Community Noise Information Report Barnes

28th March - 27th September 2019

November 2021

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Introduction

At the request of local residents, Heathrow Airport Ltd installed a temporary noise monitor on the grounds of the WWT London Wetland Centre, Barnes, between 28th March and 27th September 2019. This report presents analysis of the airport's operations and the noise data during the first six months of the monitor's deployment.

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

- **Section 2 – Key Findings** are presented.
- **Section 3 – Background & Methodology** provides an overview of how the airport operates, where aircraft fly near Barnes, noise terminology 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 Barnes, including routes, proximity, spatial distribution, height and aircraft types. As flight track data have been collected for many years in the airport's noise and track-keeping (NTK) system, analysis has compared the noise monitoring period with the equivalent six-month period in 2015.
- **Section 5 – Noise Monitor Data** presents an analysis of aircraft noise events and overall community noise levels as measured by the noise monitor. In the absence of previous monitoring at this location, the noise data are analysed for the monitoring period only.
- **Section 6 – Noise in the Wider Area** 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 the AEDT modelling software. Previous reports have been based on Heathrow's verified noise model using INM. This software has been superseded by AEDT.
- **Section 7 – Appendices** presents large-scale versions of the noise modelling results, and provides information on how sound is described, how aircraft noise is measured, and how different sound levels relate to human perception.

It should be noted that this report is intended to describe noise exposure rather than the impact of that exposure, which is subject to individual circumstances. 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 considered to present a comprehensive set of analyses, it is not intended to be exhaustive. Should this report prompt any questions or comments, these should be addressed to the HCNF for consideration.

Key Findings

Operations and the community

The noise monitor in Barnes is predominantly overflown by westerly arrivals. It is located close to the arrival path to the northern runway. Barnes is not located near arrival or departure paths on easterly operations.

On a typical westerly day, there are around 670 movements that pass through the gate above Barnes. This has not changed over the last five years.

Since all aircraft will have joined the final approach before reaching Barnes, there has been no significant change to the concentration of aircraft above Barnes since 2015.

Between 2015 and 2019, there has been not been a significant change in the average height of aircraft as they pass over Barnes. The change was consistent across all aircraft types.

Between 2015 and 2019, there has been an 8% increase in the use of large twin engine aircraft into Heathrow, predominantly driven by the increase in B787 movements. The proportion of other aircraft size categories has decreased over the same period.

During daytime hours (07:00-23:00), between 35 and 42 aircraft pass through the gate each hour. The busiest hour, however, is between 06:00 and 07:00, during which up to 45 movements pass through the gate. There has been a slight change in the distribution of flights during the day with more movements between 06:00 and 07:00 and less movements between 14:00 and 15:00.

Noise levels in the community based on measurements at the Barnes' monitor

Approximately 84% of aircraft noise events measured at Barnes are associated with arriving aircraft approaching the northern runway on westerly operations. The remaining events are generally from larger aircraft approaching the southern runway.

On days of full westerly operations, there are, on average, approximately 380 noise events recorded per day. There are rarely any aircraft noise events recorded on days of easterly operations.

The average L_{Amax} for all aircraft noise events measured at Barnes is 67dB and would typically exceed the monitor threshold for 25 seconds.

The A320 family of aircraft is responsible for almost half of all noise events recorded at Barnes, followed by the B777s (14%) and B787s (9%)

The A330 and all quad engine aircraft (B747, A380 and A340) are the loudest aircraft types that passed overhead at Barnes.

The busiest hour in terms of number of aircraft events on a typical westerly day was between 06:00 and 07:00, during which there were, on average, 32 events. During daytime hours there were typically between 13 and 25 events each hour.

Difference in community noise levels between 2013 and 2017 based on noise modelling

During westerly operations, Barnes fell within the 57-60dB $L_{Aeq,16hr}$ day contour in both 2013 and 2017; however, the average level decreased by up to 1dB during the same period.

During westerly operations, Barnes fell within the 100-200 N65 day contour in both 2013 and 2017; however, the number of noise events above 65dB decreased by up to 25 events over the same period.

During westerly operations, Barnes fell within the 50-55dB $L_{Aeq,8hr}$ night contour in both 2013 and 2017, while the average level decreased by up to 1dB over the same period.

During westerly operations, Barnes fell within the 40-50dB N60 night contour in both 2013 and 2017; however, the number of noise events above 60dB decreased by up to 2 events per night over the same period.

Barnes falls well outside both the day and night contours for easterly operations.

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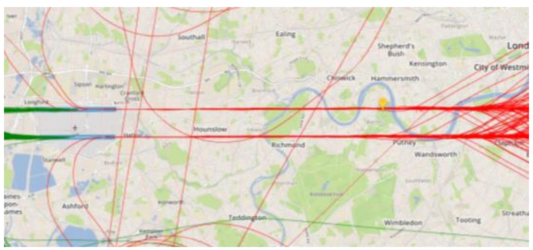
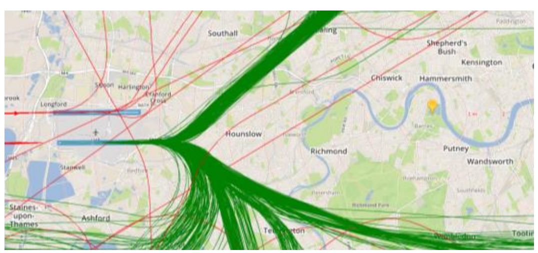
Understanding how wind direction affects aircraft operations

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 in red, departures green. The position of the noise monitor is indicated by the yellow pin drop.



Flight tracks on a westerly day (29th January 2020)



Flight tracks on an easterly day (23rd January 2020)

The proportion of easterly/westerly operations

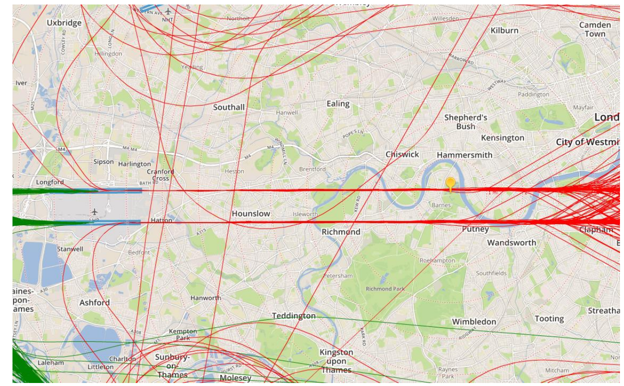
- Around Heathrow the prevailing wind direction is from the west.
- Heathrow operates what is known as the 'westerly preference'. Aircraft will continue to operate in a westerly direction until there are tail winds consistently of 5 knots or more. This was implemented to protect more densely populated areas to the east of the airport.
- As a result, the airport is typically on westerly operations for about 70-75% of the year.
- The figure below presents the **annual** proportion of easterly and westerly operations for the last 9 full years.

Note: Further information about operations at Heathrow can be found at https://www.heathrow.com/company/local-community/noise/operations

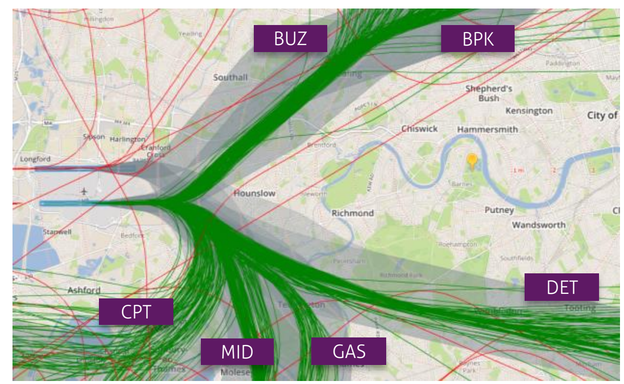
Understanding where aircraft fly near to Barnes

- The images to the right present a typical day of westerly and easterly operations with arrival tracks shown in red and departures in green.
- Aircraft departing the airport follow one of six pre-defined Noise Preferential Routes (NPRs) on both easterly and westerly operations. The choice of route is typically based upon the destination of the flight and is not selected by Heathrow. These are shown by the shaded grey areas in the lower image.
- Barnes is predominantly overflown by westerly arrivals to the northern runway. The noise monitor is positioned less than 200m south of the northern arrival path and approximately 1.2km north of the southern arrival path on westerly operations.
- A system of runway alternation is in place at Heathrow, in order to provide respite to residents living under the arrival paths on westerly operations. For one week, Heathrow uses one runway for landings and the other for take-offs, then switches over at 3pm. The following week, the pattern is reversed, such that what was done in the evening during the previous week, Heathrow does in the morning and vice versa. This is so that communities get respite from planes in the morning one week and in the evening the next.
- On easterly operations, the noise monitor is not affected by aircraft.

Arrival and departure tracks on westerly operations



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



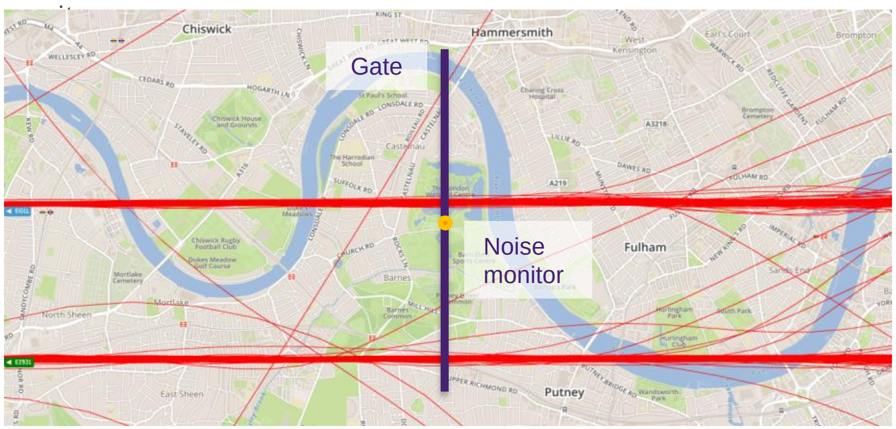
Understanding operational and gate data

Operational data

- The following operational data were provided for the period between 28th March and 27th September 2019, and also for 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.
- A single gate 3km wide to capture both arrival paths on westerly operations was drawn over Barnes centred on the temporary noise



This figure shows the position of the gate relative to both westerly arrivals and noise monitor

- The gate is 12,000ft high to cover all movements through the gate and perpendicular to the arrival paths.
- The height and position 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 entered the gate
  - Departure route flown – 'standard instrument departure' (SID) route
  - 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 the flight track data of Heathrow NTK systems.

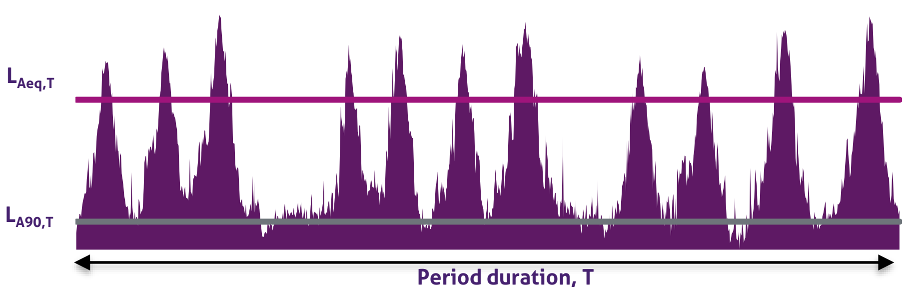
Understanding measured noise data

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 have been excluded due to adverse weather conditions.
- For this report, noise data have been provided by Heathrow for the period 28th March – 27th September 2019. Note that a historical comparison is not available since the noise monitor was not installed at this location in previous years.

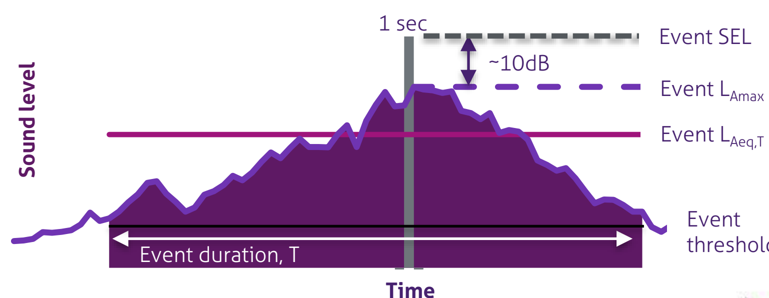
Ambient and background noise levels:

- 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 'ambient' sound level across period T from all sources
  - $L_{A90,T}$ – the 'background' sound level exceeded for 90% of the time across period T from all sources
- 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
  - 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.



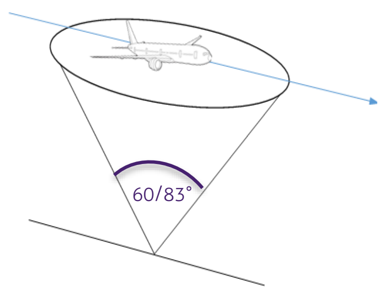
Analysing noise levels from aircraft in this area.

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 average 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 the cone above the noise monitor

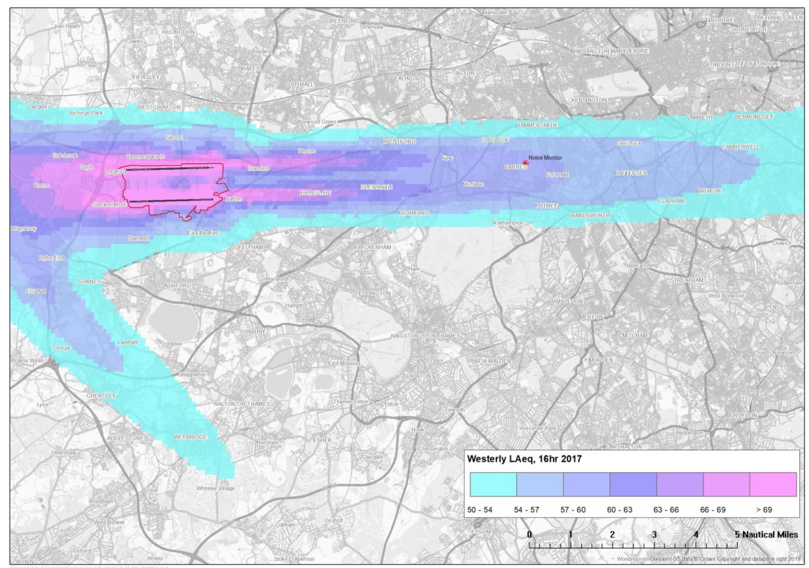


This community information report will, where applicable, present results for overhead flights determined by CAA guidance (based on the 83 degree cone), as well as all registered aircraft noise events.

Noise Modelling

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

Example contours generated by aircraft noise modelling



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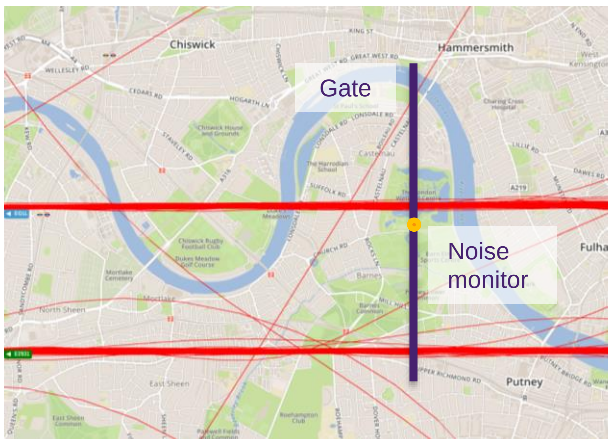
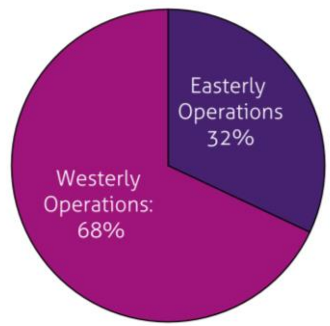
Overview of flight track data – Westerly operations

28th March - 27th September 2019

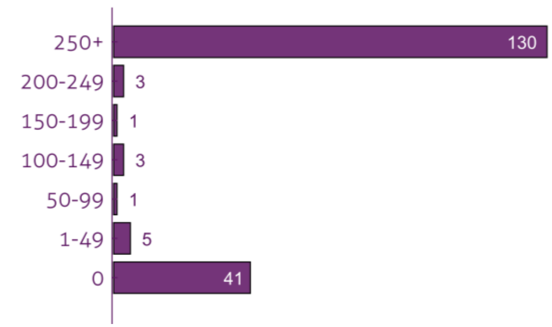


Example day of arrival aircraft tracks in the vicinity of Barnes during westerly operations & the gate position (width 3km)

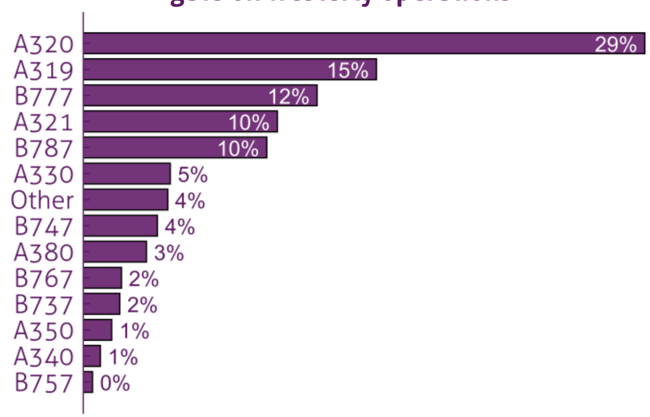
Total 248,164 operations into Heathrow



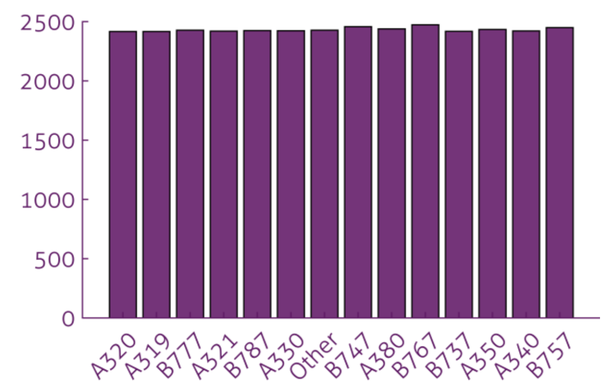
Number of movements per day passing through the gate (184 days in total)



Proportion of aircraft types passing through the gate on westerly operations



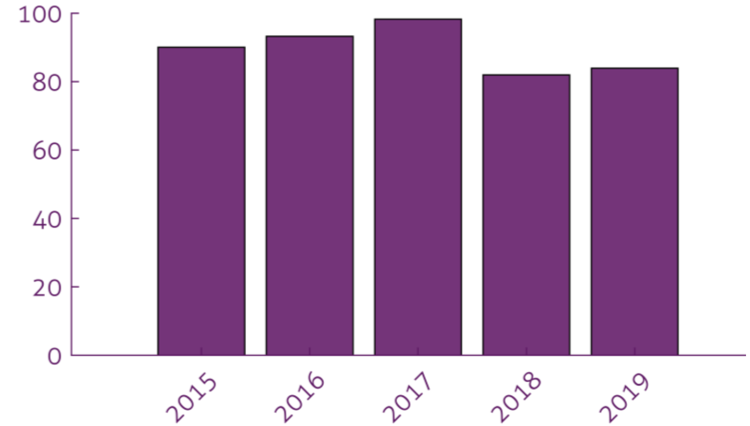
Average height (ft) of arriving aircraft passing the gate on westerly operations



Is the number of flights over the area different in 2019 to 2015?

- The figure to the right shows the total number of movements that passed through the westerly gate in the period from 28th March to 27th September from 2015 to 2019.
- Annually, between 82,000 and 98,000 movements passed through the gate, of which the vast majority were arrivals to both the northern and southern runways.
- Due to the position of the gate, year to year changes can only be attributed to fluctuations in the proportion of westerly operations (determined by wind direction) and total number of movements operating into Heathrow.
- The table indicates that the proportion of westerly operations in 2015 was 73%, and 68% in 2019.
- On a full day of westerly operations:
  - there was no change in the number of arrivals passing through the westerly gate in the 2019 period compared to 2015; and
  - there was also no change in proportion of these aircraft that were deemed to be overhead (as indicated by the numbers in parentheses).

Number of aircraft passing through the gate on westerly operations ('000s)



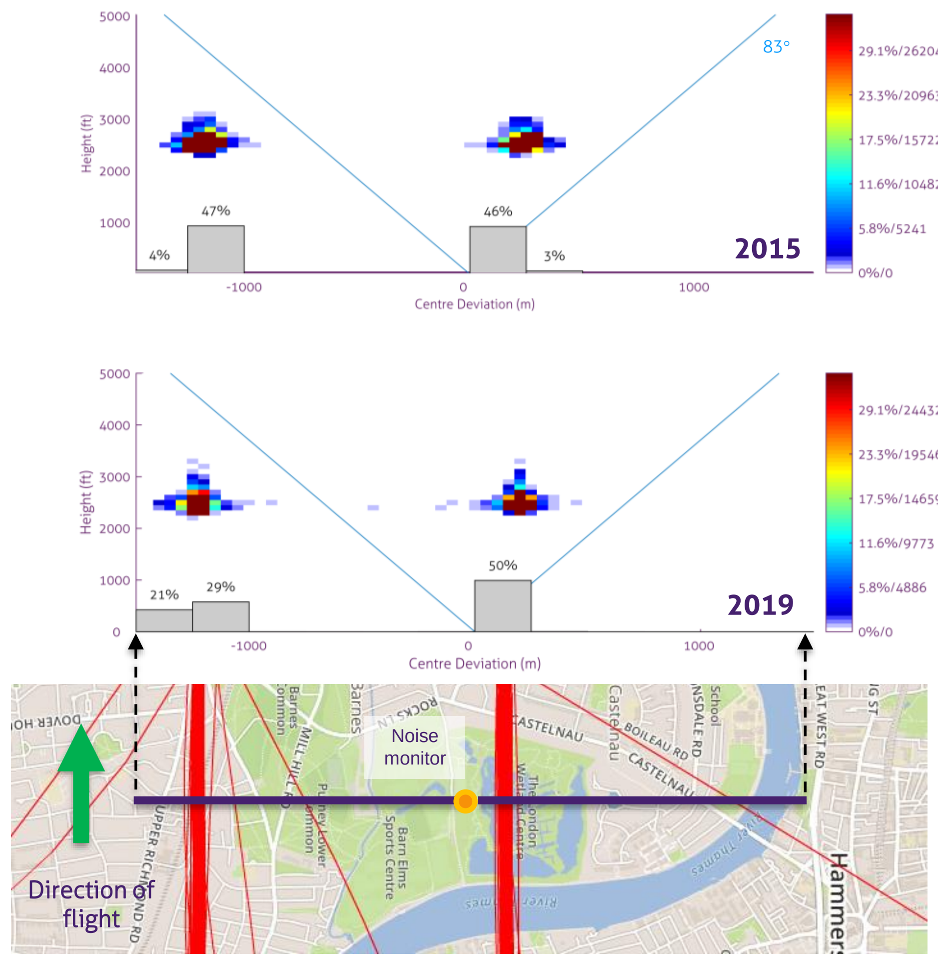
	2015	2019	Difference	Change (%)
Proportion of westerly operations (all Heathrow flights)	73%	68%	-5%	N/A
Average number of westerly arrivals passing through the gate during days of 100% westerly operations	674 (333)*	673 (334) *	-1 (+1)*	<-1% (<+1%)*

* Figures in parentheses indicate the number of flights passing through the 83 degree overhead cone.

Note: Wherever this section of the report refers to *2019*, it should be noted that this is specifically the measurement period from 28th March to 27th September 2019. Similarly, 2015 specifically refers to the period from 28th March to 27th September 2015.

Is the concentration of westerly arrivals different between 2015 and 2019?

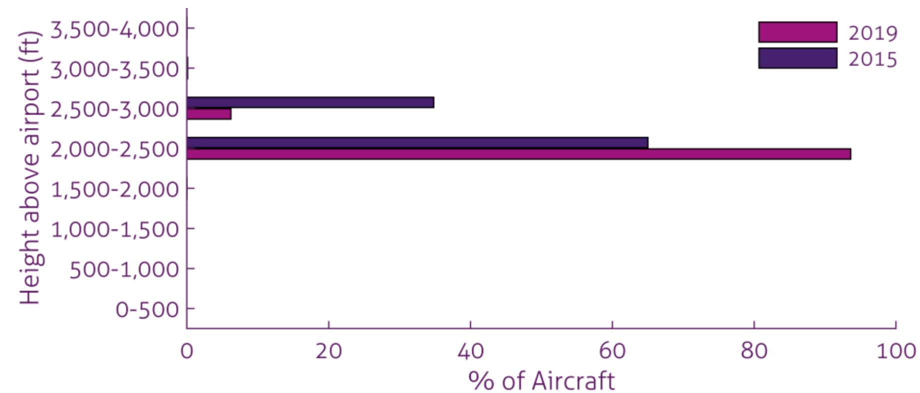
- The figures to the right are “heat maps” showing the 2D concentrations of aircraft as they pass through the gate during the 2015 (the upper figure) and 2019 (the lower figure) monitoring periods. Also shown by the grey bars is the concentration at different distances from the centre along the length of the gate.
- The scale has been normalised according to the proportion of movements. In other words, the same colour represents the same proportion of movements in each plot yet may represent a different number of movements.
- The gate has been designed to be perpendicular to the final approach path on westerly operations.
- The two spots of concentration in the plots relate to each of the arrival paths; the concentration to the right is the arrival path to the northern runway, the concentration to the left is the arrival path to the southern runway.
- At Barnes, since all aircraft have joined the ILS (Instrument Landing System), a system of radio waves which guide the aircraft to the runway, there was no significant change to the position or concentration of the aircraft above the noise monitor.

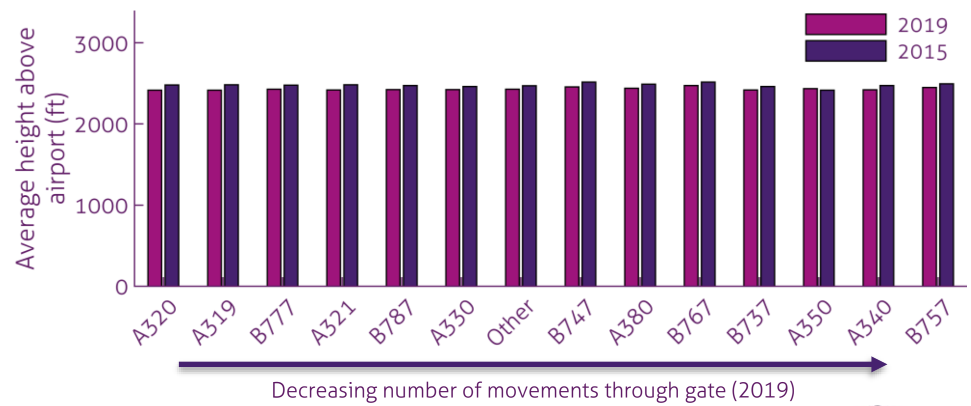


Are aircraft heights different between 2015 and 2019?

- The table to the right presents the average height of arriving aircraft as they passed through the analysis gate in the 2015 and 2019 periods.
- This indicates that aircraft above Barnes were, on average, approximately 60ft (approximately 2%) lower in the 2019 period compared to 2015. It should be noted that this change is within the tolerance of the ILS and not deemed significant.
- The figures present the distribution of these aircraft heights through the gate comparing 2015 with 2019 (upper figure) and the average height by aircraft type (lower figure).
- The upper figure shows that although in both years the greatest proportion of aircraft passed through the gate between 2,000ft and 2,500ft, in 2019 a greater proportion of aircraft passed through the gate at lower altitudes compared to 2015.
- Since all aircraft will have joined the final approach by the time they pass over Barnes, they should all be roughly at the same altitude. It appears that the slight decrease in average altitude was systematic across all aircraft types.

	2015	2019	Difference
Average height of arrivals through the analysis gate	2,480ft	2,420ft	-60ft

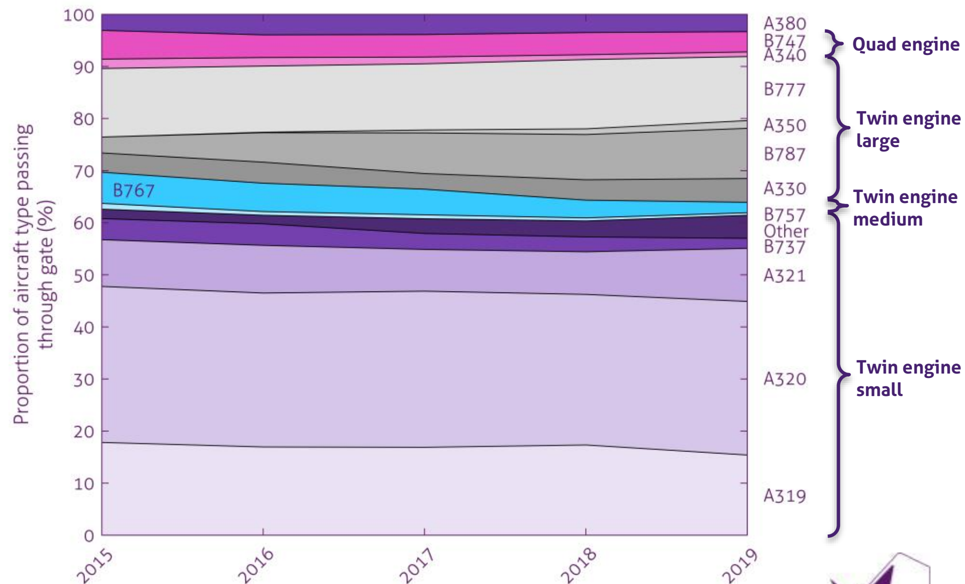




Is the fleet mix different between 2015 and 2019?

- The table to the right presents the mix of aircraft that passed through the gate and overall at Heathrow in the 2015 and 2019 periods.
- For simplicity the fleet mix has been split in to 5 groups:
  - the A380
  - quad (four) engine aircraft (including B747, A340)
  - twin engine large aircraft (B777, A350, B787)
  - twin engine medium aircraft (B767)
  - twin engine small aircraft (B737, A320 family)
- The analysis on Page 12 indicates that, on average, the number of aircraft passing through the gate has not changed on days of full westerly operations between 2015 and 2019.
- Since the gate is positioned so that all westerly arrivals pass through it, the fleet mix is very similar to the fleet mix operating into the airport as a whole.
- The analysis on this page indicates that the use of large twin engine aircraft has increased by approximately 8% between 2015 and 2019, predominantly due to the increased use of the B787. The proportion of all other aircraft size categories has decreased over the same period.
- 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.

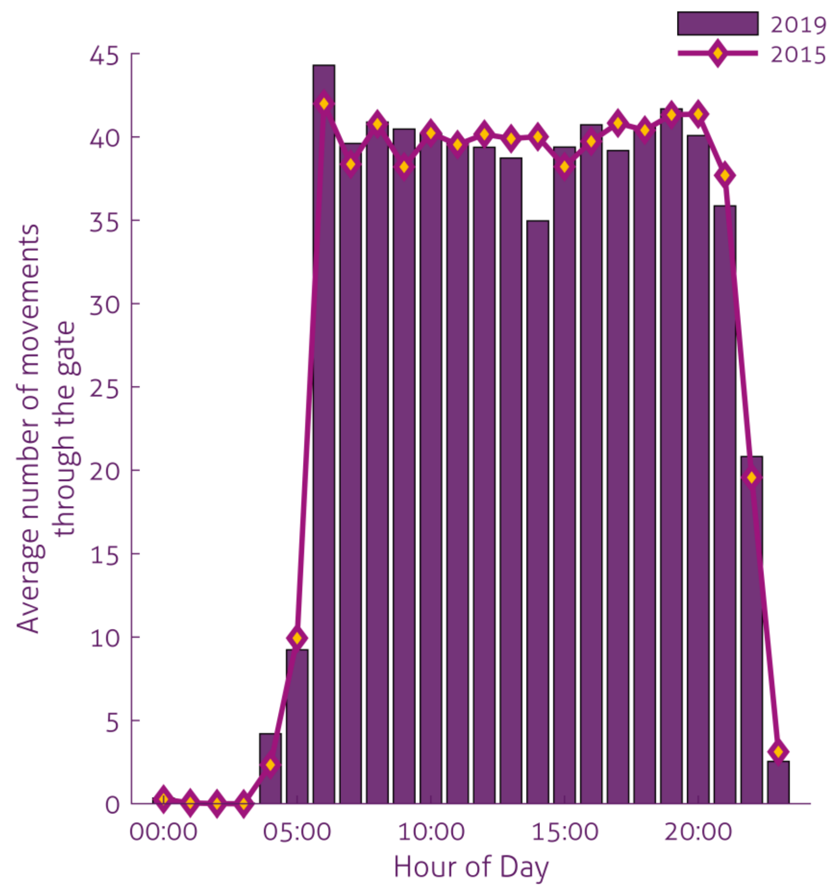
Fleet mix				
Category	Gate		Airport	
	2015	2019	2015	2019
A380	3.1%	3.3%	3.2%	3.3%
Quad engine	7.3%	4.8%	7.6%	4.8%
Twin engine large	19.9%	28.0%	20.9%	28.0%
Twin engine medium	6.2%	2.4%	1.7%	2.3%
Twin engine small	63.5%	61.6%	66.6%	61.6%



* Days of 100% westerly operations only

Does the number of flights over the area vary across the day? Is there a difference between 2015 and 2019?

- The figures to the right present the average number of aircraft passing through the gate per hour in 2015 and 2019 during full days of westerly operations.
- The figures show that during daytime hours (07:00-23:00), between 35 and 42 aircraft pass through the gate each hour. The busiest hour, however, is between 06:00 and 07:00, during which up to 45 movements pass through the gate.
- Since the gate is wide enough to encompass arrival paths to both the northern and southern runway, the effect of runway alternation is not evident in this plot; however, the difference in hourly average noise levels is shown on Page 29.
- Previous analysis on Page 12 has shown that there were the same number of daily flights through the gate in 2019 compared to 2015; however, this figure suggests there has been a slight change in the distribution of flights during the day with more movements between 06:00 and 07:00, and less movements between 14:00 and 15:00.
- Of the total 184 days in the 2019 monitoring period, 87 days (47%) were 100% westerly operations, and 35 days (19%) were on 100% easterly operations. The airport changed its direction of operation on the remaining days.



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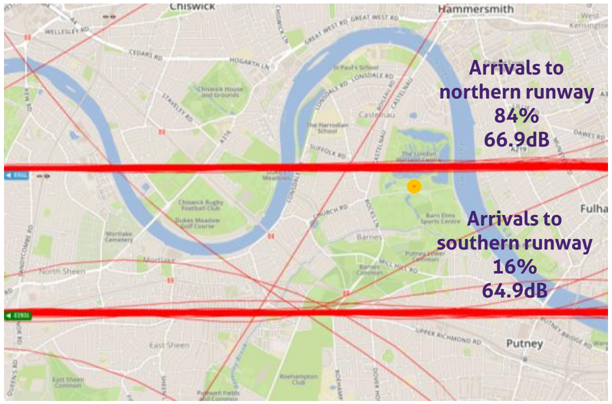
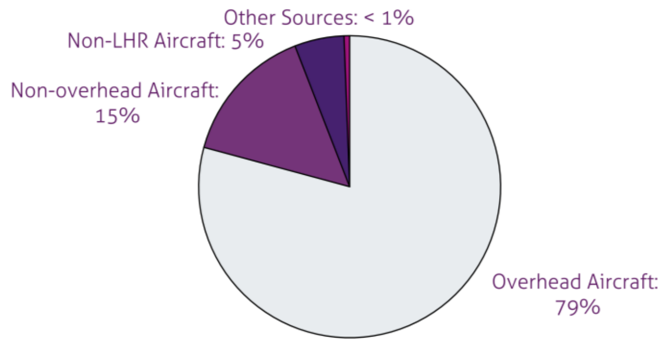
Overview of noise monitor data recorded at Barnes

28th March – 27th September 2019



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

51,123 Measured Noise Events*

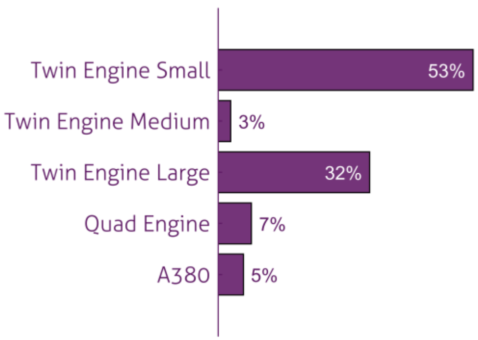


* From all noise sources

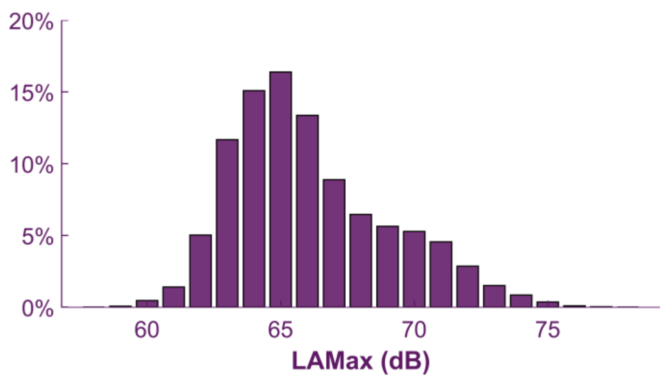
84%

of aircraft noise events recorded when aircraft were within the 83 degree cone over the noise monitor*

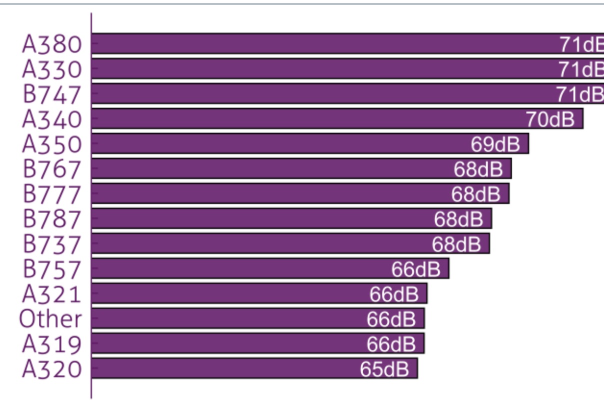
* From aircraft operating into Heathrow



Noise events by aircraft size



Overall distribution of maximum event noise level



Average L_{Amax} by aircraft type*

*Overhead aircraft on westerly arrivals only

Noise monitoring overview.

Monitoring location, duration and setup

- A temporary noise monitor was installed in the grounds of WWT London Wetland Centre in Barnes between 28th March and 27th September 2019.
- The monitor was set up to record noise events based on a threshold sound pressure level of 58.9dBA being exceeded for more than 10 seconds.
- The location of the noise monitor is shown in the figure to the right. It is 200m south of the arrival path to the northern runway.

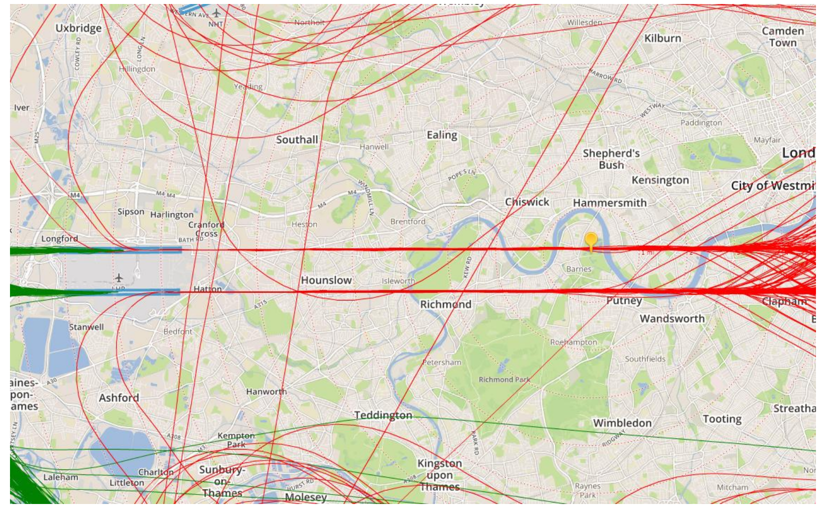
Noise event summary

- A total of 51,123 noise events were measured during the monitoring period. Of these around 94% were from aircraft using Heathrow and less than 1% were from non-aircraft sources.
- More than 84% of the aircraft registering noise events at the noise monitor were on the arrival path to the northern runway, the remainder were arrivals to the southern runway.
- Overall, 84% of aircraft registering noise events were overhead (based on the 83° cone) - all of which were arrivals to the northern runway.

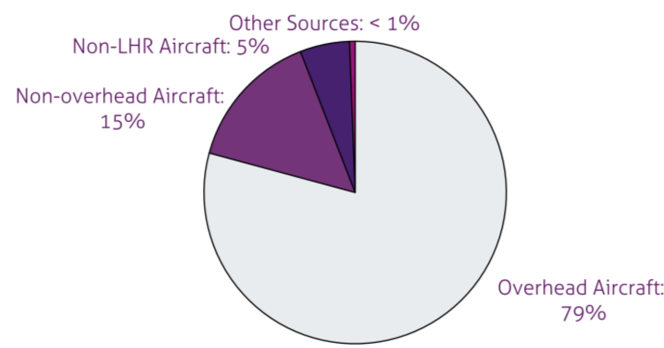
Percentage of aircraft noise events by route

Westerly Operations		Easterly Operations	Overhead
Northern Runway 27R	Southern Runway 27L		
84%	16%	0%	84%

Monitor position and flight tracks on typical westerly day

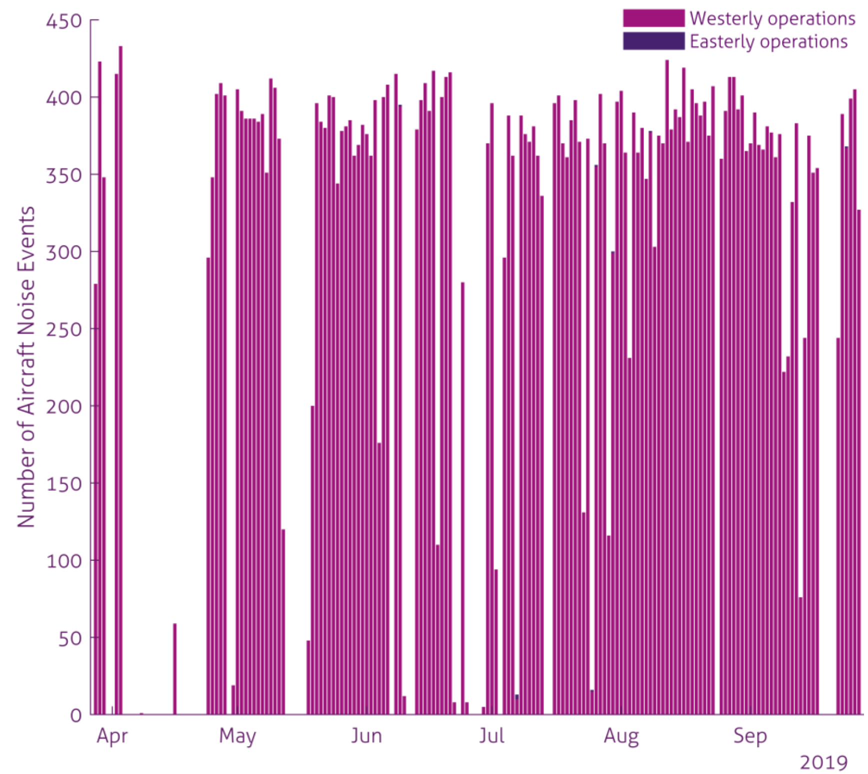


Measured noise event summary



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

- Noise events captured at Barnes are almost exclusively during periods of westerly operations. Predominantly these are recorded by aircraft approaching the northern runway.
- During the monitoring period, 87 out of 184 days (47%) were 100% westerly operations and 35 days (19%) 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, 381 aircraft noise events triggered per day.
- There were almost no noise events recorded during days of 100% easterly operations.
- Over the 184 days for which monitoring was taking place, 71% of days experienced 300 or more aircraft events, whilst 27% had less than 20 aircraft noise events.
- It is noted that an absence of aircraft noise events does not necessarily mean that aircraft would be inaudible. There may be aircraft further away that are audible but have not triggered the noise event detection threshold.

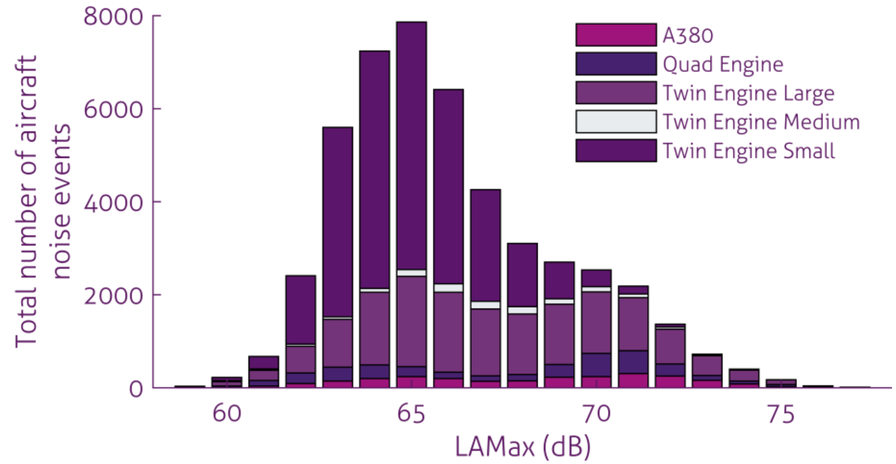


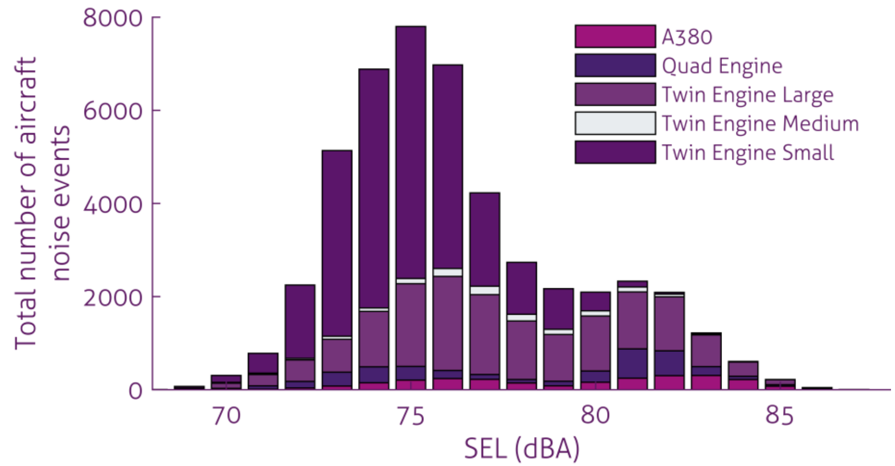
What was the range of L_{Amax} and SEL noise levels from aircraft events?

- 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 Barnes monitor during the monitoring period. An explanation of metrics is given on Page 8.
- The table below presents the average* L_{Amax} and SEL for each aircraft type group.
- The average L_{Amax} of all aircraft events is 66.6dB. The distribution of L_{Amax} is dependent on aircraft size with the larger aircraft generally recording louder events.

Aircraft group	Average L_{amax}, dB	Average SEL, dBA
A380	68.6	79.6
Quad engine	68.1	78.6
Twin engine large	67.6	77.9
Twin engine medium	67.4	77.7
Twin engine small	65.5	75.4

- The two peaks (at 65dB and 70dB) seen for the larger aircraft types in the upper figure are accounted for by the difference in noise level due to aircraft approaching either the northern or southern runway.
- 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 24.
- For non-aircraft related events, the mean L_{Amax} is 65.6dB reaching a maximum of 95.0dB.



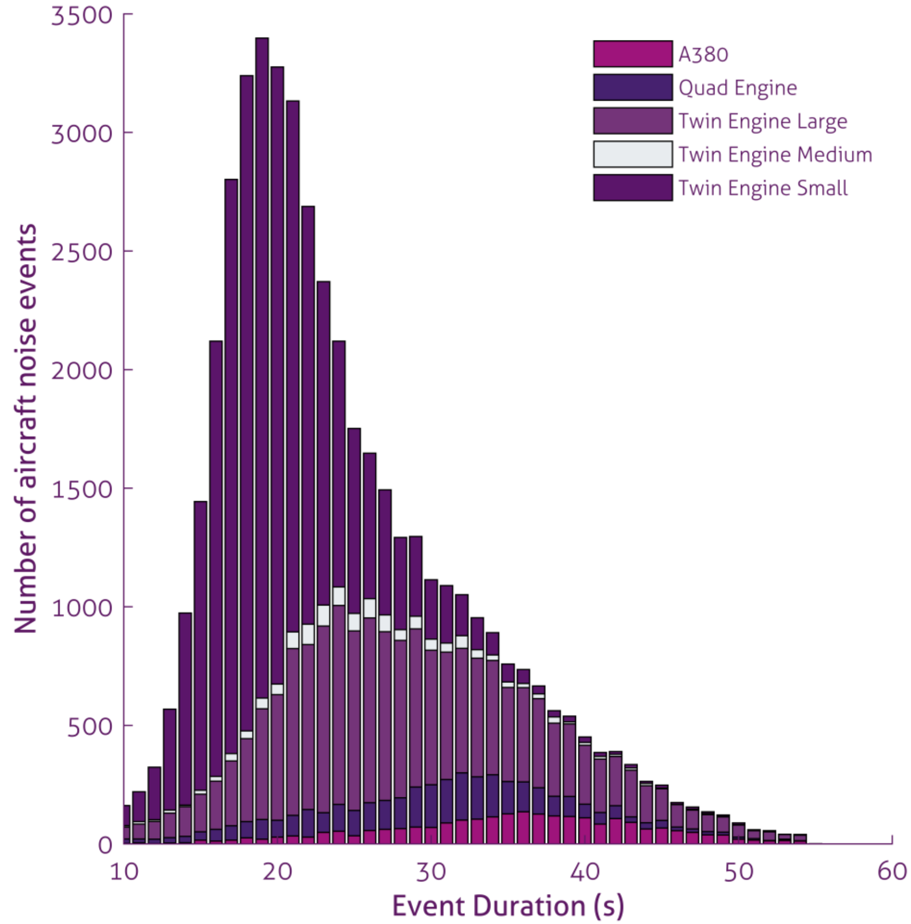


* Note: throughout this report, unless otherwise stated, the arithmetic mean is calculated.

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 58.9dB.
- In addition, events are only recorded if the duration is longer than 10s to prevent impulsive sounds that 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 25 seconds. The duration is largely dependent on the noise level of the event, with the average event duration of the A380s being approximately 35 seconds, while the duration of the smaller twin engine aircraft is only 20 seconds.
- A number of events were recorded with a duration exceeding 60 seconds. These were removed from the analysis as it was assumed they had been contaminated by other noise sources.

Aircraft group	Average noise event duration (seconds)
A380	35.2
Quad engine aircraft	29.6
Twin engine - large	28.4
Twin engine - medium	26.3
Twin engine - small	20.3



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 49% of all aircraft noise events detected by the monitor.
- The B777 (twin-engine large) series of aircraft account for around 14% of the measured aircraft noise events, while 9% of the events were from the B787.
- The majority of noise events from aircraft approaching the southern runway (27L) on westerly operations were from larger aircraft types, primarily B747s, B777s and A330s.
- The newest aircraft type in service, the A350, accounted for 2% of all recorded aircraft noise events.

Aircraft Type	Total*	Route			Overhead**
		Arrival (27R)	Arrival (27L)	Other	
A320	26	25%	0%	<1%	26
A319	14	13%	0%	<1%	13
B777	14	11%	3%	<1%	10
A321	9	9%	0%	<1%	9
B787	9	8%	2%	0	8
A330	7	4%	3%	0	3
B747	6	3%	3%	0	3
A380	5	3%	2%	<1%	3
A350	2	1%	0%	0	1
B737	2	2%	0%	0	2
B767	2	2%	1%	0	2
A340	1	1%	0%	0	1
B757	0	0%	0%	0	0
Other	3	3%	0%	<1%	3
Total* **	**100%**	**84%**	**14%**	**<1%**	**84%**

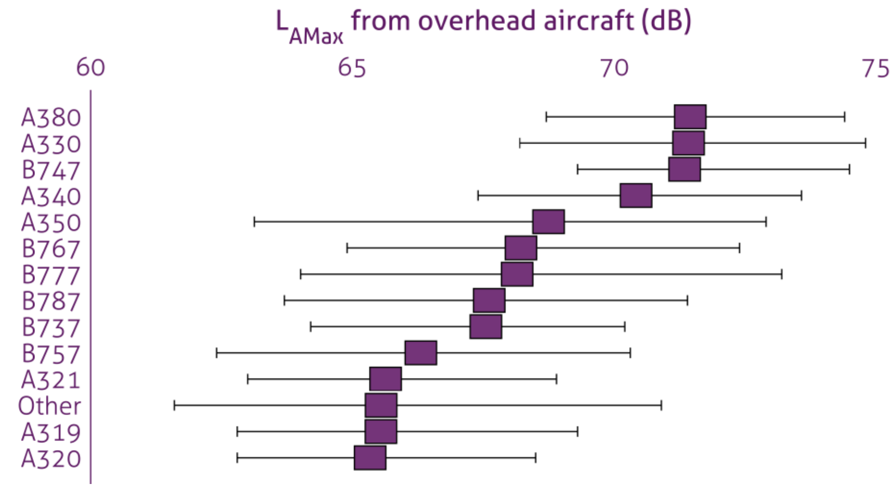
* Percentage based on 48,088 aircraft noise events recorded between 28th March and 27th September 2019.
** Defined as being with the 83 degree cone described on Page 9.
***Totals may differ to sum of aircraft types due to rounding.

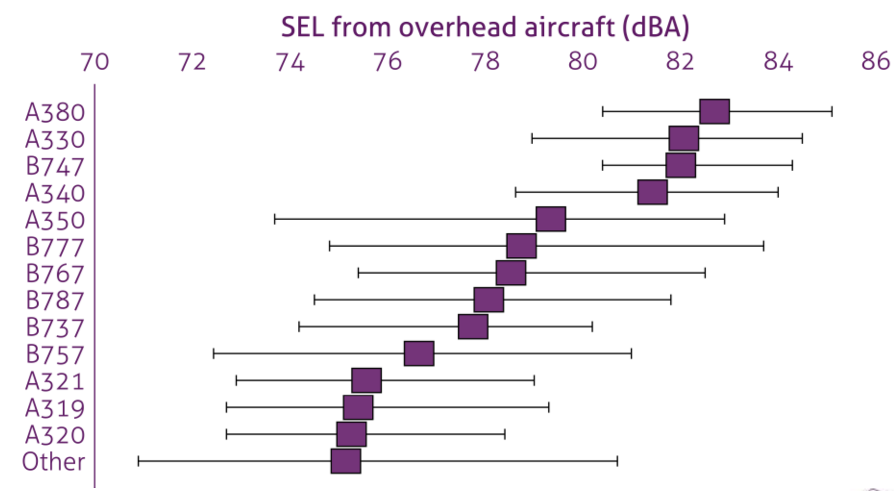
Comparison of average noise levels for different aircraft types

The plot in the top right shows the average L_{Amax} of each aircraft type in addition to the 5th and 95th percentile within the 83 degree **overhead** cone. These were almost exclusively arrivals to the northern runway.

- At Barnes, all the overhead aircraft are in a very similar position above the noise monitor and therefore the relative noise levels can be readily compared.
- The relative noise levels of each aircraft type are specific to this location. At Barnes, where all the aircraft are arrivals, noise emitting from the airframe and the engine contribute to the overall level. It should be noted that under departure routes, engine noise tends to dominate the overall level and the relative loudness of aircraft types would be different.
- The loudest aircraft types based on average measured noise level were the quad engine aircraft and the A330 (twin engine) .
- The large and medium twin engine aircraft comprise the next loudest group of aircraft while the A320 family and other generally small aircraft are, on average, the quietest.

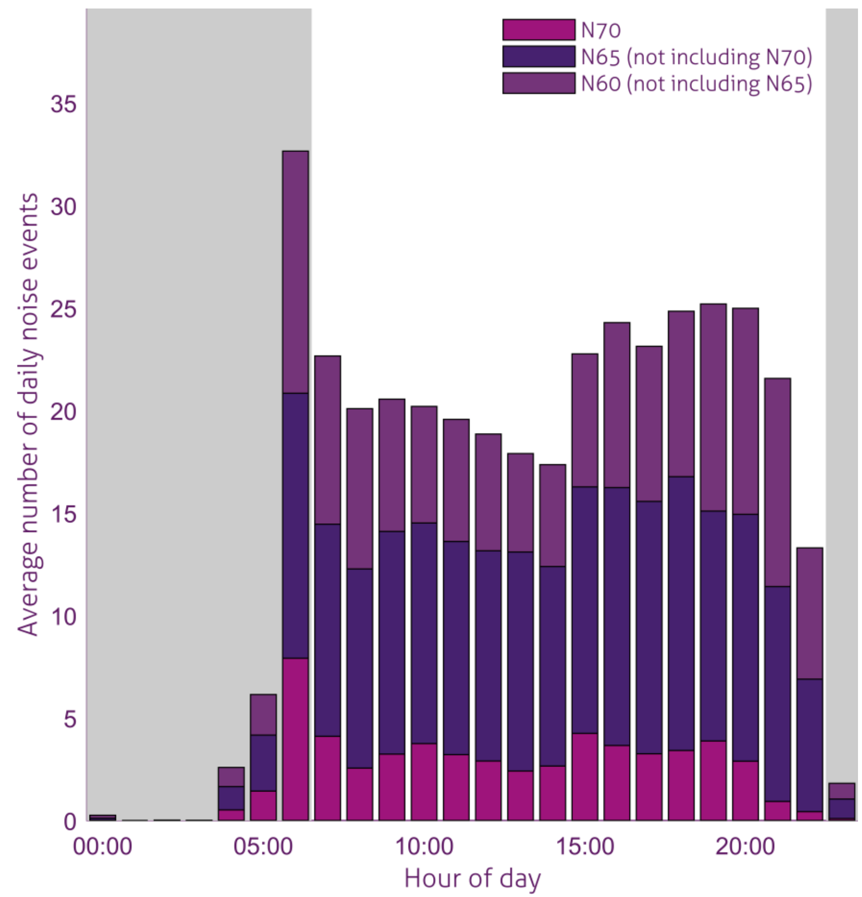
The plot in the bottom right shows the average SEL of each aircraft type. The SEL takes into account of all energy within a noise event. Although there are small changes, the relationship of aircraft types is similar to that seen in the L_{Amax} plot.





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

- It is recognised that the response to aircraft noise is related to more than average noise levels alone. The number of events and their individual levels are becoming increasingly recognised as a useful indicator of community response to aircraft noise.
- The N_{above} metrics describe the number of events in a period where the L_{Amax} exceeds a given value. For example, an $N65_{1hr}$ of 10 means that ten aircraft generated a maximum noise level greater than 65dB L_{Amax} in a single hour.
- The figure to the right shows the average hourly N60, N65 and N70 values across an average 24hr day for days of 100% of westerly operations.
- Between the hours of 07:00 and 23:00 there are typically between 13 and 25 events being registered per hour. The busiest hour, however, is between 06:00 and 07:00, during which an average of 33 events are recorded per westerly day.
- The highest number of the loudest noise events (N70) also occurred in the hour between 06:00 and 07:00.
- On an average westerly day, the N65 during the 16h day period (07:00-23:00) was 337; the N60 during the 8h night period (23:00-07:00) was 43.
- The N60 during the night period on westerly days was predominantly made up of scheduled arrivals in the 06:00-07:00 hour.



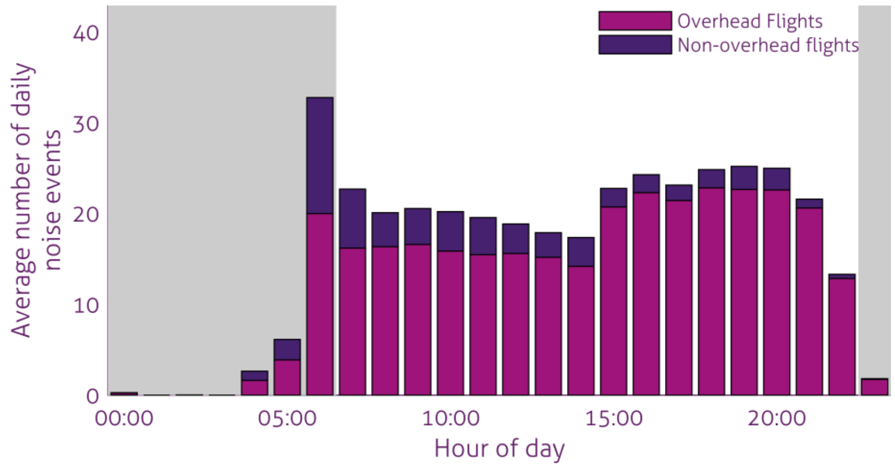
How does the number of aircraft noise events vary across a day?

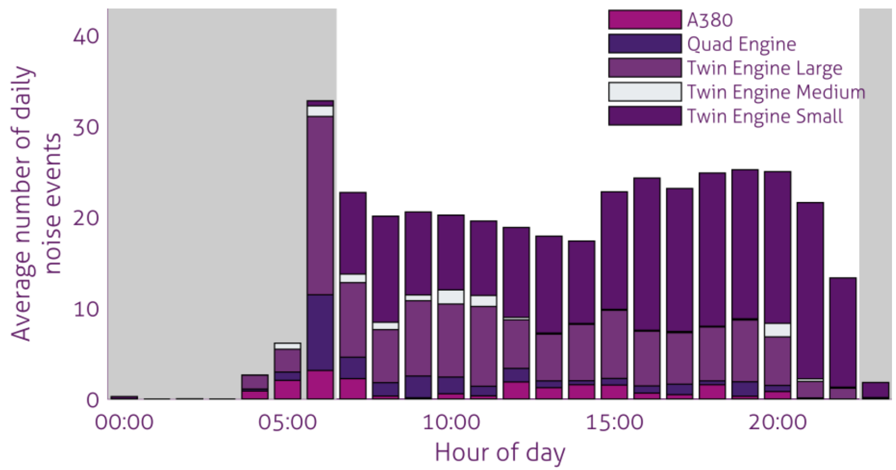
The top right figure shows the average number of noise events during each hour of the day for days of full westerly operations.

- The lowest proportion of overhead aircraft occurred in the hour between 06:00 and 07:00, during which 61% of the noise events were from overhead aircraft.
- The proportion of overhead aircraft generally increased through the course of the day.

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

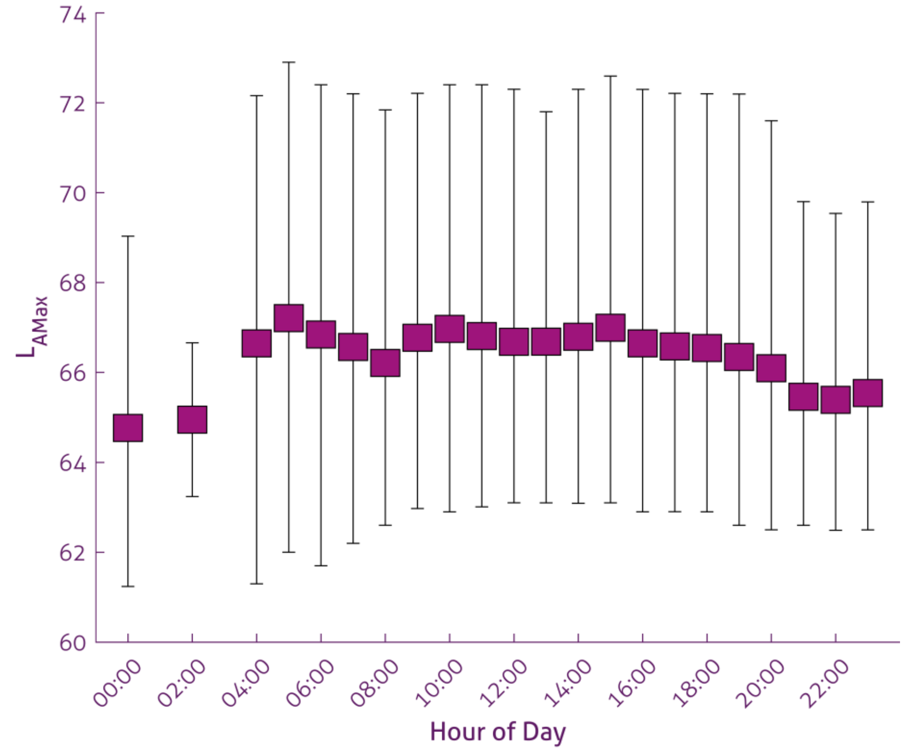
- During the early morning period, over 95% of the noise events were from larger aircraft (large twin engine and quad engine aircraft).
- The proportion of small twin engine aircraft generally increases during the day until the period from 21:00-00:00, during which the vast majority of events were from these aircraft.
- 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 25).





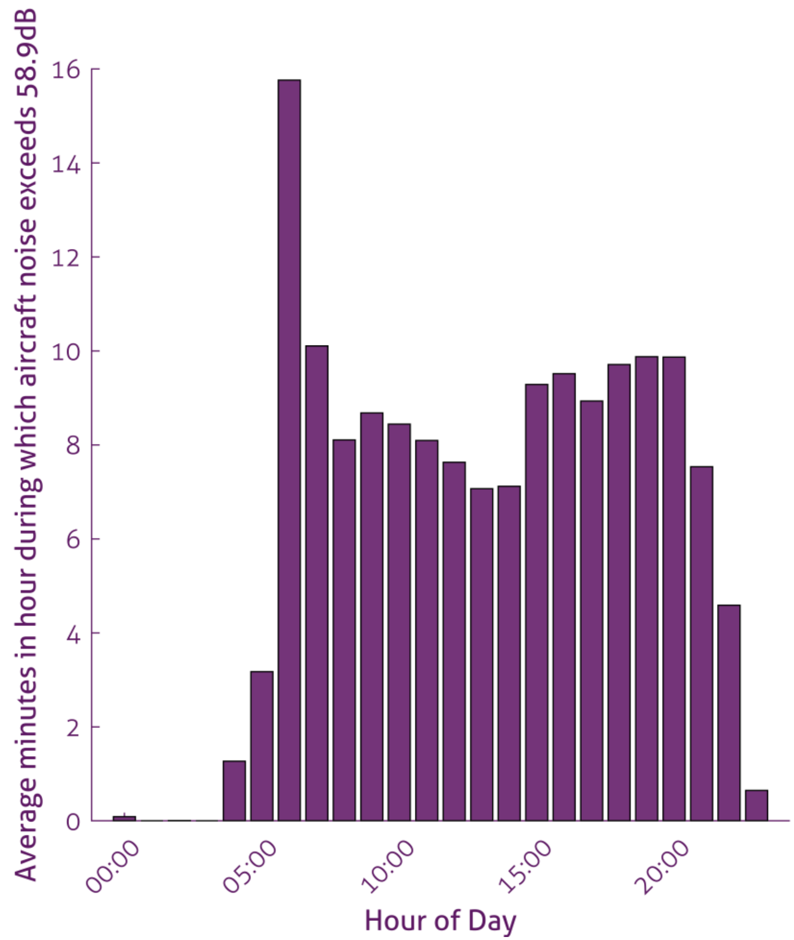
How does the L_{Amax} vary across a day?

- 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 period from 04:00 to 00:00, the average L_{Amax} in each hour is between 65 and 67dB. The hour with the highest average L_{Amax} is between 05:00 and 06:00, while the lowest average L_{Amax} (outside of the early morning period) is between 22:00 and 23:00, when there are a higher proportion of small twin engine aircraft operating into Heathrow.
- In any given hour, the range of L_{Amax} is generally between 7 and 10dB.
- The data in the 00:00-02:00 period are an average of only a small number of aircraft.



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

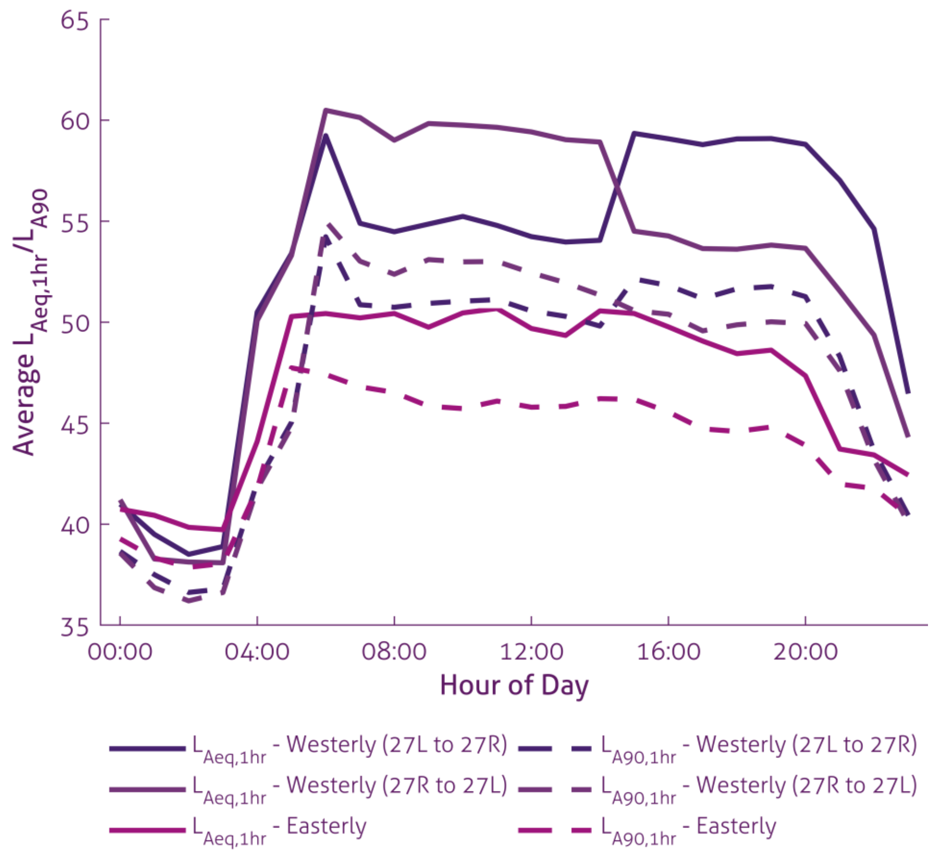
- The figure to the right shows the average number of minutes in each hour when the level of aircraft noise exceeds the noise event threshold - in this case 58.9dB – on a day of full westerly operations. At this location, this could be described as the amount of time (in minutes) that the aircraft noise level exceeds 58.9dB.
- 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 during daytime hours (07:00-23:00) on days of 100% westerly operations, aircraft noise exceeded the monitor threshold for a total of between 4 and 10 minutes in each hour; however, the hour during which the monitor threshold was exceeded for the greatest period was between 06:00 and 07:00, during which the threshold was exceeded for more than quarter of an hour.



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

Do aircraft contribute to overall ambient noise levels?

- The figure to the right shows the average hourly $L_{Aeq,1hr}$ (ambient) and $L_{A90,1hr}$ (background) noise levels on days where 100% of operations were either westerly or easterly. It also shows the effect of runway alternation on overall noise levels.
- It should be noted that these metrics describe the overall noise environment comprising all noise sources, not just aircraft noise.
- On westerly operations during the hours of 06:00 and 20:00, when the northern runway is in use, the hourly average noise levels generally fall between 59 and 60dB.
- This is approximately 5dB higher compared to the same period when the southern runway is in use.
- On easterly operations, the hourly average noise level is approximately 50dB during the day and reduces to around 45dB in the evening period. Since the noise monitor is not located near flight paths on easterly operations, it is assumed that the majority of this noise is from other sources (e.g. traffic, industry, weather etc.).
- During the period the monitor was in place, the average daytime $L_{Aeq,16hr}$ (07:00-23:00) noise level was 56dB on westerly operations and 49dB on easterly operations from all noise sources.
- During the night, the average $L_{Aeq,8hr}$ (23:00-07:00) was 52dB on westerly operations and 46dB on easterly operations.



1 Introduction

2 Key findings

3 Background and methodology

4 Where do the aircraft fly and how has this changed?

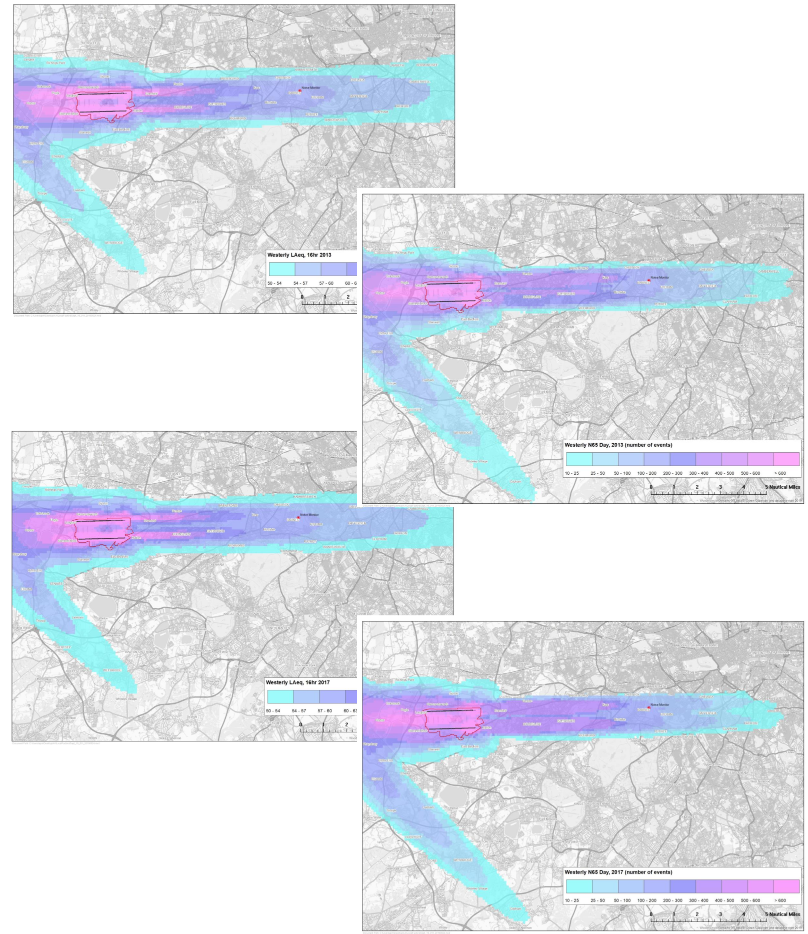
5 What does the noise monitor data tell us?

6 What does noise modelling tell us?

7 Appendices

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 night-time ($L_{Aeq, 8hr}$/N60) for an **average day and night of 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 >50dB, >54dB and then in 3dB increments to 69dB.
- Night-time $L_{Aeq, 8hr}$ values are presented in 5dB bands starting at >40dB up to 65dB.
- These are longer terms metrics averaged over 16 and 8 hours and do not directly reflect the shorter term fluctuations between individual events.
- It should be noted that aircraft noise modelling to average levels around 50dB carries increasing uncertainty in the result. In areas where aircraft noise levels are in this range, it should be noted that many non-aircraft noise sources may be of similar (or even higher) levels. Interpretation of the modelled results at this noise level should bear this mind.

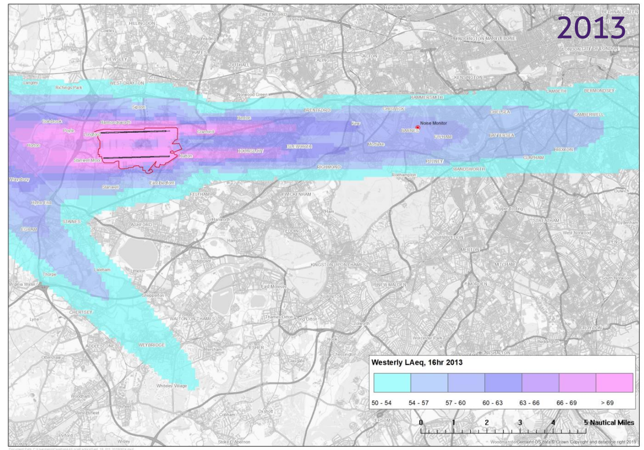


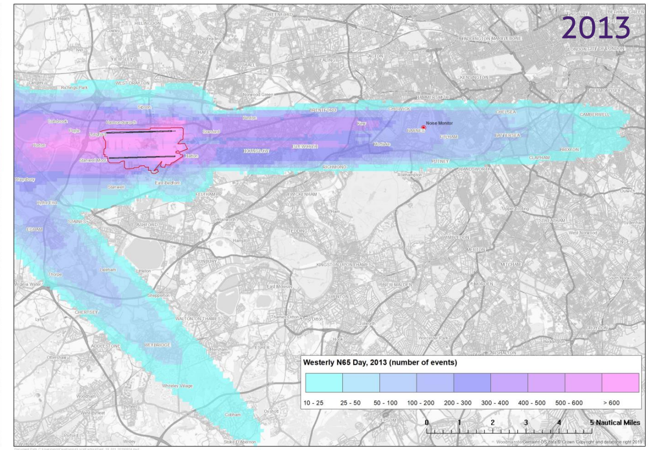
Average **daytime** aircraft noise levels – westerly operations

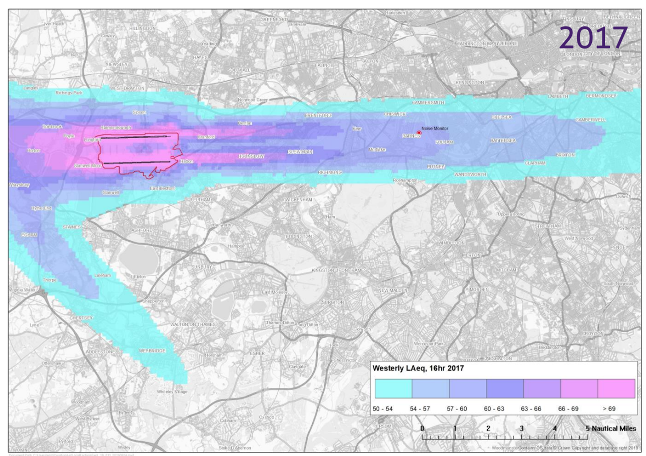
- The figures to the right show the 2013 and 2017 daytime $L_{Aeq,\ 16hr}$ bands in the left column and N65 bands in the right column for **an average summer day when the airport is on 100% westerly operations**.
- The position of the noise monitor is marked by the red dot.
- The N65 is defined as the number of aircraft noise events where the L_{Amax} exceeds 65dB over the 16 hour day period 07:00-23:00.
- Larger figures are shown in Appendix A.

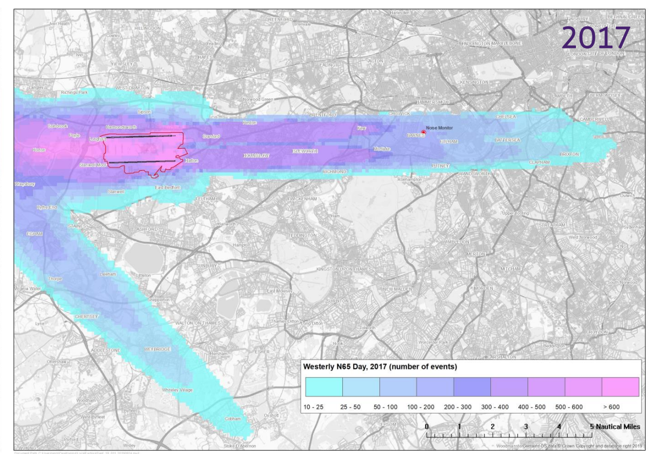
$L_{Aeq,16hr}$

N65, Daytime



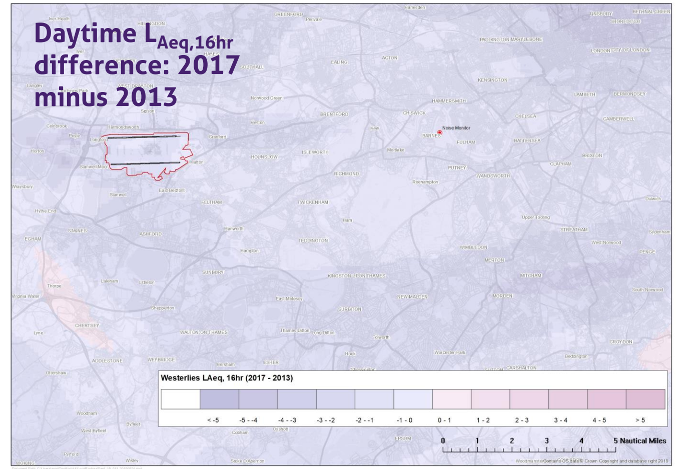


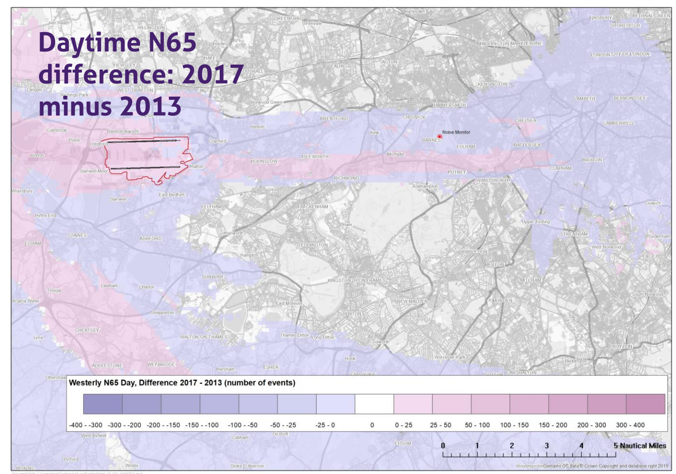




Differences in average **daytime** aircraft noise levels – westerly operations

- The difference in the modelled average $L_{Aeq,16hr}$ and $N65_{16hr}$ contours around Heathrow between 2013 and 2017 are shown in the figures to the right. This is for **an average 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 Barnes, there was approximately a 1dB decrease in average modelled daytime $L_{Aeq,16hr}$ noise level between 2013 and 2017, while the modelling also indicates a decrease of up to 25 daytime N65 events.
- It should be noted that, all other variables remaining constant, a difference of 15% in the noise levels would correspond to about a 1dB increase/decrease in $L_{Aeq,16hr}$ and a 100% difference would correspond to about a 3dB increase/decrease in $L_{Aeq,16hr}$.
- Larger figures are shown in Appendix A.



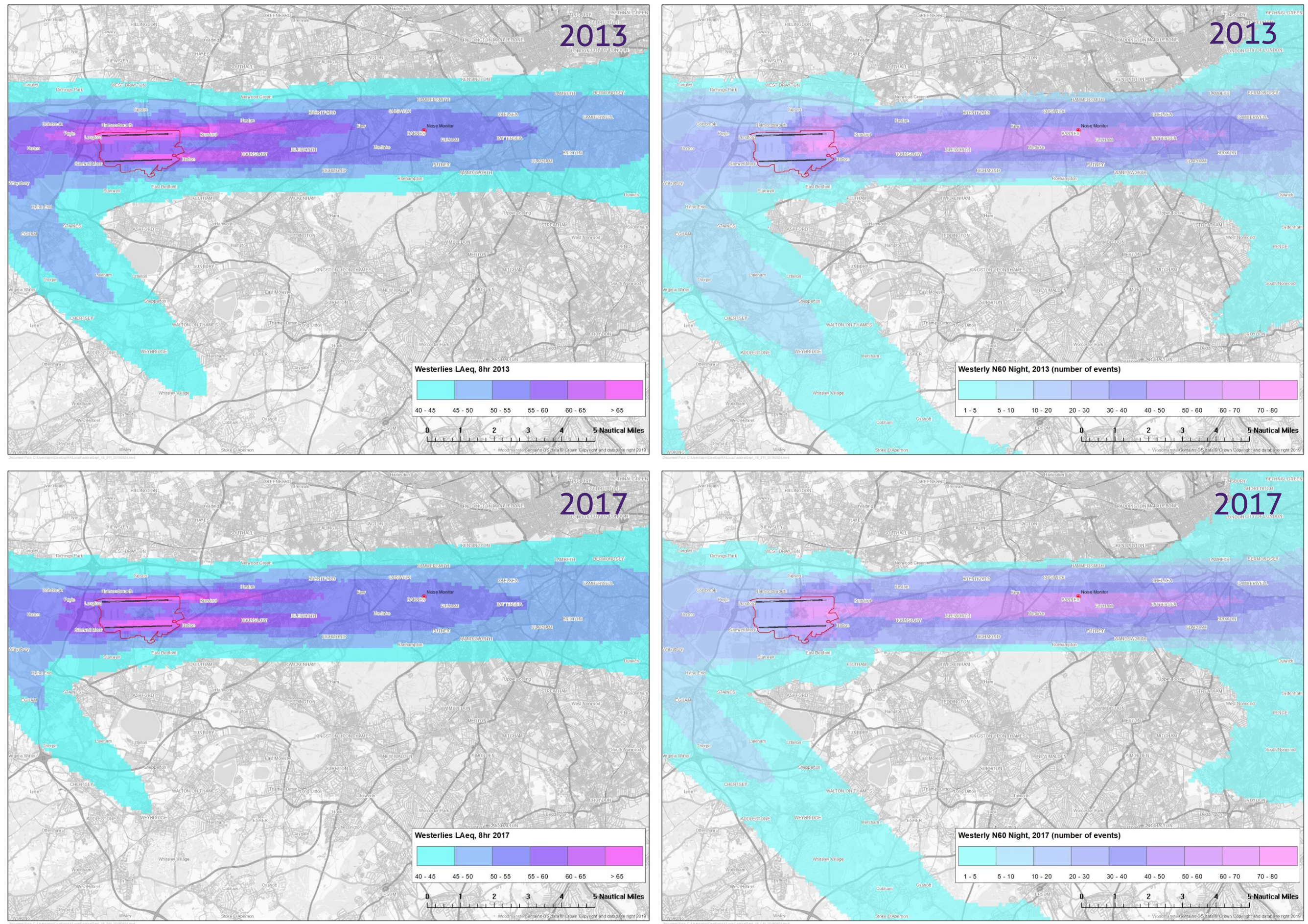


Average **night-time** aircraft noise levels – westerly operations

- The figures to the right show the 2013 and 2017 night-time $L_{Aeq,8hr}$ bands in the left column and N60 bands in the right column. This is an average noise level on **an average summer night 23:00-07:00 when there are 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 60dB over the 8 hour night period 23:00-07:00.
- Larger figures are shown in Appendix A.

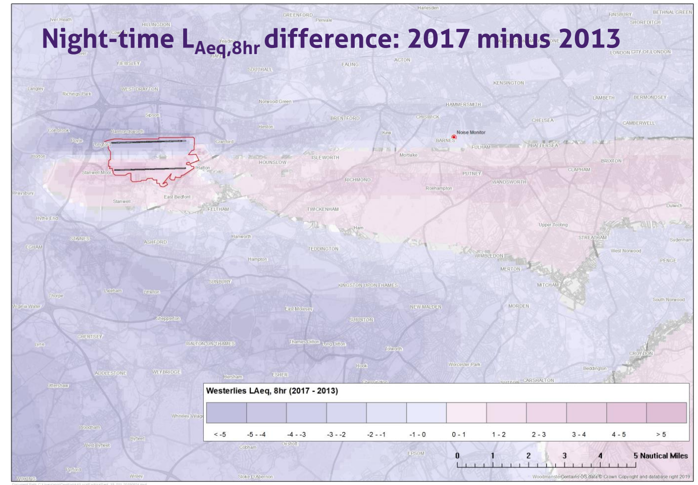
Night-time $L_{Aeq,8hr}$

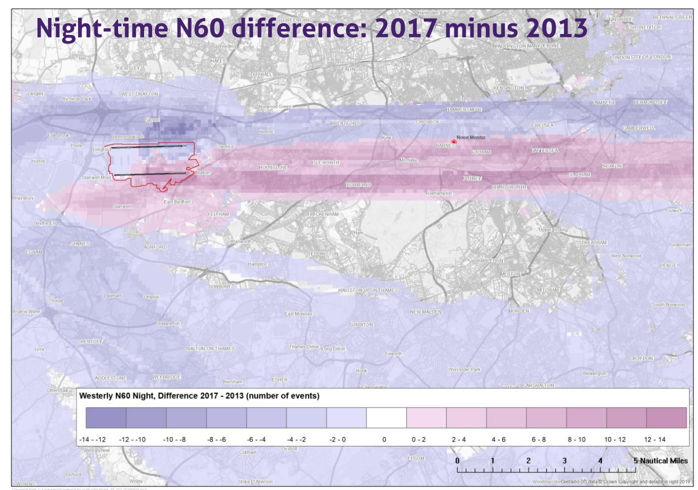
N60, night-time



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 a decrease in average night-time aircraft $L_{Aeq,8hr}$ noise levels of up to 1dB, while the N60 increased by up to two at Barnes from 2013 to 2017.
- It would appear that a change to the proportion of arrivals using each runway is the main driver for changes to the noise environment under the arrival paths on westerly operations. This is since the area in line with the approach to the northern runway generally experiences a decrease in noise, while the area in line with the approach to the southern runway generally experiences an increase in noise.
- Care should be taken when interpreting these figures since the number of flights during the night period is relatively low, therefore small changes to the total number of flights can appear as relatively large changes.
- Larger figures are shown in Appendix A.





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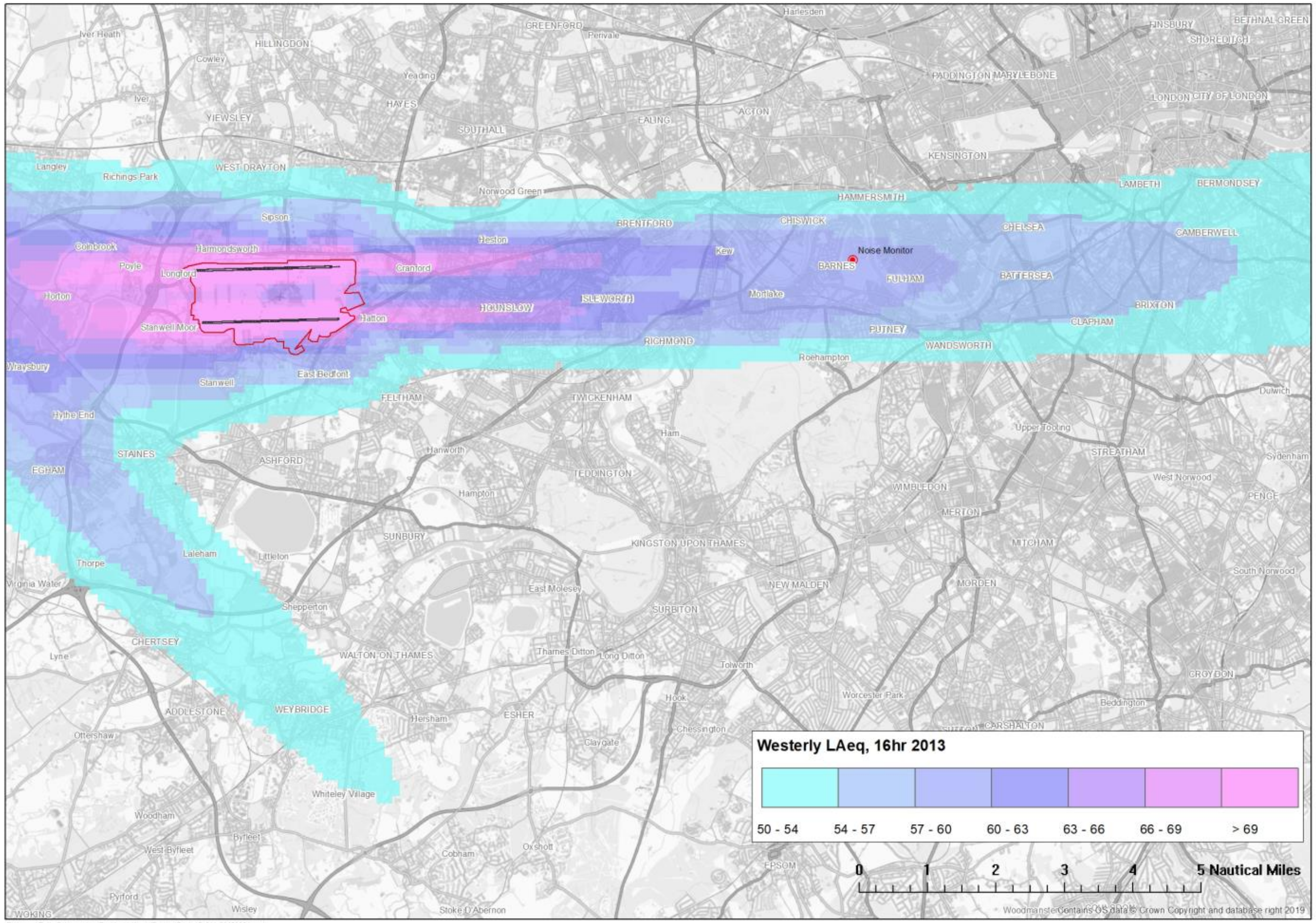
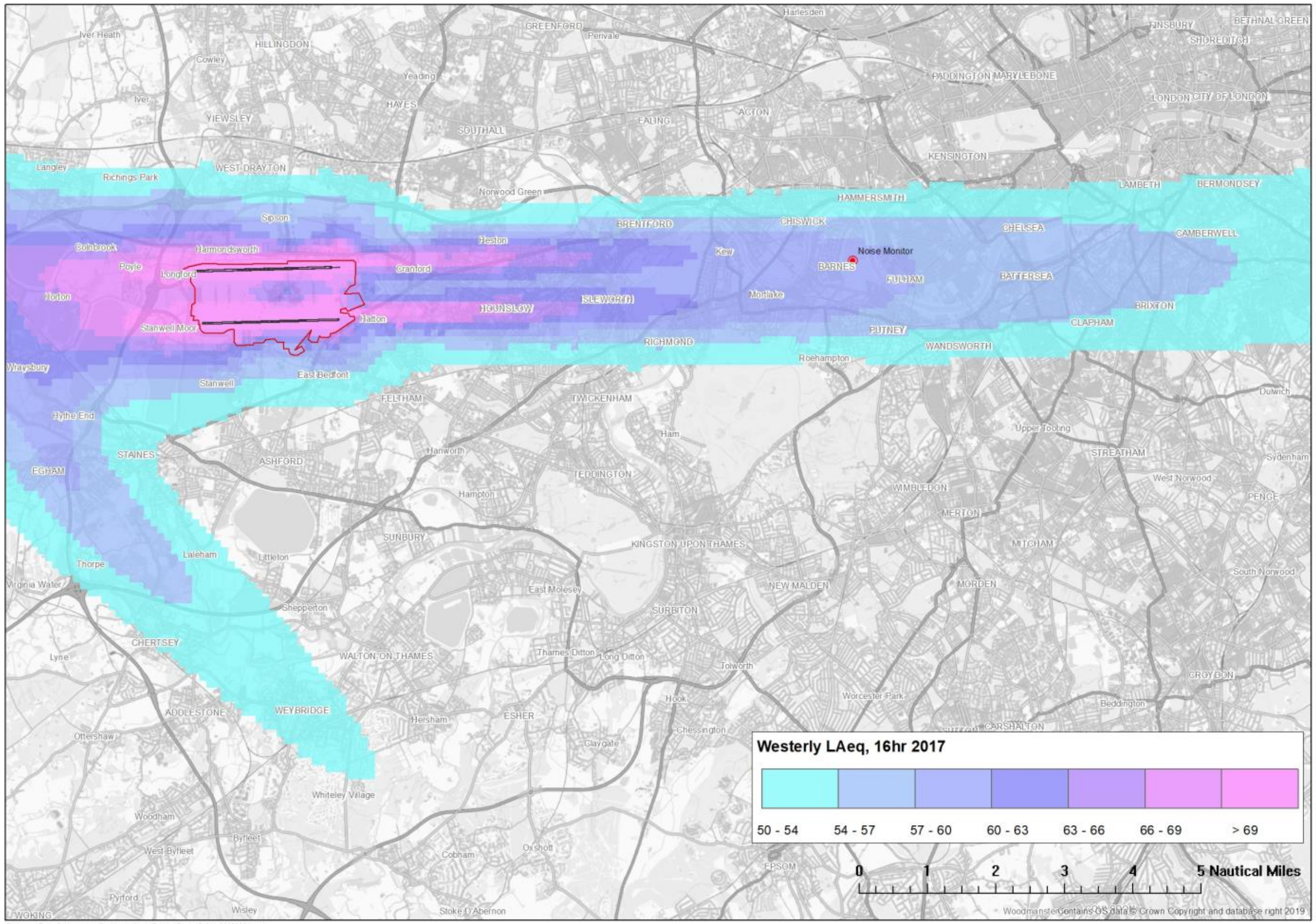
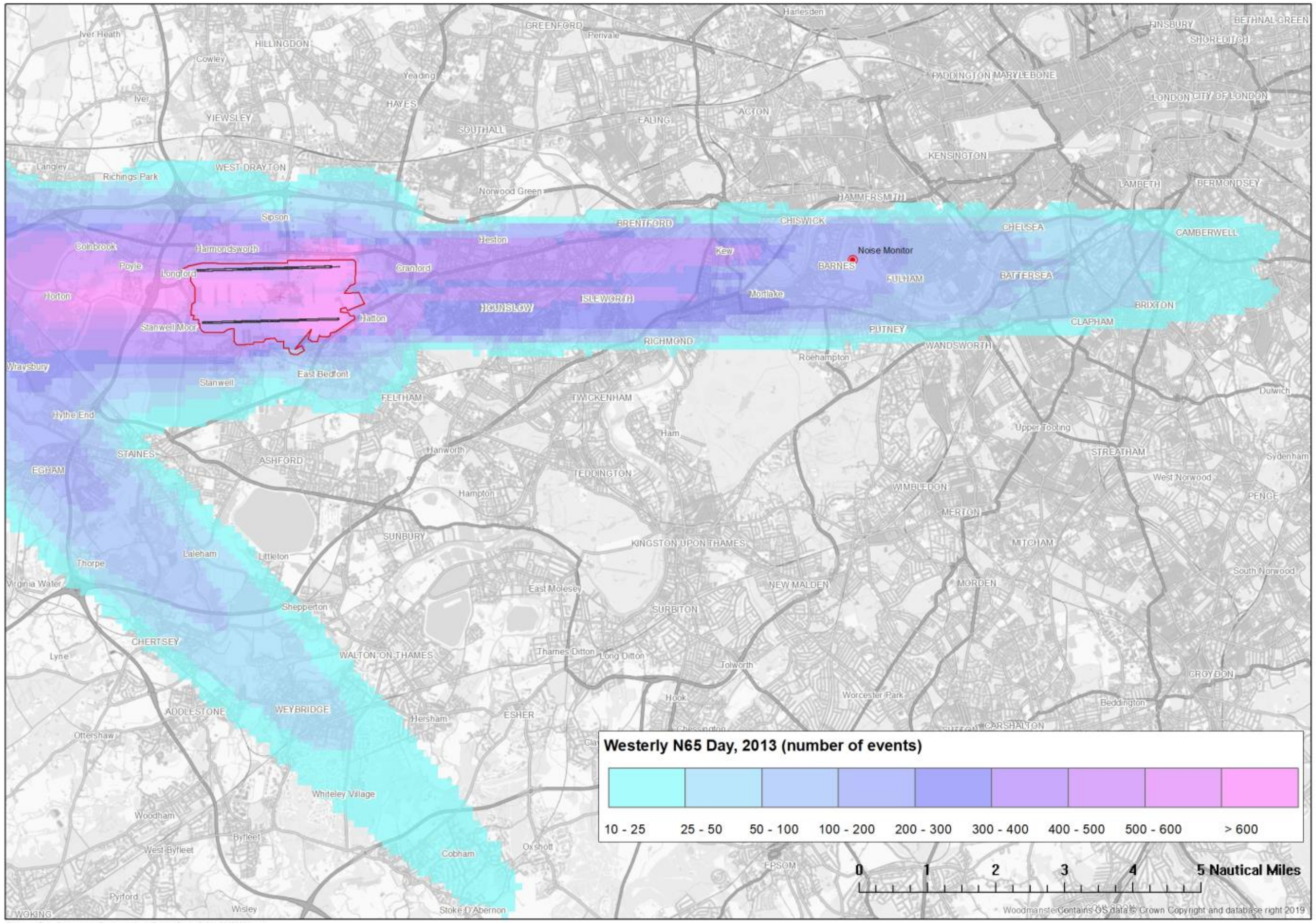
Appendix A: Average westerly day $L_{Aeq,16hr}$ contours (2013)



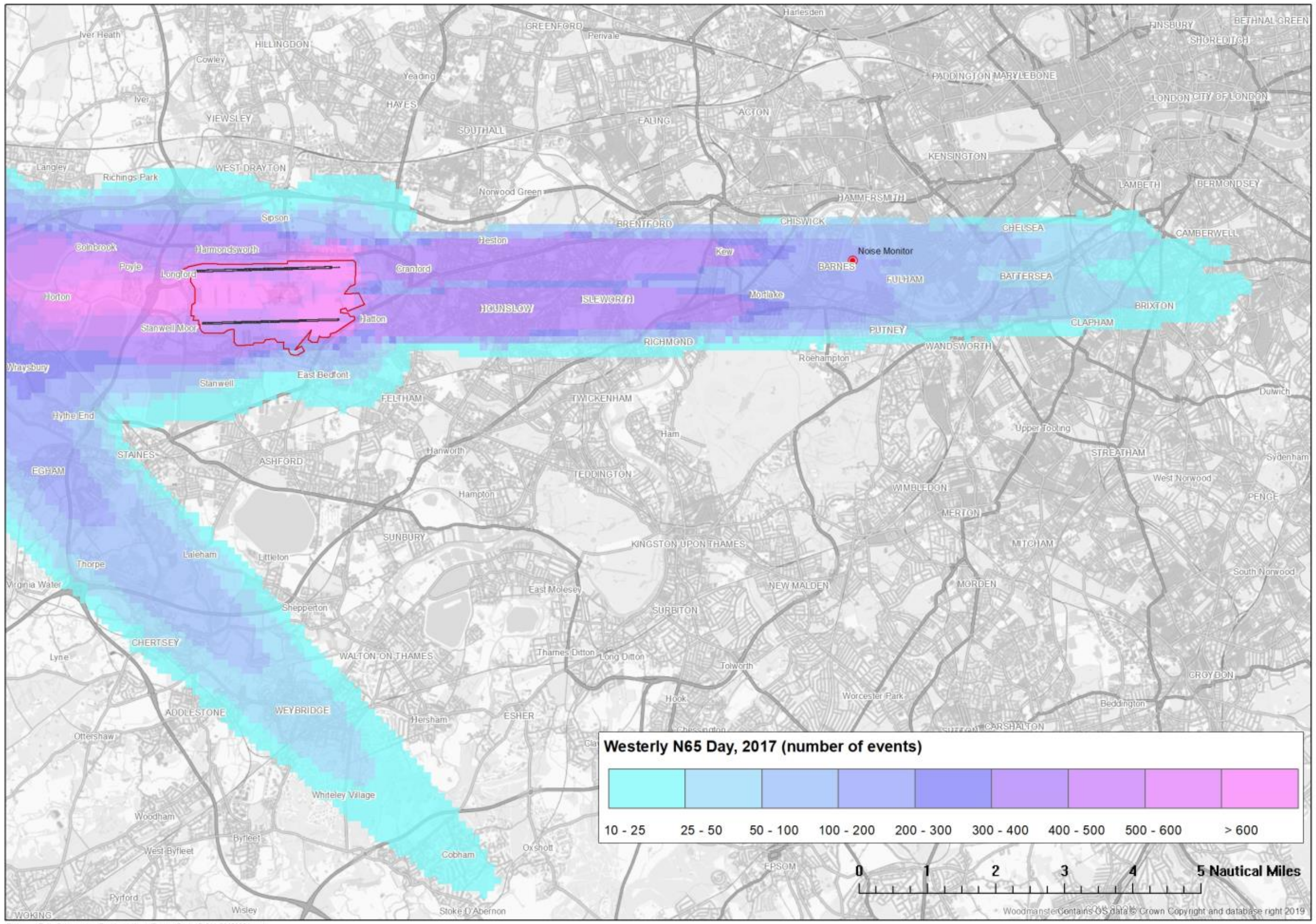
Appendix A: Average westerly day $L_{Aeq,16hr}$ contours (2017)



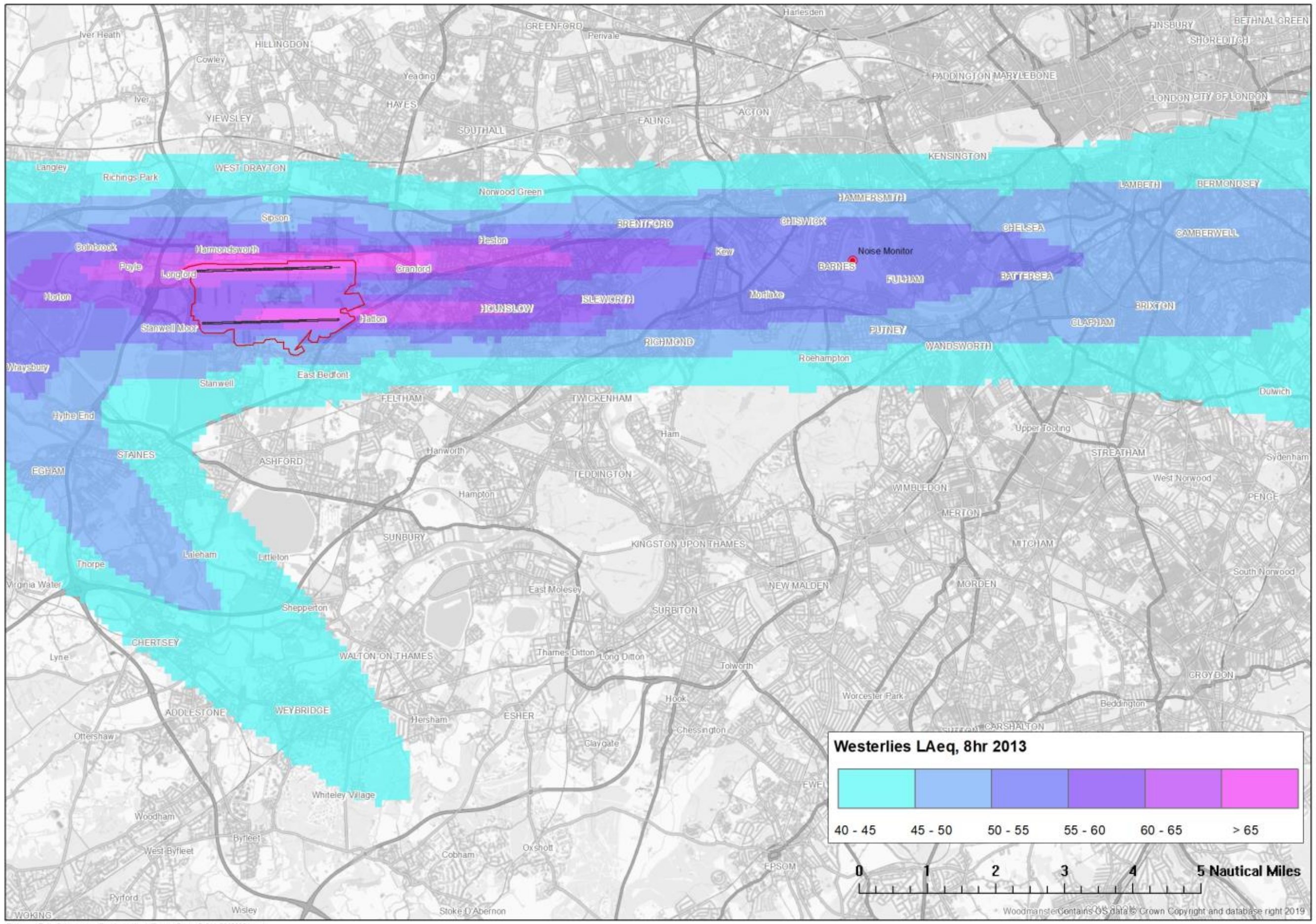
Appendix A: Average westerly day $N65_{16hr}$ contours (2013)



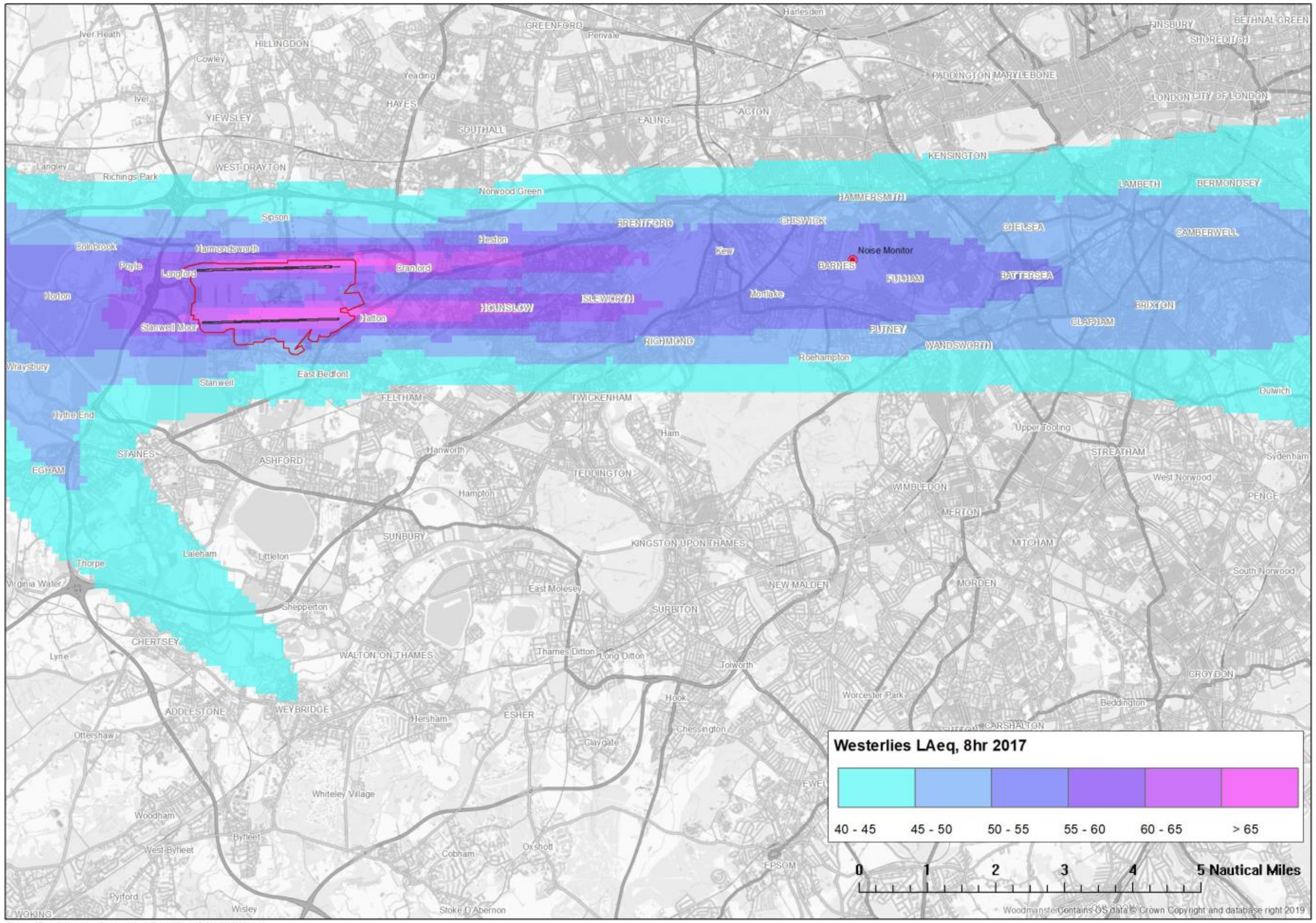
Appendix A: Average westerly day $N65_{16hr}$ contours (2017)



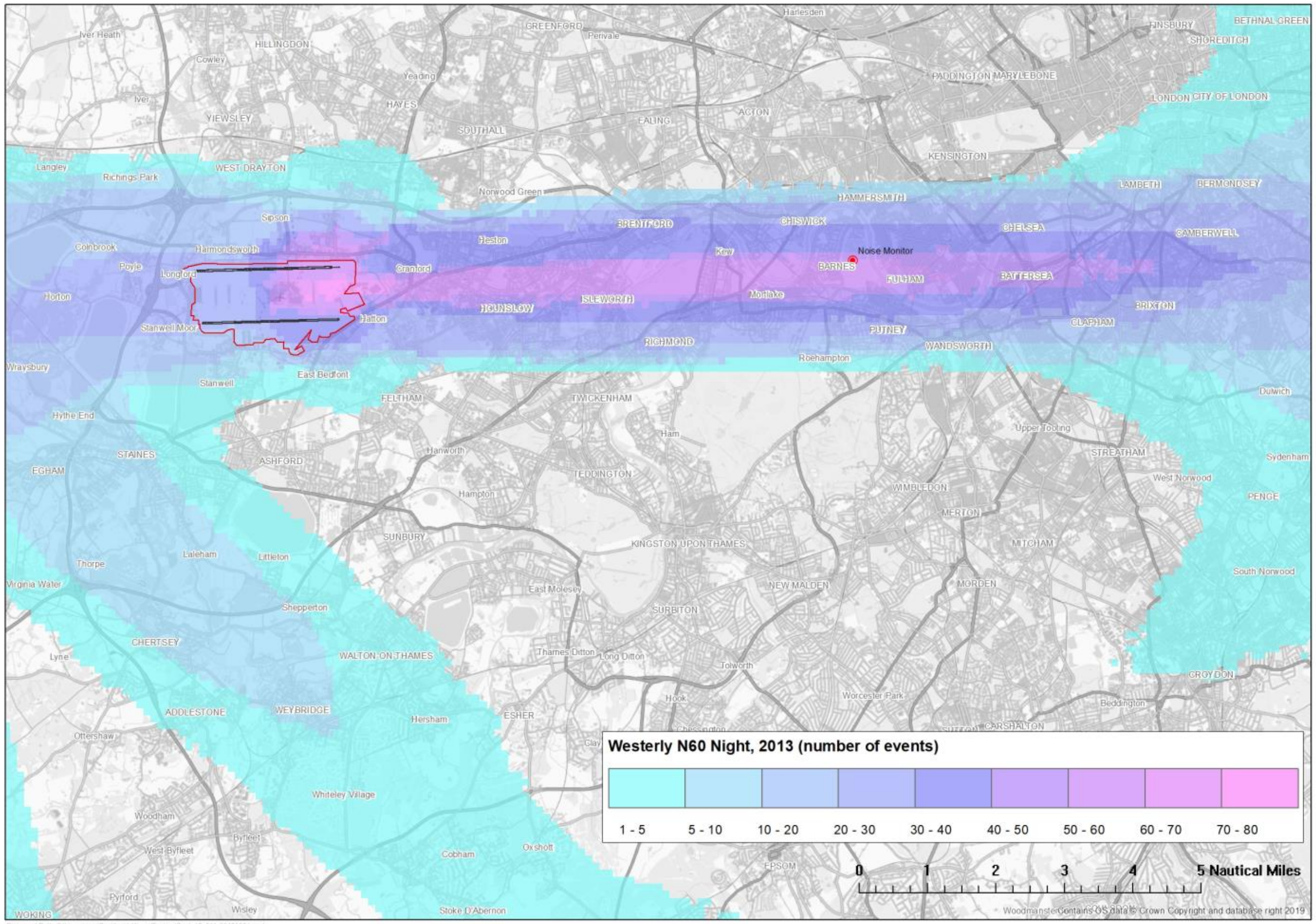
Appendix A: Average westerly night $L_{Aeq,8hr}$ contours (2013)



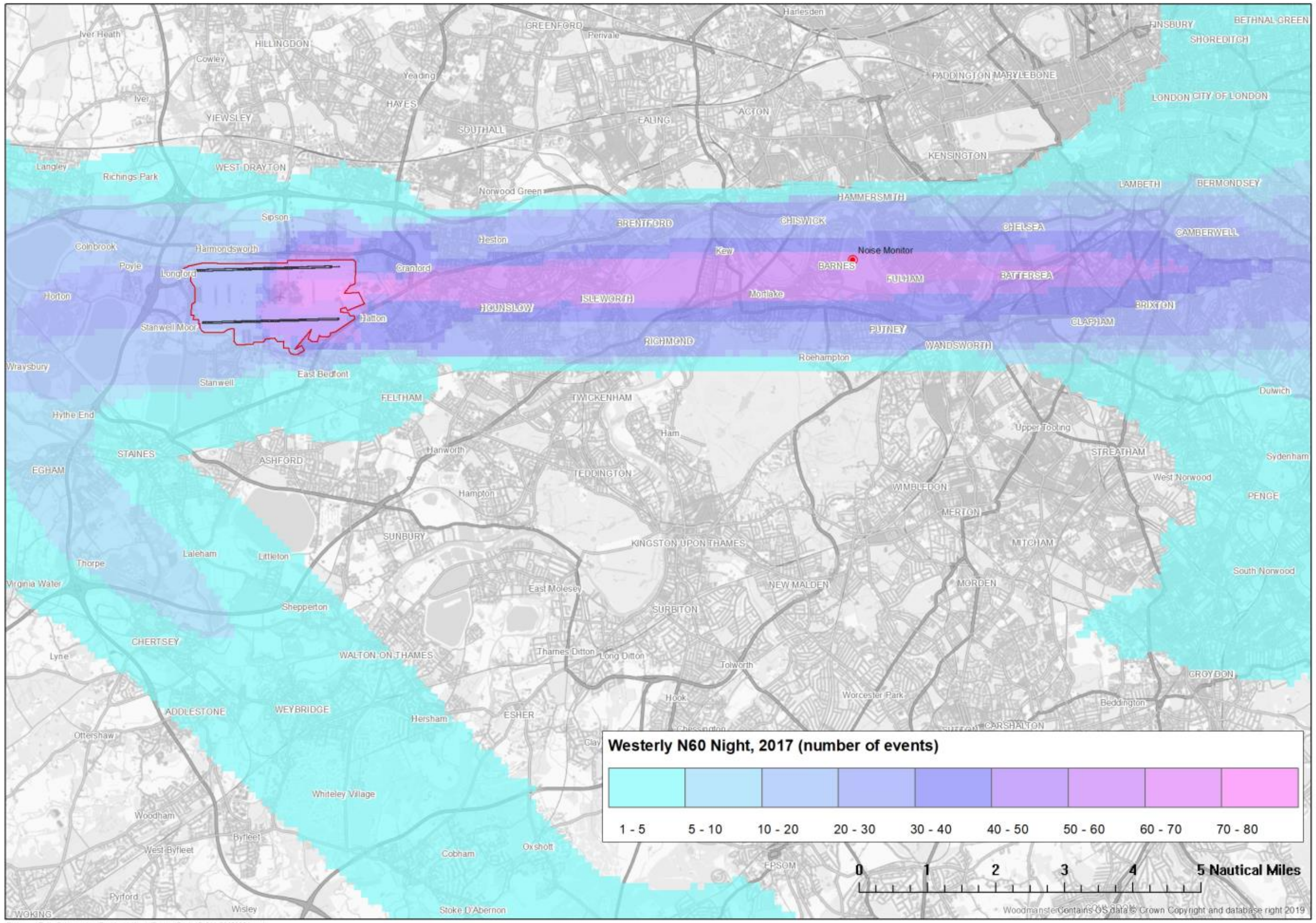
Appendix A: Average westerly night $L_{Aeq,8hr}$ contours (2017)



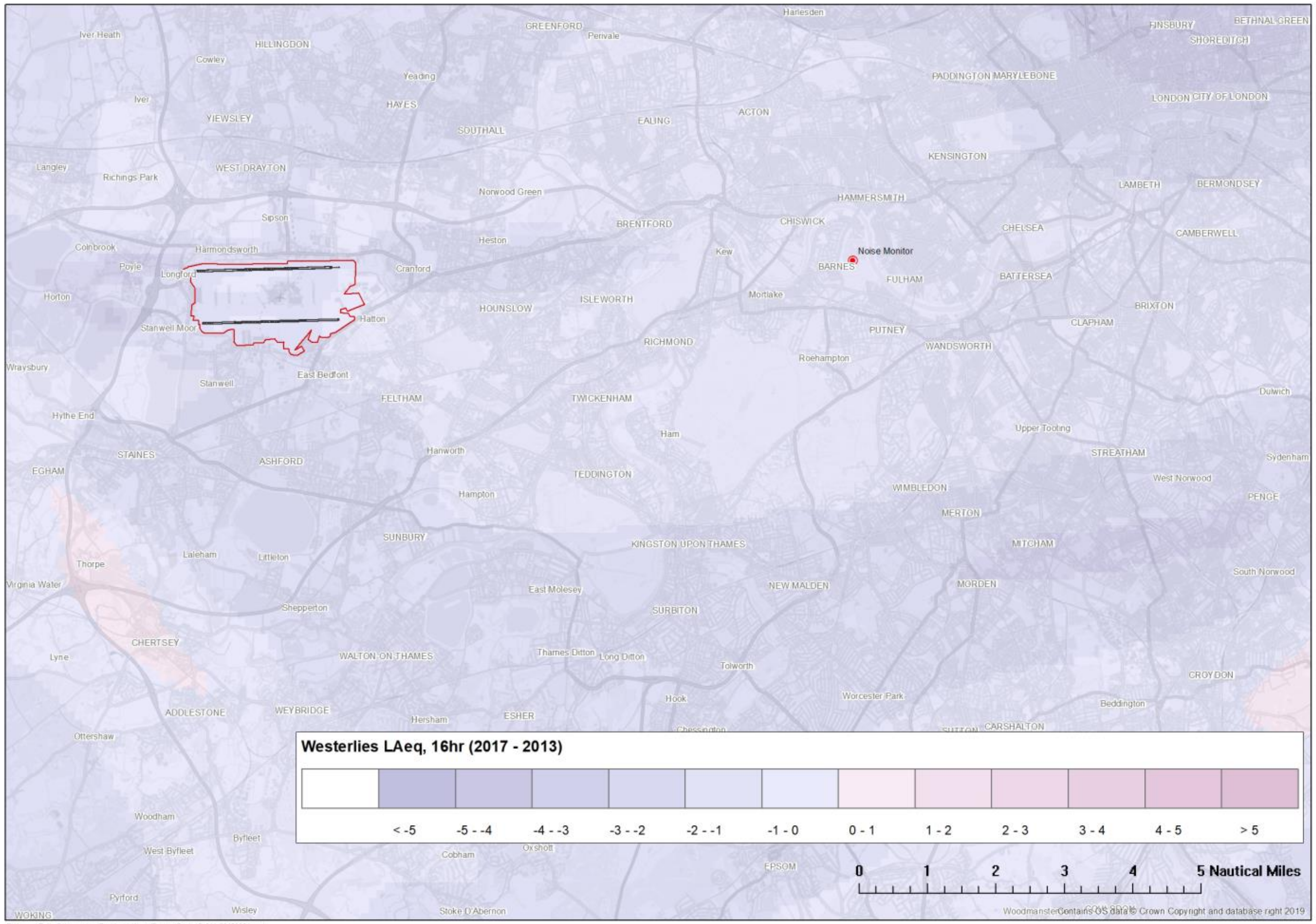
Appendix A: Average westerly night $N60_{8hr}$ contours (2013)



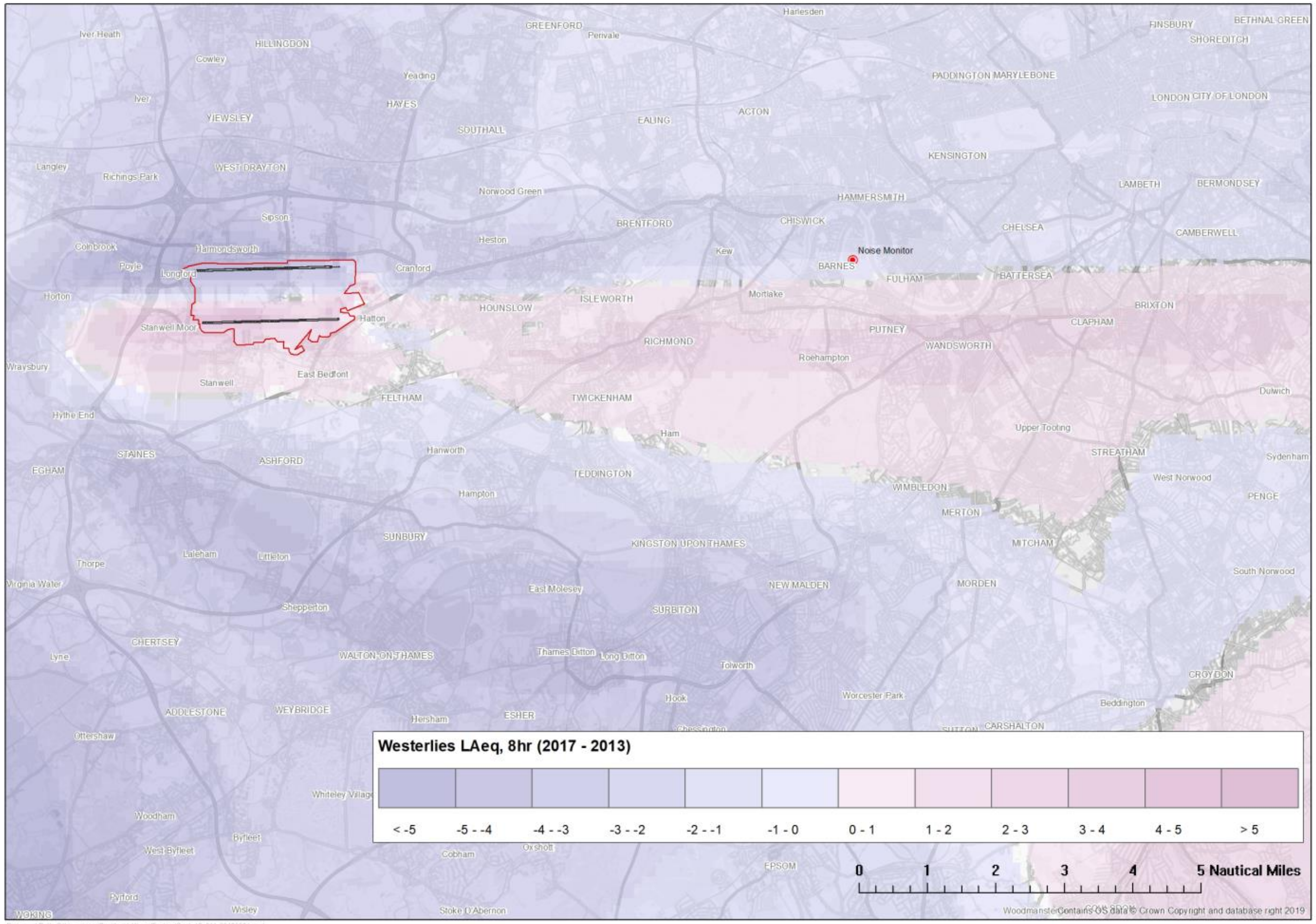
Appendix A: Average westerly night $N60_{8hr}$ contours (2017)



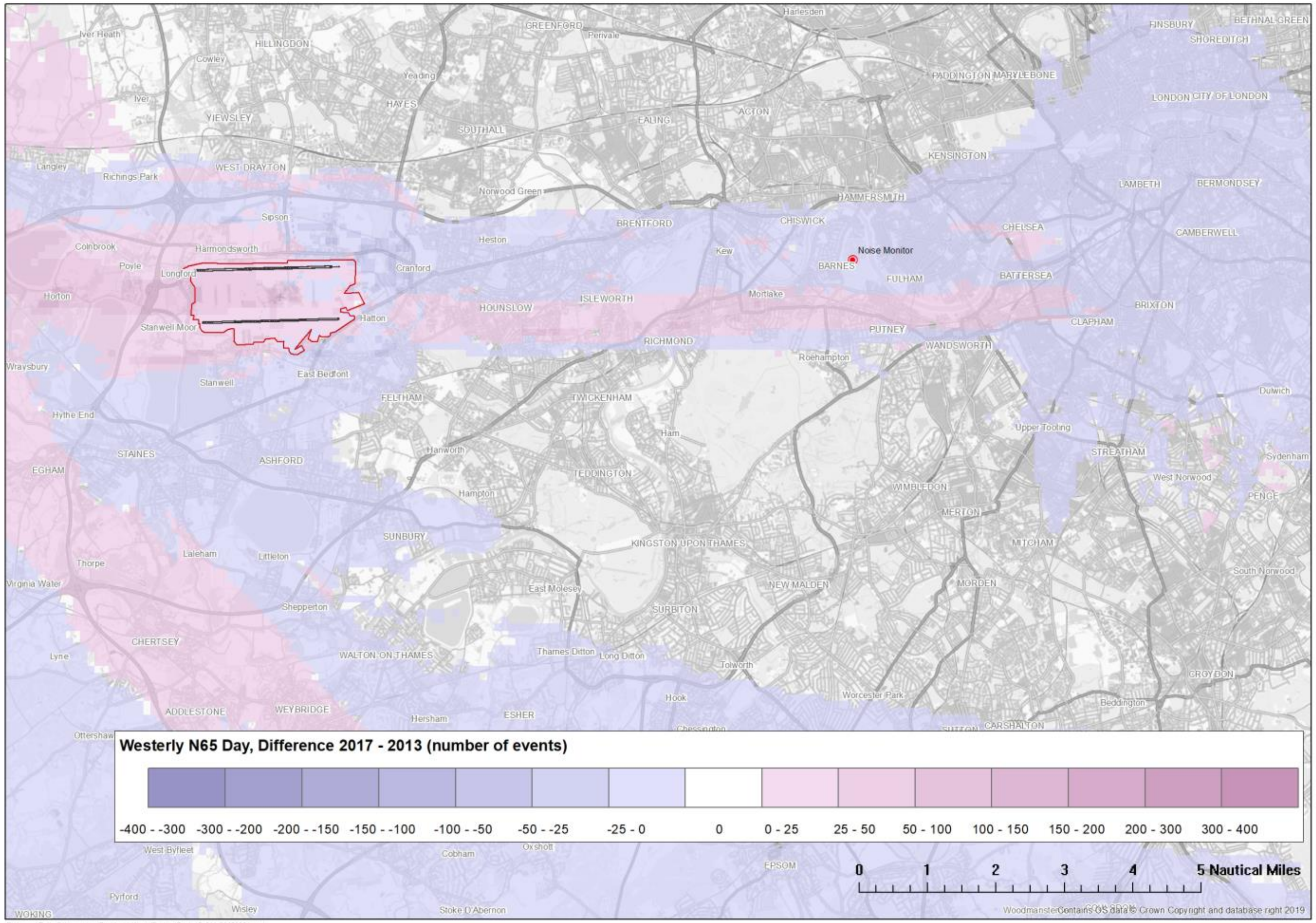
Appendix A: Average westerly day $L_{Aeq,16hr}$ difference (2017 minus 2013)



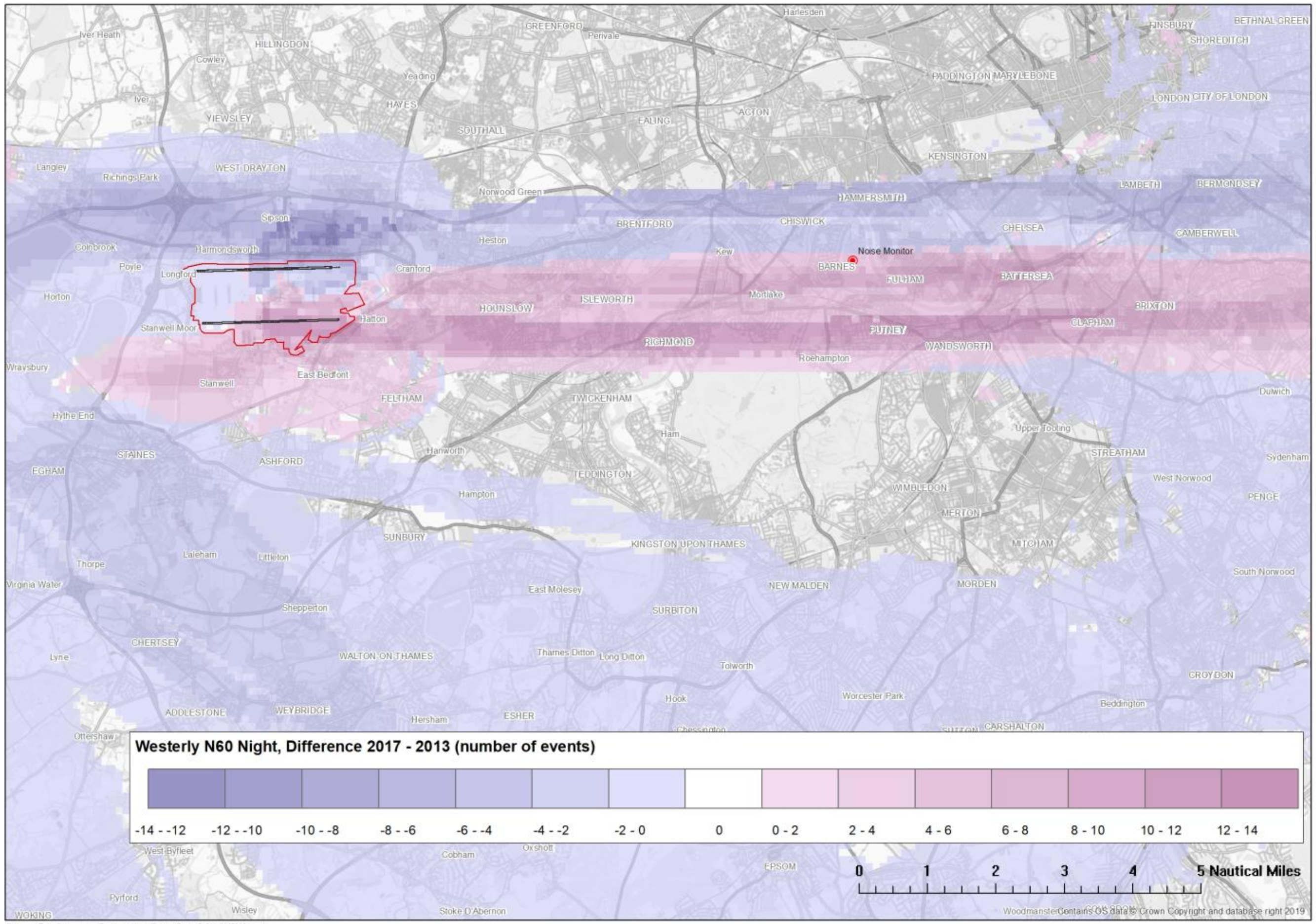
Appendix A: Average westerly night $L_{Aeq,8hr}$ difference (2017 minus 2013)



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



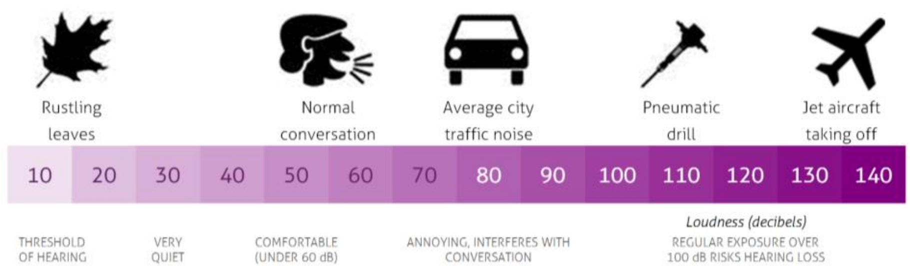
Appendix A: Average westerly night $N60_{8hr}$ difference (2017 minus 2013)



Appendix B: Noise Terminology

How is sound/noise measured?

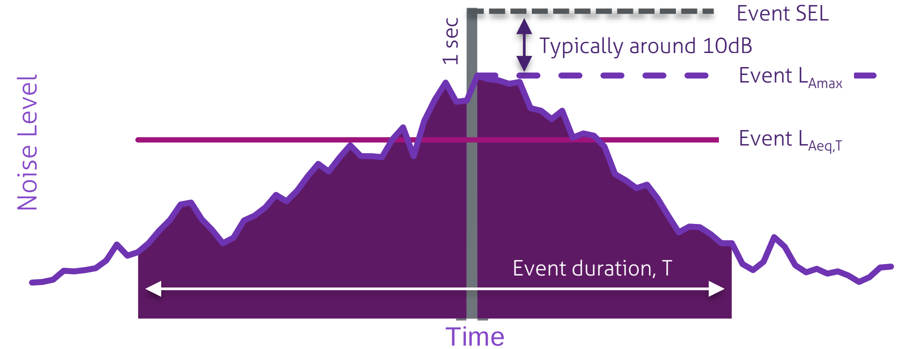
There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Furthermore, the ear mechanism responds in a non-linear manner: more efficiently to lower sounds than to higher sounds. Sound is therefore measured using a logarithmic scale, which accounts for both these features, called the decibel (dB) scale. Typical levels of everyday sounds are shown in the figure below.



As well as the large range of levels, the human ear is capable of detecting sound over a wide 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 sound (and where a single figure value is required) is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A-weighting' and is represented as dBA, dB(A) or dB $L_{Aeq,T}$, for example. All units in this report use this A-weighting.

How is aircraft noise measured?

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



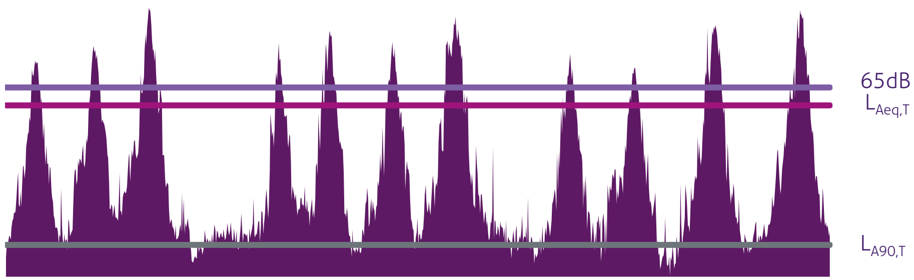
There are a number of metrics that can be used to characterise a noise event. The main ones in current use are shown above and described below. All of which can be derived from monitoring and modelling.

- The L_{Amax} is the highest A-weighted sound pressure level during the event. It is broadly an instantaneous value based on a response time of 125ms as per the Fast-time response. Can also be written L_{AFmax} or $L_{Amax,fast}$.
- The $L_{Aeq,T}$ is the equivalent continuous sound pressure level that would generate the same energy as that of the fluctuating level during the event of period, T. It is in effect the average level of the event.
- The SEL (sound exposure level or single event level) is the sound pressure that would arise if all the energy of the event was to be delivered in 1 second. It is a form of normalisation.

Appendix B: Noise Terminology

How is long term noise exposure measured?

The L_{Amax} and SEL metrics 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, primarily using the L_{Aeq} metric in the UK. The L_{Aeq} for a period of aircraft overflights, together with a particular threshold and L_{A90} (background) level, is demonstrated in the figure below. More on these below.



Although the L_{Aeq} plays a role in policy and planning assessment, it does not necessarily fully describe community experience. Supplementary noise metrics have been developed to further reflect community experience in, hopefully, understandable language. For example, the N65 describes the number of events that 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 exceeded for more 90% of monitored period and is demonstrated by the grey line in the figure above.

How does sound level 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, which is small compared to the distance from it, 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 increased 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 sound/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 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 sound/noise level relate to number of events?

Average sound 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 sound is measured, a doubling of sound 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
x10	+10dB
x4	+6dB
x2	+3dB
0	0
÷2	-3dB
÷4	-6dB
÷10	-10dB