Co-sponsors: NATS London Luton Airport

Swanwick Airspace Improvement Programme Airspace Deployment 6, (SAIP AD6) ACP-2018-65

Changes to

London Luton Airport Arrivals

CAP1616 Stage 7 Post-Implementation Review
Annex A: Traffic Dispersion & Environmental Data

Photo © Graham Custance

NATS-LLA Public

Roles

Action	Role	Date
Produced	Airspace Change Expert NATS Airspace and Future Operations	11/07/2024
Produced	Flight Operations Manager London Luton Airport	11/07/2024
Reviewed Approved	ATC Lead NATS Swanwick Development	11/07/2024
Reviewed Approved	Head of Airspace Development NATS Swanwick Development	11/07/2024
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Reviewed Approved	Senior Manager Public Policy and Community Engagement NATS Corporate Communications	11/07/2024

Drafting and Publication History

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References

Ref No	Description	Links
1	SAIP AD6 CAA web page – progress through the airspace change process, and the consultation website including responses	Link to CAA portal Link to consultation site
2	CAA Decision Document CAP2288	Link to document
3	CAA Data Request Document	Link to document
4	Airspace Change Consultation material (selection of documents)	Executive summary Link to abridged document Link to full document
5	Consultation virtual exhibition	Link to website
6	Stage 4 Step 4A(ii) The Final Airspace Design (technical map for use on computers, unsuitable for smartphones and tablets, open using the free Adobe Reader DC app to make use of switchable layers)	Link to downloadable map
7	Airspace change: Guidance on the regulatory process for changing the notified airspace design (Edition 4 in force for this review) CAP1616	Link to document (Edition 4, March 2021)
8	CAA Definition of Overflight CAP1498	Link to document Link to short animation
9	UK Government Department for Transport's 2017 Guidance to the CAA on its environmental objectives when carrying out its air navigation functions (abbreviated to ANG2017)	Link to website Link to document

Contents

1. About this document: PIR items 34a-d, 43a, 49f-v.

1.1 Introduction

1.1.1 This document is part of the NATS-London Luton Airport (LLA) co-sponsored airspace change proposal post-implementation review (ACP PIR). It should be read in conjunction with the PIR Main Document which provides the structure, the majority of the evidence, and details the PIR's regulatory requirements.

1.1.2 This document's purpose is to illustrate how air traffic patterns have changed and to provide evidence that the change is operating as anticipated, within acceptable tolerances. It also provides fuel and carbon dioxide (CO_2) emissions data, and the conclusion from a technical noise report.

1.1.3 The full technical report (including contours and additional noise modelling diagrams) is provided as a separately published Technical Appendix to Annex A.

1.1.4 It covers PIR Items 34a (density plots), 34b (lateral and vertical analysis), 34c (weather impacts), 34d (fleet mix), 43a (proportions of flights using the procedures), 49f (local air quality), 49g-o (noise metrics and methodology), 49p-t (fuel and CO_2 emissions), 49u (tranquillity) and 49v (biodiversity).

1.1.5 Note that some PIR items are used to illustrate others.

2. Density plots and analysis

2.1 Method

2.1.1 This section provides maps of the region overlaid with processed radar data of actual flights.

2.1.2 We show images of the pre-ACP (2019) flightpaths next to equivalent images of the post-implementation (2022-23) flightpaths so that the reader can see how flightpaths have changed. In turn this helps illustrate changes in impacts.

2.1.3 Our data samples for 2019 (pre-ACP) are the same as the data we used in the original consultation material: 7 days to illustrate Runway 07 easterly arrivals (10/11/22/23/26/27/28 June 2019) and a different 7 days to illustrate Runway 25 westerly arrivals (1/2/3/5/13/14/17 June 2019).

2.1.4 Our data samples for post-implementation are: 7 days to illustrate Runway 07 easterly arrivals (5/6/7/8/9/10/11 June 2023) and a different 7 days to illustrate Runway 25 westerly arrivals (23/24/25/26/27/28/29 June 2023). These were chosen because they are considered by our air traffic control experts to be representative of typical traffic flows, before and after the airspace change, for both easterly and westerly operations.

2.1.5 The primary information shows radar data processed into density plots. Each colour is associated with the number of times a specific place is overflown per day (as per the key on each map). The density plots show arrivals for each runway. The outer (grey) density indicates up to two overflights per day and is not considered a significant impact, but is included to illustrate the overall situation.

2.1.6 Each map also has coloured shapes (and associated key) indicating typical altitude bands of arrivals, along with the main flow in black. For the pre-ACP 2019 maps, they are the same as the winter 2020/2021 consultation. For the PIR period of 2022-23 those shapes show the predicted extents and altitudes from the consultation, so the reader can assess how our predictions compared with the actual flow of arrivals using the radar density plots.

2.1.7 The tool we used to create the density plots is not always able to filter out departures or some processing display errors from its output. Throughout this proposal we have been clear that only arrivals would change. Please disregard unwanted radar tracks in these pictures, we did not wish to edit the diagrams to remove them.

2.1.8 PIR Item 34c Weather Events

Should be considered if there was a significant weather event that can explain an anomaly in the plots.

2.1.9 During these four periods there were no significant weather events (named storms, heatwave, etc) resulting in anomalies to the provided radar track data. Therefore, each map is considered representative of a typical week's operation. However, in many diagrams there is radar track data displayed that is not relevant to the airspace change, and is a by-product of the tool used to create the images. Please disregard those tracks.

2.1.10 PIR Item 34d Fleet Mix

Any changes to operating fleet mix that have occurred since implementation for comparison with pre-implementation.

2.1.11 In the original consultation material we published the typical proportions of general aircraft types operating at LLA (link to published document on CAA Citizen Space site, see page 15 Table 3 of that document).

2.1.12 In Table 1 below, the green columns represent the fleet mix for the PIR period, the orange columns are reproduced from the consultation material, as per the reference above.

2.1.13 The rightmost column shows the differences in proportions, where a '+' indicates a greater proportion in the PIR period and '–' a smaller proportion.

Noise Category	PIR Period 2022-23		Calendar year 2019		% PIR period minus % 2019 (difference)
	Count	Proportion	Count	Proportion	
Turboprop* (inc all sizes of corporate aircraft, both turboprop and jet)	12,337	19.5%	12,276	17.4%	+2.2%
50 seat regional jet	1,045	1.7%	1,116	1.6%	+0.1%
70-90 seat regional jet	11	0.02%	54	0.08%	-0.1%
125-180 seat single-aisle 2-eng jet	48,711	77.1%	55,587	78.6%	-1.5%
250-seat twin aisle 2-eng jet	1,025	1.6%	1,595	2.3%	-0.6%
300-350-seat twin aisle jet	50	0.08%	99	0.14%	-0.1%
Other	5	0.01%	8	0.01%	0%
Total arrivals	63,190		70,736		

Table 1 Proportions of aircraft types in the PIR period vs. 2019, by noise category

*Note that corporate and business travel occurs in a range of aircraft types, from small single turboprop aircraft up to larger business jets and there is no CAA-defined noise category. For consistency, all these types have been placed in the turboprop category.

2.1.14 Overall there were 7,546 fewer flights in the PIR period than in 2019. The PIR period therefore was 89.3% of the 2019 period. Given that the largest overall change in proportion is 2.2%, the general proportions of aircraft types are consistent between periods.

2.1.15 A small drop in the proportion of 125-180 seat jets and 250-seat jets is balanced by the increase in turboprops and corporate jets.

2.1.16 The implementation of this airspace change was not expected to change these proportions, and this evidence supports that prediction.

2.1.17 This also means that the impacts of the flights would remain consistent in proportion of noise category, between pre and post-implementation.

2.1.18 PIR Item 43a Data on proportions of flights using procedures

Data on the % of flights that actually flew the procedure(s) vs the total number of flights (departing or arriving), compared for the relevant time periods before and after the change.

2.1.19 NATS checked with the CAA to confirm the scope of this PIR item. The CAA stated that they wanted evidence to determine if, from each major direction, the use of the arrival routes (STARs) post-implementation was consistent with the proportions pre-implementation.

2.1.20 Figure 1 (overleaf) illustrates the proportions based on a schematic flow diagram of the pre-implementation arrival routes shared with Stansted (orange), and the post-implementation routes (blue).

2.1.21 Proportions and absolute numbers are shown in text boxes illustrating arrival data from the northwest and west (NW and W), from the southwest (SW), from the south and southeast (S and SE) and from the east (E).

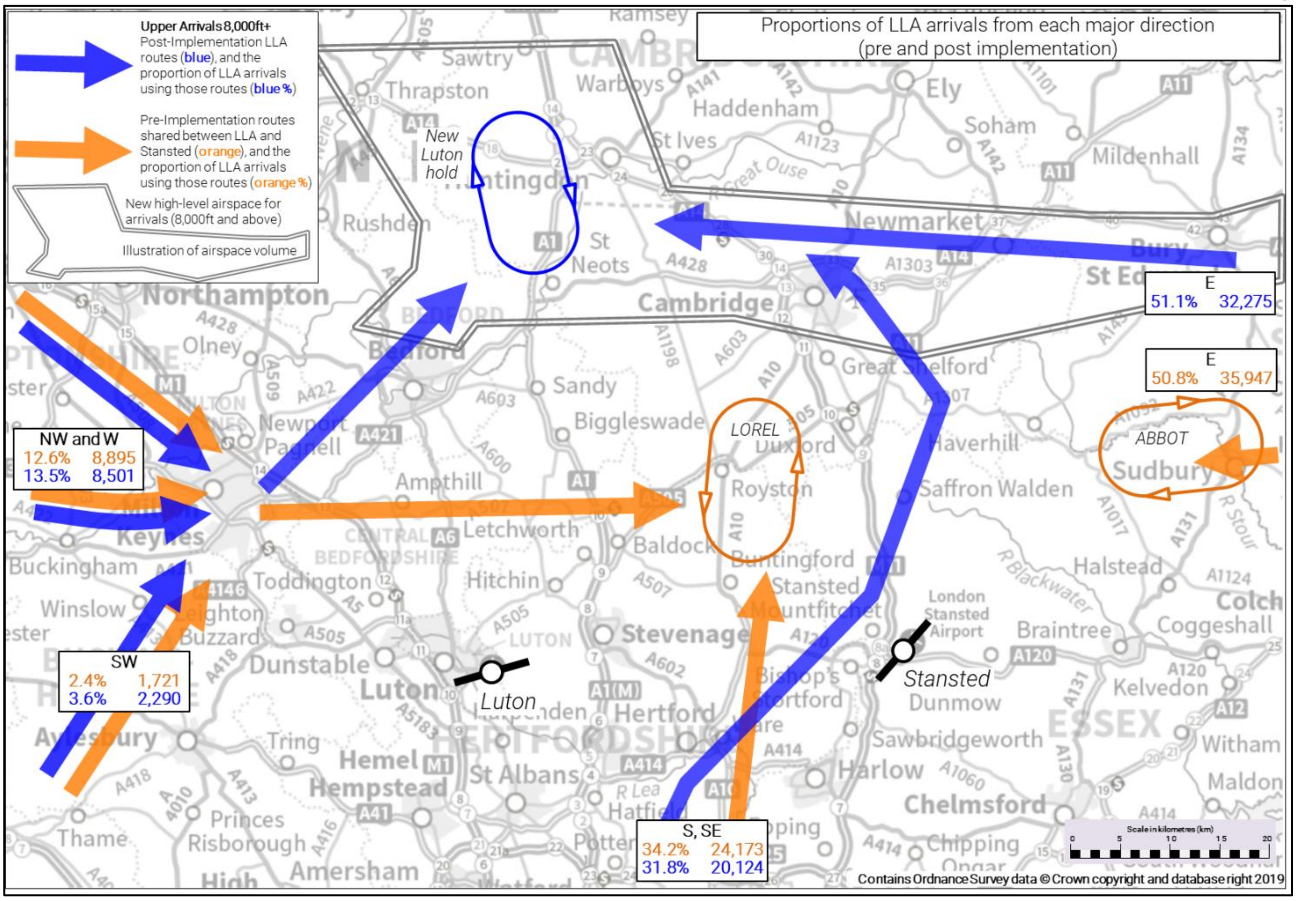


Figure 1 Schematic Proportions of LLA arrivals from each major direction, pre and post implementation

2.1.22 Figure 1's data is presented below as Table 2, with the columns colour-coded to match the arrows:

Main arrival direction	2019		PIR Period 2022-23		Difference (post minus pre)	
	Total	Proportion	Total	Proportion	Total	Proportion
NW, W	8,895	12.6%	8,501	13.5%	-394	0.9%
SW	1,721	2.4%	2,290	3.6%	569	1.2%
S, SE	24,173	34.2%	20,124	31.8%	-4,049	-2.3%
E (inc NE)	35,947	50.8%	32,275	51.1%	-3,672	0.3%
Total	70,736	100.0%	63,190	100.0%	-7,546	-

Table 2 Table of Proportions of LLA arrivals from each major direction, pre and post implementation
Note that the proportions are rounded to 0.1%.

2.1.23 As a proportion, slightly fewer flights arrived from the south and south-east, with arrivals from the west making up most of the difference. However, this difference is only 2.3%.

2.1.24 The implementation of this airspace change was not expected to change these proportions, and this evidence supports that prediction.

3. High-level arrival flow diagrams and holding data

3.1 General information about these diagrams

3.1.1 The flightplan routes and holding patterns (thin blue lines) illustrate arrivals from c.15,000ft to 8,000ft.

3.1.2 Typical flightplanned and tactical flows (both major and minor) are also shown in blue. A tactical flow is where a controller manually directs the aircraft to follow a different path than the full flightplanned route (thin blue lines), creating regularly used common flows (solid thick blue arrows) and minor flows (dashed thick blue arrows).

3.1.3 Controllers always try to be as efficient as possible with their flights; they will minimise flying time and distance wherever they can. Aircraft remain on their flightplanned route if the controller has no opportunity, or sees no advantage, to shorten the path to the runway in a safe, orderly and efficient manner.

3.1.4 Radar data is shown from c.12,000ft to 8,000ft; a density key illustrates frequency of overflight, and background maps show towns, cities and roads.

3.1.5 The diagrams also contain the same coloured polygons from the consultation material, that illustrate the typical altitudes and dispersion from 8,000ft to the runway. These are included to provide additional context for later diagrams that show 8,000ft and below, i.e. showing how arrivals got from high levels to 8,000ft.

3.2 Important notes regarding high-level arrivals data and community noise impacts

3.2.1 All the radar data and flow information on the descent diagrams in Section 3 stops on reaching 8,000ft; see later sections for complementary diagrams descending from 8,000ft to the runway.

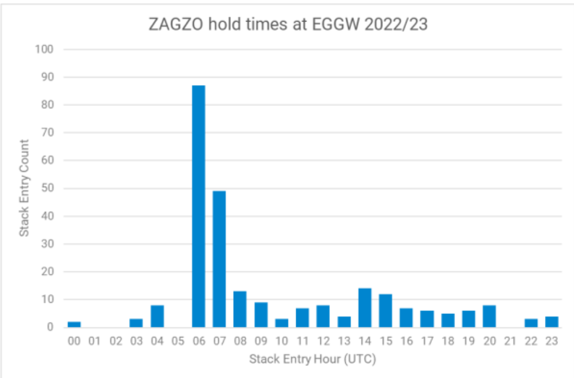
3.2.2 Government guidance on aviation environmental objectives (ANG2017, Ref 9) is that, in the airspace at or above 7,000ft, the priority should be flight efficiency; the minimising of community noise impacts is not a priority at high levels (paraphrased from ANG2017 p.18 paragraph 3.3.d, and p.21 paragraph 3.27).

3.3 PIR Item Other-b: Holding data (for LLA arrivals)

How often have the new holds been used; ZAGZO, WOBUN and MUCTE. Time periods that the holds have been used and the total number of LLA arrivals that completed at least one hold.

3.3.1 In the PIR period, for the main LLA arrivals hold ZAGZO, 258 flights completed at least one holding pattern (passing waypoint JUMZI, turning to ZAGZO then completing at least one racetrack pattern to ZAGZO again). However, aircraft were present in that vicinity that were passing through and not holding. See Section 3.5 below for radar data illustrating the wider region including the holding area.

3.3.2 The busiest time period was typically 0600-0700; May was the month where most holding occurred[1].



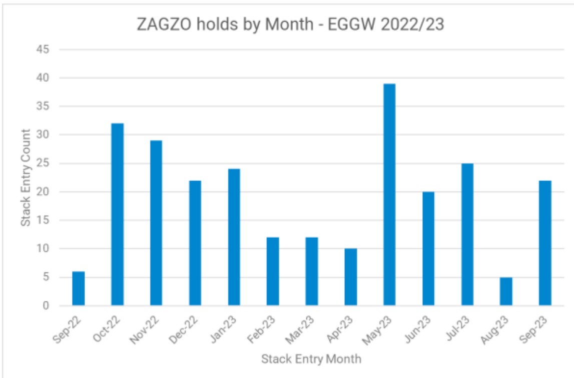


Figure 2 Time periods for holding at ZAGZO (L). (R) Number of aircraft holding by month

3.3.3 In the PIR period the contingency hold WOBUN was used only three times, and the contingency hold MUCTE was used only 32 times; as contingency holds they would not be expected to be used frequently.

3.3.4 We expected there to be a consequential reduction in the overall holding for Stansted arrivals, and this was achieved. See PIR Main Document section 16.2 for information on Stansted holding.

3.4 LLA arrivals dispersion plots Runway 07: pre and post implementation, high level

3.4.1 The diagram pairs on the following pages illustrate high-level arrival flightplan routes and actual traffic flows, for easterly Runway 07.

[1] As noted in the main PIR document, an ATC system failure over the 2023 August bank holiday caused a non-standard 4 day period of recovery. Data for this period is not included in the analysis.

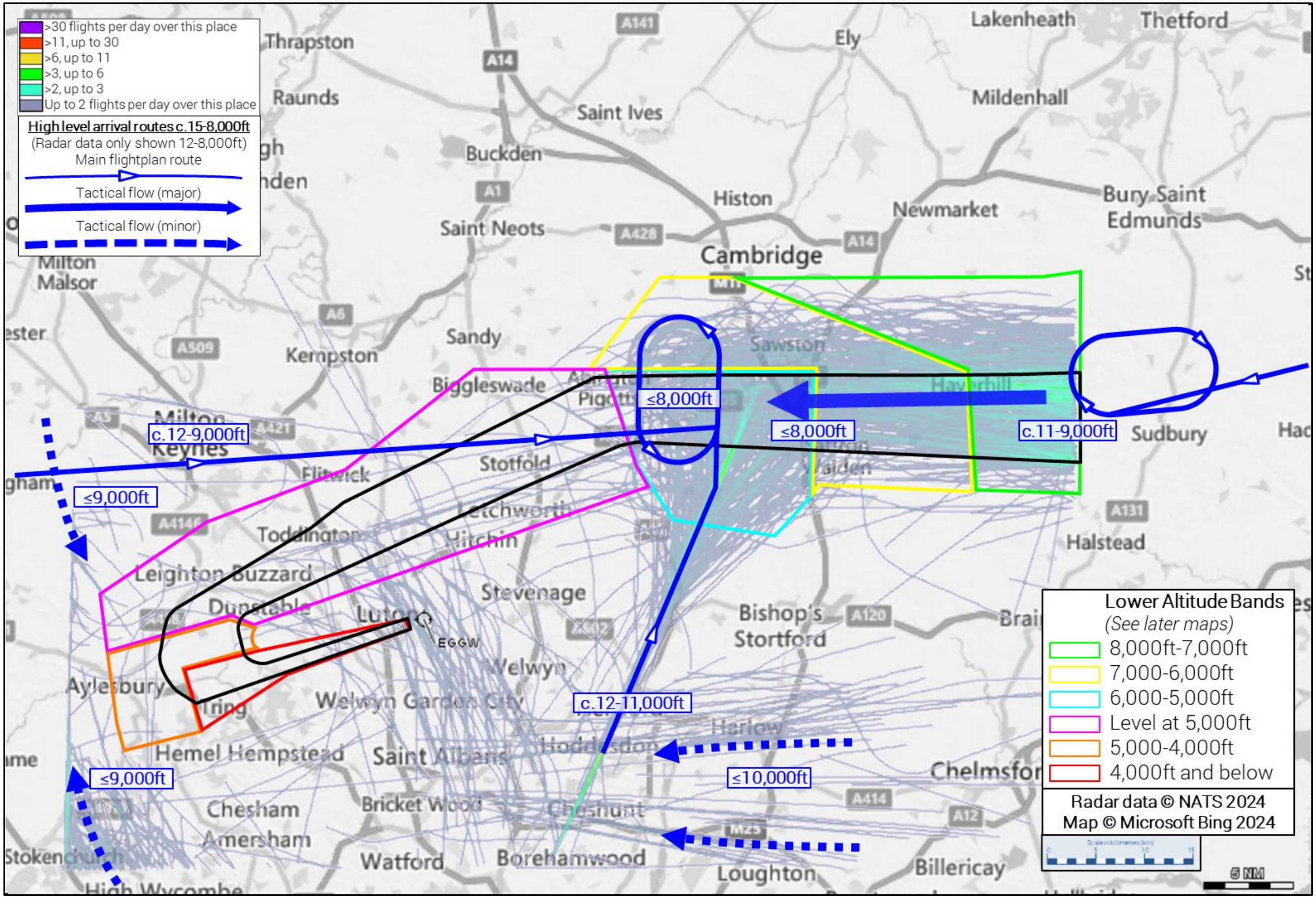


Figure 3 LLA Arrivals to Runway 07 descending from 12,000ft-8,000ft via shared holds ABBOT (east) and LOREL (west), 7 days in June 2019 pre-airspace change

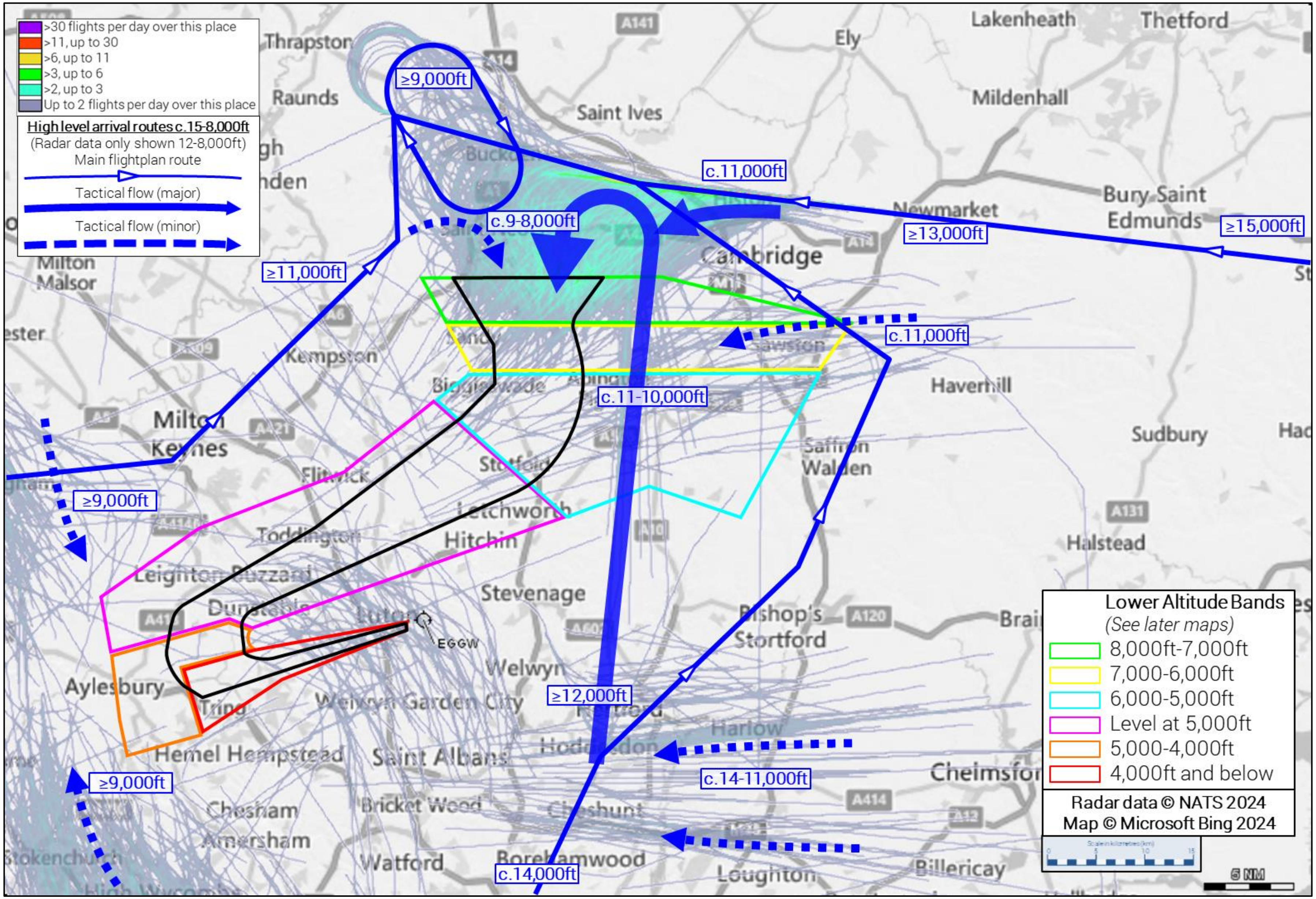


Figure 4 LLA Arrivals to Runway 07 descending from 12,000ft-8,000ft showing ZAGZO hold (north), 7 days in June 2023 post-airspace change

Pre-change high-level arrivals to Runway 07

3.4.2 In Figure 3 on p.8, high-level arrivals from the east descended towards the holding area near Sudbury to c.9,000ft. They left the holding area (with or without entering the racetrack pattern, if it was occupied) and then headed west towards Royston, where they descended below 8,000ft under the Royston holding area (LOREL), out of this diagram.

Stansted arrivals also used the same Sudbury holding area (ABBOT) for their arrivals from the east which is why LLA arrivals were descended so far away from LLA.

3.4.3 Arrivals from the south followed the flightplan route northwards towards the central holding area at Royston, descending from c.12,000ft to 8,000ft depending on whether the hold was occupied. In this area they continued their descent below 8,000ft and out of this diagram.

Stansted arrivals also used the same Royston holding area for their arrivals from the south.

3.4.4 Some arrivals from the southeast were taken off their flightplan very early and were descended over Harlow and Loughton, typically crossing the M11 motorway at or below 10,000ft. As they headed west they descended below 8,000ft and out of this diagram.

3.4.5 Some arrivals from the south were also taken off their flightplan very early and were descended over High Wycombe / Stokenchurch at or below 9,000ft. As they headed north towards Aylesbury they were descended below 8,000ft and out of this diagram. NB the radar data shown in this area is truncated, it is similar to that shown in the post-change diagram Figure 4 on p.9 but is typically at lower levels pre-change.

3.4.6 Arrivals from the west, northwest and north were flightplanned to head east towards the Royston hold. Many of them were redirected off the flightplan early onto a southbound tactical flow several km west of Milton Keynes at or below 9,000ft. This southbound flow continued descending through 8,000ft and out of this diagram. NB the radar data shown in this area is truncated, it is similar to that shown in the post-change diagram Figure 4 on p.9 but is typically at lower levels pre-change.

3.4.7 Either of the two holds could be occupied by a complex mix of LLA and Stansted arrivals. The entire descent region was shared with Stansted arrivals that had the exact same flightplanned arrival routes (Stansted radar data is not shown).

Post-change high-level arrivals to Runway 07

3.4.8 In Figure 4 on p.9, high-level arrivals from the east stay much higher and are further north than the pre-change arrivals from the east. They follow the flightplan route, staying away from the (unchanged) Stansted arrivals (not shown).

3.4.9 East of Bury St Edmunds they are typically at or above 15,000ft, descending towards Newmarket at or above 13,000ft then to the north of Cambridge at c.11,000ft.

3.4.10 After passing north of Cambridge most are peeled away from the flightplanned route by a left turn into a broad tactical flow region, heading southwest. This left turn happens along the flightplan line between Milton (4km north of central Cambridge) to Boxworth (13km northwest), Hilton (18km northwest) and beyond Buckden (28km northwest of central Cambridge).

3.4.11 This choice of exactly where to make the left turn off the flightplan route from the east means the controller can plan an effective arrival sequence early and integrate it with arrivals from the south, while the aircraft are still at high levels (typically 11,000ft-9,000ft).

3.4.12 As (or after) this left turn is given, flights are descended 9,000ft-8,000ft as they enter the top of the green polygon and black polygon, in the vicinity of Abbotsley, the Gransdens, Gamlingay and Everton villages. Within this green area most descend below 8,000ft and out of this diagram.

3.4.13 In the pre-change airspace, this region was not typically overflown by LLA arrivals.

3.4.14 Some arrivals from the east are taken off the flightplan route early, and are descended over Sawston c.11,000ft heading west, similar to the flow described in paragraph 3.4.2 above but much higher and less frequently. They descend through 8,000ft several km west of Sawston and out of this diagram.

3.4.15 Arrivals from the south follow the flightplan route northwards to the vicinity of Hertford. Here the controller usually shortcuts the doglegged flightplan, stops them turning right and continues them northwards at higher levels than the equivalent flow described pre-change in paragraph 3.4.3 above.

As they continue north past the northern edge of the green polygon c.11-10,000ft, the controller integrates them with the arrival sequence from the east, turning them left and descending them in a similar manner to that described in paragraph 3.4.8 above.

3.4.16 Some arrivals from the southeast are taken off their flightplan very early and descend over Harlow and Loughton, typically crossing the M11 motorway between 14,000ft-11,000ft. This is higher than the pre-change equivalent flow described in paragraph 3.4.4 above. As they head west they descend below 8,000ft and out of this diagram.

3.4.17 Some arrivals from the south are taken off their flightplan very early and descend over High Wycombe / Stokenchurch at or above 9,000ft, higher than (or the same as) the pre-change equivalent described in paragraph 3.4.5 above. The general flows are similar pre and post-change. As they head north towards Aylesbury they descend below 8,000ft and out of this diagram.

3.4.18 Arrivals from the west, northwest and north flightplan to head east then northeast over Milton Keynes at high levels towards the new hold. Many of them are redirected off the flightplan early, onto a southbound tactical flow several km west of Milton Keynes at or above 9,000ft, higher than (or the same as) the pre-change equivalent described in paragraph 3.4.6 above. The general flows are similar pre and post-change. This southbound flow continues descending through 8,000ft and out of this diagram.

3.4.19 As a result of this change, LLA arrivals to the easterly Runway 07 in this region do not have to be integrated with Stansted arrivals at high levels. Most arrivals have to fly a longer distance at high levels, and new areas are overflown at high levels. Where overflight occurs in similar places at high levels, it tends to be higher than in the pre-change airspace.

3.4.20 Later sections of this document illustrate how overflight has changed at altitudes below 8,000ft.

3.5 LLA arrivals dispersion plots Runway 25: pre and post implementation, high level

3.5.1 The diagram pairs on the following pages illustrate high-level arrival flightplan routes and actual traffic flows, for westerly Runway 25.

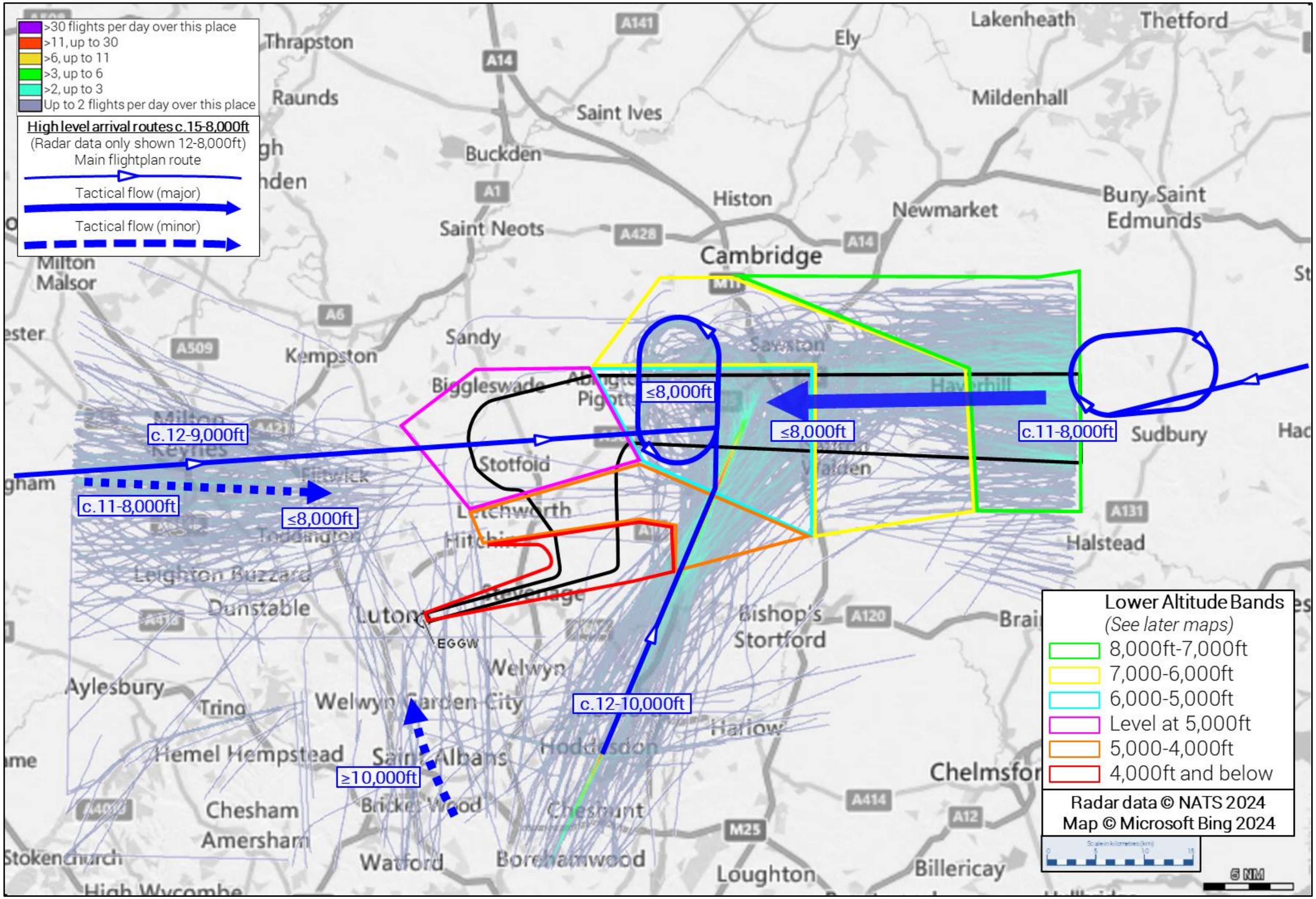


Figure 5 LLA Arrivals to Runway 25 descending from 12,000ft-8,000ft via shared holds ABBOT (east) and LOREL (west), 7 days in June 2019 pre-airspace change

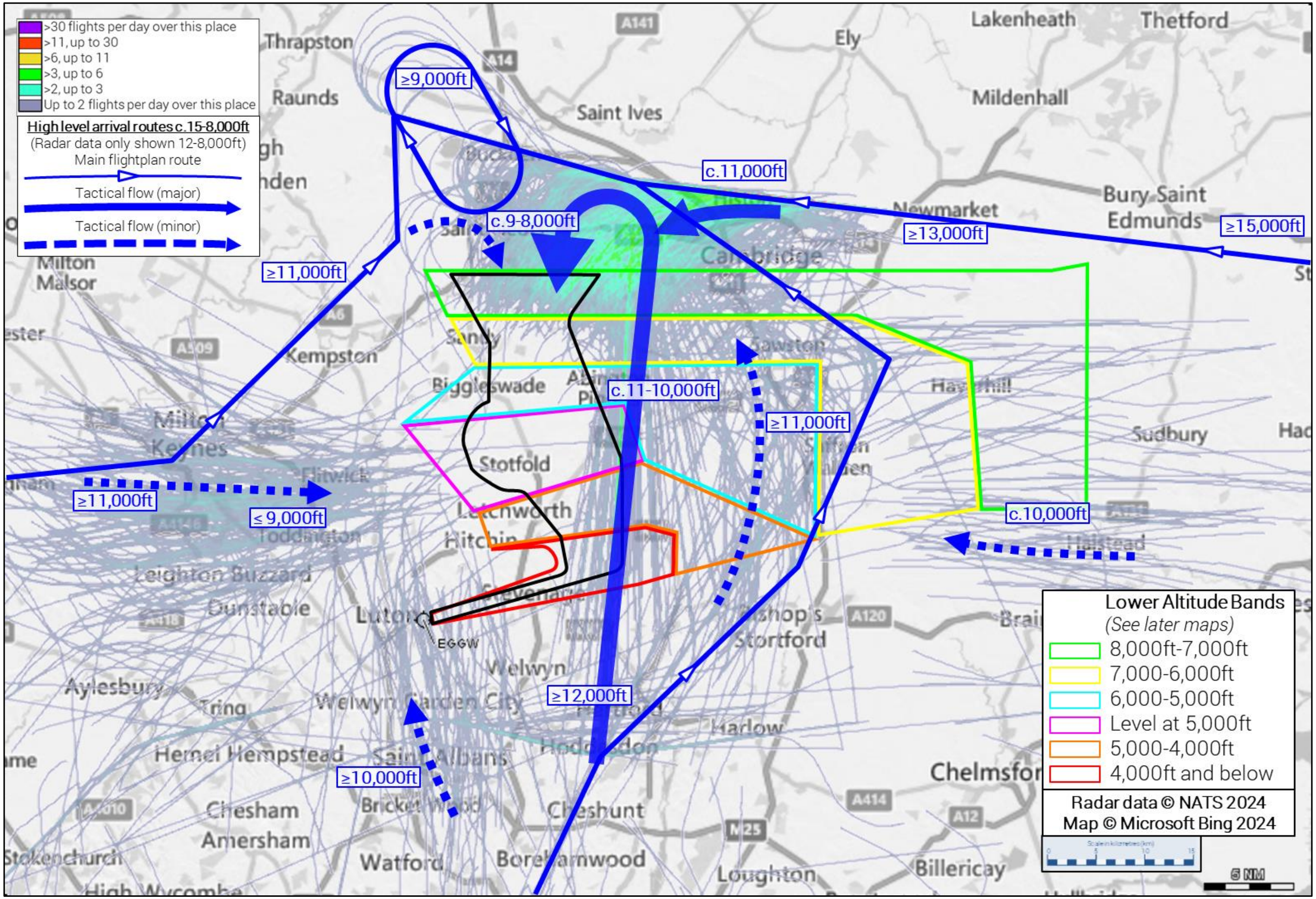


Figure 6 LLA Arrivals to Runway 25 descending from 12,000ft-8,000ft showing ZAGZO hold (north), 7 days in June 2023 post-airspace change

Pre-change high-level arrivals to Runway 25

3.5.2 High-level arrivals to westerly Runway 25 are generally similar to high-level arrivals to easterly Runway 07; the main differences are in the management of the minor tactical flows.

3.5.3 In Figure 5 on p.12, high-level arrivals from the east descended towards the holding area near Sudbury to c.8,000ft, slightly lower than in the easterly operation. They left the holding area (with or without entering the racetrack pattern, if it was occupied) and then headed west towards Royston, where they descended below 8,000ft under the Royston holding area (LOREL), out of this diagram.

Stansted arrivals also used the same Sudbury holding area for their arrivals from the east. LLA arrivals to the westerly Runway 25 have a much shorter track distance to follow than when easterly Runway 07 is operating, which is why LLA arrivals were descended slightly lower.

3.5.4 Arrivals from the south followed the flightplan route northwards towards the central holding area at Royston, descending from c.12,000ft to 8,000ft depending on whether the hold was occupied. In this area they continued their descent below 8,000ft and out of this diagram.

Stansted arrivals also used the same Royston holding area for their arrivals from the south.

3.5.5 Some arrivals from the east were taken off their flightplan very early and were descended over Halstead, typically crossing the A131 road 10,000ft-9,000ft. As they headed west they descended below 8,000ft and out of this diagram.

3.5.6 Some arrivals from the south were also taken off their flightplan very early and were descended over St Albans at or below 10,000ft. As they headed north towards the town of Luton and Flitwick they were descended below 8,000ft and out of this diagram.

3.5.7 Arrivals from the west, northwest and north were flightplanned to head east towards the Royston hold. Many of them were redirected off the flightplan early, onto an eastbound tactical flow in the vicinity of Milton Keynes descending from 11,000ft-8,000ft. This flow continued descending through 8,000ft around Flitwick and out of this diagram.

3.5.8 The Royston and Sudbury holding areas (LOREL and ABBOT respectively) could be occupied by a complex mix of LLA and Stansted arrivals. The entire descent region was shared with Stansted arrivals that had the exact same flightplanned arrival routes (Stansted radar data is not shown).

Post-change high-level arrivals to Runway 25

3.5.9 In Figure 6 on p.13, high-level arrivals from the east stay much higher and are further north than the pre-change arrivals from the east. They follow the flightplan route, staying away from the (unchanged) Stansted arrivals (not shown).

East of Bury St Edmunds they are typically at or above 15,000ft, descending towards Newmarket at or above 13,000ft then to the north of Cambridge at c.11,000ft.

After passing north of Cambridge most are peeled away from the flightplanned route by a left turn into a broad tactical flow region, heading southwest. This left turn happens in a similar region to the easterly Runway 07 arrival flow, but slightly sooner along the flightplan line. This is because the arrival flightpath to westerly Runway 25 is shorter than it is for easterly Runway 07, so aircraft must be descended sooner. The greener density area is closer to Cambridge, so the window for the left turn is narrower.

This choice of exactly where to make the left turn off the flightplan route from the east still means the controller can plan an effective arrival sequence early and integrate it with arrivals from the south, while the aircraft are still at high levels (typically 11,000ft-9,000ft).

As (or after) this left turn is given, flights are descended 9,000ft-8,000ft as they enter the top of the green polygon and black polygon, in the vicinity of Abbotsley, the Gransdens, Gamlingay and Everton villages. Within this green area most descend below 8,000ft and out of this diagram.

In the pre-change airspace, this region was not typically overflown by LLA arrivals.

3.5.10 Some arrivals from the east were taken off their flightplan very early and were descended over Halstead, typically crossing the A131 road c.10,000ft, higher than (or the same as) the pre-change equivalent described in paragraph 3.5.5 above. As they headed west they descended below 8,000ft and out of this diagram.

3.5.11 Some arrivals from the south were also taken off their flightplan very early and were descended over St Albans at or above 10,000ft, higher than (or the same as) the pre-change equivalent described in paragraph 3.5.6 above. As they headed north towards the town of Luton and Flitwick they were descended below 8,000ft and out of this diagram.

3.5.12 Arrivals from the west, northwest and north flightplan to head east then northeast over Milton Keynes at high levels towards the new hold. Many of them were redirected off the flightplan early, onto an eastbound tactical flow in the vicinity of Milton Keynes c.11,000ft, higher than (or the same as) the pre-change equivalent described in paragraph 3.5.7 above. This flow continued descending through 9,000ft-8,000ft around Flitwick and out of this diagram.

3.5.13 As a result of this change, LLA arrivals to the easterly Runway 25 in this region do not have to be integrated with Stansted arrivals at high levels. Most arrivals have to fly a longer distance at high levels, and new areas are overflown at high levels. Where overflight occurs in similar places at high levels, it tends to be higher than in the pre-change airspace.

3.5.14 The distance from the high-level route network to land on westerly Runway 25 is, for the main flows, shorter than the equivalent distance for easterly Runway 07. This was also the case pre-change, however the complexity reduction of segregating the LLA arrivals from Stansted's arrivals means that this is much easier for the controllers to set their arrival sequences.

3.6 Comparison of predicted high-level network flightpaths vs. actual flightpaths (above 8,000ft)

3.6.1 In the consultation we made a prediction that high-level arrivals to LLA would follow the blue arrows in Figure 7 below (adapted from Figure 9 on p.27 of the 2020 full consultation document).

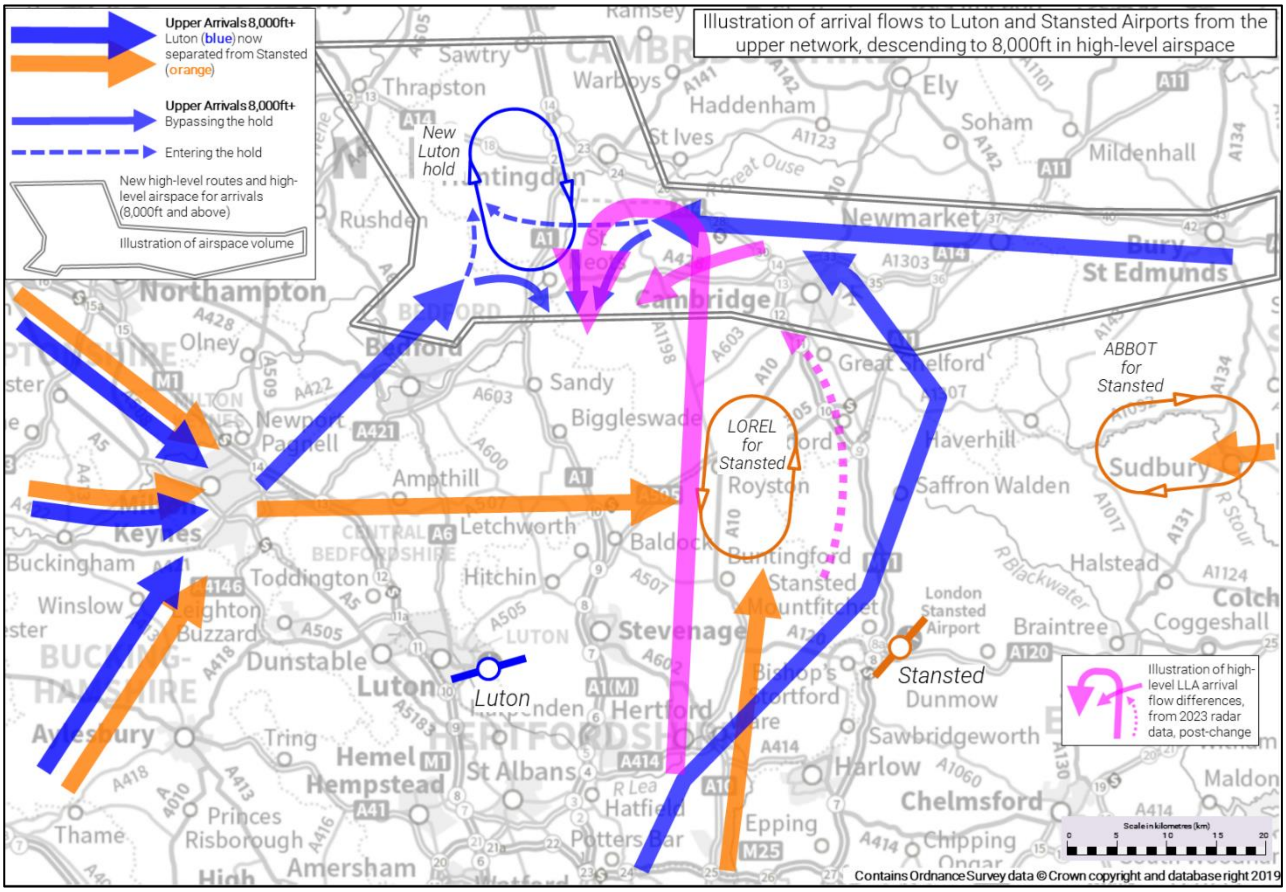


Figure 7 Extract from original consultation document illustrating predicted routes 8,000ft and above, modified to show additional flows (pink arrows)

3.6.2 Most of the network-level flows were consistent with the blue arrows in the diagram (see sections 3.4 and 3.5 above). Many arrivals from the south were also shortcut via the long pink solid arrow or the dashed pink arrow. Most aircraft bypassing the hold from the east/south were turned left earlier than we predicted (short pink solid arrow).

3.6.3 The shortcuts from the south can be partially attributed to reduced holding at the Royston holding area (LOREL), now that LLA arrivals use neither hold; they are both reserved for Stansted.

The full-length (blue dogleg) flightplan route flies, by design, between the LOREL (Royston) and ABBOT (Sudbury) holds; should those holds both be occupied by Stansted arrivals, LLA arrivals safely follow the full flightplan route between, with minimal controller input.

Should the LOREL hold be occupied less frequently and/or at lower levels, it is safe for the controller to shortcut the LLA arrival 'over the top'. This is a simplistic explanation of a complex air traffic situation, but illustrates the general scenario.

3.6.4 From a community noise impact point of view, paragraph 3.2.2 above remains relevant; the difference in noise produced by flightpaths at and above 7,000ft is not considered a priority, in accordance with Government guidance. Flight efficiency is the priority, and the pink arrows are examples of additional high-level efficiency.

3.6.5 The next sections of this document illustrate how overflight has changed at altitudes below 8,000ft. As per the previous paragraph, Government guidance is that noise impacts are considered a priority below 7,000ft (see paragraph 4.2.2 below).

4. Arrival flow diagrams from 8,000ft to the runway

4.1 General information about these diagrams

4.1.1 The radar density diagrams illustrate arrivals from 8,000ft to each runway, pre-change and post-change using the same data samples detailed in Section 2 on p.4.

4.1.2 The diagrams here are consistent with those previously published, however now we can compare what actually happened against what we predicted would happen, and also against what happened pre-change. They are newly created for this comparison, but are based on the original consultation diagrams including the same density colours, shapes and colours of the polygons illustrating the altitude bands, main concentrations (black polygon), main arrival flow directions (thick blue arrows) and shortcut or tactical arrival flows (thin dashed blue arrows).

4.1.3 Each post-change diagram has had its pink region renamed in the diagram key. Pre-change, level flight at 5,000ft was standard for significant periods of track length and the pink region is where that typically occurred. Post-change, there are more opportunities for aircraft to remain higher for longer and descend more continuously from higher levels. Some periods of level flight still occur, but they tend to be much shorter than pre-change. Thus, it would be more accurate to describe the pink region similarly to the cyan region, i.e. descending from 6,000ft-5,000ft.

4.2 Important notes regarding arrivals data from 8,000ft, and community noise impacts

4.2.1 All the radar data and flow information on these descent diagrams starts at 8,000ft; see Section 3 above for complementary diagrams descending from the high-level network c.12,000ft-8,000ft.

4.2.2 Government guidance on aviation environmental objectives (ANG2017, Ref 9) is that, in the airspace at or above 7,000ft the priority should be flight efficiency; the minimising of community noise impacts is not a priority at high levels (paraphrased from ANG2017 p.18 paragraph 3.3.d, and p.21 paragraph 3.27).

4.2.3 For these diagrams, flights within the green polygon (8,000ft-7,000ft) are shown using radar data, but the primary noise impacts are mainly considered as they leave the green polygon and cross the green-yellow boundary into the yellow polygon (7,000ft-6,000ft) and continue descent through the light blue, pink, orange and red polygons as per the altitude band key.

4.2.4 All arrivals are vectored; they are manually directed by the controller to turn and descend in sequence.

4.3 LLA arrivals dispersion plots: pre and post implementation, 8,000ft to easterly Runway 07

4.3.1 The diagrams on the following pages illustrate arrival traffic flows for easterly Runway 07. Each is followed by a narrative comparison.

- The first pair compares the entire radar data from 8,000ft to the runway
- This is followed by a diagram of a specific region for further discussion
- The second pair compares radar data in the 1,000ft band between 5,000ft and 4,000ft
- The third pair compares radar data for the final 4,000ft to the runway

4.3.2 Each diagram illustrates the two regions of the Chilterns Area of Outstanding Natural Beauty AONB[2].

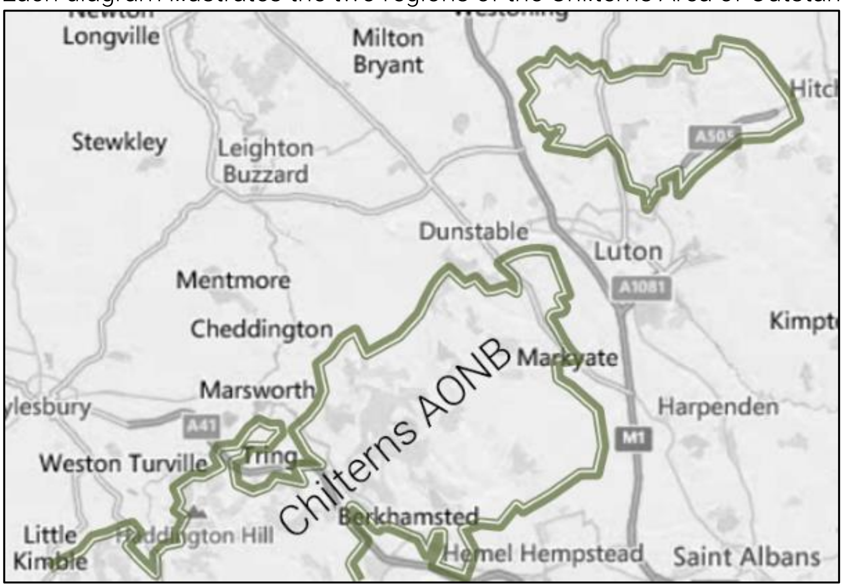


Figure 8 The two regions of the Chilterns AONB

[2] AONBs were redesignated 'National Landscapes' after the original airspace change was implemented. For continuity, we refer to AONB.

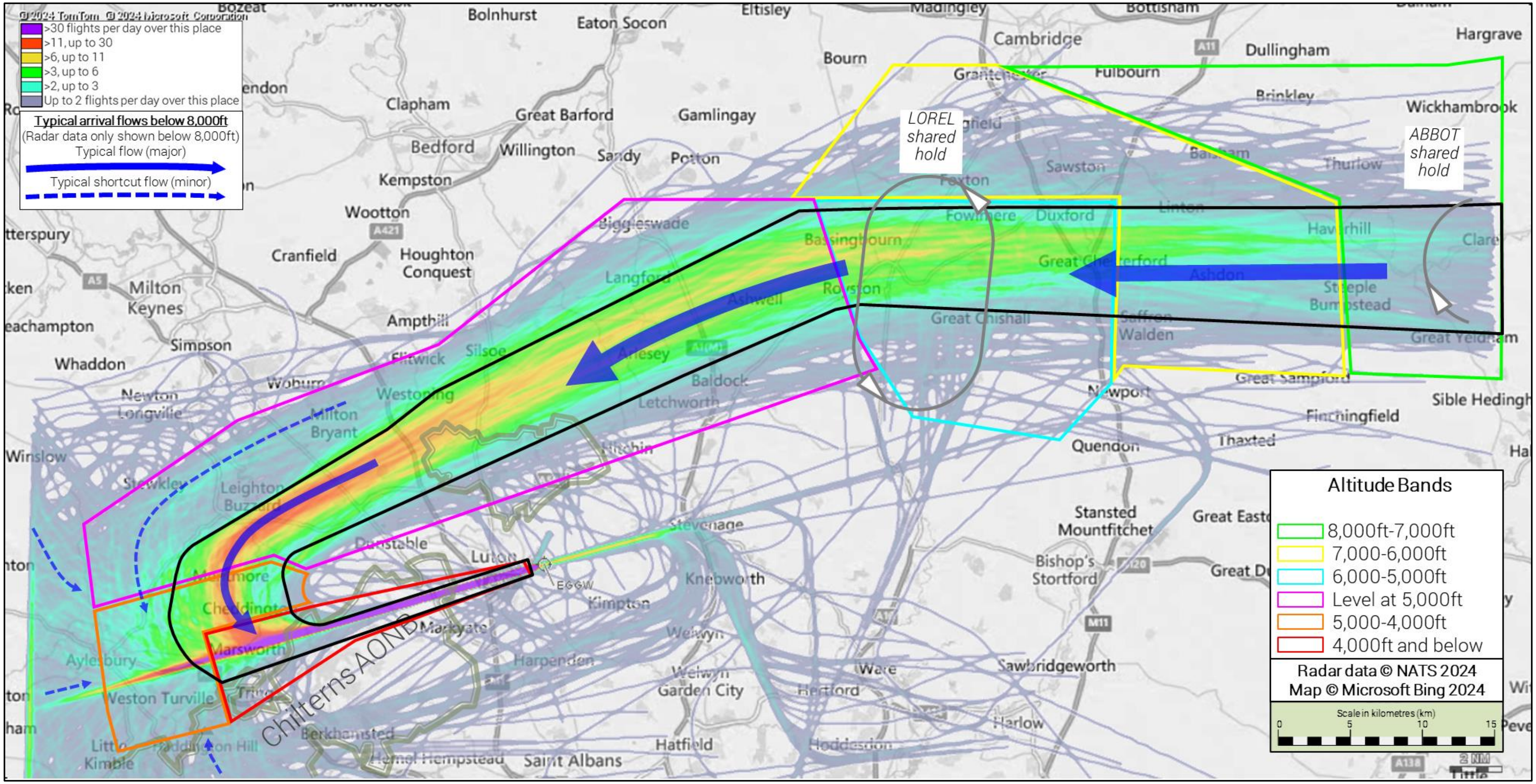


Figure 9 LLA Arrivals to Runway 07 descending from 8,000ft (7 days in June 2019 pre-airspace change)

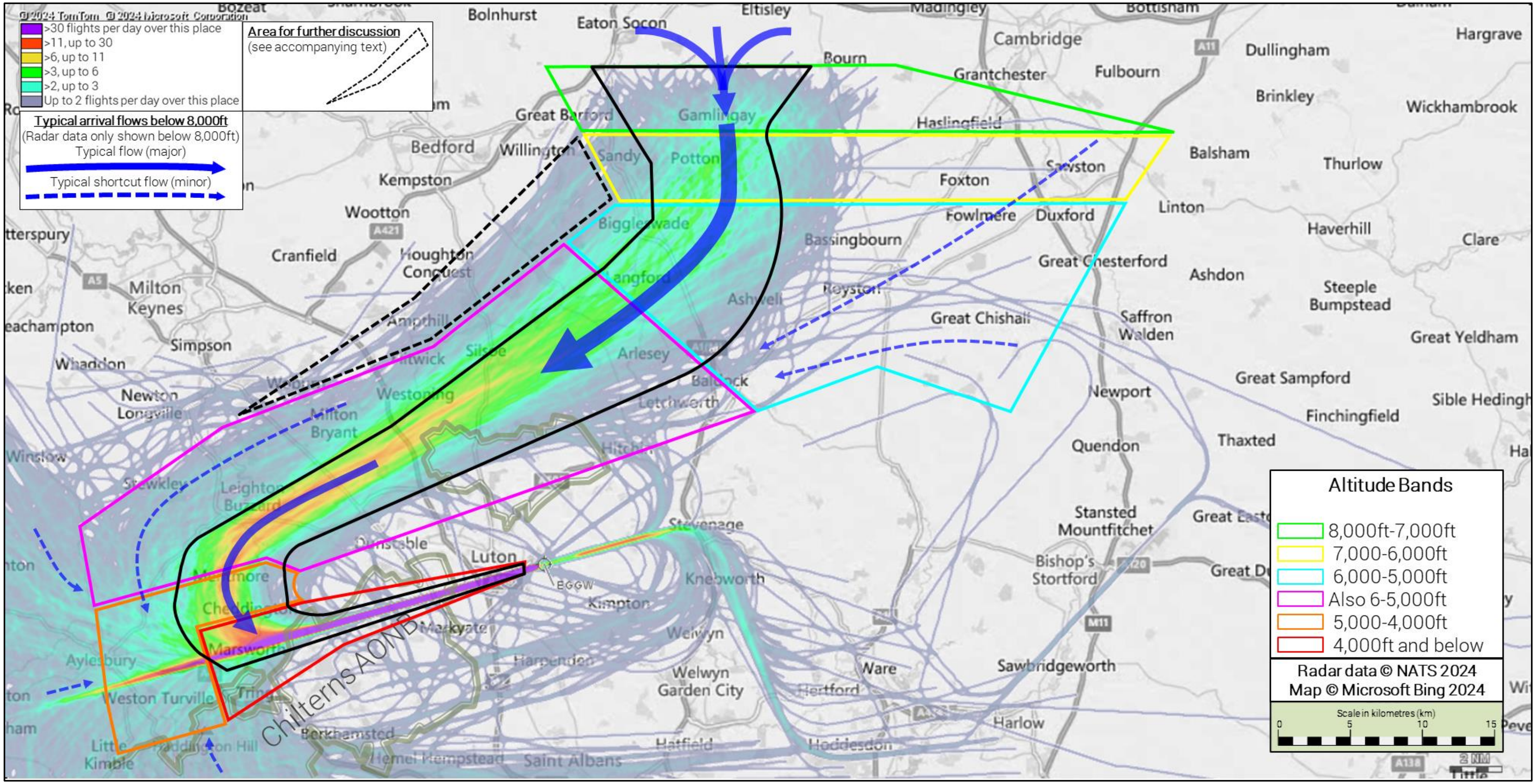


Figure 10 LLA Arrivals to Runway 07 descending from 8,000ft (7 days in June 2023 post-airspace change)

Pre-change arrivals to Runway 07: 8,000ft to land

4.3.3 Figure 9 on p.18 is equivalent to the pre-change consultation diagram; the narrative is therefore the same as the consultation document and is reproduced on the next page.

4.3.4 Controllers descended the holding traffic, then separated out the LLA traffic from each hold [previously shared with Stansted arrivals], vectoring it from 5,000ft near Royston heading west between Letchworth and Biggleswade.

4.3.5 The LLA arrival flow continued west, level at 5,000ft for about 40-50km, over the northern part of the Chilterns AONB, with the controller vectoring most aircraft south of Leighton Buzzard (but some were vectored to the north). Note that, under a previous change in 2006, the CAA placed a condition on LLA easterly arrivals that Leighton Buzzard should not be routinely overflown unless tactically unavoidable.

4.3.6 As the traffic reached an area northeast of Aylesbury the controller turned the aircraft left, roughly perpendicular to the extended runway centreline, and descended it to 4,000ft, then turned left and descended once more to establish on final approach, typically somewhere between the east of Stoke Mandeville area around 4,000ft and Pitstone Hill around 3,000ft.

4.3.7 Vectoring naturally caused some dispersion, but the area within the solid black lines was typically the most commonly used flightpath.

4.3.8 Some aircraft were given shortcuts or alternate routes as illustrated by the blue dashed arrows.

4.3.9 The swathe generally got narrower until it aligned with the runway on final approach. The final approach path to Runway 07 always overflew part of the Chilterns Conservation AONB, from Pitstone Hill to Kensworth Common, in a narrow swathe.

Post-change arrivals to Runway 07: 8,000ft to land: Predicted arrival flightpaths

4.3.10 Figure 10 on p.19 illustrates the post-change arrival flightpath and density of overflight. In the consultation we made the following prediction:

4.3.11 Arrival traffic would fly south of Grafham Water past St Neots, to the east of the A1 main road and roughly parallel with it.

4.3.12 To the east of Sandy, aircraft would be descended to 5,000ft and turned right (in the vicinity of Biggleswade or Henlow), mostly north of the A1-A505 junction near Letchworth similar to the pre-change flightpath.

4.3.13 The LLA arrival flow would continue west, level at 5,000ft for about 40km, over the northern part of the Chilterns AONB, with the controller vectoring most aircraft south of Leighton Buzzard (though some may be vectored to the north). See paragraph 4.3.5 above for a condition regarding Leighton Buzzard which we have continued to respect.

4.3.14 As the traffic reach an area northeast of Aylesbury the aircraft would be turned left, roughly perpendicular to the extended runway centreline, and descended to 4,000ft, then turned left and descended once more to establish on final approach, typically somewhere between the east of Stoke Mandeville area around 4,000ft and Pitstone Hill around 3,000ft.

4.3.15 The swathe within which controllers vector aircraft narrows until it aligns with the runway on final approach.

4.3.16 The final approach path to Runway 07 always overflies part of the Chilterns AONB, from Pitstone Hill to Kensworth Common, in a very narrow path.

4.3.17 Some would be vectored on shortcuts from the east similar to today, or to the north of Leighton Buzzard like today.

Post-change arrivals to Runway 07: 8,000ft to land: Actual arrival flightpaths

4.3.18 The actual arrival flightpaths flown, as illustrated in Figure 10 on p.19, are very similar to the prediction laterally, however (as will be shown in the next pair of diagrams) arrivals do not typically descend below 5,000ft until closer to the airport; they remain higher for longer than predicted, and the overall area overflown below 5,000ft is significantly smaller post-change.

4.3.19 This is a positive change from our prediction because aircraft at higher altitudes produce less overall noise impact and are more fuel-efficient.

4.3.20 Shortcut arrivals are similar to the pre-change flightpaths (dashed blue arrows), and some flights continue to be vectored north of Leighton Buzzard (similar to pre-change, see paragraph 4.3.5 above).

Flightpaths in a slightly different place than predicted

4.3.21 One region of slight difference from our prediction is highlighted in Figure 10 on p.19 by a slim dashed-black triangle to the northwest of the main flightpath. A very small proportion of easterly arrivals fly over this area between 7,000ft-6,000ft where we did not predict them to fly, and an even smaller proportion fly between 7,000ft-5,000ft near the southwestern tip of the triangle.

4.3.22 Note that this **only** occurs when the wind is from the east, which is c.30% of the year; otherwise (c.70%) the wind is from the west and arrivals take a different path to the other runway (see Section 4.4 below).

4.3.23 We analysed this region by studying how many flights passed through three 'gates':
Gate 1 c.1km west of the A1 and c.2km west of the town of Sandy
Gate 2 c.1.5km east of the A6 and c.3km west of the village of Haynes
Gate 3 c.1.8km west of the M1 and c.3.4km west of the village of Steppingley

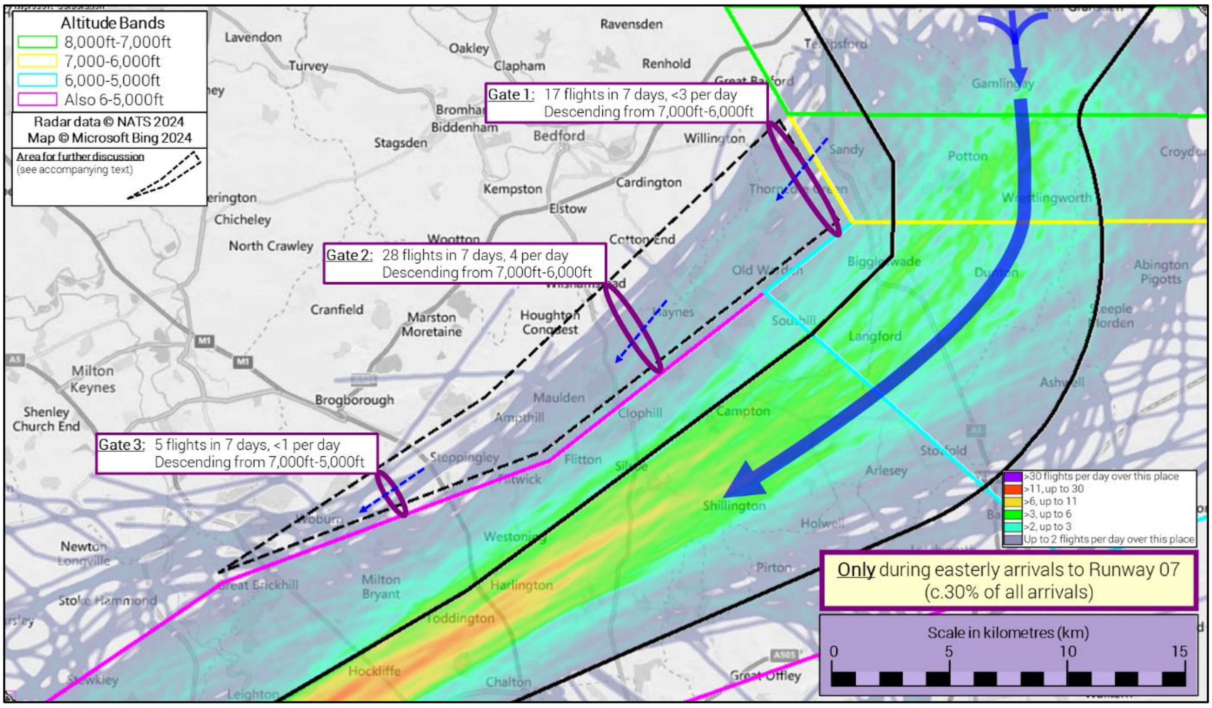


Figure 11 Analysis of arrivals outside the main predicted overflight areas

4.3.24 The radar data shown in Figure 11 above is the same data sample described in paragraph 2.1.4 on p.4; it illustrates 7 days of arrivals to easterly Runway 07 in June 2023 and is representative of typical flightpath operations to this runway. It also shows how many arrivals passed through each Gate.

4.3.25 On average over the 7 day easterly data sample, up to 3-4 aircraft per day overflew the black dashed triangular region in the descent from 7,000ft-6,000ft. Fewer than 1 per day on average were between 7,000ft-5,000ft.

4.3.26 We contend that, under easterly operations (c.30% of the year) up to 3-4 aircraft per day overflying this region from c.7,000ft-6,000ft would not cause a significant impact to those overflown. In support of that contention, there were no complaints within this region (in 575 days, see Annex D Stakeholder Feedback and Complaints, Figure 11 of that separate document). There were five complaints from Wilstead, a short distance to the north of Gate 2 outside the black dashed region, however they were general complaints which did not occur on days when the easterly runway was in operation. The Wilstead area, and the entire black dashed triangle, is regularly overflown by other flows at & above 6,000ft, and these have not changed (see paragraph 4.3.28 below).

Why does this happen?

4.3.27 As described in paragraphs 4.3.4-4.3.5 above, pre-change all easterly arrivals were level at 5,000ft from Royston westwards. There was no opportunity for aircraft to be higher, because an airspace boundary follows most of the northern edge of the pink region, preventing aircraft flying further north at 5,000ft.

4.3.28 We predicted aircraft would mainly be level at 5,000ft similar to the pre-change flightpath. Post-change, aircraft tend to be higher for longer, and the airspace base allows for descent to 6,000ft in that small area north of the pink region. The occasional need to keep some of these higher flights further north is partly due to specific interactions with departures from other airports (including Heathrow, Stansted and London City). Controllers therefore can now occasionally use this area to descend to 6,000ft before rejoining the main flightpath to 5,000ft in the pink region to the south.

Arrivals to Runway 07: Illustrating the 5,000ft-4,000ft band

4.3.29 The pair of diagrams on the next pages shows flights within the 1,000ft band from 5,000ft-4,000ft, and illustrates the differences pre and post-change.

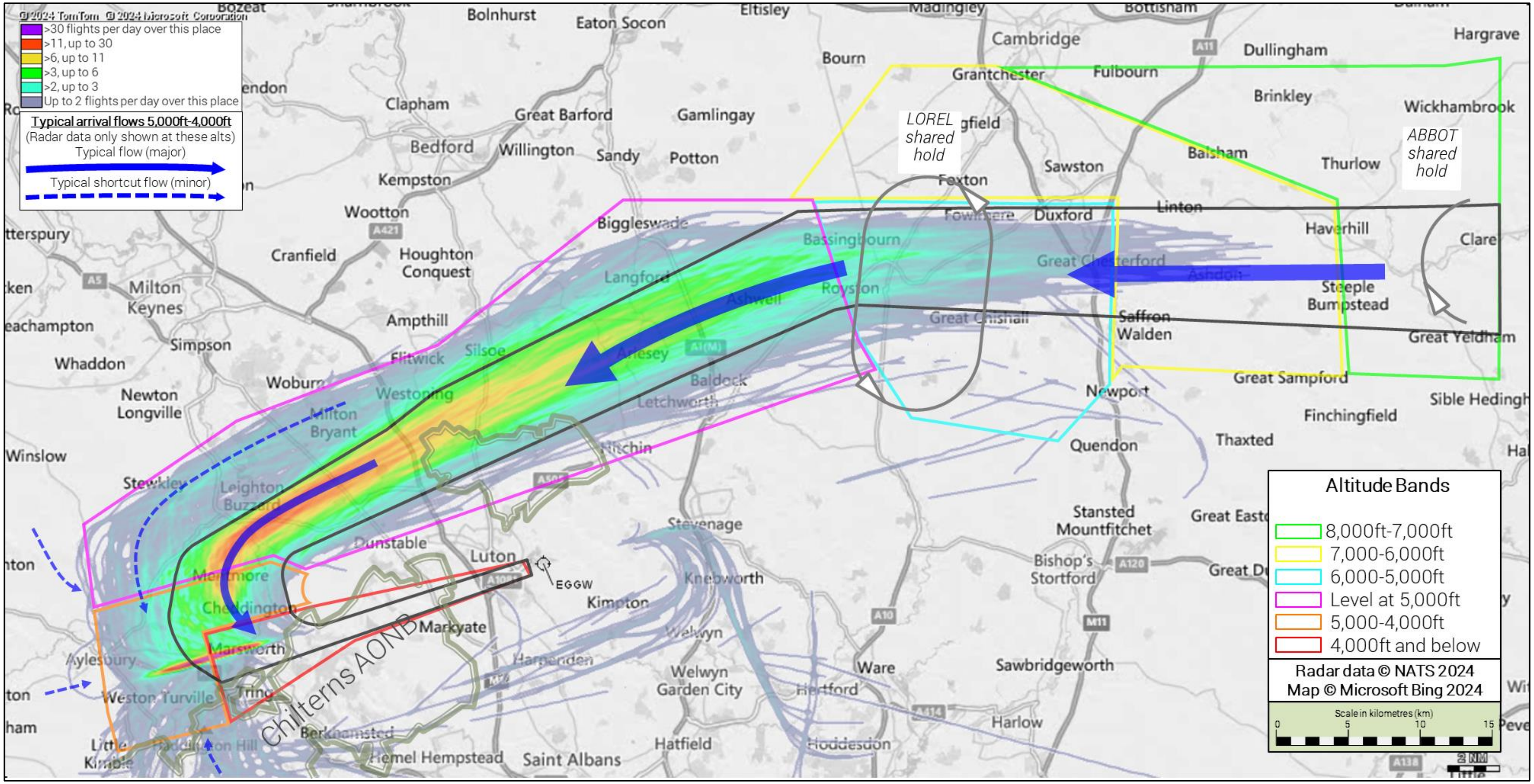


Figure 12 LLA Arrivals to Runway 07 only showing radar data from 5,000ft-4,000ft (7 days in June 2019 pre-airspace change)

4.3.30 Pre-change, as described in paragraphs 4.3.4-4.3.5 above, all easterly arrivals were level at 5,000ft for c.50km. This is from the vicinity of Great Chesterford/ Royston to south of the Leighton Buzzard area, where they were descended to 4,000ft and below, out of this diagram and into the subsequent pair of diagrams.

4.3.31 There was considerable overflight of the northern part of the Chilterns AONB at 5,000ft.

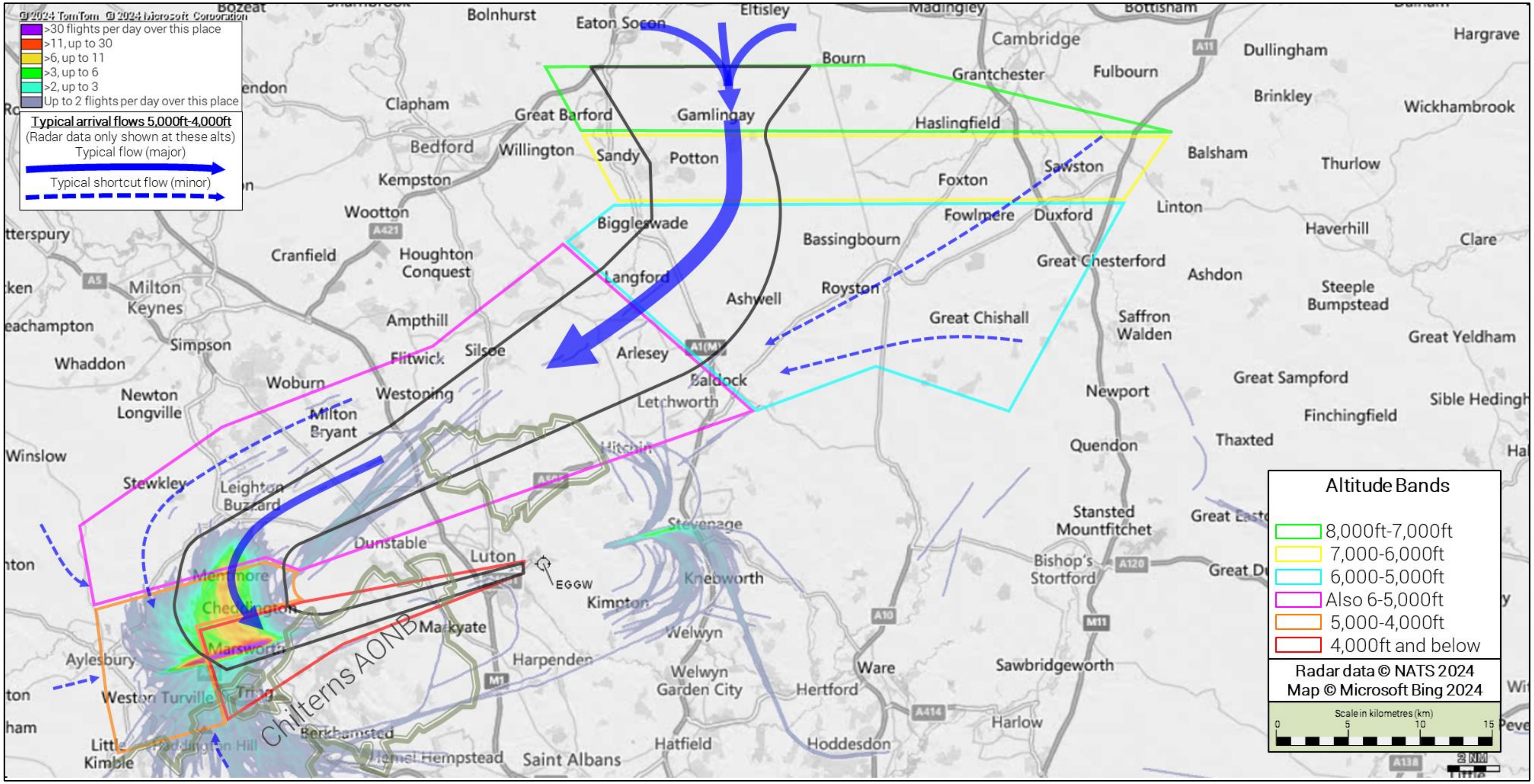


Figure 13 LLA Arrivals to Runway 07 only showing radar data from 5,000ft-4,000ft (7 days in June 2023 post-airspace change)

4.3.32 Post-change, as described in paragraphs 4.3.18-4.3.19 above, easterly arrivals stay higher for longer than we predicted in our consultation material. This is a positive change from our prediction because aircraft at higher altitudes produce less overall noise impact and are more fuel-efficient.

4.3.33 South of the Leighton Buzzard area they are descended to 4,000ft and below. There was a significant reduction in overflight of the northern part of the Chilterns AONB at 5,000ft.

4.3.34 The following pair of diagrams show the pre and post-change flightpaths descending from 4,000ft to the easterly Runway 07.

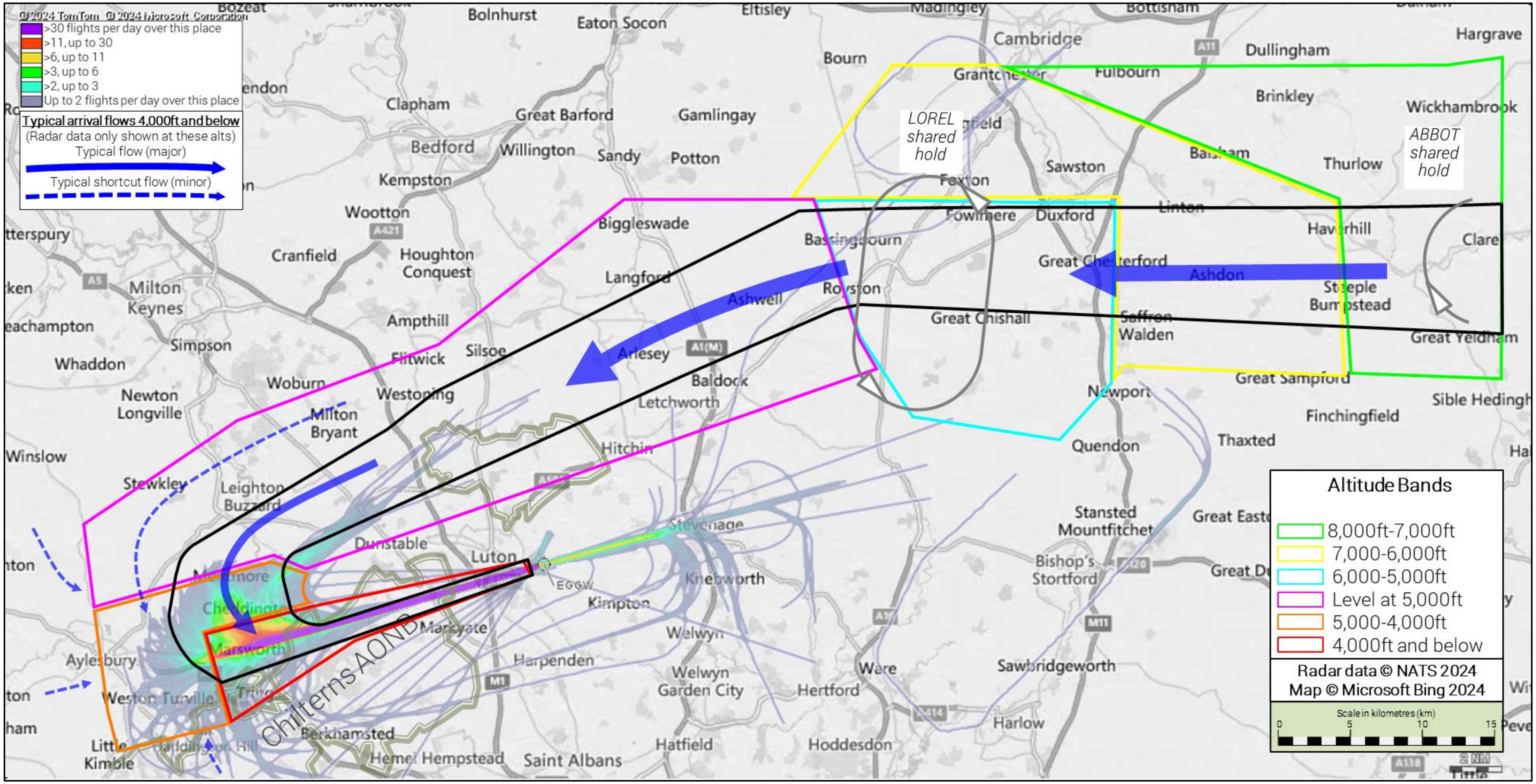


Figure 14 LLA Arrivals to Runway 07 only showing radar data from 4,000ft to land (7 days in June 2019 pre-airspace change)

4.3.35 Pre-change, south of the Leighton Buzzard area, the main arrival flow descended below 4,000ft in the Mentmore to Cheddington vicinity. Arrivals were also shortcut from the northwest, west and southwest, converging around Marsworth, Pitstone and Ivinghoe as they aligned with the runway on the final approach track from 3,000ft. The greatest concentration occurred on final approach from 3,000ft and below. Overflight of the southern part of the Chilterns AONB could not be avoided because it was directly under the final approach path to land on the easterly Runway 07.

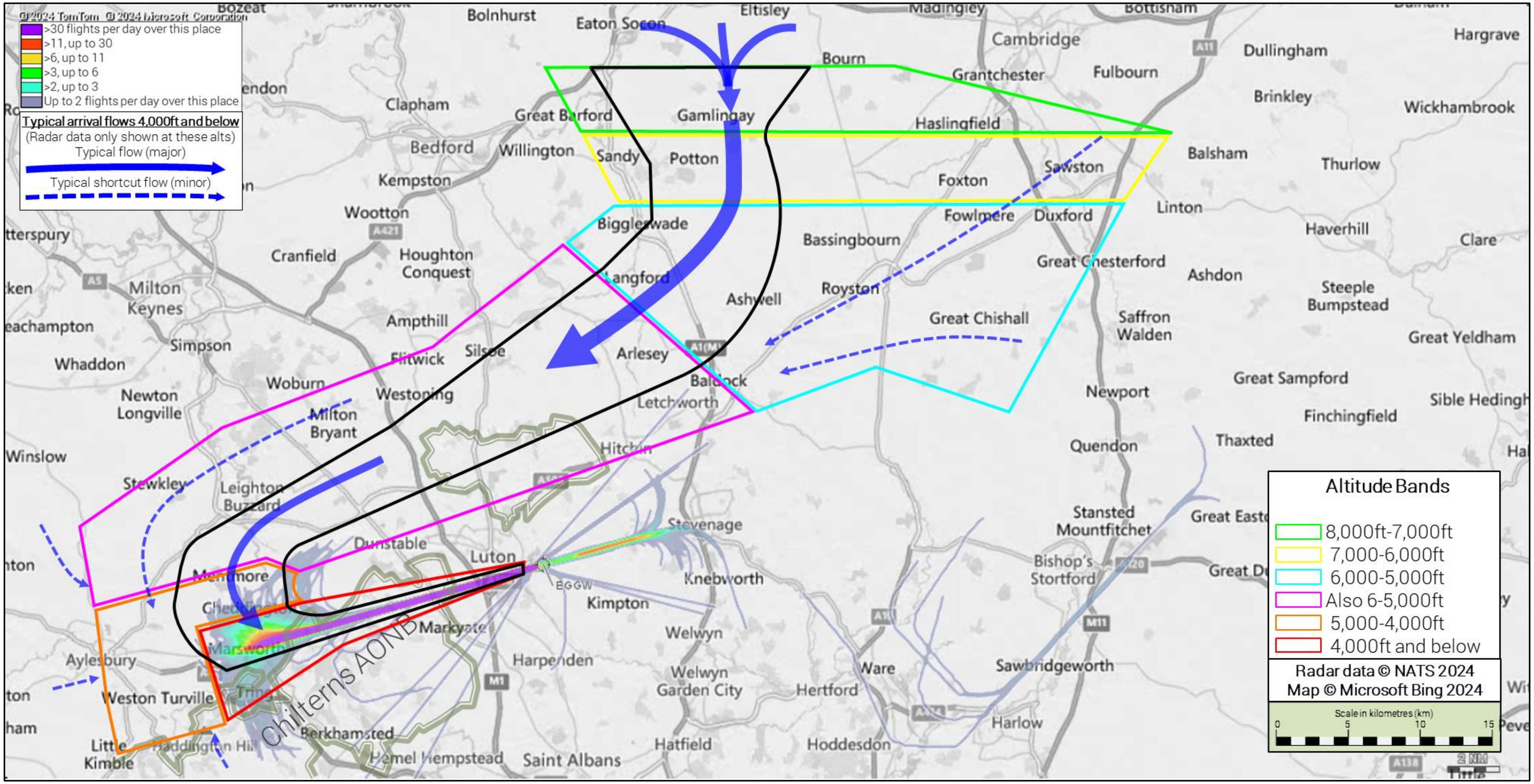


Figure 15 LLA Arrivals to Runway 07 only showing radar data from 4,000ft to land (7 days in June 2023 post-airspace change)

4.3.36 Post-change, south of the Leighton Buzzard area, the main arrival flow descends below 4,000ft in the Cheddington vicinity; this is evidence that flights remain higher for longer than the pre-change flightpath. Arrivals continue to be shortcut from the northwest, west and southwest, converging around Marsworth, Pitstone and Ivinghoe as they aligned with the runway on the final approach track from 3,000ft. However, the shortcut flights also tend to be higher than pre-change, not descending below 4,000ft until closer to Marsworth. The greatest concentration remains on final approach from 3,000ft and below. Overflight of the southern part of the Chilterns AONB cannot be avoided because it remains directly under the final approach path to land on the easterly Runway 07.

4.4 LLA arrivals dispersion plots: pre and post implementation, 8,000ft to westerly Runway 25

4.4.1 The diagrams on the following pages illustrate arrival traffic flows for westerly Runway 25. Each is followed by a narrative comparison, and includes the outline of the Chilterns AONB.

- The first pair compares the entire radar data from 8,000ft to the runway
- The second pair compares radar data in the 1,000ft band between 5,000ft and 4,000ft
- The third pair compares radar data for the final 4,000ft to the runway

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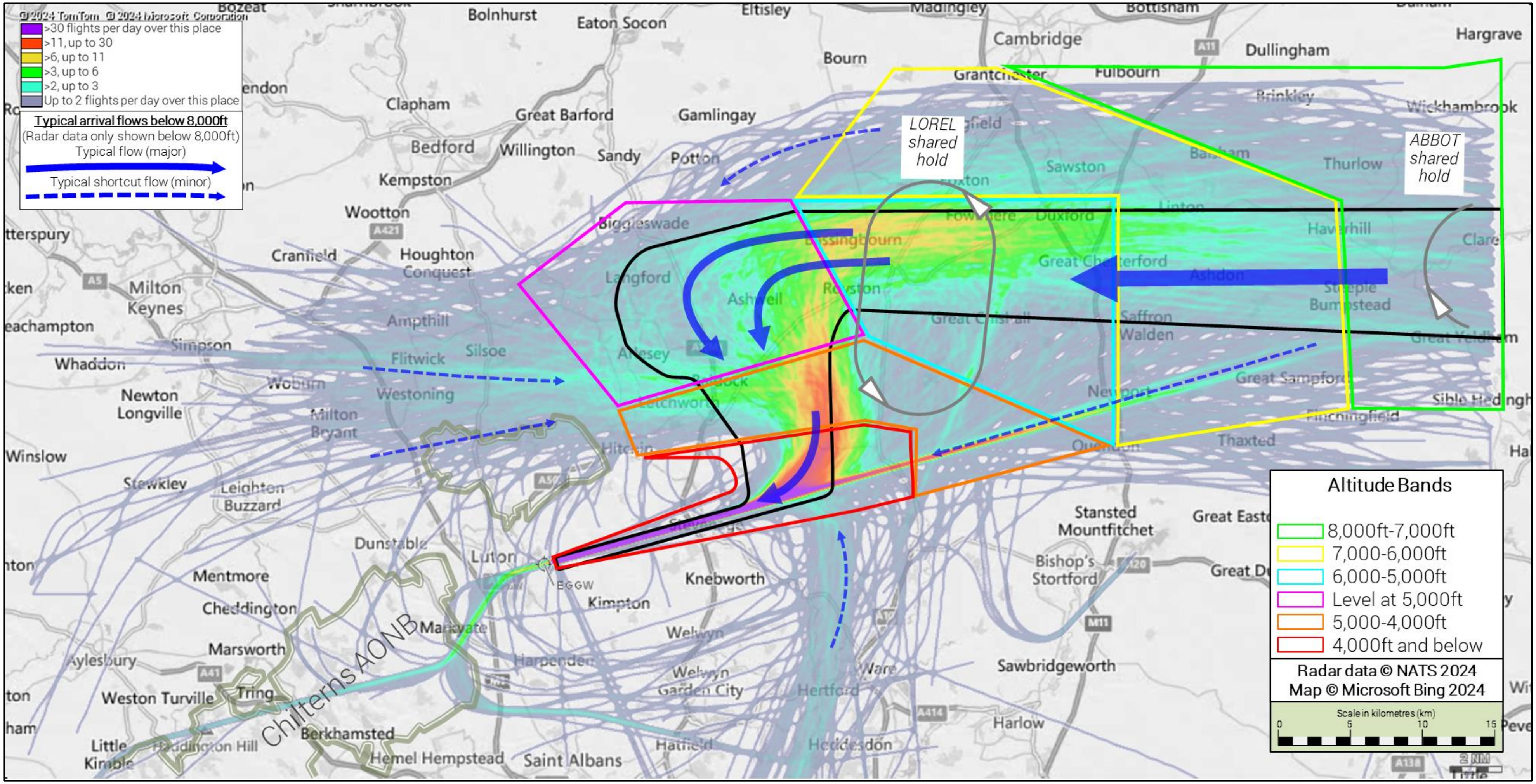

Figure 16 LLA Arrivals to Runway 25 descending from 8,000ft (7 days in June 2019 pre-airspace change)

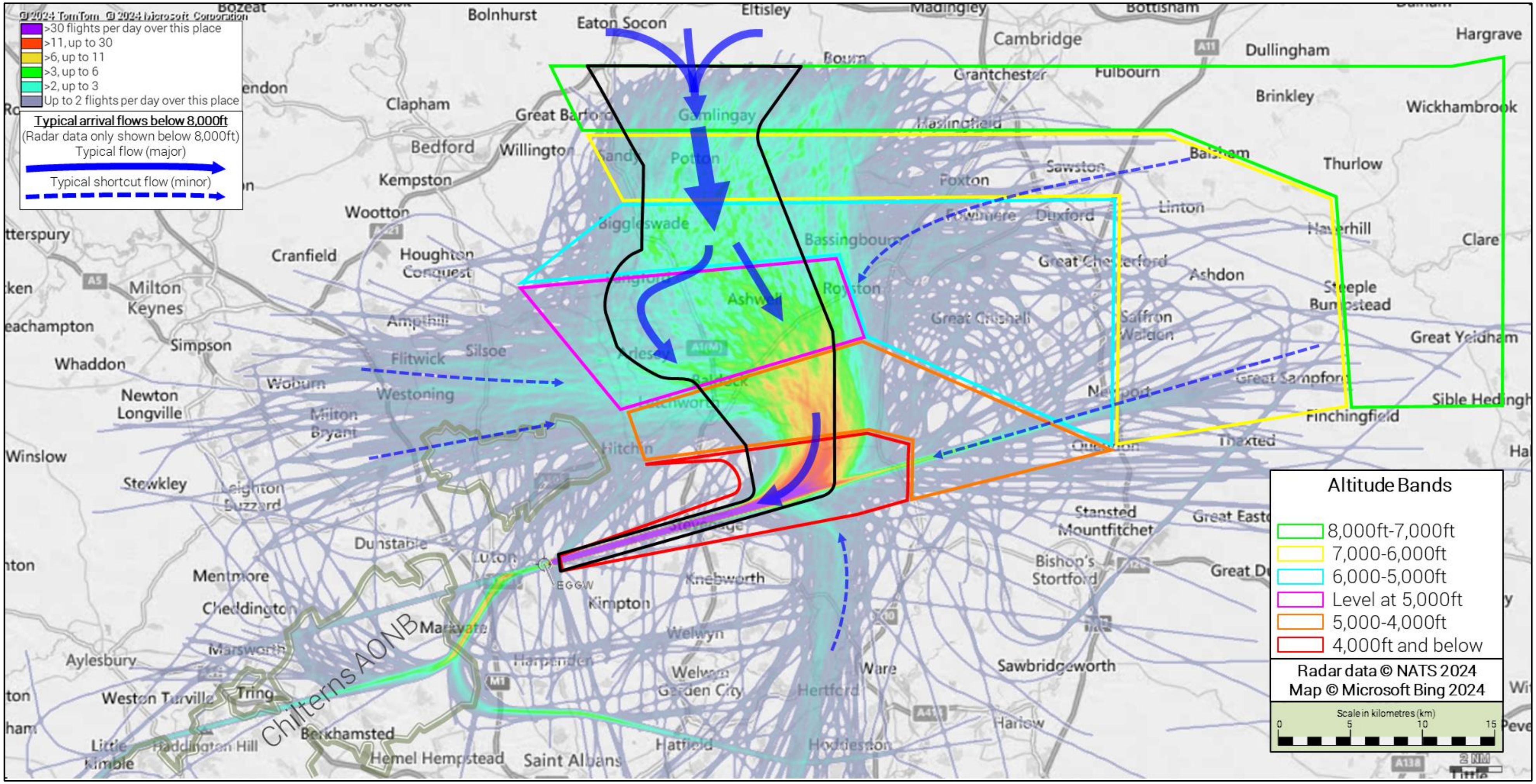

Figure 17 LLA Arrivals to Runway 25 descending from 8,000ft (7 days in June 2023 post-airspace change)

Pre-change arrivals to Runway 25: 8,000ft to land

4.4.2 Figure 16 on p.28 is equivalent to the pre-change consultation diagram; the narrative is therefore the same as the consultation document and is reproduced below.

4.4.3 Controllers descended the holding traffic, then separated out the LLA traffic from each hold [previously shared with Stansted arrivals], vectoring it from 5,000ft near Royston heading west between Letchworth and Biggleswade. The LLA arrival flow continued generally west, level at 5,000ft for about 15km before the controller turned it south (Biggleswade, Henlow), or they may have turned it south soon after passing Royston, but generally somewhere in between. That turn to the south might have been in an S-shape, or it may have been straight.

4.4.4 As the traffic reached the Letchworth-Baldock-Wallington area the controller turned the aircraft roughly perpendicular to the extended runway centreline, and descended it to 4,000ft, then turned right and descended once more to establish on final approach typically around Buntingford from 4,000ft to 3,000ft and Stevenage 3,000ft and below.

4.4.5 Vectoring naturally caused some dispersion, but the central third of the swathe was typically the most commonly used flightpath. Some aircraft were given shortcuts, or alternate routes as illustrated by the blue dashed arrows.

4.4.6 The swathe generally got narrower until it aligned with the runway on final approach. The final approach path to Runway 25 always overflew Ardeley, Walkern, Stevenage and St Paul's Walden in a narrow swathe.

Post-change arrivals to Runway 25: 8,000ft to land: Predicted arrival flightpaths

4.4.7 Figure 17 on p.29 illustrates the post-change arrival flightpath and density of overflight. In the consultation we made the following prediction:

Arrival traffic to Runway 25 would fly south of Grafham Water past St Neots, to the east of the A1 main road and roughly parallel with it, some traffic heading further east, so the 8,000ft arrivals may be spread between the east of Sandy and the west of Bourn.

The controllers would then descend the traffic to 5,000ft in this same spread, between Biggleswade and Royston, where it would likely stay level at 5,000ft for about 10-15km. The controllers would turn the traffic to the south, either in an S-shape, or straight.

As the traffic reaches the Letchworth-Baldock-Wallington area the controller turns the aircraft roughly perpendicular to the extended runway centreline, and descends it to 4,000ft, then turns right and descends once more to establish on final approach typically around Buntingford from 4,000ft to 3,000ft and Stevenage 3,000ft and below.

The swathe narrows until it aligns with the runway on final approach. The final approach path to Runway 25 always overflies Ardeley, Walkern, Stevenage and St Paul's Walden in a very narrow path.

Some could be vectored from the east to shortcut aircraft to the runway if the opportunity exists, similar to today.

Post-change arrivals to Runway 07: 8,000ft to land: Actual arrival flightpaths

4.4.8 The actual arrival flightpaths flown, as illustrated in Figure 17 on p.29, are generally consistent with the prediction. However, we expected there to be a greater concentration in the northern part of the black polygon.

4.4.9 Arrivals from the northeast were predicted to fly west and then turn south. In practice, flights descending from the northeast are more spread out. Many of them are turned left early, in a wider dispersal that straddles the eastern edge of the black polygon(see Figure 7 on p.15 for an illustration of the earlier left turn). In the yellow (7,000ft-6,000ft) and light blue (6,000ft-5,000ft) polygons[3], there is some southbound flow from the A1198 near Arrington, towards Bassingbourn towards the west of Royston.

4.4.10 This shortcutting reduces the distance to touchdown, reducing fuel consumption and greenhouse gas emissions (see Section 7 on p.39). However, it also leads to an increase in overflight from 7,000ft-5,000ft within the predicted overflight area (yellow and light blue polygons), reducing the concentration within the black polygon. We contend that this dispersal is within acceptable tolerances.

4.4.11 The majority of the main post-change concentration in Figure 17 remains consistent with our prediction, and is also similar to the pre-change concentration in Figure 16, as shown by the radar density data warming through green, yellow, red and purple as the aircraft get closer to final approach.

[3] See paragraphs 4.2.2 and 4.2.3 on p.17 regarding flight efficiency having priority at or above 7,000ft. Note the green polygon in each diagram indicates descent from 8-7,000ft.

4.4.12 Vertically, arrivals remain higher for longer than predicted. They do not typically descend below 5,000ft until slightly closer to the airport, and the overall area overflown below 5,000ft is significantly smaller post-change. This is a positive change from our prediction because aircraft at higher altitudes produce less overall noise impact and are more fuel-efficient.

4.4.13 Overflight of the northern part of the Chilterns AONB is consistent with the pre-change scenario; typically this is by arrivals from the west and northwest that have been shortcut via the Flitwick/ Westoning area (dashed blue arrows). Other shortcut arrivals from the east and south are similar to the pre-change scenario (also dashed blue arrows).

Arrivals to Runway 25: Illustrating the 5,000ft-4,000ft band

4.4.14 The pair of diagrams on the next pages shows flights within the 1,000ft band from 5,000ft-4,000ft, and illustrates the differences pre and post-change.

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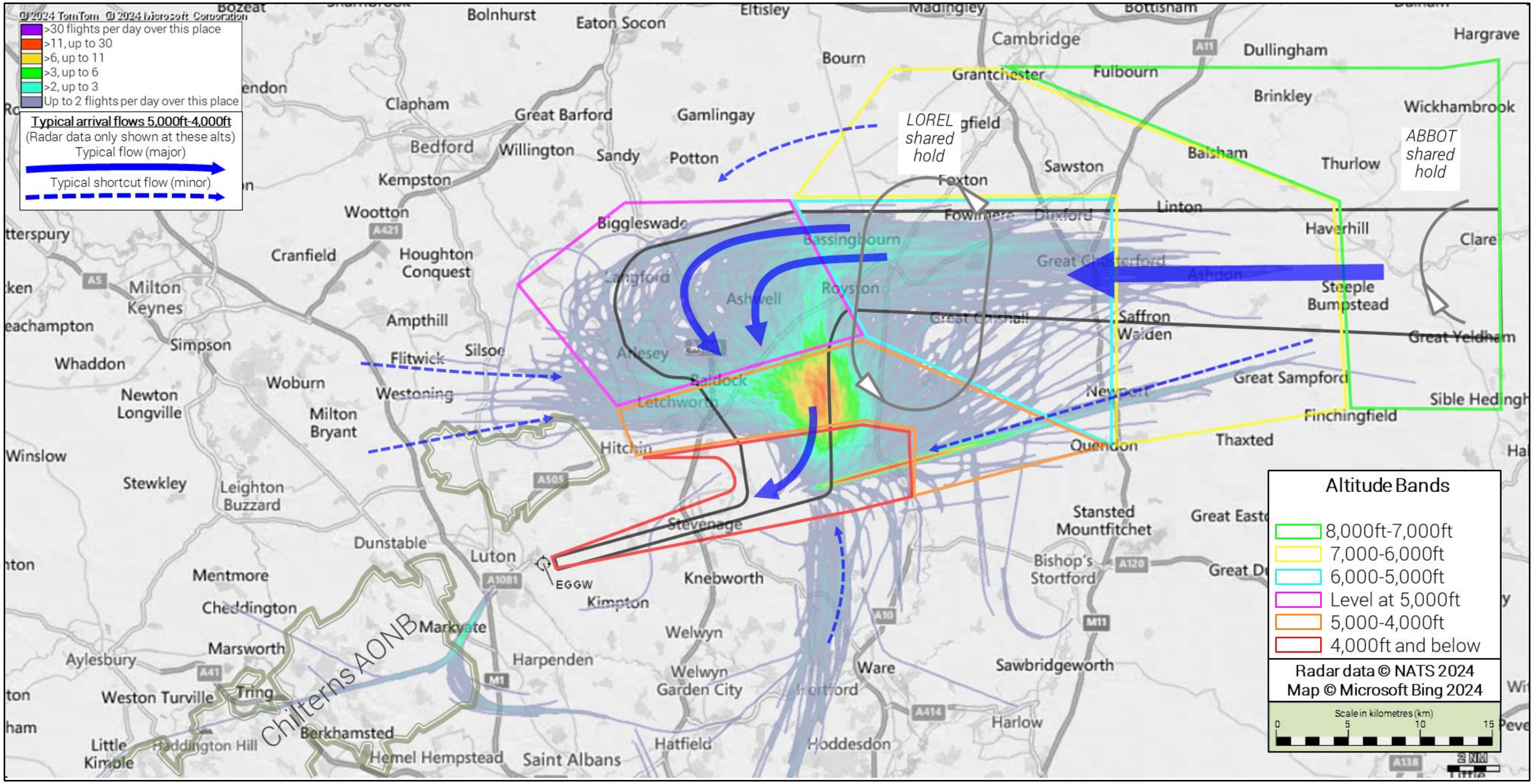

Figure 18 LLA Arrivals to Runway 25 only showing radar data from 5,000ft-4,000ft (7 days in June 2019 pre-airspace change)

4.4.15 Pre-change, as described in paragraph 4.4.3 above, all westerly arrivals were level at 5,000ft for c.15km. This is from east of Royston to the Baldock area (pink polygon), where they were descended to 4,000ft. On reaching the area south of Willian (southern orange polygon) they were descended below 4,000ft, out of this diagram and into the subsequent pair of diagrams.

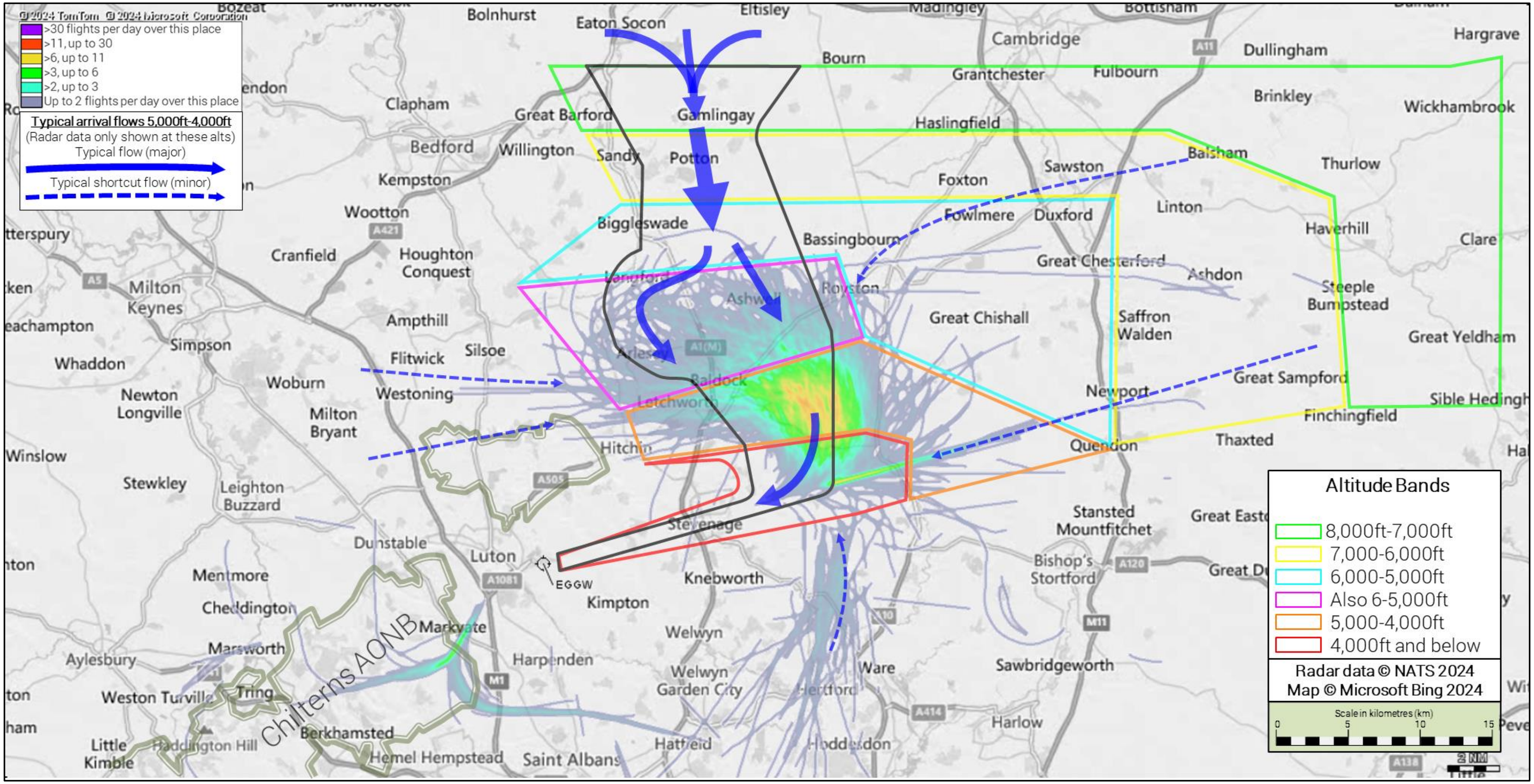

Figure 19 LLA Arrivals to Runway 25 only showing radar data from 5,000ft-4,000ft (7 days in June 2023 post-airspace change)

4.4.16 Post-change, as described in paragraph 4.4.8 above, westerly arrivals stay slightly higher for longer than we predicted in our consultation material. This is consistent with, or a positive change from, our prediction because aircraft at higher altitudes produce less overall noise impact and are more fuel-efficient.

4.4.17 On reaching the area south of Willian (southern orange polygon) they are descended below 4,000ft, out of this diagram and into the subsequent pair of diagrams on the next pages, which show the pre and post-change flightpaths descending from 4,000ft to the westerly Runway 25.

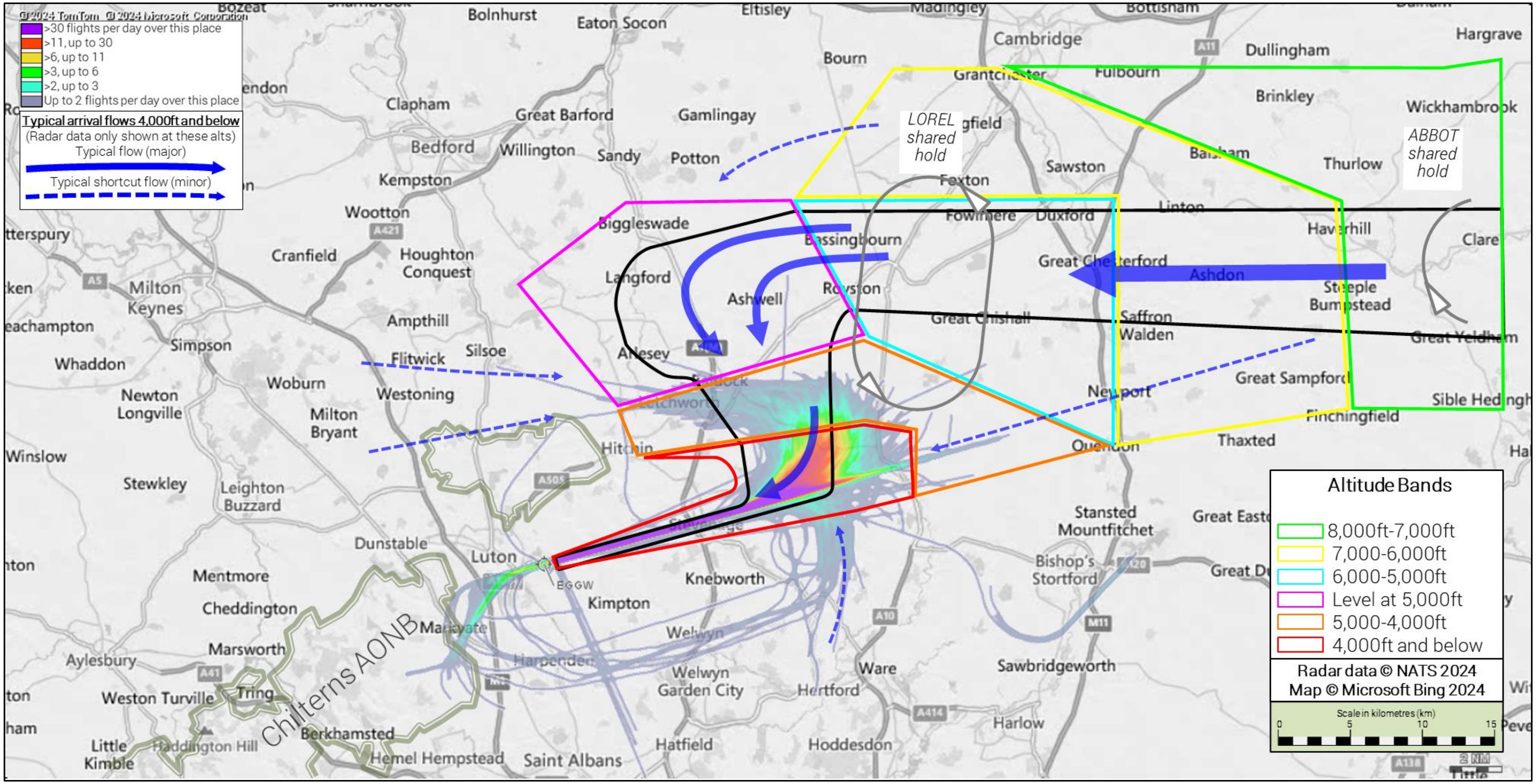

Figure 20 LLA Arrivals to Runway 25 only showing radar data from 4,000ft to land (7 days in June 2019 pre-airspace change)

4.4.19 Pre-change, the main arrival flow descended below 4,000ft in the vicinity of Buntingford, Throcking, Cottered and Weston. Arrivals were also shortcut from the northwest and west, converging with that main flow east of the A1 past Letchworth. The main flow descended to 3,000ft towards Walkern and was turned to align with the runway on the final approach track from 3,000ft towards Stevenage. The greatest concentration occurred on final approach from 3,000ft and below. There were other shortcut flows from the east and southeast. There was minimal overflight of the Chilterns AONB below 4,000ft.

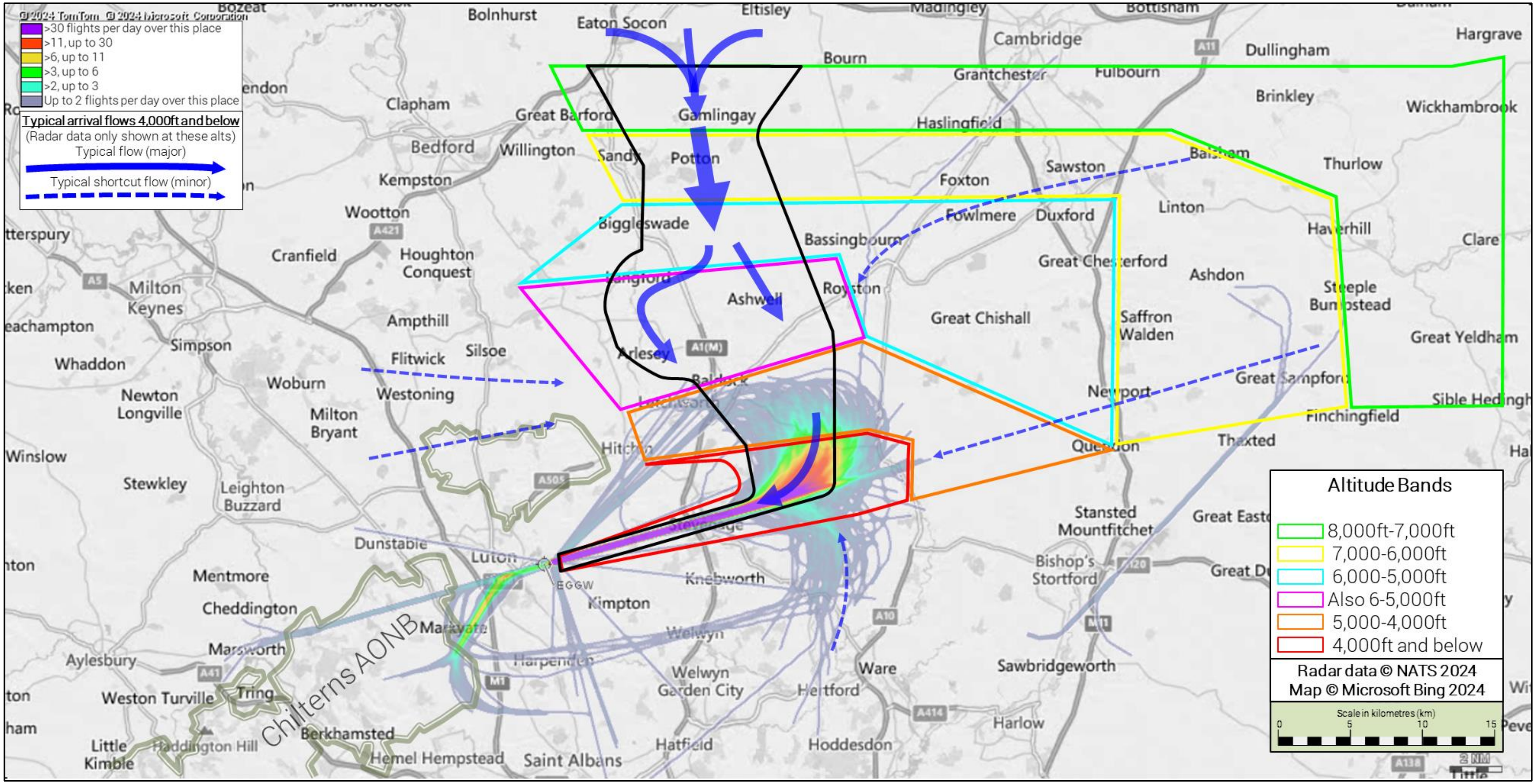

Figure 21 LLA Arrivals to Runway 25 only showing radar data from 4,000ft to land (7 days in June 2023 post-airspace change)

4.4.20 Post-change, the main arrival flow are consistent with the pre-change flightpaths. It descends below 4,000ft in the vicinity of Buntingford, Throcking, Cottered and Weston. Arrivals are also shortcut from the northwest and west, converging with that main flow east of the A1 past Letchworth, staying slightly higher than the pre-change shortcut flow. The main flow descends to 3,000ft towards Walkern and is turned to align with the runway on the final approach track from 3,000ft towards Stevenage. The greatest concentration continues to occur on final approach from 3,000ft and below. There are other shortcut flows from the east and southeast, similar to the pre-change shortcuts. There was minimal overflight of the Chilterns AONB below 4,000ft.

4.4.21 Note there are a small number of erroneous radial 'spikes' displayed emanating from LLA; these are data display errors of the tool used to create the image and are not actual flights.

5. Summary and conclusions on traffic dispersion

5.1 PIR items satisfied

5.1.1 Up to this point in the document, the following CAA-required PIR Items are covered:

34a	*Density plots that show concentration*
34b	*Lateral and vertical analysis*
34c	*Weather/meteorological impacts*
34d	*Fleet mix (aircraft types)*
43a	*Utilisation of STARs (proportions of arrivals using the routes from each major direction)*
49f	*Aircraft track data to confirm no changes below 1,000ft*
49k	*Operational diagrams*
49u	*Operational diagrams showing AONBs*
49v	*Assessment of biodiversity factors*
Other-b	*How often have the new holds been used*

5.1.2 Section 7 from p.39 provides data on fuel and greenhouse gas emissions via CO_2 calculations (PIR Items 49p-49t).

5.1.3 Section 6 on p.38 introduces the separate Technical Appendix noise metrics report (covering PIR Items 49g-j, 49l-o) and provides the conclusion in this Annex.

5.2 Holding

5.2.1 For details on frequency of holding see section 3.3 on p.7. As per paragraph 5.12 on p.26 of the full consultation document, we wrote:

We generally expected aircraft to bypass the hold because the proposed upper airspace system is less likely to require holding – but some holding would still be necessary.

5.2.2 Holding in the new area was infrequent and was usually bypassed. This is consistent with our prediction. However aircraft regularly were in the vicinity of the new holding area, as per the next section.

5.3 High level arrivals

5.3.1 For details of high level arrivals see Section 3 from p.6.

5.3.2 The post-change flightpaths at high level are generally similar to our prediction.

5.3.3 However, controllers took opportunities to shortcut arrivals, reducing their overall track distance and time airborne, more frequently than we predicted. These differences are compared in section 3.6 from p.15, via the pink arrows in Figure 7 (also on p.15).

5.3.4 These more frequent shortcuts happen at high level 8,000ft and above; the impacts of aircraft noise at such levels are not considered a priority in accordance with Government guidance. Flight efficiency is the priority, and the pink arrows are examples of additional high-level efficiency.

5.4 Below 8,000ft: Consistency with, or improvements over, our predictions

5.4.1 For details of arrival flightpaths see section 4 from p.17, divided into easterly arrivals to Runway 07 and westerly arrivals to Runway 25.

5.4.2 Easterly arrivals to Runway 07 were similar to, but higher than, our prediction (except for a small number of flights in one small triangular region, discussed next in section 5.5 below).

5.4.3 Westerly arrivals to Runway 25 were similar to our prediction, some were slightly higher.

5.4.4 The actual flightpaths were consistent with the predicted coloured polygons of the main flow extents and their altitude bands, also the greatest concentration was consistent with the black polygon of predicted greatest concentration.

5.4.5 For arrivals to both runways the shortcut minor flows were consistent with both the pre-change flightpaths and our predictions, both in location and approximate proportions.

5.4.6 For arrivals to both runways the overall area overflown below 5,000ft is now significantly smaller than pre-change, somewhat better than we predicted. This is a positive change from our prediction because aircraft at higher altitudes produce less overall noise impact and are more fuel-efficient.

5.5 Overflight above 5,000ft of an area outside the main predicted overflight areas

5.5.1 For details of this difference see paragraphs 4.3.21-4.3.28 on p.20.

5.5.2 When easterly Runway 07 is in service (c.30% of the year) a small number of aircraft overfly a small triangular region north of the predicted main pink polygon. In our 7-day data sample, this averages up to 4 per day between 7,000ft-6,000ft, and fewer than 1 per day on average between 7,000ft-5,000ft.

5.5.3 This was not predicted. We contend that the impacts caused by this small number of flights mainly above 6,000ft does not cause a significant impact. There were no attributable complaints from that region since the change was implemented.

5.6 PIR Item 49f Local Air Quality

5.6.1 Airspace change process guidance (CAP1616 Edition 4 paragraph B73 on p.171 of that guidance) explains, 'Due to the effects of mixing and dispersion, emissions from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality.'

5.6.2 LLA arrivals typically descend below 1,000ft within 5.5km of the runway, which is in the late stages of the approach to land.

5.6.3 Arrivals to neither runway changed within 5.5km/below 1,000ft due to this airspace change. For radar data evidence, compare Figure 14 on p.24 with Figure 15 on p.25 (easterly Runway 07 operation pre and post-change), and compare Figure 20 on p.34 with Figure 21 on p.35 (westerly Runway 25 operation pre and post-change). It is clear that, both pre and post-change, aircraft are highly aligned and constantly descending well before they pass 1,000ft.

5.6.4 Therefore there would be no change in local air quality impacts, post-change.

5.7 PIR Item 49u Tranquillity

5.7.1 Airspace change process guidance (CAP1616 Edition 4 paragraph B78 on p.172 of that guidance) explains, 'Given the finite amount of airspace available in the UK and the fixed location of airports and National Parks or AONBs, it will not always be practical to completely avoid overflying National Parks or AONBs – and there are no legislative requirements to do so, as this would be impractical… Therefore, in line with the altitude-based priorities, when sponsors are developing airspace change proposals that have the potential to change overflights of National Parks or AONBs below 7,000 feet, sponsors must show how they have considered and taken account of this impact as part of their option development and final design.'

5.7.2 Arrivals to easterly Runway 07 continue to overfly the northern part of the Chilterns AONB below 7,000ft, however most flights remain higher for longer, so there are fewer overflights c.5,000ft.

5.7.3 Overflight of the southern part of the Chilterns AONB cannot be avoided as it is directly under the final approach track to easterly Runway 07.

5.7.4 Some arrivals to westerly Runway 25 continue to overfly the northern part of the Chilterns AONB below 7,000ft as they are shortcut from the west and northwest. The same shortcut is used by a similar proportion, however aircraft tend to be slightly higher than the pre-change flightpath.

5.7.5 Overall when the easterly Runway 07 is operating (c.30% of the year), this is an improvement over the pre-change flightpath, reducing impacts on tranquillity when compared with the pre-change flightpaths. When the westerly Runway 25 is operating (c.70% of the year) there would be a small, probably minimal, improvement in impacts on tranquillity.

5.8 PIR Item 49v Biodiversity

5.8.1 Airspace change process guidance (CAP1616 Edition 4 Appendix B p.162 and p.180 paragraph B83 of that guidance), explains that 'Most airspace change proposals are unlikely to have an effect upon biodiversity and therefore the inclusion within the design principles is expected to be the full extent of any consideration in most instances' and 'In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not involve ground based infrastructure.'

5.8.2 This airspace change did not involve changes to ground based infrastructure, nor was biodiversity part of the design principles. We contend that this airspace change would not have changed impacts on biodiversity.

5.9 Conclusion and summary: Traffic dispersion and associated data

5.9.1 The radar data evidence shows that the vast majority of the actual flightpath behaviour of LLA arrivals is consistent with our predictions. There was one area where a small number of flights occur where we did not predict them to occur; we explain above that the impacts this might cause are not considered significant. There was another area where a partial flow of flights were within the originally-predicted overflight area but spread slightly outside the main concentrated area. We contend this is within acceptable tolerances of the original prediction. In most cases it is better than predicted, e.g. improved shortcuts at high levels and increased altitude at lower levels.

6. Noise Metrics, Contours and Diagrams

6.1 Technical Report

6.1.1 We commissioned a technical report to meet the PIR specifications agreed with the CAA, covering PIR Items 49g-j, 49l-o. The conclusion is provided below as an extract.
The full report is published separately, as the Technical Appendix to Annex A.

6.1.2 Please read sections 3.2 on p.7 and 4.2 on p.17, both of which summarise the Government guidance regarding noise impacts at & above 7,000ft and below 7,000ft respectively. This guidance is known as ANG2017 and is available here (Ref 9, link).

6.2 Conclusion (extract from noise technical report)

6.2.1 For the PIR, this report has considered three different comparisons between the pre and post AD6 scenarios to analyse the impacts of the implemented airspace:

- '2023 Actual' vs '2023 without AD6';
- 'Option 1A – Final Design in the implementation year' Vs 'Option 1A – with AD6 airspace configuration as occurred';
- 'Option 1A – with AD6 airspace configuration as occurred' vs 'Option 0 – Baseline do-nothing in the implementation Year'.

6.2.2 The first comparison has considered operations in 2023 adopting airspace assumptions that reflect the airspace before and after the implementation of the AD6 airspace change. This comparison utilises the same fleet mix and number of aircraft operations as actually occurred in 2023. The only difference between the two scenarios is about the routes which reflect the ground tracks and route utilisations before and after the implementation of AD6. Since the two models share a majority of the same modelling assumptions, this comparison is deemed to be the most reliable across the three to present the direct impacts of the AD6 airspace change. The analysis of this first comparison has shown no discernible differences in terms of population exposed to the various levels of LA_{eq16h} and LA_{eq8h} noise exposure and contour areas. Small differences are observed for the N60 metric specifically in locations influenced by easterly arrivals. This is due to the presence of the S3 route in which aircraft coming from the east join the final approach from the south. As the traffic is almost evenly split between the main vector and the S3 route, the N60 rate 5 and N60 rate 10 contours are more pronounced to the south, causing a difference of $2km^2$ compared to the pre AD6 scenario.

6.2.3 No significant differences have been found in the overflight comparison between the pre-AD6 and the post-AD6 airspace implementation up to either 1,000ft or 1,640ft which suggests that there are no impacts on both local air quality and biodiversity caused by the implementation of AD6 airspace.

6.2.4 For the other two comparisons, differences in the modelling assumptions are the main factors that contribute to different outcomes when comparing the 'do-nothing scenario' and 'Option 1A – Final Design in the implementation year' prepared for the Stage 3 FOA and Stage 4 Final Options with the 'Option 1A – with AD6 airspace configuration as occurred'. During the Stage 3 FOA and Stage 4 Final Options Appraisals different assumptions on the on the distribution of the traffic on the routes were in fact taken compared to how the traffic was effectively distributed on the routes in 2023. This resulted in different modelling outputs between the scenarios prepared for the FOA and Final Options Appraisal and the scenario considering the airspace as occurred in 2023 rather than effectively a worse outcome.

6.2.5 Based on the environmental analysis that has been carried out for the PIR, it is therefore concluded that there is no significant difference between the pre and post implementation of AD6 for the metrics and thresholds indicated in policy (i.e. 51dB LA_{eq16h} and 45dB LA_{eq8h}) and no impacts on both local air quality and biodiversity which are caused by the implementation of AD6 airspace.

7. Fuel and CO_2 emissions

This section provides evidence for PIR Items 49p-49t.

7.1 Comparing simulated predictions with actual flights

7.1.1 We originally used a simulation modelling system to predict fuel and CO_2e[4] data. We had a forecast for the total traffic numbers in 2022, for both LLA and Stansted arrivals[5].

7.1.2 The simulation model produced a per-flight average change in fuel consumption, compared with the do-nothing scenario. It predicted a slight disbenefit per flight for LLA arrivals because they would generally have a longer distance to fly in the post-change system We predicted a slight benefit per flight for Stansted arrivals because there would be no LLA arrivals in their path at higher levels, reducing the likelihood of vectoring and holding.

7.1.3 This was the best prediction we had, which we used to progress the ACP by publishing a Full Options Appraisal for the consultation, and a Final Options Appraisal for the application to make the airspace change, after the design had been modified. These were accepted by the CAA. We knew we would need to check the simulation against actual flight data as part of the PIR.

7.1.4 For the PIR we took a year's worth[6] of actual radar data, the 3D trajectories of flights for LLA arrivals and Stansted arrivals, and ran it through the same fuel calculation steps. It produced a new PIR dataset based on actual flightpaths and altitudes.

7.1.5 We compared the simulated fuel data per flight with the actual fuel data per flight to find the difference in fuel and CO_2e per flight (part of PIR Item 49q). This illustrates what we predicted the fuel use difference would be vs. the do-nothing scenario, and compares it with what the fuel use difference actually was vs. the do-nothing scenario.

7.1.6 We adjusted the fuel-to-CO_2e conversion ratio, in accordance with government data[7]. This ensured the correct CO_2e totals could be calculated from the fuel burnt. We derived the difference in CO_2e per flight (remainder of PIR Item 49q).

7.1.7 We adjusted the data to compare like-for-like annual traffic numbers. This ensured that the main variable is the airspace change itself, so other factors (different numbers of flights annually, different CO_2e conversion factors etc) are removed.

7.1.8 We did this by using the actual number of arrivals in the PIR period and recalculating what the pre-change annual fuel and CO_2e totals would have been. This means we did the calculations using the same number of annual flights pre-change and post-change, while using the pre-change (simulated) fuel consumption to compare with the post-change (actual) fuel consumption.

7.1.9 From this we derived the annual fuel usage and annual CO_2e emissions over the PIR period.

7.1.10 We compared them against what we predicted they would have been, if the pre-change scenario had exactly the same number of annual flights as the post-change scenario (PIR Item 49p).

7.1.11 Note: For LLA the number of arrivals used for the calculation was 62,843. This is slightly lower than the total number of arrivals for LLA stated elsewhere in the PIR document (63,190) because the fuel calculations cannot accurately model very short flights or circular flights. A small number of flights departing LLA and returning to LLA (without landing in between) were excluded from the calculation, as were flights positioning between Stansted and LLA or vice-versa. Stansted's number of arrivals followed the same principle, totalling 95,535 for the calculations.

7.1.12 We took the cost of aviation turbine fuel for the week ending 31st May 2024 (via Platts, the company used by IATA to monitor fuel prices); this was $778.38USD per tonne. We took USD to GBP currency conversion from XE.com on the same date, and applied it to both the pre-change and post-change fuel results, to determine the cost differences ($1USD=£0.7852GBP). One tonne of aviation turbine fuel costs £611.18GBP for the purpose of these calculations.

[4] CO_2e is Carbon Dioxide Equivalent. Burning aviation fuel produces water, CO_2 and other greenhouse gases. The fuel-to-CO_2e conversion takes the complex mixture of non-CO_2 greenhouse gases and calculates the metric as if all the gases were CO_2.
[5] The original simulation method was described in the ACP's Stage 3 Full Options Appraisal document (link, see paragraph 6.17 on p.30).
[6] Excluding 28-31 Aug 2023 to remove the non-standard impacts of the ATC system failure.
[7] Link, we used the 2023 dataset for Aviation Turbine Fuel to convert at a factor of 3.17837.

7.1.13 The above steps were performed to minimise the different variables. Therefore the data on the following pages **cannot** be directly compared with the ACP's Full Options Appraisal or Final Options Appraisal data because they used a different number of annual flights, different fuel costs and different CO_2e conversion factors.

7.1.14 From a technical point of view, a blue-sky weather picture was assumed, with no wind. AirTOP fast-time simulation version 2.3.28B159 was used for the original prediction. The fuel burn modelling uses BADA 4 data (courtesy of Eurocontrol), unless the aircraft type is not included in BADA 4 in which case it was matched to a similar aircraft type. This is standard technical methodology for the NATS Analytics team who produce the data on our behalf.

7.1.15 The explanation of supporting data / method above, and below, combined with a statement on the model version numbers, cover **PIR Items 49s and 49t**.

7.2 LLA Arrivals: Fuel, CO_2e and cost results

Change in LLA Fuel/emissions data based on the following:	Num flights# 62,843		Notes
1. PIR period actual traffic numbers 2. Original fuel simulation forecast 3. Govt 2023 fuel/CO2e conversion 4. IATA fuel cost per tonne (May 2024)	t fuel per flight	0.0342	(34.2kg fuel using original simulated data)
	t CO2e per flight	0.109	(109kg CO2e using original simulated data)
	t fuel total	2,149	(updated using actual PIR traffic)
	t CO2e total	6,831	(updated using actual PIR traffic)
	£/flight	£20.90	(updated using May 2024 fuel cost)
	£ fuel total	£1,313,575	(updated using May 2024 fuel cost)
1. PIR period actual traffic numbers 2. Fuel data using actual 3D trajectories 3. Govt 2023 fuel/CO2e conversion 4. IATA fuel cost per tonne (May 2024)	t fuel per flight	0.0165	(16.5kg fuel using actual 3D trajectories)
	t CO2e per flight	0.0526	(52.6kg CO2e using actual 3D trajectories
	t fuel total	1,039	(updated using actual PIR traffic)
	t CO2e total	3,303	(updated using actual PIR traffic)
	£/flight	£10.11	(updated using May 2024 fuel cost)
	£ fuel total	£635,087	(updated using May 2024 fuel cost)

Table 3 LLA fuel, CO_2e and cost comparison for PIR: simulated in blue, actual in green

#See paragraph 7.1.11 above

Forecast fuel (kg) increase per flight	34.2	Forecast fuel cost increase per flight	£20.90
Actual fuel (kg) increase per flight	16.5	Actual fuel cost increase per flight	£10.11
Difference (kg) reduced disbenefit	17.7	Difference in cost reduced disbenefit	£10.80

Table 4 LLA fuel per flight difference (left), and cost per flight difference (right), overall disbenefit

7.2.1 Table 3 illustrates the fuel, CO_2 e and fuel costs per flight, and for the annual total of 62,843 LLA arrivals. The numbers show the **predicted** per-flight and annual fuel/CO_2e/costs compared with the do-nothing scenario (blue), and the **actual** per-flight and annual figures compared with the do-nothing scenario.

7.2.2 We predicted there would be a fuel disbenefit due to the longer average distance LLA arrivals would have to fly in the new airspace design.

7.2.3 Table 4 shows the difference between the originally forecast fuel disbenefit, and the actual disbenefit.

7.2.4 The actual disbenefit is less than half the forecast disbenefit, this is a good result. The actual distances flown are shorter than predicted, and aircraft have remained higher for longer than we predicted. This is evidenced in the radar density maps and diagrams earlier in this document.

7.3 Stansted Arrivals: Fuel, CO_2e and cost results

Change in Stansted Fuel/emissions data based on the following:	Num flights# 95,535		Notes
1. PIR period actual traffic numbers 2. Original fuel simulation forecast 3. Govt 2023 fuel/CO2e conversion 4. IATA fuel cost per tonne (May 2024)	t fuel per flight	-0.0048	(4.8kg fuel using original simulated data)
	t CO2e per flight	-0.015	(15kg CO2e using original simulated data)
	t fuel total	-459	(updated using actual PIR traffic)
	t CO2e total	-1,457	(updated using actual PIR traffic)
	£/flight	-£2.93	(updated using May 2024 fuel cost)
	£ fuel total	-£280,269	(updated using May 2024 fuel cost)
1. PIR period actual traffic numbers 2. Fuel data using actual 3D trajectories 3. Govt 2023 fuel/CO2e conversion 4. IATA fuel cost per tonne (May 2024)	t fuel per flight	-0.0099	(9.9kg fuel using actual 3D trajectories)
	t CO2e per flight	-0.0315	(31.5kg CO2e using actual 3D trajectories
	t fuel total	-947	(updated using actual PIR traffic)
	t CO2e total	-3,011	(updated using actual PIR traffic)
	£/flight	-£6.06	(updated using May 2024 fuel cost)
	£ fuel total	-£578,961	(updated using May 2024 fuel cost)

Table 5 Stansted fuel, CO_2e and cost comparison for PIR: simulated in blue, actual in green

#See paragraph 7.1.11 above

Forecast fuel (kg) decrease per	-4.8	Forecast fuel cost decrease per	-£2.93
Actual fuel (kg) decrease per	-9.9	Actual fuel cost decrease per	-£6.06
Difference (kg) increased benefit	5.1	Difference in cost increased benefit	£3.13

Table 6 Stansted fuel per flight difference (left), and cost per flight difference (right)

7.3.1 Table 5 illustrates the fuel, CO_2 e and fuel costs per flight, and for the annual total of 95,535 Stansted arrivals. The numbers show the **predicted** per-flight and annual fuel/CO_2e/costs compared with the do-nothing scenario (blue), and the **actual** per-flight and annual figures compared with the do-nothing scenario.

7.3.2 We predicted there would be a fuel benefit mainly due to the reduced vectoring and reduced holding caused by LLA arrivals having been moved out of the path of Stansted arrivals in the new airspace.

7.3.3 Table 6 shows the difference between the originally forecast fuel benefit, and the actual benefit.

7.3.4 The actual benefit is more than double that of the forecast, this is a good result. This is likely due to a combination of reduced vectoring and reduced holding, with an improved vertical profile due to the LLA arrivals no longer being in the way to a greater extent.

7.4 Conclusion and summary: Fuel and CO_2e

7.4.1 For LLA, the expected disbenefit was halved, compared with our prediction.

- We predicted a fuel disbenefit of 34.2kg per LLA arrival
  The actual fuel disbenefit was 16.5kg per LLA arrival, less than half our prediction
- We predicted a CO_2e disbenefit of 109kg per LLA arrival
  The actual fuel disbenefit was 52.6kg per LLA arrival, less than half our prediction

7.4.2 For Stansted, the expected benefit was more than doubled, compared with our prediction.

- We predicted a fuel benefit of 4.8kg per Stansted arrival
  The actual fuel benefit was 9.9kg per Stansted arrival, more than double our prediction
- We predicted a CO_2e benefit of 15kg per Stansted arrival
  The actual CO_2e benefit was 31.5kg per Stansted arrival, more than double our prediction

Forecast **fuel** (tonnes) Annual **LLA** increase	2,149	1,691	Forecast annual total increase in **fuel** (tonnes)	Forecast **CO2e** (tonnes) Annual **LLA** increase	6,831	5,374	Forecast annual total increase in **CO2e** (tonnes)
Forecast **fuel** (tonnes) Annual **Stansted** decrease	-459			Forecast **CO2e** (tonnes) Annual **Stansted** decrease	-1,457		
Actual **fuel** (tonnes) Annual **LLA** increase	1,039	92	Actual annual total increase in **fuel** (tonnes)	Actual **CO2e** (tonnes) Annual **LLA** increase	3,303	292	Actual annual total increase in **CO2e** (tonnes)
Actual **fuel** (tonnes) Annual **Stansted** decrease	-947			Actual **CO2e** (tonnes) Annual **Stansted** decrease	-3,011		
Overall reduction in fuel disbenefit (tonnes)	1,599		Forecast disbenefit minus Actual disbenefit	Overall reduction in CO2e disbenefit (tonnes)	5,082		Forecast disbenefit minus Actual disbenefit

Table 7 Summary of annual total differences between the forecast and actual disbenefit

7.4.3 Table 7 summarises the annual total differences between forecast and actual fuel (left) and CO_2e (right). Therefore, in practice the airspace change was not as disbeneficial as we predicted.

7.4.4 We predicted an overall fuel and CO_2e disbenefit for this airspace change because its purpose was to improve safety in the region, and fuel economy was not the highest priority. However, the actual operation of the airspace change is significantly better than we predicted, from a fuel and CO_2e point of view, therefore the overall disbenefit is significantly smaller.

- The actual operation of the airspace change was c.1,600t fuel / c.5,100t CO_2e better than our prediction.
- The total disbenefit of the airspace change in the PIR period was 92t fuel / 292t CO_2e.

7.5 PIR Item 49r WebTAG Greenhouse Gas Monetisation Output

7.5.1 WebTAG is a government method for monetising greenhouse gas emissions due to an infrastructure project such as a new road or rail line. It is also used for airspace changes.

7.5.2 To comply with PIR Item 49r, we have taken the 292t CO_2e total disbenefit and applied it to the template workbook, for the PIR period, and treated the two partial years as if they were a single year calculated for 2023. This is the output. The original workbook will be supplied directly to the CAA.

Greenhouse Gases Workbook - Outputs 1

Scheme Name: SAIP AD6 PIR

Present Value Base Year 2010 — Unit of account: Factor cost

Current Year 2024

Proposal Opening year: 2022

Project (Road/Rail or Road and Rail): Road

Overall Assessment Score:

Net Present Value of carbon dioxide equivalent emissions of proposal (£): -£4,678
(Sum of traded and non-traded emissions - see note below on accounting for UK allowances in the traded sector)
*positive value reflects a **net benefit** (i.e. CO2e emissions reduction)

Quantitative Assessment:

Change in carbon dioxide equivalent emissions over 60 year appraisal period (tonnes): 292
(between 'with scheme' and 'without scheme' scenarios)
*negative value reflects a **net benefit** (CO2e emissions reduction)

Of which Traded 1036.605362

Change in carbon dioxide equivalent emissions in opening year (tonnes): 0
(between 'with scheme' and 'without scheme' scenarios)

Net Present Value of traded sector carbon dioxide equivalent emissions of proposal (£): -£102,287
*N.B. This value has been adjusted to account for the cost of emissions covered by the UK Emissions Trading Scheme (UK ETS), **under the assumption that all assessed traded emissions are within the scope of the UK ETS**. For further information, including guidance on the valuation of traded emissions outside the scope of the UK ETS, please refer to TAG Unit A3, section 4.1.*
*positive value reflects a **net benefit** (i.e. CO2e emissions reduction)

Change in carbon dioxide equivalent emissions by carbon budget period:

	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4	Carbon Budget 5	Carbon Budget 6
Traded sector	0	0	0	1036.605362	0	0
Non-traded sector	0	0	0	-744.7302019	0	0

Qualitative Comments:

Sensitivity Analysis:
(Traded and non-traded)

Upper Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): -£26,683

Lower Estimate Net Present Value of Carbon dioxide Emissions of Proposal (£): £5,336

Figure 22 WebTAG greenhouse gas monetisation output sheet

End of Annex A: Traffic Dispersion & Environmental Data