Glasgow Airport FASI-N Airspace Change Proposal

Step 2A
Design Principle Evaluation

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(Please see Change Record on CAA Airspace Change Portal for details of updates)
V1.2 Following CAA request, text changes between V1.0 and V1.1 highlighted. We would recommend reading the change record in order to understand the requirement for and the context of the clarifications.
V1.3 Updates following clarification meeting with the CAA highlighted.

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Introduction

Following the publication of the strategic rationale for airspace modernisation[1], the Government directed the Civil Aviation Authority (CAA) to "prepare and maintain a coordinated strategy and plan for the use of UK airspace up to 2040, including its modernisation". As a result, in 2018 the CAA published the Airspace Modernisation Strategy (AMS)[2], which replaced the earlier 2011 Future Airspace Strategy. The AMS sets out the initiatives required to modernise the existing Airspace System by upgrading the airspace design, technology and operations. The CAA is in the process of reviewing the AMS and expects to publish an updated version of the strategy in early 2022.

One of the most important initiatives required to achieve the AMS objective is known as FASI (Future Airspace Strategy Implementation). 21 airports in the UK comprise FASI and Glasgow Airport is one of them. This FASI initiative is considered the UK's Airspace Change National Infrastructure Programme (the Programme). The Programme encompasses the requirement to fundamentally redesign the National Airspace System at lower altitudes and in the terminal airspace that serves commercial air transport across the busiest regions of the UK, making the most of the capabilities of modern aircraft and satellite-based navigation technology. These airspace design projects are sponsored by the 21 airports (for the local arrival and departure routes below 7000ft) and by NERL (for the airspace structures and route network above 7000ft).

Today's national route network is designed with reference to a grid of ground navigation beacons distributed across the UK. Some of these beacons are outdated and reaching their end of life. Meanwhile, 99% of the current commercial air transport fleet operates almost exclusively using avionics that rely on satellite navigation. Aircraft are able to follow routes designed to satellite navigation standards (known as Performance-based Navigation or PBN) with greater precision than conventional ground navigation. The widespread deployment of routes designed to satellite navigation standards is a cornerstone of airspace modernisation. The opportunity to design a new network of PBN routes with far greater accuracy and flexibility offers the potential to address many of the issues set out in the Government's strategic rationale. Significant improvements in airspace capacity and efficiency can be achieved by positioning routes so that they are safely separated and optimised by design.

Whilst more precise routes can be used to avoid noise sensitive areas, they may also concentrate the impacts of overflight. For this reason, the use of multiple route options that can distribute the impacts more equitably, or be configured to offer predictable relief from noise, must be considered in consultation with local stakeholders when routes are being developed for deployment at lower altitudes.

The number, complexity and overlapping scope of the individual Airspace Change Proposals (ACPs) needed to deliver the Programme requires a strategic coordination mechanism in the form of a single joined up implementation plan or Masterplan.

[1] Upgrading UK Airspace Strategic Rationale
[2] UK Airspace Modernisation Strategy, CAA CAP1711, 2018

Given the large number of organisations involved (21 airports and NATS EnRoute Limited (NERL)), the CAA and Department for Transport (DfT) also required NERL to set up an impartial body, The Airspace Change Organising Group (ACOG) to develop a Masterplan, coordinate the Programme and lead the necessary engagement with external stakeholders. In this context, ACOG was established in 2019 as a unit within NERL, separate and impartial from the organisation's other functions.

Masterplan Iteration 2[3] was accepted by CAA on 27th January 2022. The purpose of Iteration 2 is to provide a system-wide view of the scope of the constituent ACPs and identify the potential interdependencies between the proposals. Collectively, the ACPs that are included in the Masterplan are referred to as the 'constituent airspace change proposals'. Each individual ACP is developed following the same detailed process steps laid out in the CAA's guidance for changing the airspace design – known as CAP1616[4]. The CAA evaluates the progress of every ACP through each stage of the process, via a series of (seven) regulatory gateways and make decisions on whether to approve further development and ultimately the implementation of the proposed changes. A summary of the CAP1616 process is available in the next section.

Iteration 2 places Glasgow Airport in the 'STMA regional cluster' alongside Edinburgh and Aberdeen Airports and the NATS Scottish TMA.

Glasgow Airport Limited (GAL) began their ACP to modernise their airspace in June 2019 and passed through Stage 1 of CAP1616 in December 2019. Shortly after this, the project and much of the wider Programme was paused due to COVID-19 pandemic whilst the aviation industry focussed on managing the pandemic and its recovery from it. The Programme was remobilised in March 2021 following the provision of DfT grant funding, allowing GAL to recommence their ACP in May 2021.

This document forms part of the GAL Stage 2 submission to the CAA. It sets out how Glasgow Airport has developed its Comprehensive List of Options for the ACP and how it tested those options and their development with their stakeholders. It then explains the methodology used to evaluate the options against the Design Principles as well as containing a summary of that evaluation.

All airspace design options in this document are subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation with all our stakeholders.

[3] Link to Iteration 2
[4] CAA CAP 1616, edition 4, March 2021

The CAP1616 Airspace Change Process

In December 2017 the Civil Aviation Authority (CAA) published CAP1616[5] Airspace Design: Guidance on the regulatory process for changing airspace design, including community engagement requirements. The guidance sets out the process for the airspace change process, which a change sponsor of any permanent change to the published airspace design must follow. The airspace change process is split into 7 Stages;

Figure 1: CAP1616 Process

[5] CAP1616

Where Glasgow Airport is in their Airspace Change Proposal

This Airspace Change Proposal is required to follow the CAP1616 process detailed in the section above. Table 1 below summarises the CAP1616 stages already undertaken for this ACP and the stage where we are at now, providing links to previous submission documents with further information.

Airspace Change Stage	Summary	Link to Documents (Also available on the ACP portal)
Stage 1A	In June 2019, Glasgow Airport submitted their following statement of need (SoN) to the CAA	Statement of Need on CAA's Airspace Change Portal
	Glasgow Airport participated in an assessment meeting with the CAA on the 18th June 2019 as part of Step 1A of the CAP1616 process. The purpose of the assessment meeting is for the change sponsor to present and discuss their SoN and to enable the CAA to consider whether the proposal falls within the scope of the formal airspace change process.	Assessment meeting minutes
Stage 1B	At Stage 1B Glasgow developed a set of design principles with identified Stakeholders. The aim of the design principles is to provide high-level criteria that the proposed airspace design options should meet. They also provide a means of analysing the impact of different design options and a framework for choosing between or prioritising options. The final design principles outlined within the Stage 1B submission, are also shown here in this document.	Stage 1B Design Principle Submission Report
Stage 2A	Stage 2A requires change sponsors to develop and assess options for the airspace change. In Stage 2A, the change sponsor develops a comprehensive list of options that address the Statement of Need and that align with the design principles from Stage 1. We then share those options with our Stakeholder representatives (the same ones engaged with on the Design Principles). Feedback from the engagement may then be used to refine and/or generate further options where feasible at this stage or later in the process. Finally, we qualitatively assess all options developed against the Design Principles and produce a Design Principle Evaluation. This is where we are now. The following sections of this document outline how we have developed airspace change options, engaged with Stakeholders, and then assessed the options against the design principles developed at Stage 1B.	This Document

Table 1: GAL ACP to date

Glasgow's Design Principles for this ACP

The design principles were set following engagement with representative stakeholder groups as part of CAP1616 Stage 1. The table of design principles and their relative priorities is shown in Table 2 below:

#	Design Principle
1	The airspace design and its operation must be as safe or safer than today.
2	Facilitate the growth in quicker, quieter and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release controlled airspace that is not required.
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.

Table 2: Design Principles

UK Airspace Change Masterplan Iteration 2

The number, complexity and overlapping scope of the individual airspace ACPs needed to deliver the Programme requires a strategic coordination mechanism in the form of a single joined up implementation plan or Masterplan. In their capacity as co-sponsors of the AMS, the Department for Transport and CAA commissioned NERL to create the Masterplan.

Airspace modernisation is a long and complex process. Larger ACPs with many interdependencies can take several years longer to develop than smaller ones with fewer interactions. As a consequence, ACOG proposed (and the co-sponsors accepted) that the final Masterplan is developed through a series of iterations. The iterative approach recognises that different information and levels of detail will be available at different times. ACOG may have an insufficient level of detail about some ACPs to make firm conclusions and need to make assumptions that are refined in later iterations. It also means that the Masterplan remains flexible and responsive to accommodate the evolving context for airspace modernisation, such as changes arising from the AMS review, new policy directions or unanticipated events.

ACOG envisages a minimum of four iterations of the Masterplan. The iterations broadly align with the regulatory gateways of the CAP 1616 process. Each iteration must be accepted separately into the AMS, except Iteration 1, which was a high-level plan that has already been assessed and published[6].

The purpose of Iteration 2 is to provide a system-wide view of the scope of the constituent ACPs and identify the potential interdependencies between the proposals. The assessment of the interdependencies between the constituent ACPs remains at a high level in Iteration 2 because most of the sponsors were yet to produce a comprehensive list of airspace design options at the time of its creation.

The Masterplan becomes, together with the CAP 1616 process, the legal basis against which individual airspace change decisions are made by the CAA. Therefore, the CAA's decisions on airspace change proposals will need to ensure that there is no misalignment with the Masterplan. The CAA must apply its airspace change decisions in accordance with the Masterplan and therefore in the best interests of the overall Airspace System and not just in the interests of the individual ACP sponsor.

The timeline and sequencing of the Masterplan ACPs are complex issues. It is not considered feasible for all the constituent ACPs in the Programme to be developed and deployed at the same time. The Masterplan takes a modular approach to deployment and requires coordination and strong programme management discipline to mitigate the risks of design conflicts, technical misalignments and a lack of transparency for external stakeholders. To help with this, the Masterplan has placed each of the ACPs into a regional cluster and Iteration 2 places Glasgow Airport in the 'STMA regional cluster' alongside Edinburgh and Aberdeen Airports and the NATS Scottish TMA.

[6] Airspace Masterplan Iteration One (Southern UK): co-sponsor assessment, CAA CAP 1884, February 2021.

Large scale ACPs are usually difficult to develop and deploy because of the complexity of the existing airspace design, the intensity of the current operation and the potential impacts on communities, the environment and other airspace users. The Masterplan ACPs bring additional deployment challenges associated with airspace design interdependencies and the widespread introduction of PBN routes, which will replace well established ATC procedures based on controller vectoring with the comparatively new concept of systemisation. Other factors being equal, the greater the complexity of the existing airspace design, and the more interdependencies, the more difficult the ACPs will be to deploy.

Iteration 2 advises that that the STMA cluster could be deployed in a single implementation, currently targeting Winter 2025.

The deployment timescales for each individual ACP within a cluster are determined by the size, complexity and interdependencies of the proposal and a series of important programme planning assumptions regarding the activities that controllers and operators must conduct to prepare for changes to the airspace structure and route network.

Glasgow’s Potential Interdependencies Identified within Iteration 2

The Masterplan identifies the interdependencies between the constituent ACPs based on an analysis of the broad sections of airspace where a flight path could ‘conceivably be positioned’ below 7000ft within the scope of each proposal. Based on this broad assessment, the Masterplan identifies that Glasgow has potential dependencies below 7000ft with flight paths to and/or from Edinburgh airport. This is as we would expect, as explained in the next section of this document.

Transition Altitude

Even with a redesign and modernisation of the airspace there is a significant and fixed constraint to consider, the Transition Altitude (TA). This is 6,000ft. This section will not explain what the TA is in detail, other than to say the way aircraft reference their height above ground changes above 6,000ft compared to at or below 6,000ft. At or below 6,000ft, they fly at an altitude. Above 6,000ft they fly at a Flight Level (FL).

Whenever aircraft are not laterally separated, they are kept at least 1000ft apart vertically. 5,000ft is obviously 1,000ft below 6,000ft. Similarly, FL70 is 1,000ft below FL80. However, due to the transition altitude, 6,000ft and FL70 are not always at least 1,000ft apart. In fact, sometimes 6,000ft and FL80 are not always at least 1,000ft apart.

This means that the ability to enable continuous climb for all departures to at least 7,000ft would actually mean that departures need to climb to at least FL90.

Glasgow's Existing Airspace Arrangements (Baseline)

Runway and Local Geography

Glasgow airport is located in Paisley, Renfrewshire, 8.6 nautical miles (15.9km; 9.9mi) west of Glasgow city centre. The airport is owned and operated by AGS Airports which also operates Aberdeen and Southampton airports.

Glasgow has one runway (23/05) and with prevailing winds in the UK from the South-west, in 2019, Runway 23 was in operation 82% of the time (westerly operations) and Runway 05 was in operation 18% of the time (easterly operations).

There are multiple areas of dense population within the local vicinity of the airport as illustrated in Figure 2.

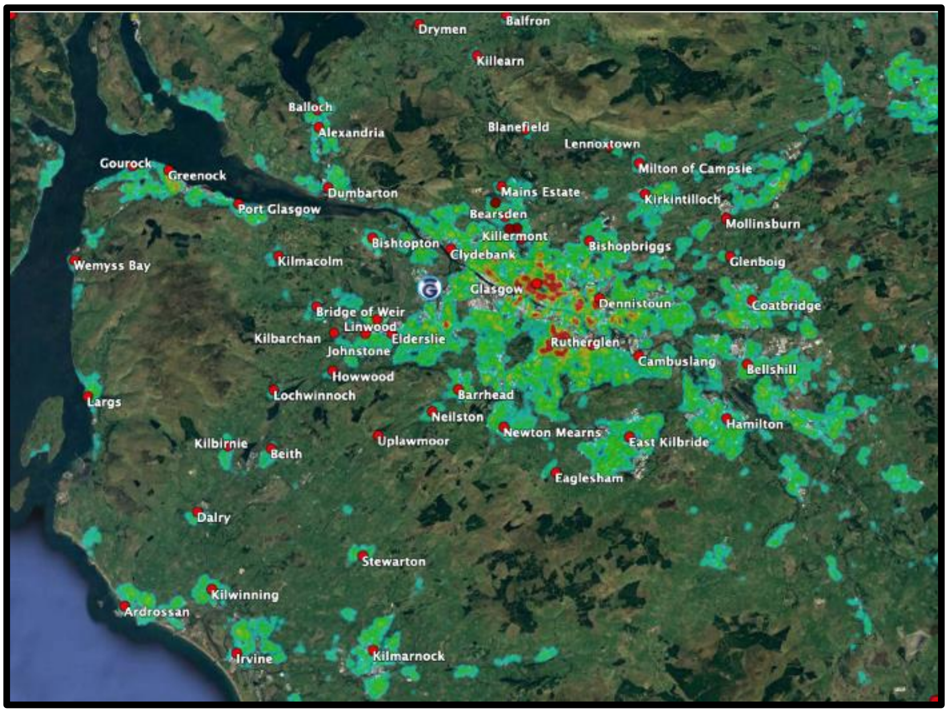

Figure 2: Local population centres

To the North of the airport is Loch Lomond National Park as shown in Figure 3.

Figure 3: Loch Lomond National Park

Controlled Airspace Arrangements and Adjacent Airports

Within c.35nm of Glasgow airports are Edinburgh and Glasgow Prestwick Airport each with their own Controlled Airspace (CAS) volumes. In addition to this, the Scottish TMA airspace sits above and around the airports' airspace which generates the volumes shown in Figure 4.

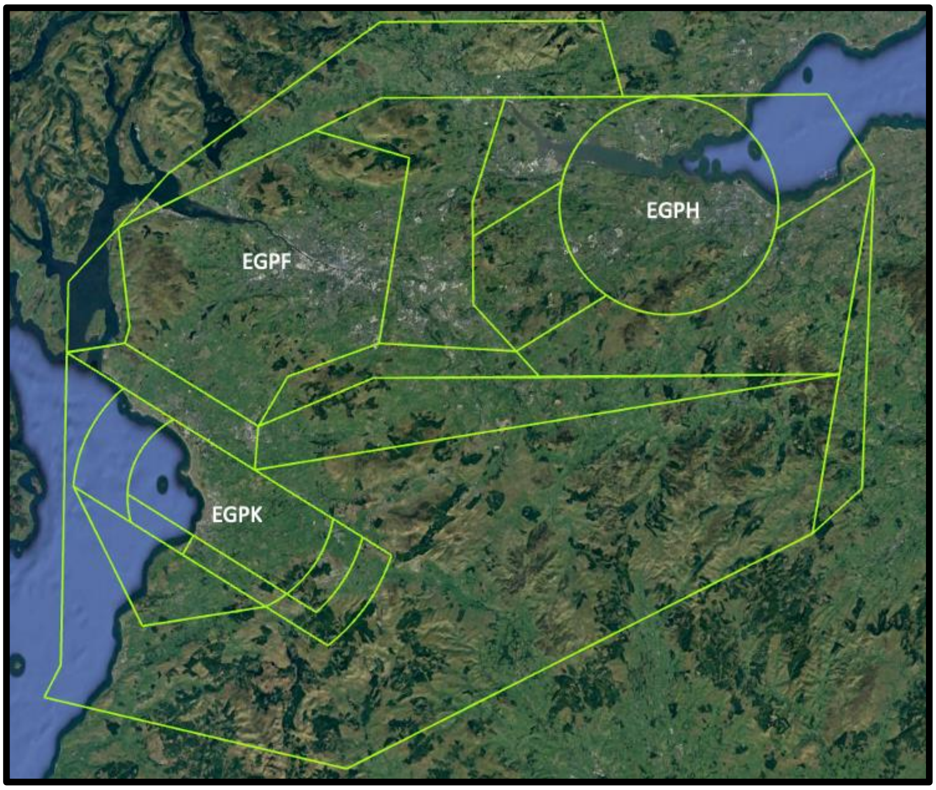

Figure 4: CAS boundaries

The controlled airspace at Glasgow has varying lower and upper limits with the volume closest to the airport going down to ground level. This is the Glasgow CTR shown in red outline in Figure 5. Also, in this figure can be seen Cumbernauld Airport approximately 15nm to the east of Glasgow airport which sits outside CAS where the base of the CTA is 3000ft. This is indicated with a yellow dot.

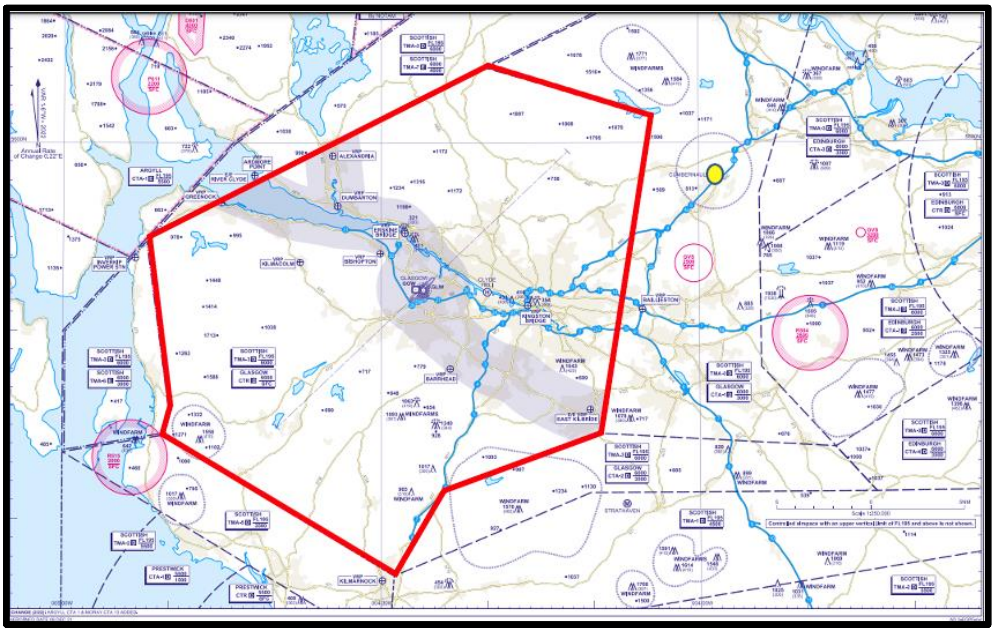

Figure 5: Glasgow Control Zone (Red outline) and Control Area CTR and Cumbernauld Airport (yellow)

General Aviation

There are several routine General Aviation activities and trends taking place in the vicinity of Glasgow Airport.

There are 2 flying clubs based at Glasgow (Glasgow Flying Club and Leading-Edge Aviation) along with an RAF University Air Squadron which operate to and from the local flying area where training is conducted with transits to/from Loch Lomond via the VFR lanes commonplace.
Gama Aviation are a Fixed Based Operator from Glasgow and emergency services helicopters are also stationed at the airport.

Cumbernauld aerodrome, Microlight Scotland (based at Strathaven airfield), the Scottish Gliding Centre (based at Portmoak airfield) and Prestwick airport generate much local GA activity. Some Controlled Airspace infringements have occurred in the north east corner of the zone around Cumbernauld. This is thought to be due to the Cumbernauld runway orientation which points towards the Glasgow CTR. There have also been recorded infringements by GA traffic operating out of Prestwick Airport to the south west.

A gliding corridor is established between Glasgow and Edinburgh to facilitate gliders transiting between established gliding areas at Portmoak airfield and the Galloway Hills to the South. The corridor is limited to transiting gliders at 4500’ and access to Controlled Airspace only at a limited number of weekends which restricts transit flights and therefore is not used frequently. Gliders are mandated to have radio in this corridor but no transponder required. ATC report very little gliding activity within CAS other than via the gliding corridor.

Figure 6 below shows a sample of surveillance data from 2019 showing track data for ADS-B[7] (red) and FLARM[8] (green) returns in and around the Glasgow CAS volumes. Commercial airline track data has been removed.

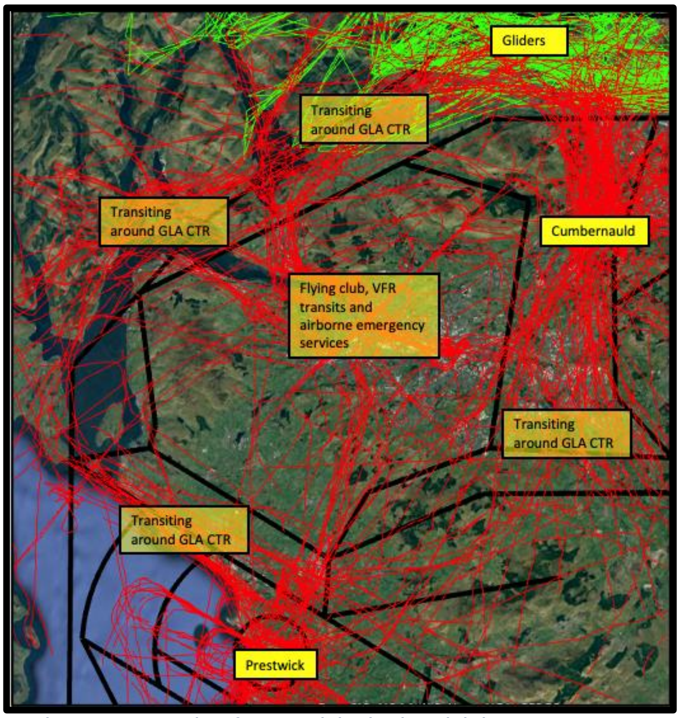

Figure 6: Sample of GA activity in the vicinity

[7] Automatic Dependent Surveillance Broadcast – a means by which aircraft can automatically transmit and/or receive data such as identification, position and additional data, as appropriate in a broadcast mode via a data link
[8] Flight Alarm – an electronic device which is used as a means of alerting pilots of small aircraft to potential collisions with other aircraft which are similarly equipped.

Figure 7 shows a Gliding activity heatmap generated by Airspace4All which helps to illustrate use of the Gliding Corridor mentioned above, supported by Figures 8 and 9 below.

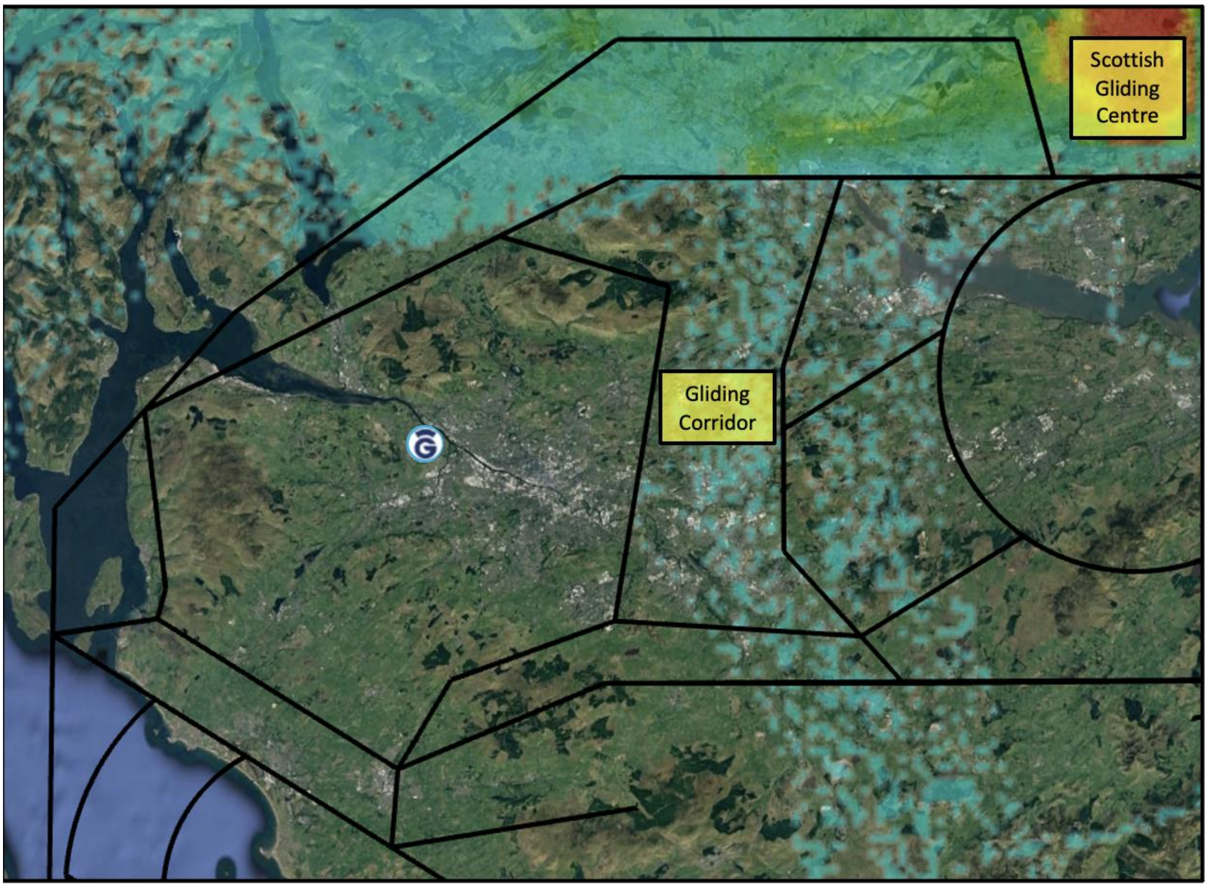

Figure 7: Gliding activity heatmap (Airspace4All Gliding Significant Areas)

In 2017, Airspace4All published a piece of work on VFR Significant Areas (VSA). The term VFR Significant Area denotes a volume of airspace which has been identified as being particularly important to VFR operations i.e. General Aviation (GA). A VSA might take the form of a route, a zone or an area chosen for its particular importance to its GA users. These areas do not have any official status but are intended to highlight the importance of a particular area so that any future airspace development plans can take due account of the GA activity.

Of relevance to Glasgow is the ‘West Central Lowlands’ and the ‘Edinburgh-Glasgow Gap’ which are illustrated in Figures 8 and 9.

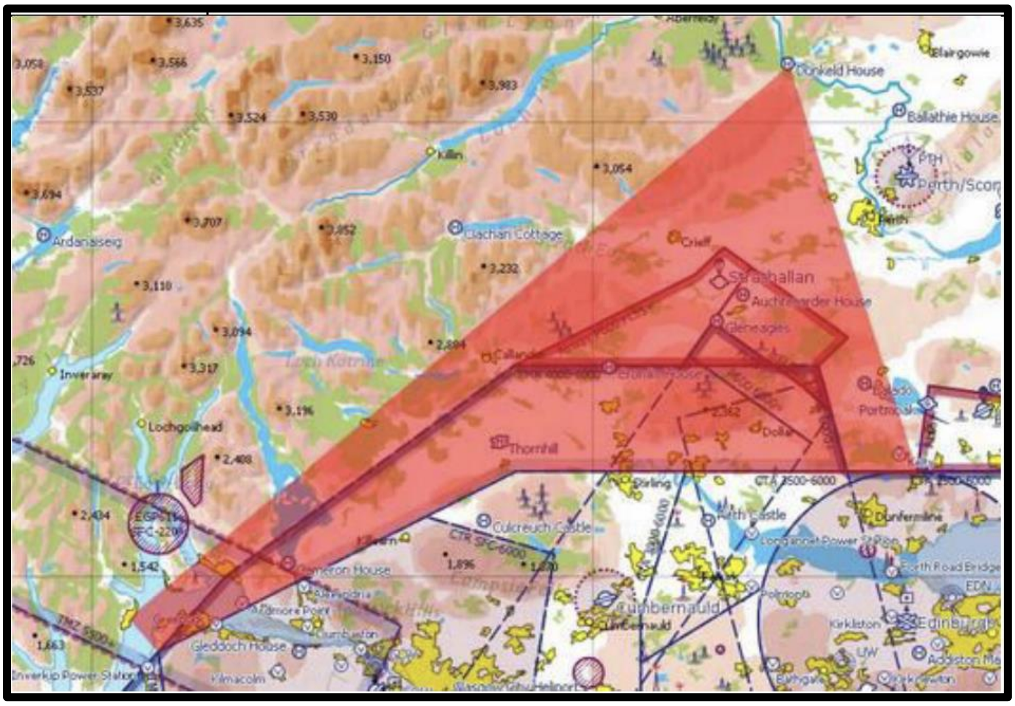

Figure 8: The West Central Lowlands area identified by Airspace4All

The West Central Lowlands area is approximately 57 nm along its northern boundary by 27 nm along the eastern side. It includes part of the Scottish TMA Class E 4,000' - 6,000' TMZ[9]; crossed by class A airways, with bases rising from FL55 to FL85. It contains two microlight airfields, a parachuting airfield, several hang gliding and paragliding sites, two balloon launching sites, grass strips and helipads. Significant high ground with wind farms in the centre of this area. East-west transit route along the highland boundary, outside Glasgow CTR[10]. Airspace4All claim that "Gliding and parachuting, in particular, would be prejudiced by any lowering of the base of airways. Northward extension of Glasgow Class D would push nonradio aircraft in the north-western transit corridor towards the high ground."

[9] Transponder Mandatory Zone
[10] Control Zone

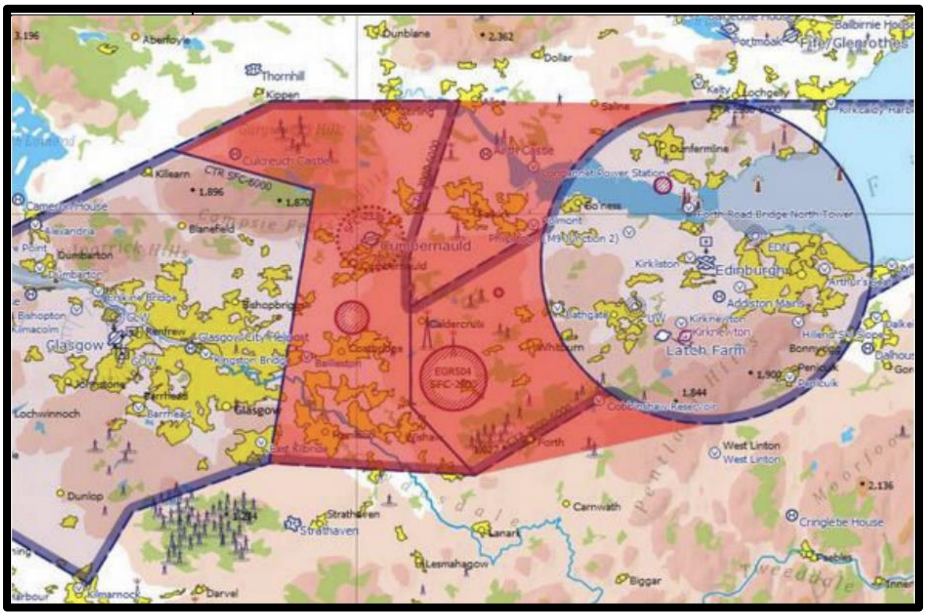

Figure 9: The Edinburgh-Glasgow Gap identified by Airspace4All

The Edinburgh-Glasgow gap is approximately 15 - 30nm north - south, 23nm west - east. Passage between Glasgow and Edinburgh Class D airspace, including their approach and departure routes. Extensive built-up areas. Masts and wind farms to 1938' amsl[11]. One airfield, one restricted area (helicopters) and two gas venting stations. High ground to north-west, hilly ground, moor, and forest, to south. North – south transits across Edinburgh airport are available. This area is used by traffic transiting north - south to/from central Scotland, southern Scotland, Northern Ireland, and England, as well as for local pilots visiting Cumbernauld and Strathaven. Airspace4All claim that “Any reduction in the 3,000' base of controlled airspace on the western side of the Edinburgh - Glasgow gap would further prejudice the ability of aircraft to land clear of the extensive built-up areas.”

CAA Airspace Classification Review Consultation

In December 2019 the CAA launched a consultation to ask respondents to identify volumes of controlled airspace, where the classification could be amended to better reflect the needs of all airspace users on an equitable basis.

The key points raised by GA stakeholders to CAA with regards controlled airspace in the vicinity of Glasgow were:

- There is only a narrow corridor of airspace between Glasgow and Prestwick airports for GA aircraft to operate in.
- Glasgow no longer needs airspace to protect a cross runway 09/27 operation
- GA consider there is currently an excessive amount of airspace for a single runway airport, and current operation.
- Access to GA hubs like Cumbernauld is difficult due to the low ceiling and areas of high terrain.

[11] Above mean sea level

- GA consider there is a lot of unused airspace in many areas of the Glasgow CTR up to 6,000ft.
- There is only a narrow low-level corridor of airspace between Glasgow and Edinburgh airports for GA aircraft who want to avoid flying over areas of water for long periods.
- High terrain on the boundary of Glasgow CTR and Scottish TMA 7 provide thermals for gliders which makes more airspace in that area valuable.
- Commercial traffic has little need for the lower airspace between Glasgow CTR and Scottish TMA 7 due to terrain clearance.
- Most of the respondents said that the GLA CTR volume needs reducing and a raise to the base of GLA CTA[12] 1

[12] Control Area

Arrivals into Glasgow

There are no defined flight paths routinely used by ATC for arriving until aircraft are established on the final approach. Arrivals into Glasgow are vectored onto final approach with the majority of arrivals routing via Glasgow's dedicated holding facility at LANAK located approximately 18 miles to the South-East of the airport

The Glasgow Approach Radar Manoeuvring Area (RMA)

To achieve an optimised delivery of aircraft onto the runway, approach controllers are given an area of airspace or Radar Manoeuvring Area, to keep aircraft under their control within.

The RMA is an Air Traffic Control (ATC) operational area articulated as a volume of airspace by the Air Navigation Service Provider (ANSP). It facilitates the close-in radar vectoring by ATC that is required to take the aircraft safely from a holding stack and established onto final approach. It provides approach controllers with the airspace necessary to perform their primary function of sequencing the aircraft into the required landing order with the distance between each aircraft which is required by the airport at any particular time.

Glasgow has Noise Abatement Requirements published in the UK Aeronautical Information Publication (AIP) which detail how far from the runway threshold ATC can position aircraft onto final approach:

For Runway 23, aircraft using the ILS (Instrument Landing System) shall not descend below 2000 FT QFE[13] before intercepting the glidepath nor thereafter fly below it unless instructed by Radar. Aircraft landing without assistance from the ILS or Radar shall follow a descent path which will not result in their being at any time lower than an approach path consistent with a 3° glidepath.

For Runway 05, jet aircraft using the ILS shall not descend below 2000 FT QFE before intercepting the glidepath. Propeller driven aircraft may, when instructed by Radar, be descended to 1600 FT QFE. Aircraft landing without the assistance of ILS or Radar shall follow a descent path which will not result in their being at any time lower than an approach path consistent with a 3° glidepath.

For visual approaches to Runways 05 or 23 the following limitations will apply: All aircraft whose MTWA[14] exceeds 5700 KG must route via 5 NM from the runway threshold and maintain 1500 FT QFE until established on final approach.

In the case of Glasgow, their RMA together with other operational procedures is an area within extant notified Controlled Airspace (CAS) and ensures that Glasgow arrivals remain safely separated from the other flows of traffic to/from Edinburgh and Prestwick Airports. Two of those operational procedures of note to future airspace design options are set out below.

[13] The pressure set on the aircraft altimeter so that it indicates the aircraft height above the reference elevation being used
[14] Maximum Take-off Weight Authorised

The Glasgow/Edinburgh Buffer

This operational procedure helps to ensure that Glasgow and Edinburgh ATC maintain separation between arrivals to Glasgow RWY23 and arrivals to Edinburgh RWY 06. The specifics of the procedure vary depending on the surveillance system in use at the time but results in Glasgow arrivals having to remain either 2nm, 3nm or 5nm from the buffer. This operational procedure will need to remain in any future operating environment.

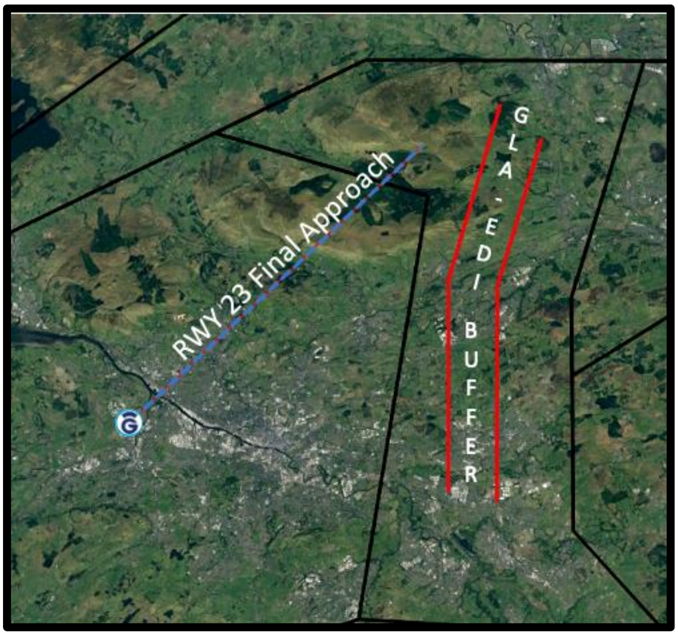

Figure 10: Glasgow – Edinburgh Buffer

The Glasgow Campsie Line

There is an escarpment on the RWY 23 Final Approach track that can trigger aircraft Ground Proximity Warning Systems (GPWS) if aircraft are below c. 3,500ft descending on a westerly heading to establish on final approach around 10nm from touchdown. To prevent false GPWS warnings there are a number of rules that ATC must adhere to in this area. It is possible that a PBN arrival in this area could help to address this issue however this, combined with the Glasgow Edinburgh Buffer may heavily restrict flexibility on route positioning onto RWY 23 final approach from the South.

Existing arrival swathes

Figure 11 and Figure 12 below show typical arrival swathes into Glasgow:

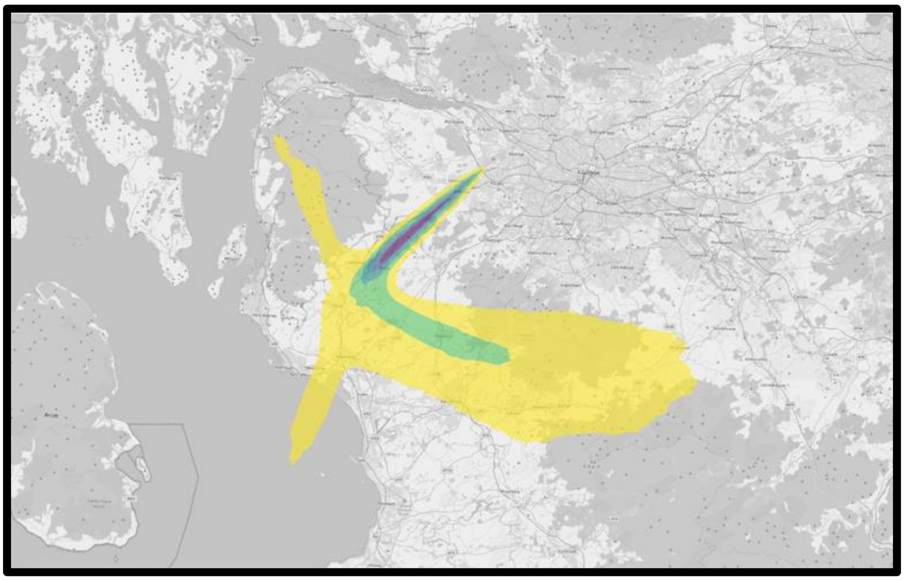

Figure 11: Runway 05 Arrivals Heat Map

Figure 12: Runway 23 Arrivals Heat Map

Departures from Glasgow

Most aircraft taking off from Glasgow are required to follow specific flight paths called Noise Abatement Procedures (NAPs), unless directed otherwise by air traffic control.

Each NAP is contained in a corridor extending 1.5 km either side of the NAP centre line and applicable departing aircraft must remain within the NAP before turning. Aircraft flying inside this corridor are considered to be flying on-track. All departing jet aircraft and all other departing aircraft of more than 5700 KG Maximum Take-off Weight Authorised (MTWA) are to adhere to the NAPs unless otherwise instructed by ATC or unless deviations are required in the interests of safety.

The NAPs are the same for each runway end and are incorporated in Glasgow's Standard Instrument Departures (SIDs) and ensure applicable aircraft climb straight ahead for 5nm before turning. The result is that the vast majority of departures fly the same area overflown by arrivals on the opposite runway end.

As all of Glasgow's SIDs climb straight ahead for 5nm, this means that the minimum departure interval between successive departing aircraft is at least 2 minutes. The result is that during peak departure times, aircraft are held on the runway and at the runway holding points, leading to increased emissions and delay.

Figure 13 and Figure 14 show the existing published SID centrelines from Runway 05 and Runway 23.

Figure 13: Runway 05 SID centrelines

Figure 14: Runway 23 SID centrelines

Aircraft not departing via the SID (less than 5700Kg MTWA) will be issued with a non-standard clearance by ATC. These aircraft are usually non-jet and therefore slower than the jet aircraft. The non-standard clearances often ensure that those aircraft turn off the extended runway centreline before 5nm. This helps to reduce the track miles flown by such departures by turning them towards their destination earlier but also helps to reduce departure delay by allowing the faster jet departures to depart behind the slower departures in a more timely manner.

Once a departure is 5nm from the runway, air traffic control can instruct it to turn onto a more direct heading to its destination and/or to position against other aircraft, which may take the aircraft away from the published SID centreline - this is called vectoring. There may be occasions where it is necessary for safety reasons (e.g. to avoid severe weather conditions) to vector aircraft off NAPs before 5nm from the end of the runway. Vectoring is a common occurrence, which is as a direct result of managing Glasgow's departures against their arrivals and other traffic flows within the airspace. For example, the Runway 05 NORBO SID turns left at 5nm but a large proportion of those departures are actually tactically vectored to turn right (south) on reaching 5nm. Figure 15 and Figure 16 below show track density plots of all of Glasgow's departing traffic across a 92-day summer period 2019. Whilst there is a clear concentration underneath the route centrelines, there is a large amount of dispersion.

Figure 15: Runway 05 departure density plots (Summer 2019)

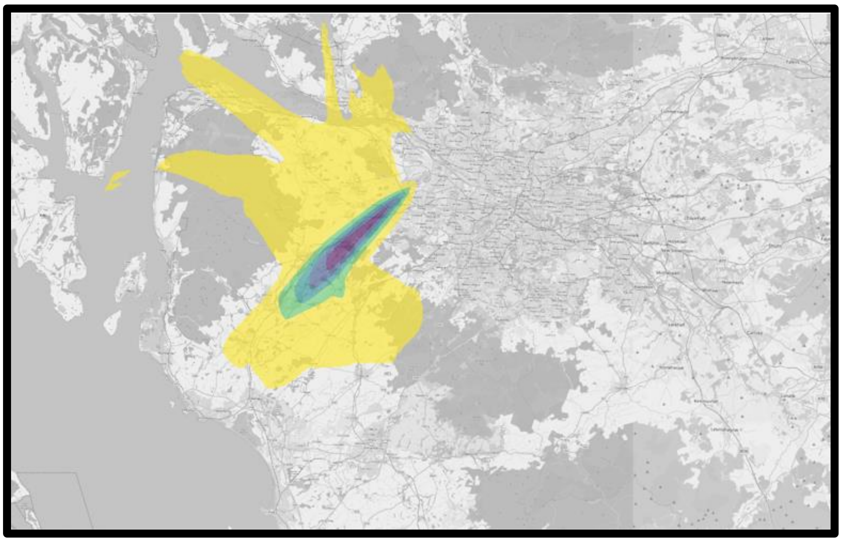

Figure 16: Runway 23 departure density plots (Summer 2019)

Departure Demand

The majority of Glasgow's departures are to destinations South of the airport. In the first rotation of the day, during summer 2019, 97% of departures were routing to the South of the airport. That demand is slightly lower for the rest of the day as it drops to 80% of Glasgow's departures routing Southbound. NORBO has the greatest demand with c.60% of all of Glasgow's departures (85% first rotation) filing this SID.

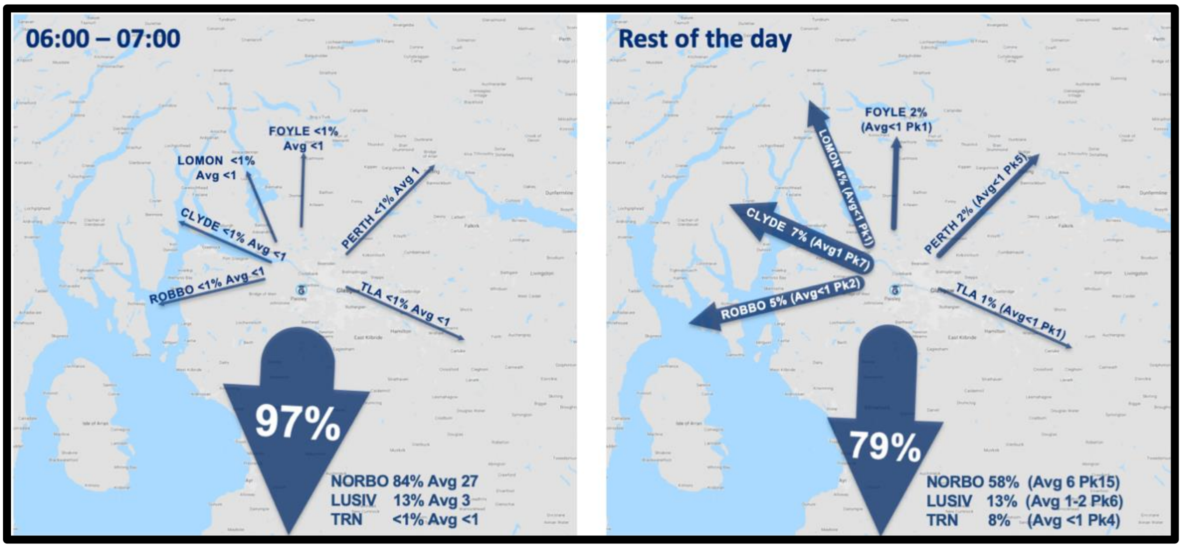

Figure 17: Glasgow departure demand 2019

An assessment was undertaken to identify the required configuration and number of SIDs that would enable Glasgow Airport's runway capacity to meet future demand. The assessment analysed a variety of new SID configurations to find solutions to meet demand with the lowest delay. This information would help us to understand the number of initial departure tracks required to meet DP2, DP4, DP12 and DP15.

The outcome of the analysis demonstrated that increasing the number of initial departure tracks decreases the delay across the day. The configuration with three initial departure tracks has delays closest to the theoretical best case and any additional initial departure tracks above this number would only marginally improve the delay. Ideally, NORBO departures distributed across 2 of those initial departure routes would result in the lowest delay. Existing departure separations and airspace design rules means that, ideally, there would be 3 initial departure tracks, each diverging from each other by at least 45˚ 'immediately' after departure[15].

This work set a firm requirement that in order to meet demand, the status quo of no turns on departure until 5nm from the runway end is not a viable option. There is no set definition for what constitutes 'immediately after departure'. RNAV1 generally requires turns no sooner than 1nm from the end of the runway but it is possible to design turns earlier than this. There are examples of SIDs from other airports which turn at distances up to c.2nm from the runway which currently enable 1 min departure separations.

This requirement to enable 1 min departure intervals combined with a dominant loading onto the NORBO SID is a feature within Glasgow's Comprehensive List of Options.

Glasgow's Existing Noise Environment[16]

There are a range of metrics which are used to describe sound and inform policy relating to aircraft.

The most common international measure of noise is the L_{Aeq}, meaning 'equivalent continuous sound level'. This is a measurement of the total sound energy over a period of time. It is easiest to think of this as an average, but important to note that all the sound energy in the time period is captured by this metric. In the UK, daytime aircraft noise is typically measured by calculating the equivalent continuous sound level in decibels (dB) over 16 hours (07:00 to 23:00) to give a single daily figure ($L_{Aeq,16h}$). Night-time aircraft noise is most typically measured over an eight-hour night period (23:00 to 07:00). The average noise exposure is commonly calculated for the 92-day summer period from 16 June to 15 September. The summer day period is used because people are more likely to have their windows open or be outdoors, and because aviation activity is generally at its most intense during the summer periods. Separate assessment for day and night recognises that daytime and night-time noise can lead to quite different effects (principally daytime annoyance and night-time sleep disturbance) and thus it is better to define and measure daytime and night-time noise separately.

Glasgow do not have any planning conditions which requires them to generate and publish noise contours on an annual basis. Generating noise contours is extremely detailed work and at this stage in the project it is not proportionate to generate such contours for a baseline (and then for every potential system combination of new design options) which would likely need to be re-done for Stages 3 and 4[17]. However, Glasgow did generate $L_{Aeq\ 16h}$ area (Day) and $L_{Aeq\ 8h}$ area (night) contours in 2017 for their *Noise Action Plan 2018-2023* which we will use here to help inform the baseline at Stage 2. These will be updated to inform the assessment of the shortlisted options against the baseline in Stage 3[18] but the

[15] In order to achieve 1 min departure separations, MATS Part 1 rules state that this can be achieved "Provided that the aircraft fly on tracks diverging by 45° or more immediately after take-off."
[16] See Glossary for definitions
[17] CAP1616 Para 146
[18] Noise modelling will be performed to CAP2091 Category C in Stage 3 onwards

existing 2017 contours are considered a suitable benchmark against which to help qualitatively appraise options in Stage 2.

The *size* of these contours are determined largely by four main factors:

- The type of aircraft using the airport
- The number of aircraft using the airport
- The frequency of use of each flight path
- The height of aircraft on those flight paths

The *shape* of these contours are directly influenced by the position of the flight paths, especially at c.3,000-4,000ft and below.

Figure 18 and Figure 19 show Glasgow's noise contours as they were in 2017. It can be seen that, as the vast majority of Glasgow's departures climb straight ahead (over the reciprocal final approach) for 5nm before turning, the noise contours are elongated along the 05/23 axis, confining most of the quantifiable noise impacts to those communities under the extended runway centreline on both ends.

As a result of the COVID-19 pandemic, we would expect the much lower volume of flights operating at Glasgow airport would have resulted in much smaller noise contours in 2020/21 than in 2017-19.

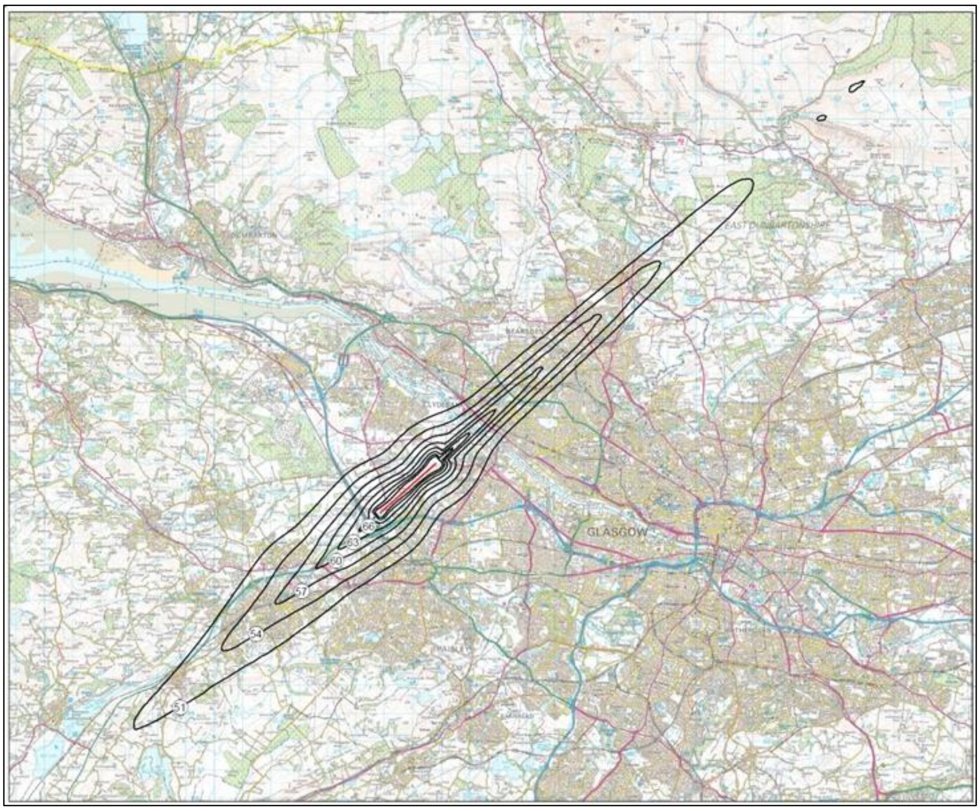

Figure 18: 2017 average summer day (78% W / 22% E) LAeq,16h noise contours

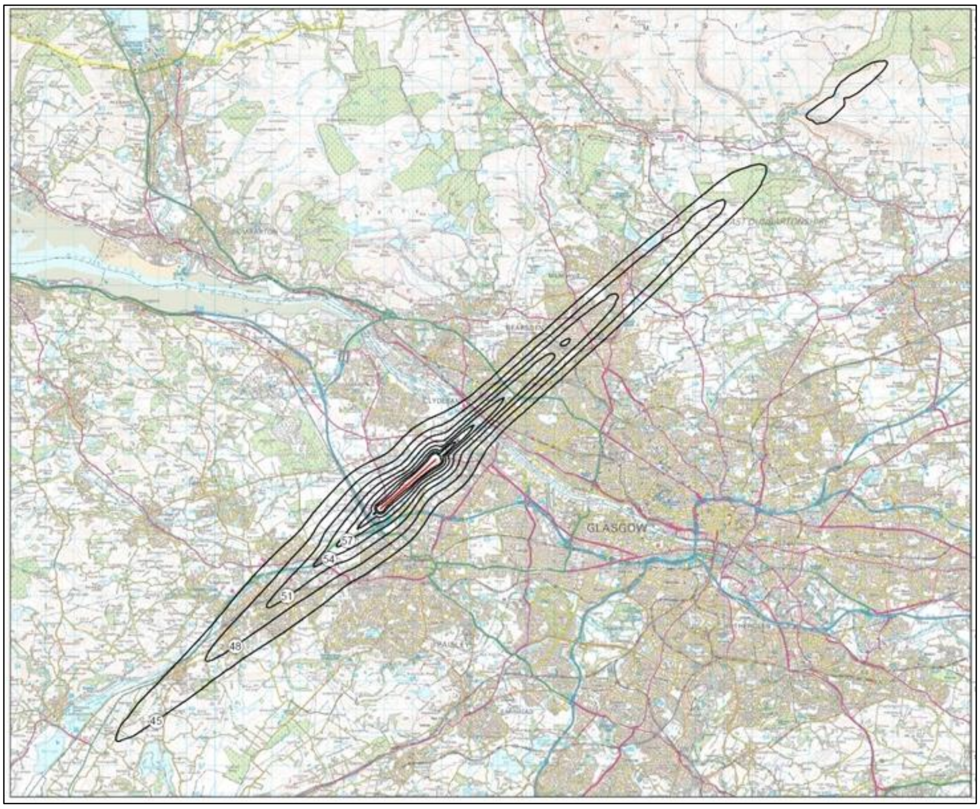

Figure 19: 2017 average summer night (78% W / 22% E) LAeq, 8h noise contours

Glasgow currently operate a home owner relocation scheme for residential properties within the 69dB LAeq,16h contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB $L_{Aeq,16h}$ contour area and residential properties within the 66dB $L_{Aeq,16h}$ contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB $L_{Aeq,16h}$ noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area.

Contour Population Counts

CAA use population density within certain contours to help inform their decision making. The population numbers are used to help determine the scale of any adverse effects from aircraft noise. Glasgow's dwelling and population counts are given for the 2017 daytime and night-time contours in Tables 3 and 4 below. Population data and household estimates are given to the nearest 100 and are based on 2011 census data updated for 2017, supplied by CACI Information Solutions.

$L_{Aeq,\,16h}$ (dBA)	AREA (km^2)	POPULATION	HOUSEHOLDS
> 51	56.6	83,200	38,900
> 54	30.0	43,500	20,500
> 57	16.2	14,500	6,750
> 60	8.7	3,100	1,500
> 63	4.7	500	250
> 66	2.5	0	0
> 69	1.4	0	0
> 72	0.9	0	0

Table 3: 2017 average summer day (78% W / 22% E) LAeq, 16h area, residential building and population counts

$L_{Aeq,\,8h}$ (dBA)	AREA (km^2)	POPULATION	HOUSEHOLDS
> 45	57.4	80,600	37,600
> 48	31.0	41,500	19,200
> 51	16.0	17,300	7,800
> 54	8.4	4,900	2,300
> 57	4.3	1,100	600
> 60	2.2	0	0
> 63	1.2	0	0
> 66	0.7	0	0

Table 4: 2017 average summer night (78% W / 22% E) LAeq, 8h area, residential building and population counts

Continuous Climb/Continuous Descent Performance

There are a number of factors that can influence Continuous Descent and Continuous Climb performance to/from an airport. These can be operational restrictions, interactions with other traffic flows to/from the same airport or another airport and also Controlled Airspace restrictions.

The proximity of Edinburgh airport's traffic flows generates some interactions and dependencies with Glasgow's traffic flows. The main dependency has been covered in the Glasgow/Edinburgh Buffer section above. The other interaction involves Edinburgh's Westbound departure from Runway 24 known as the GOSAM departure. The vast majority of the time these Edinburgh departures will climb above Glasgow traffic but it can inhibit Continuous Climb on Glasgow's departures as ATC have to 'step up' underneath.

Glasgow's performance for continuous descent performance is measured between 6,000ft and 1,800ft. Between April 2020 and March 2022, 70% of arrivals performed a Continuous Descent on approach to Glasgow.

Glasgow's performance for continuous climb performance is measured between the runway and FL100. Even though Glasgow's SIDs climb procedurally to only 6,000ft, between April 2020 and March 2022, 93% of departures climbed continuously on departure to at least FL100. This is achieved by ATC routinely clearing departures above 6000ft before they level off.

Options Development and Stakeholder Engagement

This section describes the stakeholder engagement conducted by GLA for Step 2A of the ACP process and aims to:

- Provide evidence that engagement with stakeholders has created a good understanding of the options development process, including the need for the options to be aligned with the Design Principles in a fair and consistent manner.
- Demonstrate how the stakeholder engagement conducted by GLA and the feedback received has helped to influence the options development process.

Following the announcement in March of 2021 from The DfT and CAA of short-term financial support for the next phase of the FASI programme, GLA restarted its ACP in May 2021. The following month, in June 2021, we contacted our stakeholders to inform them that the ACP was restarting and that stakeholder engagement for Stage 2 would begin later that year.

Stakeholder qualification

During Stage 1, Glasgow Airport undertook a stakeholder mapping exercise to identify stakeholders that are affected by current airport operations and those that could be affected by any changes associated with the ACP.

Given the broad scope of communities currently/potentially affected by any future ACP GLA adopted the following approach to stakeholder selection in Stage 1:

- Involving representatives of communities currently affected by the flightpaths
- Involving representatives of communities that could be affected by future flight paths
- Proactively engaging the representatives of any relevant seldom heard/hard to reach groups, including equalities groups
- Targeting interested parties and/or those with a willingness to engage through future phases as per CAP1616 guidance
- Qualifying participants to ensure we have the right representative

All stakeholders that were identified during Stage 1 as affected by current operations or as potentially affected by future changes, were carried forward into our Stage 2 stakeholder database.

Due to the fact that the ACP process was paused because of COVID-19, some stakeholders from Stage 1 changed for a variety of reasons (retirement, redundancy, leaving post etc.). As such, before inviting stakeholders to participate in an engagement process for Stage 2, Glasgow Airport carried out another qualification exercise to confirm and/or update stakeholder data inherited from Stage 1, which included:

- A desktop update of the stakeholder database where new contact information was publicly available (e.g. newly elected MPs/MSPs).

- Issued two emails to all Stage 1 stakeholders asking them to confirm that they remained the relevant contact or, alternatively, confirm a replacement contact.
- Endeavoured to establish a replacement contact within an organisation if required (e.g. where stakeholders asked to be removed from our database or if previous contacts were generating failed delivery notices).
- Mapped qualified stakeholders against our stakeholder categories (as outlined in Appendix C of CAP1616 for Stage 1B engagement and the CAA's engagement plan template), to ensure all stakeholder categories had active contacts that could participate in engagement.

Regardless of whether Stage 1 stakeholders had confirmed if they were the appropriate contact, all Stage 1 stakeholders were retained in our Stage 2 database and received all correspondence throughout the Stage 2 process.

The only stakeholders that were removed from engagement and from our database were those that requested to be removed or those contacts that were consistently generating failed delivery notices. In the latter case, we endeavoured to establish an alternative contact for the organisation.

Moreover, while it is not anticipated by the CAA that key impacted audiences will be identified at Stage 2A, it became apparent during the options development process that the geographical area that could potentially be affected by future changes was larger than previously anticipated. No new local authority areas were affected, but 22 new community councils were invited to participated in Stage 2 engagement as a result of this evaluation.

In line with CAP1616, Glasgow intends to bring stakeholders on the ACP journey. Using the methods and approach to stakeholder identification and qualification outlined above, Glasgow was able to ensure that every effort was made to involve as many Stage 1 stakeholders as possible in Stage 2, and re-engage them ahead of future stages.

Overview of our approach to engagement

Methodology

Our approach to engaging stakeholders is based on the Inform, Listen and Adapt model:

- *Inform* stakeholders of the background, drivers, issues and opportunities associated with the ACP and the factors that influence options development as outlined in the Design Principles.
- *Listen* to the feedback from stakeholders about the options development process and if it has been guided by the Design Principles.
- *Adapt* the Comprehensive List of Design Options if stakeholder feedback indicates that this is necessary.

CAP1616 makes it clear that the CAA is not seeking detailed discussion on the plusses and minuses of individual design options at Step 2A. Rather, it is looking for sponsors to test their hypotheses with stakeholders, with a view to ensuring the design principles have been met as far as possible.

As such, it was important that we delivered an engagement process that mitigated against the potential for detailed commentary on individual options, and instead promoted reflection on the approach to options development. To achieve this we held ‘briefing sessions’ offering appropriate time for feedback and Q&A, as opposed to a workshop style session.

Maximising participation

We hosted five briefing sessions in total. The first two sessions were specific to airline and general aviation stakeholders, and the final three were open to all stakeholders.

We decided to hold separate airline and general aviation briefing sessions in advance, in order to provide a forum for these stakeholder groups to raise questions that are of particular interest/relevance to their community. This allowed for more equal participation during the all-stakeholder briefing sessions that followed.

All the briefing sessions were hosted online, due to the fact that, at the time of organising, a number of public health restrictions remained in place to prevent the spread of COVID-19 and there was continued uncertainty about when these would be lifted/if they would be increased. To inform this decision we also issued a survey to our stakeholders, which asked the following questions:

1. Are you able and willing to take part in online events about Glasgow Airport's ACP?
2. Is there any assistance or support you would need to be able to take part in online events?

In total, 44 stakeholders responded to the survey and all respondents indicated that they were able and willing to take part in online events. Glasgow Airport also requested that stakeholders contact the ACP engagement team via email or a free information phone line if they could not participate online, so that we could make alternative arrangements. No such requests were received, although one stakeholder was provided with IT support to join the online briefing session.

Stakeholders could sign up to attend a briefing sessions through Glasgow’s dedicated ACP website, or by emailing or phoning the ACP engagement team. We aimed to maximise participation in the briefing sessions using the following measures:

- Issued an initial invite via email to all stakeholders four weeks in advance of the first session.
- Issued a reminder to register via email to all stakeholders two weeks in advance of the first session.
- Followed up by telephone contact with all qualified stakeholders (stakeholders for whom we had confirmed contact information).
- Mapped registrants against our stakeholder categories, and continued follow up telephone contact with organisations of any stakeholder categories that were under-represented.

The full list of invitees to the briefing sessions can be found in Appendix B. The attendees at each briefing session are outlined in Tables 5-9.

Association of Remotely Piloted Aircraft Systems	Glasgow Flying Club
Babcock Helicopters	Lanarkshire and Lothian Soaring Club
British Parachute Association	Light Aircraft Association
Cloudbusters Paragliding	Loch Lomond Seaplanes
Cumbernauld Airport	Strathaven Airfield
Edinburgh Airport	

Table 5: Attendees at GA Briefing Session

Air Canada	Guild of Air Traffic Control Officers
British Airways	Jet2
British International Freight Association	Loganair
easyJet	NATS

Table 6: Attendees at Airline/ATC Briefing Session

British Helicopter Association	Milngavie Community Council
Drymen Community Council	NATS
Emirates	NatureScot
Glasgow Airport Consultative Committee	Thornhill and Blairdrummond Community Council
Light Aircraft Association	Tui
Loganair	Visit Scotland
Mains Estate Residents' Association	

Table 7: Attendees at Briefing Session #1

Agrekko	Light Aircraft Association
Babcock	NATS
Balquhidder, Lochearnhead and Strathyre Community Council	PDG Helicopters
Bearsden East Community Council	Prestwick Airport
Beith and District Community Council	Renfrewshire Council
easyJet	Scottish Passenger Agents Association
Edinburgh Airport	South Lanarkshire Council
Falkirk Council	Unite
Inverclyde Community Council	University of West Scotland

Table 8: Attendees at Briefing Session #2

Air Canada	General Aviation Alliance
Bearsden East Community Council	Glasgow City Council

Bearsden West Community Council	Loch Lomond Sea Planes
Clydebank East Community Council	North Ayrshire Council
Cumbernauld Airfield	West Dunbartonshire Council
East Dunbartonshire Council	West Dunbartonshire Council Community and Voluntary Service
Environmental Protection Scotland	

Table 9: Attendees at Briefing Session #3

Engagement with MPs and MSPs

We hosted five briefing sessions in total. The first two sessions were specific to airline and general aviation stakeholders, and the final three were open to all stakeholders.

We took the decision to engage with MPs and MSPs on a separate one-to-one basis, as we did in Stage 1. This was to account for the fact that these stakeholders represent multiple communities, possibly with conflicting interests. In total, GLA representatives met with four local parliamentarians:

- Margaret Ferrier MP (Ind, Rutherglen and Hamilton)
- Tom Arthur MSP (SNP, Renfrewshire South)
- Natalie Don MSP (SNP, Renfrewshire North and West)

Stage 2A briefing sessions and stakeholder feedback

Overview of briefing sessions

During the briefing sessions, stakeholders were given a presentation on the background to Glasgow's ACP to date, our approach to options development and presented the options themselves. Due to the volume of options, we did not discuss each option in detail but talked through several examples. Stakeholders were informed that the full list of options will be supplied to them after the workshop. They were also informed about the next steps in the process, including how to provide feedback on whether our initial Comprehensive List of Design Options is aligned with the Design Principles.

Airline and general aviation stakeholders were given a similar presentation, which was also inclusive of information on the initial Illustrative Controlled Airspace Volume[19]. While this information was not presented during the all-stakeholder briefing sessions, stakeholders were informed that the information was available to view on the website and all five sessions used the same format and running order.

Participants had opportunities to ask questions throughout the presentation, as well as at the end of the presentation. Questions could either be typed in a Q&A box or asked verbally. All responses were provided verbally to ensure a full answer to individual questions, and stakeholders were encouraged to follow up over email or telephone if they required more information.

[19] See Section on Controlled Airspace for more information

The presentation slides can be found in Appendix F. Table 10 outlines the questions asked relating to the options and Glasgow's responses to those questions.

Question	Answer
You are basing this on forecast demand however work patterns are changing and other ways of working are now the norm which could leave to great reduction in short haul or business travel. Has this been reflected in your forecasts?	Yes, our forecasts do not assume that we return to domestic and business travel as it was pre pandemic. For example, Flybe traffic made up a significant proportion of overall traffic at Glasgow and this is not expected to be backfilled like for like and will reflect this based on best assumptions available to us and the trends of the travelling domestic and business passenger.
How have you balanced the effect of noise versus the environmental effect of increased emissions? There is a clear trade-off between the two. Noise-preferred routings are (almost) always longer than optimum minimum track mile routes.	The balance is assessed through the creation and subsequent evaluation of multiple options and through stakeholder feedback. This enables us to evaluate the pros of cons of noise re-distribution versus environmental and operational performance. We are also guided by DfTs Altitude Based Priorities.
Having a limited number of FIR entry/exit points bottlenecks, particularly where inbounds and outbounds are in conflict. This is very inefficient in terms of track miles and altitudes flown. What liaison is there with NATS to widen the spread of entry/exit points?	We are actively engaging with NATS on their network design options however significant changes to flows of traffic at the FIR boundaries is unlikely.
Given that property values are affected by noise, do you take into account effects of different noise distribution on future prices?	Noise distribution is taken into account and high-level noise analysis will be done on all the options. Once these options are narrowed down to a short-list, more detailed noise analysis will take place. The effects (positive and negative) of noise distribution are informed by guidance from the CAA and UK Government. The aim of the consultation is to share the final proposed option(s) and request feedback from stakeholders to try and find a balance between those effects.
The departures and arrivals at this stage have been based on standard rates of climb and descent. Have variable climb gradients or	We had to pick one rate of climb to illustrate potential overflight altitudes and we chose 7% which from data analysis suggested that this was a common climb rate of the 'lower

steeper approaches been considered or will be at a later date? How accurate are the indicative altitudes marked on the options?	performers' which makes the illustrations slightly pessimistic to assume all departures would climb at that rate. In the Appraisals, we will assess more typical climb performance and the IOA will begin to give a more realistic overflight cones. The arrivals are illustrated at 3˚ which is a much more typical/standard approach angle. We will consider a slightly steeper RNP Approach in Stage 3 however the ILS will remain at 3˚ due to international standards.
At what stage in the design appraisal do you consider the ground surface level?	All overflight and noise analysis in the the Full Options Appraisal (Stage 3) is required to take into account height above ground level.
You seem to have a couple of options where you've increased track miles. How do you justify this to the airlines who are looking at cost and CO2 emissions? If you start increasing track miles you're going to have a lot of unhappy customers. A few extra miles on an arrival from Dubai which is a seven-and-a-half-hour flight, requires us to carry that extra fuel, which has another fuel burn implication in itself.	It's not possible to reduce miles on every arrival and departure route as there are interdependencies between them/ Our options have therefore targeted reduction of miles on the most frequent departure routes. The arrival routes were generated by determining lowest population and noise sensitive areas alone, hence many of them increase miles. Some of those increases are potentially disproportionate (see DfT Altitude based priorities, ANG2017 3.3) and this could be determined in the evaluations. However, these routes will be refined in Stage 3 to minimise any increases. However as presented on Slide 36 vectoring of arrivals is still being considered which often cater for more direct routings than PBN to ILS can allow.
For the design Principles are each weighted and if so how is this determined?	During Stage 1 stakeholders were asked if DPs should be prioritised. Responses were considered polarised and therefore not sufficiently representative to determine a definitive prioritisation of the principles other than DP1 and DP15 regarding safety and airspace modernisation, the latter being mandated by CAA.
Your slides show approximate track mile increases/decreases. Which routes are being referenced to compare the track mileages?	For departures we are comparing against the track miles of the published SIDs. For departures we compared against the most

	common arrival path from the North and South to each runway.
Is there changes to CAS planned as well as new PBN routes?	Yes, changes to CAS are being considered as part of the scope.
Are RNP approaches being considered as part of the current scope?	Yes RNP Approaches are within scope.
Has there been consideration of Local Development Plans for each Local Authority area which identifies designated land areas for future uses e.g. housing? This may change the local landscape and could introduce new receptors/increase population densities under proposed flight paths.	Yes. CAP1616 requires our Initial, Full and Final Options Appraisals to have regard to Local Development Plans.
Given the overall length of the flight the $C0_2$ saving by turning earlier is surely minimal but may have greater noise impact on communities newly overflown. How will you address this? If you change departure routes to turn within 2nm (instead of 5nm) from the end of the runway, you're going to be increasing noise levels in those areas. So it sounds that shorter mileage for those departures is going to make more folk miserable with noise, than if you were going out to five?	All our options result in more frequent overflight of areas less overflown today. We are aiming to mitigate this through assessment of options which move SIDs and different times of day or by 'splitting' the main departure flow (NORBO) across 2 different SIDs to reduce the frequency of overflight (although this results in more people overflown overall). Respite options could also offer some noise benefits.
Is further environmental analysis going to be done at a later stage in quite a detailed form so we can see the benefits/impacts of how the proposed routes?	Yes the Initial Options Appraisal in Stage 2 will start to generate metrics on benefits and impacts and this information will be used to whittle down options into a shortlist to take into Stage 3. Stage 3 will see much more detailed appraisals including monetisation of some of the impacts and benefits.

Table 10: Questions asked and answers provided during Step 2A briefing sessions

Whilst none of these comments, influenced changes or additions to the options, the questions did inform our understanding of areas of concern stakeholders have with certain options.

Generating further feedback

GLA wanted to ensure that all stakeholders had an opportunity to provide feedback on its options development process, regardless of whether or not they had attended one of the briefing sessions. We achieved this by making all the relevant information (presentation slides, Design Principles and the full List of Comprehensive Design Options) and a recording of one of the briefing sessions available to view on GLA's dedicated ACP website. This enabled stakeholders to submit informed feedback even if they did not attend a live briefing session.

All stakeholders in our database received an email after the briefing sessions had taken place, asking them to submit feedback via an online feedback form. We also offered to post hardcopies of the feedback form if required and, in the case of one individual, we provided the feedback form in Word format. Some stakeholders provided feedback via email, which was formally recorded alongside the online feedback form responses.

To ensure that we heard from as many stakeholders as possible, we used the following methods to maximise the response rate:

- Issued an email to all stakeholders explaining how they can provide feedback (including non-attendees).
- Issued a reminder email to all stakeholders asking them to provide feedback (including non-attendees).
- Provision of briefing session materials and recording on a dedicated Glasgow ACP website.
- A dedicated Glasgow ACP email address and freephone information line to encourage and coordinate correspondence.
- Bilateral engagement between the sponsor and individual stakeholders where this was requested.
- Extended the feedback window from four weeks to six weeks to account for decreased engagement over the festive period.
- Reopened the feedback window for two weeks to allow for further feedback on the initial Illustrative Controlled Airspace Volume[20].

After the feedback period closed, we issued correspondence to all stakeholders (including those who did not attend the briefing sessions) to outline what outputs would be shared with them and the next steps in the ACP process.

Stakeholder engagement log

Table 11 sets out the chronology of the engagement activities conducted to develop our design principles. A full engagement log that records all forms of engagement with our stakeholders during the course of the engagement is provided in Appendix B, with copies of all of the correspondence in Appendix C.

Engagement activity	Date
ACP restart	May 2021
Email issued advising of restart and asking Stage 1 stakeholders to confirm or nominate a point of contact	15th July 2021

[20] See Section on Controlled Airspace for more information

Email issued to MPs and MSPs advising of restart and intention to engage stakeholders	15th July 2021
Invites to Stage 2 airline and general aviation briefing sessions issued to airline and general aviation stakeholders	26th August 2021
General aviation briefing session	9th September 2021
Airline briefing session	15th September 2021
Invite to Stage 2 briefing sessions issued to all stakeholders	28th October 2021
Correspondence with stakeholders (telephone and email) to encourage registration	October-November 2021
Pre-reading materials sent to all stakeholders registered to attend Stage 2 briefing sessions	22nd November 2021
Briefing session #1	25th November 2021
Follow up email sent to stakeholders who attended briefing session #1	26th November 2021
Briefing session #2	1st December 2021
Follow up email sent to stakeholders who attended briefing session #2	1st December 2021
Briefing session #3	2nd December 2021
Follow up email sent to stakeholders who attended briefing session #3	2nd December 2021
Email issued to all stakeholders (including those who did not attend the briefing sessions) providing briefing session materials and inviting feedback	9th December 2021
Email issued to all stakeholders reminding them to submit feedback	5th January 2022
Initial feedback deadline	10th January 2022
Email issued to all stakeholders to inform them of extended feedback deadline	11th January 2022
Second feedback deadline	24th January 2022
Email issued to all stakeholders inviting more feedback on Initial Illustrative Controlled Airspace Volume	4th February 2022
Deadline for feedback on Initial Illustrative Controlled Airspace	18th February 2022
Email issued to all stakeholders informing them of next steps	22nd February 2022

Table 11: Chronology of engagement activities

In total, 39 organisations provided feedback on GLA's approach to options development. All the responses from stakeholders are provided in Appendix D.

The following sections summarise the feedback received and provides responses to that feedback.

Community, Tourism and Local Government Stakeholder Feedback

Glasgow Airport received written feedback from community stakeholders. Full copies of all the feedback received is at Appendix D.

Stakeholder	Summary of Feedback	Glasgow Response
West Dunbartonshire Council	There needs to be much more detail on how the improvement of route options will support a net zero future.	The Stage 2A slides provided a very high level amount of information on track mile differential between various options. More analysis and detail on CO_2 emissions will come at later stages of the CAP1616 process beginning with the Initial options Appraisal. More rigorous assessments will be completed on Glasgow's shortlisted options in Stage 3 of the CAP1616 process
Bearsden East Community Council	Offset Departures and Variation of Track were not mentioned in the discussions leading up to the formation of the design principles. These new items have the potential to defeat DP 7 and must be discussed to eliminate this possibility DP 6 & DP 13 are at risk from all the 05 departure examples which have earlier turns than today which will increase noise pollution below 7000ft. Flightpath design must be more considerate when new flightpaths are planned which introduce new or more noise pollution. Requested maps for all 05 departures which show the ground detail and details of buildings under proposed	Offset departures and track variations are design elements which are used to develop designs in accordance with design principles. They are specifically included to address DP2, DP4, DP5, DP6, DP8 and DP12. As explained during the development of the Design principles, it is common for Design Principles to contradict each other. For example this stakeholder quite rightly points out that DP6 (*…avoid…areas that are not currently affected by aircraft noise*) is not possible if we are to also meet Design Principles to reduce CO2 emissions, enhance capacity, avoid communities under both final approach and immediate climb out and provide noise dispersion We fully agree that changes to flight paths will result in both noise increases for some areas and noise reductions for others and

	flightpaths as well as the scale and height above ground when turns take place. Requested a 'Status Quo' option for Runway 05 departures to avoid overflying new areas at low altitude.	the purpose of having many different options is to help understand the pros and cons of different options. We can confirm that the current day baseline for 05 departures is included as an option. While information on potential route options is presented to stakeholders at Stage 2, it is during Stage 3 that detailed descriptions of preferred options will become available. During this phase, detailed analysis work of environmental impacts and benefits/disbenefits for each option (including the baseline option) will be produced. A range of detailed maps and metrics, including height over ground and noise levels, will be available to help stakeholders provide informed responses to the public consultation. A key element of the Stage 3 public consultation is that it takes place when proposals are at a formative stage, so that feedback from the consultees can potentially impact the final proposal. However, in response to this feedback and together with feedback received by other stakeholders we generated two new options (RWY 05 Departure Option H and I) which do not feature turns to the south earlier than today. These are in addition to Options B and D which also do not feature turns to the south before 5nm.
Environmental Protection Scotland	There are many uncertainties around the recovery of air transport given the current state of the pandemic and it is difficult to agree with the prediction that it	Our forecasts suggest that traffic will return to pre-pandemic levels around the time of implementation of the ACP. The new airspace design will be in effect for many years after implementation hence the designs must be fit for 2030-2040

	will return to 2019 levels by 2024/25. Need to take into account plans for major new housing developments new communities that may arise as part of the Scottish Government's plans to build 100,000 more homes in Scotland by 2040.	traffic levels which are expected to be significantly in excess of 2019 levels. CAP1616 requires us to consider all relevant noise-sensitive areas and population centres both in existence and within the planning system. Review of the planning system applications has taken place and will continue throughout the design process.
Mains Estate Residents' Association (MERA) and Milngavie Community Council	The design process must consider the safety impacts in areas of higher terrain, and areas likely to attract birds. Glasgow therefore must consider height above ground and therefore departure routes must not be moved over higher terrain in populated areas (e.g. the Mains Estate and Milngavie) Should avoid moving departure routes closer to sites likely to attract birds. Suggested Glasgow consider safety margins around opencast mineral workings/quarries in relation to explosions and highlighted the Douglasmuir Quarry Highlighted that the Mains Estate, including the adjacent Mains Plantation, are designated as a historic Garden and Designed Landscape in the East Dunbartonshire Local Development Plan (LDP, 2017) and would expect this protected landscape to be recorded in the Glasgow airspace redesign	The evaluation of options in terms of overflight metrics as well as noise impacts do have to take into account height above ground *"Terrain adjustments must be included in the calculation process (i.e. the height of the aircraft relative to the ground is accounted for)".* Note that terrain will not yet be taken into account in the quantitative modelling for the IOA but it will be included in Stage 3. Reference Birds, the UK AIP says "… offshore islands, headlands, cliffs, inland waters and shallow estuaries attract flocks of birds for breeding, roosting and feeding at various times of the year. Within 20 NM or so of such locations concentrations of birds flying mostly below 1500 FT may be encountered. In order to lessen the risk of bird strikes, pilots of low flying aircraft should, whenever possible, avoid flying at less than 1500 FT above surface level over areas where birds are likely to concentrate. Where it is necessary to fly lower than this, pilots should bear in mind that the risk of a bird strike increases with speed (it is a fact that birds rarely hit an object moving slower than 80 knots). Apart from endangering aircraft by flying close to bird colonies, the breeding of the birds may be upset, and the practice

	process and included in the Noise Sensitive Areas. Highlighted Douglas Academy National Music School as a noise sensitive building as well as lying within the designated historic garden and designed landscape of the Mains Estate.	should be avoided on conservation grounds." The AIP lists Bird Sanctuaries to be avoided but none are in the vicinity of Glasgow Airport. Although ENR 6-79 does highlight a Bird Concentration Area along the River Clyde and Firth of Clyde. However, none of our options would overfly these waters any more or less than today below 1500ft. Reference Douglasmuir Quarry, any activities considered a hazard to aviation activity are listed in the UK AIP ENR 5 Navigation Warnings and this quarry is not listed there and Glasgow ATC are not aware of any restrictions of overflight. Aircraft below 5700Kg MTWA that are not restricted to the NAP routinely fly over this quarry on departure from Runway 05. The Mains Estate Plantation is not currently listed in Historic Scotland's Inventory of Gardens and Designated Landscapes so it was not within our Noise Sensitive Receptor database although the nearby Milngavie Reservoirs are. We confirm that Douglas Academy is already in our database of noise sensitive buildings and has been taken into account in the assessment of overflight. New Options RWY 05 Departure Option H and I have been generated. Option H would reduce overflight of Douglas Academy and Option I would not position any SID centrelines over the Academy.
Bearsden West Community Council and Canniesburn Place Proprietors' Association	Concerns over forecast increase in flights, designs that enable reduced departure intervals and that this will not facilitate reductions in emissions. How will the flight numbers breakdown	The ACP is striving to provide the most efficient and environmentally friendly operational system which provides sufficient capacity to satisfy the forecast demand for Glasgow Airport.

	between night and day? Desires more detailed noise modelling but also with more evidence rather than computer modelling. Concerns that earlier turns will mean more noise at low altitude. Emphasis should be placed on utilising Prestwick airport more.	The best way for an airspace design to reduce CO2 emissions is to reduce the distance aircraft need to fly and the time spent holding in the air or on the ground. For Glasgow, to achieve this requires a turn or turns on departure earlier than today which inevitably means a redistribution of noise. Preliminary noise data will emerge in the Initial Options Appraisal with more detailed metrics, including noise contours and flight forecasts to follow in Stage 3 or the shortlisted options.

Table 12: Summary of Stage 2A Community feedback

Industry Stakeholder Feedback

Glasgow Airport received written feedback from 16 industry stakeholders. Full copies of all the feedback received is in Appendix D.

Stakeholder	Summary of Feedback	Glasgow Response
Lanarkshire & Lothian Soaring Club	(Based on illustrative CAS volume) The illustrative changes would represent a considerable improvement. It will enable flying to take place on the Inverclyde hills at Greenock and also allow continued flying at Fairlie without the need for a Letter of Agreement. It will also allow extra altitude at several well used flying sites in the Fintry hills. The increased altitude now available east of Glasgow opens up possibilities for much longer possibly record breaking North South cross country flights which have been almost impossible with the existing arrangements.	Feedback taken on board and we will try to achieve this in the refined CAS volume to accompany the shortlisted design(s).

Stakeholder	Summary of Feedback	Glasgow Response
Emirates Airline	Desires to see more detail on the actual CDO/CCO achieved from the new designs.	Full details will become available in Stage 3 in the Cumulative and Net impact assessment work performed jointly by NATS, Glasgow and Edinburgh.
Light Aircraft Association (LAA)	Reducing controlled airspace volume will reduce infringements and wants to see more focus on reducing the volume of CAS. Existing Glasgow CAS volume is too large and would like to see even less CAS than in the illustrative CAS volume. An inverted wedding cake shaped controlled airspace would seem to become more feasible.	As explained, the illustrative CAS volume was generated for discussion only and is an illustrative volume to contain every single arrival and departure option in accordance with the buffers required by the CAA's Controlled Airspace Containment Policy. It also assumes a 7% climb gradient and that all SIDs would continue to 7000ft and be wholly contained within. Of course 7000ft does not exist with a 6000ft Transition Altitude and it is highly likely northbound SIDs will terminate at 6000ft or lower before leaving CAS. All feedback received from GA is being considered and will be taken on board in determining an actual CAS proposal in Stage 3 to accompany Glasgow's preferred Option(s). This includes suggestions such as a 2500ft step in the CTR and considerations of R/T coverage to the north. We will also need to consider ATC feedback and airspace boundary complexity. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. Therefore, we can say that all options offer potential to reduce the existing total volume.
British Gliding Association (BGA)	The illustrative CAS volume is unacceptably large and fails any test of reasonableness in relation to existing airspace given advances in technology and aircraft performance.	Concerns noted, see LAA response above

Stakeholder	Summary of Feedback	Glasgow Response
	Enacting such airspace designs would result in the creation of volumes of CAS which demonstrably has not been used by Commercial Air Traffic. Environmental factors should dictate a reduction in the need for CAS, not an increase	
easyJet	The current proposals aren't ambitious enough to fully meet DP2 / DP12 where the overall ambitions should strive for these significant sustainability gains particularly post COP26. The majority of route options shown, increase the track mileage flown compared to current published procedures, especially arrivals. RWY 05 NORBO departures should turn south, not north and should route direct to the South, not towards NORBO. Safety concern over SIDs that change at different times of day and aircraft flying the wrong SID.	The majority of departure options are shorter than what is published today however the arrivals are either similar or longer than today's most common vectored path. It will not be possible for NORBO departures to be procedurally routed more direct to the South where they are often tactically vectored today as the route needs to be safely separated from the arrivals. Routing direct south would take them into direct confliction with arrivals. We understand this would be more favourable from a fuel uplift perspective (relying on tactical intervention when necessary) but the result is a fail-dangerous, not fail-safe environment. Airspace design has to assume there is always traffic on conflicting routes – hence arrivals are always there at the same time as departures. We have options that turn both North and South with NORBO departures, the trade off being early turns on Southbound departures would fly over the most populated area, therefore Southbound NORBO traffic would need to turn in the same vicinity as today. However, routing north with an earlier turn is shorter than turning south at 5nm. The IOA will start to unearth the pros and cons of all these options including the prospect of both North and South NORBO departures by either splitting the flows permanently or switching the flows at a time of day. Safety

Stakeholder	Summary of Feedback	Glasgow Response
		concerns are noted which we are aware of and are working through with NATS to understand if SID switching with significantly differing paths is a viable option.
Cumbernauld Aerodrome	Illustrative CAS volume too large. CAS boundary should be no closer to Cumbernauld to help enable our proposed RNP Missed Approach. Please mark Cumbernauld on your maps.	See LAA response above. However the illustrative CAS volume would reduce the volume of CAS significantly around Cumbernauld although this has to be balanced against ATC ability to deliver CDA with stepped bases. Cumbernauld has been marked onto maps.
British Helicopter Association	Keep CAS to a minimum	See LAA response above.
General Aviation Alliance, BGA, LAA, Gliding Scotland joint email	We appreciate the quality of the presentation and the openness of its delivery however the illustrative CAS volume is too large. Fewer routes combined with steeper gradients should reduce the CAS requirement. Referred us to a piece of work done by NATS in 2013 on the EDI/GLA gap suggested they identified an opportunity to increase the width and height of the EDI/GLA gap to 10nm and 5000ft. Consider Radio and Radar coverage to the North. We do understand that the result we have seen are preliminary and we confirm our willingness to work with you to	Concerns noted, see LAA response above Reference the 2013 work mentioned, an ACP in 2009 reclassified Glasgow's airspace to Class D. Subsequently they modified the airspace in 2011 by raising some of the bases to 3500ft. We've spoken to NATS and they are not aware of any suggestion that widening the airspace to 10nm and up to 5000ft between Glasgow and Edinburgh was possible. We look forward to working together in Stage 3.

Stakeholder	Summary of Feedback	Glasgow Response
	get a solution which is efficient and works for all parties	
DAATM	Pointed out to use the Illustrative CAS volume was not available on the website	Illustrative CAS volume had been moved in admin error and added back on the website with an extension given to feedback period. No further subsequent feedback received from DAATM.
Universities of Glasgow and Strathclyde Air Squadron	Concern over any increase of CAS to the North. GA traffic operating above 3500ft for stalling, spinning, aerobatics or to avoid cloud layers will be forced further north or west where the terrain in the event of a forced landing is less hospitable than in the Drymen Valley	Concerns noted, see LAA response above.
Airspace4All	CAS, especially CTR needs to be smaller. References Gatwick CTR as a more appropriate size.	Concerns noted, see LAA response above.
Glasgow ATC	Raised significant concerns with those options with SID configurations that change at certain times of day and are fundamentally different. For example, turn left at one time of day and then turn right another, particularly when the turns happen very soon after departure. They identified hazards which would leave very little reaction time for controllers to recover the situation should an aircraft fly an incorrect version of a SID. They suggested SIDs that vary but follow the same general structure are less likely to have significant hazards associated with them. For example – follow	Concerns noted regarding Safety hazards and this will be documented within the IOA. Suggestions over SID configurations that don't meet demand throughout the day noted and will be considered in the evaluations and appraisals. New Options RWY 05 Departure Option H and I have been generated.

Stakeholder	Summary of Feedback	Glasgow Response
	the same general direction but are offset from their counterpart SID by a distance. Concerns with SID configurations that only cater for demand during first rotation only and felt that an optimal SID configuration should service demand in a safe way, H24, whilst sharing flights for the busiest departure routes over different communities. They proposed a different version of RWY 05 Option G where ROBBO/CLYDE departures are not penalised.	
Glasgow Prestwick Airport	Interactions with our arrival and departure routes will need to be considered. We do not want to have to changes any of our CAS boundaries as a result of the GLA ACP. We want to see the complete CAS picture and hope that the future design still enables ATCOs to tactically co-ordinate aircraft through each other's airspace, for example RWY12 arrivals to Prestwick and RWY 05 arrivals to Glasgow. The volume of CAS needs to be sufficient to contain the published routes but also the tactical practices that ATC use to deliver efficiencies. Recommend that SIDs off each runway end have the same SID	At this stage we have not identified any interdependencies with Glasgow Prestwick's IFP but this will be re-assessed once the shortlisted options are matured early in Stage 3. As will the CAS arrangements to support the final proposed IFPs as well as the tactical operation. We fully appreciate that changes to EGPK's CAS arrangements are to be avoided. Thank you for the recommendation regarding SID termination points, we will work with NERL to achieve this if at all possible in all circumstances.

Stakeholder	Summary of Feedback	Glasgow Response
	termination point where possible to reduce flight planning and airway connectivity issues.	
Aberdeen Airport	There appears to be no interdependencies or impact on Aberdeen Airport below 7000ft	Noted

Table 13: Summary of Stage 2A Industry feedback

Interdependent ACP sponsor feedback

Glasgow Airport received written feedback from NATS and Edinburgh Airport. Full copies of all the feedback received is in Appendix D.

Stakeholder	Summary of Feedback	Glasgow Response
Edinburgh Airport	No comments on any options but look forward to continued engagement.	N/A
NERL	Gave helpful feedback on each option which can be summarised as: All arrival options as presented should be compatible with the NERL Network Questioning the need for LUSIV and TLA SIDs in the future given low demand and if jet/non-jet SIDs are required. Further work required by all parties on ability for SIDs to switch at a time of day however if they are viable and progressed, they will need to terminate at the same point regardless of direction. Would much prefer a permanent SID arrangement and the proposed L/R split of NORBO traffic into 2 flows seems most favourable as it shares the noise, enables 1 min splits and can be accommodated in the future network. A new route over Firth of Forth could be used by some Glasgow departures which may increase use of PERTH SIDs	We're pleased to hear that all options appear to be compatible and we acknowledge the potential difficulties and hazards with SID switches. Firth of Forth route would be very beneficial to Glasgow as it would reduce demand slightly on NORBO, help to reduce frequency of overflight for those under NORBO (DP5/DP6) and enable reduced emissions (DP2/DP4/12). LUSIV/TLA and jet/non-jet variables are being considered by ATC. We confirmed with NATS that our options remain very flexible and advised that route centrelines are still likely to move as options are refined throughout the ACP. Refinement will be on the basis of integration with the wider airspace network below and above 7,000ft, reacting to ongoing stakeholder engagement, increasing environmental and operational performance and in accordance with more detailed IFP design and validation in Stages 3 and 4. This refinement could potentially include merging some elements of different options into a final design solution if that is considered to provide greater benefit to Glasgow Airport, their stakeholders and/or the wider FASI programme.

Stakeholder	Summary of Feedback	Glasgow Response
	Requested confirmation that Glasgow options are flexible and not concrete at this stage.	

Table 14: Summary of Stage 2A NERL and EDI feedback

In addition to the engagement above, we have also taken part in a number of technical working groups and bilateral workshops with ACOG, NERL, NATS Glasgow, Aberdeen and Edinburgh Airports. Technical working groups and Programme co-ordination meetings allow sponsors within the STMA regional cluster to discuss timelines, risks, deployment strategies, Masterplan integration as well as CAP1616 interpretations and different methodologies to meet CAP1616 requirements. The bilateral workshops were focussed on sharing their ACP design options (where available) to understand the level of interactions and dependencies that exist. In the case of Glasgow, so far adjacent designs have not driven a change to designs being considered.

Response to Stakeholder Feedback

Our options development process, specifically its alignment with the Design Principles, was thoroughly tested through engagement with and feedback from a wide range of stakeholders that are potentially affected by the airspace change. The briefing sessions that we organised brought together a mix of representatives from different backgrounds and with different interests. All the sessions were attended by airport staff, technical specialists, and third-party facilitators to ensure that our engagement was effective.

We would like to thank all stakeholders that gave their time to consider the issues and opportunities associated with the airspace change and share their views on the options development process. We feel that the engagement has allowed us to thoroughly test our approach to options development to ensure it is aligned with the Design Principles.

We understand that there will never be unanimous agreement on all the airspace design options. We also acknowledge that some of the principles do come into conflict with one another and difficult trade-offs need to be made. We feel we have been transparent about these conflicts, which in turn has supported our stakeholders to give substantive feedback that will be used to inform trade-off decisions.

As can be seen above, two pieces of feedback were received to request amendment to options or to create additional options. There was an email from Bearsden East Community Council requesting that we should have an option for Runway 05 departures which ‘maintains the status quo’. We explained that this was already addressed by our Do Nothing Option however we already have RWY 05 Options B and D which don’t feature SIDs turning right (i.e. over Bearsden) earlier than today. There was also a suggestion by Glasgow ATC for another RWY 05 SID configuration that would be less penal to ROBBO/CLYDE departures to improve CO_2 benefits and address some safety concerns on other options. Both of these pieces of feedback resulted in RWY 05 Departure Option H and I.

Many comments were received on the trade-offs between operational and environmental efficiencies versus creating ‘new’ noise. We explained that all changes to flight paths, especially below 4000ft will inevitably change the distribution of noise and in the case of Glasgow's departures, the only way to deliver such operational and environmental efficiencies is to change some SIDs before 5nm from the runway end. We feel that we have a sufficiently wide range of options that help us to evaluate various ways of mitigating those new impacts through either minimising numbers affected by the change, splitting the NORBO departures across 2 SIDs (instead of 1) or turning SIDs on/off. Stakeholder concerns regarding this will be used to help inform the IOA and help Glasgow to determine a shortlist of options to take into Stage 3.

Many of the comments on the Illustrative CAS volume were with regards to an opposition to any increase of CAS to the north. As can be seen in the LAA response, we are hopeful that an increase to the north can be minimised/negated. There have been several useful suggestions on how to reduce the volume of CAS which will be taken on board in Stage 3. Please see section on Controlled Airspace for more information.

Glasgow's Comprehensive List of Options is set out in the next section. The route centrelines used for the illustration of the options will inform the DPE and IOA. However, those route centrelines are still likely to move as options are refined throughout the ACP. Refinement will be on the basis of integration with the wider airspace network below and above 7,000ft, reacting to ongoing stakeholder engagement, increasing environmental and operational performance and in accordance with more detailed IFP design and validation in Stages 3 and 4. This refinement could potentially include merging some elements of different options into a final design solution if that is considered to provide greater benefit to Glasgow Airport, their stakeholders and/or the wider FASI programme.

Glasgow’s Airspace Design Options at Stage 2A

This section sets out Glasgow’s Comprehensive List of Options at Stage 2A of the Airspace Change Process. Each option has a description of what it is trying to achieve and, for the purposes of enabling stakeholder engagement so far and allowing for analysis in the Initial Options Appraisal, provisional route centrelines. However, those route centrelines are likely to move as options are refined throughout the project. Refinement will be on the basis of integration with the wider airspace network below and above 7,000ft, reacting to stakeholder engagement, increasing environmental and operational performance and in accordance with more detailed IFP design and validation in Stages 3 and 4. This refinement could potentially include merging some elements of different options into a final design solution if that is considered to provide greater benefit to Glasgow Airport, their stakeholders and/or the wider FASI programme.

As described in the Stakeholder engagement section, Glasgow has as series of different options broken down into the following categories:

- Runway 05 Departure Options
- Runway 23 Departure Options
- Runway 05 Arrival Options
- Runway 23 Arrival Options

For a description of the methodology used to develop these options please refer to Slides 10-28 of our Stage 2A engagement slides in Appendix F. As described in the Departure Demand section above, the requirement to enable 1 min departure intervals combined with the dominance of the southbound demand plays a key feature in all of Glasgow’s options.

The requirement for turns ‘immediately after departure’ means areas that are overflown less frequently today will become more frequently overflown. The demand on the NORBO route also means that that optimising that departure flow has the potential to deliver the most CO_2 reductions. At the same time, the demand on that departure flow means that those communities overflown by that route will be the most frequently overflown (by departures) and combined with the early turns also has potential to be dominate any adverse impacts. These considerations are a feature in many of our departure options through a combination of, where possible:

- Separating NORBO departures over 2 SIDs which reduces frequency of overflight of communities whilst also enabling reduced departure intervals (DP2, DP4, DP5, DP6, DP12, DP15)
- Designing solutions which prioritise track mile reductions on NORBO departures (DP2, DP4, DP12, DP15)
- Positioning NORBO departures over areas of lowest population (DP5)
- Positioning NORBO departures over areas already routinely overflown (DP7)

Other prominent design features include consideration of 'track adjustments' on departures. These allow departures to bank very slightly to the left or right on departure earlier than a 'turn' is allowed in RNAV1 PANS OPS criteria which means certain departures might be able to avoid those communities that are currently affected by aircraft noise on final approach or in the vicinity of the immediate climb out where overflight is unavoidable (DP8). The maximum track adjustment allowed is 15˚ and any option with this feature has the maximum angle permitted in the illustration and subsequent analysis.

The UK CAA has an additional IFP Design requirement over and above PANS OPS to ensure an aircraft doesn't turn at all (even a track adjustment) before the end of the runway. This has a downstream impact on the route construction after the track adjustment, which could make them technically challenging to design and fly for some routes. In addition, very careful consideration needs to be given to the potential change in populations that would experience changes in noise at very low altitude. Therefore, we have options with and without this track adjustment feature. There are no track adjustments to the right of track on any RWY 05 departures owing to the obvious density of population in this area, whereas to the left of RWY 05 climb out and to either side of RWY 23 departures, population variances are much more subtle.

Finally, we had an assumption that 'immediately after departure' meant that turns no later than 2nm from the Declared End of Runway (DER).

Runway 05 Departures Do Nothing

This option represents the do-nothing scenario for Glasgow's RWY 05 SIDs. More detail on the baseline is described in the section above.

Figure 20 below shows the swathes (red) of a week of departures from Glasgow's Easterly runway. The routine vectoring away from the existing SID centrelines (green) can be seen on all routes once aircraft are at least 5nm from the runway, however there is concentration around the centrelines. The tracks turning before 5nm are aircraft that don't currently have to adhere to the NAPs.

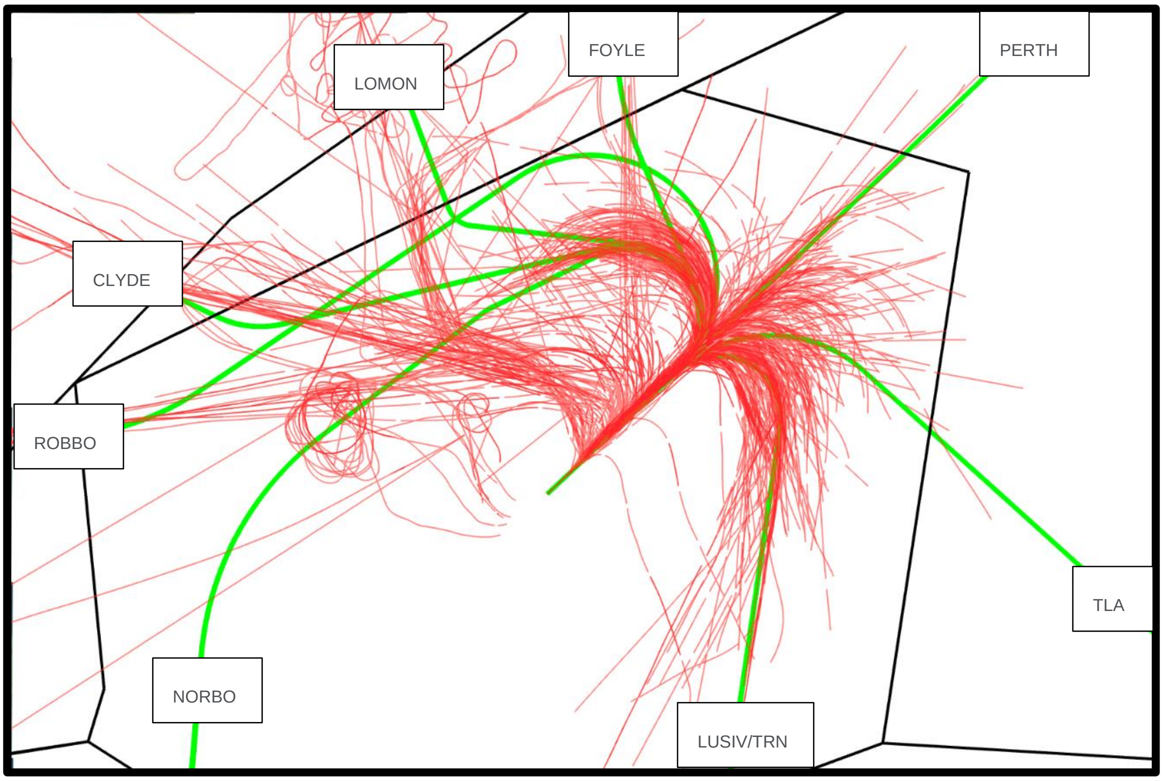

Figure 20: Existing departure swathes (red) and published centrelines (green) from Glasgow's Easterly runway

The NORBO SID centreline turns left at 5nm although ATC often tactically vector these departures to the South if the traffic conditions permit.

Runway 05 Departures Option A

This option would see the busiest NORBO SID turning left 'immediately' after take-off preceded by a 15˚ track adjustment to the left. The PERTH/FOYLE/LOMON/CLYDE/ROBBO departures are grouped together and also have a 15˚ track adjustment to the left.

The right turn LUSIV/TLA departures turn at c.3nm to enable CO_2 benefits whilst aiming to avoid the core Glasgow City Centre populations.

Owing to the prioritisation of the NORBO departure, the ROBBO/CLYDE/LOMON departures are forced to route much further East before commencing their turn back towards the network entry points. Route spacing criteria for 2 x 180˚ RNAV1 wrap arounds has not been published by the CAA so the exact spacing against the NORBO departures is not yet known. This illustration currently has a spacing of c.6nm between the routes centrelines.

Figure 21 below illustrates Runway 05 Departure Option A and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

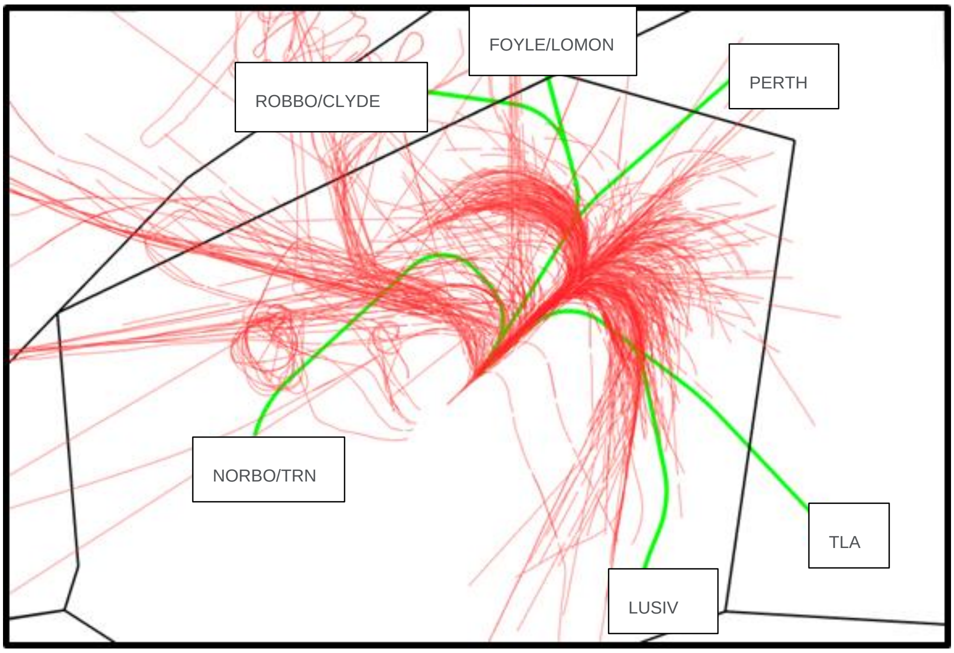

Figure 21: Existing departure swathes (red) and RWY 05 Departure Option A illustrative centrelines (green)

Runway 05 Departures Option B

This option is exactly the same as Option A except that the right turn LUSIV/TLA departures turn right at 5nm to remain in line with existing traffic patterns. This is due to a consideration that traffic demand on these routes may be lower than today in the future and therefore the level of CO_2 benefits available may be negligible versus the impacts of overflying new communities. The LUSIV/TLA routes in this option are also expected to overfly fewer people than in Option A.

Figure 22 below illustrates Runway 05 Departure Option B and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

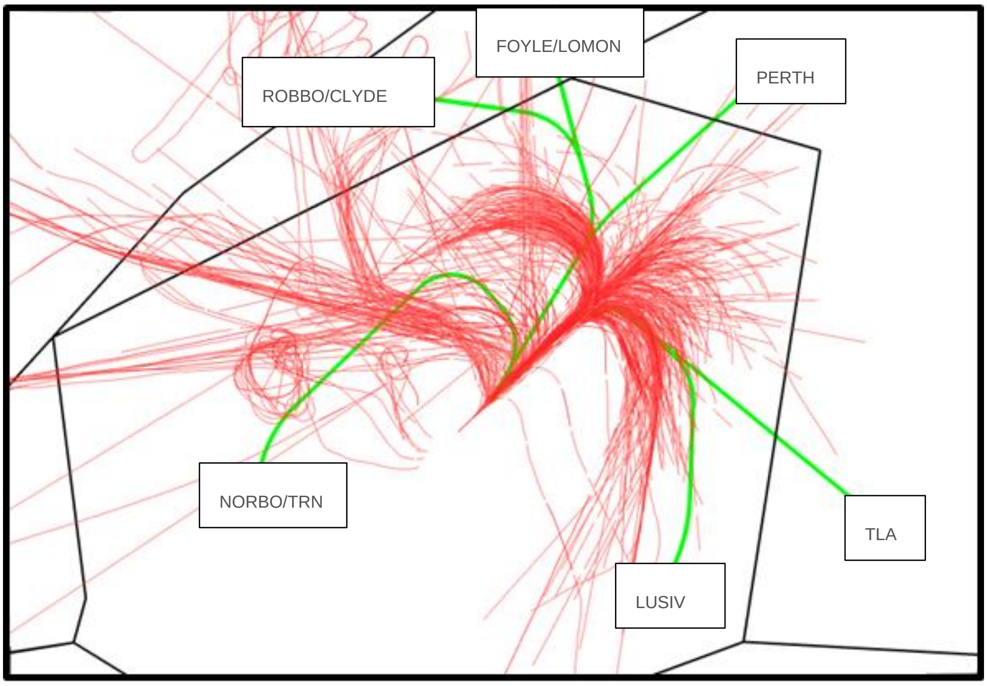

Figure 22: Existing departure swathes (red) and RWY 05 Departure Option B illustrative centrelines (green)

Runway 05 Departures Option C

This option is the same as Option A except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180˚ turn for the NORBO departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE/LOMON/CLYDE/ROBBO would also not feature a track adjustment.

Figure 23 below illustrates Runway 05 Departure Option C and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

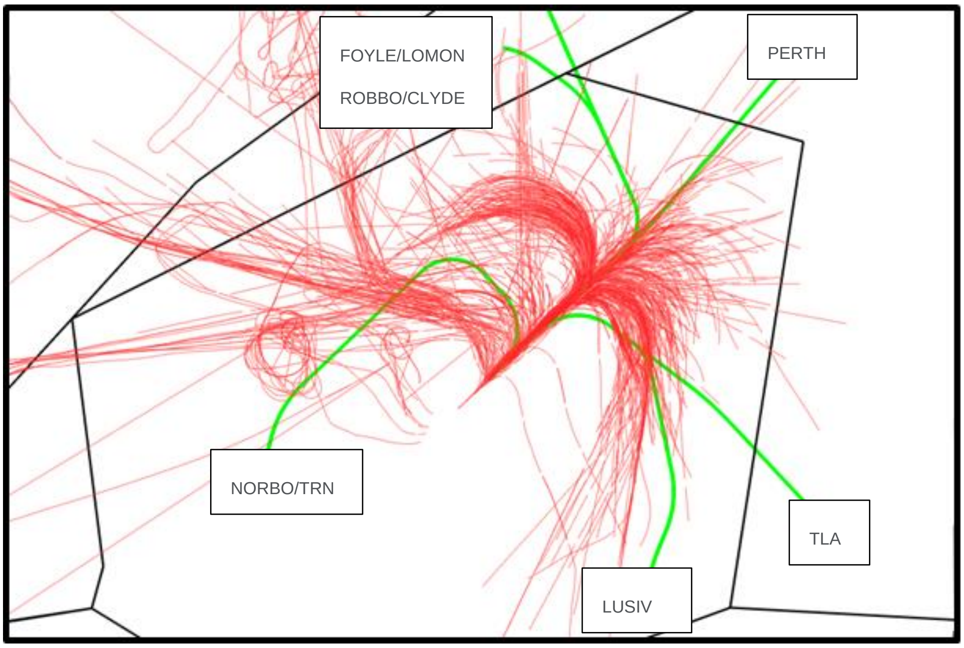

Figure 23: Existing departure swathes (red) and RWY 05 Departure Option C illustrative centrelines (green)

Runway 05 Departures Option D

This option is the same as Option B except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180˚ turn for the NORBO departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE/LOMON/CLYDE/ROBBO would also not feature a track adjustment.

Figure 24 below illustrates Runway 05 Departure Option D and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

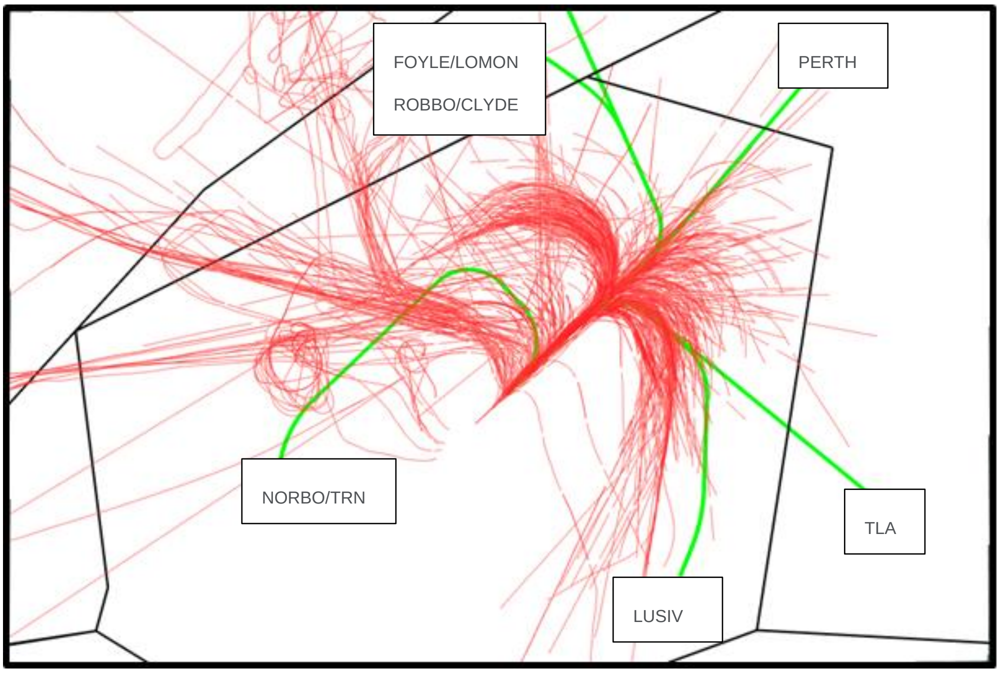

Figure 24: Existing departure swathes (red) and RWY 05 Departure Option D illustrative centrelines (green)

Runway 05 Departures Option E

This option would see PERTH/FOYLE/LOMON/CLYDE/ROBBO departures being prioritised with the earlier left turn, preceded by a track adjustment to the left. This means that the FOYLE/LOMON/CLYDE/ROBBO flights would experience shorter track milage and although a PBN SID would concentrate tracks in this area, that area would experience similar volumes and departures and types of aircraft that they currently experience.

The busiest NORBO route would turn right earlier than 5nm to enable CO_2 reductions. A turn initiation of c.2-3nm would enable to area of Glasgow City centre with the most dense population to be avoided. As a result of this, the LUSIV and TLA SIDs are forced to route much further East before commencing there turn back towards the network entry points. Route spacing criteria for 1 x 180˚ RNAV1 wrap around against a diverging but turning track has not been published by the CAA so the exact spacing against the NORBO departures is not yet known. This illustration currently has a spacing of c.4-5nm between the route centrelines.

Figure 25 below illustrates Runway 05 Departure Option E and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

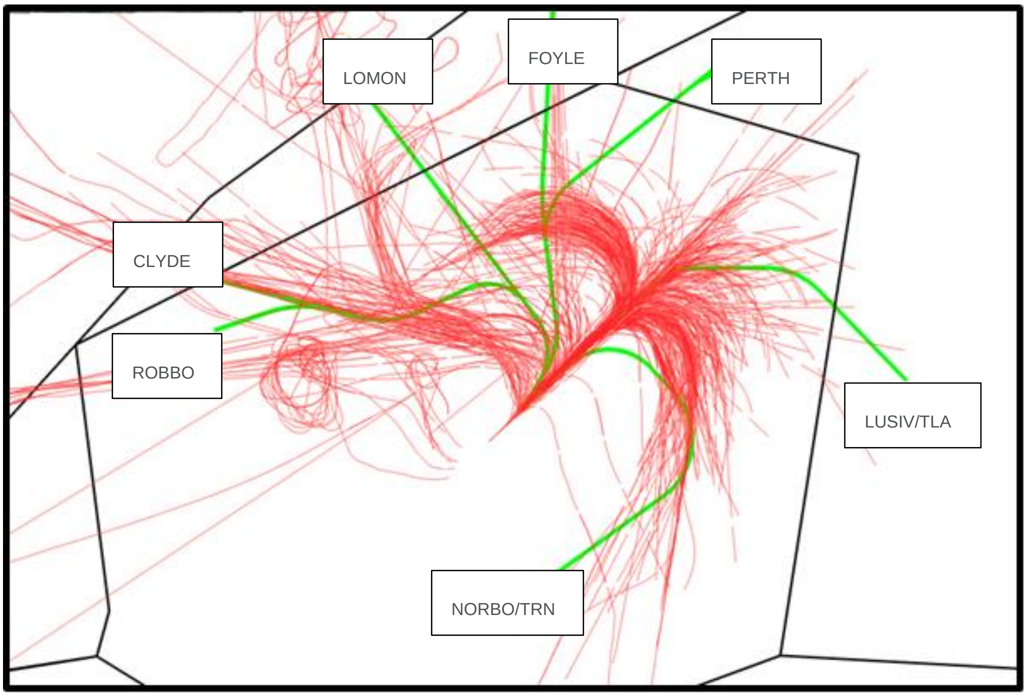

Figure 25: Existing departure swathes (red) and RWY 05 Departure Option E illustrative centrelines (green)

Runway 05 Departures Option F

This option has been designed to enable the busiest NORBO departure route to switch from a left turn (with track adjustment) to a right turn to provide predictable respite to communities under both SID tracks. In both of these scenarios, the NORBO SID would overfly new communities and therefore the provision of predictable respite is seen as a mitigating factor.

To minimise the amount of change required to the SID configuration by the ‘switch’ (in an attempt to reduce operational impact and safety risk), the remaining SID tracks would remain the same, noting the lower demand on those routes. However, as a result the FOYLE/LOMON/CLYDE/ROBBO/LUSIV/TLA flights would all experience increases in track miles compared to today. The Period 1 SID configuration would enable reduced departure intervals between NORBO departures and the other SIDs however the Period 2 SID configuration may not achieve this as a turn at c.2-3nm may not be classified as an immediate turn. However, avoidance of the most densely populated part of Glasgow city centre was considered to take priority in terms of DfT’s Altitude Based Priorities in this scenario.

Figure 27 (Period 2) below illustrates Runway 05 Departure Option F and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow’s Easterly runway. Actual centrelines are likely to change throughout the process.

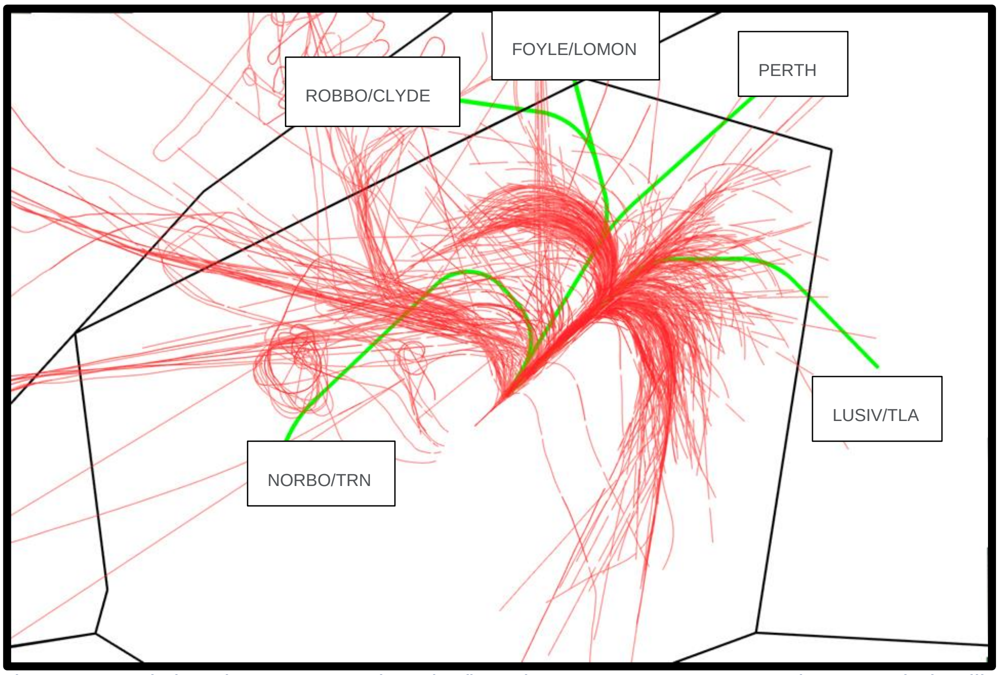

Figure 26: Existing departure swathes (red) and RWY 05 Departure Option F Period 1 illustrative centrelines (green)

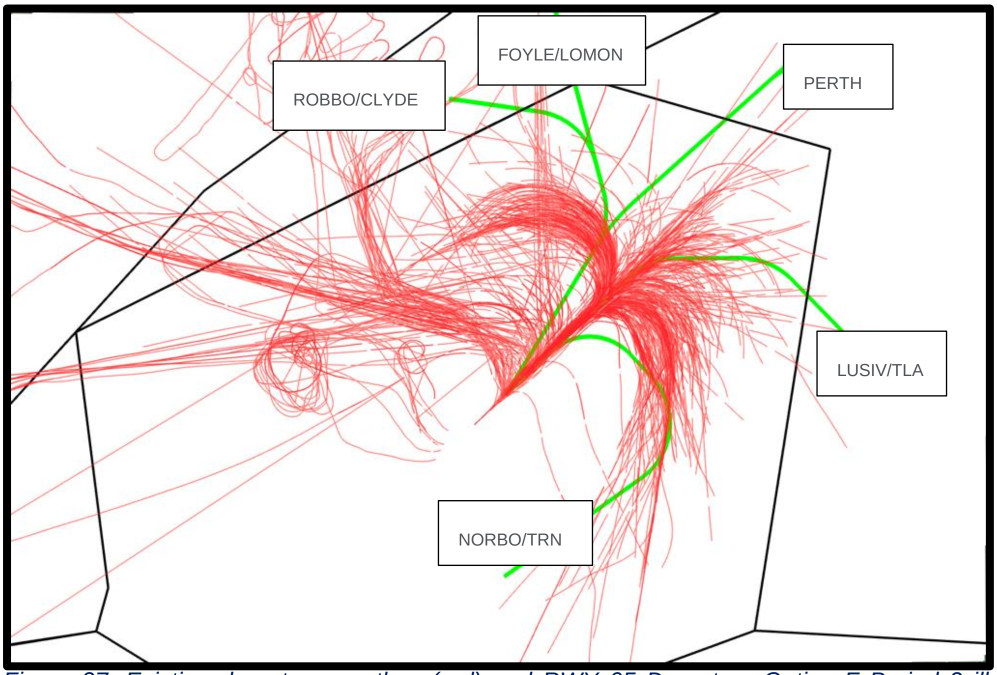

Figure 27: Existing departure swathes (red) and RWY 05 Departure Option F Period 2 illustrative centrelines (green)

Runway 05 Departures Option G

This option is the most technically challenging option and would see 2 very different SID configurations operating at different times of day with one configuration (Period 1) for a ‘peak departure period’ and another for periods of lower demand (Period 2).

The option attempts to have an optimal departure throughput configuration for Period 1 which shares the NORBO departures across 2 different SIDs with track adjustments for the left-hand flow. The sharing of the NORBO flow across 2 different SIDs would not only enable reduced departure delay but also reduce frequency of overflights for communities under those tracks.

The Period 1 configuration would penalise ROBBO/CLYDE/LOMON departures with a longer track length than today. The right turn NORBO flow in this period would not turn until 5nm to minimise number so people newly overflown.

The Period 2 configuration would then benefit ROBBO/CLYDE/LOMON departures but then places all NORBO departures back into a single track. For this single NORBO track we have illustrated a different SID track to either of the Period 1 NORBO tracks, to provide predictable respite to some communities as well as enabling some CO_2 reductions but noting this would then result in more newly overflown communities.

Figure 28 (Period 1) and Figure 29 (Period 2) below illustrates Runway 05 Departure Option G and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow’s Easterly runway. Actual centrelines are likely to change throughout the process.

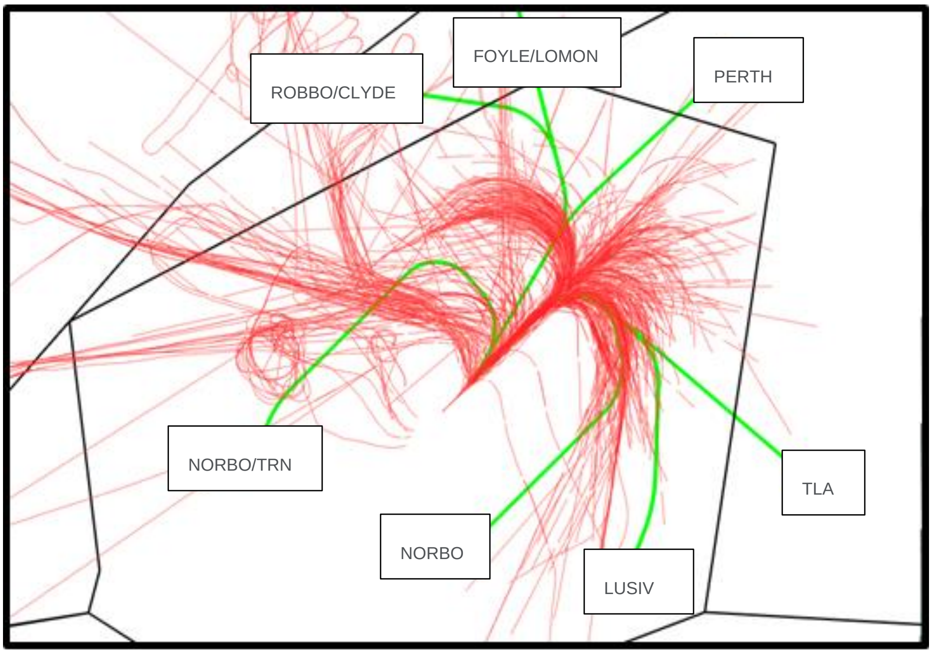

Figure 28: Existing departure swathes (red) and RWY 05 Departure Option G Period 1 illustrative centrelines (green)

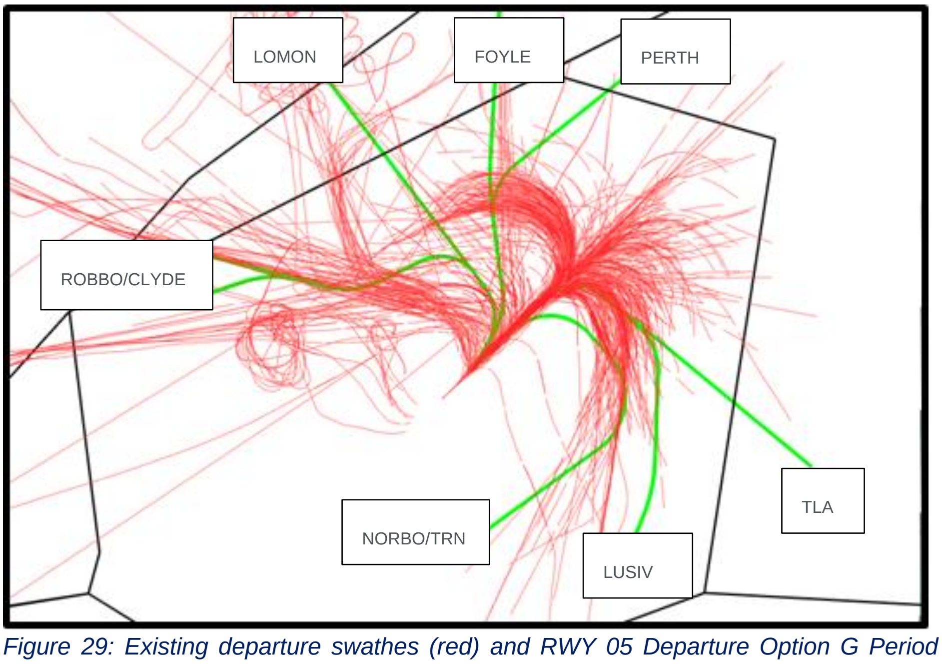

Figure 29: Existing departure swathes (red) and RWY 05 Departure Option G Period 2 illustrative centrelines (green)

Runway 05 Departures Option H

This option was generated as a result of Community and ATC feedback in our engagement. It aims to incorporate a number of positive elements of earlier options but also address ATC's serious safety concerns regarding the SID switching in Options F and G. They proposed that ROBBO/CLYDE/LOMON SIDs could also turn left immediately, together with the left turn NORBO SID. Predictable respite is not a feature, but this option would help provide CO_2 benefits for nearly all easterly SIDs, meet forecast demand, reduce frequency of overflight for communities under the NORBO departures and under final approach and negate the need to turns earlier than 5nm to the south.

Figure 30 below illustrates Runway 05 Departure Option H and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

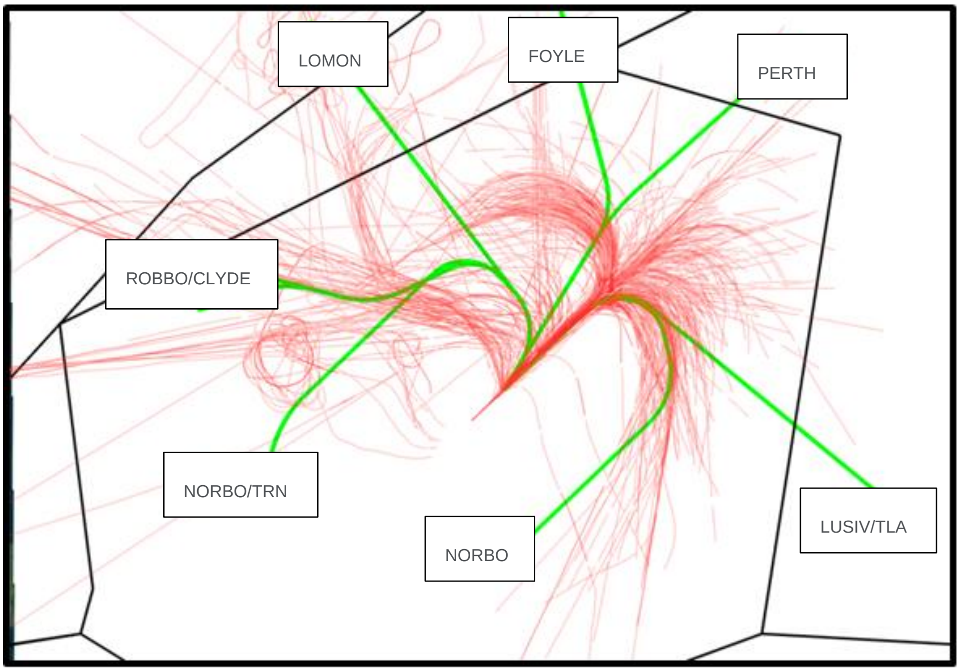

Figure 30: Existing departure swathes (red) and RWY 05 Departure Option H illustrative centrelines (green)

Runway 05 Departures Option I

This option is the same as Option H except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180˚ turn for the NORBO/ROBBO/CLYDE/LOMON departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE would also not feature a track adjustment.

Figure 31 below illustrates Runway 05 Departure Option I and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

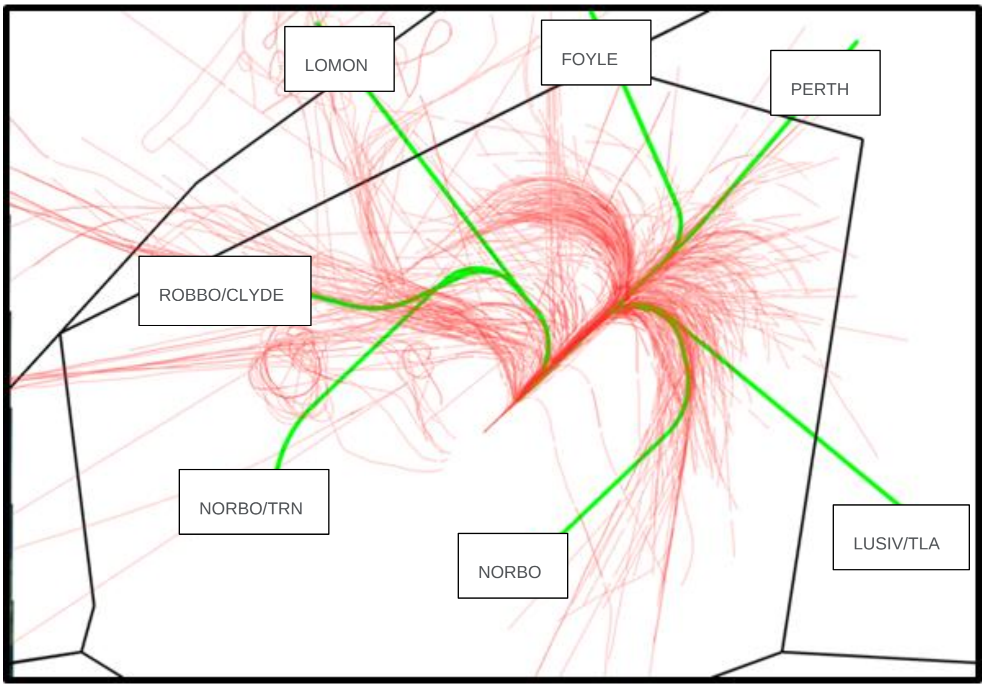

Figure 31: Existing departure swathes (red) and RWY 05 Departure Option I illustrative centrelines (green)

Runway 23 Departures Do Nothing

This option represents the do-nothing scenario for Glasgow's RWY 23 SIDs. More detail on the baseline is described in the section above.

Figure 32 below shows the swathes (red) of a week of departures from Glasgow's Westerly runway. The routine vectoring away from the existing SID centrelines (green) can be seen on all routes once aircraft are at least 5nm from the runway, however there is concentration around the centrelines. The tracks turning before 5nm are aircraft that don't currently have to adhere to the NAPs.

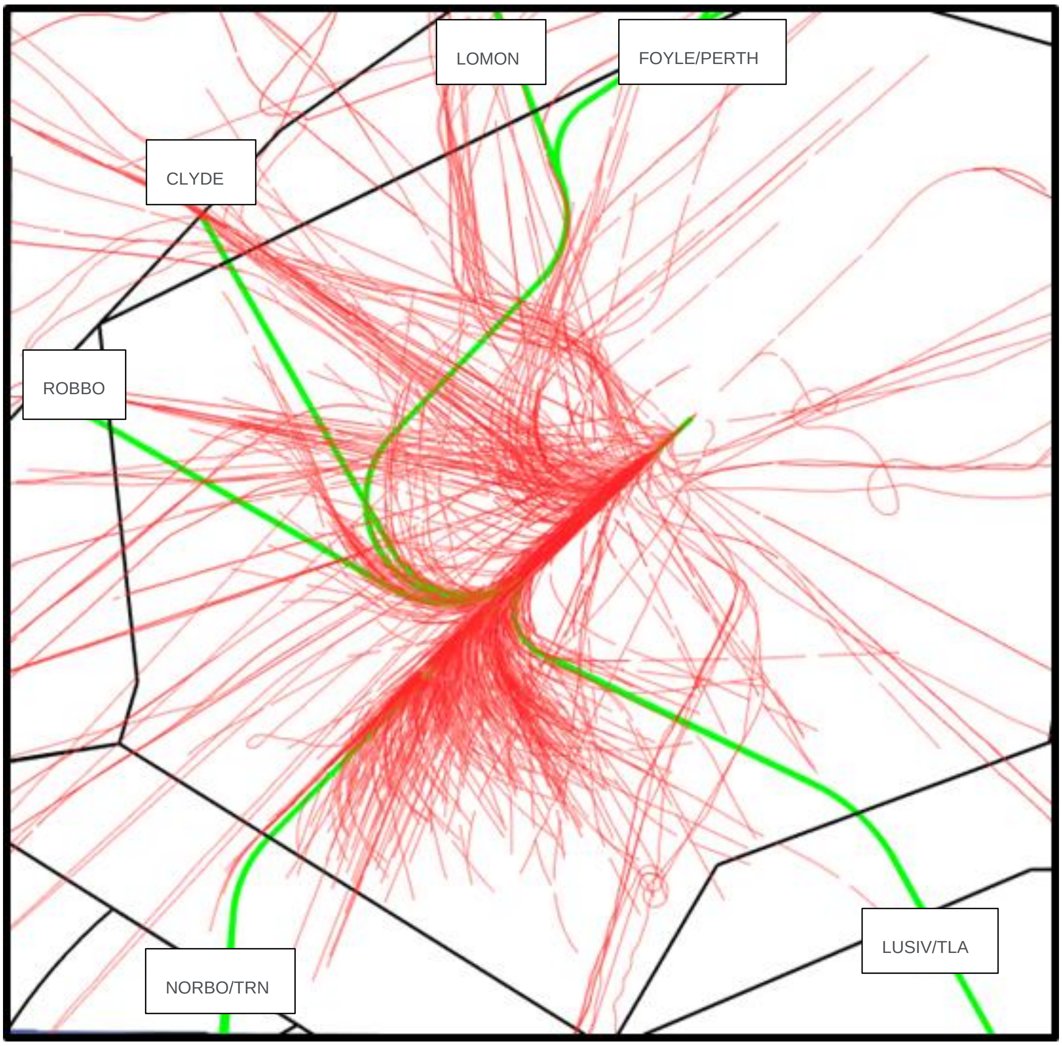

Figure 32: Existing departure swathes (red) and published centrelines (green) from Glasgow's Westerly runway

Runway 23 Departures Option A

This option would see the busiest NORBO demand split across 2 SIDs with every SID featuring a track adjustment to either the left or right. These track adjustments address DP8 whilst also, on a single SID track basis, aim to each overly the areas of lowest population.

The 2 NORBO SIDs would need to diverge by at least 45˚ which would mean one of those tracks could receive a small increase in track miles below 7000ft compared to today.

Figure 33 below illustrates Runway 23 Departure Option A and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

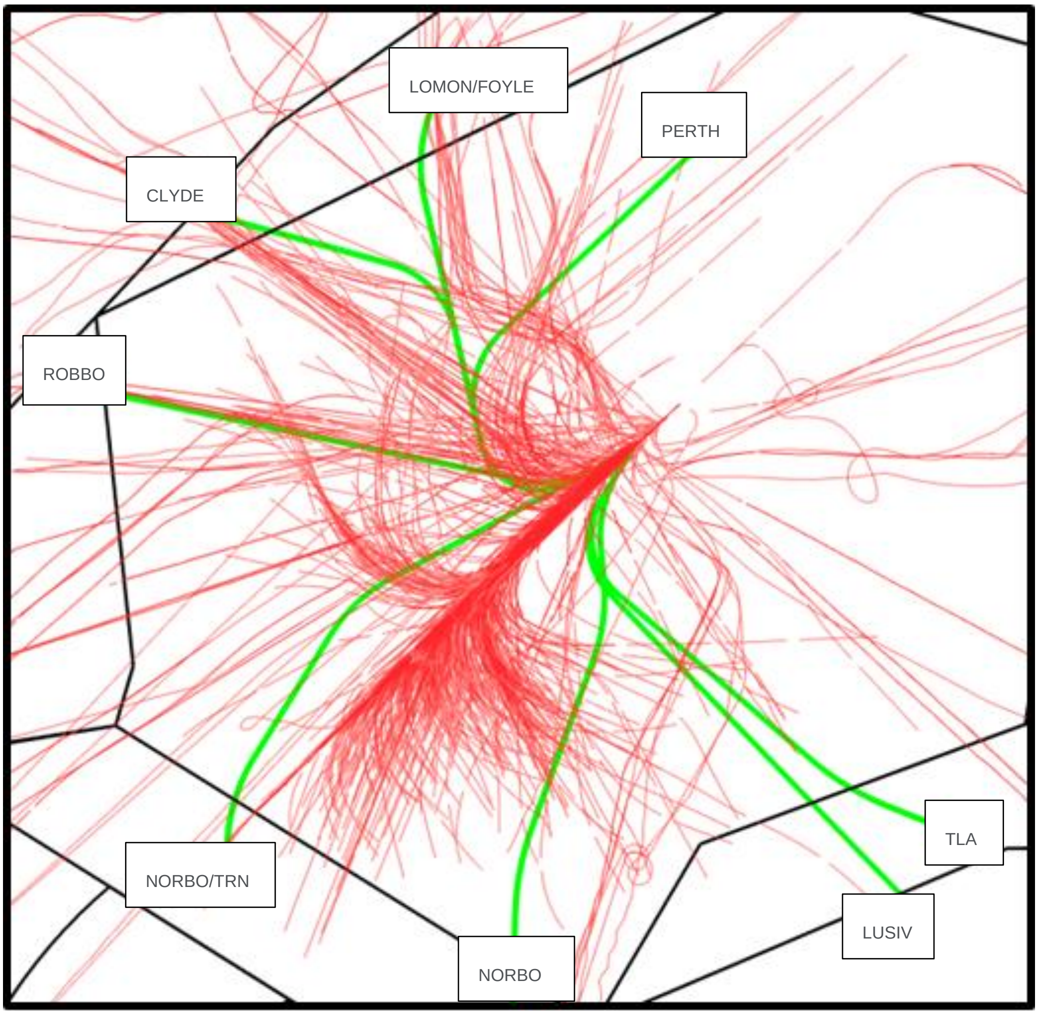

Figure 33: Existing departure swathes (red) and Runway 23 Departure Option A (green) from Glasgow's Westerly runway

Runway 23 Departures Option B

This would not split NORBO departures across different initial SID tracks which would reduce numbers newly overflown however would increase frequency of overflight for those communities under the NORBO track. This option would enable enhanced track milage reductions compared to Option A but this option is unlikely to meet future demand leading to increased ground delay.

The illustrations in this option include track adjustments for all SIDs.

Figure 34 below illustrates Runway 23 Departure Option B and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

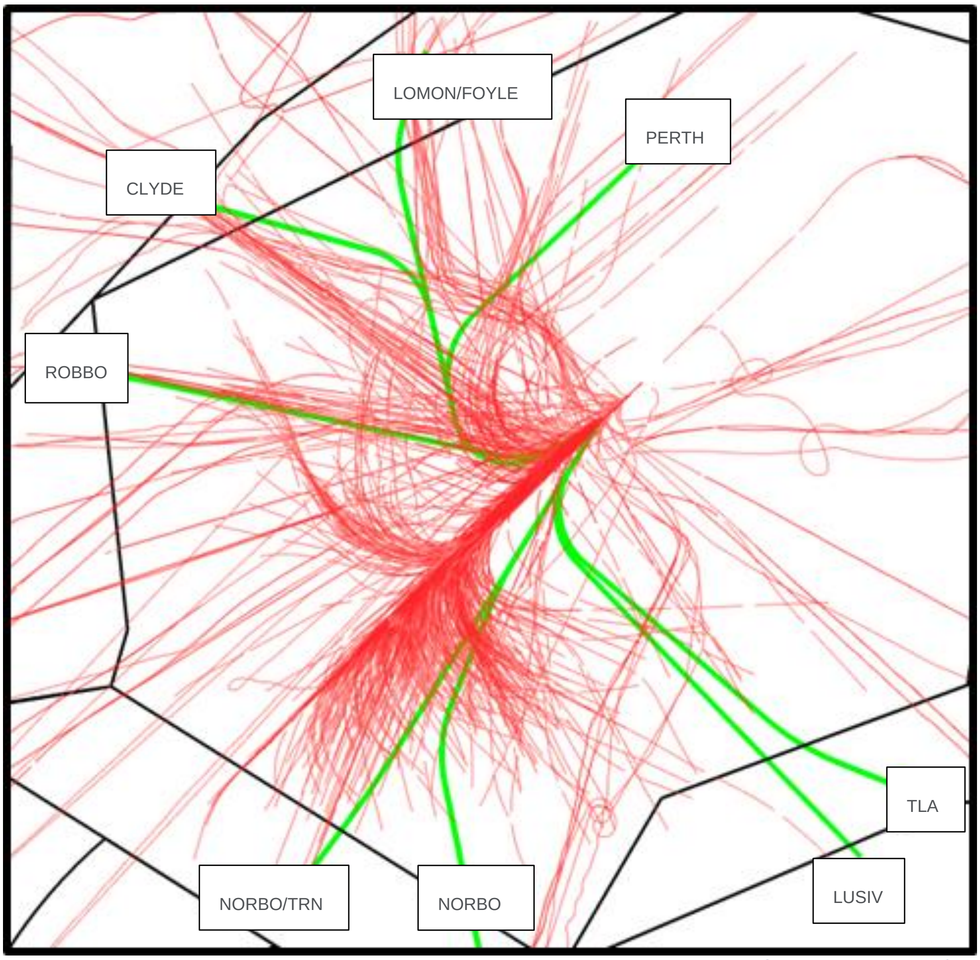

Figure 34: Existing departure swathes (red) and Runway 23 Departure Option B (green) from Glasgow's Westerly runway

Runway 23 Departures Option C

This option is a combination of Option A (Period 1) and Option B (Period 2). It would enable NORBO departures to be shared across 2 SIDs during the peak departure periods (Period 1) but then the NORBO SID configuration would switch during periods of lower demand (Period 2). The reason for the switch is to mitigate the impact of effects to those communities newly overflown by the right turn NORBO in Period 1 and enable the shorter track miles when the reduced departure intervals are not required. However, this would come at the expense of communities under the left turn NORBO SID who would be overflown during Periods 1 and 2.

To minimise the amount of change required to the SID configuration by the ‘switch’ (in an attempt to reduce operational impact and safety risk), the remaining SID tracks would remain the same, noting the lower demand on those routes.

Figure 35 (Period 1) and Figure 36 (Period 2) below illustrates Runway 23 Departure Option C and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow’s Easterly runway. Actual centrelines are likely to change throughout the process.

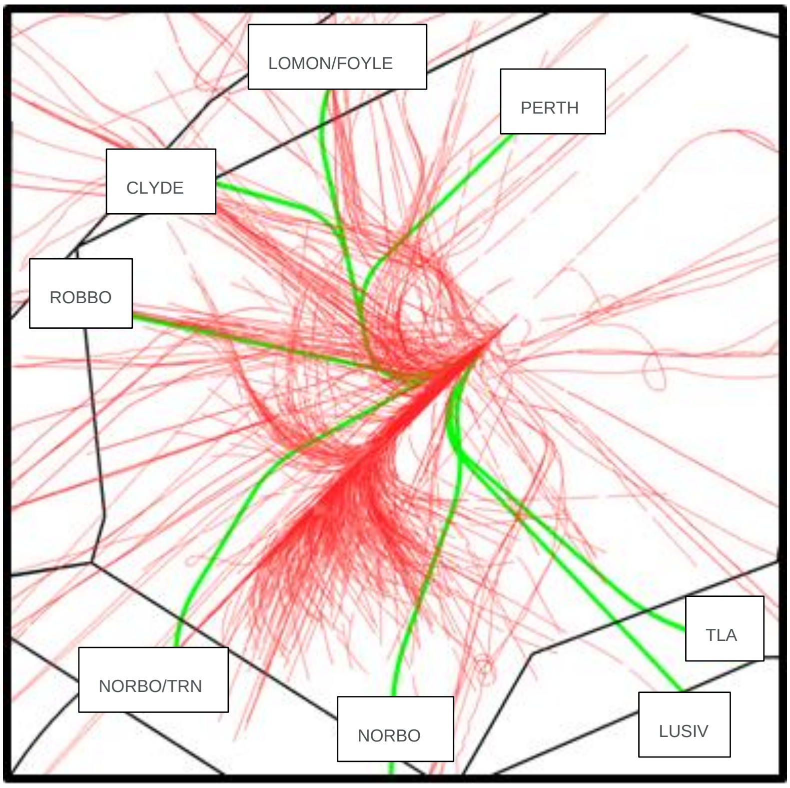

Figure 35: Existing departure swathes (red) and Runway 23 Departure Option C Period 1 (green) from Glasgow's Westerly runway

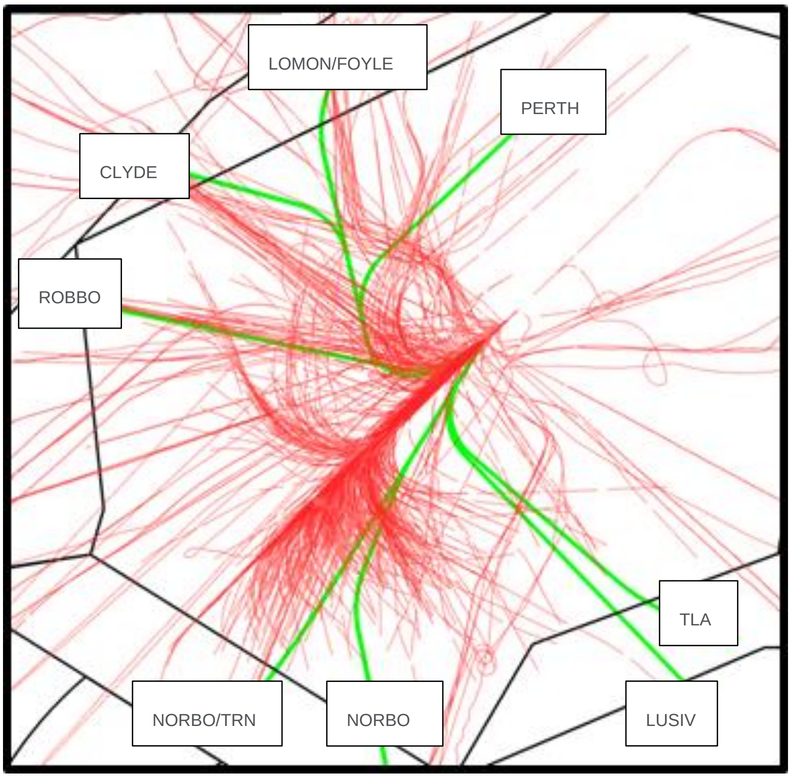

Figure 36: Existing departure swathes (red) and Runway 23 Departure Option C Period 2 (green) from Glasgow's Westerly runway

Runway 23 Departures Option D

This option is similar to Option C expect that both the Period 2 NORBO SIDs are different to Period 1. This helps to address a consequence of Option C where the communities under the Period 2 NORBO SIDs would always be overflown. However, the trade off this time is that the Period 2 NORBO SIDs would receive less benefit in track miles to the network entry points.

Figure 37 (Period 1) and Figure 38 (Period 2) below illustrates Runway 23 Departure Option D and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

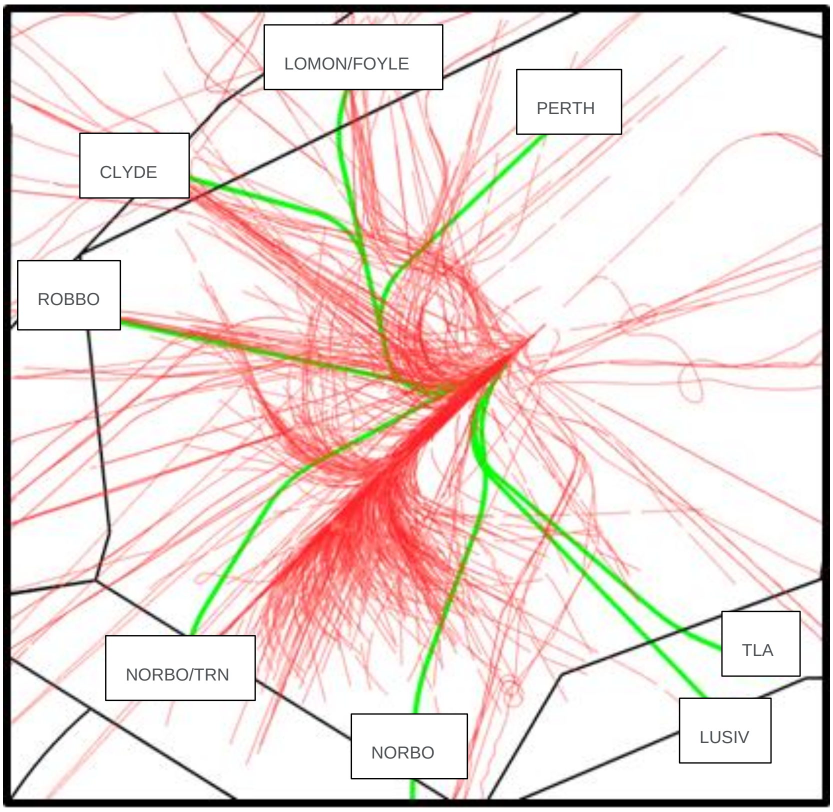

Figure 37: Existing departure swathes (red) and Runway 23 Departure Option D Period 1 (green) from Glasgow's Westerly runway

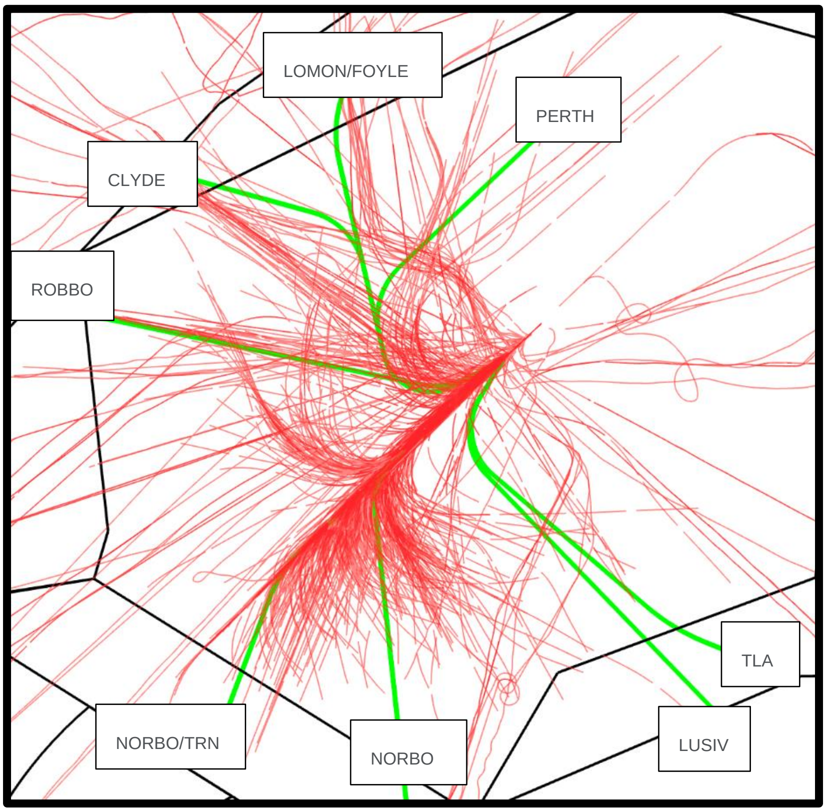

Figure 38: Existing departure swathes (red) and Runway 23 Departure Option D Period 2 (green) from Glasgow's Westerly runway

Runway 23 Departures Option E

This option would see a single SID configuration with NORBO departures split across 2 SID tracks. Predictable respite is not a feature, but this option would distribute noise more equitably than today, provide CO_2 benefits for all of the westerly SIDs, meet forecast demand and reduce frequency of overflight for communities under the NORBO departures.

This illustration does not feature track adjustments for any departure route.

Figure 39 illustrates Runway 23 Departure Option E and shows the SID centrelines (green) that will be used for Stage 2 analysis, against existing departure swathes (red) from Glasgow's Easterly runway. Actual centrelines are likely to change throughout the process.

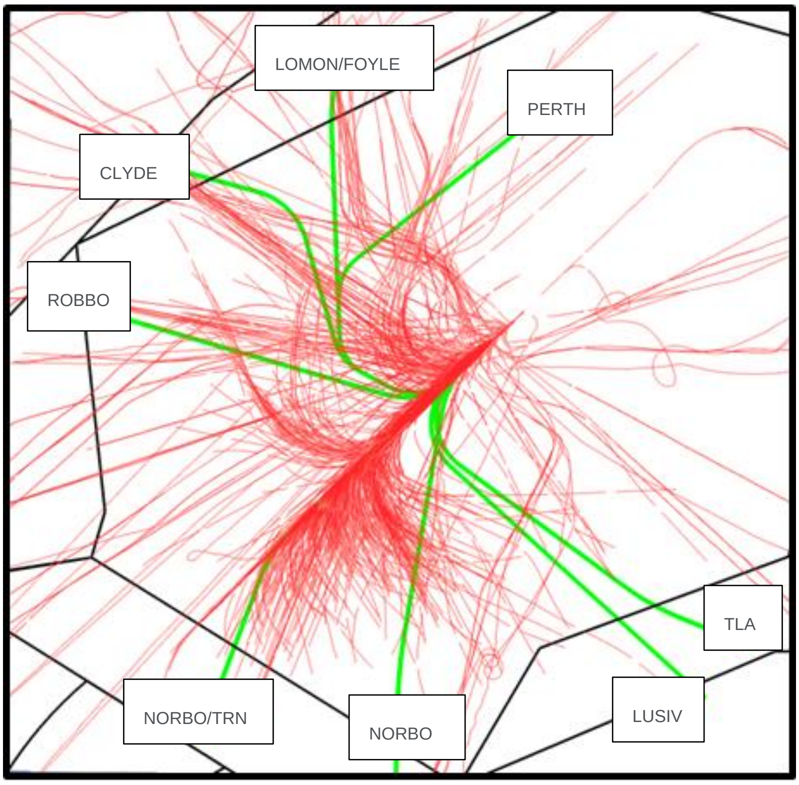

Figure 39: Existing departure swathes (red) and Runway 23 Departure Option E (green) from Glasgow's Westerly runway

Runway 05 Arrivals Do Nothing

This option is the baseline for arrivals vectored to Runway 05. More detail on the baseline is described in the section above.

Figure 40 below shows the swathes (magenta) of a week of arrivals to Glasgow's Easterly runway. The majority of aircraft are vectored to join final approach between approximately 8nm and 11nm from touchdown however they are allowed to join final approach as close as 2000ft/6nm when using the ILS. The tracks shown which join final approach inside 6nm are likely performing a visual approach.

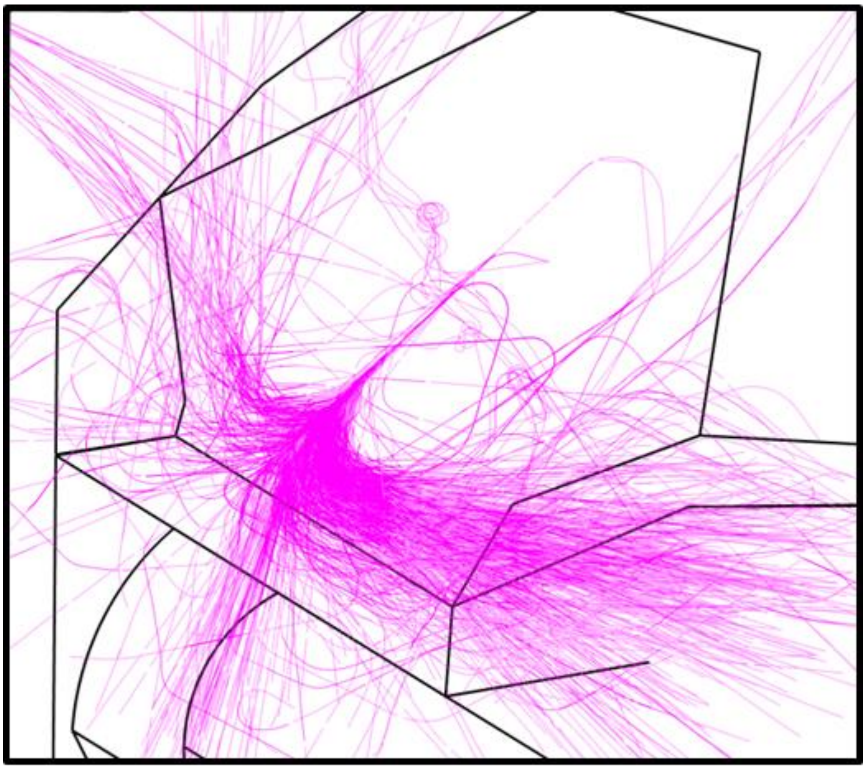

Figure 40: Existing Easterly arrival swathe (magenta)

Runway 05 PBN Arrivals

This option would see all arrivals directed via a fixed PBN path from c.7000ft to the runway. The PBN routes in Options A-D are similar but subtly different, joining final approach between 10nm and 11nm from touchdown and have slight variances on base-leg. They have been designed to avoid as many noise sensitive areas/buildings and population as possible, whilst catering for RWY 05 departure options and adhering to IFP Design and also Glasgow's Noise Abatement requirements. There are no options joining final approach beyond these areas as this would position arrivals over the populated areas of Ayr, Troon, Kilmarnock, Irvine, Kilwinning, Largs, Fairlie, Hunterston and West Kilbride.

In these options we would expect high concentration on the route centrelines with the PBN enabling improved CDA performance.

Figures 41-44 below show Options A – D (green) against the swathes (magenta) of a week of arrivals to Glasgow's Easterly runway.

Runway 05 Arrival Option A

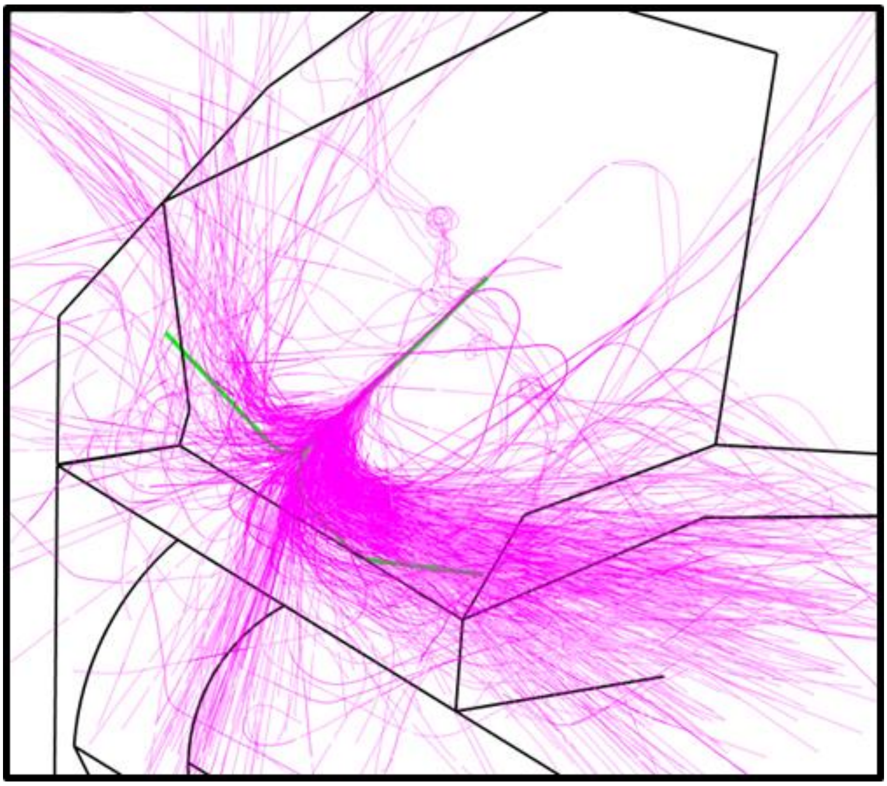

Figure 41: Existing arrival swathes (magenta) and Runway 05 Arrival Option A (green) to Glasgow's Easterly runway

Runway 05 Arrivals Option B

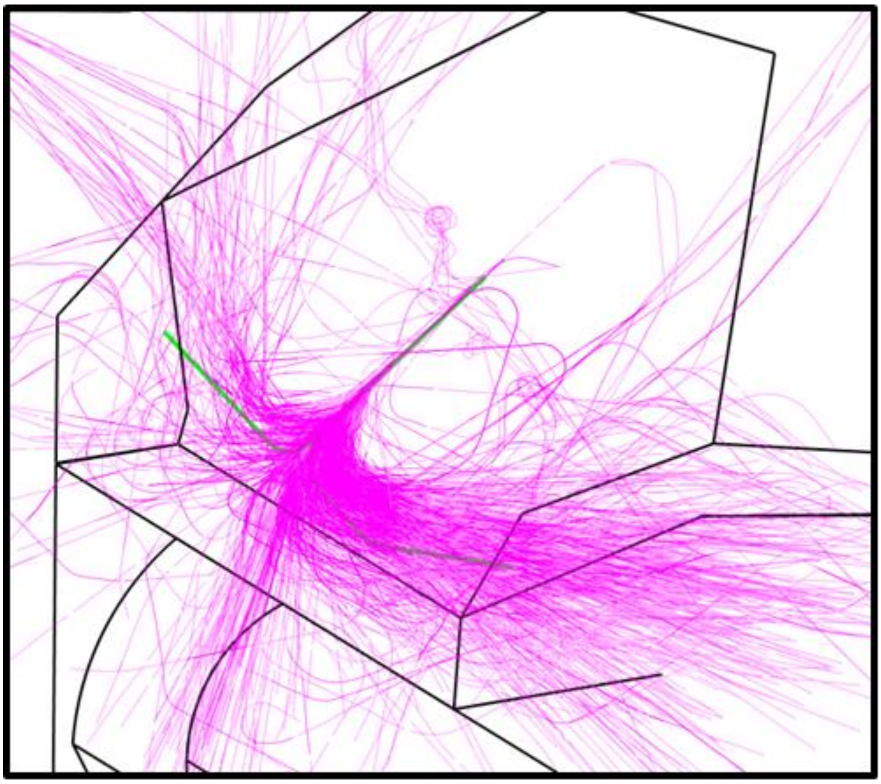

Figure 42: Existing arrival swathes (magenta) and Runway 05 Arrival Option B (green) to Glasgow's Easterly runway

Runway 05 Arrivals Option C

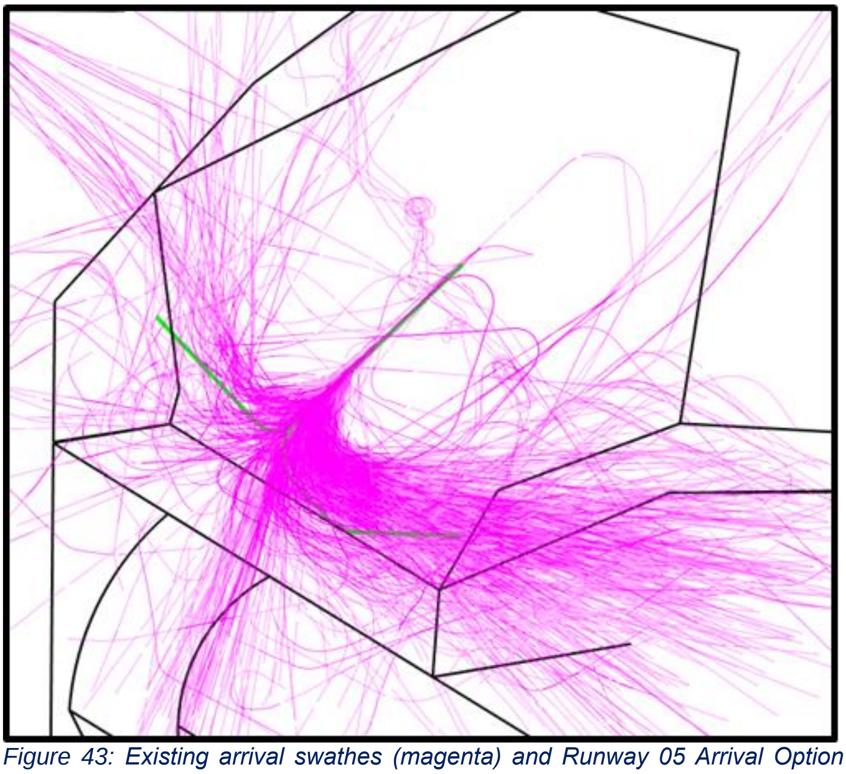

Figure 43: Existing arrival swathes (magenta) and Runway 05 Arrival Option C (green) to Glasgow's Easterly runway

Runway 05 Arrivals Option D

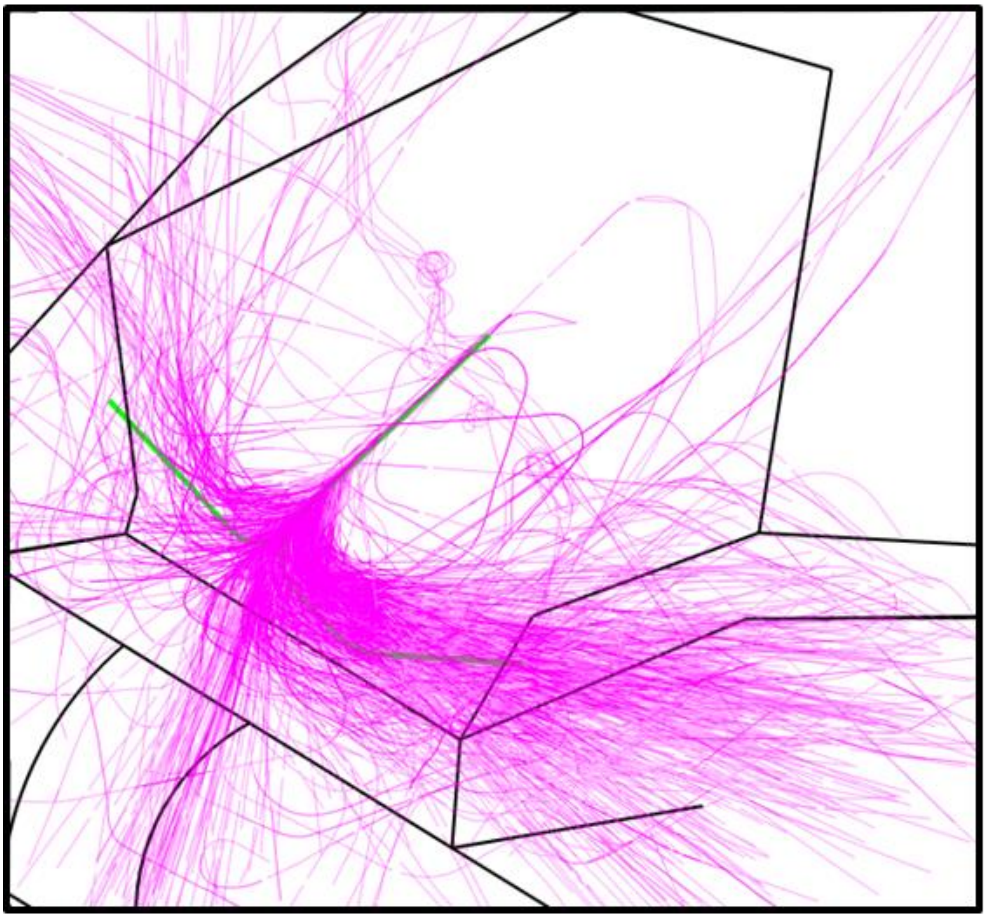

Figure 44: Existing arrival swathes (magenta) and Runway 05 Arrival Option D (green) to Glasgow's Easterly runway

Runway 05 Arrivals Vectors Only

Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only which will still require routine vectoring to manage and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Easterly arrivals on a single path. Communities can sometimes favour the 'spreading' of arrivals through vectoring to mitigate against potential adverse effects of concentration.

This option would see all arrivals continuing to be vectored with no PBN paths available for routine use.

Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet so there is not an illustration for this option.

For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however, for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.

Runway 05 Arrivals Vectors and PBN Hybrid

As described above, a pure PBN arrival option is not always optimal and therefore a standalone PBN for arrivals is unlikely to be progressed. There are however the benefits of PBN for arrivals. In addition, from an operational perspective for RWY 05, due to the interaction of NORBO departures with arrivals, ATC have advised than the option of PBN for arrivals would be extremely desirable. This is because it would provide a Waypoint for use which, when combined with an altitude restriction, could be used to guarantee separation against NORBO departures.

This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing.

The PBN arrival(s) would likely be the ‘best performing’ of Options A-D above which are then optimised in Stage 3 to balance CO_2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.

Runway 23 Arrivals Do Nothing

This option is the baseline for arrivals vectored to Runway 23. More detail on the baseline is described in the section above.

Figure 45 below shows the swathes (magenta) of a week of arrivals to Glasgow's Westerly runway. The majority of aircraft are vectored to join final approach between approximately 7nm and 13nm from touchdown however they are allowed to join final approach as close as 2000ft/6nm when using the ILS. The tracks shown which join final approach inside 6nm are likely performing a visual approach.

The larger range of final approach joining points on Runway 23 is due to the combination of this being the dominant direction of arrivals (c.70% of the time) and also the operational procedures to prevent false GPWS warnings.

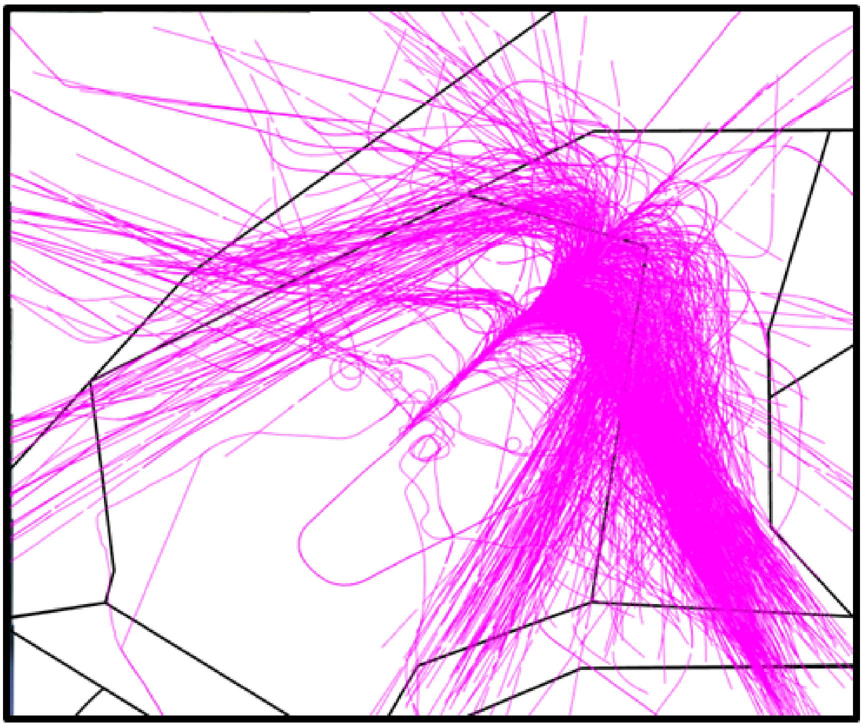

Figure 45: Existing Westerly arrival swathe (magenta)

Runway 23 Arrivals

This option would see all arrivals directed via a fixed PBN path from c.7000ft to the runway. The PBN routes in Options A-F join Final approach between 8nm and 18nm from touchdown. They have been designed to avoid as many noise sensitive areas/buildings and population (hence the Options A, B and F with the much longer final approach joining points).

In these options we would expect high concentration on the route centrelines with the PBN enabling improved CDA performance.

Figures 46-51 below show Options A – F (green) against the swathes (magenta) of a week of arrivals to Glasgow's Easterly runway.

Runway 23 Arrival Option A

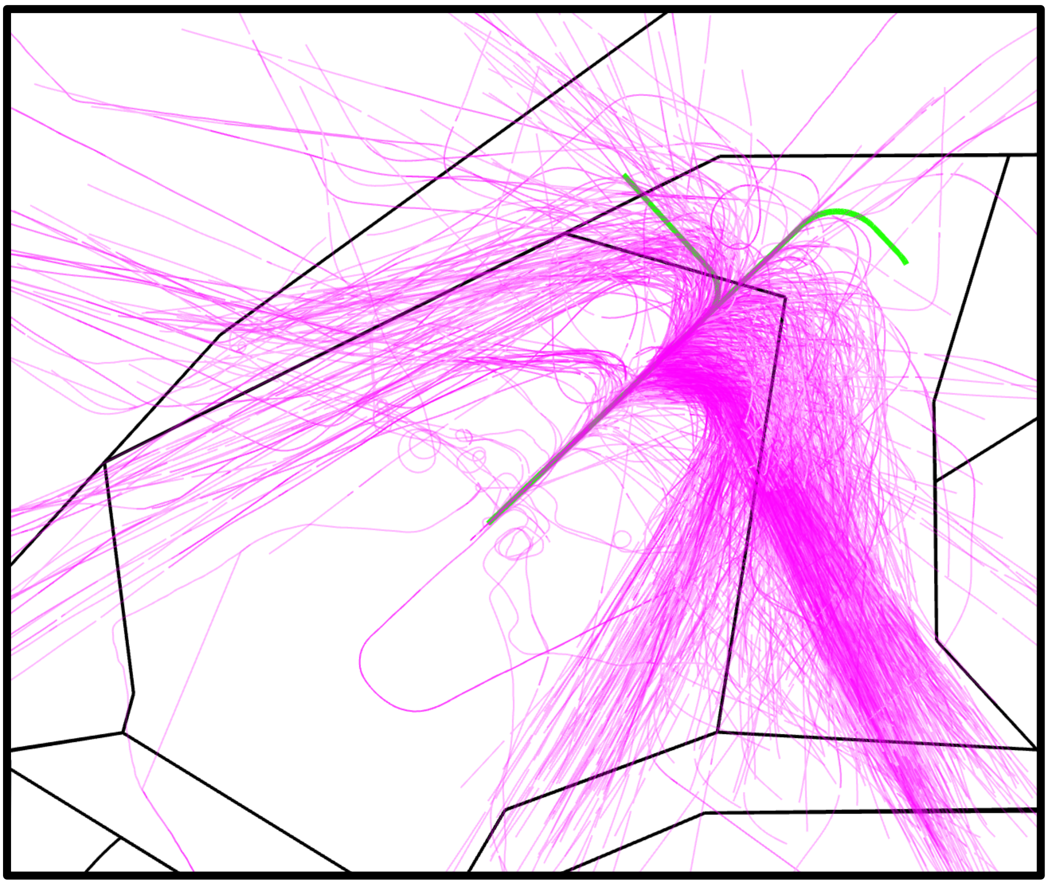

Figure 46: Runway 23 Arrival Option A (green) to Glasgow's Easterly runway

Runway 23 Arrivals Option B

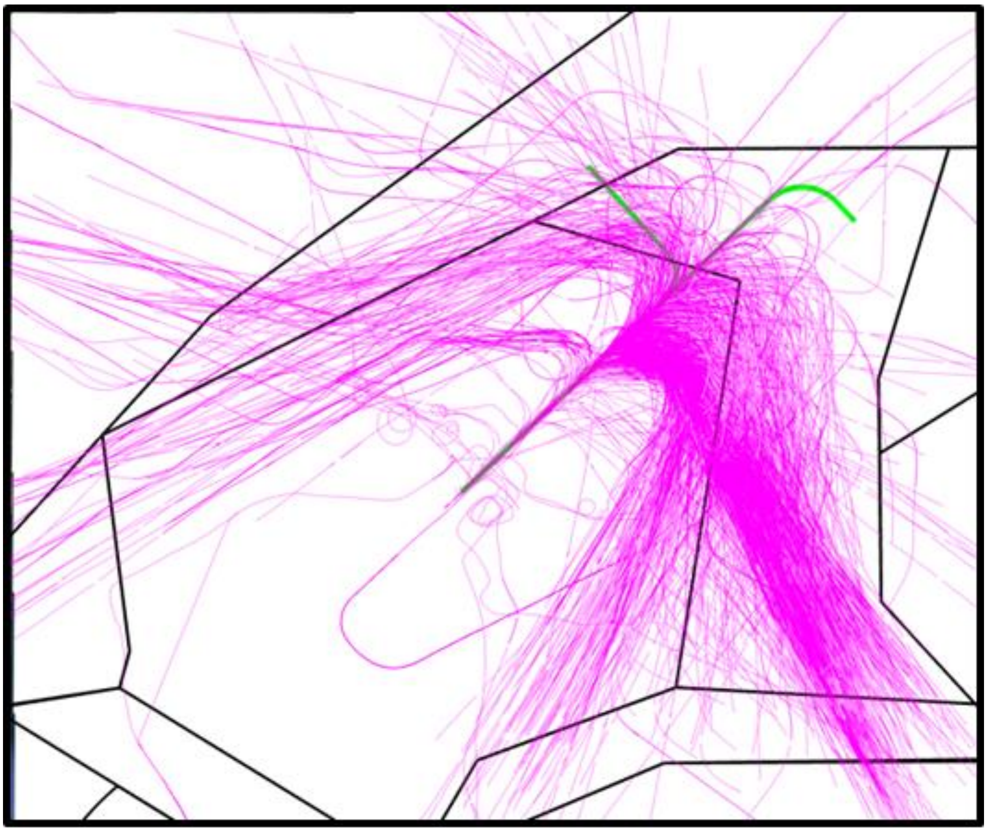

Figure 47: Runway 23 Arrival Option B (green) to Glasgow's Easterly runway

Runway 23 Arrivals Option C

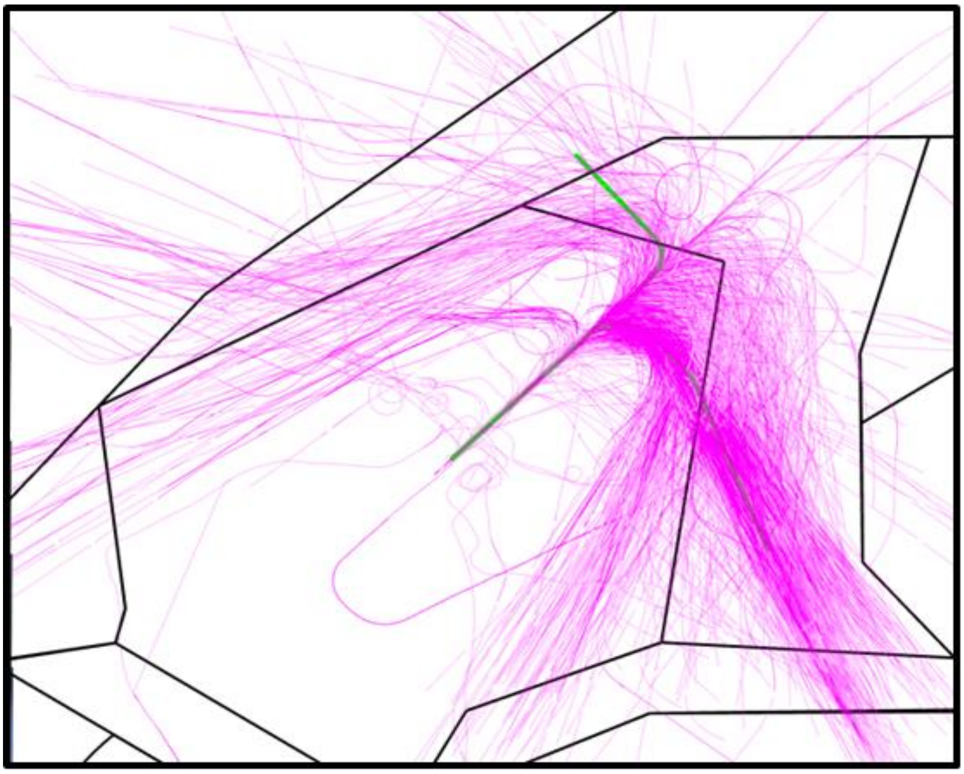

Figure 48: Runway 23 Arrival Option C (green) to Glasgow's Easterly runway

Runway 23 Arrivals Option D

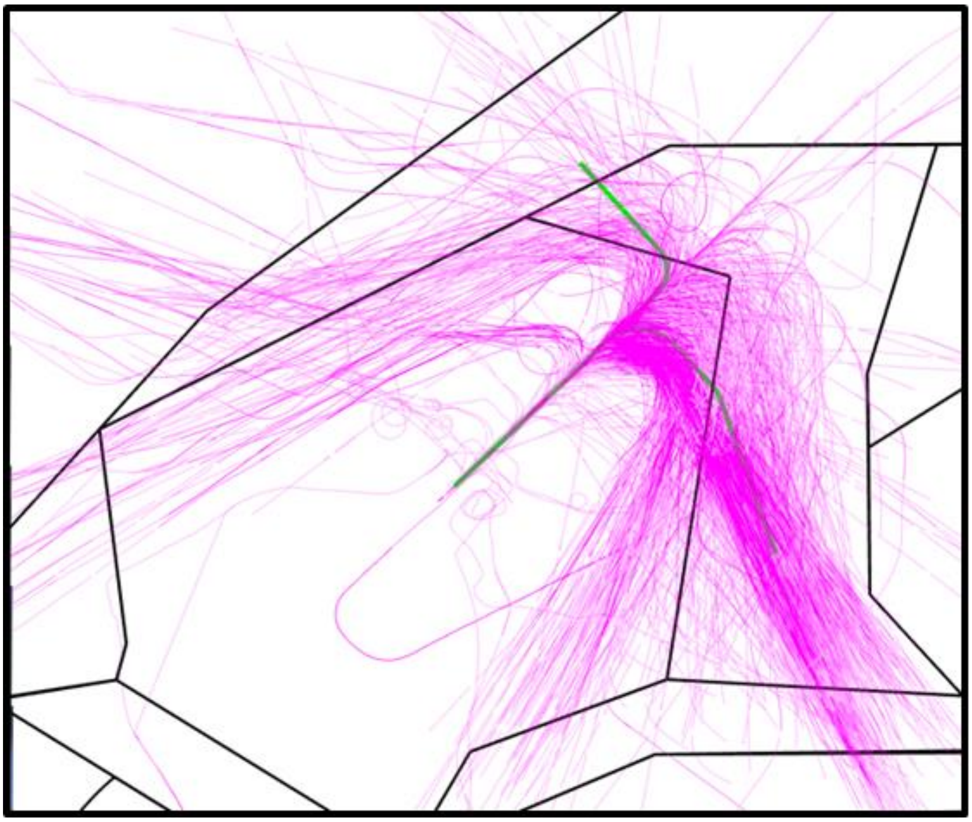

Figure 49: Runway 23 Arrival Option D (green) to Glasgow's Easterly runway

Runway 23 Arrivals Option E

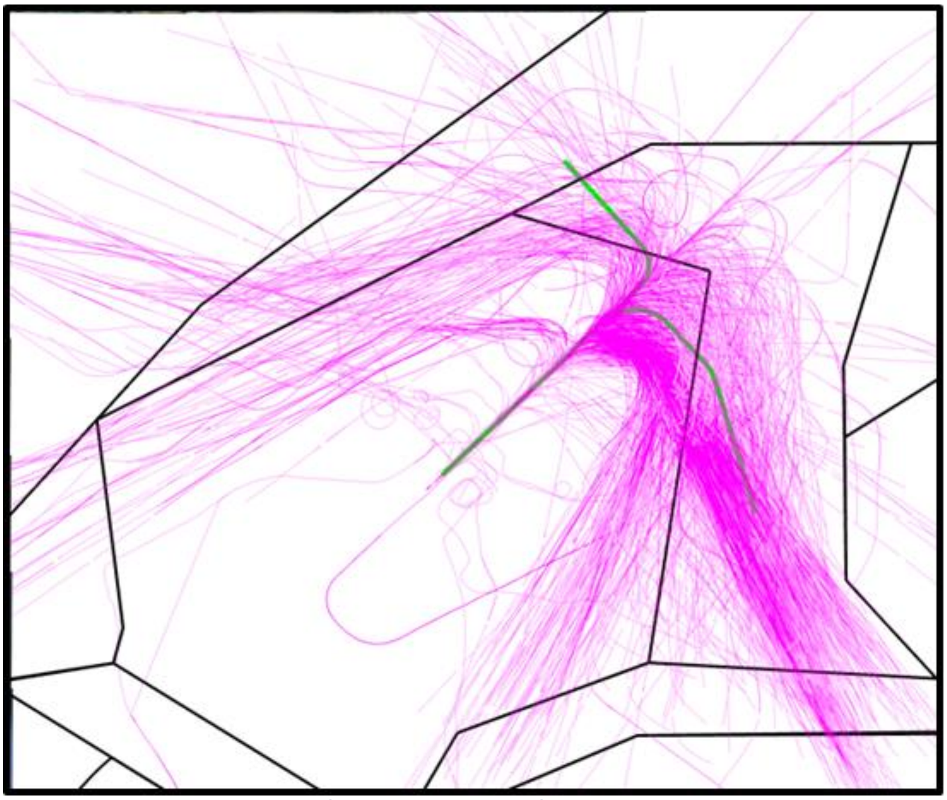

Figure 50: Runway 23 Arrival Option E (green) to Glasgow's Easterly runway

Runway 23 Arrivals Option F

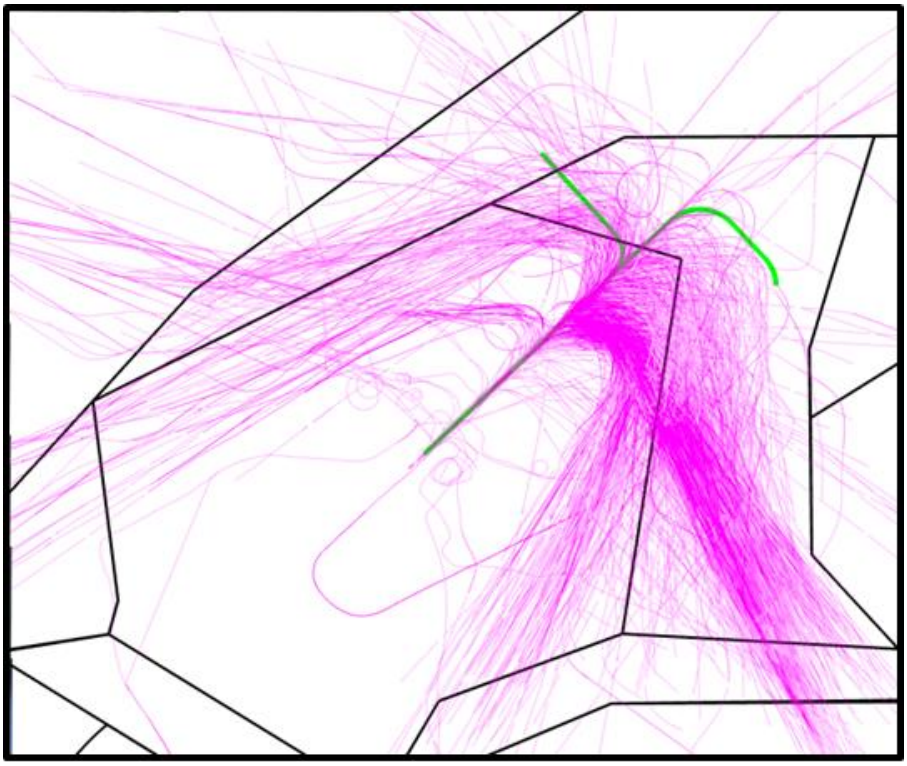

Figure 51: Runway 23 Arrival Option F (green) to Glasgow's Easterly runway

Runway 23 Arrivals Vectors Only

Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only which will still require routine vectoring to manage and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Westerly arrivals on a single path. Communities can sometimes favour the ‘spreading’ of arrivals to mitigate against potential adverse effects of concentration.

This option would see all arrivals continuing to be vectored with no PBN paths available for routine use.

Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a ‘Do Nothing’ option for arrivals. However, what that change is not possible to determine yet, so there is not an illustration for this option.

For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft.

Runway 23 Arrivals Vectors and PBN Hybrid

As described above, a pure PBN arrival option is not always optimal and therefore is unlikely to be progressed as a standalone PBN solution. There are however the benefits of PBN.

This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing.

The PBN arrival(s) would likely be the ‘best performing’ of Options A-F above which are then optimised in Stage 3 to balance CO_2, noise impacts and Controlled Airspace containment requirements. They will also need to carefully consider the GPWS issues and ensure they are not exacerbated. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.

Options for Controlled Airspace and other Procedures

Options for CAS

Airspace containment of IFPs (Instrument Flight Procedures) is very closely related to the design characteristics as well as track performance (flyability) along the route centrelines. As describes previously, the provisional route centrelines are likely to move as options are refined throughout the project. Refinement will be on the basis of integration with the wider airspace network below and above 7,000ft, reacting to stakeholder engagement, increasing environmental and operational performance and in accordance with more detailed IFP design and validation in Stages 3 and 4.

The CAS construct needs to be based on both easterly and westerly operations and there could be many hundreds of differing CAS designs to support every combination of airspace design options and operating modes.

It is therefore not proportionate at this stage to design CAS structures to support each possible option and configuration, especially when the fine details of interactions, climb gradients and network connectivity are not known.

However, it is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size. Knowing that the CAS structures will change, we considered how best to illicit meaningful feedback from GA on changes before we know what those changes are. With this in mind, we generated what we termed an "Illustrative CAS Volume" to generate an informed discussion with GA. This illustrative CAS volume was generated with the following requirements in mind:

- Protect all potential options in accordance with the CAA's Controlled Airspace Containment Policy, assuming a 7% climb gradient for each SID to 7000ft.
- Provide CAS to cater for a 3˚ CDA from every direction
- Provide symmetry and simplicity wherever possible

The illustrative CAS volume did not:

- Consider the impact of steeped CAS bases on the ability for ATC to provide instruction to enable CDA, it just catered for a 3˚ arrival profile. The two things are not the same.
- Consider the classification of the airspace
- Take any account of existing CAS arrangements
- Represent the proposed CAS volume for Glasgow's ACP

We advised stakeholders that this volume is a starting point for discussion only and that we will develop and refine the volume based in Stage 3 based on:

- The options that are shortlisted
- engagement with General Aviation Stakeholders
- engagement with Glasgow Airport's ATC team
- engagement with NATS (NERL) and integration into the ScTMA
- Engagement with Edinburgh, Cumbernauld and Prestwick Airport
- Feedback from the CAA's Airspace Classification Review

The presentation provided is available in Appendix G and Figure 52 below presents the illustrative CAS volume.

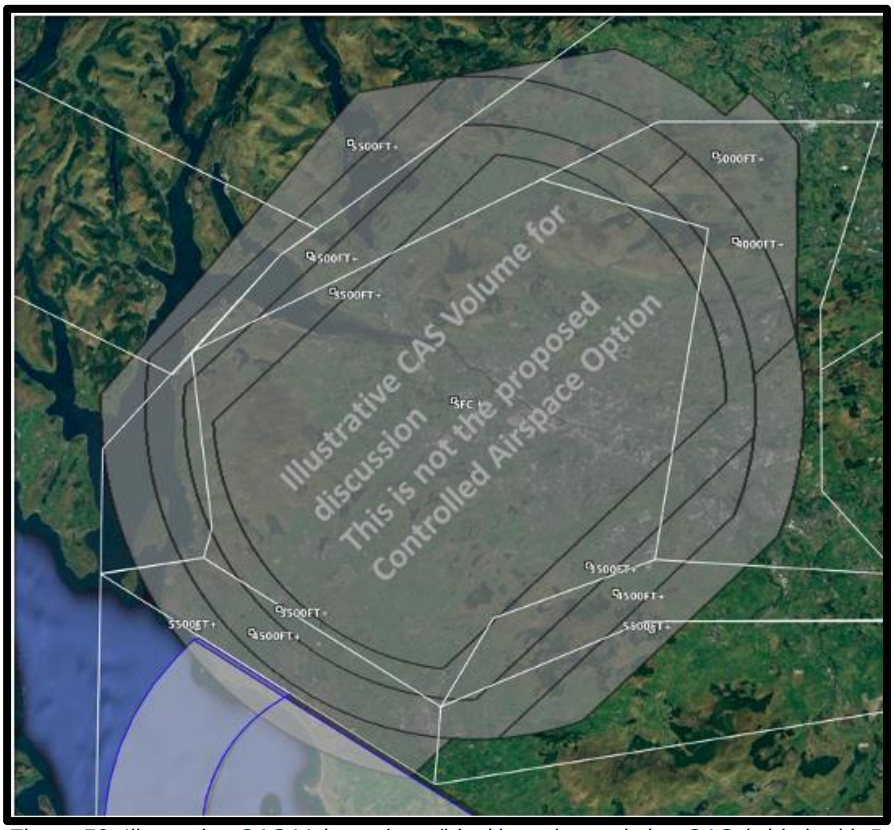

Figure 52: Illustrative CAS Volume (grey/black) against existing CAS (white) with Prestwick CAS in Blue

This volume is potentially pessimistic in some areas whilst also overly ambitious in others however it was useful for generating useful feedback and understanding the potential change in overall volume of CAS that may be achievable. The difference in CAS volume between this and what currently exists helped us to perform the Design Principle Evaluation and Initial Options Appraisal through the nm^3 volume differential and also as to potential impact on Infringements based on historical Mandatory Occurrence Reports.

CAS Volume differential

Comparing this volume to the existing is not straightforward because the existing CAS in the area is comprised of both Glasgow, Edinburgh and ScTMA airspace. Without determining whether each of the segments are CTR, CTA or TMA and their associated upper limits we couldn’t do a true comparison at this stage.

The methodology we created was to take the outline of the illustrative CAS volume and compare against the existing volume of airspace within that outline. This is illustrated in Figure 53. For the calculation, we assumed that the illustrative volume was all Glasgow CTR/CTA with an upper limit of 6000ft.

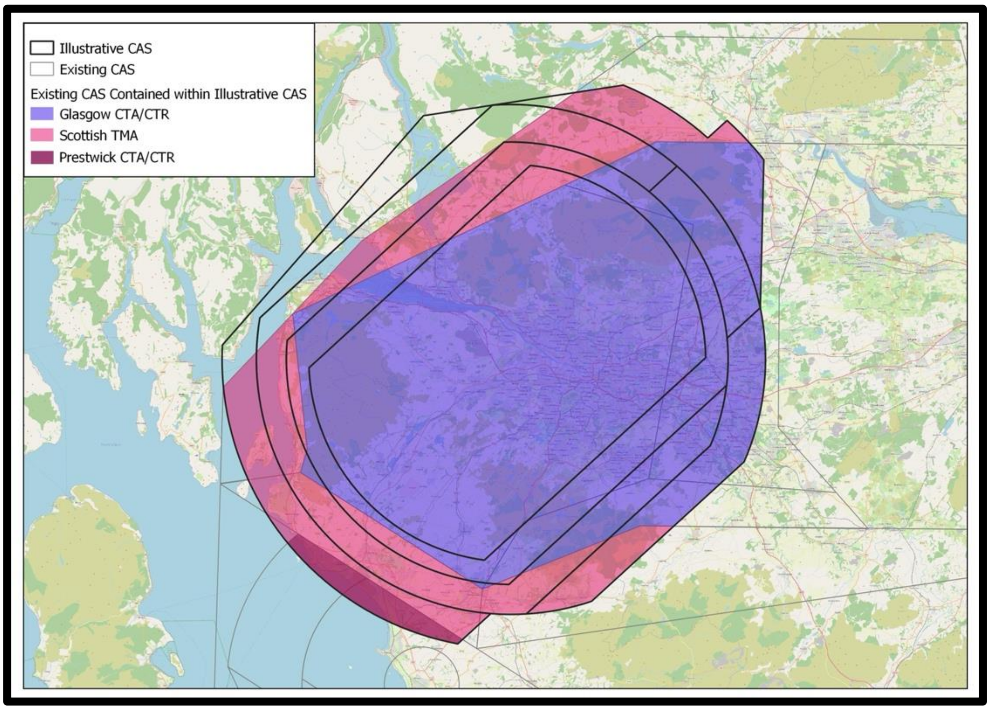

Figure 53: Illustrative CAS Volume comparison

The results of the calculation were that the Illustrative CAS Volume was c.100nm^3 smaller in volume than the extant CAS in the same lateral location. The Glasgow CTR was c.47nm^3 smaller.

As explained in the stakeholder engagement section above, feedback received was mixed with some good suggestions for consideration on how to further reduce this volume, even if it were to contain all the options currently under consideration, which of course it won’t have to do.

Options for other Procedures

Missed Approaches

These procedures are part of an Instrument Approach Procedure and enable aircraft to safely reposition for another approach under certain circumstances if they are unable to land from their first approach. This is a safe and routine part of operations for all pilots and controllers. There are many reasons for a pilot, or a controller, to initiate a missed approach. On average, there are only around 5 Missed Approaches per month at Glasgow meaning that any environmental considerations are negligible.

The design of the Missed Approach is very specific to the type of approach and the airspace construct and sometimes, the initial departure tracks. We do not yet know if we will need to change the Missed Approach procedures and if we do, cannot attempt to guess what they will look like due to all the variables and it would not be proportional to attempt to do so.

After the Full Options Appraisal concludes and Glasgow's preferred options are chosen, we can then consider the Missed Approaches to support the safe operation of the design and include the considerations in the consultation material in Stage 3.

Noise Abatement Procedures

As the NAPs are defined by the existing SID centrelines, if those centrelines move Glasgow's NAPs will need to be amended accordingly. This could result in changes to the lateral track, the width of the NAP and/or the height of the NAP. Options for NAP definitions have not been included in Options Development at this stage, but we will incorporate new dimensions for our NAPs in the public consultation material in Stage 3.

Alignment with the Masterplan

As set out in CAA's Assess and Accept Criteria, Sponsors will be unable to progress through the Stage 3 gateway of the CAP 1616 process until the system-wide airspace design of the proposed options, and the cumulative impacts of those options, are represented in an accepted Iteration 3 of the masterplan. To generate Iteration 3, ACOG will require "granular data from ACP sponsors' 'full' options appraisals" and furthermore, Iteration 3 will not be accepted by the CAA until ACOG has published a draft of it and conducted a public engagement exercise on some of its content. Glasgow will not be able to progress through Stage 3B without NATS, Aberdeen and Edinburgh Airports if there are dependencies between the 3 sponsors. At this stage, there will certainly be dependencies between NATS and Glasgow and between NATS and Edinburgh. As a result, this may generate dependencies between Glasgow and Edinburgh. Consultations will need to be aligned and it is likely there will be a single implementation although the latter is to be confirmed.

Masterplan Iteration 2 suggests an STMA cluster implementation date of Q4 2025.

Design Principle Evaluation

The Design Principle Evaluation involves taking all of the options developed and qualitatively evaluating them against the Design Principles to understand how they respond. This helps to determine which options best meet the design principles and therefore proceed to the next stage of the airspace change process.

As part of the Airspace Change Process at Stage 1B, Glasgow Airport developed a set of design principles with identified stakeholders. The aim of the design principles is to provide high-level criteria that the proposed airspace design options should meet. They also provide a means of analysing the impact of different design options and a framework for choosing between or prioritising options.

Design Principle Evaluation Methodology

At the DP Evaluation Stage, CAP1616 requires airspace change sponsors to qualitatively evaluate options against the design principles, and categorises each evaluation as either ‘met’, ‘partially met’ or ‘not met’.

As part of this evaluation, sponsors must clearly set out the methodology that has been applied when evaluating each option. The below sub-sections of this document outline the methodology before providing a summary of the Design Principle Evaluation. The full Design Principle Evaluation is shown in Annex A.

In the case of technical design principles, technical language or references may be used as part of the evaluation. Wherever possible, we have endeavoured to explain these technicalities as part of the earlier sections of this document, and within the assessment methodology itself, however we would also recommend reviewing the glossary pages at the end of this document.

Assessing against the Airspace Modernisation Strategy

The CAA has requested evidence that the Design Principle Evaluation includes an assessment of how the different Design Options respond to the relevant AMS Design Principle:

“Subject to the overriding design principle of maintaining a high standard of safety, the highest priority principle of this airspace change that cannot be discounted is that it accords with the CAA’s published Airspace Modernisation Strategy (CAP 1711) and any current or future plans associated with it.”

There are 5 known outcomes, or ends, that are expected from the Airspace Modernisation Strategy (AMS) as detailed in CAP1711 and Glasgow’s Design Principles already encompass 4 out of 5 of these objectives. Table 15 sets out which parts of our Design Principle Evaluation assesses against the 5 AMS known outcomes.

AMS known outcome	Glasgow's design principle which assesses this outcome
Maintain and enhance high aviation safety standards	(DP1) The airspace design and its operation must be as safe or safer than today. (DP9) Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.
Secure the efficient use of airspace and enable integration	(DP3) Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release controlled airspace that is not required. (DP9) Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.
Avoid flight delays by better managing the airspace network	(DP2) Facilitate the growth in quicker, quieter and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport. (DP4) Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic
Improve environmental performance by reducing emissions and by better managing noise	(DP2) Facilitate the growth in quicker, quieter and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport. (DP4) Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic. (DP5) Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing. (DP6) Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, enroute network and procedural constraints (DP7) The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty / National Scenic Areas and areas that are not currently affected by aircraft noise (DP8) Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable

	(DP11) Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick. (DP12) Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change. (DP13) Aircraft operating at Glasgow Airport should climb and descend continuously to / from at least 7000ft with a preference for the most environmentally beneficial option to be chosen if both cannot be achieved simultaneously
Facilitate defence and security objectives	We don't have a specific design principle to meet this objective. However, none of our options are assessed as affecting defence and security objectives and our stakeholder list ensures that this aspect is considered by the relevant parties.

Table 15: AMS known outcomes mapped against Glasgow's Design Principles

Please see the assessment methodology section below, for information about the methodology applied to determine the overall outcome of the AMS Design Principle.

Design Principle Evaluation Methodology: Met, Partially Met and Not Met Categorisation

In order to evaluate each option in a fair and transparent way, we have followed the methodologies set out in Table 16 when evaluating against each design principle.

Design Principle		Approach to Evaluation	Met	Partially Met	Not Met
1	The airspace design and its operation must be as safe or safer than today.	Qualitative assessment will be undertaken by SME. The assessment will state any potential safety concerns and indicate if additional safety case mitigation may be required ahead of ACP submission.	The airspace design is as safe or safer than today with no safety concerns at this time	The airspace design is anticipated to be safe however additional work is required to generate an acceptable safety case	Acceptable safety assurances are not likely to be met and therefore option discounted
2	Facilitate the growth in quicker, quieter and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.	Qualitative SME assessment of whether the option is expected meet the forecast demand for air transport.	Option is expected to meet the forecast demand for air transport.	[21]	Option is not expected to meet the forecast demand for air transport.
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release controlled airspace that is not required.	Assessment of whether the option could be contained within the existing volume or whether adjustments would need to be made. In the CAS section of this document, we explained that it is very difficult to quantify the exact CAS dimensions at this time given the options are split into easterlies and westerlies and the number of permutations that would be required to create full systems. At this stage SMEs are however able to qualitatively assess whether an option has the potential to require more CAS (because the option extends beyond existing boundaries), whether it could be contained within the existing CAS volume and/or whether the option has potential to reduce the size of existing CAS volume, This assessment helps us understand the options which have the potential to release CAS that is not required, and/or whether the option would require new CAS in areas outside of the existing boundaries. Both of these aspects are important to some of our stakeholders who have expressed the need to reduce the volume of CAS at Glasgow. Our categorisation of 'met', 'partially met' and 'not met' therefore reflects the information available and helps initially guide us around which options may offer the potential to reduce the volume of controlled airspace within the scope of the existing CAS today, or which options may have the potential to reduce the overall volume of CAS but would require changes outside the area of the existing CAS. To help stakeholder engagement on potential impacts, we created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm^3 smaller than currently exists. Therefore, we can say that no option offers no potential to reduce the existing total volume and so all options can be assessed as either Meeting or Partially Meeting this design principle.	The design option could be contained within the existing CAS volume and also offers potential to reduce the total volume of CAS	The design option may require changes to the existing CAS boundaries but still offers potential to reduce the total volume of CAS	The design option would require changes to the existing CAS boundaries and offers no potential to reduce the total volume of CAS
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.	Qualitative SME assessment of whether the option is expected to reduce, maintain or increase airborne or ground holding.	Option is expected to reduce ground or airborne holding	Option is not expected to affect ground or airborne holding	Option is expected to increase ground or airborne holding

[21] Formatting updated to remove 'partially met'

Design Principle		Approach to Evaluation		Met	Partially Met	Not Met
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.	This principle cannot be assessed qualitatively as the total adverse effects of noise can only be quantified by building a detailed noise model using a complete airspace design and schedule, which is not proportionate analysis at this early stage of airspace development. At this stage, the number of people overflown (as per CAP1498) and the number of people within the 60dB (night) and 65dB (day) LAmax contour (from a typical aircraft overflight) from each airspace design option could be used as an early indicator for the total adverse effects of noise. For this DPE, we have used 65dB. Any options which spread the noise across more centrelines than today below 4000ft is likely to overfly more people (when comparing centreline to centreline) and have potential adverse effects. However this can also reduce the frequency of overflight for those overflown most regularly today who could be considered to be those most adversely affected (those under the extended centreline within 5nm of the runway). This evaluation has therefore been split into 3 parts: Numbers overflown below 4000ft, numbers within the 65dBL$_{Amax}$ contour (from a typical aircraft overflight) and impact on those most frequently overflown today. For the aircraft we chose the B738 which is one of the largest and noisier aircraft that regularly flies at GLA and therefore tends towards the worst case. The evaluation of this principle is informed by data generated by environmental consultants however the data itself will be articulated within the IOA. Owing to the lower fidelity of modelling at this stage (single flights, route centreline to route centreline) we have used a broad +/-25% range marker either side of the baseline numbers for assessing numbers overflown and numbers within 65dBL$_{Amax}$ contour. The CAA's overflight metric has in part been derived to quantify the perception of being overflown based on the visual location of an aircraft in the sky, so is considered a suitable indicator for the 'visual intrusion' of an airspace design (See paragraph 3.8 of CAP1498 Definition of Overflight).	Number of people overflown below 4000ft (route centreline to route centreline)	Option is expected to reduce the Number of people overflown below 4000ft (centreline to centreline) by more than 25%	Option is expected to remain within 25% of the Number of people overflown below 4000ft (centreline to centreline)	Option is expected to increase the Number of people overflown below 4000ft (centreline to centreline) by more than 25%
			Number of people within the 65dBLAmax contour (from a typical aircraft overflight)	Option is expected to reduce the number of people within the 65dBLAmax contour (from a typical aircraft overflight) by more than 25%	Option is expected to remain within 25% of the number of people within the 65dBLAmax contour (from a typical aircraft overflight)	Option is expected to increase the number of people within the 65dBLAmax contour (from a typical aircraft overflight) by more than 25%
			Affect on frequency of overflight for those currently most overflown (those under the extended centreline within 5nm of the runway)	Option is expected to reduce the frequency of overflight for those under the extended centreline within 5nm of the runway	Option is expected to have no change to the frequency of overflight for those under the extended centreline within 5nm of the runway	Option is expected to increase the frequency of overflight for those under the extended centreline within 5nm of the runway
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.	We do have options which offer both noise concentration and noise dispersion. This assessment is based on whether the option makes use of multiple routes for the same traffic flow to share the noise more equitably	Use of multiple routes	Option does see the use of multiple routes to share noise more equitably	Option doesn't see the use of multiple routes to share noise however mode of operation does disperse the traffic	Option doesn't see the use of multiple routes to share noise more equitably
		We do have options which offer both noise concentration and noise dispersion. This assessment is based on whether the option has mechanisms for turning routes on/off to provide respite for communities	Mechanisms for predictable respite	Option does contain mechanism for predictable respite	N/A (this is a met or not met assessment)	Option doesn't contain mechanisms for predictable respite

	Design Principle	Approach to Evaluation		Met	Partially Met	Not Met
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.	This assessment is informed by the number of sensitive areas and buildings, national parks, Areas of Outstanding Natural Beauty (National Scenic Areas) that will be overflown by the route centreline in the new option compared to the published centreline of today's operation. The evaluation of this principle is therefore informed by data generated by environmental consultants however the data itself will be articulated within the IOA.	Noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas	Option reduces the number of noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas overflown below 7000ft	Option not expected to affect the number of noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas overflown below 7000ft	Option increases the number of noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas overflown below 7000ft
		A qualitative comparison of each option to the existing arrival or departure swathes at Glasgow Airport to state whether the option will result in overflight of areas not currently affected by aircraft noise or not. This assessment is based on radar tracks of areas currently overflown as well as centreline to centreline	Overfly new areas	Option will not see an increase in frequency of overflight of areas that are less frequently overflown today.	N/A (this is a met or not met assessment)	Option will see an increase in frequency of overflight of areas that are less frequently overflown today.
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.	An assessment of the extent to which impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out are mitigated through the use of offset departures		Option makes use of offset departures for all SIDs	Option makes use of offset departures for some SIDs	Option does not make use of offset departures
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.	An SME assessment of whether the option could contribute to an increase in complexity within controlled airspace (CAS) and whether any increase is tolerable or not. This assessment will review the departure and arrival configurations along with the expected traffic usage on routes in order to understand if there is expected to be an increase or decrease to complexity inside CAS compared to the baseline. It will also highlight where potential mitigations or further investigation may be required; this will investigated further as part of the IOA should the option progress.	Complexity inside CAS	Option is likely to contribute to a reduction in complexity for GLA ATC inside CAS	Option is likely to stay the same or contribute to a tolerable increase in complexity for GLA ATC inside CAS	Option is likely to contribute to an intolerable increase in complexity for GLA ATC inside CAS
		As SME assessment of whether the CAS required to support this option could contribute to a reduction or increase in complexity and bottle necks outside CAS. For the purposes of this assessment, we have made a direct link to assessments undertaken for Design Principle 3 where we looked at which options may offer the potential to reduce volume of controlled airspace within the scope of the existing CAS today, or which options may have the potential to reduce the overall volume of CAS but would require changes outside the boundaries of the existing CAS. In the case where an option is expected to require changes to the boundaries of existing CAS, we have assumed that this has the potential to increase bottlenecks outside of CAS. At this early stage in the process, where we are yet to combine easterly and westerly options into full systems that would allow us to fully assess potential impacts to CAS, this methodology is considered proportionate to give us indicative information about the potential performance of an option.	Bottleneck outside CAS	Option may contribute to a reduction in bottlenecks outside CAS	Option unlikely to affect bottlenecks outside CAS	Option has potential to contribute to an increase in bottlenecks outside CAS

	Design Principle	Approach to Evaluation		Met	Partially Met	Not Met
		To evaluate this option we have considered the CAS infringements recorded by Glasgow ATC between March 2021 and March 2022 against our Illustrative Volume of CAS to see whether, had that volume of CAS been operational at the time, whether the reported infringement would have occurred. In doing this for each option, we have considered whether the particular route option had contributed to a potential CAS reduction in the area of the infringement(s). It is noted that this method of assessment has not considered whether any reduction in CAS anywhere would contribute to an increase in infringements as that is not possible to assess at this time.	Infringements	Option is likely to contribute to a reduction in infringements	Option unlikely to have an impact on infringements	Option may contribute to an increase in infringements
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude (below 7000ft) and network airspace changes (above 7000ft) being coordinated by the FASI North programme.	An SME assessment of whether the option is compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.		No feedback to date to suggest option is not, or cannot be, compatible with the wider FASI North programme	Some feedback that means the option may not be compatible with FASI but it depends on the option taken forward by that sponsor	Feedback received that the option is not compatible with the wider FASI North programme
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.	A comparison of each option to Edinburgh's (EDI) options to see if the routes are procedurally deconflicted. We have assumed a CDO/CCO from/to FL90 in this assessment as 7000ft does not exist in practical terms. The areas of overlap between EDI and GAL, set out in Masterplan Iteration 2 are used to help identify these interactions		All routes are likely to be procedurally deconflicted from EDI up to FL90	Some routes are likely to not be procedurally deconflicted from EDI up to FL90	No routes are procedurally deconflicted from EDI up to FL90
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.	A qualitative statement on whether the options could be expected to increase local air quality emissions. ANG2017 states that 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. Therefore the impact of airspace design on local air quality is generally negligible compared to changes in the volume of air traffic and that of the local transport infrastructures feeding the airport. If an option has a change to flightpaths below 1000ft it will be evaluated as 'Partially Met' however further analysis will be required to determine the scale of change to local air quality.	Local Air Quality	Option has potential to maintain or reduce the level of local air quality emissions	Option has potential to change the location of emissions below 1000ft	Option has potential to increase the level of local air quality emissions
		The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance states that "In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not involve ground-based infrastructure. As such they are unlikely to have a direct impact that would engage the Birds or Habitats legislation." Though there is limited research available on the effects of aircraft noise on wildlife, there is some evidence that disturbance effects associated with aircraft can occur during take-off and landing where aircraft are below around 500m (~1,640ft) . Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft. For the purposes of our assessment ecology is equivalent to biodiversity as described in CAP1616.	Ecological Impacts	The airspace design has the potential to result in decreased ecological impacts compared to the baseline	The airspace design is not expected to result in any changes to ecological impacts compared to the baseline	The airspace design has the potential to result in increased adverse ecological impacts compared to the baseline

Design Principle		Approach to Evaluation		Met	Partially Met	Not Met
		As aircraft emissions arise from the combustion of aviation fuel, the track mileage associated with each airspace design compared to the existing airspace design will be used to inform the qualitative evaluation of this principle.	Climate Change	Option will clearly contribute to an overall reduction in aircraft emissions	Option has potential to maintain or reduce aircraft emissions	Option has potential to contribute to an increase in overall aircraft emissions
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.	Owing to the transition altitude (TA) of 6,000ft, guaranteed procedural continuous climb/decent to/from FL90 in all circumstances is unlikely. However the future designs should maximise the ability for CDO/CCO and improve Glasgow's performance. This is an SME assessment of whether the option is likely to improve, maintain or degrade CCO/CDO performance		Option is likely to improve CCO/CDO performance	Option is unlikely to affect CCO/CDO performance	Option is likely to degrade CCO/CDO performance
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.	A statement as to whether the option can be designed to at least an RNAV1 specification		Option can be designed/ to at least an RNAV1 specification	N/A because the option doesn't require PBN	Option cannot be designed to at least an RNAV 1 specification
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.	There are 5 known outcomes, or ends, that are expected from airspace modernisation as detailed in CAP1711 and Glasgow's Design Principles already encompass 4 out of 5 of these objectives	Maintain and enhance high aviation safety standards	Evaluated in DP1 and DP9		
			Secure the efficient use of airspace and enable integration	Evaluated in DP3 and DP9		
			Avoid flight delays by better managing the airspace network	Evaluated in DP2, DP4		
			Improve environmental performance by reducing emissions and by better managing noise	Evaluated in DP2, DP4, D5, DP6, DP7, DP8, DP11, DP12 and DP13		
			Facilitate defence and security objectives	Option expected to facilitate defence and security objectives	Option not expected to affect defence and security objectives	Option expected to impede defence and security objectives

Table 16: Methodology

Assessment of Design Principles with multiple components

Within our DPE, we have chosen to break some Design Principles into components in order to fairly and transparently evaluate different aspects of the Design Principle. For example the assessment of Design Principle 12 '*Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change'* has been broken down into three components; local air quality, ecological impacts and climate change. In order to assess an options' overall performance against the Design Principle, the following methodology has been applied to all Design Principles that have been broken down into components:

Overall Met	Overall Partially Met	Overall Not Met
All components of the Design Principle are 'Met'	All components of the Design Principle are 'Partially Met' or a mixture of 'Met' and 'Not met'	All components of the Design Principle are 'Not met'

Working Example: Taking DP12 as an example:

			Example #1 Option Performance			
Design Principle		**Component**	Met	Partially Met	Not Met	**Overall Outcome**
12	*Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change'*	Local Air Quality				Met
		Ecological Impact				
		Climate Change				

			Example #2 Option Performance			
Design Principle		**Component**	Met	Partially Met	Not Met	**Overall Outcome**
12	*Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change'*	Local Air Quality				Partially Met
		Ecological Impact				
		Climate Change				

			Example #3 Option Performance*			
Design Principle		**Component**	Met	Partially Met	Not Met	**Overall Outcome**
12	*Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change'*	Local Air Quality				Partially Met
		Ecological Impact				
		Climate Change				

*There could be any permutation of 'met/partially met', 'met/not met', 'partially met/not met', or 'met/partially met/not met' in order for the overall outcome to be partially met.

			Example #4 Option Performance			
Design Principle		**Component**	Met	Partially Met	Not Met	**Overall Outcome**
12	*Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change'*	Local Air Quality				Not Met
		Ecological Impact				
		Climate Change				

The outcome of the overall performance is shown in the 'Summary of the Design Principle Evaluation' section of this document below. The full DPE shown in Annex A shows the breakdown of the performance against each of the components.

Special case (Not Met): Using the methodology outlined above, in the context of the AMS the baseline scenarios would be considered as partially met however a 'do nothing' scenario would not result in any Airspace Modernisation for Glasgow and therefore would fundamentally not meet the AMS. These baseline options therefore are categorised as 'not met' for the AMS design principle.

Summary of the Design Principle Evaluation[22]

The tables below summarise the outcome of the Design Principle Evaluation; this details the outcomes based on the 'Assessment of Design Principles with multiple components' methodology detailed above. The full detail of the Design Principle Evaluation is available in Annex 1.

Notes on the Design Principle Evaluation

The purpose of the DPE is to evaluate each option clearly and transparently against each Design Principle. In order to achieve this, we have set out a clear methodology as described in the section above.

In some cases, when reviewing the DPE in Annex 1, you may note that the word count for the assessment of some options is longer than others. This reflects the evaluation outcomes associated with the specific option as some options may have a greater number of impacts/benefits or points to raise than others. In the case of some options, it may also reflect the assessment of two separate respite configurations which would increase the length of the assessment.

[22] Formatting of the DPE summary tables updated to remove components and show overall outcomes. Some DP2 assessment outcomes updated to reflect update to methodology (see Change record document on CAA portal for further information). V1.3 DPE summary updated following CAA clarifications; please see Annex A for further details.

RWY 05 DEPARTURES											
#	Design Principle	Do Nothing	Option A	Option B	Option C	Option D	Option E	Option F	Option G	Option H	Option I
1	The airspace design and its operation must be as safe or safer than today										
2	Facilitate the growth in quicker, quieter, and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.										
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release-controlled airspace that is not required.										
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.										
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.										
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.										
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.										
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.										
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.										
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.										
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.										
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.										
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.										
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.										
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.										
	Taken forward to IOA?	No but used for comparative purposes only	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

#	RWY 23 DEPARTURES Design Principle	Do Nothing	Option A	Option B	Option C	Option D	Option E
1	The airspace design and its operation must be as safe or safer than today						
2	Facilitate the growth in quicker, quieter, and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.						
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release-controlled airspace that is not required.						
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.						
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.						
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.						
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.						
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.						
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.						
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.						
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.						
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.						
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.						
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.						
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.						
	Taken forward to IOA?	No but used for comparative purposes only	Yes	Yes	Yes	Yes	Yes

#	RWY 05 ARRIVALS							
#	Design Principle	Do Nothing	Option A	Option B	Option C	Option D	Vectors Only	Vectors/PBN hybrid
1	The airspace design and its operation must be as safe or safer than today							
2	Facilitate the growth in quicker, quieter, and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.							
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release-controlled airspace that is not required.							
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.							
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.							
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.							
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.							
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.							
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.							
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.							
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.							
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.							
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.							
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.							
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.							
	Taken forward to IOA?	No but used for comparative purposes only	Yes but only for use in Vectors/PBN hybrid	Yes but only for use in Vectors/PBN hybrid	Yes but only for use in Vectors/PBN hybrid	Yes but only for use in Vectors/PBN hybrid	Yes	Yes

#	RUNWAY 23 ARRIVALS									
#	Design Principle	Do Nothing	Option A	Option B	Option C	Option D	Option E	Option F	Arrival Vectors Only	Vectors/PBN hybrid
1	The airspace design and its operation must be as safe or safer than today		DISCONTINUE	DISCONTINUE				DISCONTINUE		
2	Facilitate the growth in quicker, quieter, and cleaner traffic by configuring the airspace to improve efficiency and meet the forecast demand for air transport.									
3	Design the appropriate volume of controlled airspace to support commercial air transport, enable safe, efficient access for other types of operation and release-controlled airspace that is not required.									
4	Mitigate any future requirements for airborne holding for inbound traffic and holding on the ground pre-departure for outbound traffic.									
5	Minimise the total adverse effects of aircraft noise and visual intrusion on physical and mental health and wellbeing.									
6	Offer communities options for both noise concentration and noise dispersion through the use of predictable and transparent multiple route options and other respite methods that are possible within the technical ATC system, en-route network and procedural constraints.									
7	The arrival and departure routes that serve Glasgow Airport below 7000ft should avoid noise sensitive areas and buildings, national parks, areas of outstanding natural beauty/National Scenic Areas and areas that are not currently affected by aircraft noise.									
8	Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or the vicinity of the immediate climb out, where overflight is unavoidable.									
9	Reduce complexity and bottlenecks in controlled and uncontrolled airspace and contribute to a reduction in airspace infringements.									
10	Collaborate with other Scottish airports and NATS to ensure that the airspace design options are compatible with the wider programme of lower altitude and network airspace changes being coordinated by the FASI North programme.									
11	Routes to/from Glasgow and Edinburgh airports should be procedurally deconflicted from the ground to a preferred level in coordination with NATS Prestwick.									
12	Minimise the growth in aircraft emissions, the further degradation in local air quality and adverse ecological impacts to address growing concerns about the impact of aviation on climate change.									
13	Aircraft operating at Glasgow Airport should climb and descend continuously to/from at least 7000ft with a preference for the most environmentally beneficial option to be chose, if both cannot be achieved simultaneously.									
14	Routes should be designed to meet a RNAV1 specification as a minimum in order to gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport in line with the guidance provided in CAA CAP1385 on enhanced route spacing for PBN and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure.									
15	The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.									
	Taken forward to IOA?	No but used for comparative purposes only	No	No	Yes but only for use in Vectors/PBN hybrid	Yes but only for use in Vectors/PBN hybrid	Yes but only for use in Vectors/PBN hybrid	No	Yes	Yes

Discontinuing Methodology and DPE Outcome

The Design Principle Evaluation itself is considered the main methodology for discontinuing options; at this early stage it provides a broad overview of an options' overall performance against all of the Design Principles and allows us to identify any options that overall perform comparatively poorly. There is no CAP1616 requirement to discontinue options at this early stage, and it is often more appropriate to gather further information from the Initial Options Appraisal (IOA) at Step 2B before choosing to discontinue an option. There are however some exceptions to this when an option has not met certain Design Principles.

With the exception of the DP1 (Safety) which is the top priority and DP15 (AMS) which comes second to safety, Glasgow Airport's Design Principles are not prioritised or weighted. When reviewing the outcomes of the DPE, we therefore first looked to these two prioritised design principles when discontinuing options.

When reviewing DP1 *The airspace design and its operation must be as safe or safer than today*, RWY 23 Arrivals Option A, B and F were categorised as 'Not Met'. This meant that acceptable safety assurances are not likely to be met if the option was to be progressed through the process. These three options have therefore been discontinued. Where this option was categorised as 'Partly Met' this was not grounds for discontinuation at this stage but flagged that further consideration is necessary in the IOA or beyond. It might be that the further consideration of the hazards associated with an option in the IOA means the option could be discontinued. We will not then go back and update the DPE to a "Not Met" as that would have meant the IOA would not have taken place. i.e. Chronologically, the IOA follows the DPE.

We next looked to DP15 *The GLA ACP accords with the CAA's published Airspace Modernisation Strategy (CAP1711), any current or future plans associated with it and all other relevant policies and regulatory standards.* The CAA has requested evidence that the Design Principle Evaluation includes an assessment of how the different Design Options respond to the relevant AMS Design Principle:
"Subject to the overriding design principle of maintaining a high standard of safety, the highest priority principle of this airspace change that cannot be discounted is that it accords with the CAA's published Airspace Modernisation Strategy (CAP 1711) and any current or future plans associated with it."

The four 'do nothing' scenarios did not meet the AMS Design Principle as they would not offer the opportunity for the airspace to be modernised, nor would they address the statement of need or enable any environmental or operational benefits; these four scenarios have therefore been discontinued. The 'do nothing' scenarios will however remain present throughout the ACP for baseline comparative purposed only.

All of the remaining options partially meet the AMS design principle. This is because there are many competing factors within the parameters of the AMS, and there is a inevitably a balance to be achieved between these. We therefore decided to not discontinue any further options on the sole basis of the AMS, until we understood more detail about their benefits and impacts at the IOA.

We finally looked to the remainder of the Design Principles to understand if there are any options that overall performed comparatively poorly against the remaining 13 Design Principles. When reviewing the departure options, we found a mix of performance across the options and design principles and given the design principles themselves are not prioritised, all the remaining options proceed to the Initial Options Appraisal.

When reviewing the arrival options, we found that the use of pure PBN for arrivals into Glasgow does not overall perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. It would not meet forecast demand (DP2) which is a key component of the Statement of Need and also the AMS but ultimately vectoring of arrivals to some extent would still be routinely required. However, the DPE showed that the option of a mix of PBN arrivals and vectoring (created to overcome this issue with pure PBN for arrivals above) does come through very favourable. In this scenario, we would want to use the best performing PBN routes so we chose to take the PBN arrival options (other than the ones discounted above) into the Initial Options Appraisal for further assessment to help inform the hybrid vectors and PBN options.

The following table summarises the options proceeding to Step 2B:

Group	Option	Continued to IOA
Runway 05 Departures	Do nothing	✗
	A	✓
	B	✓
	C	✓
	D	✓
	E	✓
	F	✓
	G	✓
	H	✓
	I	✓
Runway 05 Arrivals	Do nothing	✗
	A	Yes but only for use in Vectors/PBN hybrid
	B	Yes but only for use in Vectors/PBN hybrid
	C	Yes but only for use in Vectors/PBN hybrid
	D	Yes but only for use in Vectors/PBN hybrid
	Vectors	✓
	Vectors and PBN	✓

Group	Option	Continued to IOA
Runway 23 Departures	Do nothing	✗
	A	✓
	B	✓
	C	✓
	D	✓
	E	✓
Runway 23 Arrivals	Do nothing	✗
	A	✗
	B	✗
	C	Yes but only for use in Vectors/PBN hybrid
	D	Yes but only for use in Vectors/PBN hybrid
	E	Yes but only for use in Vectors/PBN hybrid
	F	✗
	Vectors	✓
	Vectors and PBN	✓

Next steps

The next stage of the ACP process involves undertaking an Initial Options Appraisal (IOA) of the remaining options, to understand in further detail the benefits and impacts. The IOA is the first of three phases of appraisal undertaken as part of the Airspace Change. It forms part of the iterative process of CAP616 whereby the detail of analysis builds as options progress through the process. As part of our DPE, we noted that some elements of some options may require further investigation, and this will form part of our Initial Options Appraisal.

This step of the process will help us to generate a shorter list of preferred options to take into Stage 3.

Glossary

Acronym	Term	Description
ACOG	Airspace Change Organising Group	Established in 2019 at the request of the Department for Transport and Civil Aviation Authority to coordinate the delivery of key elements of the UK's Airspace Modernisation Strategy.
ACP	Airspace Change Proposal	To carry out any permanent change to the published airspace, the Civil Aviation Authority (CAA) requires the change sponsor to carry out an airspace change proposal in accordance with CAP1616.
ADS-B	Automatic Dependent Surveillance Broadcast	A means by which aircraft can automatically transmit and/or receive data such as identification, position, and additional data, as appropriate in a broadcast mode via a data link.
AIP	Aeronautical Information Publication	A publication which contains details of regulations, procedures and other information pertinent to the operation of aircraft in the particular country to which it relates.
AMS	Airspace Modernisation Strategy	UK Government has tasked the aviation industry to modernise airspace in the whole of the UK. The long-term strategy of the CAA and the UK Government is called the Airspace Modernisation Strategy (AMS). Its CAA document reference number is CAP1711.
AMSL	Above Mean Sea Level	
ANSP	Air Navigation Service Provider	An organisation that provides the service of managing the aircraft in flight or on the manoeuvering area of an airport and which is the legitimate holder of that responsibility.
AONB	Area of Outstanding Natural Beauty	
ATC	Air traffic control	The ground-based personnel and equipment concerned with controlling and monitoring air traffic within a particular area.
ATZ	Aerodrome Traffic Zone	An airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.
CAA	Civil Aviation Authority	The UK Regulator for aviation matters
CAP1616	Civil Aviation Publication 1616	The airspace change process regulated by the CAA
	Capacity	A term used to describe how many aircraft can be accommodated within an airspace area without compromising safety or generating excessive delay
CAS	Controlled Airspace	Generic term for the airspace in which an air traffic control service is provided as standard; note that there are different sub classifications of airspace that define the particular air traffic services available in defined classes of controlled airspace.
-	Centreline	The nominal track for a published route

Acronym	Term	Description
-	Concentration	Refers to a density of aircraft flight paths over a given location, this generally refers to high density where tracks are not spread out; this is the opposite of dispersal
CCO	Continuous Climb Operations	An aircraft operating technique facilitated by the airspace and procedure design and assisted by appropriate ATC procedures, allowing the execution of a flight profile optimised to the performance of aircraft, leading to significant economy of fuel and environmental benefits in terms of noise and emissions reduction
CDO	Continuous Descent Operations	An aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight to the extent permitted by the safe operation of the aircraft and compliance with published procedures and ATC instructions
-	Conventional navigation	The historic navigation standard where aircraft fly with reference to ground-based radio navigation aids
-	Conventional route	Routes defined to the conventional navigation standard, i.e. using ground based radio navigation beacons to determine their position.
CTA	Control Area	Controlled airspace extending upwards from a specified limit above the earth. Control Areas are situated above the Aerodrome Traffic Zone (ATZ) and afford protection over a larger area to a specified upper limit.
CTR	Control Zone	Controlled airspace extending upwards from the surface of the earth to a specified upper limit. Aerodrome Control Zones afford protection to aircraft within the immediate vicinity of aerodromes
db	Decibels	A unit used to measure the intensity of a sound (or the power level) of an electrical signal by comparing it with a given level on a logarithmic scale.
DER	Declared End of Runway	
-	Dispersal	Refers to the density of aircraft flight paths over a given location, this generally refers to lower density – tracks that are spread out; this is opposite of Concentration
DPE	Design Principle Evaluation	A evaluation of each option against each design principle which forms part of Stage 2A of the CAP1616 process
-	Easterlies	When a runway is operating such that aircraft are taking off and landing in an easterly direction
-	Final Approach	The final part of an arrival flight path that is directly lined up with the runway
FL	Flight Level	The Altitude above sea-level in 100 feet units measured according to a standard atmosphere. A flight level is an indication of pressure, not of altitude. Only above the transition level (which

Acronym	Term	Description
		depends on the local QNH but is typically 4000 feet above sea level) are flight levels used to indicate altitude; below the transition level feet are used.
FLARM	Flight Alarm	FLARM (an acronym based on 'flight alarm') is the proprietary name for an electronic device which is in use as a means of alerting pilots of small aircraft, particularly gliders, to potential collisions with other aircraft which **are similarly equipped.**
FUA	Flexible Use Airspace	Airspace which is not solely designated for a single purpose, but can be allocated flexibly according to need, or switched entirely on/off according to a schedule or agreed process.
-	Flight-path	The track flown by aircraft when following a route, or when being directed by air traffic control
ft	Feet	The standard measure for vertical distances used in air traffic control
FASI	Future Airspace Implementation Strategy	Under the Government's Airspace Modernisation Strategy (AMS, ref 15) airports in the UK are required to update their airspace and routes in a coordinated way.
GA	General Aviation	All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire. The most common type of GA activity is recreational flying by private light aircraft and gliders, but it can range from paragliders and parachutists to microlights, balloons, and private corporate jet flights.
IFP	Instrument Flight Procedures	A published procedure used by aircraft flying in accordance with the instrument flight rules, which is designed to achieve and maintain an acceptable level of safety in operations and includes an instrument approach procedure, a standard instrument departure, a planned departure route and a standard instrument arrival.
ILS	Instrument Landing System	An ILS operates as a ground-based instrument approach system that provides precision lateral and vertical guidance to an aircraft approaching and landing on a runway, using a combination of radio signals to enable a safe landing even during poor weather.
IOA	Initial Options Appraisal	A qualitative appraisal of an option against a baseline 'do nothing' scenario, as required at Step 2B of CAP1616
L_{Aeq}		The most common international measure of noise, meaning, 'equivalent continuous sound level'. This is a measurement of sound energy over a period of time.
$L_{Aeq\ 16h}$		The A-weighted Leq measured over the 16 busiest daytime hours (0700-2300) is the normal time-period used to develop the Airport Noise Contours for day-time operations.

Acronym	Term	Description
$L_{Aeq\ 8h}$		The A-weighted Leq measured over the 8 night-time hours (2300-0700) is the normal time-period used to develop the Airport Noise Contours for night-time operations.
-	Lower Airspace	Airspace in the general vicinity of the airport containing arrival and departure routes below 7,000ft. Airports have the primary accountability for the design of this airspace, as its design and operation is largely dictated by local noise requirements, airport capacity and efficiency
NAP	Noise Abatement Procedures	Noise abatement procedures are designed to minimise exposure of residential areas to aircraft noise, while ensuring safety of flight operations
NATS (ATC)		NATS ATC - the air navigation service provider at Glasgow Airport under commercial contract for the aerodrome control provision.
NATS NERL		NATS NERL - The UK's licenced air traffic service provider for the en route airspace (upper network) that connects airports with each other, and with the airspace of neighbouring states.
nm	Nautical Mile	Aviation measures distances in nautical miles. One nautical mile (nm) is 1,852 metres. One road mile ('statute mile') is 1,609 metres, making a nautical mile about 15% longer than a statute mile.
-	Network Airspace / Upper network	En route airspace above 7,000ft in which NATS has accountability for safe and efficient air traffic services for aircraft travelling between the UK airports and the airspace of neighbouring states.
NTK	Noise Track Keeping	A system that monitors and records radar data to monitor aircraft operations and report statistics focused around noise.
PANS OPS	Procedures for Air Navigation Services Aircraft Operations	PANS-OPS is contained in an ICAO Document 8168 which sets out the design criteria and rules for instrument flight procedures which include approach and departure procedures.
PBN	Performance Based Navigation	Referred to as PBN; a generic term for modern standards for aircraft navigation capabilities including satellite navigation (as opposed to 'conventional' navigation standards)
PC	Prestwick Centre	Prestwick Centre handles air traffic across northern England, Scotland and out into North East Atlantic.
RMA	Radar Manoeuvring Area	An ATC operational area articulated as a volume of airspace by the ANSP. It facilitates the close-in radar vectoring by ATC that is required to take the aircraft safely from a holding stack and established onto final approach.
RNAV / RNAV 1	aRea NaVigation	This is a generic term for a particular specification of Performance Based Navigation. The suffix '1' denotes a requirement that

Acronym	Term	Description
		aircraft can navigate to with 1nm of the centreline of the route 95% or more of the time. In practice the accuracy is much greater than this.
RNP-RF	Required Navigation Performance – Radius to fix	An advanced navigation specification under the PBN umbrella. The suffix '1' denotes a requirement that aircraft can navigate to with 1nm of the centreline 95% or more of the time, with additional self-monitoring criteria. In practice the accuracy is much greater than this. The RF means Radius to Fix, where airspace designers can set extremely specific curved paths to a greater accuracy than RNAV1.
RNP-AR	Required Navigation Performance – Authorisation required	An advanced navigation specification under the PBN umbrella. 'Authorisation required' refers to aircraft and operators complying with specific airworthiness and operational requirements. RNP-AR allow airspace designers to set extremely specific curved paths to a greater accuracy than RNAV1, these can be designed before and after the Final Approach Fix.
-	Separation	Aircraft under Air Traffic Control are kept apart by standard separation distances, as agreed by international safety standards. Participating aircraft are kept apart by at least 3nm or 5nm lateral separation (depending on the air traffic control operation), or 1,000ft vertical separation.
SID	Standard Instrument Departure	Usually abbreviated to SID; this is a route for departures to follow straight after take-off.
	Tactical Intervention	Air traffic control methods that involve controllers directing aircraft for specific reasons at that particular moment (see Vector)
TMA / ScTMA	Terminal Manoeuvring Area (Terminal Airspace) / Scottish Terminal Manoeuvring Area	An aviation term to describe a designated area of controlled airspace surrounding a major airport or cluster of airports where there is a high volume of traffic. The airspace surrounding Glasgow & Edinburgh airports is described as the Scottish TMA (ScTMA). This is the airspace that contains all the arrival and departure routes for Glasgow & Edinburgh from the surface to 6000ft.
TMZ	Transponder Mandatory Zone	Airspace of defined dimensions where the carriage and operation of transponder equipment is mandatory.
VFR	Visual Flight Rules	Visual Flight Rules (VFR) are the rules that govern the operation of aircraft in Visual Meteorological Conditions (VMC) (conditions in which flight solely by visual reference is possible)
VMC	Visual Meteorological Conditions	Visual meteorological conditions (VMC) are the meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima
VSA	VFR Significant Area	A volume of airspace which has been identified as being particularly important to VFR operations. A VSA might take the

Acronym	Term	Description
		form of a route, a zone, or an area chosen for its particular importance to GA users. These areas do not have any official status but are intended to highlight the importance of a particular area so that future airspace development plans can take account of the GA activity.
-	Vector / vectoring	An air traffic control method that involves directing aircraft off the established route structure or off their own navigation – ATC instruct the pilot to fly on a compass heading and at a specific altitude. In a busy tactical environment, these can change quickly. This is done for safety and for efficiency.
-	Westerly operation	When a runway is operating such that aircraft are taking off and landing in a westerly direction