from 15 to 21; a 40% increase.



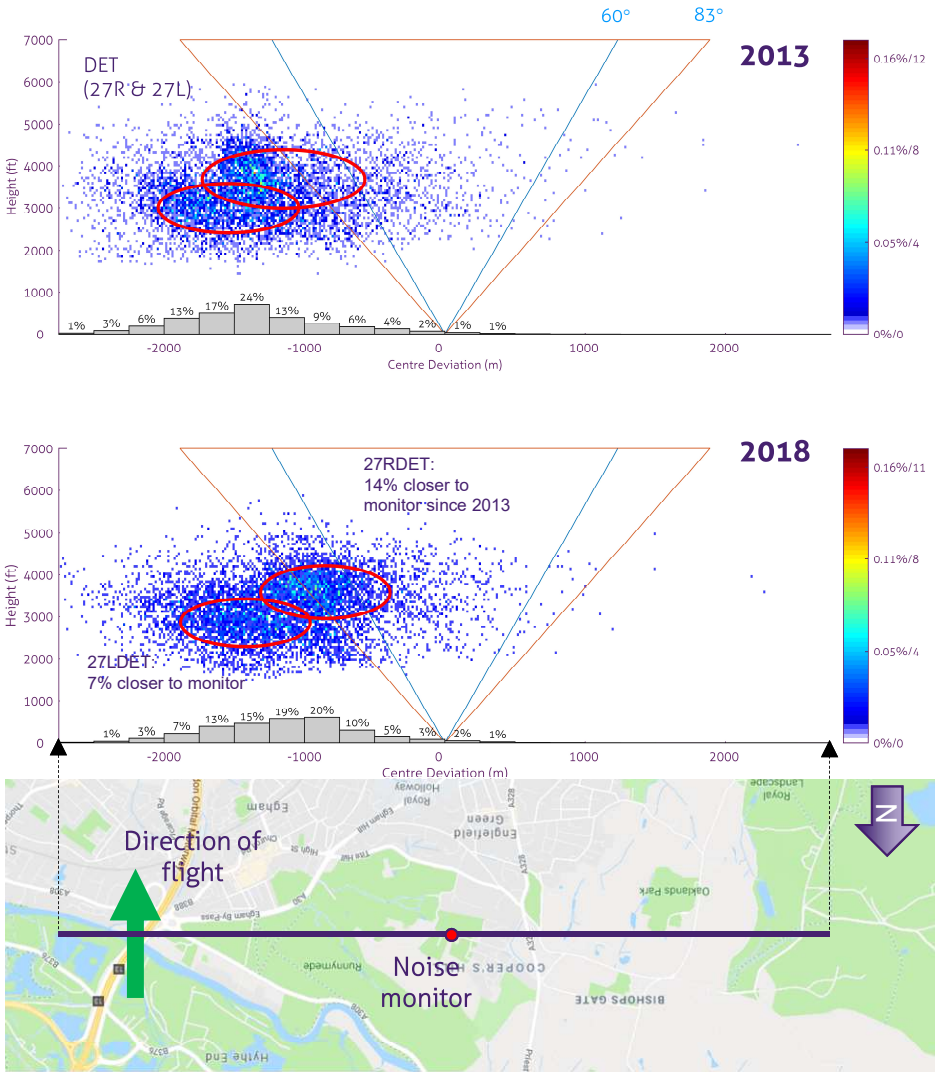
	2013	2018	Change	Change (%)
Proportion of westerly operations (all Heathrow flights)	52%	45%	-7%	N/A
Average number of westerly departures passing through Westerly Gate 1 on the DET route during days of 100% westerly operations (overhead flights in parentheses).	159 (15/31)	160 (21/57)*	+1 (+40%/+84%)*	+<1% (~/~)*

* Figures in parentheses indicate the number of flights passing through the 60 and 83° overhead cone respectively.

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 31st May 2018. Similarly, 2013 specifically refers to the period from 1st March to 31st May 2013.

Is the concentration of aircraft on the westerly DET route different between 2013 and 2018?

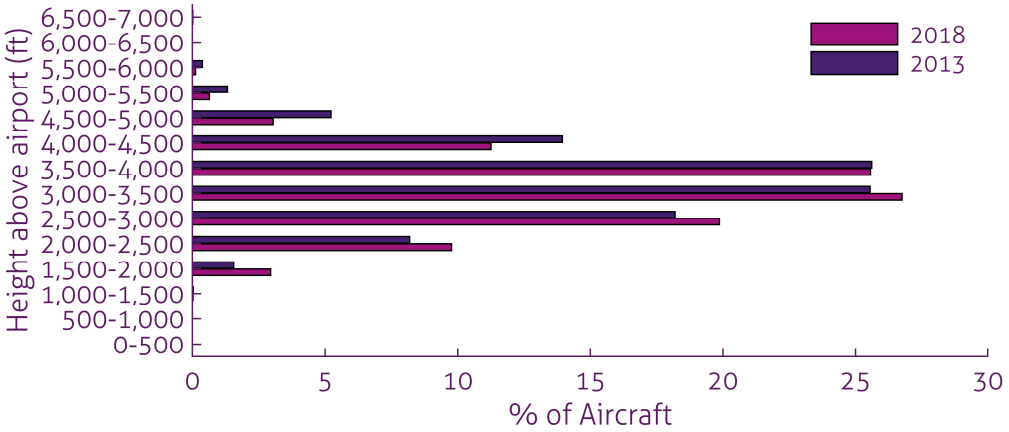
- The figures to the right are heat maps showing the 2D concentrations of departing aircraft as they pass through WG1 during the 2013 (the upper figure) and 2018 (the lower figure) period (1st March – 31st May) in addition to the concentration at different distances from the centre along the length of 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 0.16% 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 0.28%, in 2018 this figure was 11).
- The gate has been designed to be perpendicular to the DET route. The gate also includes some aircraft on the MID route however these aircraft have been omitted from this plot to give a clear indication of how the position and concentration of flights of the DET route have changed. For information on the MID route please see the section for WG2.
- The figures indicate that DET routes are no more concentrated in the 2018 period compared to 2013, however the position of the swath has moved towards the noise monitor.
- The position of the main concentration of the DET route from the northern runway (27RDET) has moved about 14% (~220m) closer to the noise monitor while the route from the southern runway (27LDET) is 7% (~120m) closer to the monitor.

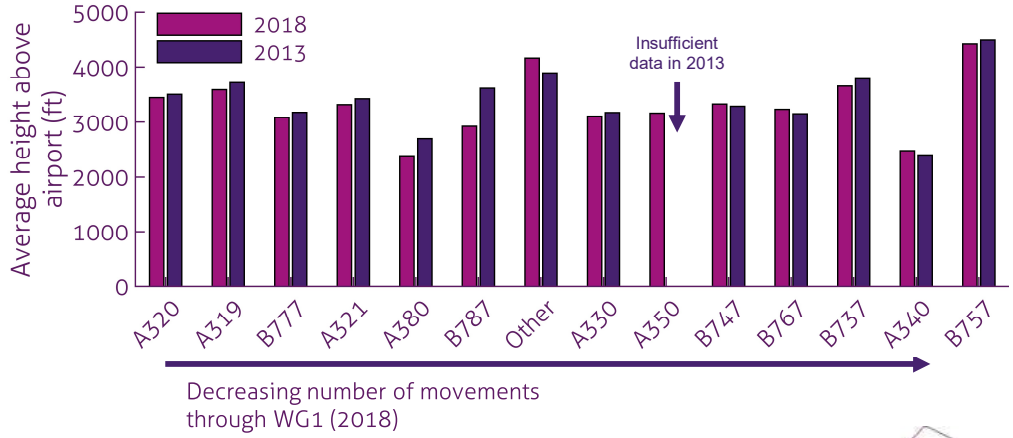


Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft departing on westerly operations as they passed through the WG1 in the 2013 and 2018 periods.
- This indicates that aircraft above Englefield Green were on average 130ft lower in 2018 compared to 2013.
- The figures present the distribution of these aircraft height through the WG1 (upper figure) and the average height by aircraft type (lower figure) both comparing 2013 with 2018 .
- The upper figure shows that generally, the vertical concentration of aircraft is similar in 2013 and 2018, however in 2018, a greater proportion of aircraft are passing over Englefield Green at lower altitudes.
- The lower figure shows that the average height of aircraft varies with type. The B757 is the highest aircraft type (although is responsible for very few movements) while the A380 and A340 are the lowest – both quad engine aircraft.
- Most aircraft types reduced in altitude with the exception of the B747, B767 and A340 which are higher in 2018 compared to 2013.

	2013	2018	Difference
Average height of departures through WG1	3,440ft	3,310ft	-130ft

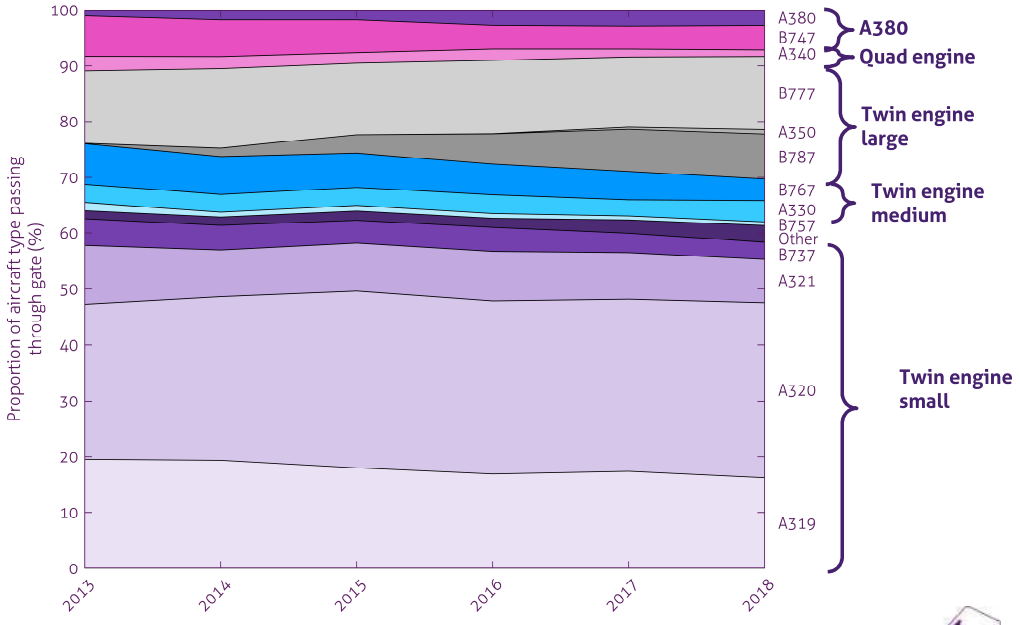




How has the fleet mix changed between 2013 and 2018?

- The table to the right presents the mix of departing aircraft that passed through WG1 and overall at Heathrow in the 2013 and 2018 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - remaining quad (four) engine aircraft (including B747, A340),
  - twin engine large aircraft (B777, A350, B787, A330)
  - twin engine medium aircraft (B767)
  - twin engine small aircraft (B737, A320 family).
- Previous slides indicated that although the number of departing aircraft flying through WG1 has not, on an average day of full westerly operations, increased between 2013 and 2018, the aircraft have generally moved closer to Englefield Green.
- The analysis on this page indicates that there was an increase in the proportion of A380 operations departing through WG1 from 4.0% in 2013 to 6.4% in 2018. The proportion of the other 4 engine (quad) aircraft types reduced.
- There was a large increase in the proportion large twin engine aircraft due to the introduction and increased use of the B787 and A350
- 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.

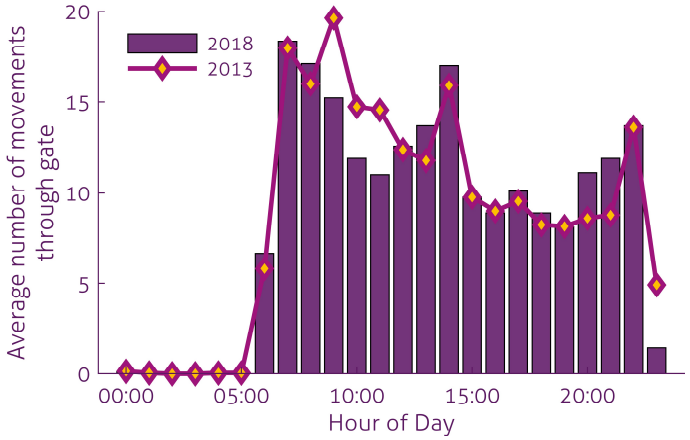
Fleet mix				
Category	WG1		All LHR	
	2013	2018	2013	2018
A380	4.0%	6.4%	3.7%	3.5%
Quad engine (excl. A380)	5.5%	2.8%	9.9%	5.4%
Twin engine large	15.0%	24.6%	17.3%	26.5%
Twin engine medium	3.6%	2.8%	2.9%	4.2%
Twin engine small	72.0%	63.4%	66.2%	60.5%



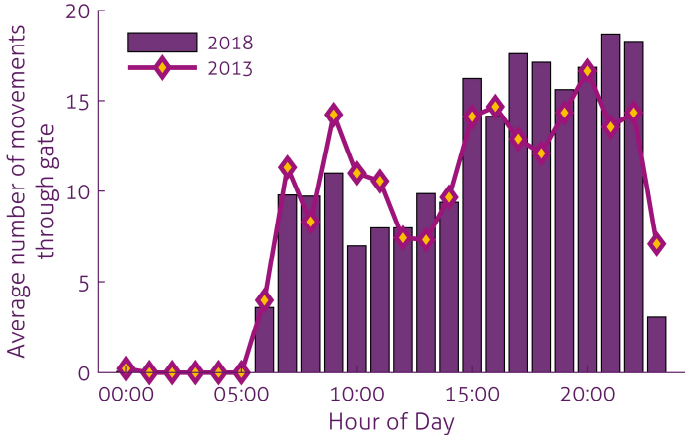
Does the number of flights over the area vary across the day? Is there a difference between 2013 and 2018?

- The figures to the right present the average number of departures through WG1 per hour in 2013 and 2018 during days of 100% westerly operations for both runway alternation patterns. The top figure shows the average movements per hour on days where aircraft departing from the southern runway (27L) during the hours 07:00-15:00 and the northern runway (27R) the remainder of the day
- The figures show that, in general, more aircraft pass through the gate when 27L is on operation.
- For both runway alternation patterns, more aircraft passed through the gate between 09:00 and 12:00 in 2013 compared to 2018.
- In 2018, there were more aircraft passing through the gate between 15:00 and 23:00 while aircraft were departing runway 27L. The increase during this period was less marked while aircraft were departing from 27R.
- For both runway alternation patterns, the number of late runners departing in the hour 23:00 to 00:00 decreased by more than a half.
- Of the total 92 days in the 2018 monitoring period, 24 days (26%) were 100% westerly operations and 26 days (28%) were on 100% easterly operations.

Westerly Departures – 27L to 27R

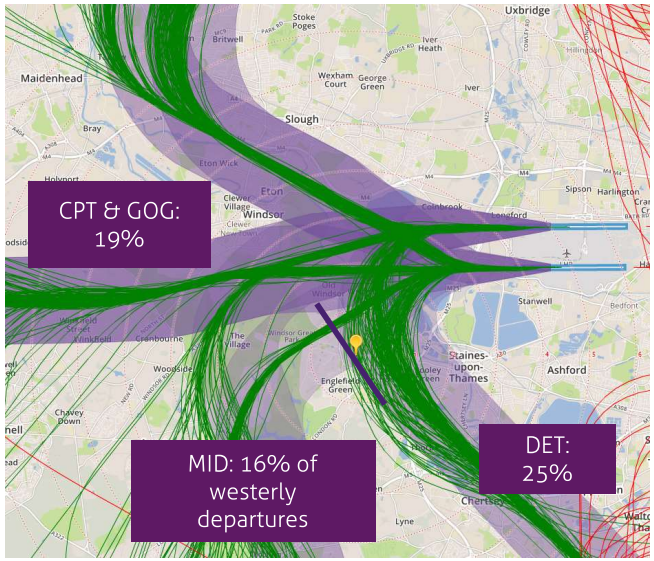


Westerly Departures – 27R to 27L



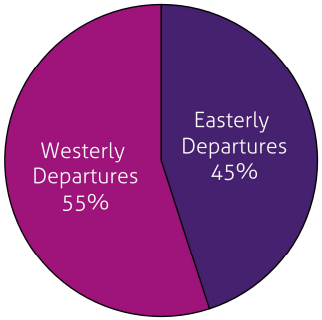
Overview of flight track data – Westerly Gate 2

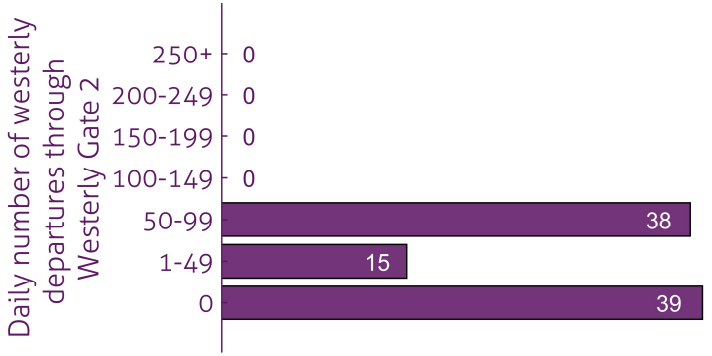
1st March 2018 - 31st May 2018 (dates to avoid Operational Freedoms Trials)



Example day of departing aircraft tracks in the vicinity of Englefield Green during westerly operations & Westerly Gate 2 (width 5km)

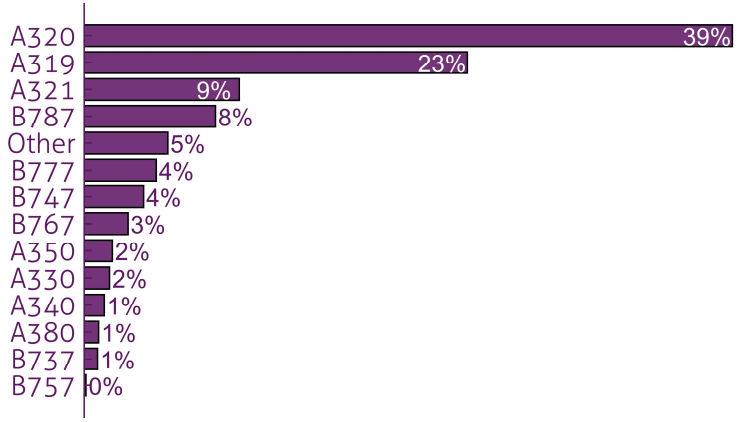
Total 60,293 departures from Heathrow



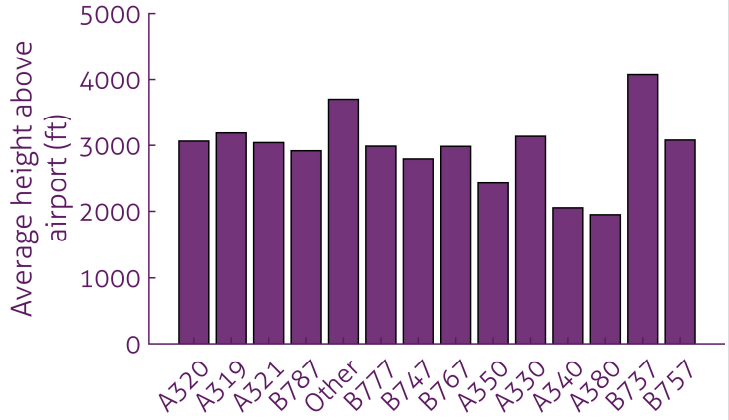


Number of westerly departures per day passing through Westerly Gate 2 (92 days in total)

Proportion of departing aircraft types passing through Westerly Gate 2

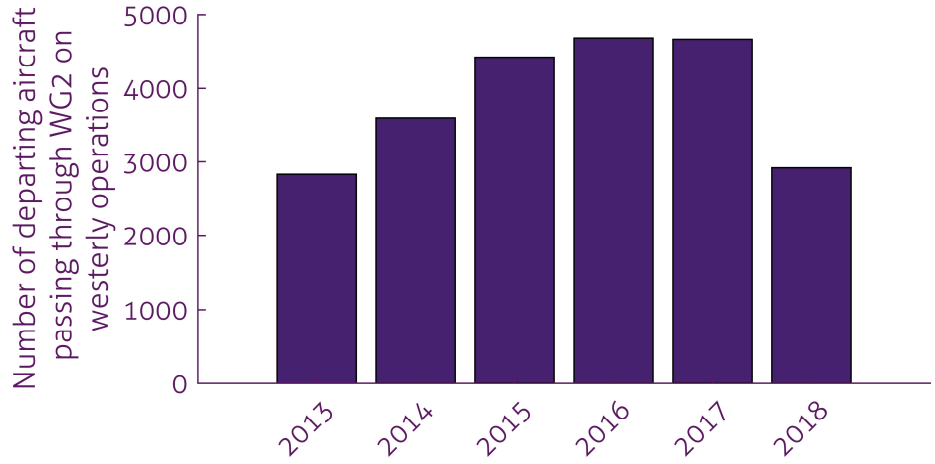


Average height of departing aircraft as they pass through Westerly Gate 2



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 WG2in the period from 1st March to 31st May in the years from 2013 to 2018.
- During each period, between around 3,000 and 5,000 departures penetrated the WG1 the majority of which were are following the MID route (departing the southern runway).
- 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 all movements on westerly operations in 2013 was 52%, in 2018 45%; these figures are lower than the long term average.
- On a full day of westerly operations;
  - There was a 2% increase in departures following the MID route passing through WG2 in the 2018 period compared to 2013.
  - The number of these passing overhead was less than 1 per day in both years.



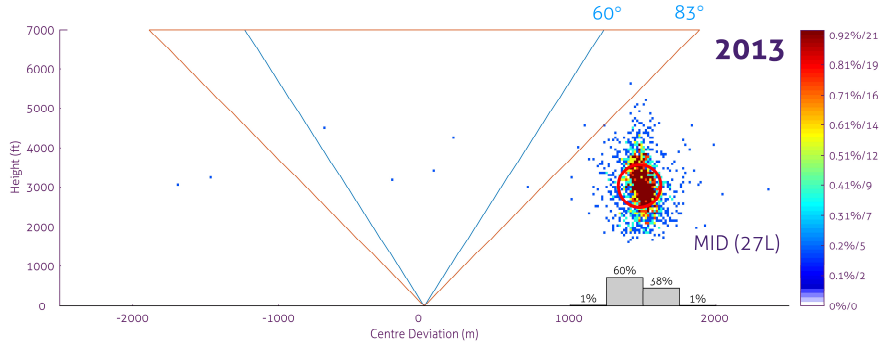
	2013	2018	Change	Change (%)
Proportion of westerly operations (all Heathrow flights)	52%	45%	-7%	N/A
Average number of westerly departures on the MID route passing through the westerly gate during days of 100% westerly operations.	51 (<1/<1)*	52 (<1/<1) *	+1 (~/~)*	+2% (~/~)*

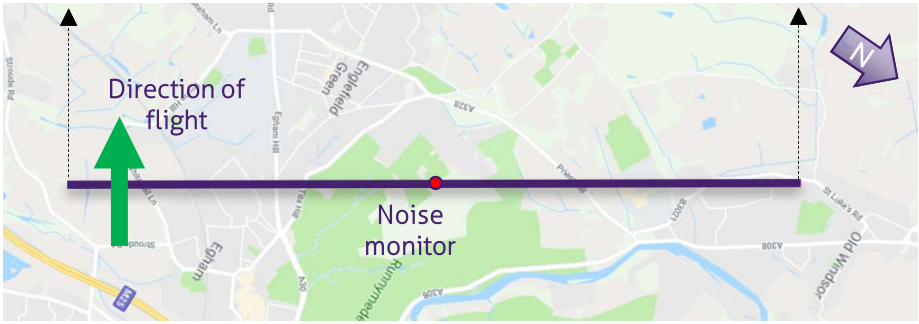
* Figures in parentheses indicate the number of flights passing through the 60 and 83° overhead cone respectively.

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 31st May 2018. Similarly, 2013 specifically refers to the period from 1st March to 31st May 2013.

Is the concentration of aircraft on the westerly MID route different between 2013 and 2018?

- The figures to the right are heat maps showing the 2D concentrations of departing aircraft as they pass through WG2 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 0.92% 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, however in this case, 0.92% corresponds to 21 movements in both figures).
- The gate has been designed to be perpendicular to the southern MID route. The gate also includes some aircraft on the DET route however these aircraft have been omitted from this plot to give a clear indication of how the position and concentration of flights of the MID route have changed. For information on the DET route please see the section for WG1.
- The figures indicate that southern MID route is more concentrated in the 2018 period compared to 2013 and the position of the swathe has moved towards the noise monitor.
- The position of the main concentration of the southern MID route (27LMID) has moved about 7% (~80m) closer to the noise monitor.

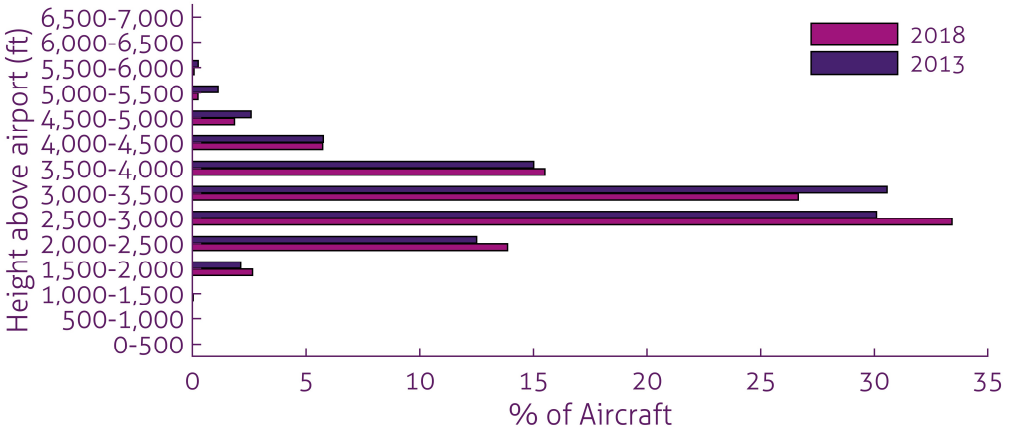


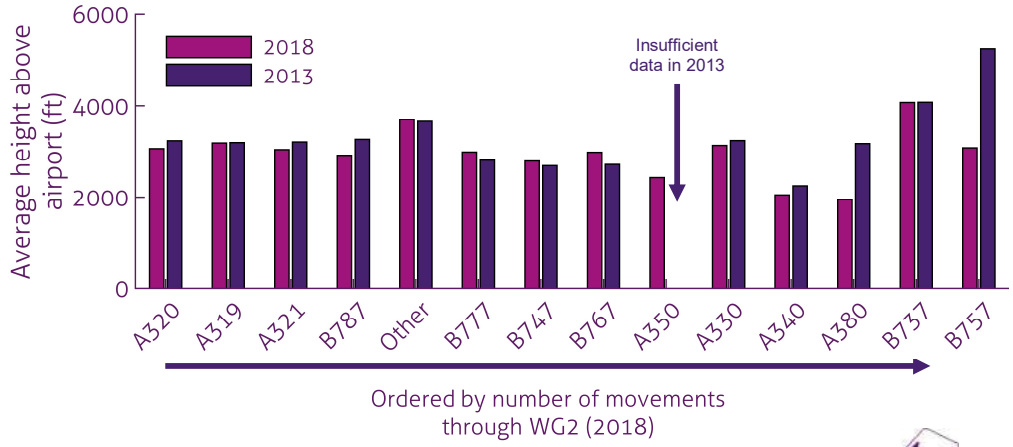


Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft departing on westerly operations as they passed through the WG2 in the 2013 and 2018 periods.
- This indicates that aircraft above Englefield Green were, on average, approximately 70ft lower in 2018 compared to 2013.
- The figures present the distribution of these aircraft height through the WG2 (upper figure) and the average height by aircraft type (lower figure) both comparing 2013 with 2018 .
- The upper figure shows that generally, the vertical concentration of aircraft is similar in 2013 and 2018, however in 2018, a greater proportion of aircraft are passing over Englefield Green at lower altitudes.
- The lower figure shows that the average height of aircraft varies with type. The B737 is the highest aircraft in 2018 while the A380 and A340 are the lowest – both quad engine aircraft.
- The most common aircraft types passing through WG2; the A320 family and the B787 all flew lower on average in 2018 while other aircrafts types, notably the B777, B747, and B767 all flew higher in 2018 above Englefield Green. The height of the A380 reduced by almost 40% although the sample size is very small, representing 1% (~40) of all movements through the gate in 2018.

	2013	2018	Difference
Average height of departures through WG2	3,140ft	3,070ft	-70ft

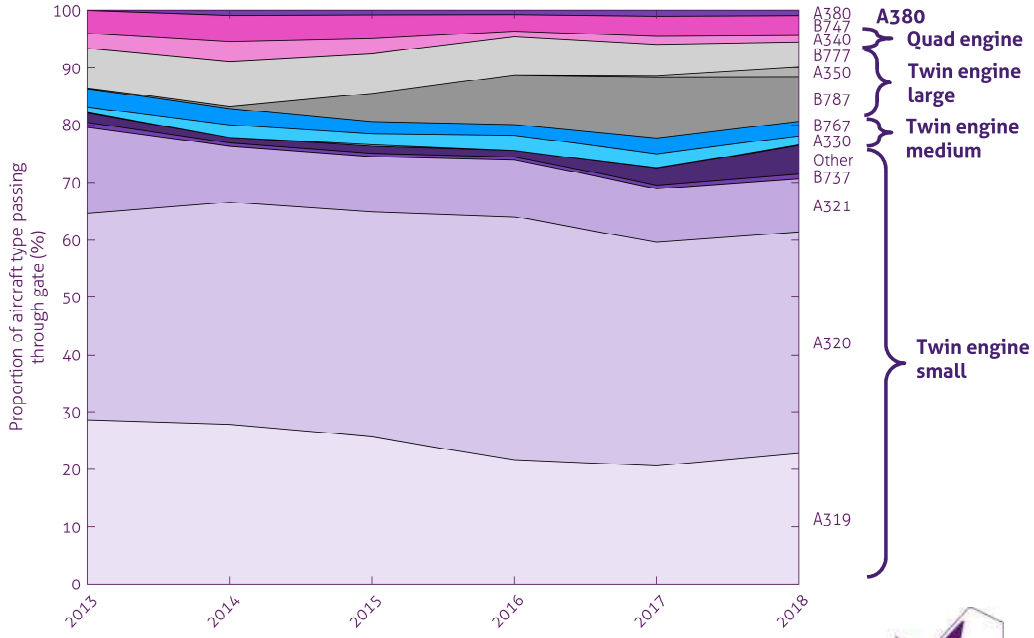




How has the fleet mix changed between 2013 and 2018?

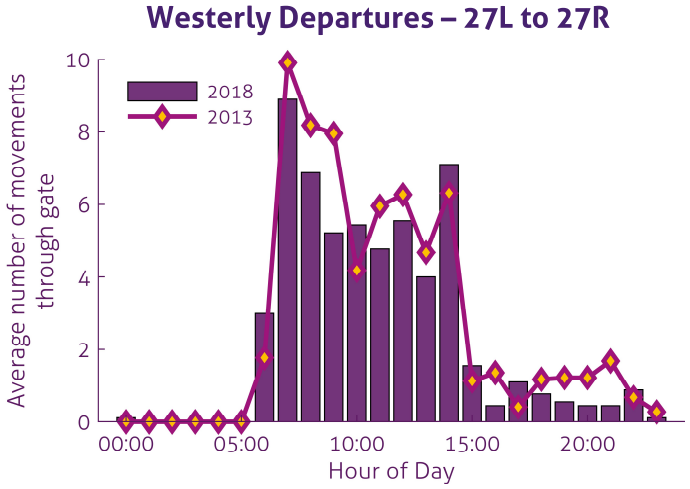
- The table to the right presents the mix of departing aircraft that passed through WG2 and overall at Heathrow in the 2013 and 2018 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - quad (four) engine aircraft (including B747, A340),
  - twin engine large aircraft (B777, A350, B787, A330)
  - twin engine medium aircraft (B767) and
  - twin engine small aircraft (B737, A320 family).
- Previous slides indicated that although the number of departing aircraft flying through WG2 has not, on an average day of full westerly operations, increased between 2013 and 2018, the aircraft have generally moved closer to Englefield Green.
- The analysis on this page indicates that, proportionally, large twin engine aircraft saw the largest increase in movements through the gate at the expense of quad engine, medium twin engine and small twin engine aircraft. Over the same period there was a small increase in the use of A380 from 0 to 1%.
- 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 increase in the proportion of large twin engine aircraft was predominantly driven by the introduction and increased use of the B787 and A350.

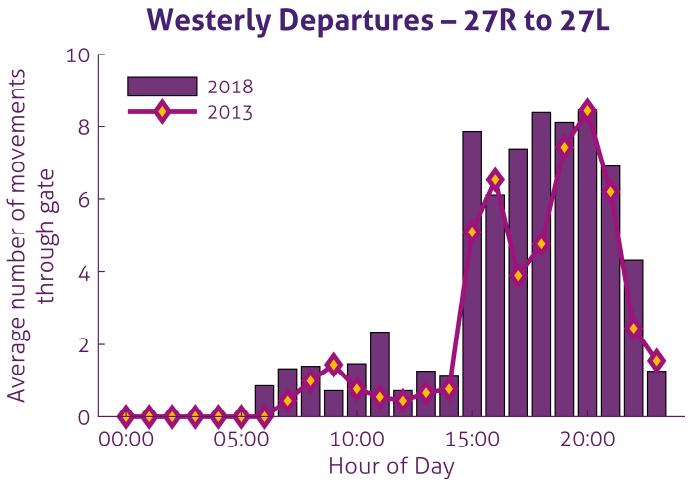
Fleet mix				
Category	WG2		All LHR	
	2013	2018	2013	2018
A380	0.0%	0.9%	3.7%	3.5%
Quad engine (excl. A380)	6.7%	4.7%	9.9%	5.4%
Twin engine large	8.0%	15.2%	17.3%	26.5%
Twin engine medium	3.5%	2.8%	2.9%	4.2%
Twin engine small	81.8%	76.3%	66.2%	60.5%



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

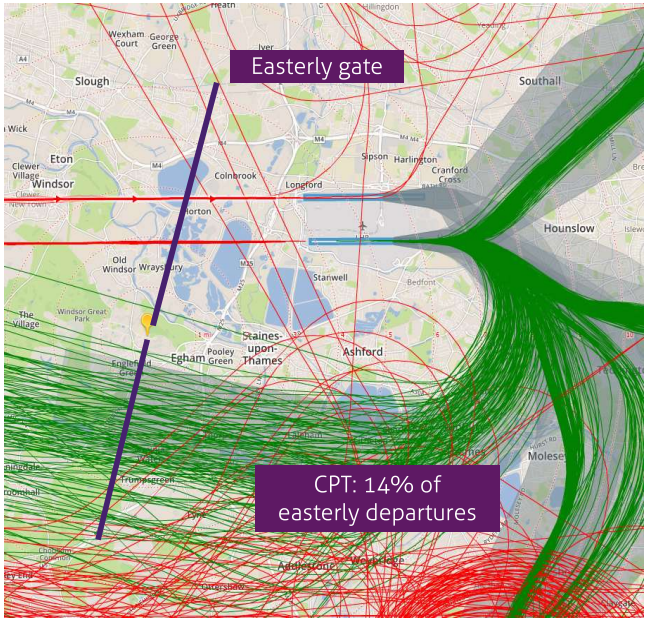
- The figures to the right present the average number of departures through WG2 per hour in 2013 and 2018 during days of 100% westerly operations for both runway alternation patterns. The top figure shows the average movements per hour on days where aircraft departing from the southern runway (27L) during the hours 07:00-15:00 and the northern runway (27R) the remainder of the day
- The figures show that the number of aircraft through the gate is highly dependent on the runway alternation pattern in use. When aircraft are departing the southern runway, there are between 4 and 9 movements through the gate per hour. When aircraft are departing the northern runway, there is typically less than one movement through the gate per hour.
- In general, the number of movements passing through the gate per hour is lower in 2018 compared to 2013 for the alternation pattern 27L to 27R while for the alternation pattern 27R to 27L the number of movements through the gate has generally increased across the day.
- There has been a small reduction in the number of late runners in the hour 23:00-00:00.
- Of the total 92 days in the 2018 monitoring period, 24 days (26%) were 100% westerly operations and 26 days (28%) were on 100% easterly operations.





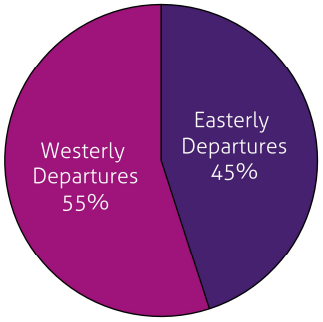
Overview of flight track data – Easterly Gate

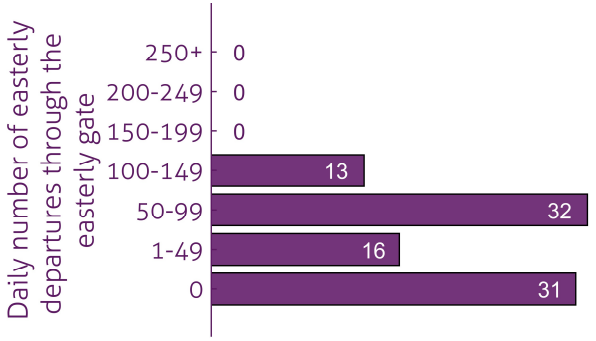
1st March 2018 - 31st May 2018 (dates to avoid Operational Freedoms Trials)



Example day of departing aircraft tracks in the vicinity of Englefield Green during easterly operations & the easterly gate (width 17km)

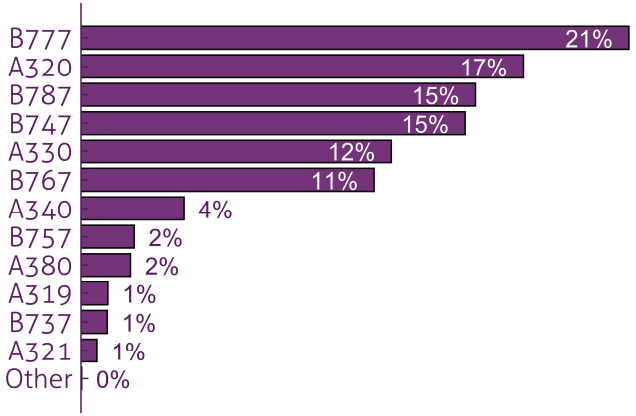
Total 60,293 departures from Heathrow



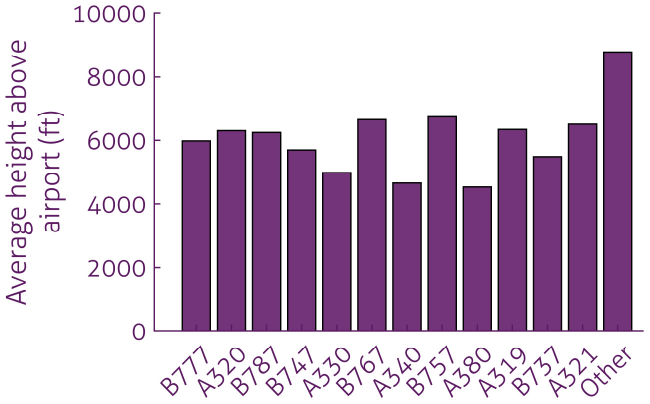


Number of easterly departures per day passing through the easterly gate (92 days in total)

Proportion of departing aircraft types passing through the easterly gate

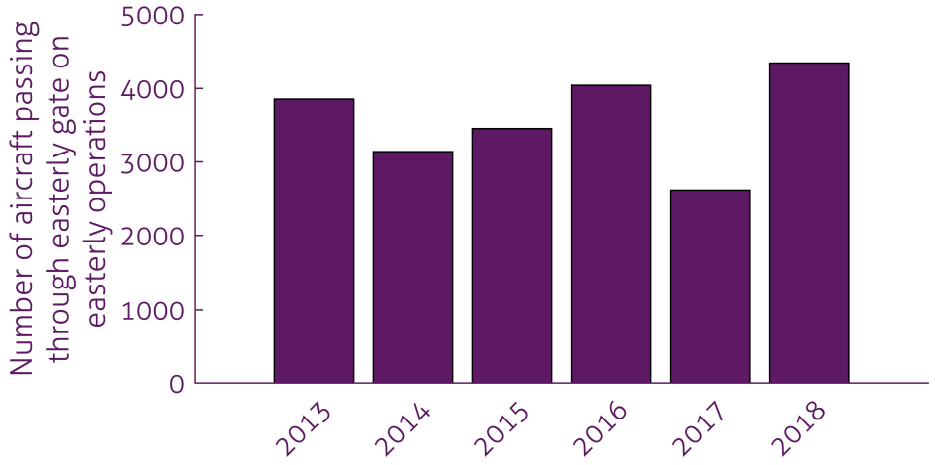


Average height of departing aircraft as they pass through the easterly gate



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 easterly gate in the period from 1st March to 31st May in the years from 2013 to 2018.
- Annually, between around 3,000 and 5,000 departures penetrated the easterly gate the majority of which were are following the CPT route (departing 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 of all movements in 2013 was 48%, in 2018 55%; these figures are lower than the long term average.
- On a full day of easterly operations;
  - There was an increase in the average number of aircraft passing through the gate from 87 to 91 in the 2018 period compared to 2013.
  - There was also a small increase in aircraft passing overhead (the noise monitor) when defined as a 60 degree overhead cone.



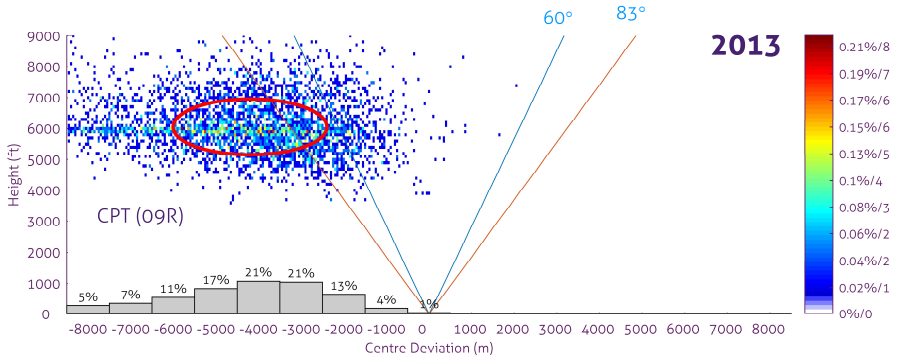
	2013	2018	Change	Change (%)
Proportion of easterly operations (all Heathrow flights)	48%	55%	+7%	N/A
Average number of easterly departures passing through the easterly gate on the CPT route during days of 100% easterly operations.	87 (2/6)*	91 (4/10) *	+4 (+2/+4)*	+5% (+100%/+67%)*

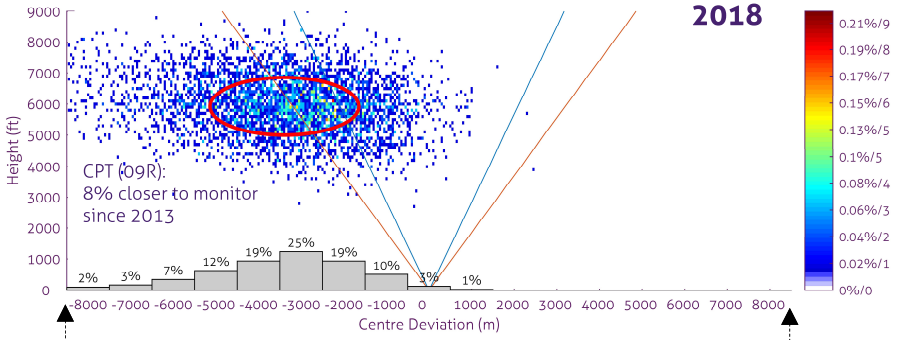
* Figures in parentheses indicate the number of flights passing through the 60 and 83° overhead cones respectively.

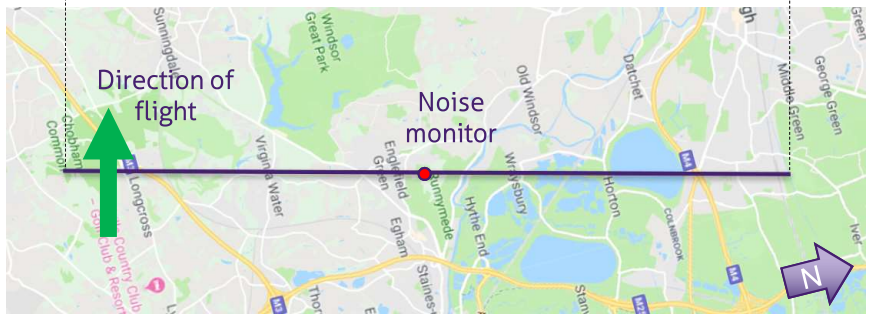
Note: Wherever this section of the report refers to *2018*, it should be noted that this is specifically the measurement period from 1st March to 31st May 2018. Similarly, 2013 specifically refers to the period from 1st March to 31st May 2013.

Is the concentration of aircraft on the easterly CPT route 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 periods 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 0.21% of the movements passing through a grid square in the gate in both figures.
- The gate has been designed to be perpendicular to the easterly CPT route departing from the southern runway. The gate is much wider than WG1 and WG2 at 17km in order to encompass the full swath of the CPT route.
- The figures indicate that although the easterly CPT route is more concentrated in 2018 compared to 2013 while the position of the main concentration has moved about 8% (~450m) closer to the noise monitor at Englefield Green.



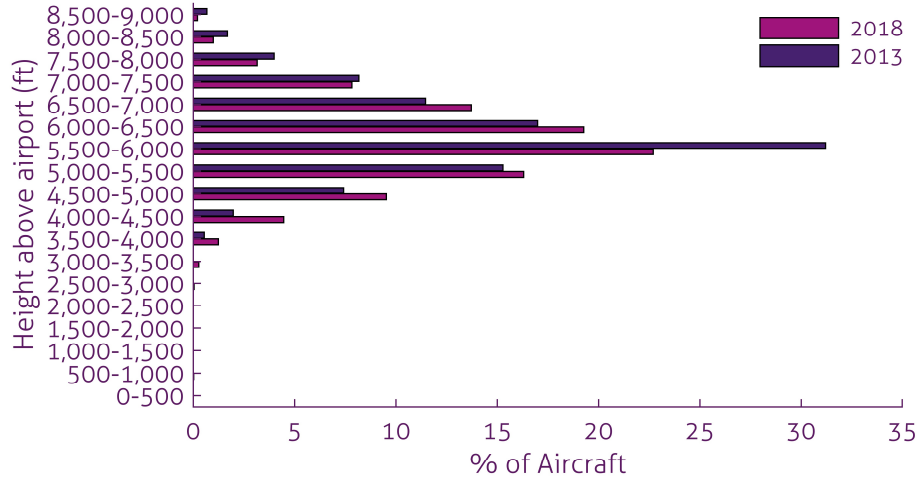


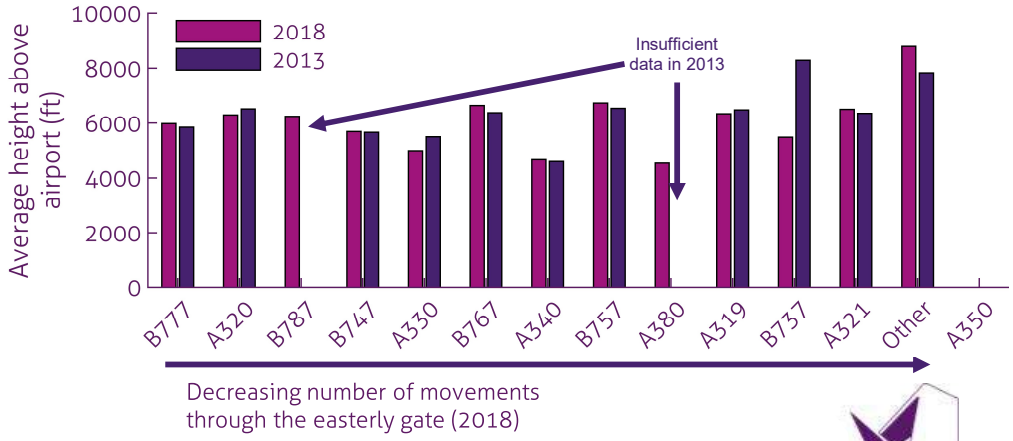


Are aircraft heights different between 2013 and 2018?

- The table to the right presents the average height of aircraft departing on easterly operations as they passed through the easterly gate in the 2013 and 2018 periods.
- This indicates that aircraft above Englefield Green were approximately 130ft lower in 2018 compared to 2013.
- The figures present the distribution of these aircraft height through the easterly gate (upper figure) and the average height by aircraft type (lower figure) both comparing 2013 with 2018 .
- The upper figure shows that generally, the vertical concentration of aircraft is similar in 2013 and 2018, however in 2018, a greater proportion of aircraft are passing over Englefield Green at lower altitudes.
- The lower figure shows that the average height of aircraft varies with type. The B757 is the highest aircraft in 2018 while the A380 and A340 are the lowest – both quad engine aircraft.

	2013	2018	Difference
Average height of departures through the easterly gate	6,060ft	5,930ft	-130ft -2%

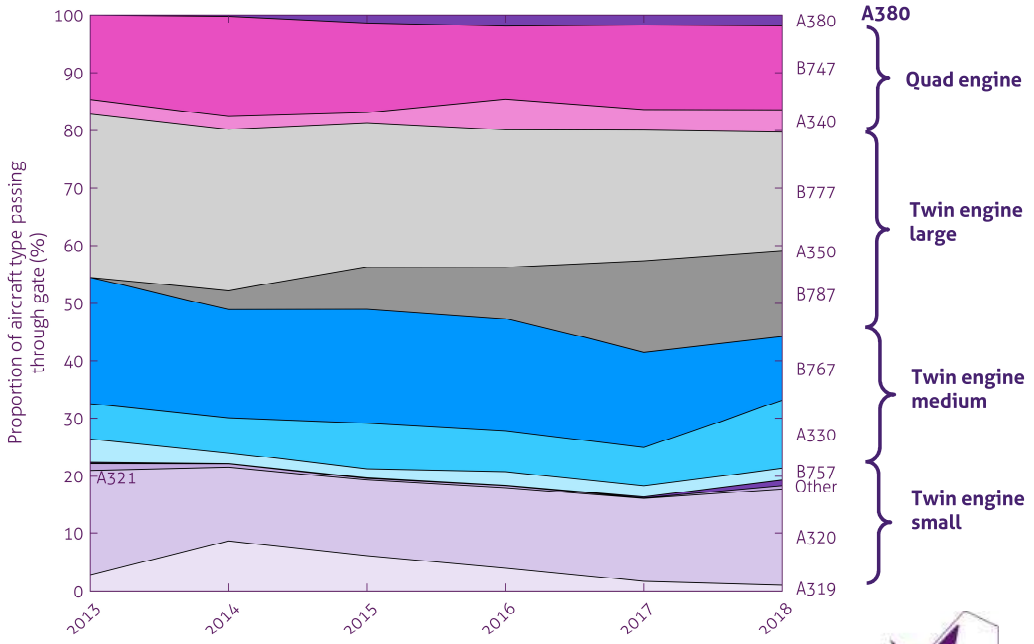




How has the fleet mix changed between 2013 and 2018?

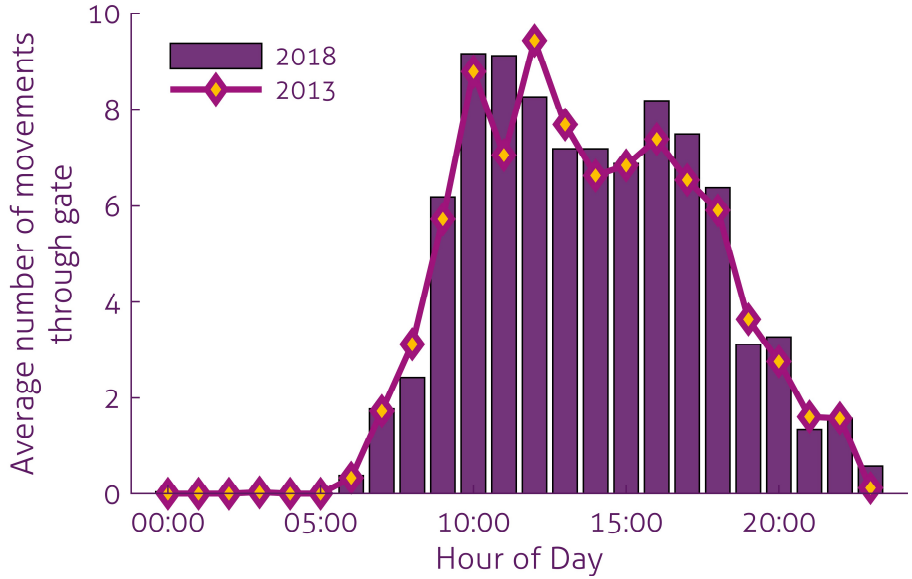
- The table to the right presents the mix of departing aircraft that passed through the easterly gate and overall at Heathrow in the 2013 and 2018 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - quad (four) engine aircraft (including B747, A340),
  - twin engine large aircraft (B777, A350, B787, A330)
  - twin engine medium aircraft (B767) and
  - twin engine small aircraft (B737, A320 family).
- Previous slides indicate that although the number of departing aircraft flying through the CPT gate has, on an average day of full easterly operations, increased between 2013 and 2018, the aircraft have generally moved closer to Englefield Green.
- The analysis on this page indicates that there was an increase in the proportion of A380 operations departing through the easterly gate from zero in 2013 to almost 2% in 2018, although this is still less than the average for the airport. The proportion of the other 4 engine (quad) aircraft types remained roughly the same. There has been a shift from medium and small twin engine aircraft to large twin engine aircraft.
- 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 addition to the increase in use of the A380 as noted earlier, there were increases in the use of the B787 (introduced in 2011, from less than 1% to 8%) while the A319, and B767 both saw a decrease through this gate.

Fleet mix				
Category	Easterly Gate		All LHR	
	2013	2018	2013	2018
A380	0.0%	1.9%	3.7%	3.5%
Quad engine (excl. A380)	17.1%	18.4%	9.9%	5.4%
Twin engine large	34.6%	47.3%	17.3%	26.5%
Twin engine medium	21.9%	11.1%	2.9%	4.2%
Twin engine small	26.4%	21.3%	66.2%	60.5%



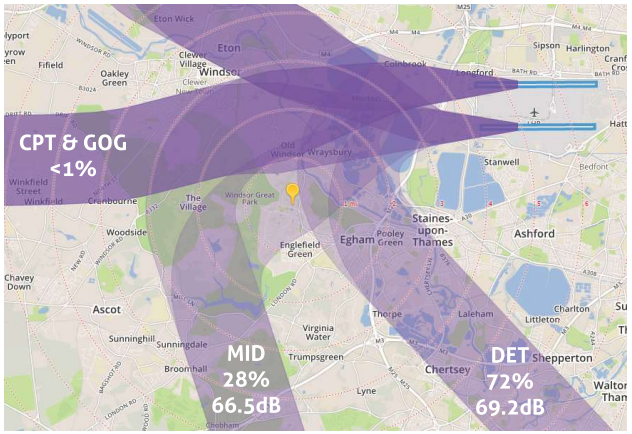
Does the number of flights over the area vary across the day? Is there a difference between 2013 and 2018?

- 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 in both 2013 and 2018, the main bulk of movements through the gate occurs between 09:00 and 17:00. During this time, between 6 and 10 movements pass through the gate each hour. The distribution of flights has not changed much between the two years.
- Previous analysis shows there are, on average, five more flights through the gate across the day. This plots shows these additional flights are spread through the day while in some hours the number of movements through the gate has decreased.
- The analysis indicates that on average, on a day of full easterly operations in 2018, there were around on average less than one delayed departures between 23:00 and 00:00. This is more than in 2013.
- Of the total 92 days in the 2018 monitoring period, 26 days (28%) were on 100% easterly operations and 24 days (26%) were 100% westerly operations.



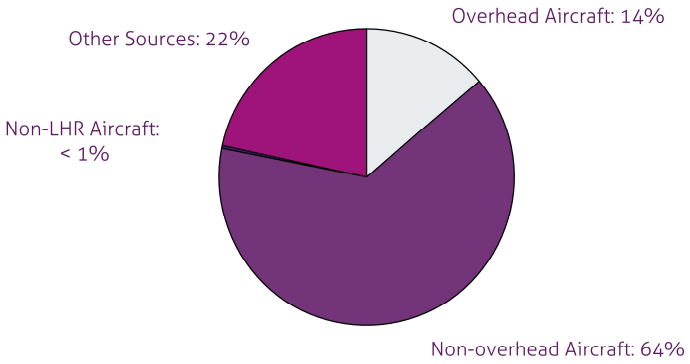
Overview of noise monitor data recorded at Englefield Green

18th September 2017 – 31st May 2018



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

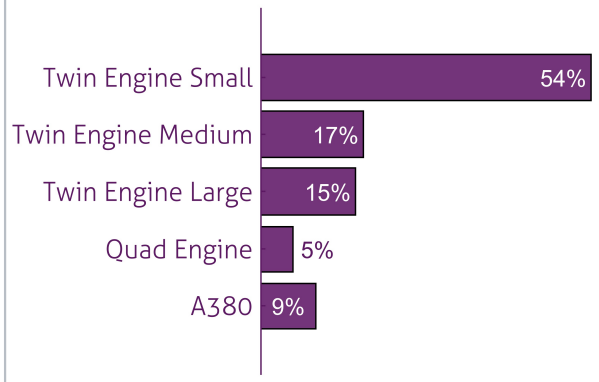
37,392 Measured Noise Events*



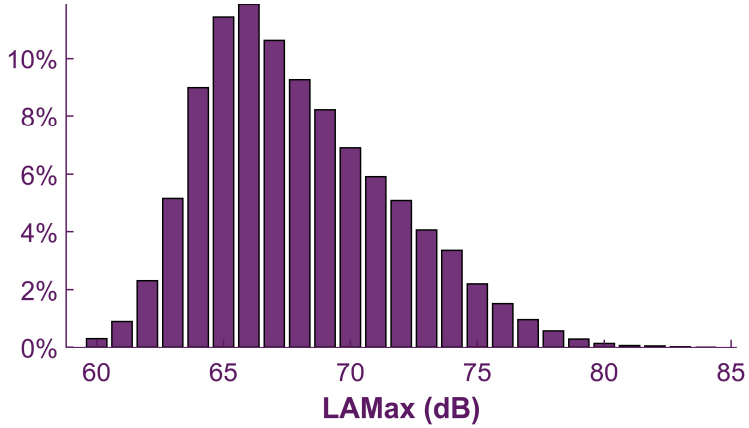
* From all noise sources

18%

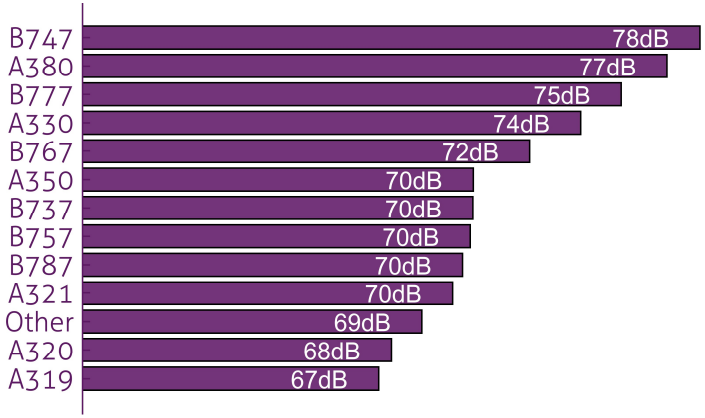
of aircraft noise events recorded when aircraft were within 60° cone over the noise monitor



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 at the Air Force Memorial in Englefield Green between 18/09/2017 and 31/05/2108.
- The monitor was set up to record noise events based on a threshold sound pressure level of 60 dBA being exceeded for more than 10 seconds.
- The location of the noise monitor is shown in the figures to the right. It is close to the outer edge DET NPR from the northern runway and the centre line of the MID route from the southern runway whilst on westerly operations.

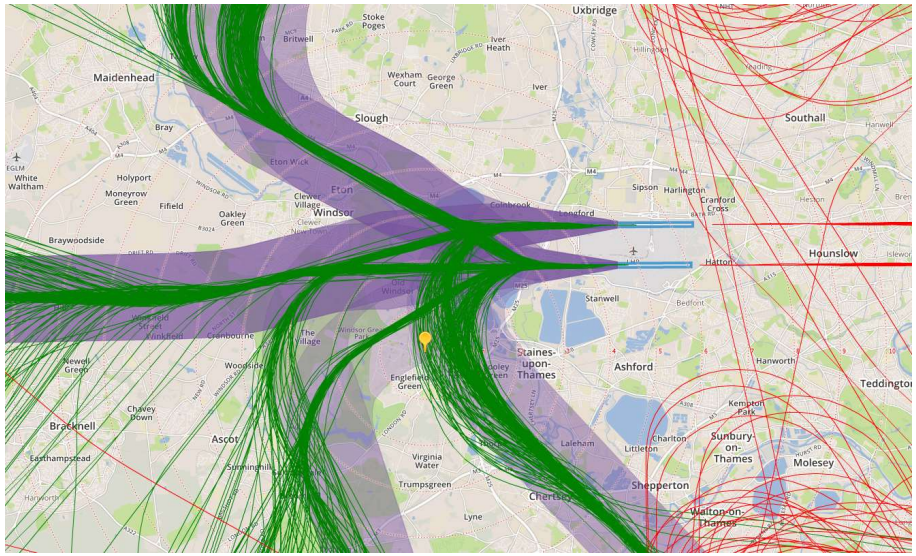
Noise event summary

- A total of 37,392 noise events were measured during the monitoring period. Of these around 78% were from aircraft using Heathrow and 22% were from non-aircraft sources.
- Overall, 70% of the aircraft registering noise events at the noise monitor were using the DET route, 26% from aircraft using the MID route.
- Overall, 18% of aircraft registering noise events were overhead (based on the 60° cone); 93% of these were on the westerly DET route, 7% the easterly CPT route.

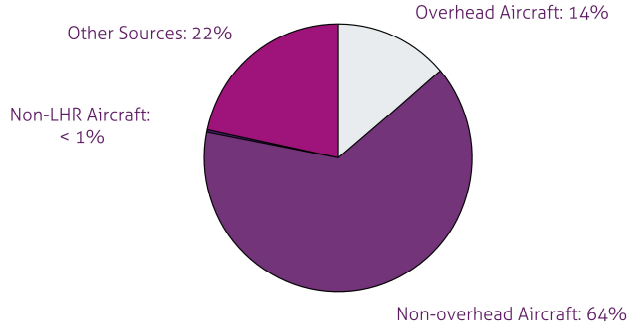
Percentage of aircraft noise events by route

Westerly						Eastery		Overhead	
DET		MID		Others		CPT			
27L	27R	27L	27R	27L	27R	09L	09R	60°	83°
25	45	26	0	0	0	0	4	18	36

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

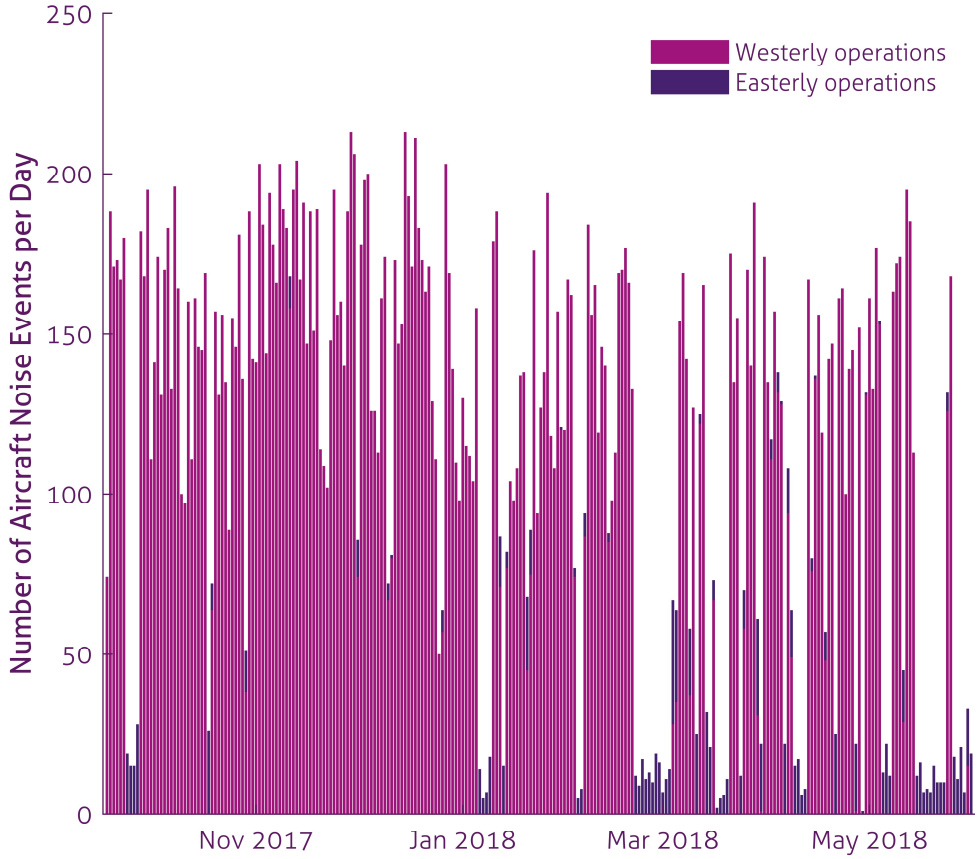


Measured noise event summary (all sources)



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

- Noise events are captured at the Englefield Green noise monitor mostly during periods of westerly operations by aircraft using the DET and MID route.
- During the full monitoring period, 143 out of 256 days (56%) were 100% westerly operations and 46 days (18%) 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, 155 aircraft noise events triggered per day.
- During 100% easterly operations there was an average of 13 aircraft noise events – predominantly from departures following the Compton (CPT) route.
- On average, 18% of measured aircraft noise events were recorded by aircraft passing within the 60° overhead cone.
- Over the 256 days for which monitoring was taking place, 38% of days experienced 150 or more aircraft events whilst 18% of the days 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.



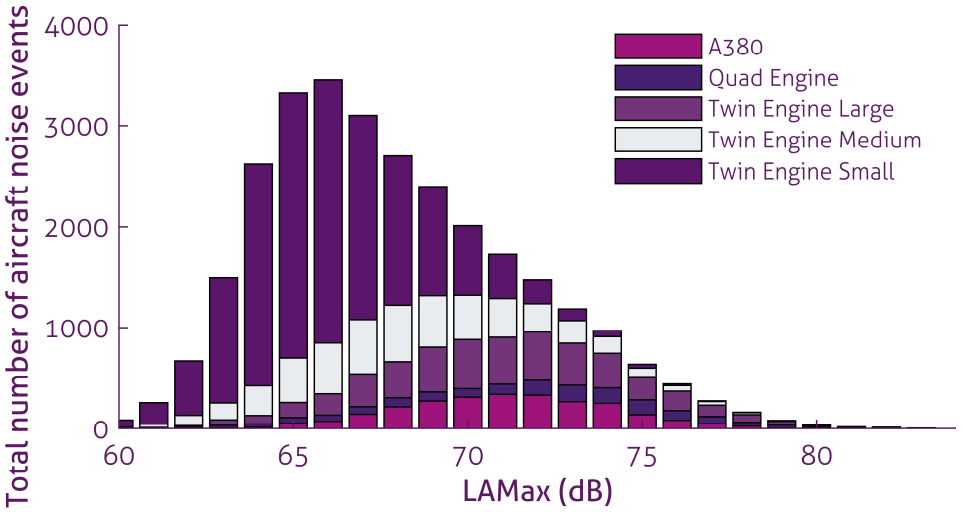
What was the range of L_{Amax} and SEL noise levels from aircraft events?

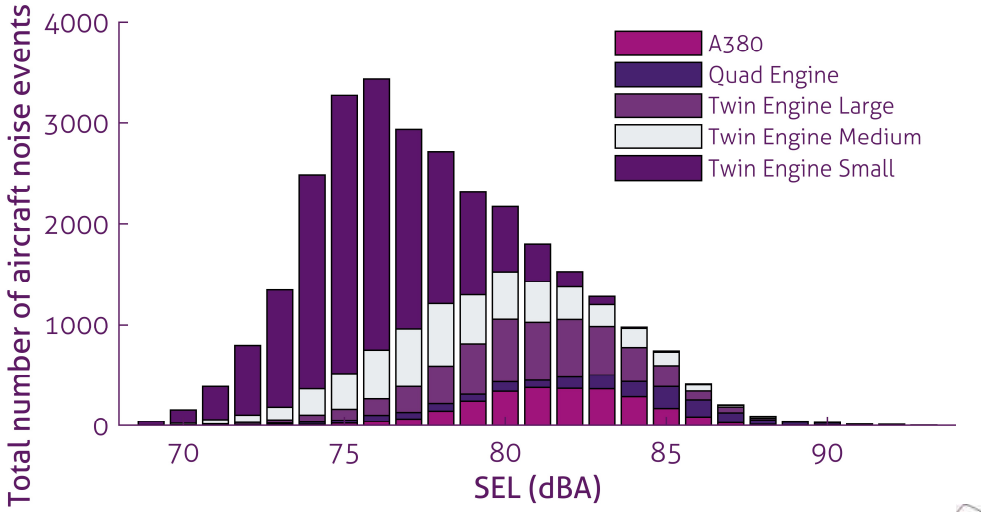
- The figures to the right present the range of L_{Amax} (top) and SEL (bottom) noise levels for all aircraft noise events measured at the noise monitor during the monitoring period. An explanation of metrics is given on page 10.
- The table below presents the average* L_{Amax} and SEL for each aircraft type group.
- The average L_{Amax} of all aircraft events is 68.4dB. The distribution of L_{Amax} is dependent on aircraft size with the larger aircraft generally recording louder events with the exception of the other quad engine aircraft being approximately 1dB louder than the A380

Aircraft group	Average L_{Amax}	Average SEL, dBA
A380	71.5	82.0
Quad engine	72.3	83.1
Twin engine large	71.2	81.0
Twin engine medium	68.8	79.0
Twin engine small	66.6	76.4

- 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 38.
- For non-aircraft related events, the mean L_{Amax} is 67dB reaching a maximum of 88dB.

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

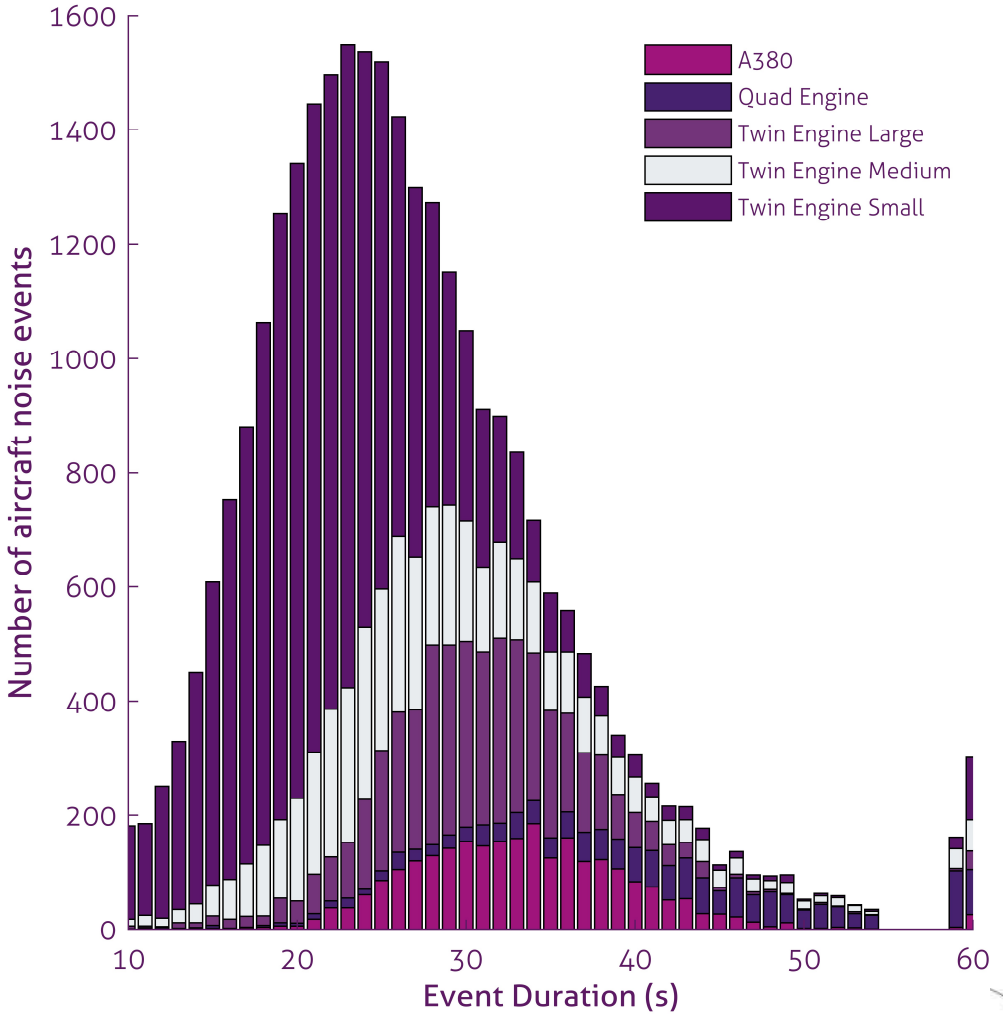




How does the duration of an aircraft event vary?

- 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 60dBA.
- 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 27 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 42 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	33.4
Quad engine aircraft	41.9
Twin engine - large	30.6
Twin engine - medium	28.5
Twin engine - small	22.6



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 51% of all aircraft noise events detected by the monitor.
- The B777 (twin-engine large) series of aircraft account for around 15% of the measured aircraft noise events, of which the majority were using the DET route..
- 9% of the events were from the A380 mostly using the DET route – very few of these were overhead.
- The newest aircraft types in service, the B787 and A350 accounted for 8% and 2 % respectively of all recorded aircraft noise events. Again most of these were on the westerly DET route.

Aircraft Type	Total*	Route						Overhead**	
		Easterly	CPT	DET	GOG	MID	WOB	60°	83°
A320	29	0	0	18	0	11	0	7	12
B777	15	1	0	14	0	1	0	2	6
A319	14	0	0	7	0	7	0	2	4
A380	9	0	0	8	0	0	0	0	1
A321	8	0	0	6	0	3	0	1	3
B787	8	0	0	7	0	0	0	2	4
B747	5	1	0	2	0	1	0	1	1
A330	4	1	0	3	0	1	0	1	1
B767	3	1	0	1	0	1	0	1	1
A350	2	0	0	2	0	0	0	0	1
B737	1	0	0	1	0	0	0	1	1
A340	1	0	0	0	0	1	0	0	0
B757	0	0	0	0	0	0	0	0	0
Other	2	0	0	1	0	1	0	0	1
Total* **	**100%**	**4%**	**0%**	**69%**	**0%**	**26%**	**0%**	**18%**	**35%**

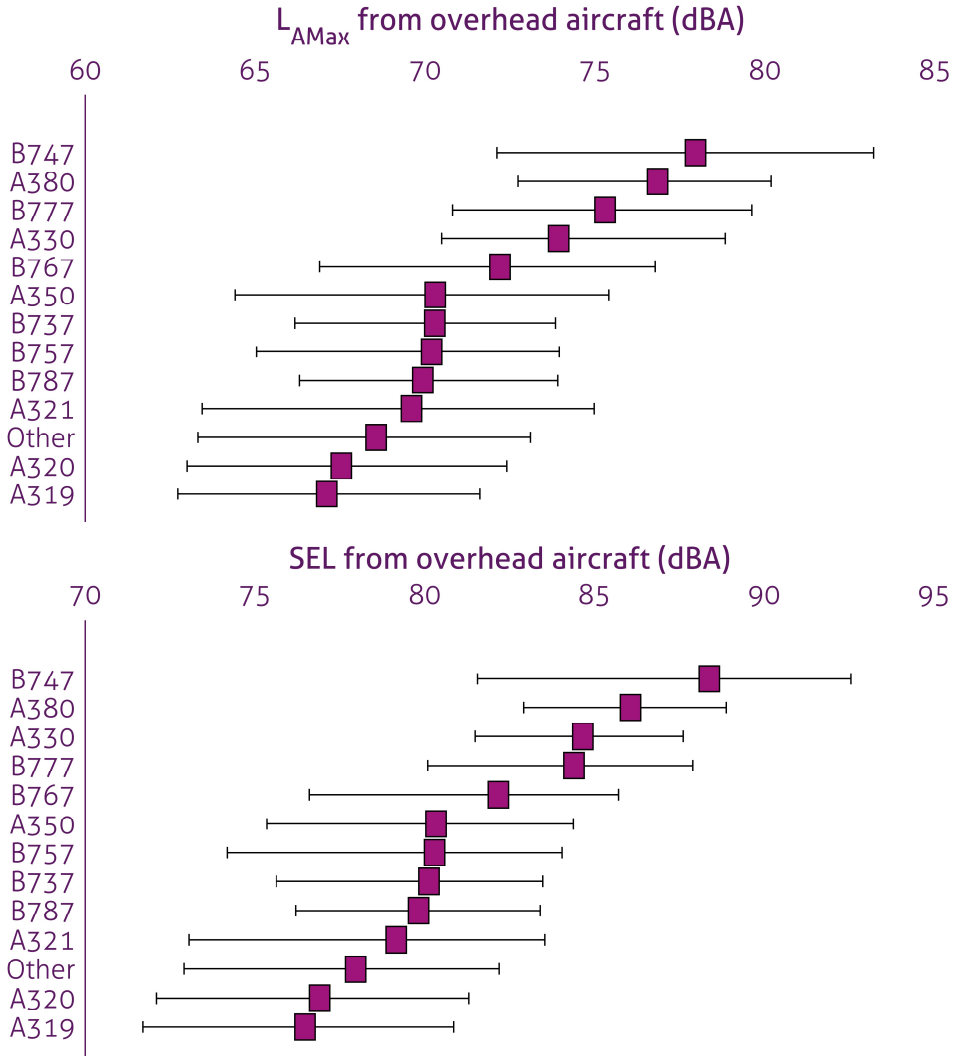
* Percentage based on 37,392 aircraft noise events recorded between 18th September 2017 and 31st May 2018.
** Defined as being with the 60 degree cone described on page 9
***Totals may differ to sum of aircraft types due to rounding

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 type the A380.
- It should be noted that there is a large range of levels for each aircraft type, typically between 8 and 12 decibels depending on the aircraft type.
- The B787 and A350, the newest aircraft types in service (both in the medium twin engine category) are on average the quietest overhead aircraft, generating an L_{Amax} of 70dB.
- The A320 family (consisting of the A319, A320 and A321) in addition to a range of smaller aircraft are, on average, the quietest aircraft types when over Englefield Green between 67 and 70dB.

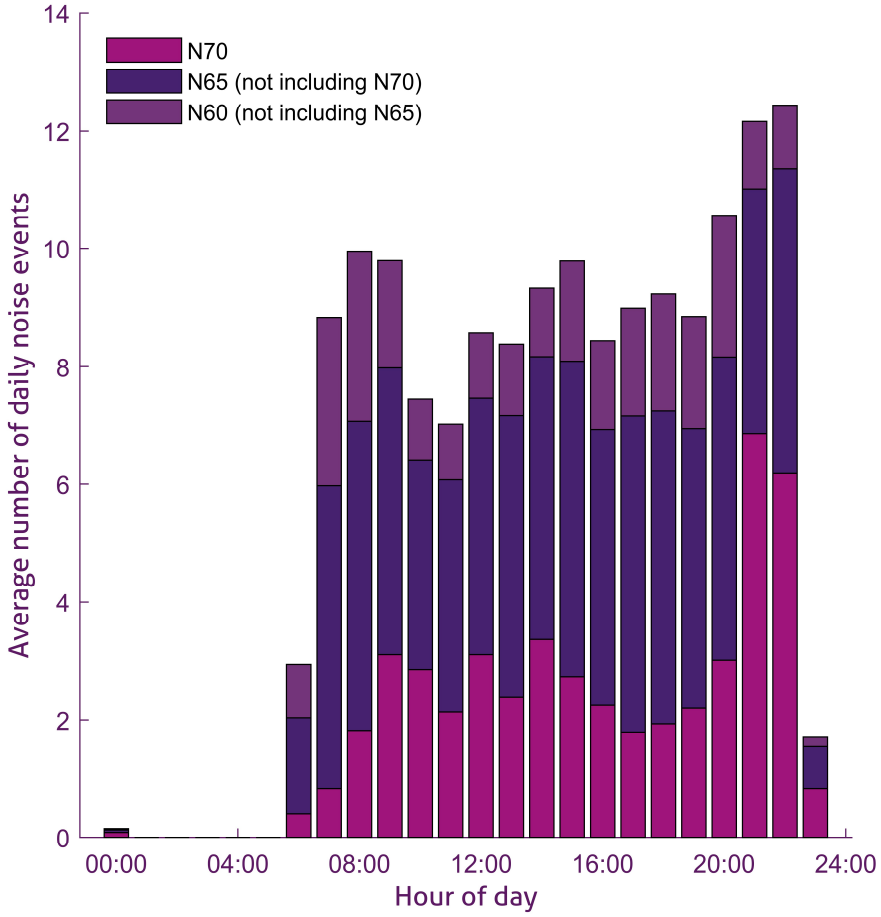
The plot in bottom right corner shows the average SEL of each aircraft type. The SEL takes into account of all energy within a noise event. The relationship of aircraft types is similar to that seen in the L_{Amax} plot with the A330 being the notable exception, which when measured using the SEL is the third loudest aircraft type.



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

How does the number of noise events above 60, 65 and 70 dB L_{Amax} noise events vary across a day (N60, N65 and N70)?

- 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 08:00 and 21:00 there are typically, between 8 and 10 events being registered per hour. This rises to a maximum approximately 12 events per hour between 21:00 and 22:59.
- On an average westerly day, the N65 during the 16h day period (07:00-23:00) was 150; the N60 during the 8h night (23:00-07:00) was less than 5.
- 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.
- On westerly days, there are on average just less than 2 noise events occurring in the hour from 23:00 to 00:00 reaching a maximum of 10 events on one day. On 121 of the 256 days, there were no noise events recorded from late runners.



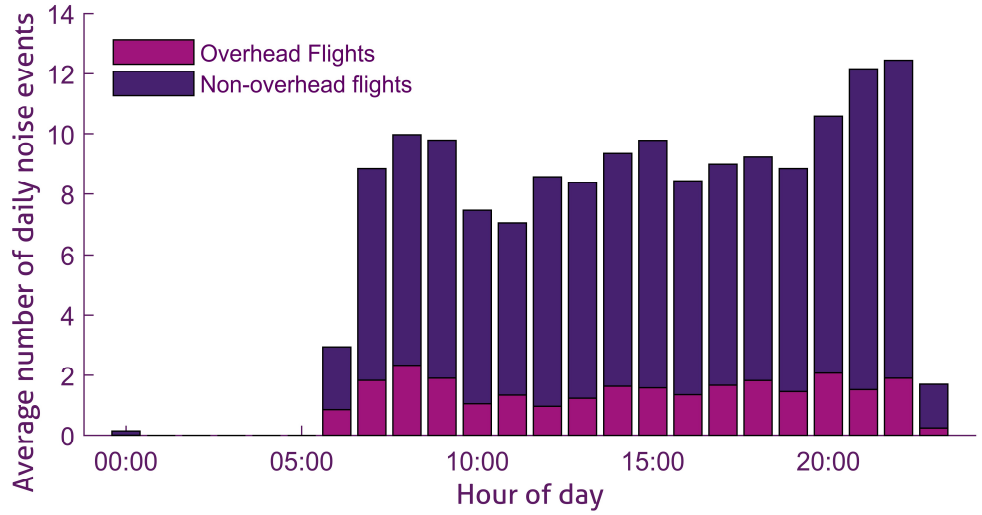
How does the number of aircraft noise events vary across a day?

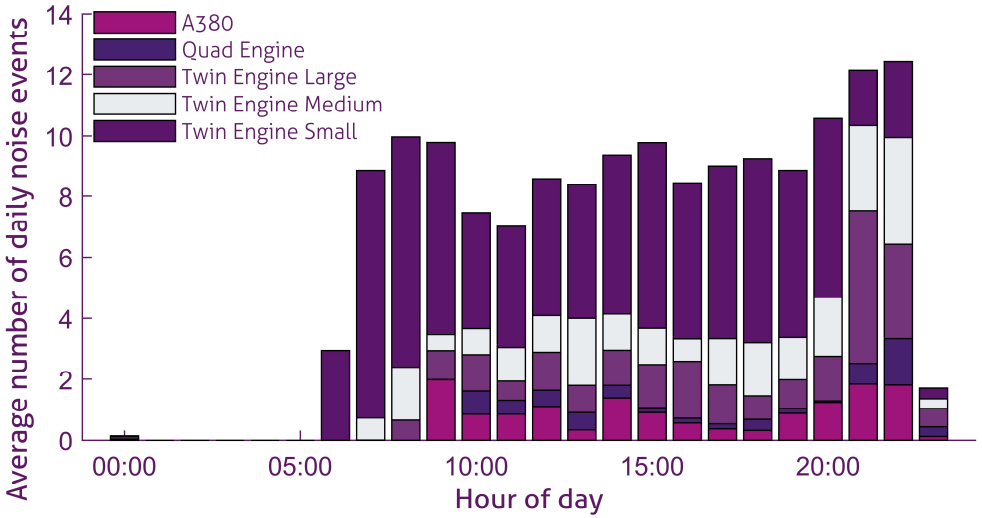
The top right figure shows the average number of noise events during each hour of the day for days of full westerly operations.

- During daytime hours, there were typically between 7 and 12 aircraft noise events flights per hour of which up to 2 were overhead (passing within the 60° cone above the monitor).
- The busiest hour of the day in terms of aircraft noise events fell between 22:00 and 23:00 while the busiest hour for overhead aircraft was 08:00-09:00.

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

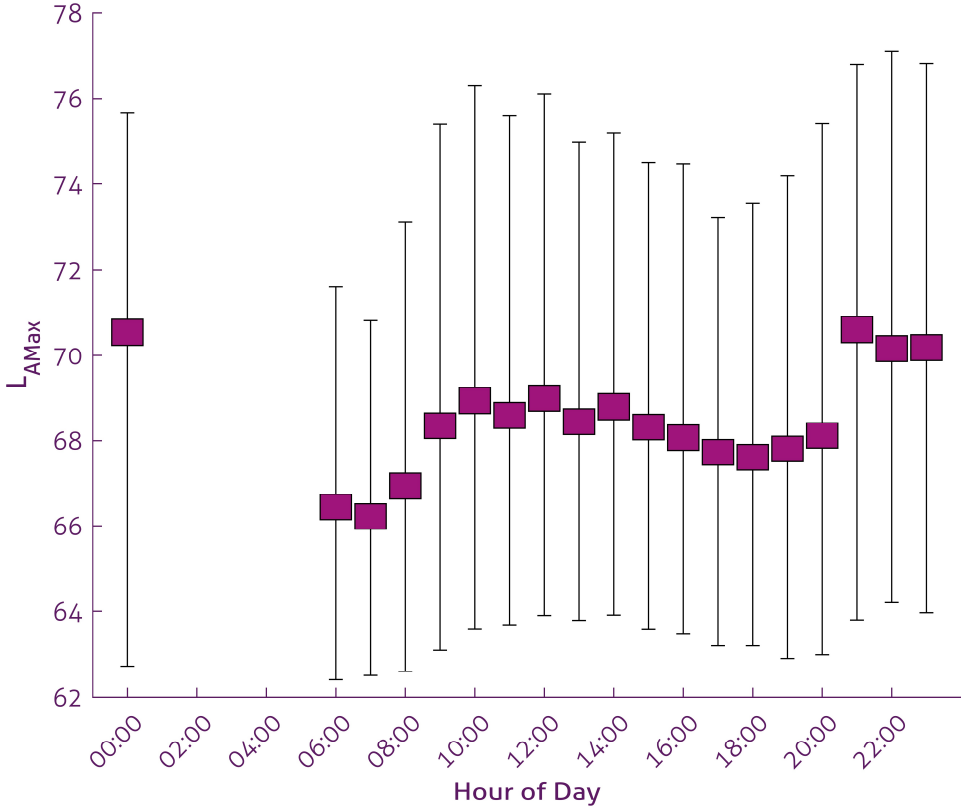
- Before 09:00, the vast majority of noise events were from small or medium sized aircraft; predominantly the A320 family.
- Small twin engine aircraft account for more than half the aircraft noise events throughout the day until 21:00 at which point the proportion of medium and large twin engine aircraft, and quad engine aircraft increases.
- 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 39).





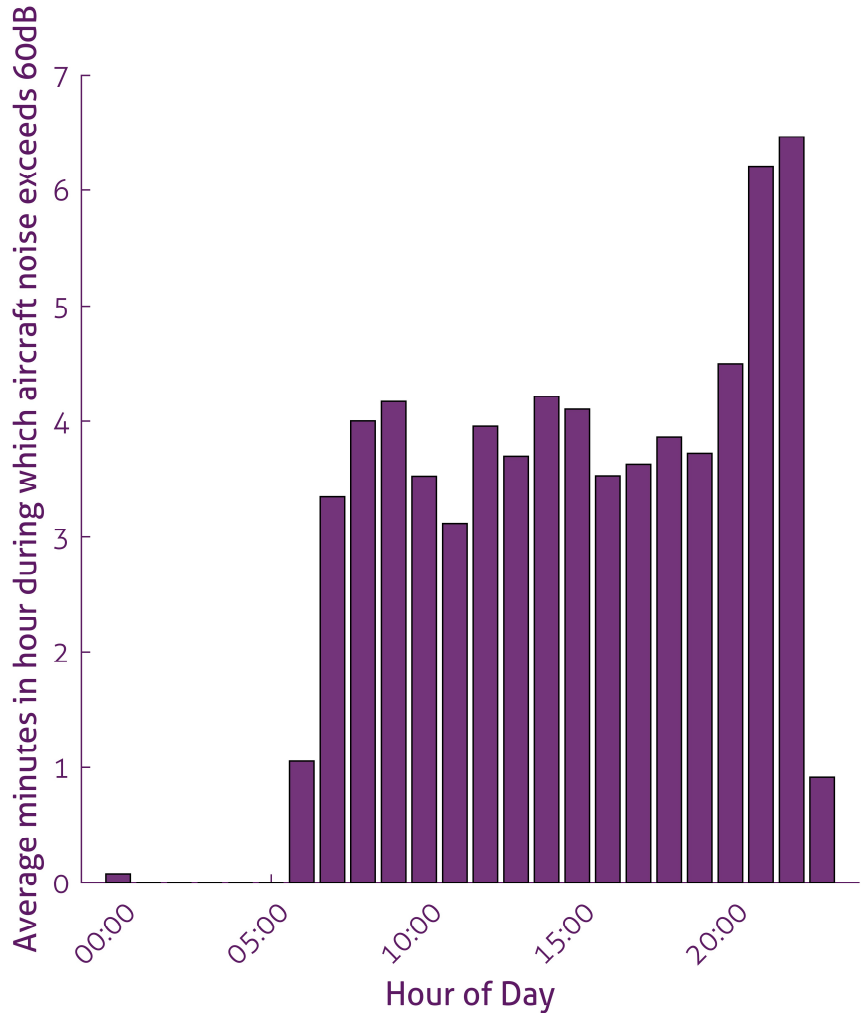
How does the L_{Amax} vary across a day?

- 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 increase to about 69dB around midday before reducing into early 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} values is generally between 10 and 12dB.



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

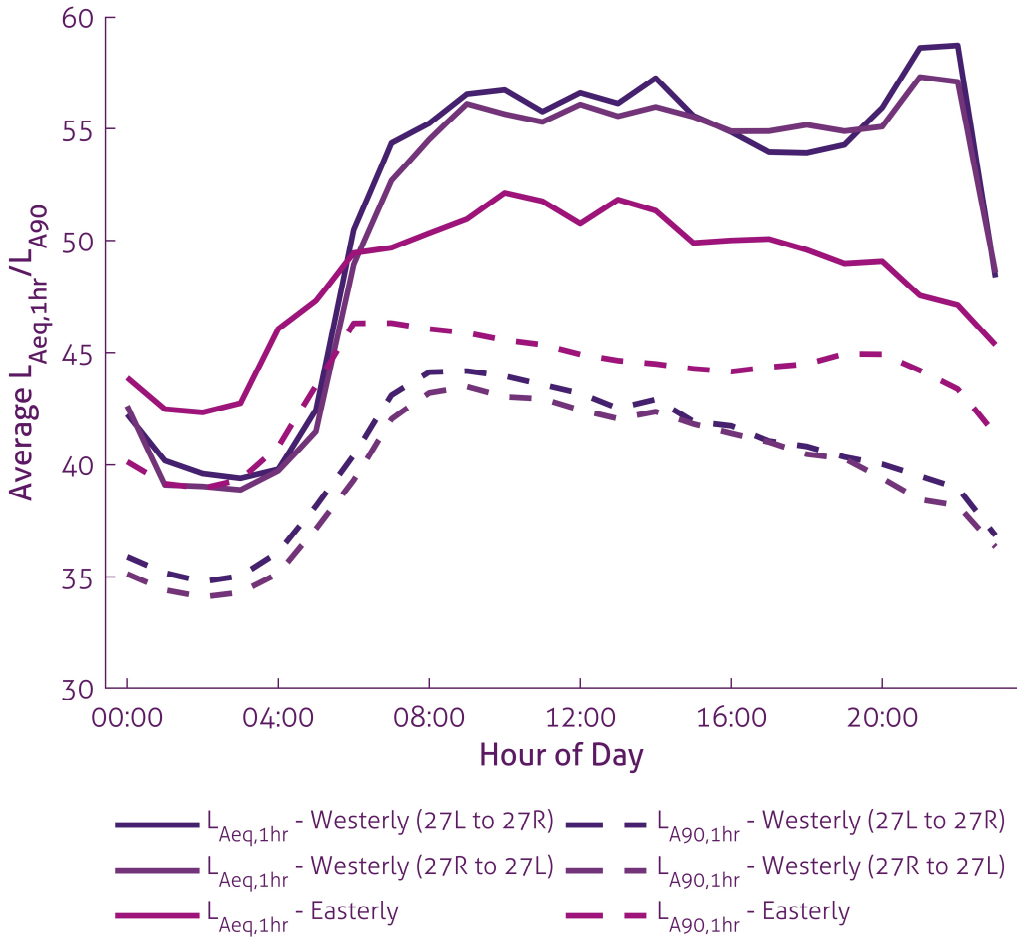
- The figure to the right shows the average number of minutes in each hour when the sound level within an aircraft noise event exceeded the measured noise event threshold - in this case 60dBA – on a day of full westerly operations. At this location this could be described as the amount of time (in minutes) that the aircraft noise level exceeds 60 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 4.5 minutes in each hour (5-7.5% of the hour) between the hours of 7am and 9pm.
- Between 9pm and 11pm this increased to 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.

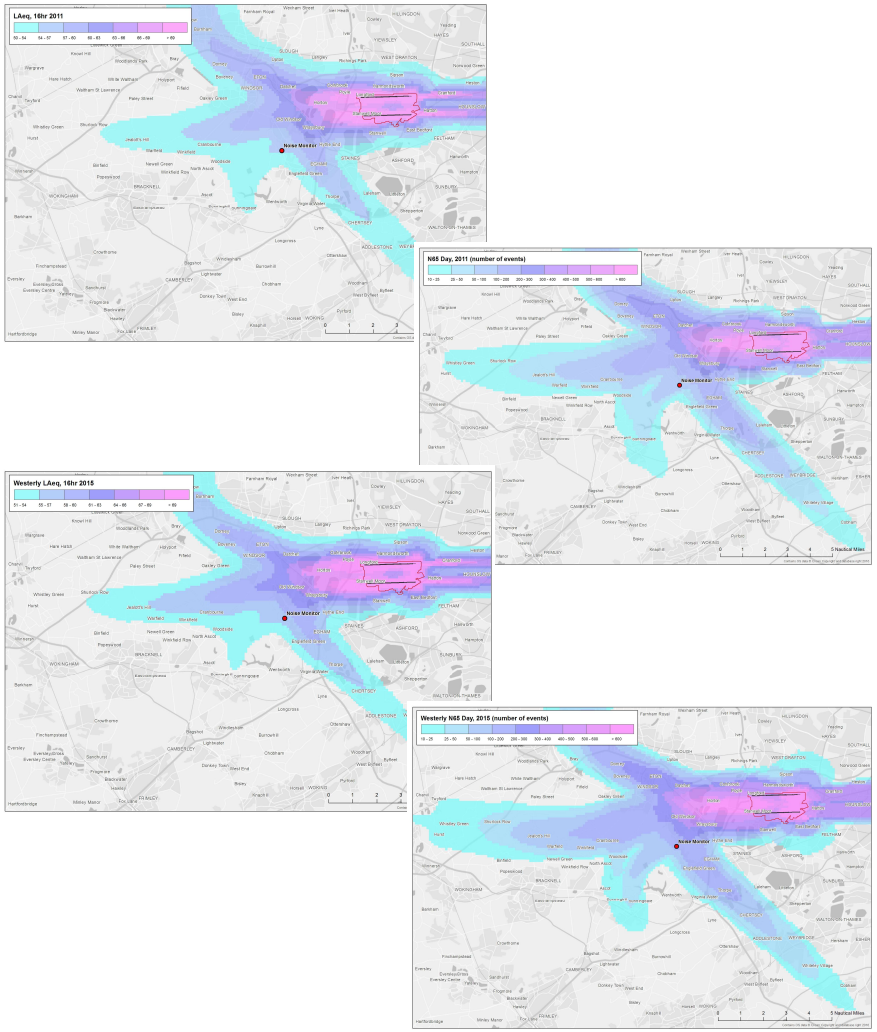
Do aircraft contribute to overall ambient noise levels on days of westerly operations?

- 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. The westerly days have been presented for both days when aircraft were departing runway 27L in the morning and 27R after 15:00 and the opposite.
- 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 LAeq,1hr values were around 4-6dB higher when compared with the same hour during a full easterly day. This difference rises to 10dB between 21:00 and 23:00. This indicates that the overall noise environment for each hour is governed by aircraft noise when on westerly operations.
- The noise levels over the day are very similar when aircraft depart 27L in the morning and 27R in the afternoon compared to 27R in the morning and 27L in the afternoon.
- 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 58dB on westerly operations at a time when background noise (as indicated by the L_{A90}) is reducing.
- During the period the monitor was in place, the average daytime LAeq,16hr, 1hr average between 07:00 and 23:00 was 56dB on westerly operations and 50dB on easterly operations from all noise sources.
- During the night, the average LAeq,8hr,1hr average between 23:00 and 07:00 was 45dB 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 in mind.

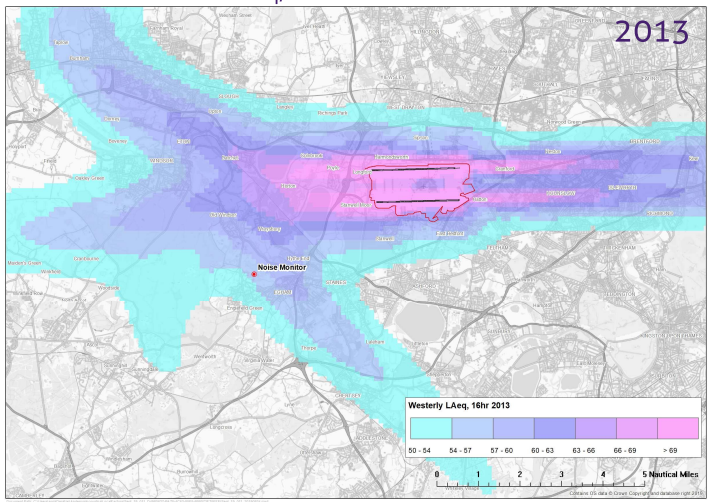


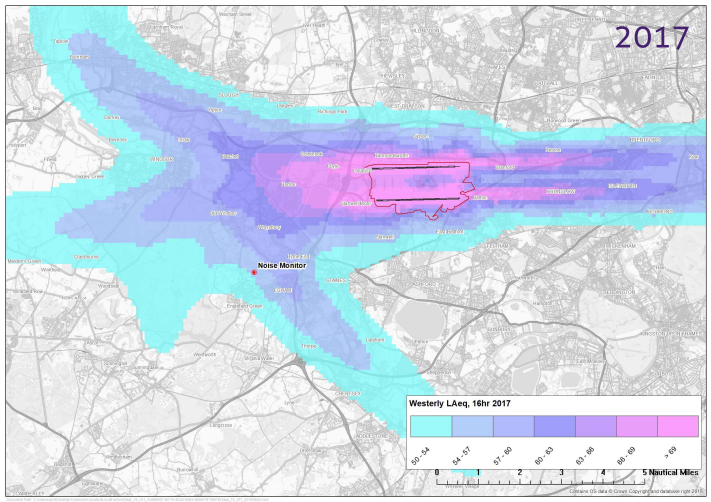
Average **daytime** aircraft noise levels – westerly operations

- 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.

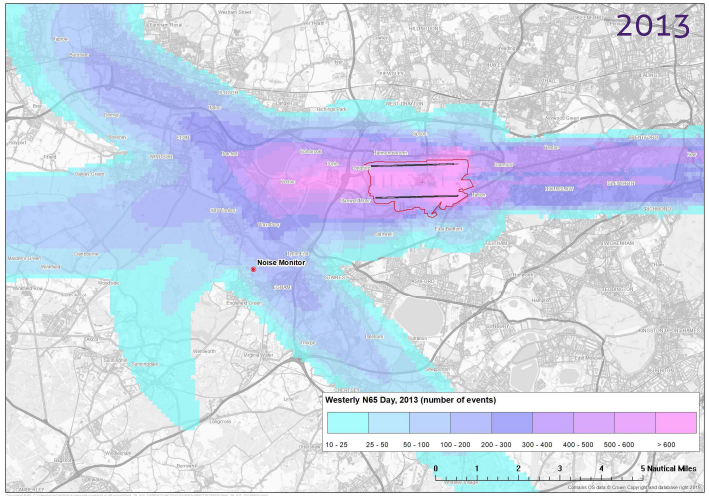
- Larger figures are shown in Appendix A.

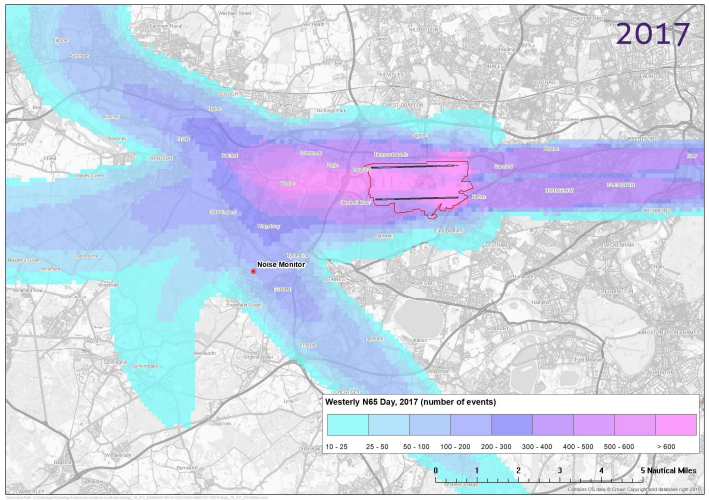
$L_{Aeq,16hr}$





N65, Daytime

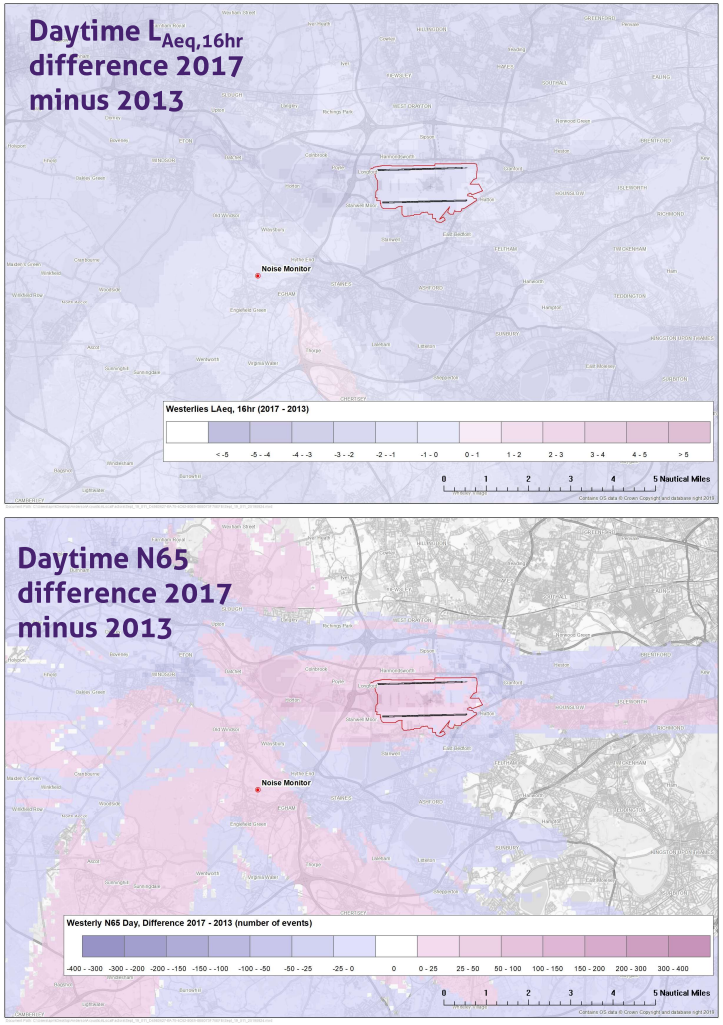




Differences in average **daytime** aircraft noise levels – westerly operations

- 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 Englefield Green there was up to a 1dB decrease in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017.
- 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.

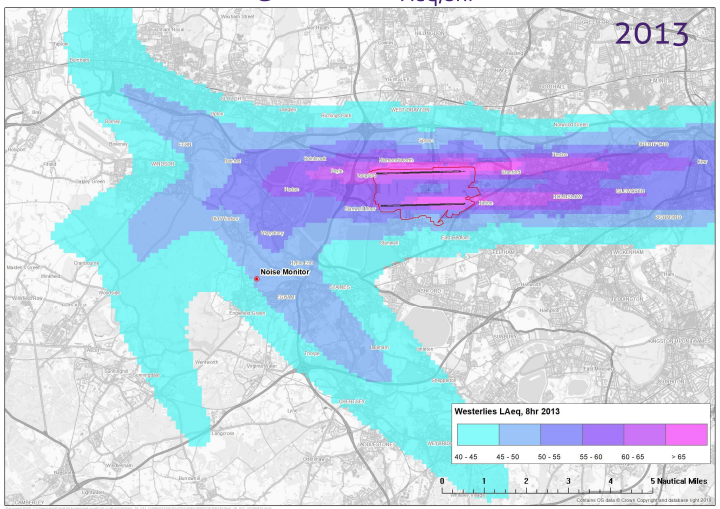


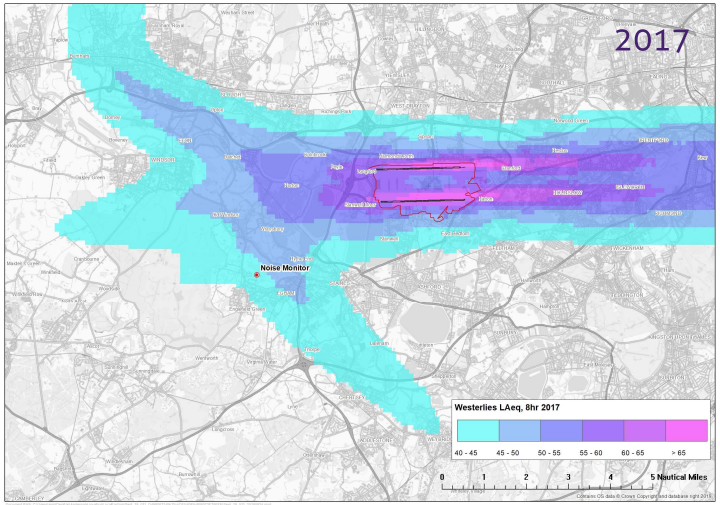
Average **night-time** aircraft noise levels – westerly operations

- The figures to the right show the 2013 and 2014 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 in contours from 1 up to greater than 80 on occasions when the airport is on westerly operations.

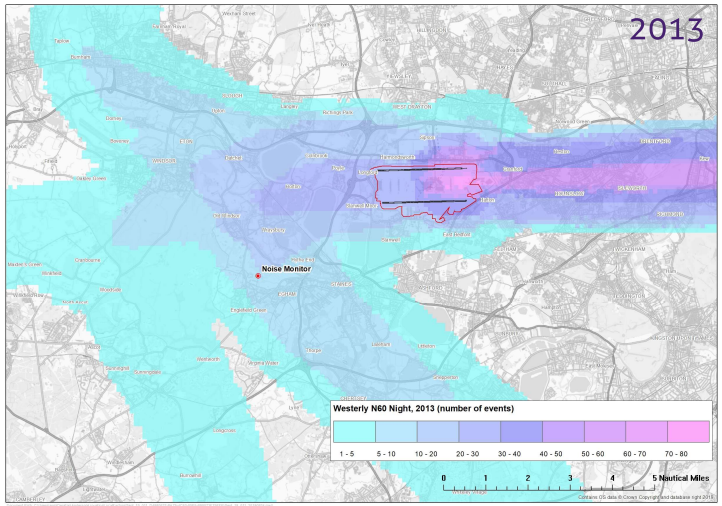
- Larger figures are shown in Appendix A.

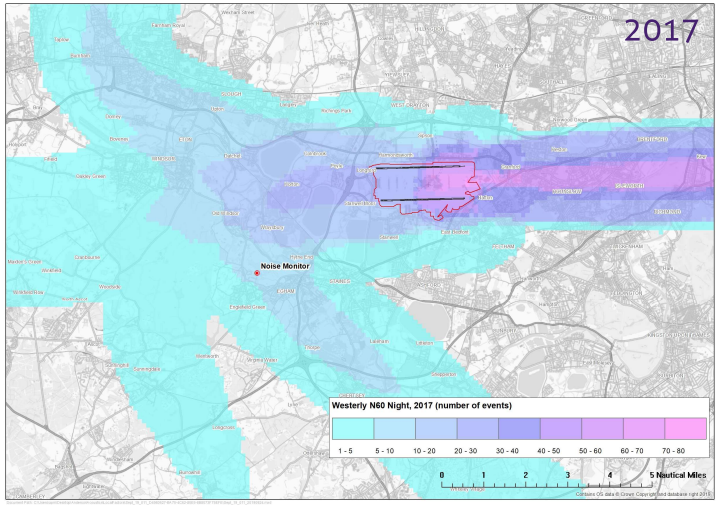
Night-time $L_{Aeq,8hr}$





N60, night-time

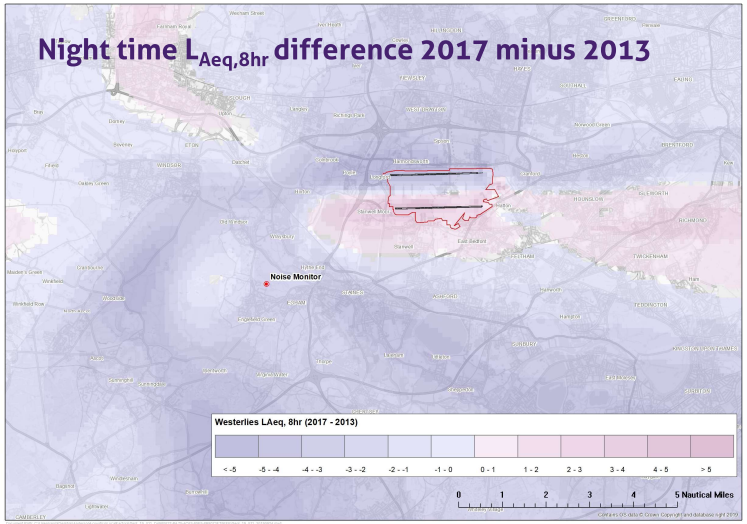


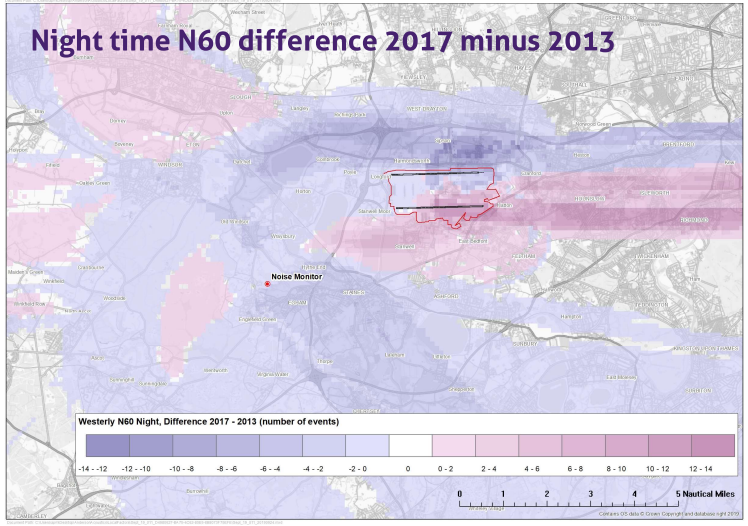


Differences in average **night-time** aircraft noise levels – westerly operations

- 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 average night-time aircraft noise $L_{Aeq,8hr}$ decreased by between 2 and 3 decibels and the N60 decreased by up to 2 at Englefield Green from 2013 to 2017.

- Larger figures are shown in Appendix A.





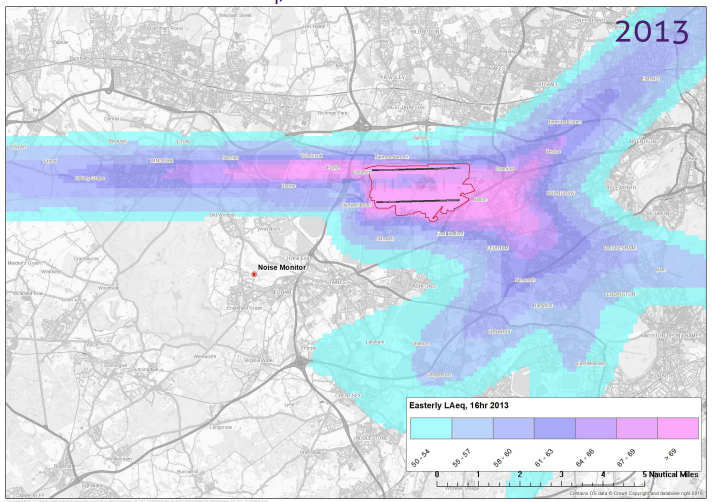
Average **daytime** aircraft noise levels – easterly operations

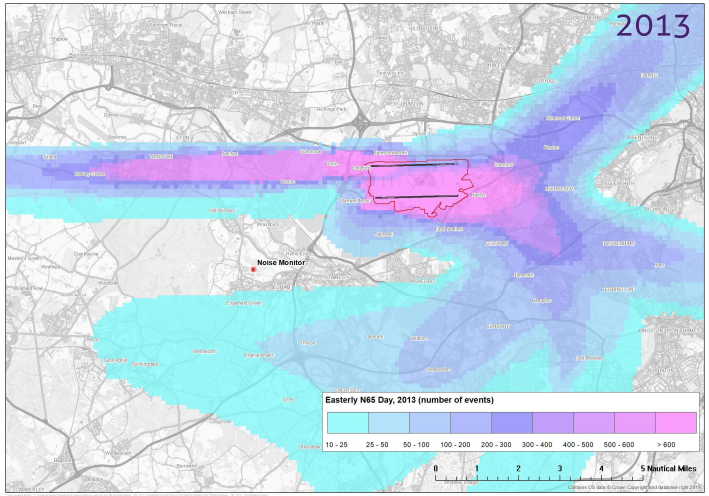
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq, 16hr}$ bands in the left column and N65 bands in the right column for **an average easterly summer day when the airport is on 100% easterly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined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

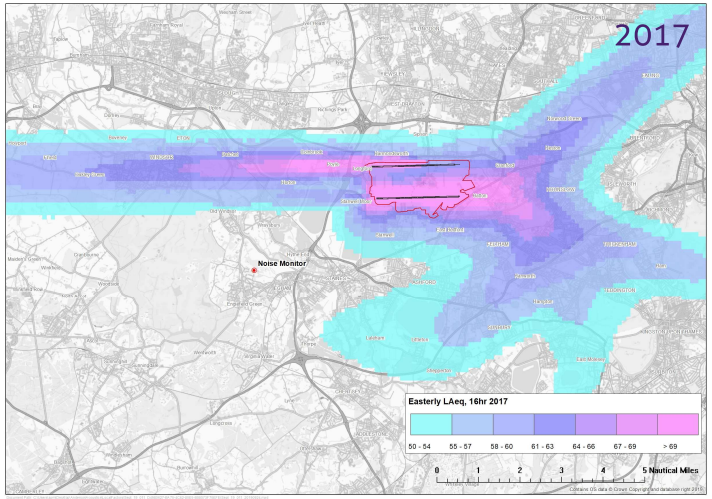
- Larger figures are shown in Appendix A.

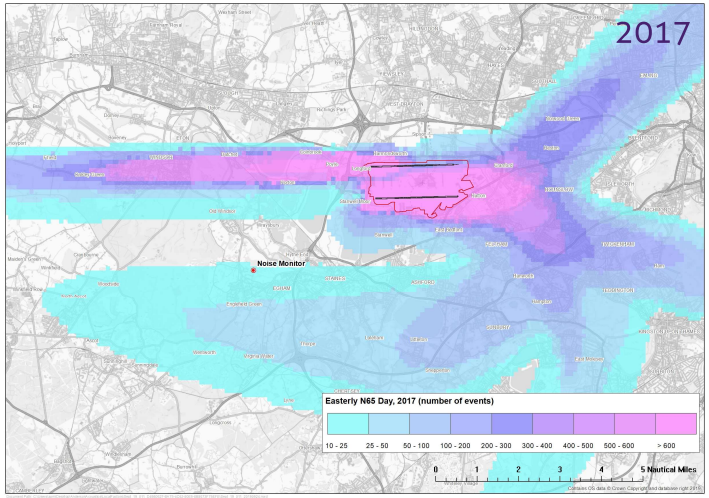
$L_{Aeq,16hr}$

N65, Daytime





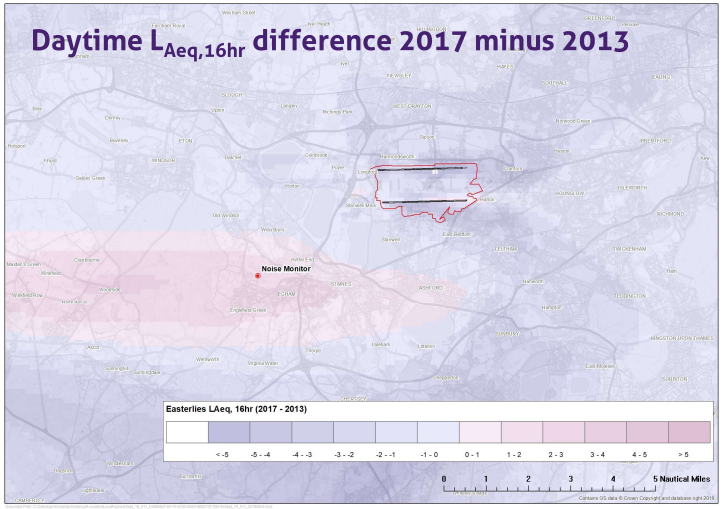


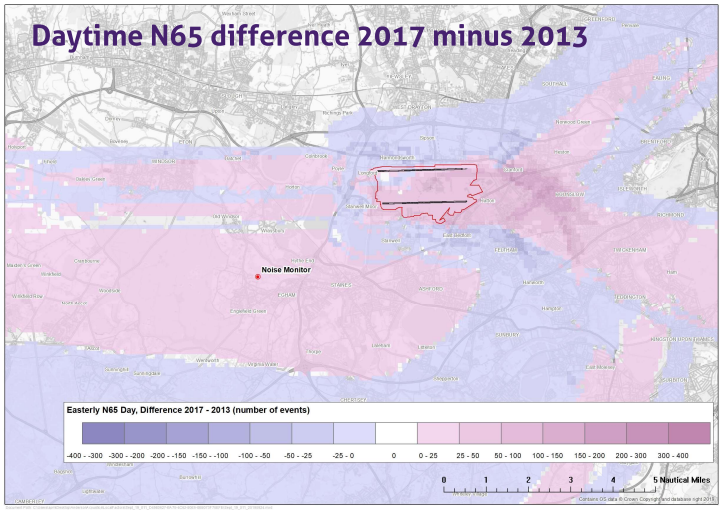


Differences in average **daytime** aircraft noise levels – easterly operations

- 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 (in 2017 compared to 2013) are shown in blue and those areas with an increase in average exposure shown in pink.
- At Englefield Green there was between a 1 and 2dB increase in average modelled daytime noise level $L_{Aeq,16hr}$ between 2013 and 2017.
- 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.

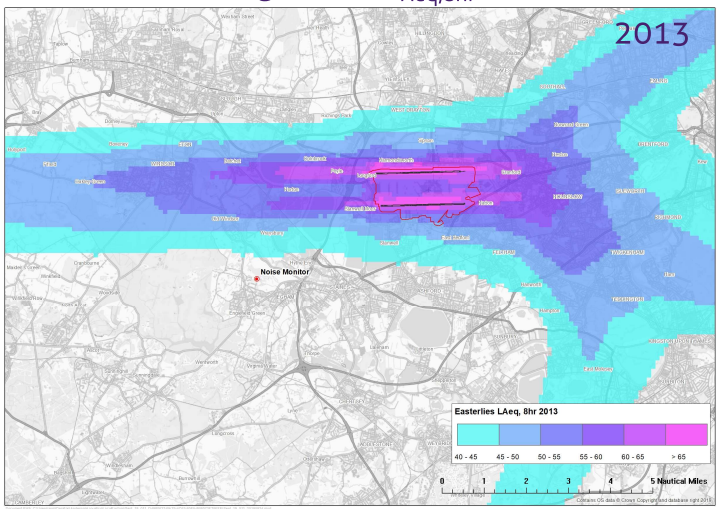


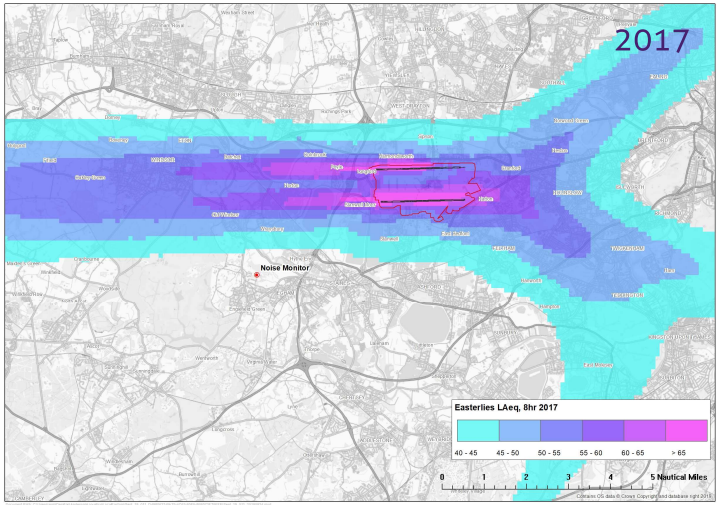


Average **night-time** aircraft noise levels – easterly operations

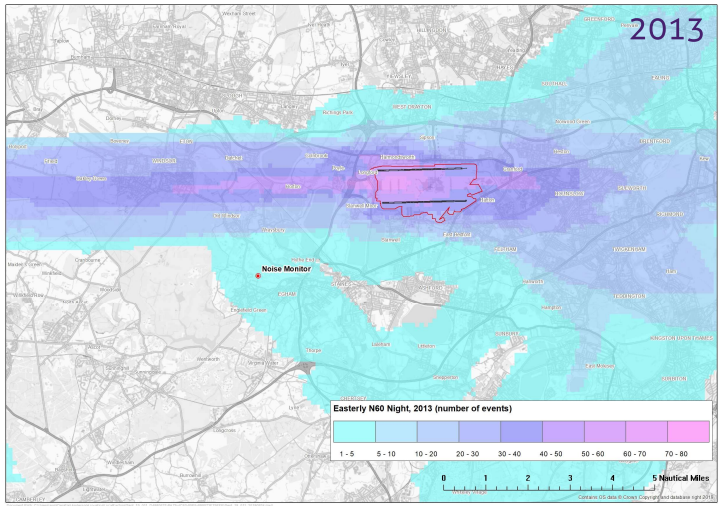
- The figures to the right show the 2013 and 2017 night-time $L_{Aeq, 8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on an average easterly summer night between 11pm and 7am when there are 100% easterly operations. Generated from **an average easterly 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.

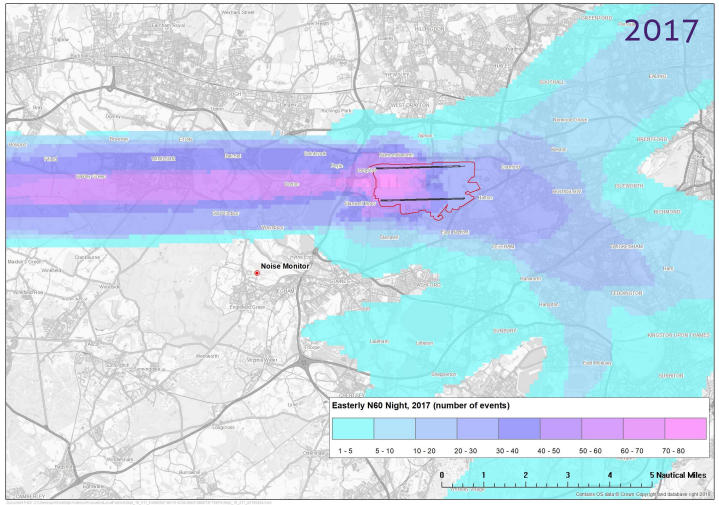
Night-time $L_{Aeq,8hr}$





N60, night-time

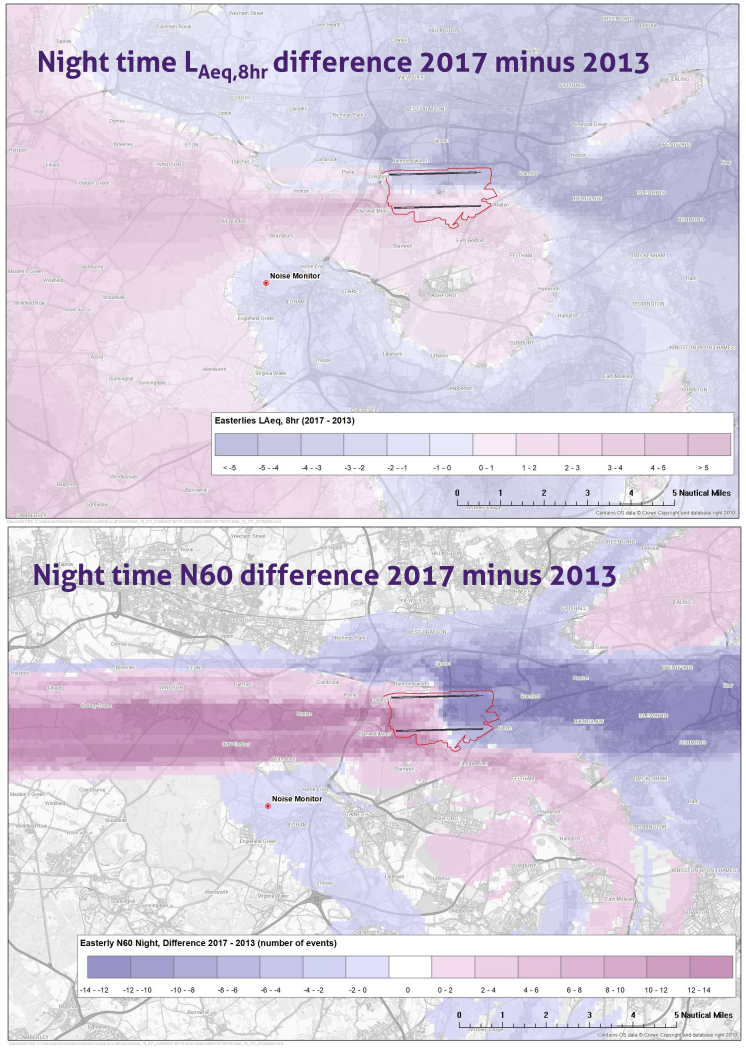




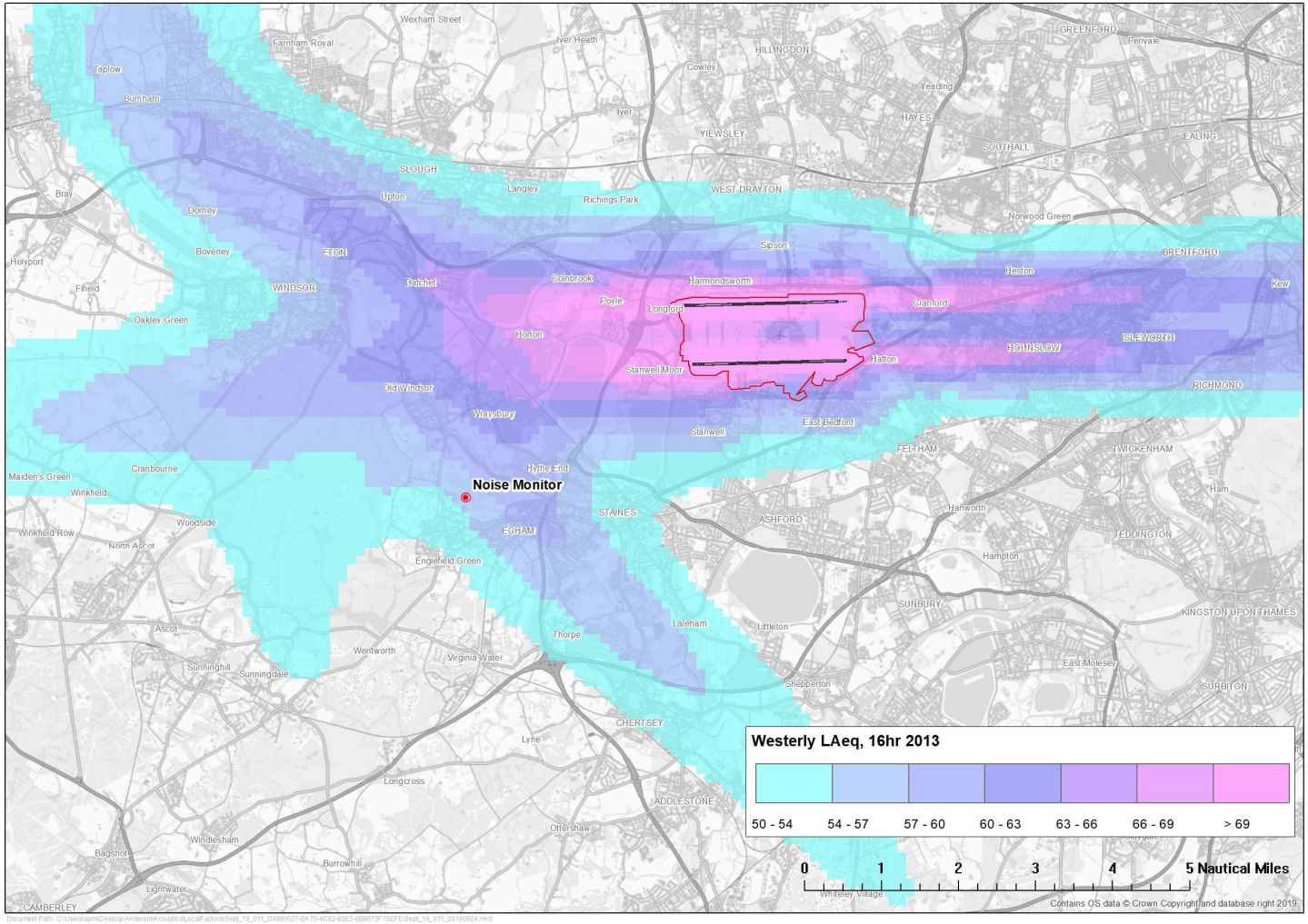
Differences in average **night-time** aircraft noise levels – easterly operations

- 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 (in 2017 compared to 2013) are shown in blue and those areas with an average increase in pink.
- The results indicate a 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 Englefield Green from 2013 to 2017.

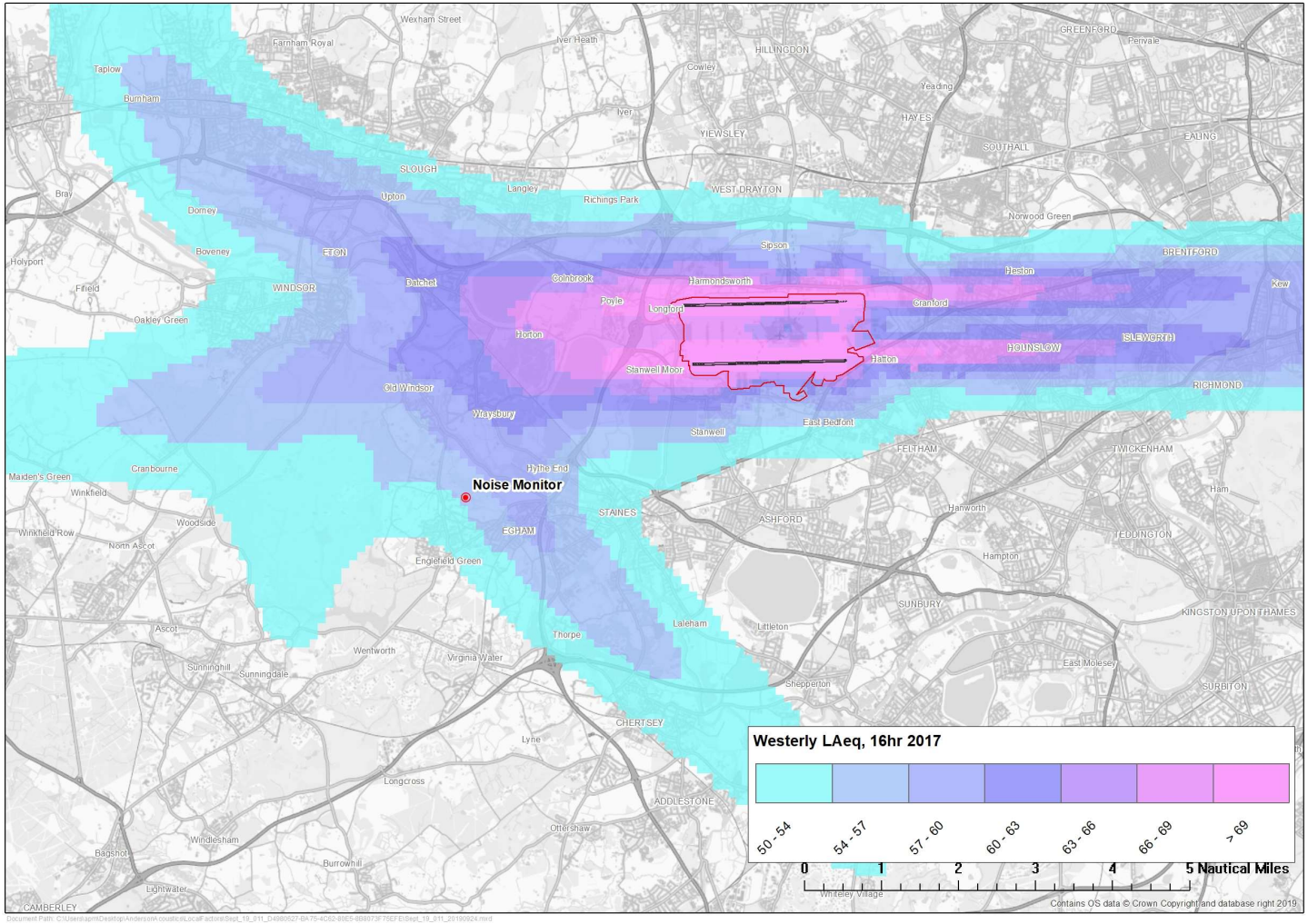
- Larger figures are shown in Appendix A.



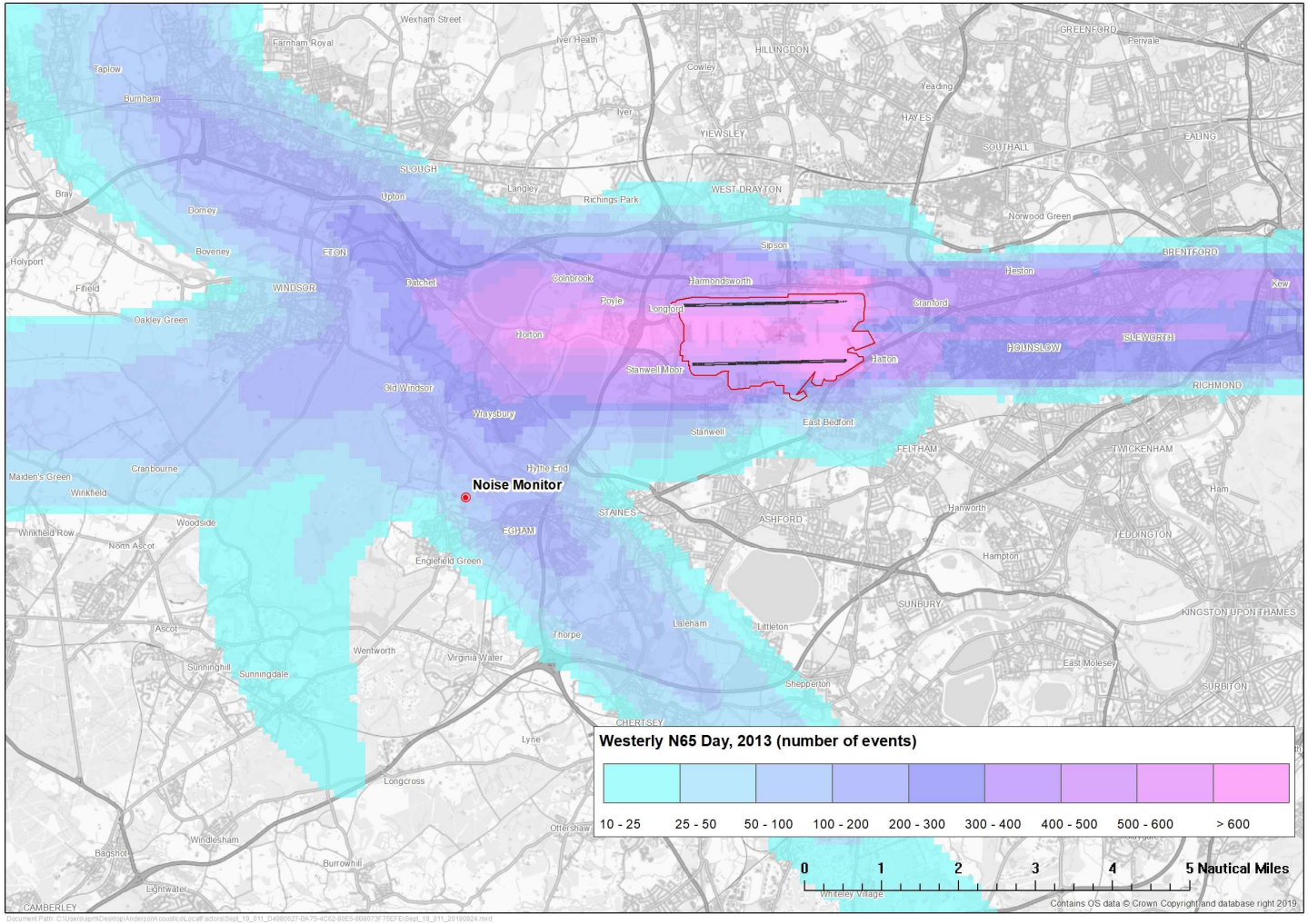
Appendix A: Average westerly day $L_{Aeq, 16hr}$ contours (2013)



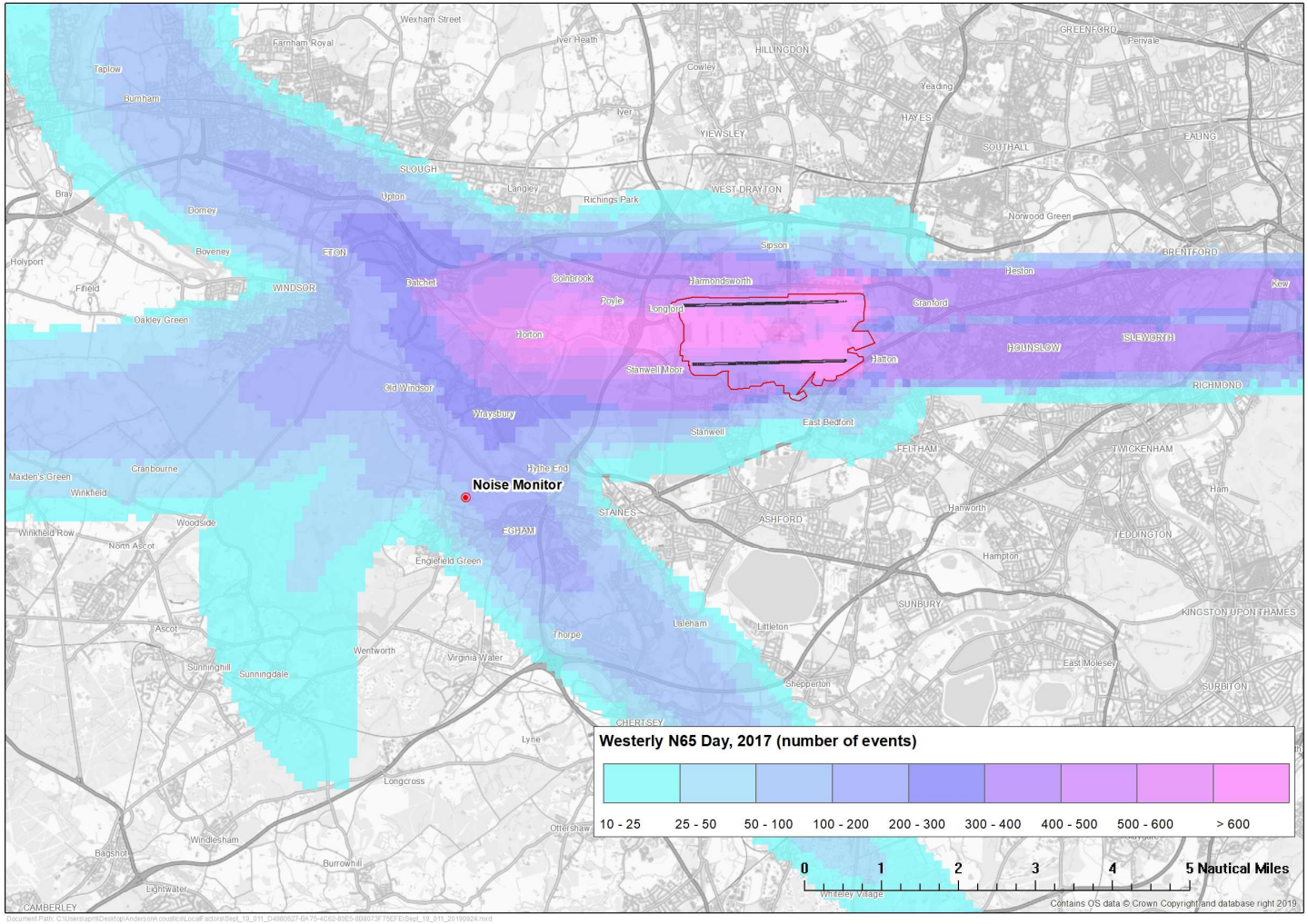
Appendix A: Average westerly day $L_{Aeq, 16hr}$ contours (2017)



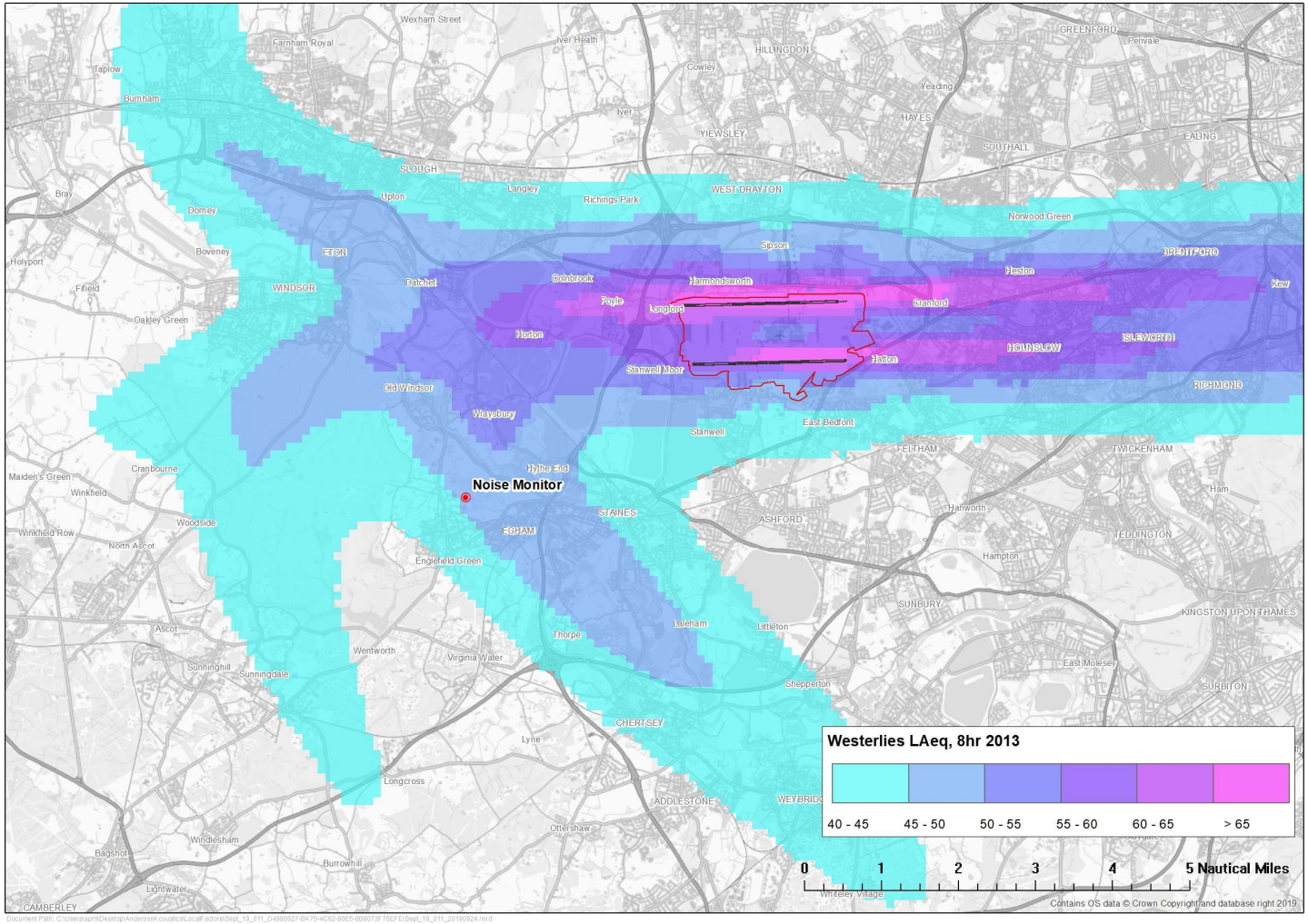
Appendix A: Average westerly day $N65_{16hr}$ contours (2013)



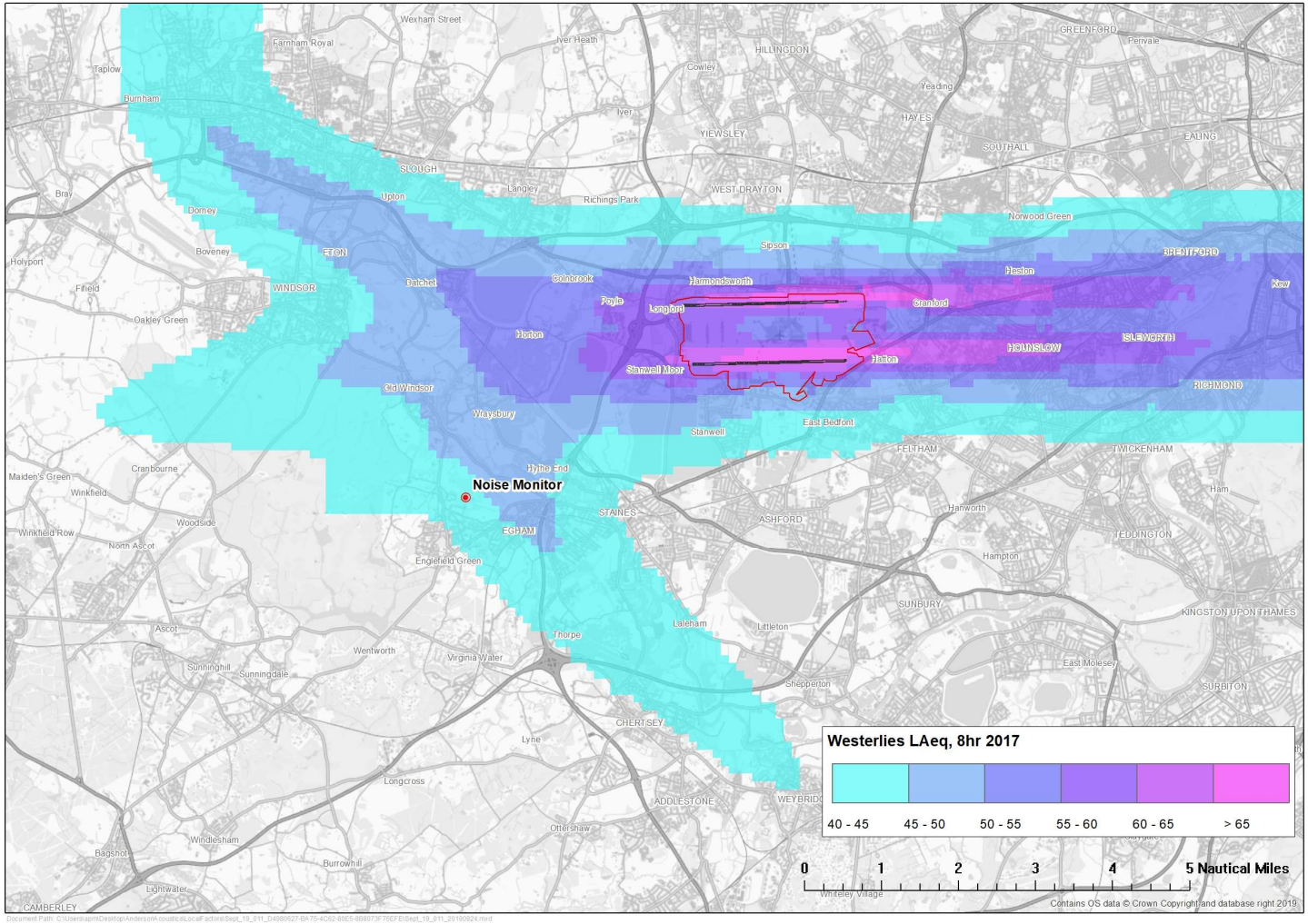
Appendix A: Average westerly day $N65_{16hr}$ contours (2017)



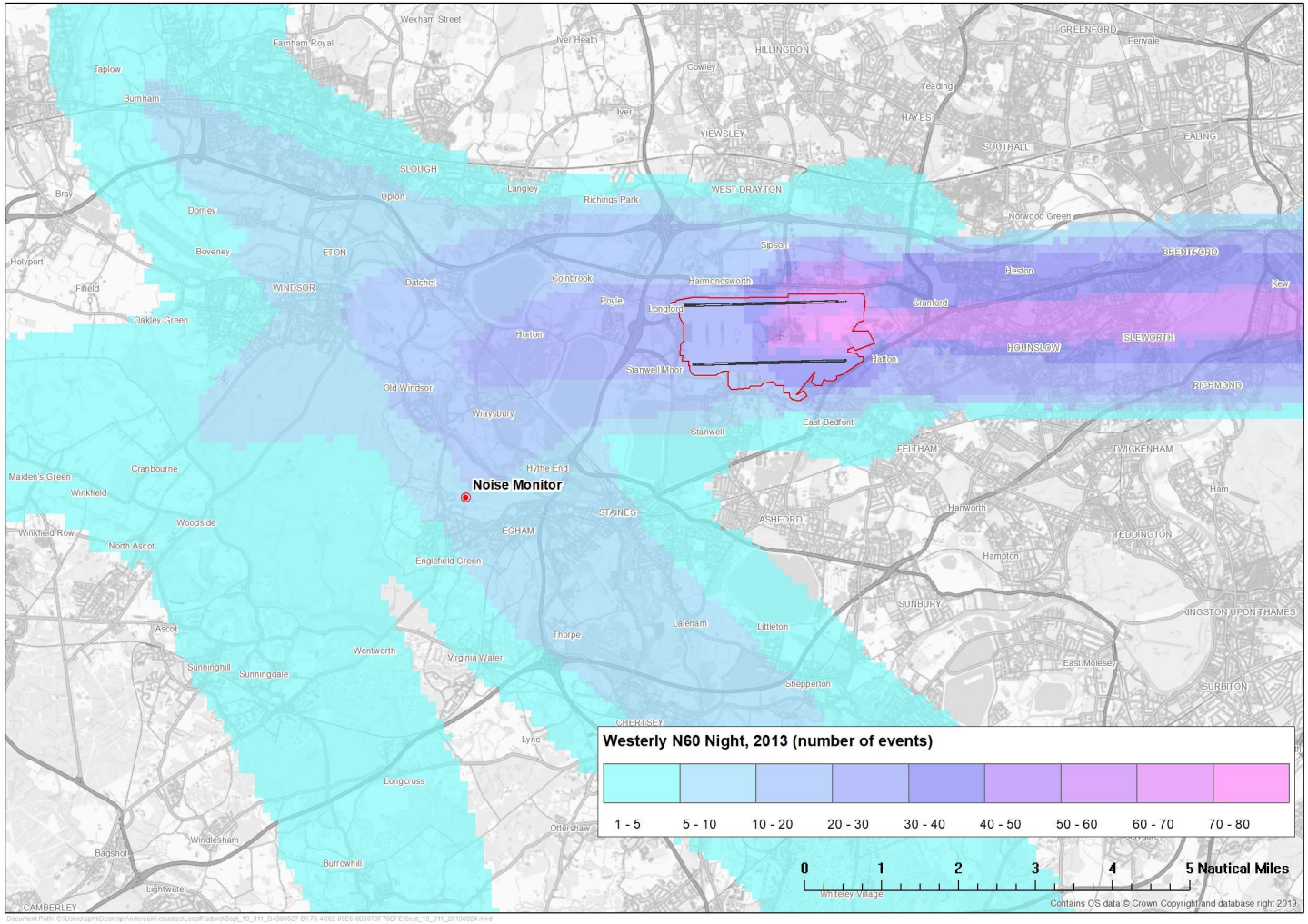
Appendix A: Average westerly night $L_{Aeq, 8hr}$ contours (2013)



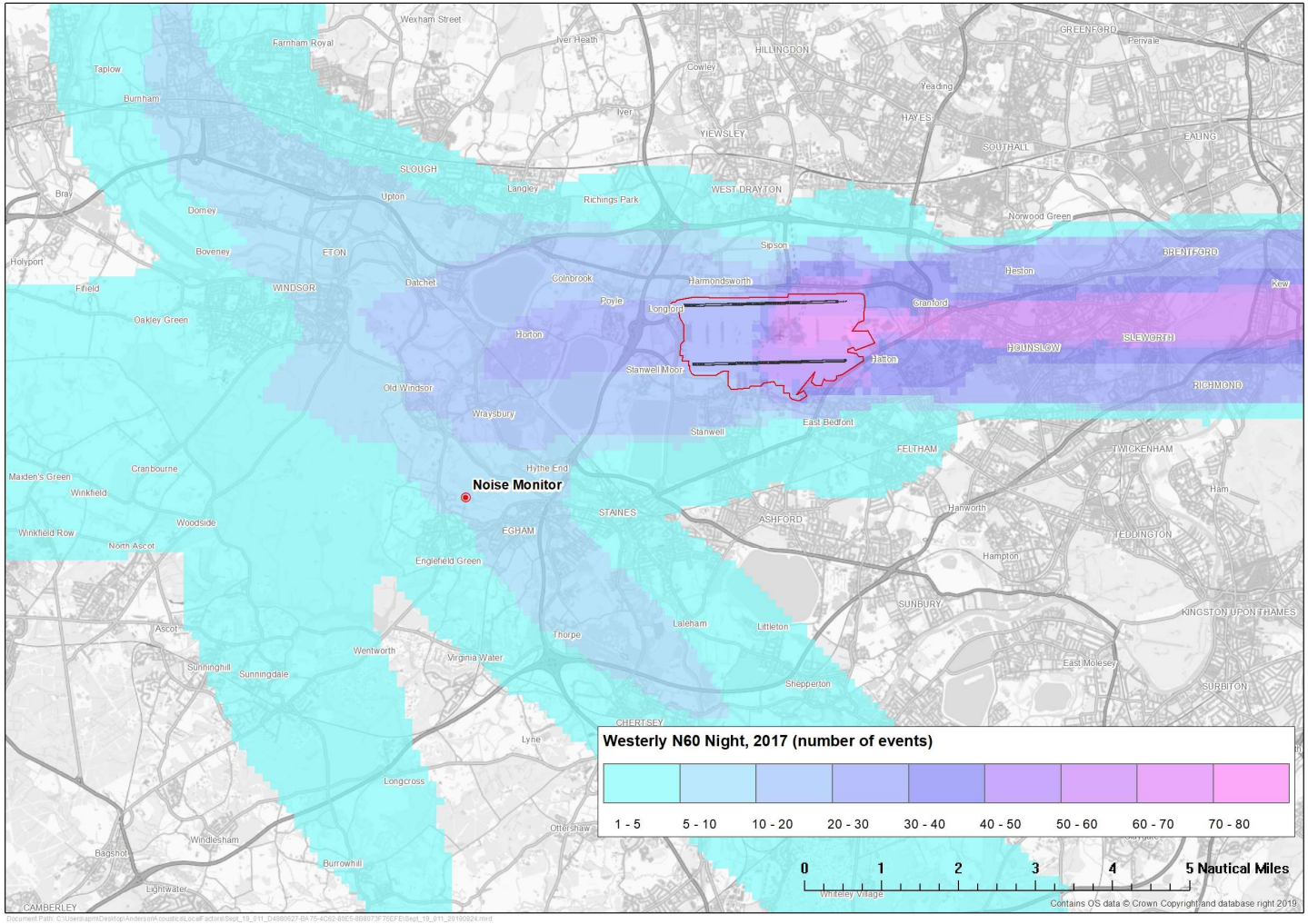
Appendix A: Average westerly night $L_{Aeq, 8hr}$ contours (2017)



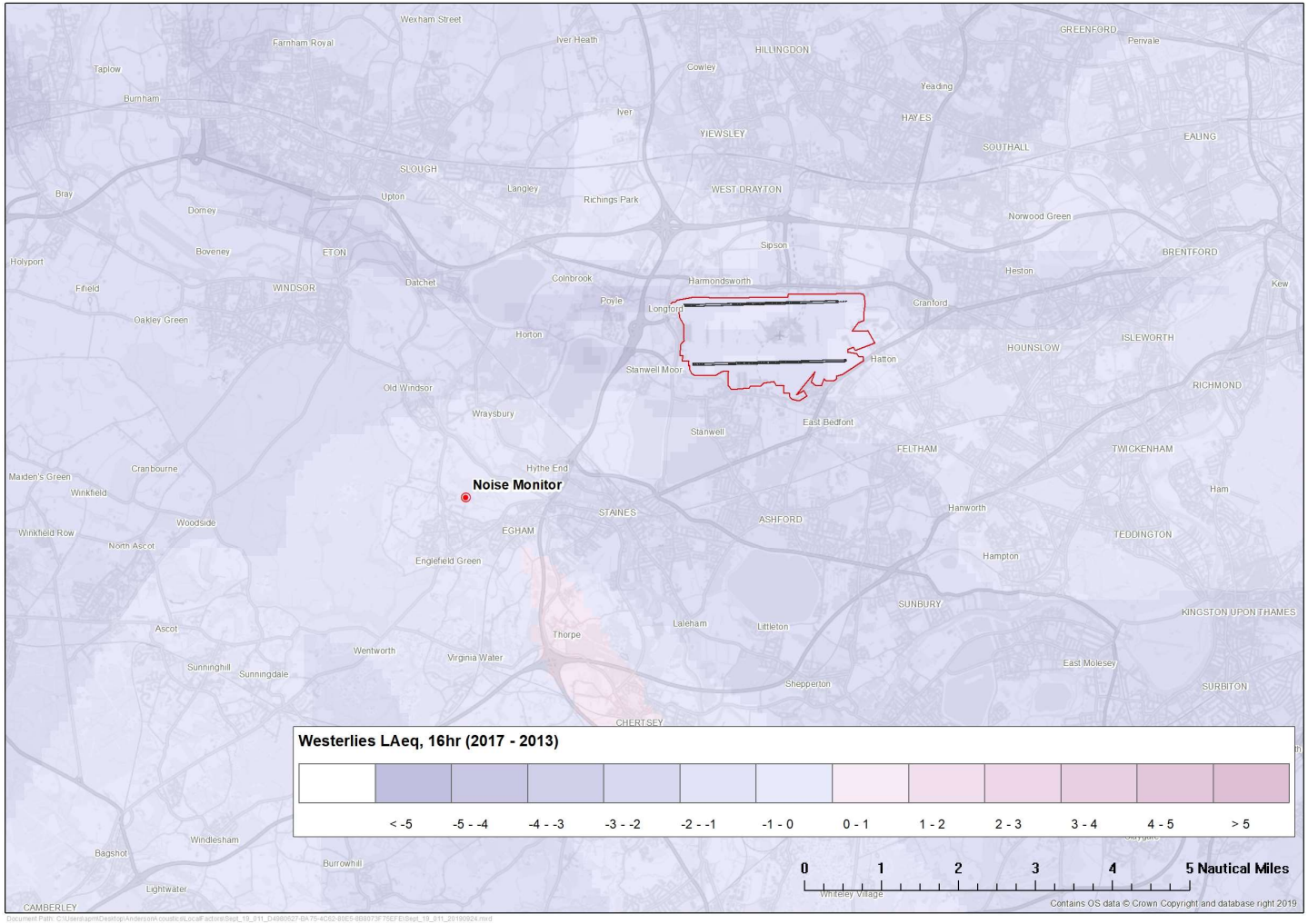
Appendix A: Average westerly night $N60_{8hr}$ contours (2013)



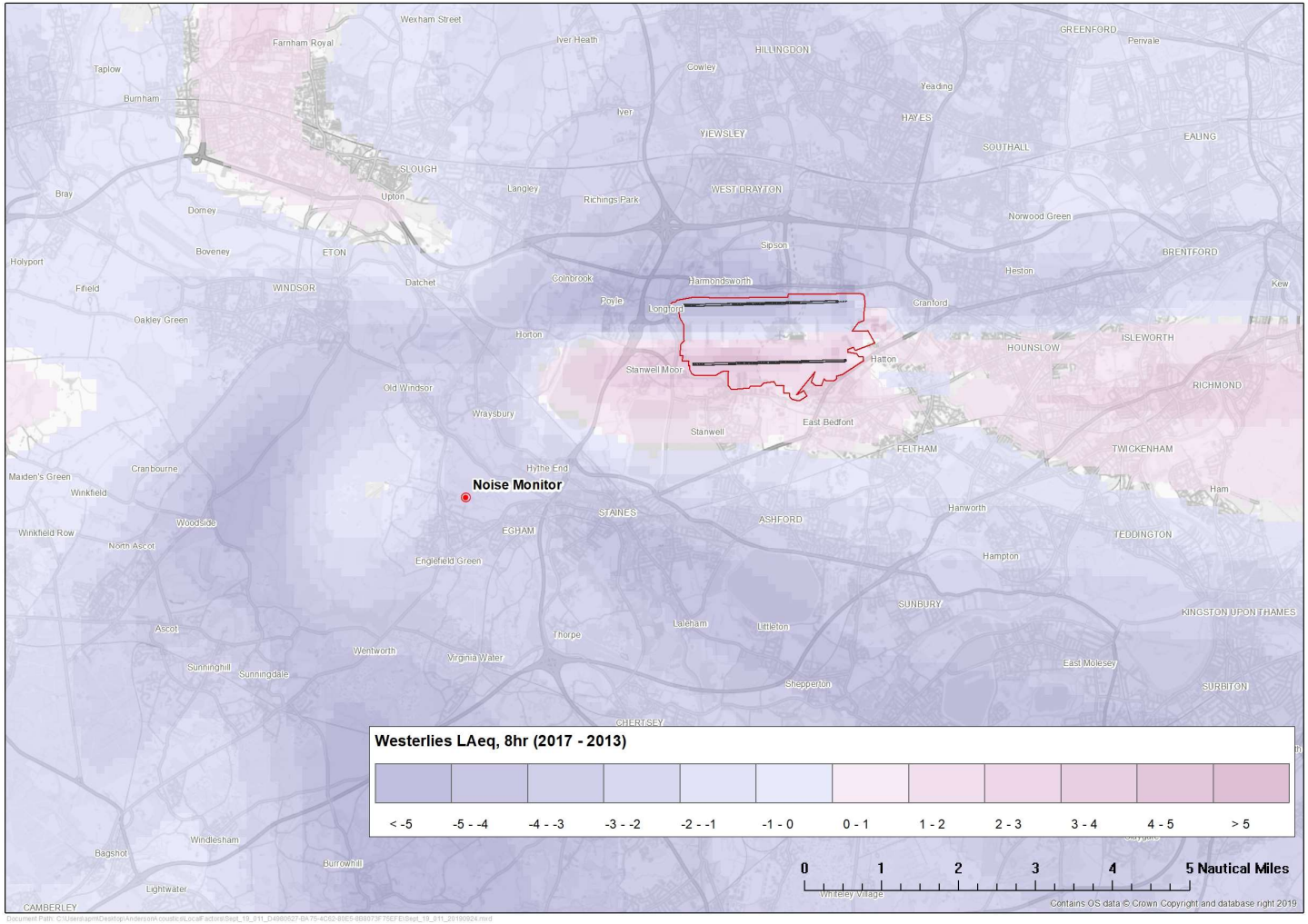
Appendix A: Average westerly night $N60_{8hr}$ contours (2017)



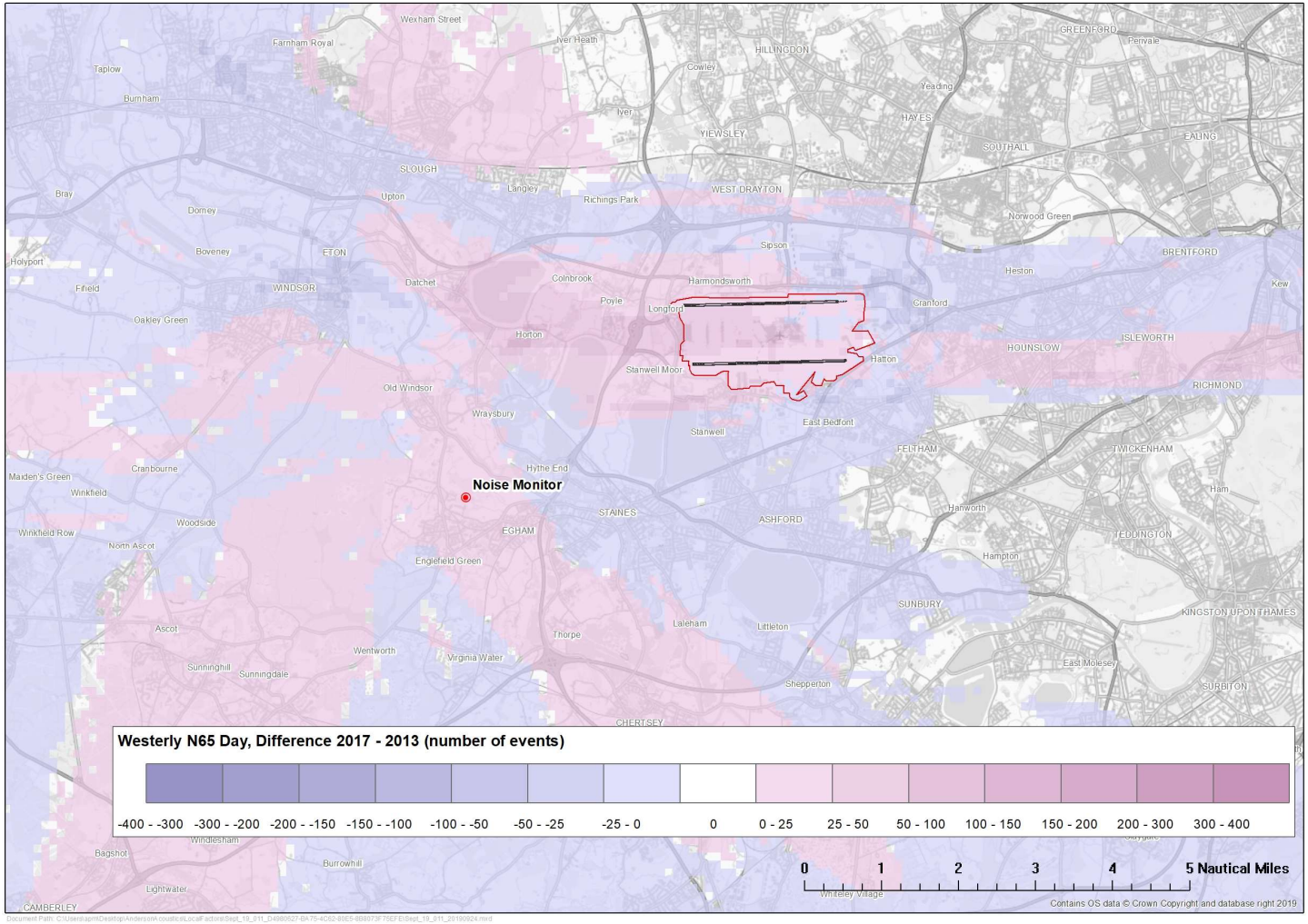
Appendix A: Average westerly day $L_{Aeq, 16hr}$ difference (2017 minus 2013)



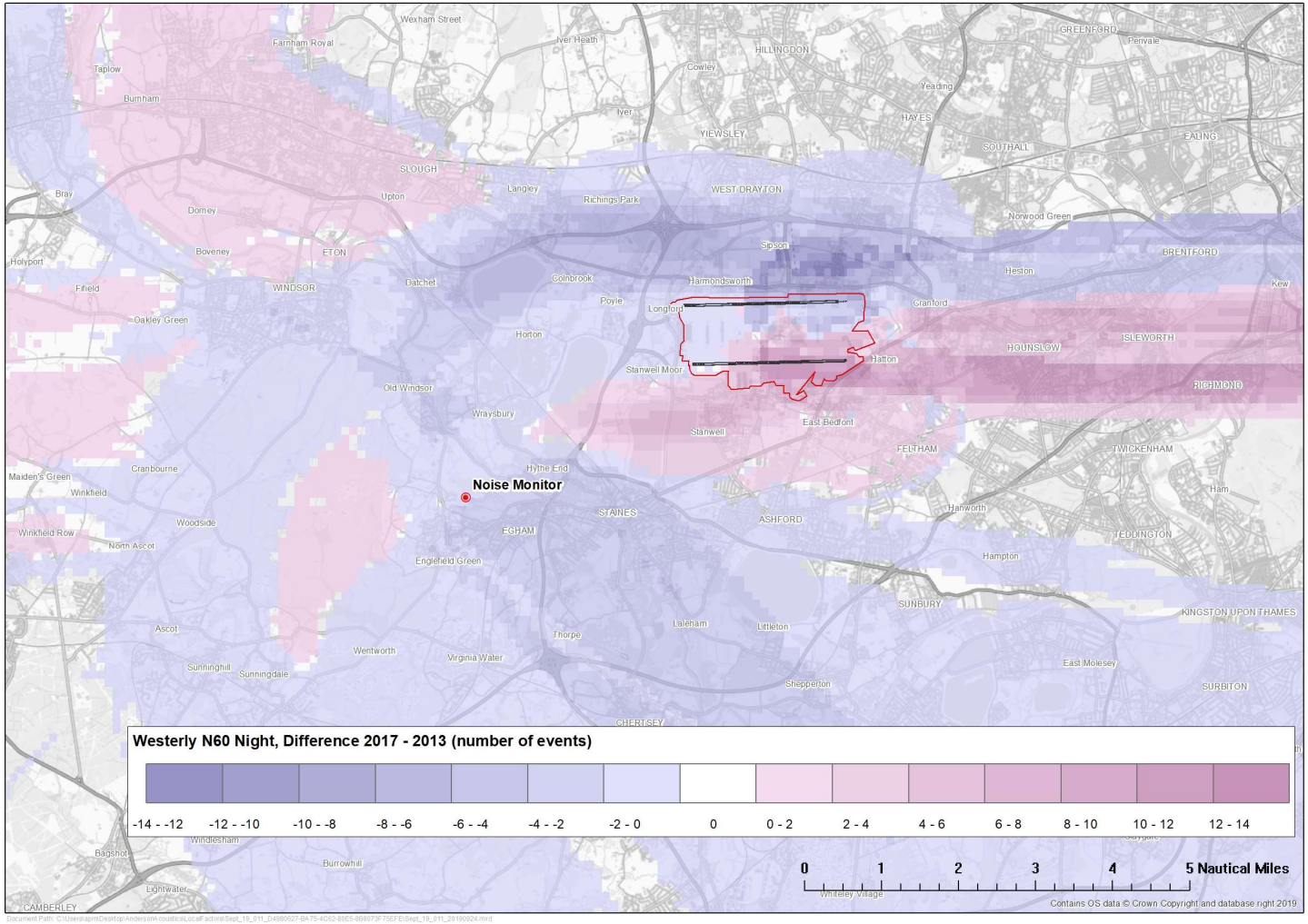
Appendix A: Average westerly night $L_{Aeq, 8hr}$ difference (2017 minus 2013)



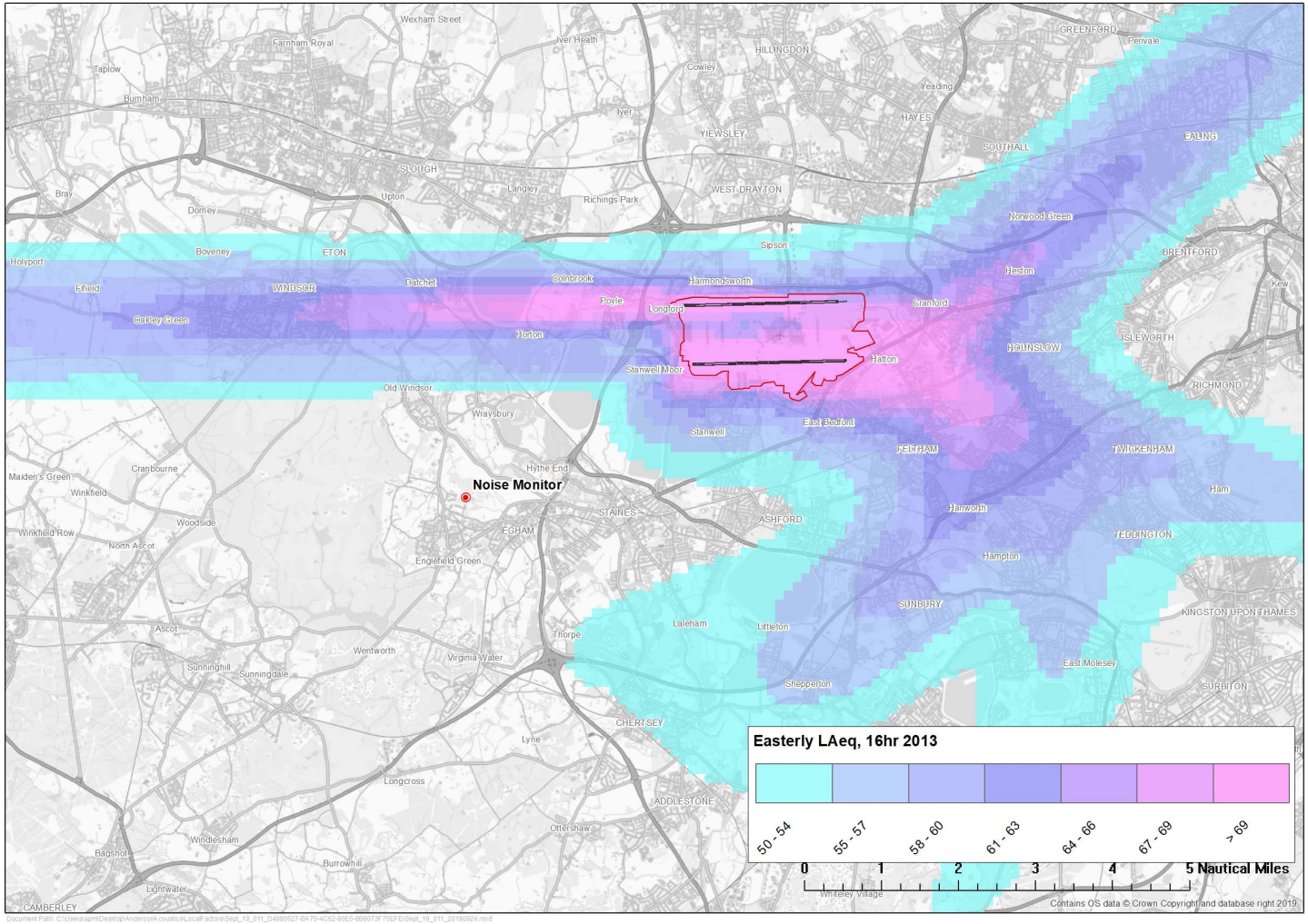
Appendix A: Average westerly day $N65_{16hr}$ difference (2017 minus 2013)



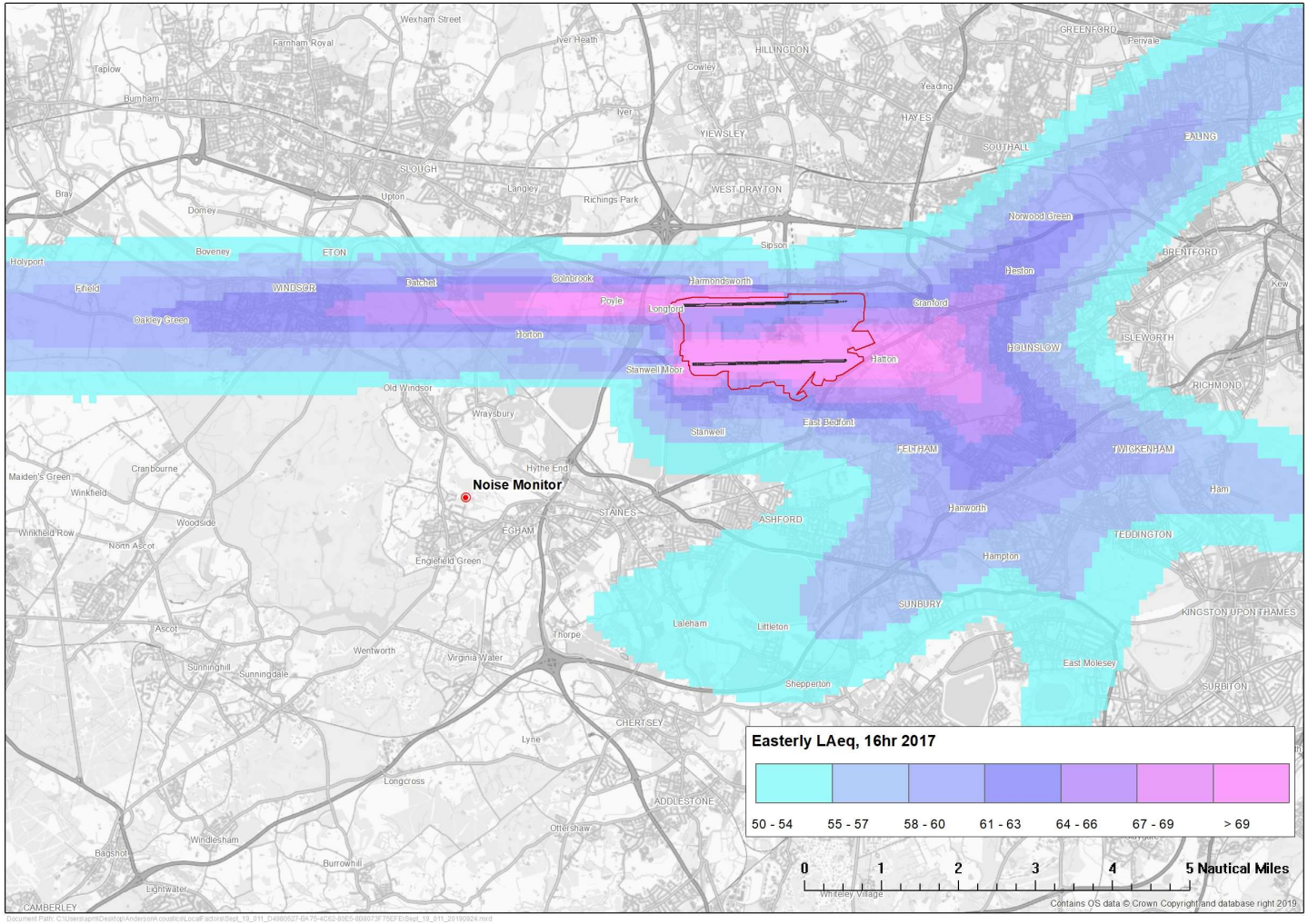
Appendix A: Average westerly night $N60_{8hr}$ difference (2017 minus 2013)



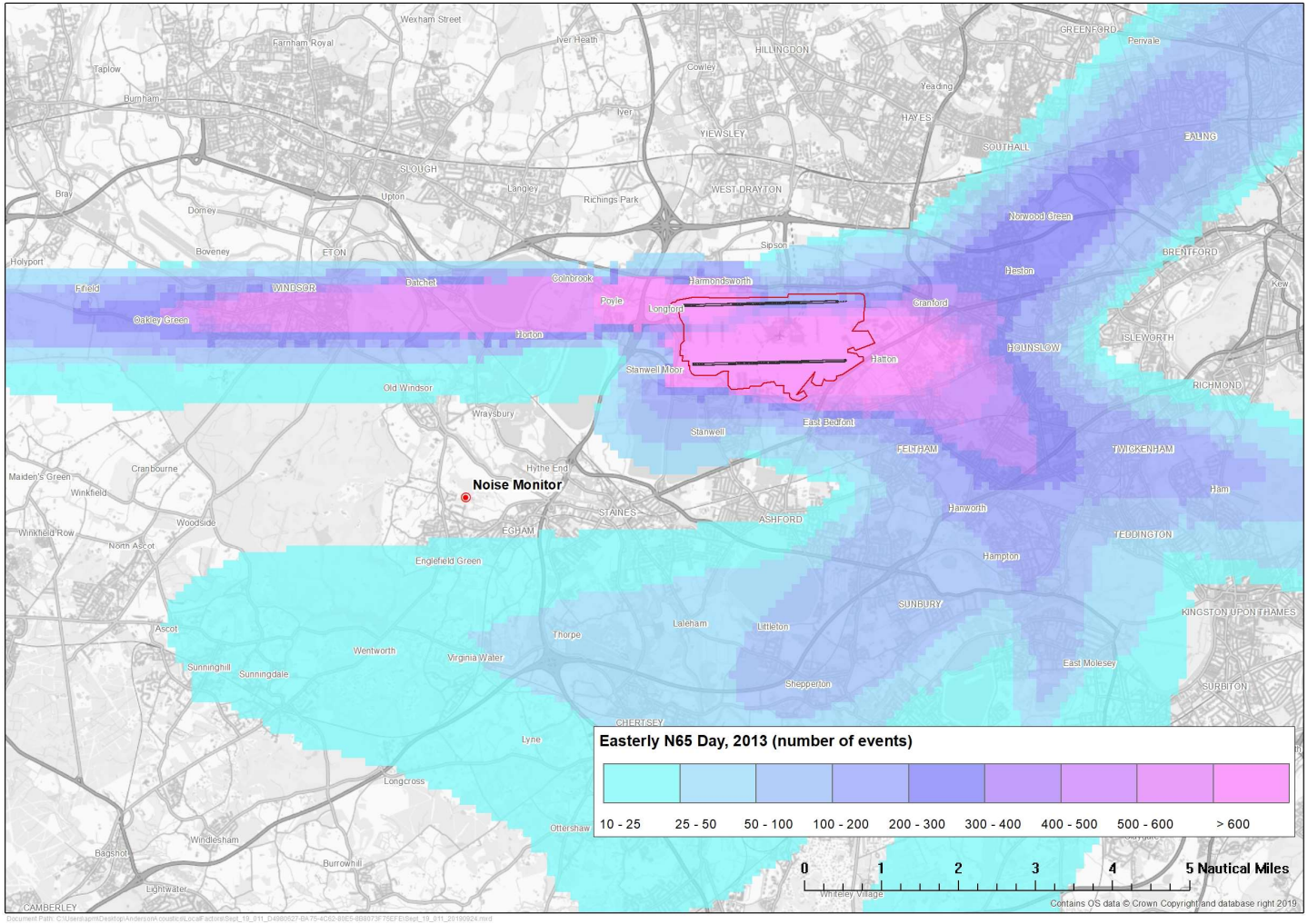
Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2013)



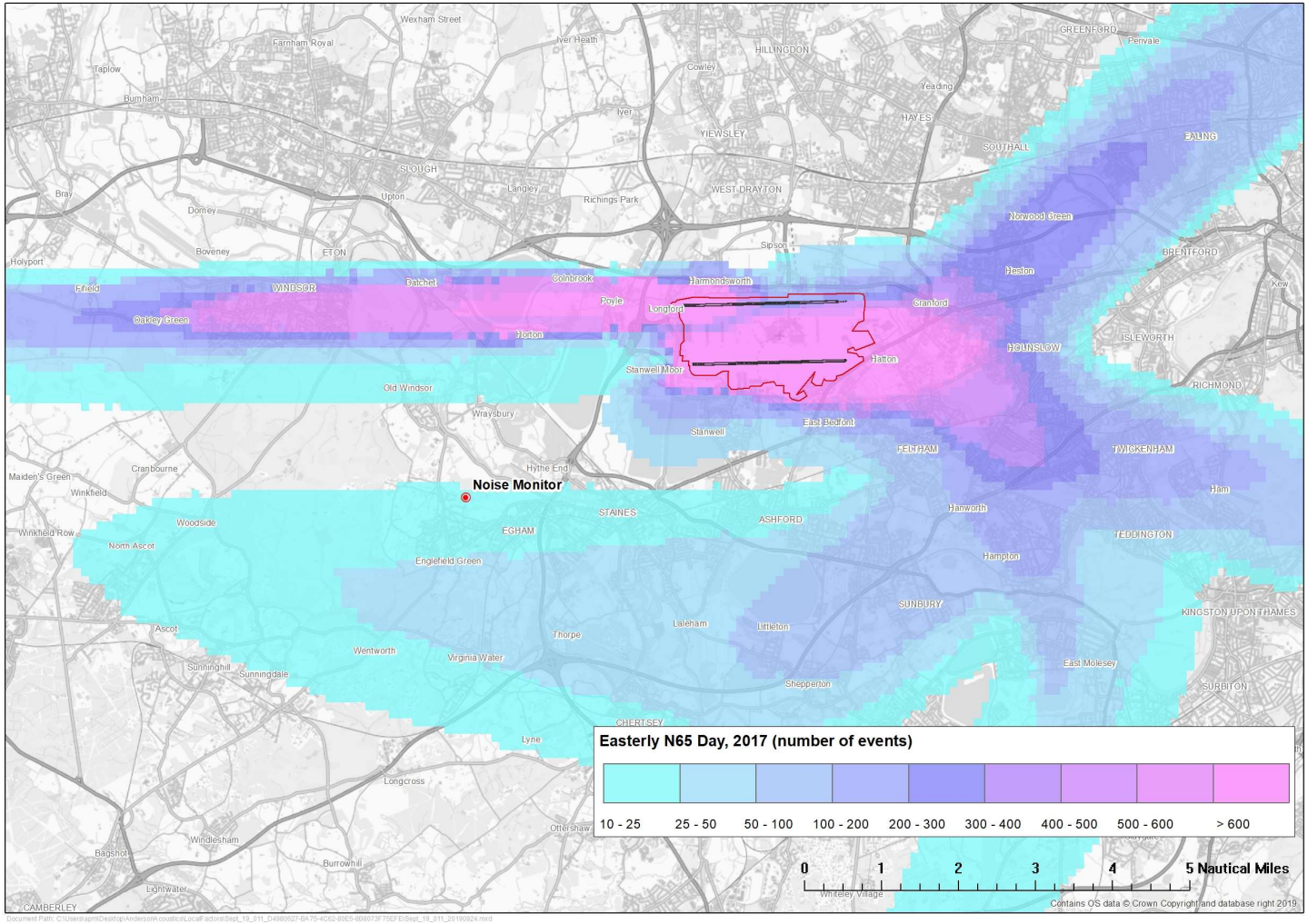
Appendix A: Average easterly day $L_{Aeq, 16hr}$ contours (2017)



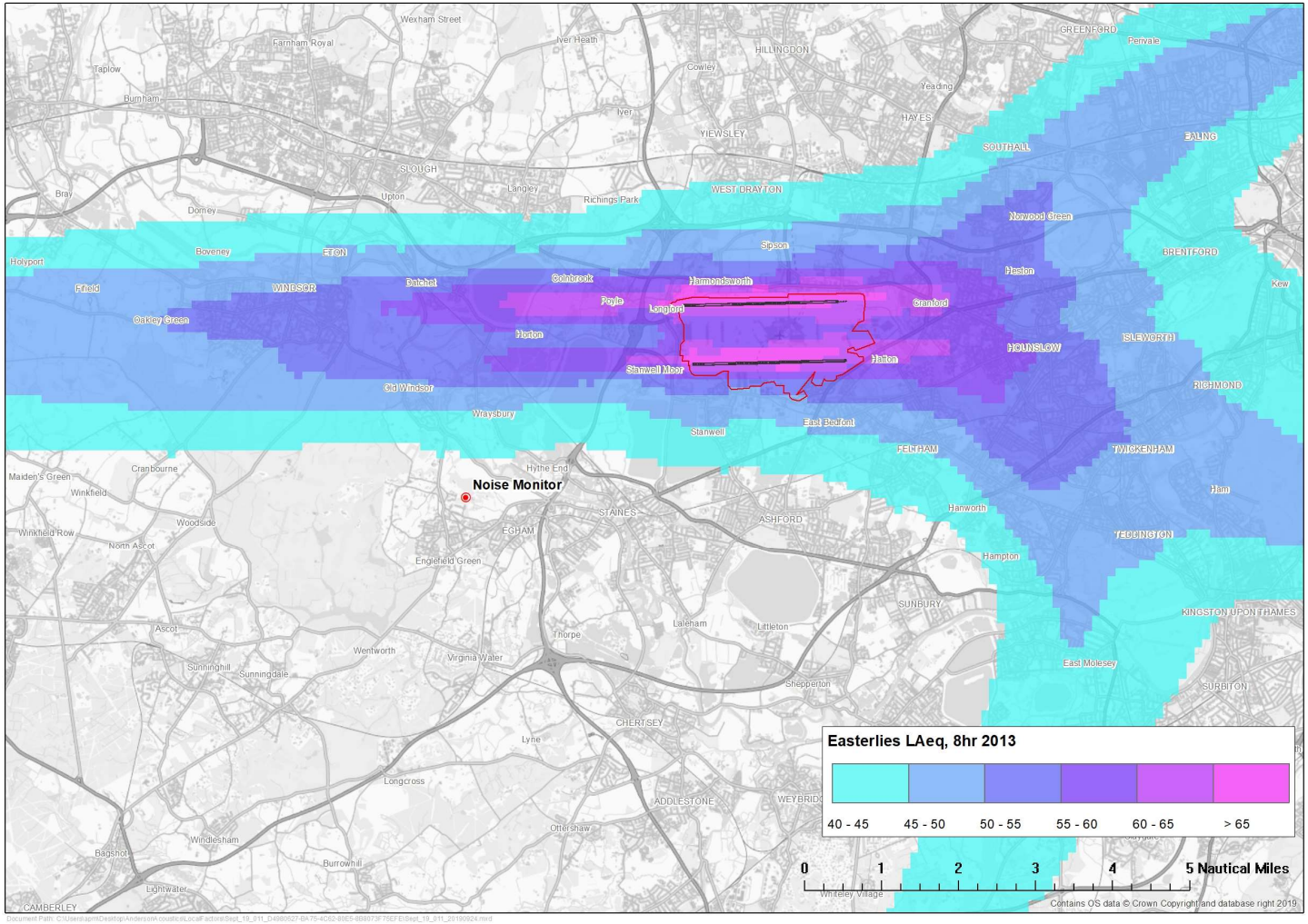
Appendix A: Average easterly day $N65_{16hr}$ contours (2013)



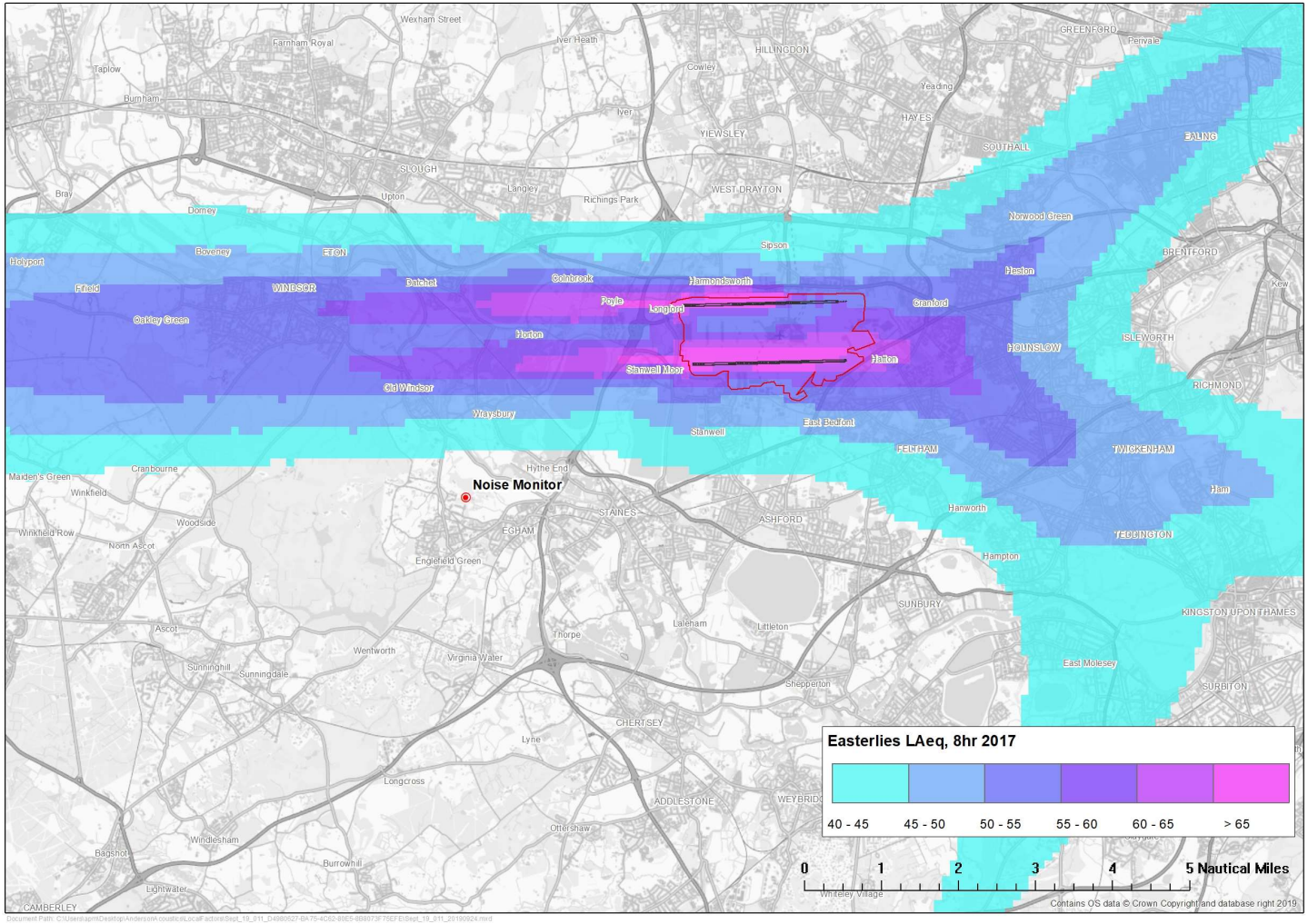
Appendix A: Average easterly day $N65_{16hr}$ contours (2017)



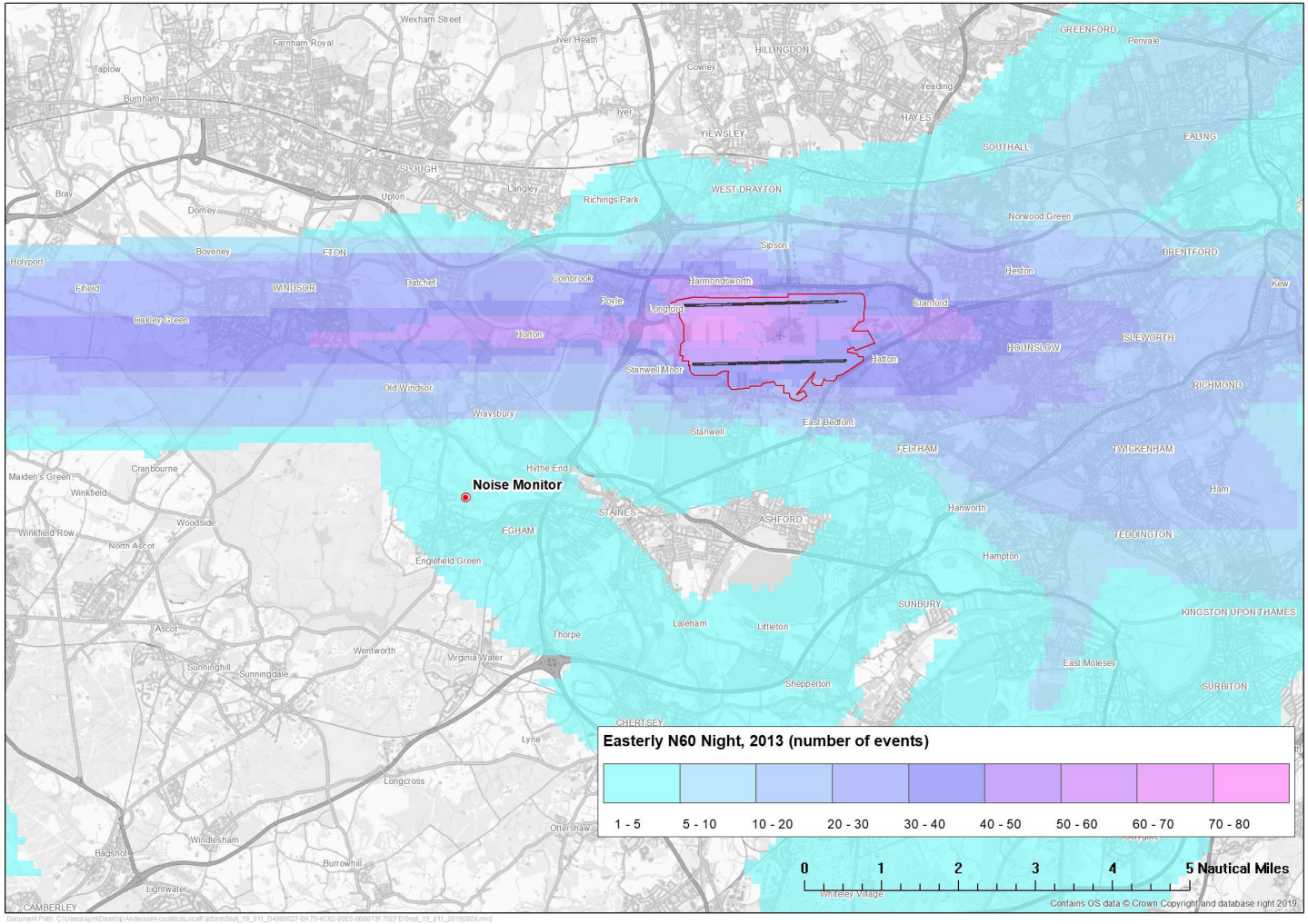
Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2013)



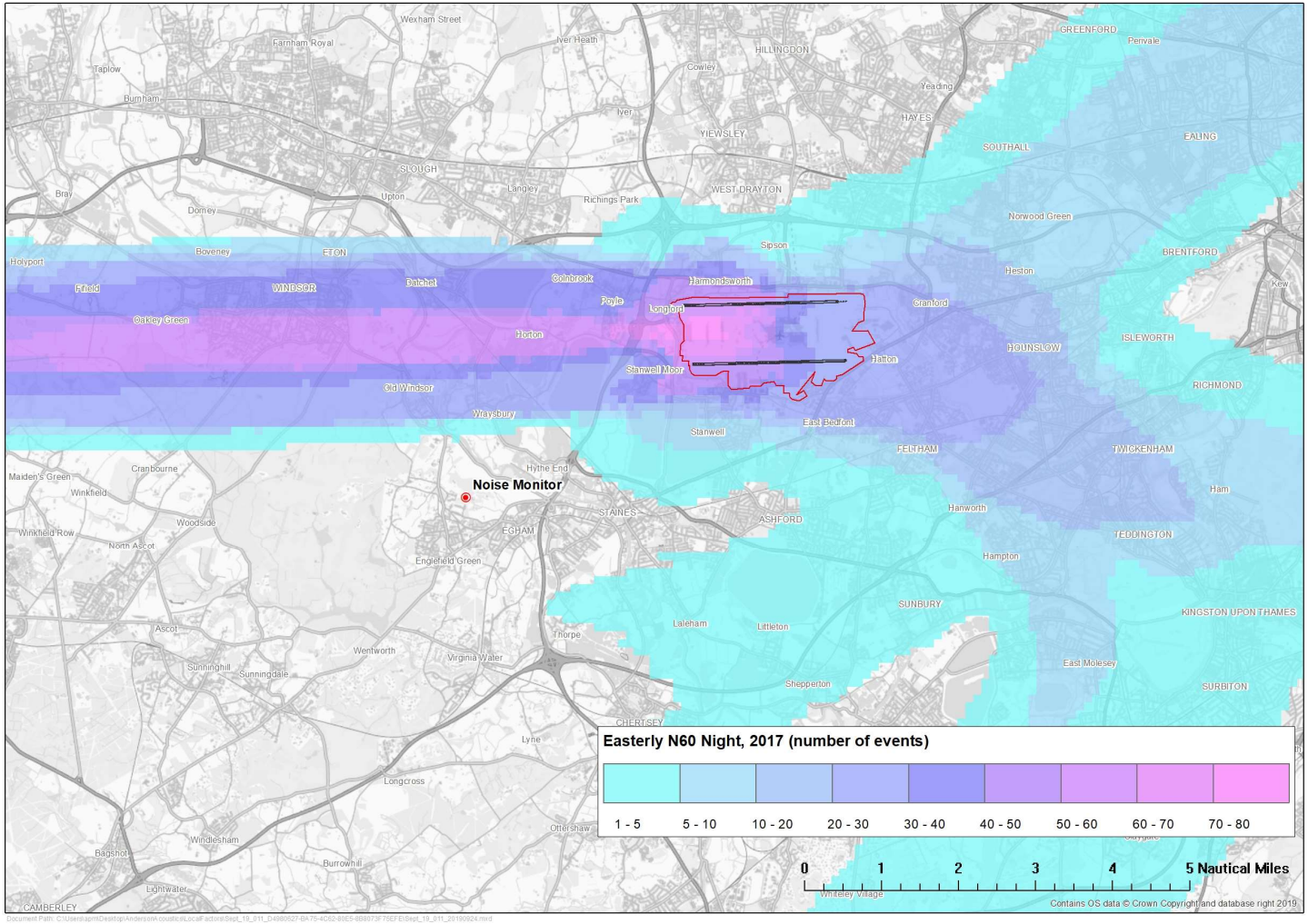
Appendix A: Average easterly night $L_{Aeq, 8hr}$ contours (2017)



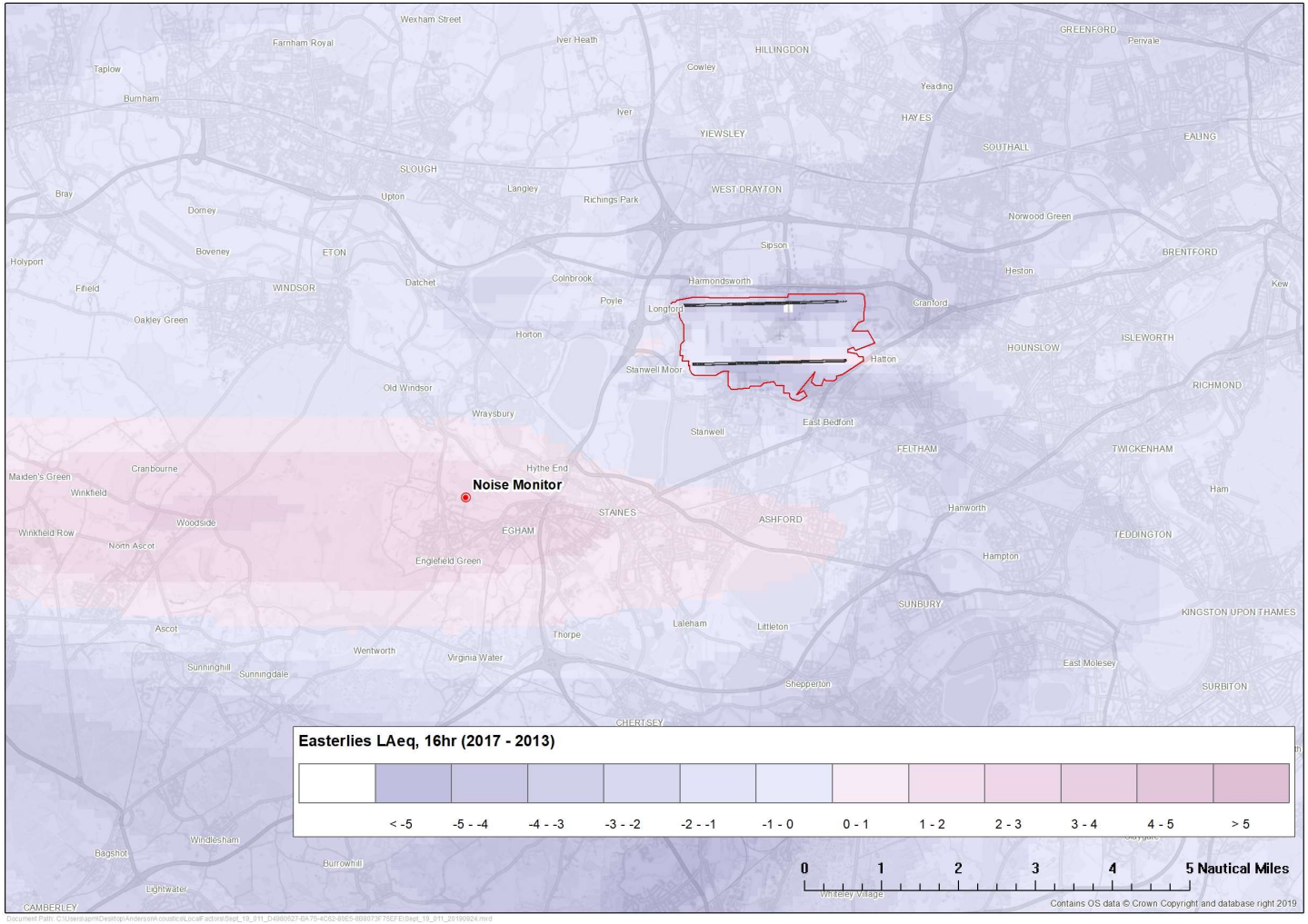
Appendix A: Average easterly night $N60_{8hr}$ contours (2013)



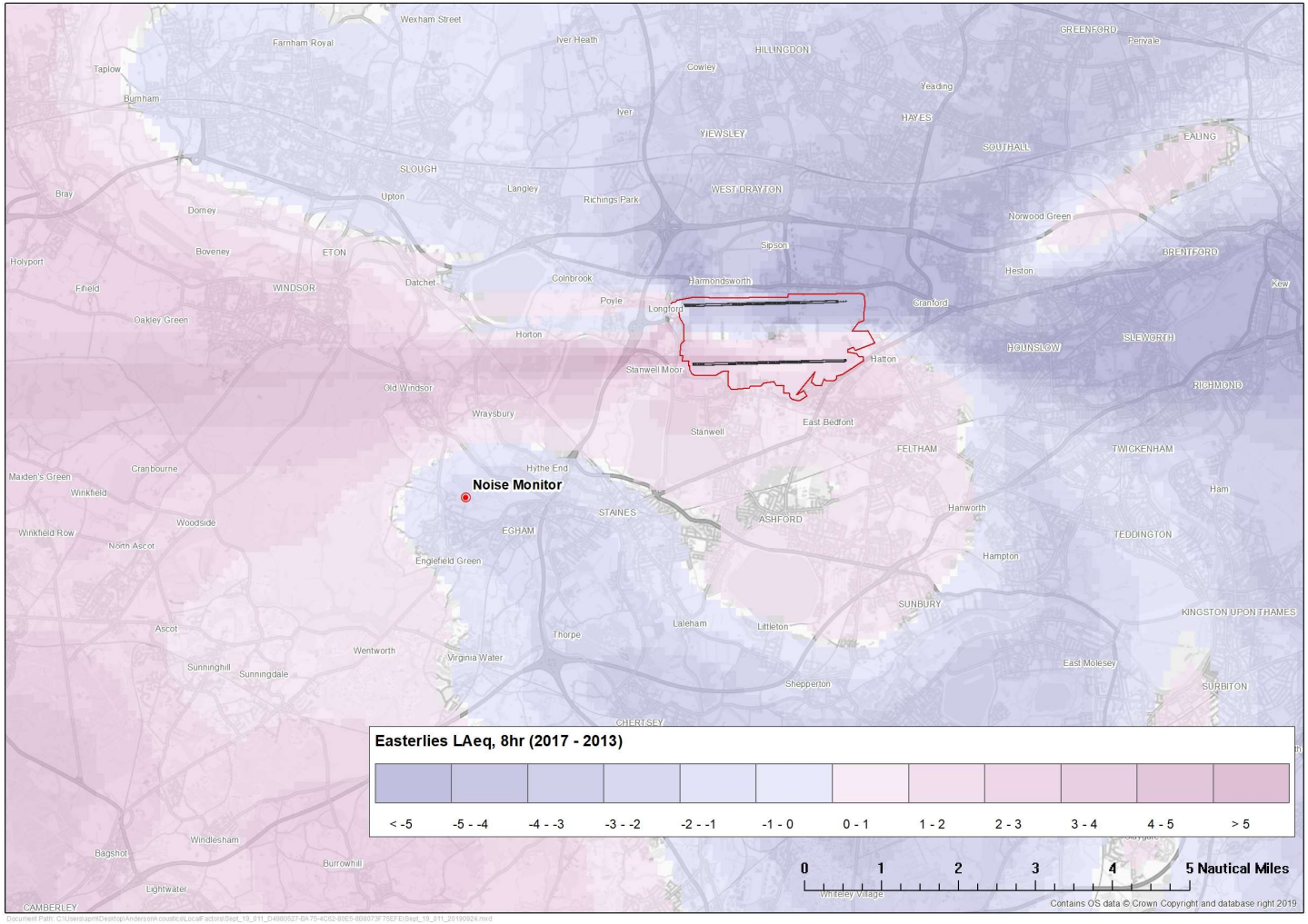
Appendix A: Average easterly night $N60_{8hr}$ contours (2017)



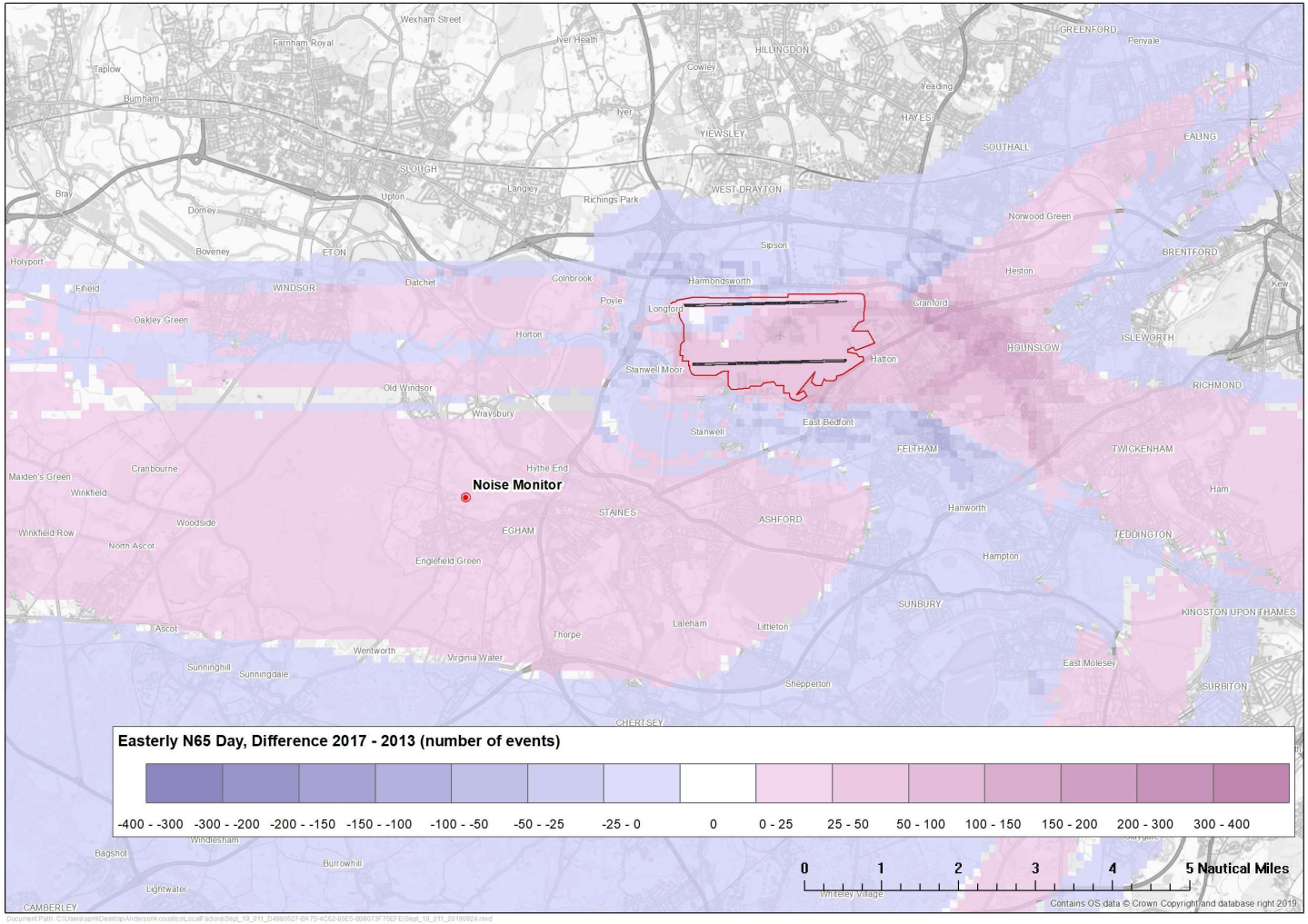
Appendix A: Average easterly day $L_{Aeq, 16hr}$ difference (2017 minus 2013)



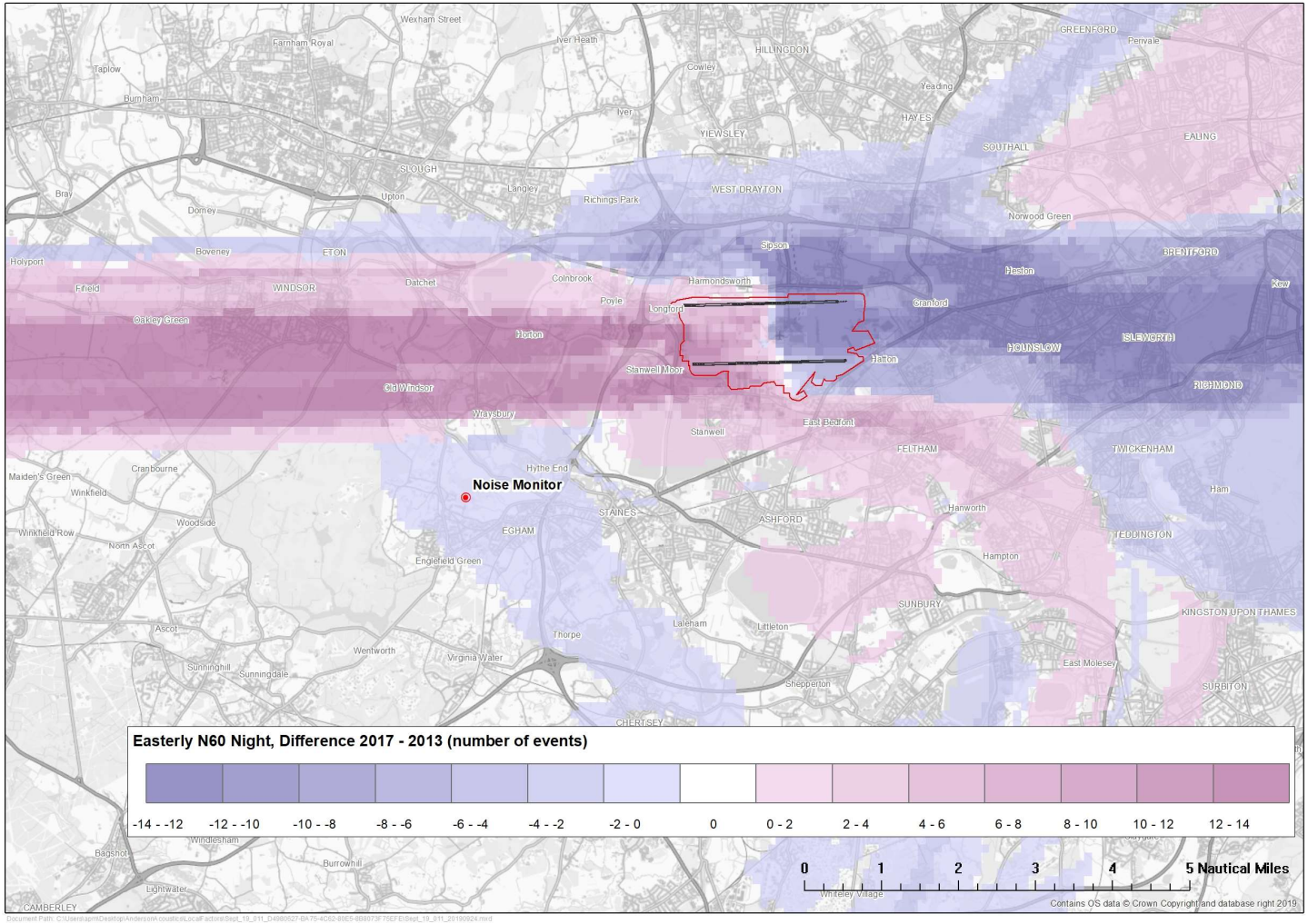
Appendix A: Average easterly night $L_{Aeq, 8hr}$ difference (2017 minus 2013)



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



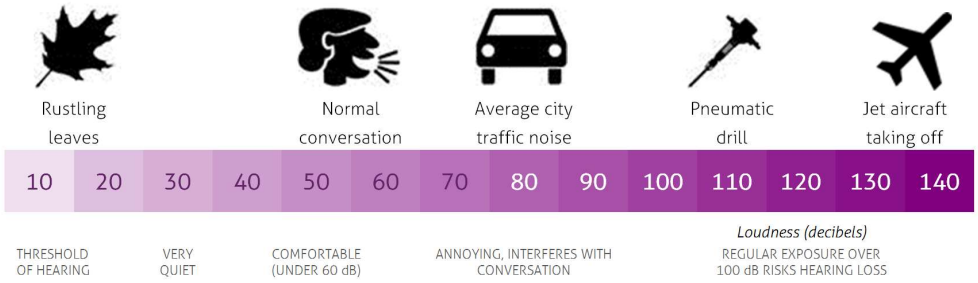
Appendix A: Average easterly night $N60_{8hr}$ difference (2017 minus 2013)



Appendix B: Noise Terminology

How is noise measured?

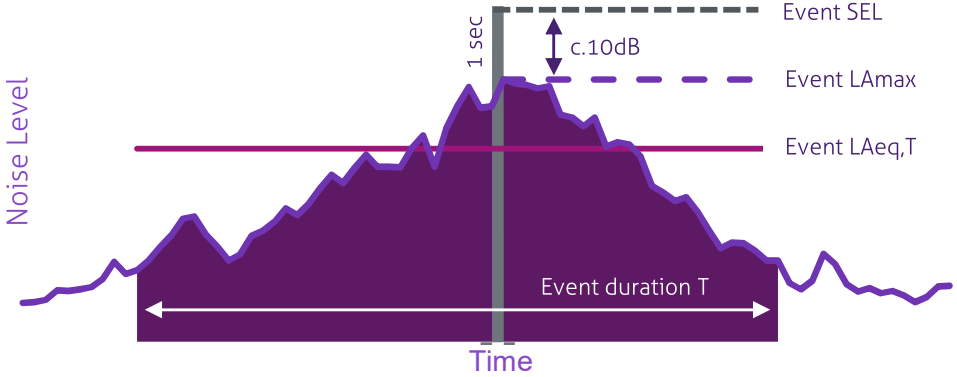
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Typical noise levels of everyday sounds are shown in the figure below.



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.



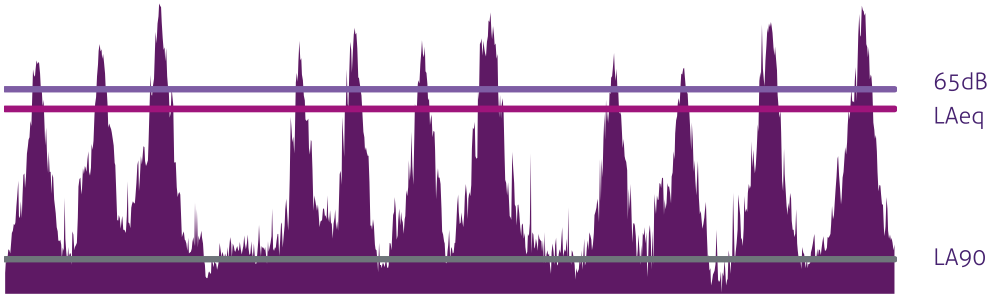
There are a number of metrics that can then be used to characterise a noise event all of which can be derived from modelling:

- 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