Glasgow Airport Airspace Change Proposal

Stage 3
Full Options Appraisal

Consultation 20 October 2025 to 25 January 2026
ACP-2019-46

GLASGOW AIRPORT

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1. Introduction

1.1 Airspace Modernisation

1.1.1 In 2017 the Department of Transport (DfT) notified aviation stakeholders that, as demand for aviation is forecast to continue growing, delays and environmental impacts are expected to increase if the UK's airspace is not upgraded to introduce additional capacity.

1.1.2 In response, the Civil Aviation Authority (CAA) was tasked to develop the UK Airspace Modernisation Strategy (AMS) which was first published in December 2018.

1.1.3 The overall programme of changes required to implement the AMS is considered one of the most significant airspace and Air Traffic Management (ATM) developments ever undertaken. Some of the most important changes described in the AMS concern the widespread adoption of satellite-based navigation technology, known as Performance Based Navigation (PBN).

1.2 Airspace Change Organising Group (ACOG) and the Masterplan

1.2.1 The Airspace Change Organising Group (ACOG) was formed in 2019 under the direction of the UK Government Department for Transport (DfT) and Civil Aviation Authority (CAA), who co-sponsor and regulate airspace modernisation. ACOG is tasked with developing the UK Airspace Change Masterplan (the Masterplan), with oversight from an impartial Steering Committee of senior representatives drawn from across the aviation sector. More information is available on ACOG's website, www.acog.aero.

1.2.2 The UK's airspace is being upgraded as part of the UK Government's airspace modernisation programme. This includes redesigning the arrival and departure routes that serve many of the UK's airports. Airspace modernisation will be delivered, in part, through a series of linked ACPs. Eighteen of the UK's airports are sponsoring ACPs to upgrade the arrival and departure routes that serve their operations in the lower airspace (below 7,000 ft). NATS, the UK's licensed Air Navigation Service Provider for en route operations, is currently sponsoring seven ACPs to upgrade the route network that sits above 7,000 ft, in busy portions of airspace where there are lots of climbing and descending flights, referred to as Terminal Control Areas (TMAs).

The Masterplan

1.2.3 Airspace modernisation is a complex programme, with many organisations working together on a single coordinated implementation plan out to 2040 – the Masterplan. The changes that make up the Masterplan will upgrade the UK's airspace and deliver the objectives of the Government's AMS.

1.2.4 The Masterplan is organised into four regional clusters (shown in Figure 1) so that the simpler airspace changes can be deployed sooner, realising benefits earlier. The timelines for making airspace changes are generally shorter for the simpler clusters where there are fewer airports and less complex interdependencies between the airport ACPs.

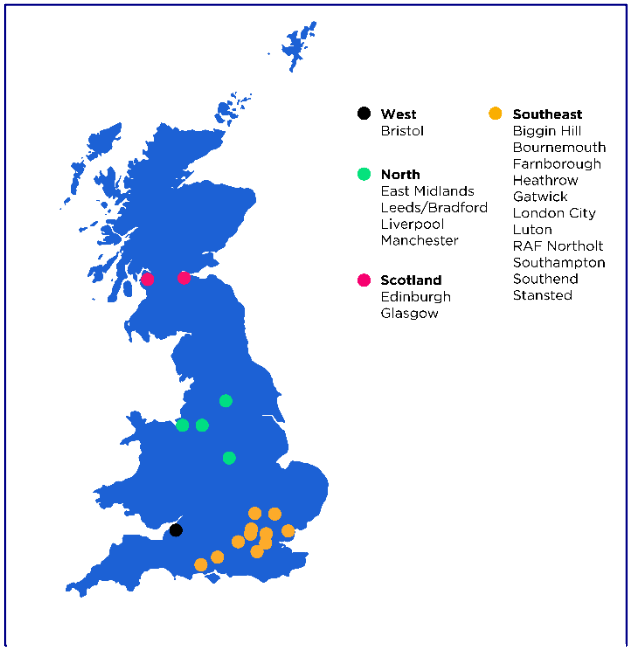


Figure 1 Four clusters of the Airspace Change Masterplan and airport sponsored ACPs

1.3 Scottish Airspace Modernisation

1.3.1 Glasgow Airport's ACP forms part of a wider Scottish Airspace Modernisation proposal. This is formed between Glasgow Airport, Edinburgh Airport and NATS EN-route Ltd (NERL). Within The Masterplan, it is referred to as the Scottish Terminal Control Area (ScTMA) cluster.

1.3.2 Glasgow Airport and Edinburgh Airport are responsible for the modernisation of their departure and arrival routes below 7,000ft and the airports Controlled Airspace. NERL are responsible for connecting these routes into the network airspace, and the wider route network above 7,000ft.

1.3.3 The three ACPs are being progressed independently however there are design interdependencies between the proposals i.e. a change to Glasgow Airport's design may result in a knock-on change for NERL and/or Edinburgh Airport.

1.3.4 This means that Glasgow Airport, Edinburgh Airport and NERL, coordinated by ACOG, have worked closely together to develop the Scottish Airspace Modernisation proposal.

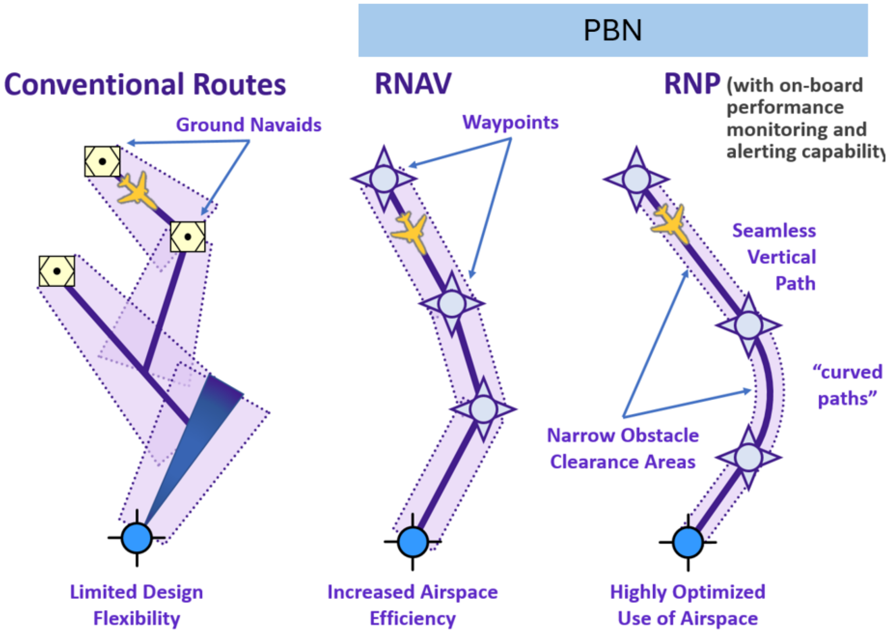
1.3.5 This Full Options Appraisal document describes the evolution of Glasgow Airport's options as a result of the overall Scottish Airspace Modernisation proposal before then focusing on the appraisal of the specific Glasgow Airport options taken forward to this FOA. ACOG have published a number of documents that present information about the development and outcomes of the system wide Scottish Airspace Modernisation proposal. As we progress through this document, we will provide information and links to the relevant ACOG documentation which shows how the Glasgow Airport proposal fits within the wider system design.

1.4 Performance Based Navigation (PBN)

1.4.1 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, over 99% of the current commercial air transport fleet operates almost exclusively using avionics that also use 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.

1.4.2 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.

1.4.3 Figure 2 shows the types of PBN specification which have been considered by Glasgow Airport.



RNP can enable the use of curved paths and some of the designs proposed in our ACP utilise this functionality although not all aircraft are capable of flying the curved-paths.

RNP is also used for certain types of final approach procedures.

RNAV can use both GNSS and ground-based navigation aids, whereas RNP uses GNSS only.

ANSPs are required to ensure they have sufficient procedures to cater for GNSS outage and/or interference.

To ensure we gain maximum benefit of the performance capabilities of the modern aircraft fleet operating at Glasgow Airport and provide sufficient resilience and redundancy against Global Navigation Satellite System (GNSS) failure (DP14), Glasgow's proposals have a mix of both RNAV, and RNP departures together with RNAV, RNP and some conventional arrival procedures procedures.

Figure 2 Types of Performance Based Navigation considered as part of the Glasgow Airport option design

1.5 CAP1616

1.5.1 Since January 2018 any changes to airspace are required to follow the CAA's CAP1616 regulatory guidance. CAP1616 outlines a 7-stage process for changing airspace design, including community engagement requirements as shown in Figure 3.

1.5.2 A key principle of the airspace change process is that it is as transparent as possible throughout. Those potentially affected by an airspace change proposal should feel confident that their voice has a formal place in the airspace change process.

1.5.3 The CAA monitors the progress of an airspace change proposal against the requirements of the airspace change process at key defined points, called gateways. At each gateway, the CAA will assess whether the relevant airspace change process requirements have been met. The gateways are there to determine whether the airspace change process has been followed up to that point, and whether to approve the progress to the next stage.

1.5.4 In early 2023 the CAA conducted a public consultation on proposed changes to CAP1616, and Edition 5 of the document was published at the end of October 2023. In November 2023 the CAA wrote to Glasgow Airport to inform them that Stage 3 of the CAP1616 should be carried out in accordance with Edition 5.

1.5.5 As such, this Full Options Appraisal and all our Stage 3 documentation will be based on the guidance provided in Edition 5 of CAP1616 and CAP1616f, Guidance on Airspace Change Process for Permanent Airspace Change Proposals. Stages 1 and 2 of the Glasgow ACP were written in accordance with CAP1616 Edition 4, which is available here.

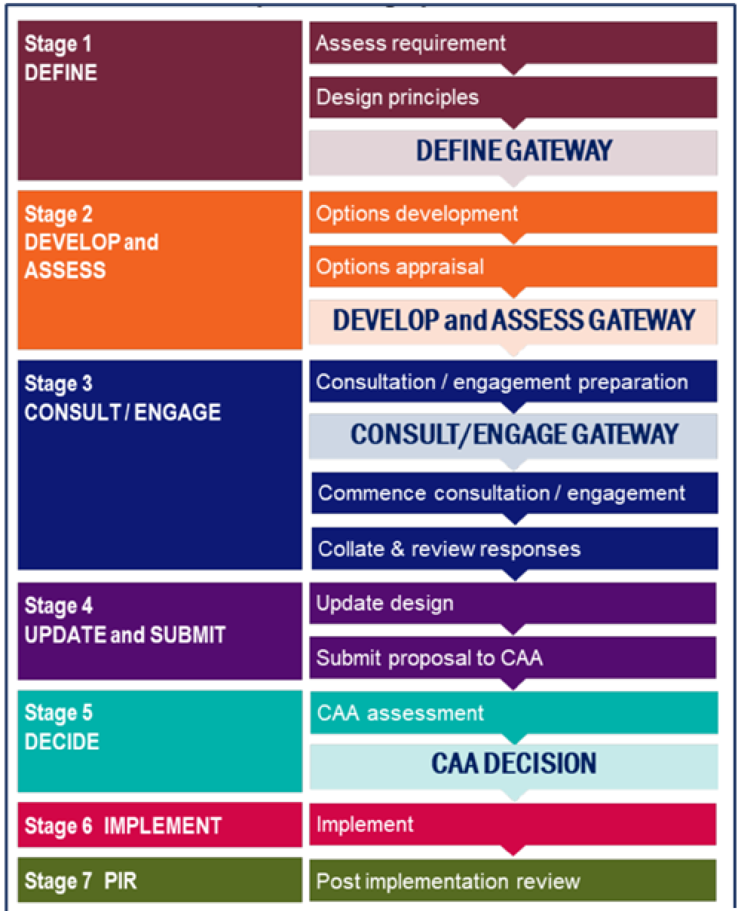


Figure 3 CAP1616 (Edition 5) 7-Stages

1.6 Glasgow Airport's Airspace Change Proposal

1.6.1 Glasgow Airport Limited (Referred to as 'Glasgow Airport', 'we', or 'our' throughout this document) began the ACP to modernise our 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 Glasgow Airport to recommence our ACP in May 2021.

1.6.2 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.

Table 1 ACP progress to date

Airspace Change Stage	Summary	Link to Documents (Also available on the ACP portal)
Stage 1A	In June 2019, Glasgow Airport submitted their 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.	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	Stage 2A DPE Submission Document

	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 (DPE). Our comprehensive list of options is then shortlisted before progressing to Stage 2B. Our Stage 2A document provides details of this process, and our shortlisted options following the DPE.	
Stage 2B	At Stage 2B an Airspace Change Sponsor is required to undertake an Initial Options Appraisal (IOA) of the airspace change options which proceed from Stage 2A. The IOA initially described the options under assessment and the baseline option, followed by explaining the methodology used to assess each option, and then the IOA outcome. At the end of the document we explained, based on the IOA, the options which were taken forward to Stage 3 and the preferred option.	Stage 2B IOA Document
Stage 3	At Stage 3, an airspace change sponsor is required to plan for stakeholder consultation and engagement by preparing a Consultation Strategy, Consultation documents, and a Full Options Appraisal (FOA). The FOA is the second phase of appraisal, following the IOA at Stage 2B, with more rigorous analysis of the impacts and benefits of this proposed airspace change options. The following sections of the document initially describe the options taken forward from Stage 2B, and how they have been developed further following integration with the wider airspace and Instrument Flight Procedure (IFP) design. It then describes the options under assessment at Stage 3 and the baseline ‘do nothing’ option, followed by explaining the methodology used to assess each option, and then the FOA outcome. At the end of the document we explain, based on the FOA outcome, the options we intend to take to consultation and our preferred option.	This document

1.7 This Full Options Appraisal (FOA) document

1.7.1 This Full Options Appraisal (FOA) document forms part of Glasgow Airport's Stage 3 submission to the CAA. The FOA is part of a suite of materials that are presented within the Stage 3 public consultation. It is a more technical document which:

- Describes the evolution of the options from Stage 2 to Stage 3, including technical procedure design and network integration (Section 3)
- Describes the methodology used to assess each option based on the assessment categories required by CAP1616 (Section 4)
- Explains the baseline 'do nothing' pre-implementation scenario (Section 5.1)
- Compares each option against the baseline scenario to identify the positive benefits and negative impacts of each option. (Section 5)
- Draws conclusions based on these assessments around the preferred option to take forward to Consultation (Section 6)

1.7.2 As part of our Consultation materials, we have created a glossary and terminology explained document which may be beneficial to refer to when reading this document.

1.7.3 When developing a FOA, airspace change sponsors are required to ensure the FOA meets certain requirements, as listed in CAP1616. These are outlined in Table 2 alongside details about where to find the information within this document.

Table 2 CAP1616 Full Options Appraisal requirements and where to find in this document

CAP1616 Full Options Appraisal Requirement	Where to find in this document
Each shortlisted design option fully developed, including a comparison of its impacts against the baseline scenarios	A description of how the design options have been developed can be found in Section 3 Evolution of options. Comparison of each options positive benefits and negative impacts against the without airspace change pre-implementation baseline can be found in Section 7 Full Options Appraisal.
All evidence gaps identified at Stage 2 fully assessed	The methodology section (section 4), includes details of the evidence gaps from Stage 2 and how these have been addressed in the FOA.
All reasonable costs and benefits quantified	

CAP1616 Full Options Appraisal Requirement	Where to find in this document
All other costs and benefits described qualitatively	The methodology section (Section 4) explains our approach to quantitatively and qualitatively appraising the options, including justification for the approach if not quantified. The Full Options Appraisal section (section 5) then describes these costs and benefits for each option against the 'without airspace change' pre-implementation baseline.
Reasons why costs and benefits have not been quantified	
Detail on the preferred design option, setting out reasons for the preference (where relevant)	Details of the FOA conclusions can be found in 'FOA summary and conclusion' (section 6) including which option we are taking to Consultation as our preferred option.
A more detailed assessment of the impacts on safety, if completed by the change sponsor	Details of the methodology for assessing safety can be found in section 4.3 Full Options Appraisal Methodology and the safety assessments themselves are then including in section 5.
A quantified and monetised environmental assessment of the design options, including direct and consequential impacts	Full details of the assessments of environmental impacts are included in section 5 Full Options Appraisal. Net Present Value (NPV) and Cost Benefit Analysis (CBA) tables are included in section 6 FOA summary and conclusions.

All airspace design options in this document are subject to change throughout the next stages of the airspace change process as options are matured in detail and refined in accordance with safety requirements and as an outcome of the Stage 3 public consultation.

1.8 Scottish Airspace Modernisation system wide design

1.8.1 The options included within this FOA form part of a wider design which aims to modernise Scottish Airspace. There are three interdependent Airspace Change Proposals (ACPs) that form the Scottish Terminal Manoeuvring Area (ScTMA) Cluster of the FASI-N programme being co-ordinated by the Airspace Change Organising Group (ACOG) (referred to as Scottish Airspace Modernisation in the consultation material). This proposal is Glasgow's part in the redesign of the wider area referred to as the ScTMA cluster. This cluster also includes a proposal from Edinburgh Airport for their routes below 7,000ft and also one for NATS EN-route Ltd (NERL) for the network connecting routes above and beyond the airports.

1.8.2 The ACPs in the ScTMA cluster must adhere to CAP1616 and the UK Airspace Change Masterplan Iteration 3 – ScTMA (referred to as 'the Masterplan').

1.8.3 The Masterplan outlines how the options in each cluster ACP relate to one another (their interdependencies), including any design conflicts and the potential solutions. The Masterplan includes a Cumulative Analysis Framework (CAF), described here, that considers the cumulative and collective impacts of the cluster ACPs when viewed as an integrated system. Cumulative impacts occur when specific options from different ACPs overlap in the same airspace below 7,000 ft. In contrast, collective impacts represent the combined positive and negative effects of all the cluster ACPs combined.

1.8.4 The CAF guides ACP sponsors in identifying the interdependencies between their proposals and provides a suite of metrics to evaluate the potential solutions to design conflicts, highlighting where there may be trade-offs, for example between mitigating noise and reducing greenhouse gas emissions. The CAF ensures that the cumulative and collective impacts of the cluster ACPs have been considered by the sponsors when developing their individual proposals.

1.8.5 The CAF has three parts that are aligned to the three phases of options appraisal that the individual ACPs are required to conduct in the CAP1616 process. These parts are explained below and summarised in Table 3.

1.8.6 The CAF Part 1 (CAF1) provides a basis for the ACP sponsors to collaborate on the identification of interdependencies and resolution of any design conflicts, before producing the CAP1616 Full Options Appraisals. The outputs of the CAF1 review for the Scottish cluster ACPs are reported in the Masterplan Iteration 3 – Scotland here. The CAF1 outputs are also summarised in ACOG's document titled 'Description of the proposed system-wide design for the Scottish (ScTMA) Cluster of the Airspace Change Masterplan'.

1.8.7 **The CAF Part 2 (CAF2)** provides more information on how the options presented by the ACP sponsors for consultation work together as a system. The CAF2 is produced by combining information from each sponsors' Full Options Appraisal. The result is a suite of tables and diagrams to match those presented in the Full Options Appraisals for each ACP, showing the cumulative and collective impacts for the cluster as a whole, rather than the impacts for each proposal in isolation.

1.8.8 **Cumulative data** helps stakeholders identify where and how they may be affected by more than one ACP at or below 7,000ft (e.g. a person is overflown by 10 aircraft a day from one ACP and 20 from another ACP – giving a cumulative overflight impact from both ACPs of 30 over flights per day for that person (Note that within Scottish Airspace Modernisation, there are no cumulative overflight impacts between Edinburgh and Glasgow Airports).

1.8.9 **Collective data** describes the overall performance of all the ACPs when considered as a single cluster.

1.8.10 The outputs of the CAF2 review are expected to be of value to stakeholders who are interested in the impacts of the three Scottish cluster ACPs when viewed as a system. The CAF2 report has been produced by ACOG using information from Edinburgh, Glasgow and NATS' Full Options Appraisals and can be found in this proposal in Annex A. The CAF2 outputs have also been summarised in ACOG's document titled 'Description of the proposed system-wide design for the Scottish (ScTMA) Cluster of the Airspace Change Masterplan'.

1.8.11 The **CAF Part 3 (CAF3)** will be produced after the consultation, once the preferred designs have been finalised by the ACP sponsors, incorporating stakeholder feedback. The CAF3 will use information from the Stage 4 Final Options Appraisals produced for the Edinburgh, Glasgow and NERL ACPs.

Table 3 CAF Stages as summarised in ScTMA Masterplan Iteration 3

CAF Phase	Key characteristics and use	Link to CAP1616 and Masterplan
CAF1: Review of Route Interdependencies, Design Conflicts and Trade-Offs	• Provides an assessment of design conflicts and trade-offs between route options in interdependent ACPs • Provides a basis for sponsors to resolve design conflicts considering collective performance (including cumulative impacts) • Trade-off information may be drawn from Initial Options Appraisals • Qualitative, with additional quantitative assessment added where necessary	• Prior to sponsors starting CAP1616 Full Options Appraisal • Outputs will be presented in the Stage 3 Consult Gateway submissions and Masterplan Iteration 3 • CAF1 information in Masterplan Iteration 3 demonstrates how cumulative impact, collective impact and trade-offs have been accounted for in the design pre-consultation

CAF2: Full CAF	• Identifies cumulative impact of consultation options • Generation of information to describe collective cluster -wide performance and trade-offs for consultation options • Comparison between cluster-wide consultation option(s) and the cluster-wide baseline • Information drawn from Full Options Appraisals	• After each sponsor in the cluster has completed Full Options Appraisal • Outputs are presented in the Stage 3 Consult Gateway submissions and Masterplan Iteration 4
CAF3: Final CAF	• Identifies cumulative impacts of final designs • Generation of information to describe collective performance and trade-offs in the final cluster-wide design • Comparison between final cluster-wide design and the cluster-wide baseline • Information drawn from Final Options Appraisals	• After each sponsor in the cluster has completed Final Options Appraisal • Outputs will be presented in Masterplan Iteration 4 • Comparison of CAF3 and CAF2 output in Masterplan Iteration 4 will demonstrate how cumulative impact, collective impact and trade-offs have been affected by the design updates in Stage 4

2. Evolution of the options

2.1 Options following Stage 2B Initial Options Appraisal

2.1.1 As part of Stage 2A, Glasgow Airport developed a comprehensive list of options based on the Stage 1 Design Principles and the Statement of Need. Following Stakeholder engagement, there were 32 options on the comprehensive list. These 32 options went through to the Design Principle Evaluation (DPE) where each option was evaluated against each Design Principle before being initially shortlisted.

2.1.2 28 options proceeded to the Initial Options Appraisal (IOA) (9 Runway 05 departure, 8 Runway 23 departure, 6 runway 05 arrival and 5 runway 23 arrival options). The IOA compared each option against a 'do nothing' pre-implementation baseline, to understand the potential positive benefits and negative impacts of each option. Following the detailed assessments of each option, further options were shortlisted and Table 4 outlines those which were taken forward to Stage 3 which is where we are now.

2.1.3 For the purposes of this FOA and the subsequent consultation documentation, we have renamed the options and so Table 4 also includes information about how we have referred to the options throughout the documentation.

Table 4 Options taken forward from Stage 2

Runway	Arrival / Departure	Stage 2 IOA Option Name	FOA Option Name
23	Departure	Option A	Offset SIDs
		Option E	Straight ahead (No offset) SIDs
23	Arrival	PBN Option D (Hybrid with vectors)	PBN and vectors
		Vectors Only	Vectors only
05	Departure	Option H	Offset SIDs
		Option I	Straight ahead (No offset) SIDs
05	Arrival	PBN Option B (Hybrid with vectors)	PBN and vectors
		Vectors Only	Vectors only

What do we mean by 'Vectors only' and 'Vectors and PBN'?

2.1.4 In terms of arrivals, the vectors only options mean that there is no set route flown between the holding stacks, that form part of the NATS NERL ACP, and the final approach procedures. The final approach is where aircraft descend along the extended runway centreline in preparation for landing. Rather than a route, aircraft would always be vectored by Air Traffic Control, this means that pilots are given instructions about where to fly based on compass headings and descent / climb instructions. Vectoring of arrivals is what happens today and typically leads to lots of dispersion across the airspace.

2.1.5 When referring to PBN and Vectoring, this means there is now a PBN arrival route between the holding stack and the final approach. This typically leads to concentration of flight paths along the PBN route however sometimes; in order to achieve safe separation and optimum spacing between aircraft, ATC will still be required to vector aircraft. This means there is a hybrid combination of the use of PBN routes and vectoring. On some occasions ATC may also look to utilise certain waypoints on the PBN route to position aircraft directly to those points.

What do we mean by 'Offset SIDs' and 'Straight ahead (no offset) SIDs'?

2.1.6 Departure route procedures are called Standard Instrument Departures (SIDs). As part of Stage 2, we developed some options which use 'offset SIDs'. This means that when the aircraft reach 500ft on departure, the aircraft would undertake a 'track adjustment' which is a very small turn of an angle of no more than 15 degrees. This means that aircraft are offset slightly compared to a straight ahead take off where aircraft continue straight ahead along the extended runway centreline.

2.2 Option Rationalisation and Refinement

2.2.1 Ahead of the Full Options Appraisal, options undergo a rationalisation and refinement phase. This is where options are developed and refined as part of:

- Full airport system option development
- Integration with the network airspace and neighbouring airports
- Technical IFP development and operational viability assessments

2.2.2 As part of this work, some options may be discontinued ahead of undertaking the main FOA analysis. 4.13 of CAP1616f explains '*The change sponsor may undertake further work as part of the design process to rationalise and refine their design options before completing the full options appraisal. This further work may be especially necessary for complex airspace change proposals, or where there are a significant number of design options remaining after the initial options appraisal. As a result of this work, the change sponsor may decide not to progress some of the design options that were initially shortlisted at the end of Stage 2 on to the full options appraisal. The change sponsor must provide a robust rationale supported with appropriate evidence, justifying why certain design options were not progressed to the full options appraisal. This rationale plus the supporting evidence must be clearly explained in any consultation/engagement materials and in the final airspace change proposal submitted to the CAA.'*

2.2.3 The following subsections outline the various considerations as part of the rationalisation and refinement of the options before describing the evolution of the options.

Full airport system option development

2.2.4 The Stage 3 Full Options Appraisal (FOA) requires airspace change sponsors to generate analysis which reflects the overall airport's air traffic operation (taking into account operations to/from all runways including arrivals and departures). This means that we need to develop full airport system options (combinations of easterly, westerly, arrival and departure options).

Runway 05 departure option + Runway 23 departure option + Runway 05 arrival option + Runway 23 arrival option

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Full Airport System Option

2.2.5 Table 5 shows how the options taken from the Stage 2B IOA (shown in Table 4 above) have been combined to make Full Airport System Options ahead of the FOA. Note that differing options for arrivals to each runway end, for example to have vectors only to final approach to runway 05 and PBN and Vectors to runway 23, have not been generated because of the increased risk of confusion and changes to the methods of operation and controlling techniques for ATC.

Table 5 Full airport system options for FOA

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 1	Vectors	Vectors	No offset SIDs	No offset SIDs
Option 2	Vectors	Vectors	Offset SIDs	No offset SIDs
Option 3	Vectors	Vectors	No offset SIDs	Offset SIDs
Option 4	Vectors	Vectors	Offset SIDs	Offset SIDs
Option 5	PBN and Vectors	PBN and Vectors	No offset SIDs	No offset SIDs
Option 6	PBN and Vectors	PBN and Vectors	Offset SIDs	No offset SIDs
Option 7	PBN and Vectors	PBN and Vectors	No offset SIDs	Offset SIDs
Option 8	PBN and Vectors	PBN and Vectors	Offset SIDs	Offset SIDs

Integration with the network airspace and neighbouring airports, technical IFP development and operational viability assessments

2.2.6 As articulated in Masterplan Iteration 3, there are three interdependent Airspace Change Proposals (ACPs) that form the Scottish Terminal Manoeuvring Area (ScTMA) Cluster of the FASI-N programme being co-ordinated by the Airspace Change Organising Group (ACOG) (referred to as Scottish Airspace Modernisation). Those ACPs are sponsored by Glasgow Airport, Edinburgh Airport and NATS En Route Limited (NERL) (referred to as NATS NERL throughout this document).

2.2.7 The three ACPs are separate design projects, each following the CAP1616 process with their own gateways. However, the designs are dependent on each other as they each form part of the complete design that needs to integrate safely and efficiently. Glasgow Airport and

Edinburgh Airport are responsible for the design of their flight paths to/from 7000ft, with NATS NERL responsible for the design above this height. However, in practice, the flight paths are continuous through 7000ft. Owing to the relationship between the 3 ACPs, sometimes the positioning of flight paths below 7000ft influenced the designs above 7000ft and vice-versa. Where this happened and there were competing demands for the same airspace at the same altitudes by multiple sponsors (i.e. where there were trade-offs across ACPs to be considered), the sponsors followed the Cumulative Analysis Framework (CAF) overseen by ACOG to provide guidance as to the optimal solution for the cluster.

2.2.8 For full details of the interdependencies and trade-offs between the three sponsors, please see the CAF1 document published by ACOG. The following sections of this document provide an overview of the rationalisation and refinement of the Glasgow design options.

Instrument Flight Procedure (IFP) Development

2.2.9 For most ACPs, the design process typically begins with relatively immature 'lines' drawn without the rigour of formal Instrument Flight Procedure (IFP) design as that is a very detailed and time-consuming process. It is not practical or proportionate to have IFP-designed flight paths from the outset, especially with multiple design options and iterations. As the proposed designs begin to take shape, IFP designers are then tasked with trying to formally design the procedures to reflect the intent of the draft designs being settled upon for Full Options Appraisal. For this reason, there can be variances between designs before and after IFP design.

2.2.10 At the end of Stage 2, Glasgow Airport had relatively detailed design options as we had articulated nominal centrelines to aid stakeholder engagement as well as the initial appraisal of impacts and benefits. However, we noted in our engagement and documentation that there will be further changes to the designs and that those changes will be on the basis of integration with the wider airspace network below and above 7,000ft, reacting to stakeholder engagement and consultation feedback, increasing environmental and operational performance and/or in accordance with more detailed IFP design and validation in Stage 4.

2.2.11 Edinburgh Airport on the other hand had only identified broad swathes within which centrelines were yet to be determined and NERL were similar, with concepts only and no identification of key features such as ATS routes or holding stacks. A series of iterative design workshops were therefore needed as NERL and EDI's design options matured.

2.2.12 The three sponsors had engaged each other throughout Stage 2 and therefore mutual aspirations were understood, so no significant changes to Glasgow Airport's design options were anticipated. None-the-less, some adjustments were required to ensure network connectivity and as a result some optimisation was required to help enable the lowest impacts balanced against benefits, whilst maintaining the integrity and intent of the options shortlisted at the end of Stage 2. Finally, once a mature design emerged, the detailed IFP design to ensure all routes were flyable were required.

2.2.13 This design story describes the journey through to FOA. We anticipate there will be further changes to the designs following consultation.

2.2.14 **The images within the below sections depict nominal PBN centrelines for both arrivals and departures whereas our arrival options assume either just vectors or a mixture of vectors and PBN arrivals. This Design Story articulates the design evolution of the route centrelines themselves and therefore any vectoring swathes for arrivals or departures are not depicted in the images.**

Scope of Instrument Flight Procedure (IFP) Design

2.2.15 Aircraft climb and descend at different rates. This is due to a number of different factors primarily involving the aircraft type, the weight of the aircraft, weather conditions, the number and type of engines and operating procedures. Descent rates are more standard, particularly on final approach from c.3-4000ft but climb rates vary significantly. There is therefore no single lateral point on a flight path where all aircraft reach 7000ft and IFP design responsibility shifts between the airport and NATS NERL.

2.2.16 In Stage 2, we depicted our flight paths to/from 7000ft, assuming continuous climb and descent and on a standard gradient. This was for 2 reasons:

1. Glasgow Airport's ACP design responsibility is to/from 7000ft
2. The design above 7000ft was uncertain and therefore the route connectivity between GLA and NATS NERL designs was not established.

2.2.17 We expect that in the new airspace design, the majority of Glasgow Airport's arrivals and departures will climb/descend continuously through 7000ft as this is one aspiration of the design. However, this design story shows the evolution of the anticipated flight paths to/from a higher altitude as sponsors are required to pragmatically determine the point at which Instrument Flight Procedure (IFP) design responsibilities transfer between each other.

2.2.18 **Scope of IFP Design – Arrivals:** For arrivals, the transfer of IFP design responsibilities was chosen at the holding stacks. This means that NATS NERL developed the procedures for flight paths flown to the holding stack and for the holding patterns themselves, which are in some cases are only as low as 9000ft. Glasgow Airport then developed the IFPs for the flight paths down to the landing runway.

2.2.19 **Scope of IFP Design – Departures**: For departures, Glasgow Airport designed the IFPs for the departure routes (Standard Instrument Departures (SIDs)) until they connect with the ATS routes. The exact point at which a SID ends and an ATS route starts is variable. It is a NATS NERL requirement that the SIDs from each runway need to connect to an ATS route in the same location from either runway end; they therefore cannot necessarily end at 7000ft. It's important to note that sometimes a SID chart may only depict climb to, say 6,000ft, and then end at an ATS route many miles away from the airport but this does not mean that departing aircraft climb only to 6,000ft and fly level until reaching the ATS route. Air Traffic Control (ATC) will ensure that aircraft keep climbing above the SID level the vast majority of the time. Glasgow Airport and NATS NERL have worked together to determine what is expected to happen operationally and this is reflected in the noise assessments undertaken for the options.

2.3 Evolution of the options

2.3.1 The following options proceeded from the Stage 2A IOA:

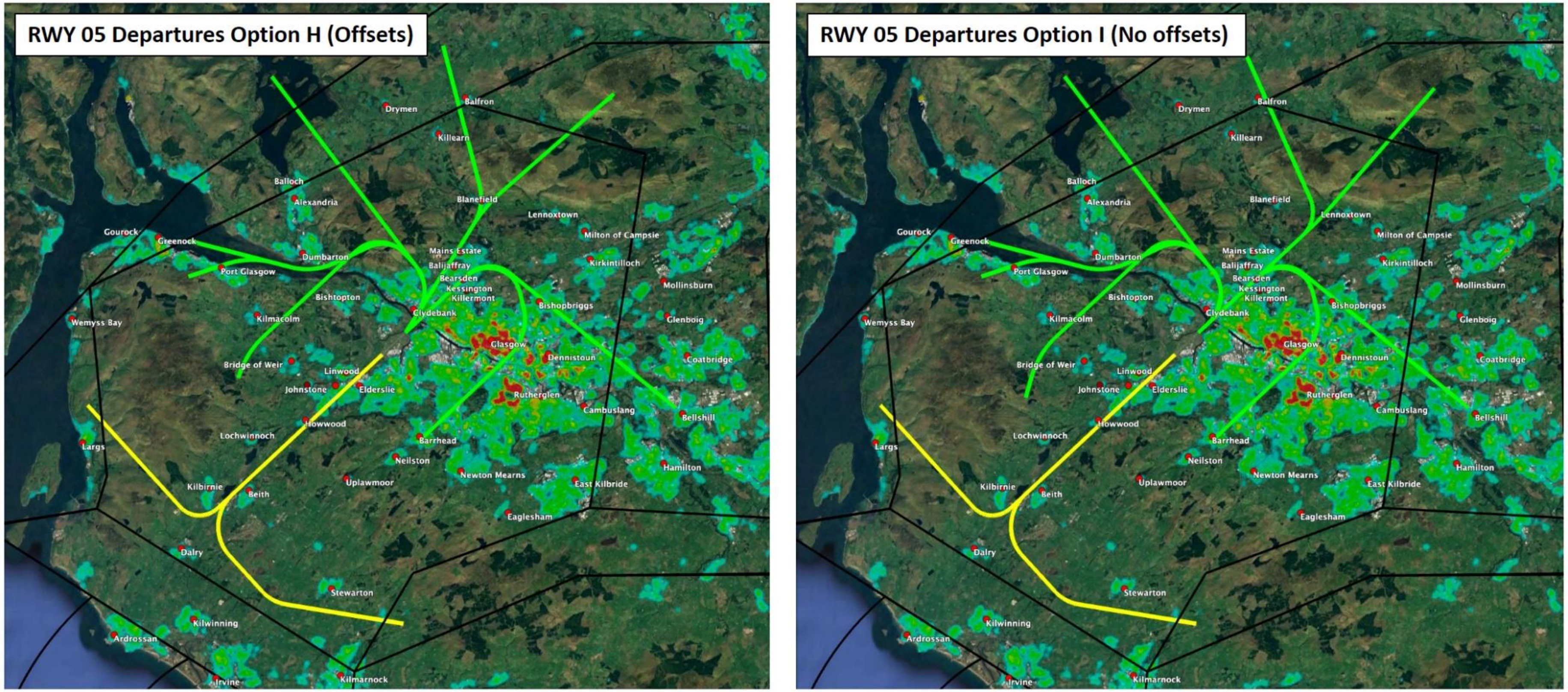


Figure 4 Runway 05 Options from Stage 2

Population density   Stage 2 departure route   Stage 2 PBN arrival route   Existing CAS boundary

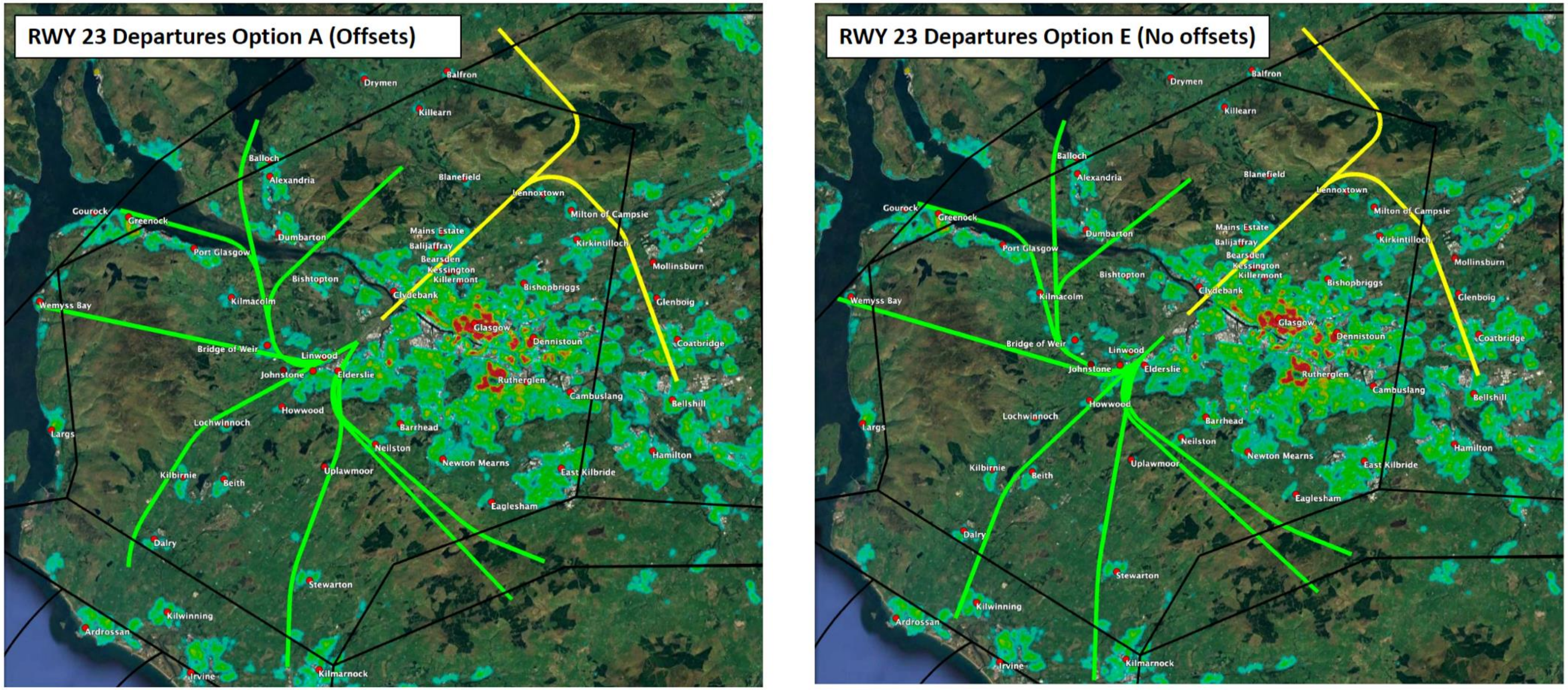


Figure 5 Runway 23 Options from Stage 2

Population density — Stage 2 departure route — Stage 2 PBN arrival route — Existing CAS boundary

2.3.2 The main difference between the options concerns the use of offset departures or non-offset departures. Offset departures involve aircraft undertaking a small turn (called a track adjustment) at 500ft, rather than flying straight ahead for slightly longer on the same heading as the runway. Our offset departure options were specifically created to address DP8 (Mitigate the impacts on local communities that are currently affected by aircraft noise on final approach or in the vicinity of the immediate climb out, where overflight is unavoidable) allowing us to investigate the pros and cons compared to the non-offset departures which turn slightly later.

2.4 Evolution of the Departure Options

2.4.1 In order to explain the design decisions and the evolution of the departure options, we first need to outline the existing network structure for NORBO, LUSIV, Turnberry (TRN) and TALLA departures. Figure 6, on the next page, shows the existing SID and ATS route structure for these departures.

2.4.2 The LUSIV and TALLA SIDs flown today are for non-jet traffic only and they feed traffic onto ATS routes to Dean Cross (DCS) or NATEB. These SIDs route into the main flow of Glasgow arrivals from the south, underneath the existing LANAK holding pattern, shown in purple. As a result, departures can be held at low altitude over the densely populated areas to the south of the airport.

2.4.3 The TRN SID is also for non-jet traffic only feeding traffic to the south west.

2.4.4 All jet traffic flight planning to route via TRN, DCS or NATEB departs via the NORBO SID. Therefore, jet traffic wanting to go east to NATEB or south to DCS have to flight plan to a point 18nm to the west of Glasgow (as the crow flies) before turning back towards the east or south. On easterly operations, this means jet traffic are flight planned via NATEB c.36nm in the wrong direction before turning back east to NATEB.

2.4.5 NATS NERL's proposed network design offers very different ATS route connectivity towards TRN, DCS and NATEB to eradicate these inefficiencies. As a result, Glasgow Airport can remove the interaction of the LUSIV and TALLA SIDs with arrivals. The new network connectivity also means that many of the departures previously routing via NATEB can now route in a completely different direction, east over the Firth of Forth, and enter European airspace in a different and much more efficient location.

2.4.6 Our options at the end of Stage 2 did cater for potential LUSIV/TALLA connectivity but these are no longer required. These departures can be handled much more efficiently by utilising other SIDs feeding the new network design. As such, these routes were discontinued from the design process. Figure 7 shows the routes which have been discontinued. Note this also applies to the LUSIV TALLA SID routes in RWY 23 Departures Option E and RWY 05 Departures Option I which are not shown on the image.

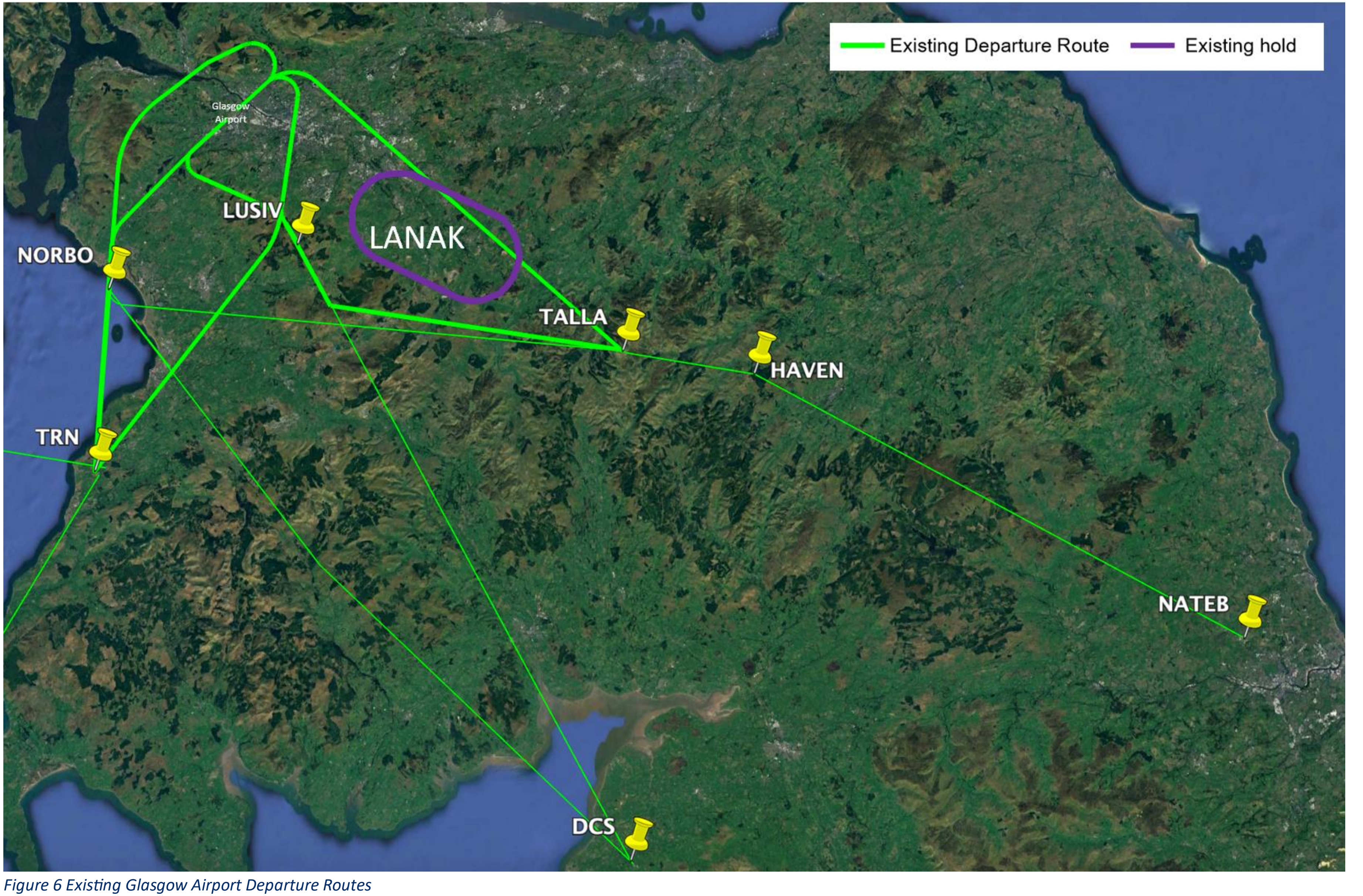


Figure 6 Existing Glasgow Airport Departure Routes

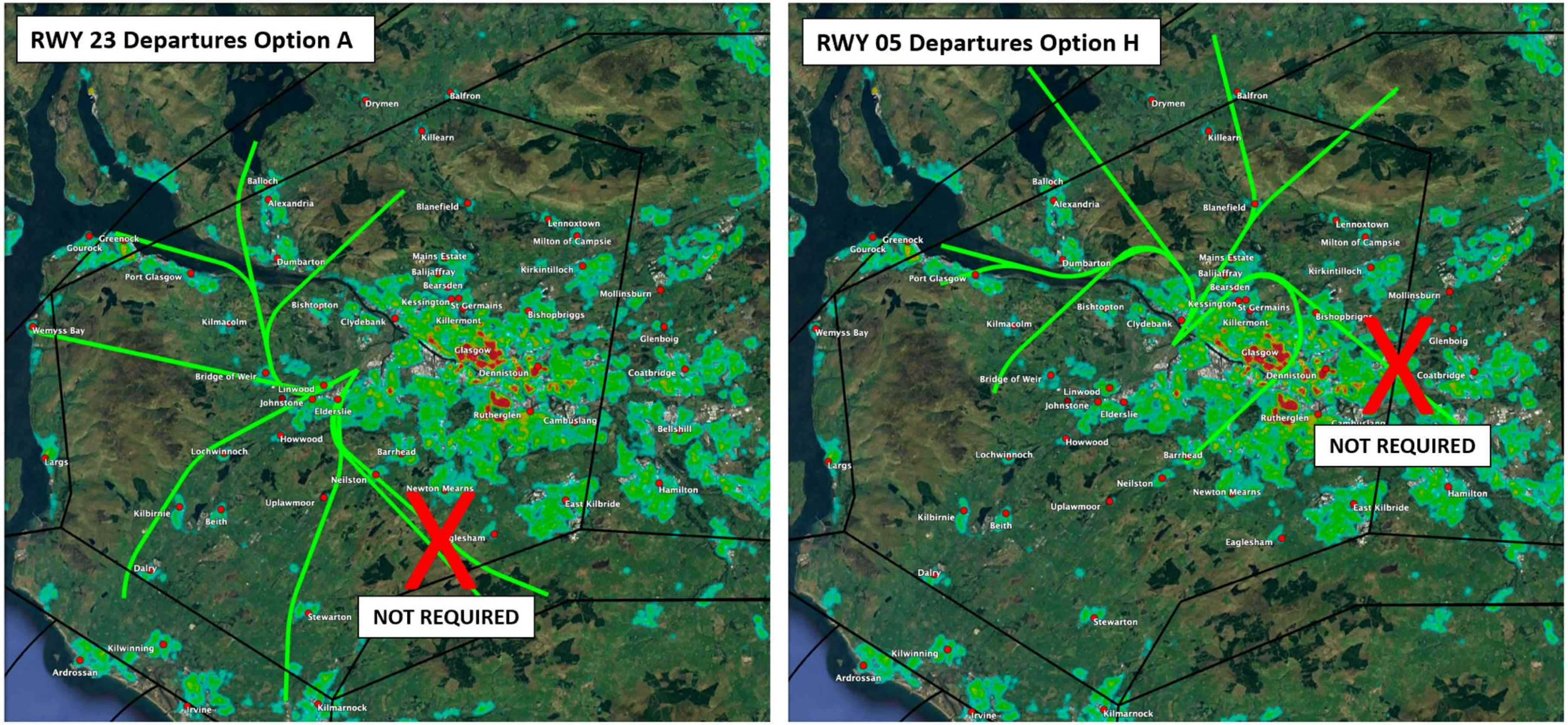


Figure 7 LUSIV/TALLA routes no longer required

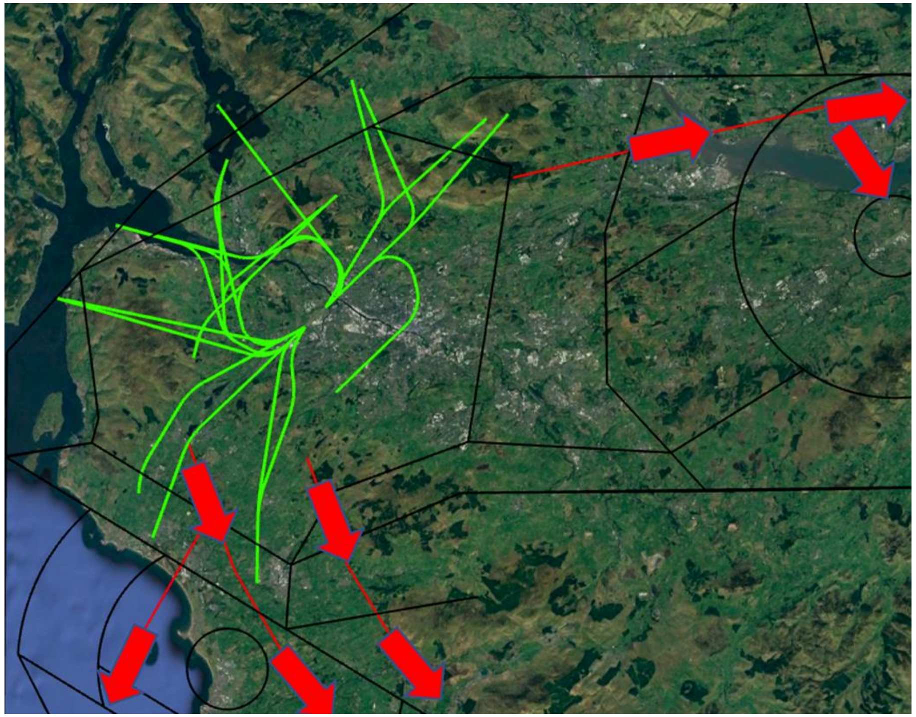
Population density — Proposed new departure route (from Stage 2) — Existing CAS boundary

2.4.7 The network structure to the north west and north of Glasgow Airport is not proposed to change significantly with regards to connectivity. However, the network changes to the south and east of Glasgow Airport, described above, resulted in us needing to “connect” the proposed SIDs to the new proposed ATS routes that form part of the NATS NERL ACP.

2.4.8 Figure 8 shows all the SID options at the end of Stage 2 (green), less the LUSIV and TALLA SIDs, in relation to where we needed to connect some of them with NATS NERL’s proposed network (red).

2.4.9 One of the NATS NERL requirements for network connectivity and airline flight planning is that SIDs routing onto the same ATS routes from each runway end should terminate at the same waypoint. This requirement plays a part in determining SID end points which may be above or below 7000ft.

2.4.10 The following sub sections explain how Glasgow Airport’s departure routes have evolved as part of the work to integrate the designs with the network airspace.



Proposed new departure route (from Stage 2) Proposed departure airway (NATS NERL ACP) Existing CAS boundary

Figure 8 Glasgow Stage 2 Departure Options and NERL proposed routes

Departure connectivity to the North East and East

2.4.11 During stakeholder engagement between Glasgow Airport and NATS NERL in Stage 2, we were aware of a potential new route over the Firth of Forth although there was insufficient certainty at that time as to whether this could facilitate both Glasgow departures and arrivals, and the location of holding stacks, to be able to refine that route in detail below 7000ft.

2.4.12 Our working assumption therefore was that these Firth of Forth departures would follow the proposed PTH SID and then turn to the east at some point as illustrated by the arrow in Figure 9.

2.4.13 Once the position of NATS NERL's Firth of Forth ATS route was determined, we looked to the Stage 2 designs and refined them to turn them east to connect to the airway as shown in Figure 10.

2.4.14 Below 7000ft there were no areas of population affected by doing this and no other significant draw backs below 7000ft were identified. This meant there was no trade-off scenario between Glasgow Airport and NATS NERL around the position of these routes.

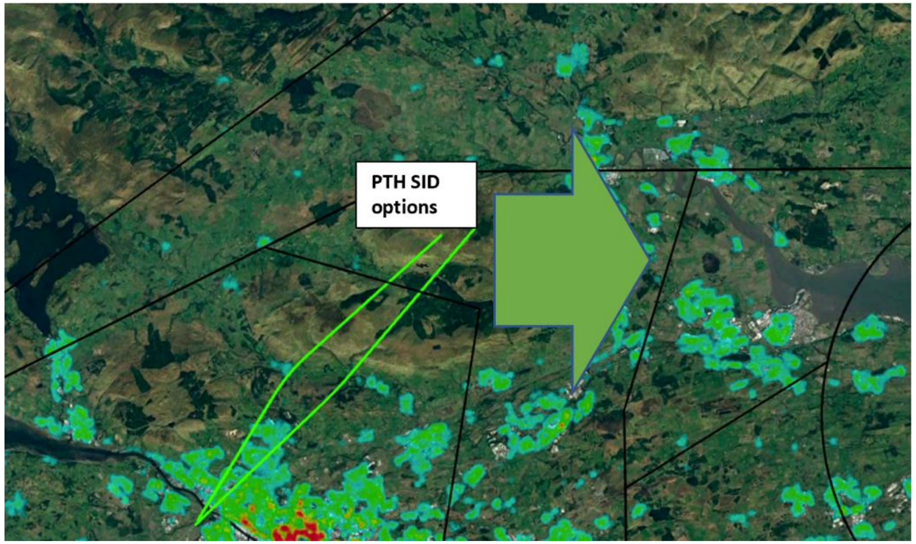


Figure 9 Stage 2 PTH Departure routes and broad area expected to turn

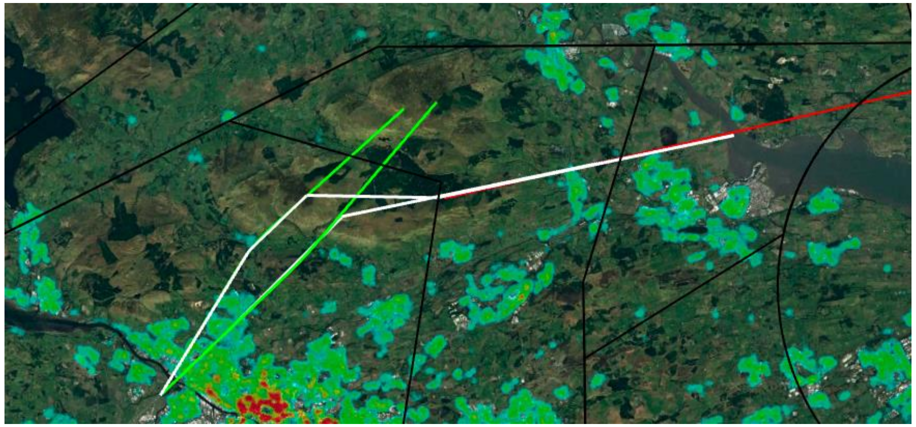


Figure 10 Proposed Firth of Forth departure options Runway 05

Departure route (from Stage 2) Proposed departure airway (NATS NERL ACP) Proposed Firth of Forth departure route Existing CAS boundary

2.4.15 Connectivity with the new ATS route for RWY 23 departures was more straightforward with the departure routes from Stage 2 connected to the new ATS route without any requirement for a lateral change below 7000ft as shown in Figure 11.

2.4.16 Note the slight kink in the white route (above 7000ft) is to provide separation against the COYLE holding stack to the north.

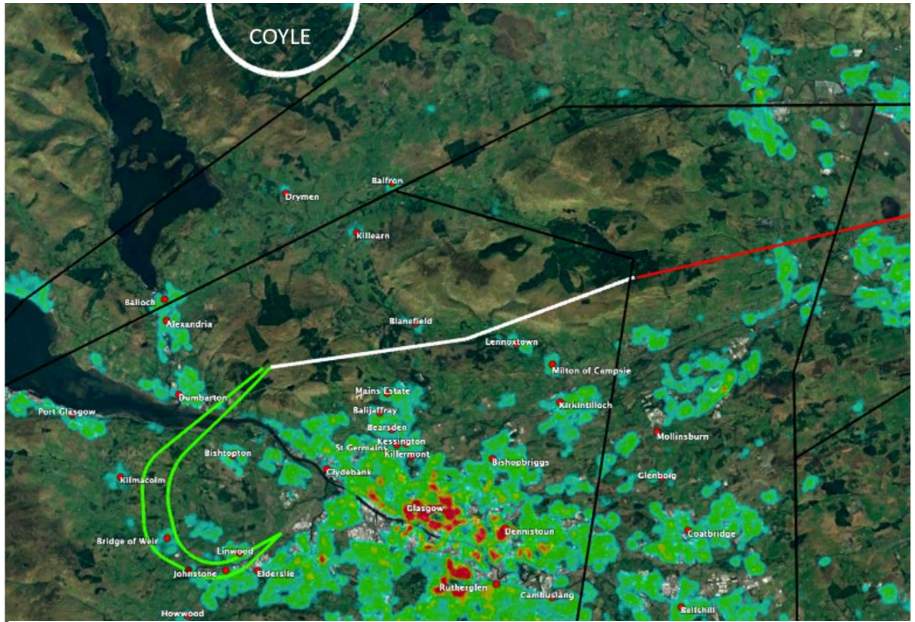


Figure 11 Proposed Firth of Forth departure option Runway 23

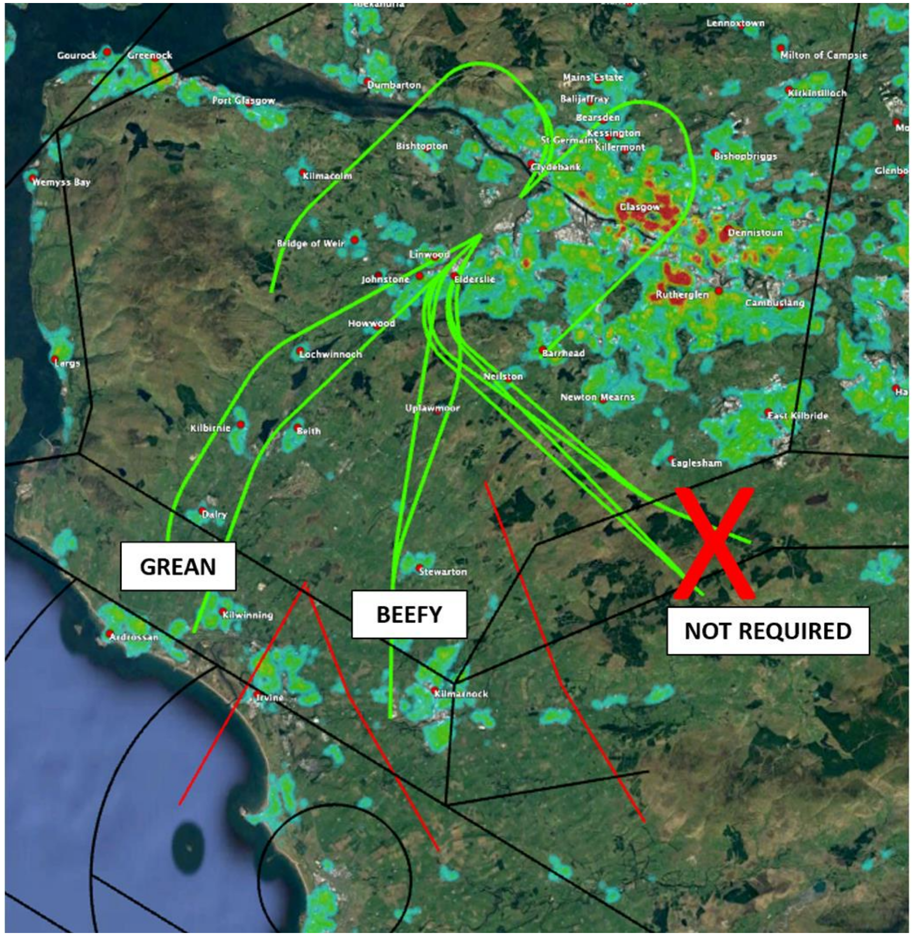
Departure route (from Stage 2) | Proposed departure airway (NATS NERL ACP) | Proposed Firth of Forth departure route | Existing CAS boundary

Departure connectivity to the South and South West

2.4.17 Figure 12 shows the southerly departure options shortlisted as part of Glasgow Airport's stage 2 work.

2.4.18 The figure shows the LUSIV/TALLA SIDs from RWY 23 that are no longer required as this helps to articulate how originally the presence of those SIDs constrained the position of the SIDs next to them, which we are referring to as BEEFY SIDs which in turn constrained the position of the GREAN SIDs.

2.4.19 The red tracks illustrate NERL's proposed new southerly ATS route structure. The two parallel tracks are required to be laterally separated to enable both departures to be climbed independently. The departures from both runways need to be positioned onto these ATS routes. The position of the ATS routes was dependent on the broader airspace structure above 7000ft and there is more information about this contained in the NERL ACP documentation.



Departure route (from Stage 2) | Proposed departure airway (NATS NERL ACP) | Existing CAS boundary

Figure 12 Stage 2 departure routes and proposed network route structure

2.4.20 Figure 13 shows the refinement of the southerly departure options in order to connect these to the proposed ATS routes.

2.4.21 In this scenario, the southerly departure routes required some significant lateral changes in order to integrate with the network and therefore close attention was paid to whether there was a trade-off scenario between the Glasgow Airport ACP and the NATS NERL ACP.

2.4.22 In the case of the Runway 05 departures, the integration takes place where the departures will be above 7000ft and therefore there was no trade-off.

2.4.23 In the case of the Runway 23 departures, the removal of the TALLA LUSIV SID allows realignment of the southerly BEEFY and GREAN SIDs to reduce population overflown between c.4-7000ft, avoiding Dalry, Kilwinning, Uplawmoor, Dunlop, Stewarton, Kilmaurs and Kilmarnock. This refinement does not impact the part of the SID which influences the shape of the Lowest Observed Effect Level (LOAEL) noise contour.

2.4.24 In addition to the reduction of population overflown, there would be a reduction in track mileage which would result in greenhouse gas and fuel burn benefits compared to the original Stage 2 routes.

2.4.25 Given the above, and this refinement aligns with NERL's desired ATS route location, there was no trade off in this scenario.

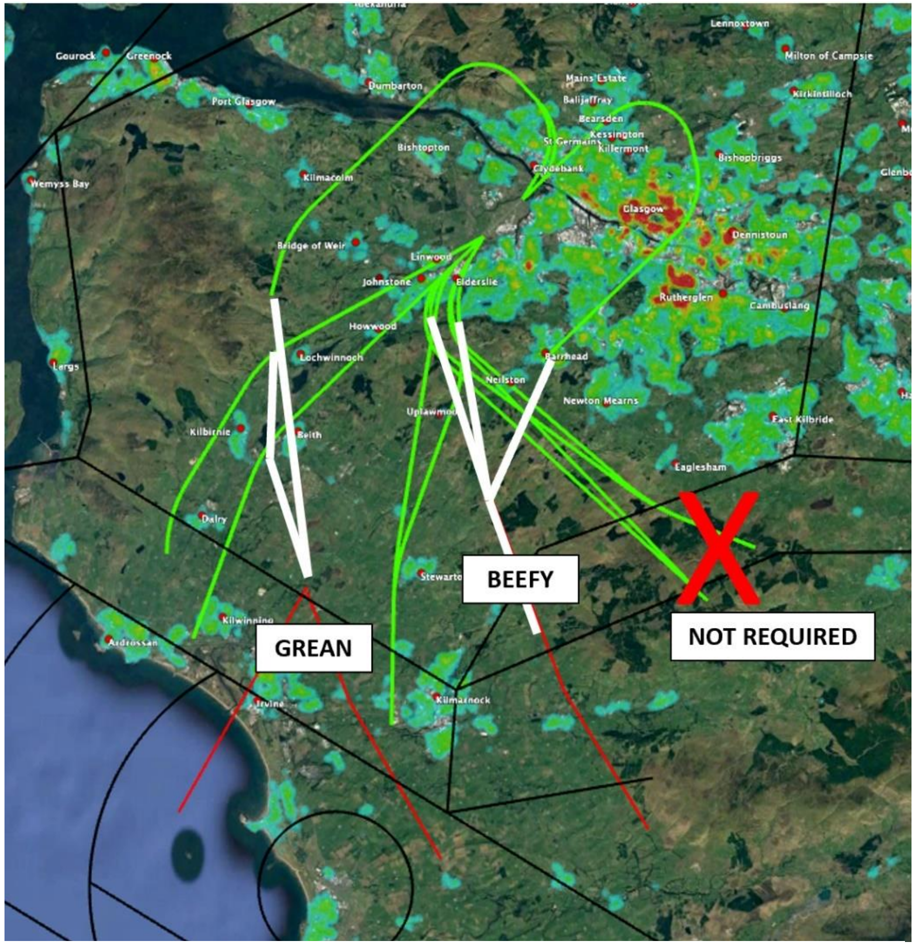


Figure 13 Evolution of the departure options to connect to network routes

Departure route (from Stage 2) Proposed departure airway (NATS NERL ACP) Proposed departure route Existing CAS boundary

Departure connectivity Runway 23 CLYDE SID (Option E)

2.4.26 As part of the detailed IFP development, the Runway 23 CLYDE departure for Option E was refined in order to optimise it for noise, greenhouse gas emissions and fuel burn.

2.4.27 Figure 14 shows the original Stage 2 CLYDE departure route in green which initially follows the same route as the LOMON/FOYLE departure.

2.4.28 As part of IFP development, it was identified that if the CLYDE departure followed the same initial route as the ROBBO SID, and then turned to the North-north-west, it would reduce overflight of Bridge of Weir, Quarriers Village, Kilmacolm and Bardrainney and provide more dispersion from the LOMON, FOYLE and MOODI departures which is aligned with our Design Principle 6. It would also have slightly reduced track mileage compared to the route developed in Stage 2.

2.4.29 In addition to the above, it also meant that after the first turn, the CLYDE departure would follow the same route as the original CLYDE departure published in the baseline.

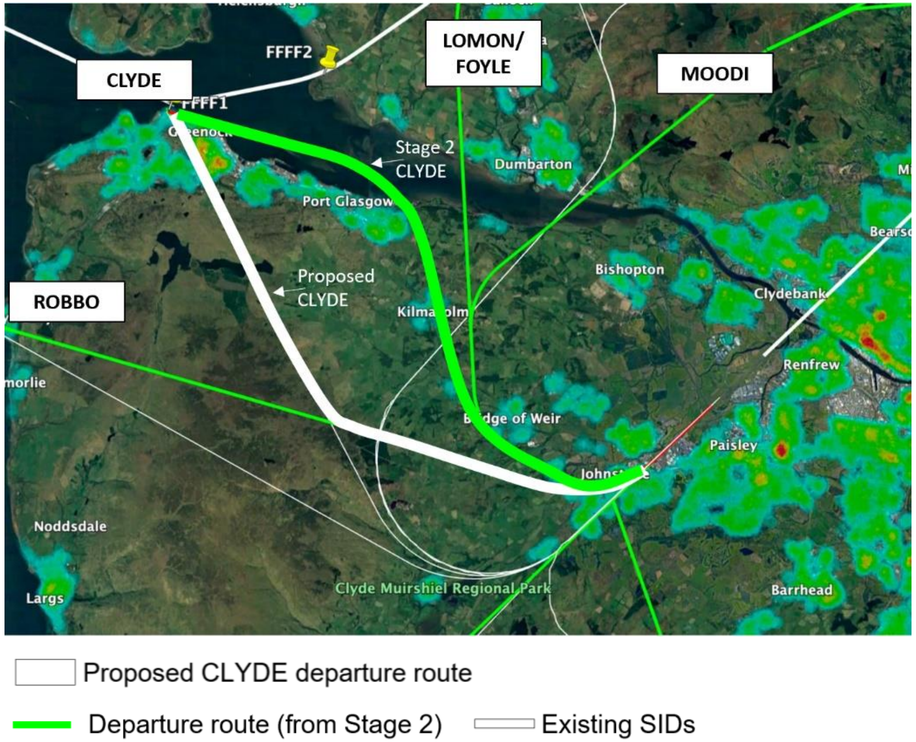


Figure 14 Stage 2 CLYDE departure and proposed refined route

2.4.30 Based on all the information above, the CLYDE route therefore evolved as part of the refinement phase to reflect the white route shown in Figure 14 above.

2.5 Evolution of the Arrivals Options

2.5.1 The evolution of the Glasgow arrival options was dependent on the integration work between the Glasgow Airport and NATS NERL ACP to connect Glasgow's arrivals with the holding stacks that form part of the NERL ACP.

2.5.2 Figure 15 illustrates the different locations for Glasgow's holding stacks (blue) that were considered by NERL, in collaboration with Glasgow and Edinburgh Airport, mapped against Glasgow's arrival and departure options at the end of Stage 2. Those in pink are the 3 Glasgow Airport stack locations currently proposed by NERL.

- Population density
- Stage 2 departure route
- Stage 2 PBN arrival route
- Existing CAS boundary
- Potential holding locations
- Proposed hold location after integration

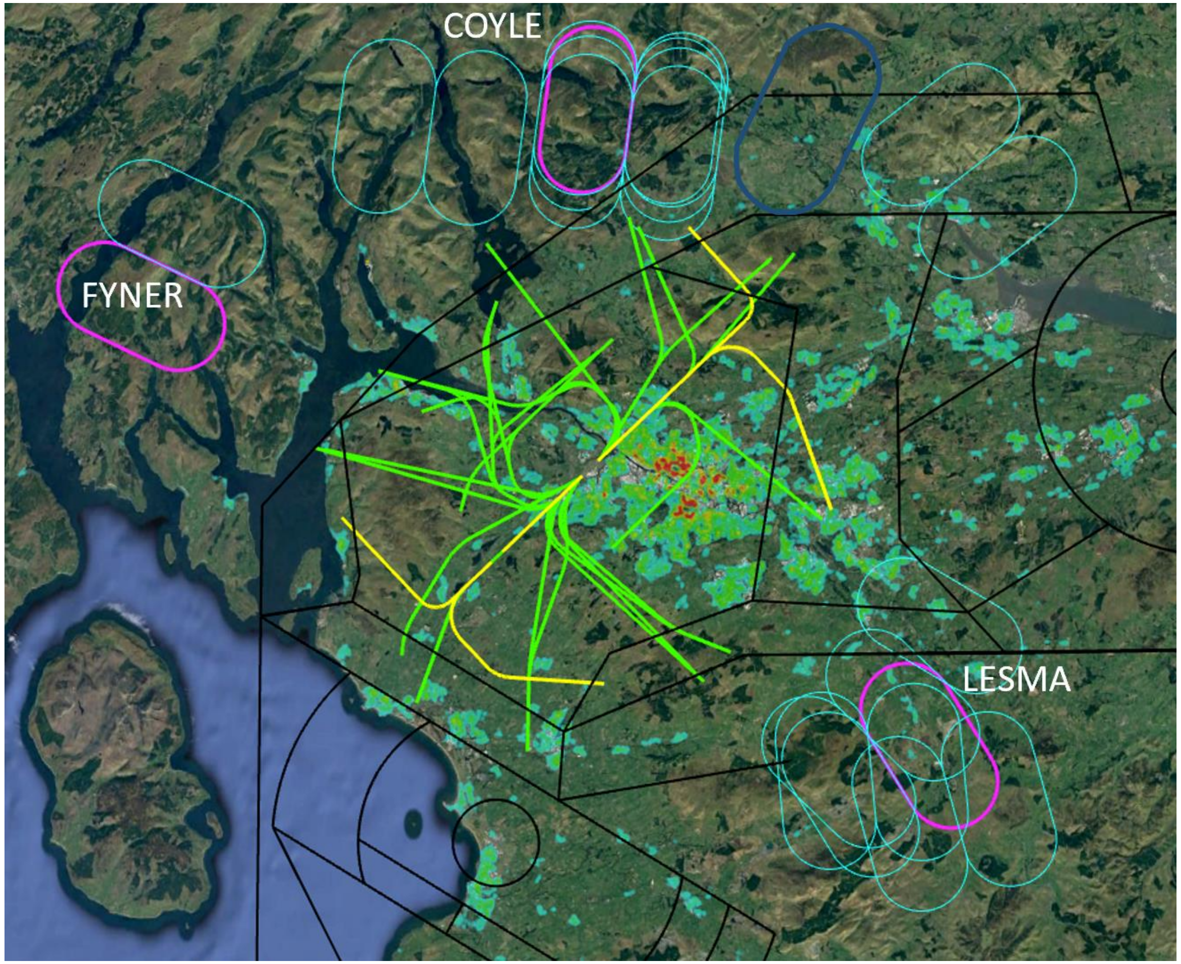


Figure 15 Potential hold locations and Glasgow's Stage 2 options

2.5.3 The normal minimum holding levels are expected to be as follows, although holding lower at LESMA and FYNER may sometimes be required:

- FYNER 9000ft+
- COYLE 7000ft+
- LESMA 9000ft+

2.5.4 For more details on the development of the network airspace and the hold locations, please see the NERL ACP.

2.5.5 To begin the integration work, we needed to 'connect' our arrival flight paths to these stack locations. The flight paths that connect the stack with final approach are known as 'Approach Transitions' as aircraft are effectively transitioning from the en-route flight into the approach phase.

2.5.6 Aircraft are expected to usually be above 7000ft for portions of these flight paths and therefore, based on the Governments altitude-based priorities, track mileage, increased efficiency and reduced emissions are the focus. Notwithstanding this, as the arrival transitions have been developed there has also been a focus on ensuring they remain laterally separated from GLA's proposed departure flight paths, remain inside existing CAS, and, where possible, avoid areas of high population density. In addition to this, the development of the transitions had to consider IFP design criteria whereby there are design limitations on the angle of an approach transition from the axis of the holding stack.

2.5.7 Figure 16 shows how the approach transitions have been connected to the holding stacks (white) against the stage 2 options designs (yellow). These yellow lines also help to articulate where an aircraft performing a continuous descent could be expected to descend through 7000ft.

2.5.8 For runway 05, by connecting the northerly arrivals to part-way along the yellow track, we were able to keep the proposed arrival route further from Largs, along with meeting the criteria and requirements outlined in the paragraph above.

2.5.9 For runway 23, there are two discernible differences with these Approach Transitions compared to the original stage 2 yellow lines and these differences are explored in further detail in the next section.

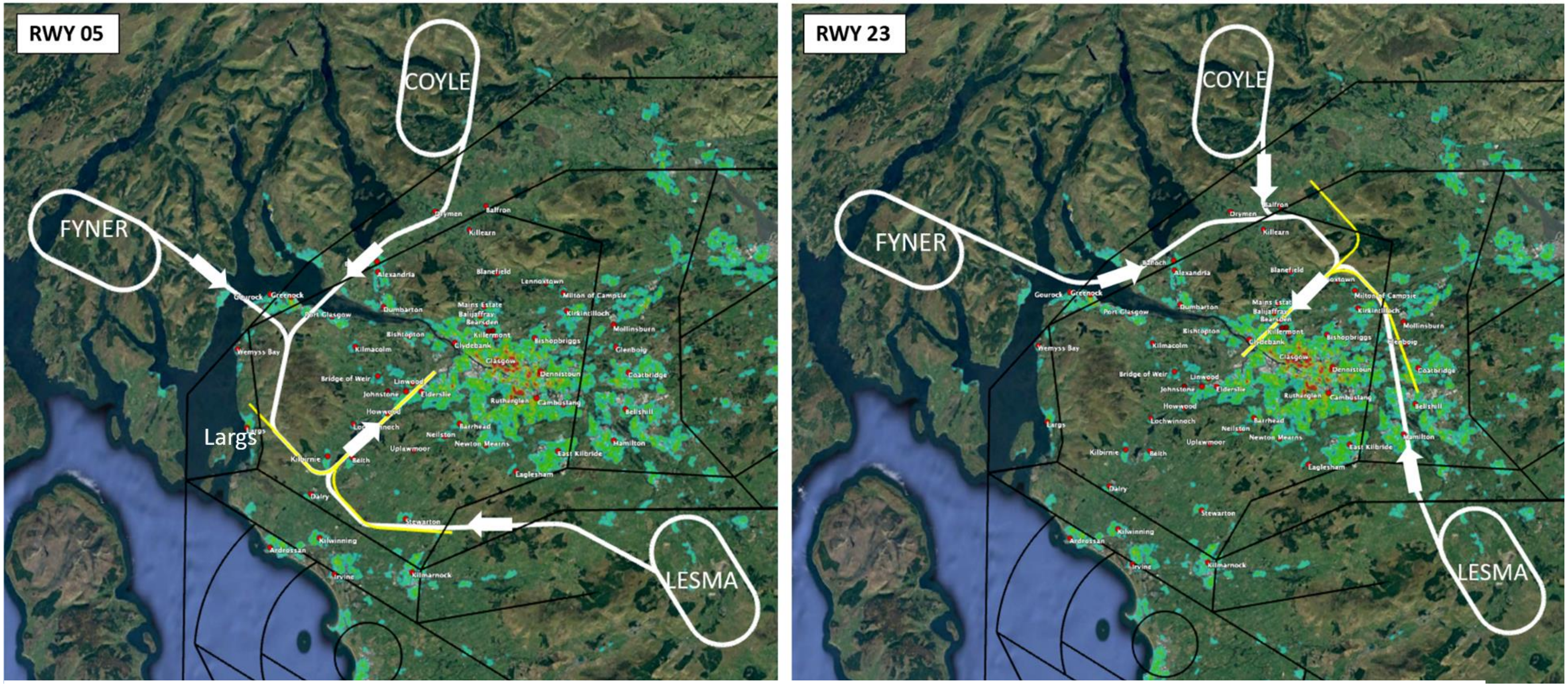


Figure 16 Proposed approach transitions compared to stage 2 options

Population density — Stage 2 PBN arrival route — Existing CAS boundary — Proposed approach transition

Evolution of runway 23 arrival options

2.5.10 When considering the transition from LESMA, initially the Stage 2 track shown in yellow within Figure 17, was connected to the LESMA hold via the magenta line in a way that met IFP design requirements.

2.5.11 Following this, we considered whether further refinement of the option, to fly a more direct route from the LESMA hold to the transition, would be beneficial. This found that the route shown in white overflew 8000 less people than the original yellow/magenta route. Furthermore, the white line is slightly more direct, which minimises greenhouse gas emissions above 7000ft in line with NERL's design principles.

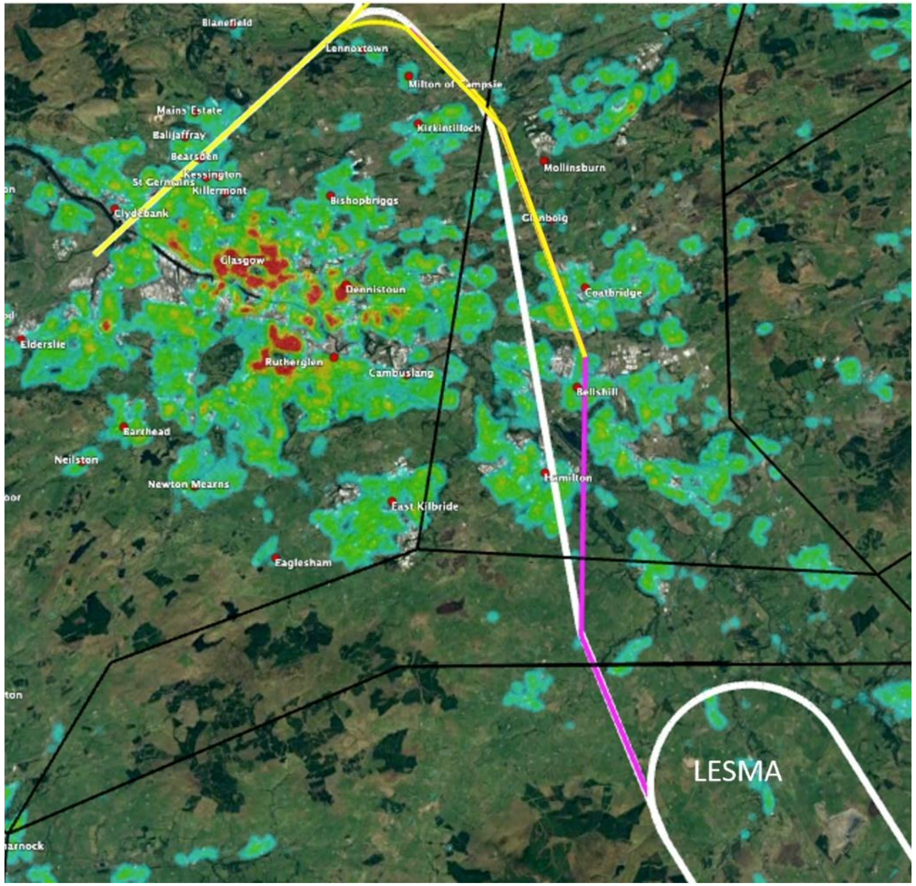


Figure 17 LESMA transition development

Population density — Stage 2 PBN arrival route — Existing CAS boundary — Proposed approach transition

Potential connection between Stage 2 option and proposed hold location

2.5.12 When considering the transition from COYLE/FYNER, initially the Stage 2 track shown in yellow within Figure 18, was connected to the holds via the magenta line in a way that met IFP design requirements. Owing to these design rules, it was not possible to avoid directly overflying Balfron and, in addition to this, when considering Controlled Airspace containment, the yellow track would have needed considerable additional low level controlled airspace in this area.

2.5.13 When considering the arrival from the west from FYNER, the Magenta line routed closely to Drymen and directly overfly Buchlyvie.

2.5.14 The detailed rationalisation and refinement work therefore identified that there was an opportunity to evolve the option, whereby some of these disadvantages could be minimised without creating any other significant disbenefits below 7000ft.

2.5.15 As such, the route centreline was refined as shown in white. This avoids direct overflight of Drymen, Killearn and Balfron, is slightly shorter (which benefits greenhouse gas emissions and fuel burn) and requires less controlled airspace. Note that whilst the route centerline may avoid these areas, they may still be considered as overflown in accordance with CAA's definition of overflight. However, avoiding direct overflight and considered in conjunction with reduced miles and controlled airspace, we are proposing the white arrival options.

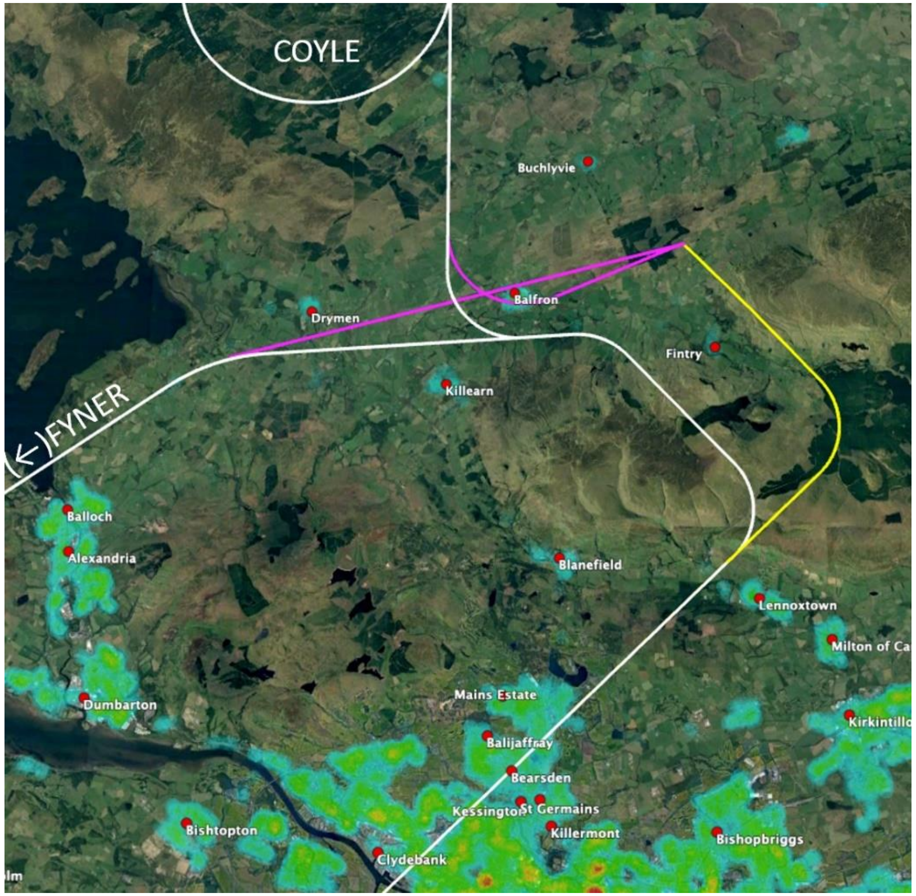


Figure 18 COYLE/FYNER transition development

Population density | Stage 2 PBN arrival route | Existing CAS boundary | Proposed approach transition

Potential connection between Stage 2 option and proposed hold location

2.6 Consideration of Noise Respite/Relief Options

2.6.1 The Air Navigation Guidance 2017 requires airspace change sponsors to consider and appraise the pros and cons of different options which may include concentrating traffic on single routes, which normally reduce the number of people overflown, versus the use of multiple routes which can potentially provide relief or respite from noise, if routes can be sufficiently separated[1]. In addition to this, Glasgow Airport has Design Principle 6 which says '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'.

2.6.2 Industry tends to use two definitions[2]:

- **Relief** which can be defined as a break or reduction in aircraft noise.
- **Respite** which can be defined as scheduled relief from aircraft noise for a period of time.

2.6.3 Glasgow's ACP has considered the positive benefits and negative impacts of both relief and respite as well as options with fewer routes which would concentrate noise. More information around this is contained in the following subsections of this section:

What happens today

2.6.4 In today's route structure, all of Glasgow's SIDs climb straight ahead for at least 5nm before turning. Based on actual 2022 92 day summer data (16 June to 15 September inclusive) around 8.5 to 8.7%[3] of aircraft which are smaller, non-jet aircraft may be turned by ATC sooner than this, but the majority do not turn until 5nm. This means that those communities living under the extended runway centreline within 5nm of the runway are always overflown by arrivals or departures. i.e. they receive no Respite or Relief from alternation between easterly and westerly operations. Conversely communities living to the north or south of the extend centreline or under the centreline more than 5nm from the runway, do tend to receive respite or relief as a result of runway alternation between easterly and westerly configurations. The density of existing operations is shown in Figure 20 below.

[1] Para 1.3 ANG 2017 https://assets.publishing.service.gov.uk/media/5f624adae90e072bbae22c2c/air-navigation-guidance-2017.pdf

[2] A Review on the State of the Art of Respite, Respite Working Group Report https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/local-community/noise/making-heathrow-quiter/respite-research/Respite_Review_June_2016.pdf

[3] The percentage varies depending on which runway is operation.

2.6.5 This pattern and concentration of noise influences the shape of Glasgow Airport Lowest Observed Adverse Effect Level (LOAEL) contour. The LOAEL is level above which adverse effects on health and quality of life can be detected i.e those communities within the LOAEL are considered to be those who are adversely affected by aircraft noise following Government airspace policy[4]. Glasgow Airport's 2022 baseline daytime LOAEL contour is shown in Figure 19.

[4] https://www.gov.uk/government/publications/uk-airspace-policy-a-framework-for-the-design-and-use-of-airspace

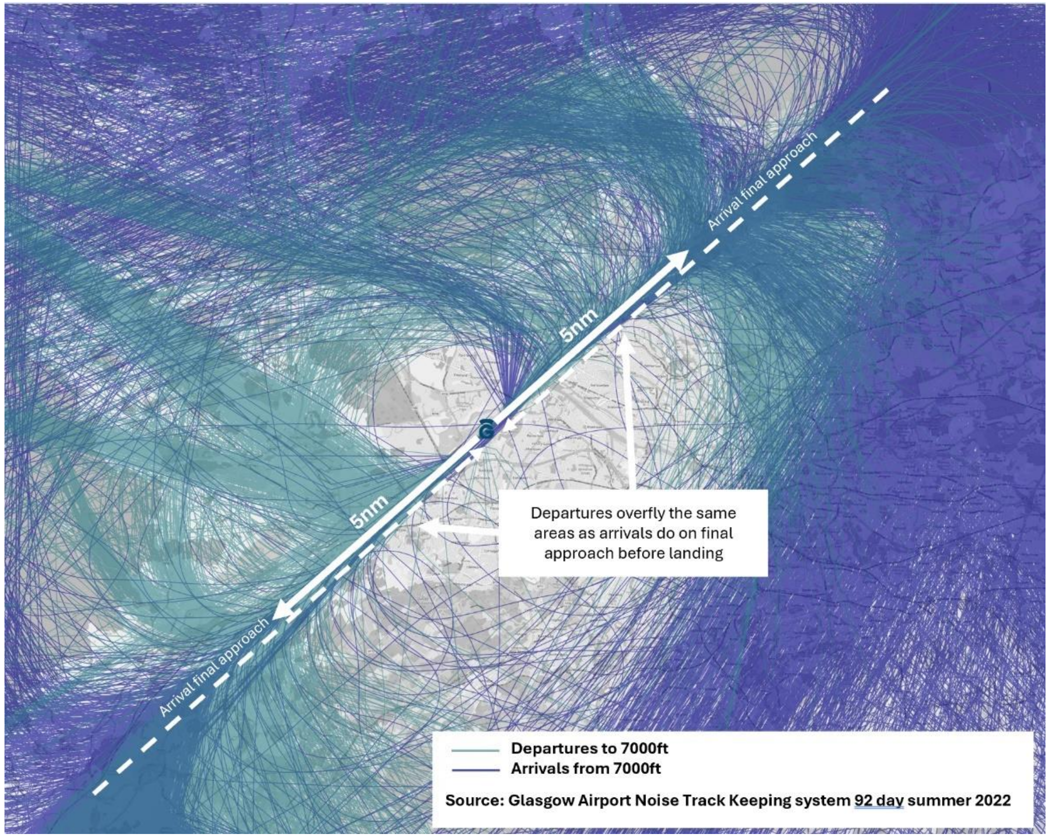


Figure 20 Existing overflight density along final approach

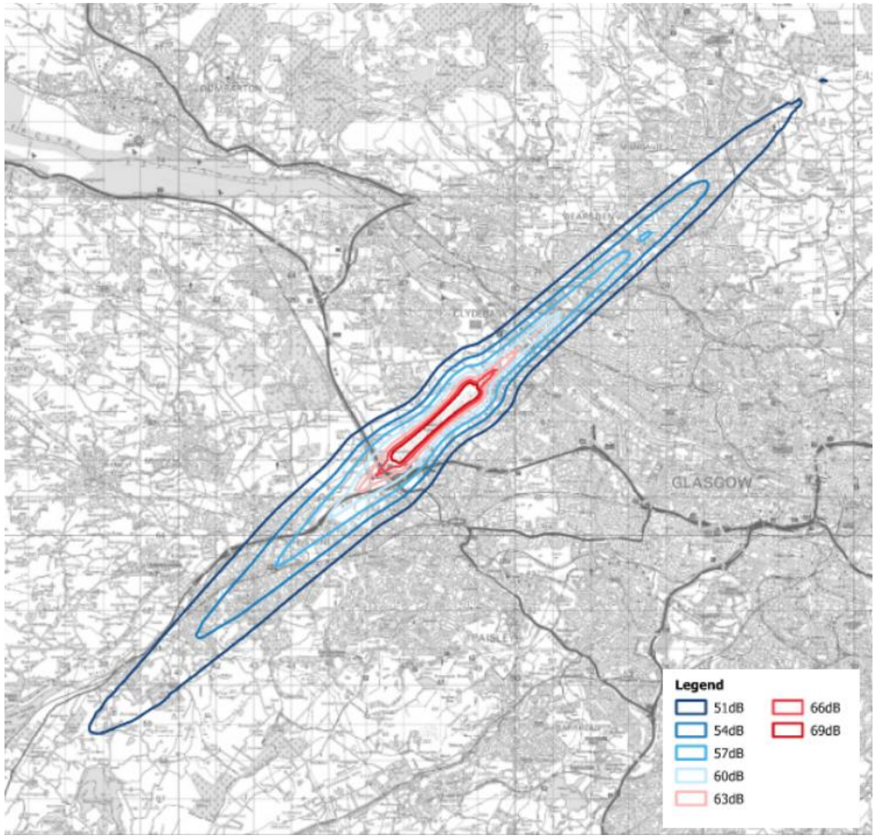


Figure 19 2022 92-day summer $L_{Aeq,16h}$ Contour (see Figure TA1 in the Technical Appendix)

How have we considered respite / relief in our options development to date

2.6.6 Single and multiple routes both have costs and benefits associated with them. In terms of noise, a single route will, generally, tend to affect fewer people overall compared to multiple routes. It may mean however that those that are overflown could be exposed to increased noise exposure and hence be at greater risk of experiencing adverse effects, than if noise was more dispersed.

2.6.7 In Stage 2 we developed options on our comprehensive list that considered how best to distribute the noise so as to limit, and where possible reduce, the total adverse impacts on health and quality of life from aviation noise whilst also meeting other design principles. Those other principles include reducing Greenhouse Gas emissions, reducing delays and meeting forecast demand.

2.6.8 This option development focused on Glasgow's busiest departure route which is the southbound NORBO departure. This departure accounts for c.67 % of all of departures. Table 6 below outlines how each of the departure options appraised in Stage 2 either concentrated this busiest departure flow over fewer routes or whether it considered multiple routes which would provide relief or respite from noise by reducing the frequency of overflight for those overflown. The options highlighted in bold are those that were taken through to Stage 3 following shortlisting at Stage 2.

Table 6 Noise management considerations of Stage 2 departure options

Runway 05	Noise management consideration	Runway 23	Noise management consideration
Option A	Concentrate traffic on fewer routes	Option A	**Multiple routes which provide relief or respite**
Option B	Concentrate traffic on fewer routes	Option B	Concentrate traffic on fewer routes
Option C	Concentrate traffic on fewer routes	Option C	Multiple routes which provide relief or respite
Option D	Concentrate traffic on fewer routes	Option D	Multiple routes which provide relief or respite
Option E	Concentrate traffic on fewer routes	Option E	**Multiple routes which provide relief or respite**
Option F	Multiple routes which provide relief or respite		
Option G	Multiple routes which provide relief or respite		
Option H	**Multiple routes which provide relief or respite**		
Option I	**Multiple routes which provide relief or respite**		

2.6.9 The Stage 2 departure work therefore explored the ANG2017 para 1.3 requirement for departures, and progressed options into Stage 3 which only contained multiple departure routes to share the extant busiest departure route across 2 SIDs instead of just one. In addition, the changes to the network made in NERL's ACP providing access to the Firth of Forth (see para 2.4.11), further reduce the departure loading on those 2 new departure route, with more aircraft departing to the east instead of the south, providing a more even distribution of flights across Glasgow's proposed SIDs.

2.6.10 For arrivals, for both runway ends there are two core options that were carried forward for FOA:

1. **Vectors:** A continued reliance on vectoring of all arrivals between the holding stacks and final approach. This would be expected to provide similar dispersion and patterns as today, although not identical owing to different holding stack positioning and different interactions with departure routes.
2. **PBN and vectors:** A system of PBN arrival routes between the holding stacks and final approach which would be used in conjunction with some vectoring. The PBN arrival routes have been positioned to minimise the total population overflown and minimise the number of people newly overflown. PBN arrival routes will generate a concentration around the route centrelines which would therefore generate an increase in frequency of overflight for those under the centrelines compared to today. As noted in paragraph 5.12 of CAP1616i, the impact of this concentration is captured through the TAG noise analysis. However, there would still be some dispersion between the holding stacks and final approach as a result of the necessary vectoring by ATC to deliver the required spacing between arrivals to the runway.

2.6.11 In the first instance when considering potential respite routes or relief options we looked at their influence on the LOAEL contours. In the case of Glasgow Airport, the forecast day and night LOAEL contours extend along the final approach for approximately 7-8nm from each runway threshold. At this point, arriving aircraft are approximately 2,500ft above aerodrome level and are aligned with the extended runway centreline as they are in the final stages of landing. This means that we are unable to alternate or provide multiple final approach paths within the LOAEL contour area for arrivals. In other words, there are no options for respite routes or relief options that could result in changes to adverse effects on health and quality of life from noise as defined by Government aviation noise policy.

2.6.12 However, we are aware that for some stakeholders, overflight of arriving aircraft at altitudes higher than 2,500ft and therefore outside of the LOAEL contour can be audible and can affect the acoustic character of the area. Therefore, whilst not mitigating adverse effects above the LOAEL as defined by Government aviation noise policy, ahead of the FOA we have assessed the benefits and impacts of concentrating arriving aircraft on single routes, versus the use of multiple routes which would be alternated on a scheduled basis, with only one set of arrival routes being in operation at any one time[5]. This was considered using 60dB and 65dB L_{ASmax} noise contours (to align with the N60 and N65 contours) for two aircraft types; A medium jet Airbus A321 and the Turboprop Saab340[6]. These two aircraft types were selected as they are an example of a jet and turbo prop which are representative of the fleet mix at Glasgow Airport. For the avoidance of doubt, the Full Options Appraisal methodology utilise the full fleet mix operating at the airport for the noise and overflight modelling.

2.6.13 More information about how aircraft noise is measured can be found in the methodology section of this document.

[5] There would still be routine vectoring of arrivals away from those route centrelines to provide accurate final approach spacing.

[6] At the time of producing the forecasts for the FOA, the Saab 340 was the most common twin propellor aircraft operating at Glasgow Airport. Since that time, the Saab fleet has been retired in favour of ATR-72s, also a twin propellor aircraft. However, it is still considered that the Saab is a representative aircraft for this exercise and can be considered representative of other turboprop aircraft such as the ATR-72s which will now make up a larger proportion of the fleet.

Overview of the additional arrival route options considered

2.6.14 Figure 21 shows the proposed route centrelines from approximately 7000ft in white together with an additional set of centrelines in yellow which have been considered as additional routes to provide noise respite. Around each route centreline is the overflight cone, representing the areas typically overflown by each route up to 7000ft based on the CAA's definition of overflight (CAP1498).

2.6.15 The distance between where the white and yellow routes join final approach is driven by the minimum distances required for IFP design purposes. It is not possible to have them closer owing to the required distance between subsequent waypoints after the Initial Fix on the Instrument Approach Procedures (e.g the ILS or RNP Approach).

2.6.16 The measurement of 'overflight' is a secondary metric[7] that can be useful for explaining the operational impacts of airspace change proposals. These are a means of defining and portraying the pattern and dispersion of aircraft below 7,000 feet, and the frequency that they occur. They are based upon a perception of overflight – they do not illustrate noise impacts however overflight data has been included in the following section.

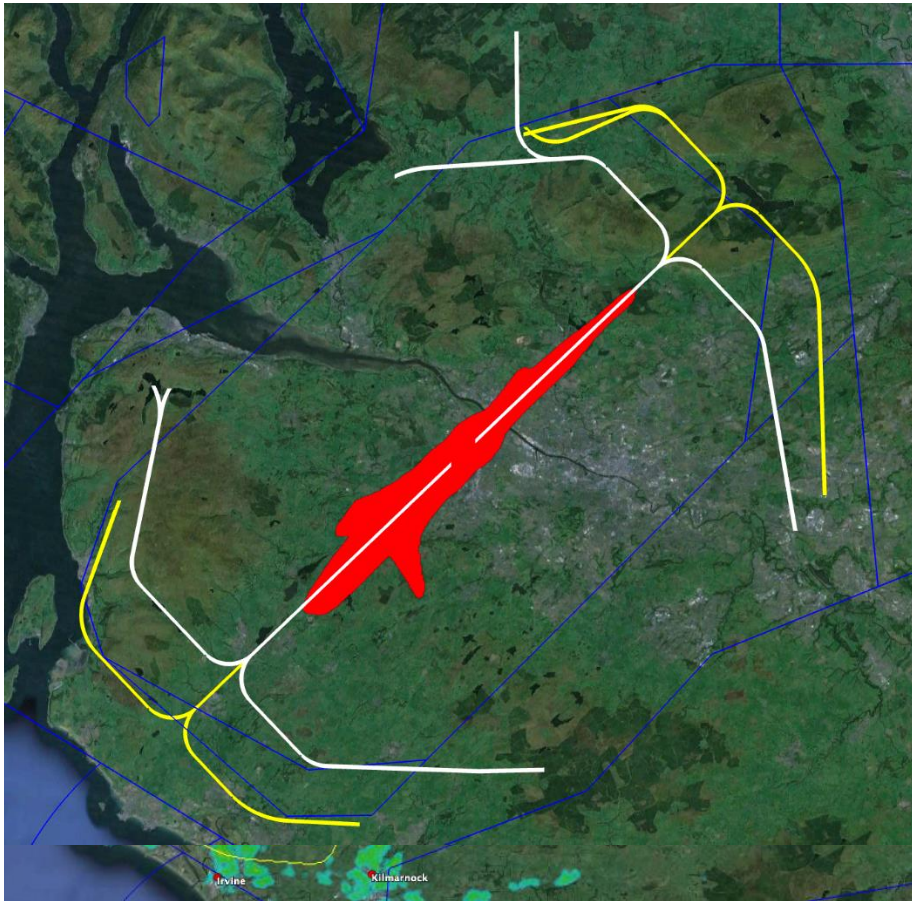


Figure 21 Proposed PBN arrival transitions and potential noise relief routes (shown with overflight contours to 7000ft)

Influence on the LOAEL Contour (Primary CAP1616 metrics)

Figure 22 Potential noise relief routes compared against the extent of the daytime and nighttime LOAEL contours for all FOA options

[7] Noise primary impacts are defined by Equivalent Continuous Noise Levels (LAeq) and Contours, above 51dB LAeq for day and 45dB LAeq for night known as the LOAEL contours. They are also supported by secondary metrics to show where noise exceeds 65dB LAmax (day) or 60dB LAmax (night). (See noise methodology section for more info).

2.6.17 Within paragraph 2.6.11 we explained that multiple arrival route options would not influence the shape or size of the LOAEL contours as any changes would be beyond the extent of those contours.

2.6.18 To confirm this was the case, following the FOA analysis of the options, which is explained in further detail later in this document, we checked the potential additional noise relief routes against the LOAEL contours generated for the FOA.

2.6.19 Figure 22 shows the extent of the forecast (2036) 45dB $L_{Aeq,8h}$ Night and 51dB $L_{Aeq,16h}$ Day LOAEL contours for all options within our FOA. It can be seen that they do not extend as far as where the PBN arrival routes join final approach. Therefore, we can conclude that providing arrival routes that alternate would not mitigate the adverse effects on health and quality of life from noise that occur due to exposure above the LOAEL.

2.6.20 We therefore next looked to the secondary L_{ASmax} metrics.

Proposed arrival route centreline

Potential additional noise relief routes

Proposed CAS boundary

Extent of 2036 FOA LOAEL contours overlaid together

Influence on L_{ASMax} Contours (Secondary CAP1616 metrics)

2.6.21 Ahead of the FOA, we generated contours and population counts within the 60dB and 65dB L_{ASmax} arrival contours for two aircraft types; A321 and SF34. These contours were generated for the proposed arrival route and the potential noise relief routes.

2.6.22 Figure 23 shows these contours with areas circled to show the regions where changes in the 60dB and 65dB L_{ASmax} contours could occur from arrival route alternation.

2.6.23 The following paragraphs explore the advantages and disadvantages of having this additional set of routes, which has been informed by these contours and population counts.

2.6.24 When considering this, we have assumed routes would be used in an alternation pattern where only one set of routes (white or yellow) would be in use at any one time. It's important to note that in certain traffic conditions, vectoring of aircraft would still also occur in order for ATC to achieve the required safe aircraft spacing onto the runway.

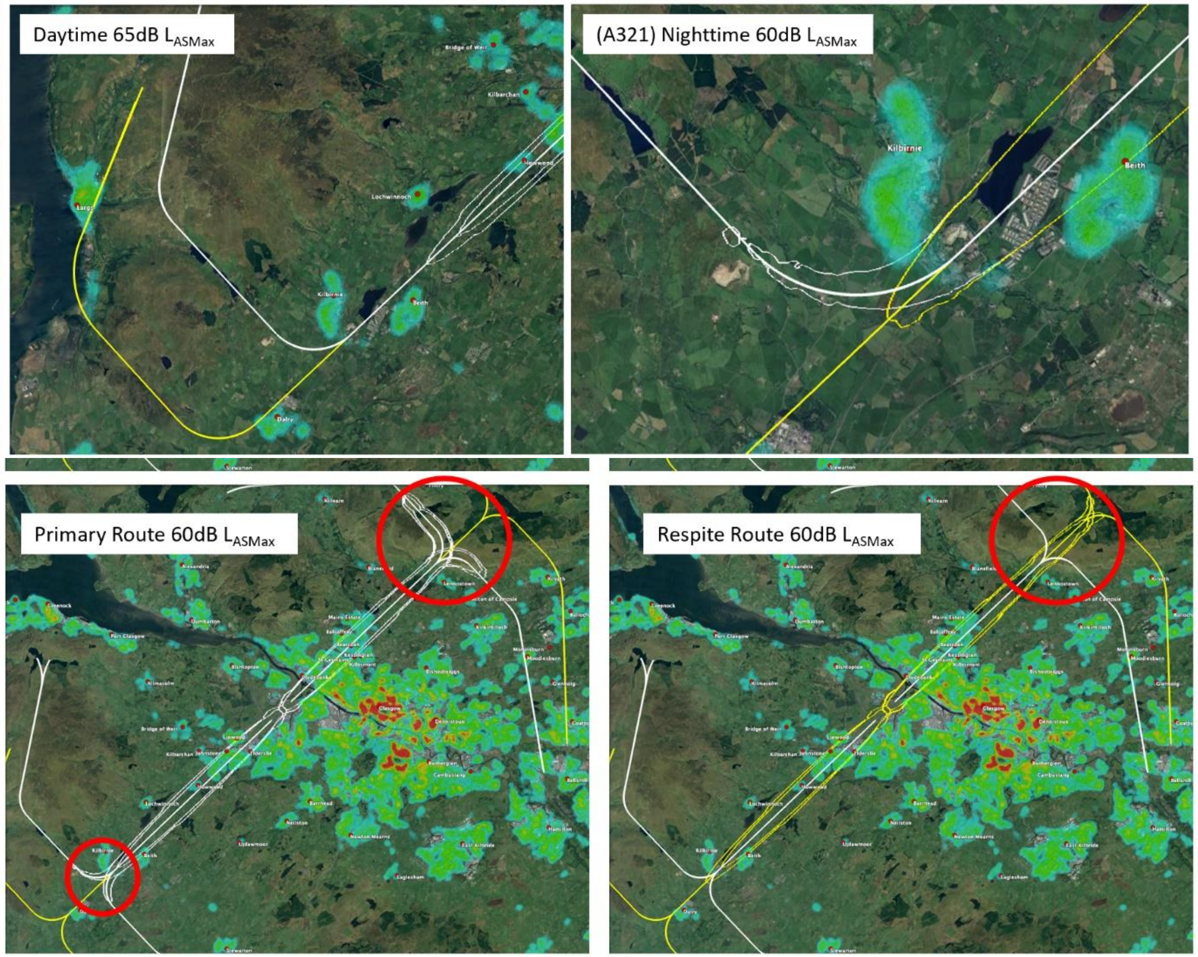


Figure 23 L_{AMax} contours of potential noise relief routes

Proposed arrival route centreline and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Potential additional noise relief routes and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Population density

Consideration of a noise relief route for arrivals from the north on easterly operations

2.6.25 Approximately 5% of all Glasgow's annual arrivals arrive from the north whilst on easterly operations.

2.6.26 Considering easterly operations occur 26% of the year on average, this equates to an annual average of 9 arrivals per day by 2036.

2.6.27 On days of easterly operations there would be in the region of 34 arrivals per day on average from this direction by 2036.

2.6.28 Figure 24 shows the proposed northerly arrival route on easterly operations (white) alongside the potential noise relief route (yellow). Considering also the 60dB (Night) and 65dB (Day) single sound event L_{ASmax} contours, the 65dB (Day) contours are not affected by the presence of a noise relief route. The 60dB (Night) contour for the A320 does extend around the turn of the white route onto final approach.

2.6.29 Although this does show that a very small amount of noise sharing could occur by implementing multiple routes, this broadly occurs over low populated areas. To understand the pros and cons further we then looked to the overflight contour information.

Figure 24 L_{AMax} contours for arrivals from the north on easterly operations

Proposed arrival route centreline and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Potential additional noise relief routes and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Population density

2.6.30 Figure 25 shows the change in areas overflown between 0-4000ft and 4000-7000ft against areas of population density. The noise relief route overflies the densely populated areas of Largs, Fairlie and Dalry, whereas the white route only overflies part of the densely populated southern edge of Kilbirnie. The noise relief route would also overfly large parts of this area too. Under the noise relief route lies Kelburn Castle, marked in purple, which is a designated garden and landscape.

2.6.31 Whilst the images show the route centrelines and overflight cones, in reality traffic will still be vectored and shortcut by ATC in order to facilitate expeditious traffic flows as well as accurate final approach spacing. Therefore, whilst arrival routes would be alternated, communities underneath them would still experience frequent overflight even when the 'other' route was in operation.

2.6.32 Table 7 compares the proposed arrival route (white) against the noise relief route (yellow). It shows the main categories where there is differentiation between the proposed route and the noise relief route.

2.6.33 By 2036, there is expected to be c.9 arrivals per day on average from the north on easterly operations. The table shows how the average number of movements per day would change if alternating with a noise relief route **however this assumes all arrivals will fly the PBN route centrelines which would not be the case in reality as, whilst there would be a concentration of aircraft on the route centrelines, there would still be routine vectoring of arrivals away from those route centrelines** to provide accurate final approach spacing.

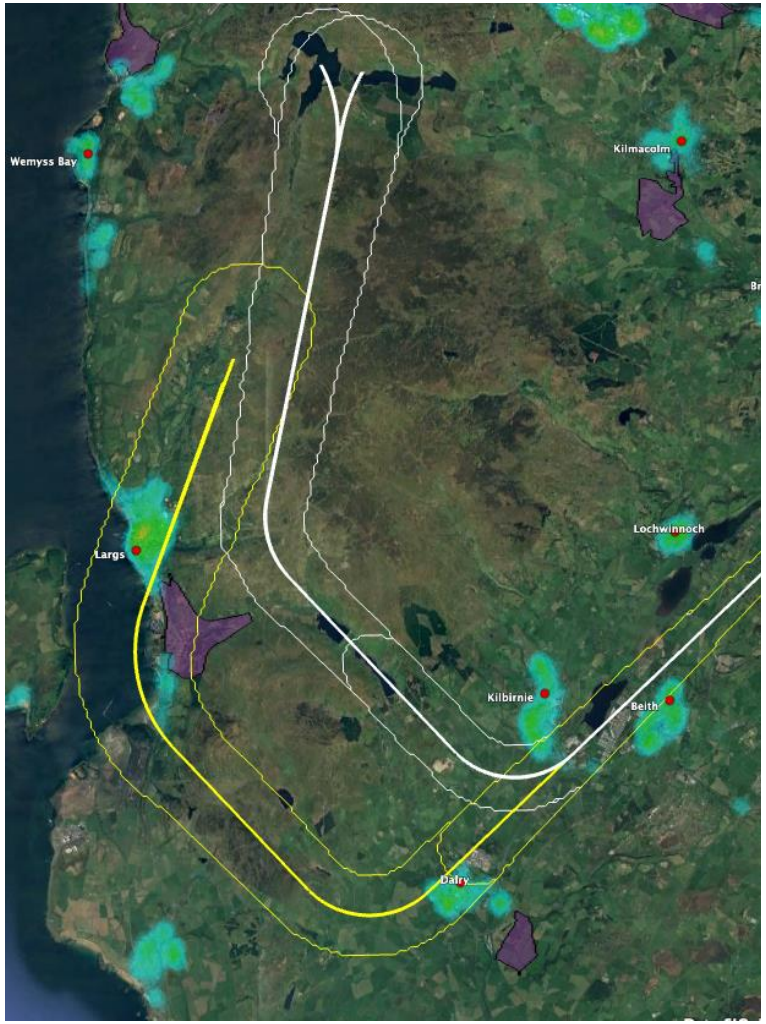


Figure 25 Overflight contours for arrivals from the north on easterly operations

Proposed arrival route centreline and overflight contour to 7000ft

Potential additional noise relief routes and overflight contour to 7000ft

Population density

Designated garden and landscape.

Table 7 Noise relief route comparison for arrivals from the north (COYLE / FOYLE) on easterly operations

Assessment category	COYLE / FYNER RWY05	COYLE / FYNER RWY05 RELIEF	Notes
Average number of arrivals per day (2036)	4.5	4.5	'Worst case' estimate based on all arrivals flying PBN route with no vectoring occurring
Noise Metric	Population		
Overflight 0 - 1000ft	3,100	3,084	No change below 3000ft therefore population within these areas would not benefit from a noise relief route.
Overflight 1000 - 2000ft	2,100	2,000	
Overflight 2000 - 3000ft	1,100	1,100	
Overflight 3000 - 4000ft	1,400	1,600	A small change between 3,000ft – 4000ft
Overflight 4000 - 5000ft	<100	4,000	Between 4000ft – 7000ft there is a significant increase in numbers overflown by the noise relief route, compared to the numbers experiencing a 50% reduction in overflight
Overflight 5000 - 6000ft	-	200	
Overflight 6000 - 7000ft	<100	12,200	
Overflight 0 - 7000ft	7,600	24,100	
Saab 340 60dB L_{AMax}	22,700	22,700	The noise relief route is outside the scope of these contours.
Saab 340 65dB L_{AMax}	13,000	13,000	
A321 60dB L_{AMax}	26,000	26,400	The majority of the noise relief route is outside the scope of these contours and hence there is only a very small change to the A321 60dB L_{ASmax} contour which occurs from less than 1 night time arrival per day from the north to runway 05.
A321 65dB L_{AMax}	18,000	18,500	
Tranquillity		Difference	
Designated parks and gardens		+1	The noise relief route introduces additional overflight of Kelburn Castle
Track mileage		Additional mileage (nm)	
Mileage difference	n/a	+5.3	This would equate to around an additional 8705nm flight plannable track miles per year. Increases in track mileage will result in increased fuel burn and associated greenhouse gas emissions.
Impact on other Airspace users			
Controlled Airspace	The noise relief route would not require any additional Controlled Airspace however it comes within 2.5nm of Prestwick's airspace. This would require co-ordination of Glasgow's arrivals which may result in more of Glasgow's arrivals needing to be vectored off the noise relief arrival route.		

2.6.34 Based on the data within Table 7 Glasgow Airport concluded that a noise relief route would not be appropriate for arrivals from the north whilst on easterly operations as it would not offer any benefit in terms of the adverse effects on health and quality of life from noise (due to no change in exposure above the LOAEL contours). There would also be no change in the secondary daytime 60dB L_{ASmax} contour, and there would be very little benefit for those within the secondary 65dB L_{ASmax} nighttime contour. In addition to this, it would increase track mileage and associated fuel burn and greenhouse gas emissions. Finally, although it would not require additional CAS, ATC would frequently need to vector traffic off this route due to the proximity to Prestwick Airport, and therefore any potential benefits of a noise relief route may be lost if aircraft are then vectored over the ‘other’ route which is not in operation at the time.

Consideration of a noise relief route for arrivals from the south on easterly operations

2.6.35 Approximately 15% of all Glasgow's annual arrivals arrive from the south whilst on easterly operations. Considering easterly operations occur 26% of the year on average, this equates to an annual average of 24 arrivals per day by 2036.

2.6.36 On days of easterly operations there would be in the region of 93 arrivals per day on average from this direction by 2036.

2.6.37 Figure 26 shows the proposed southerly arrival route on easterly operations (white) alongside the potential noise relief route (yellow). Considering also the 60dB (Night) and 65dB (Day) single sound event L_{ASmax} contours, the 65dB (Day) contours are not affected by the presence of a noise relief route. The 60dB (Night) contour for the A321 does extend around the turn of the white route onto final approach.

2.6.38 Although this does show that a very small amount of noise sharing could occur by implementing multiple routes, this broadly occurs over low populated areas. To understand the pros and cons further we then looked to the overflight contour information.

2.6.39 Figure 27 shows the change in areas overflown between 0-4000ft and 4000-7000ft against areas of population density. The noise relief route overflies the populated areas of Kilmarnock, Irvine, Kilwinning, Dalry and the southern edge of Kilbirnie compared to the white route which overflies the southern half of Stewarton and the southern edge of Kilbirnie. Also, under the noise relief route lies Eglinton Castle, marked in purple which is a designated garden and landscape.

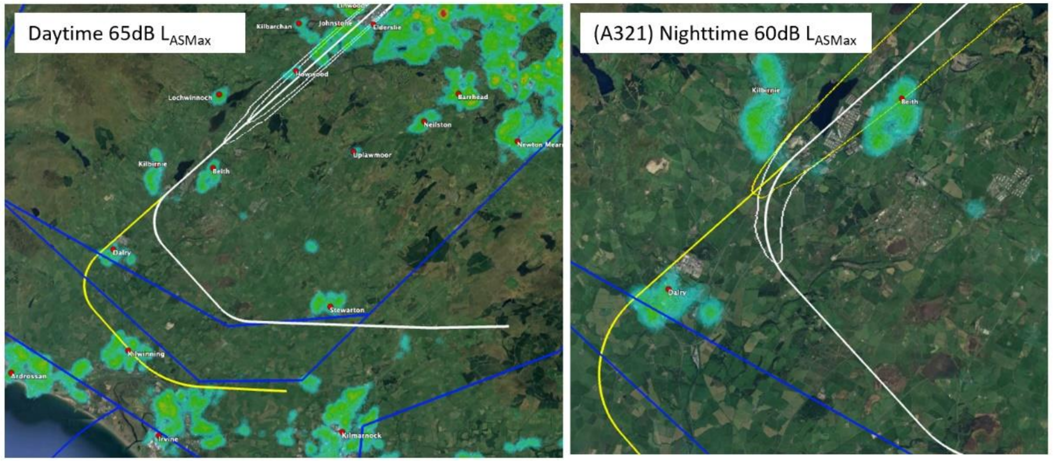


Figure 26 L_{AMax} contours for arrivals from the south on easterly operations

Proposed arrival route centreline and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Potential additional noise relief routes and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Population density

2.6.40 Whilst the images show the route centrelines and overflight cones, in reality traffic will still be vectored and shortcut by ATC in order to facilitate expeditious traffic flows as well as accurate final approach spacing. Therefore, whilst arrival routes would be alternated, communities underneath them would still experience frequent overflight even when the 'other' route was in operation.

2.6.41 Table 8 compares the proposed arrival route (white) against the noise relief route (yellow). It shows the main categories where there is differentiation between the proposed route and the noise relief route.

2.6.42 By 2036, there is expected to be c.24 arrivals per day on average from the south on easterly operations. The table shows how the average number of movements per day would change if alternating with a noise relief route **however this assumes all arrivals will fly the PBN route centrelines which would not be the case in reality as, whilst there would be a concentration of aircraft on the route centrelines, there would still be routine vectoring of arrivals away from those route centrelines** to provide accurate final approach spacing.

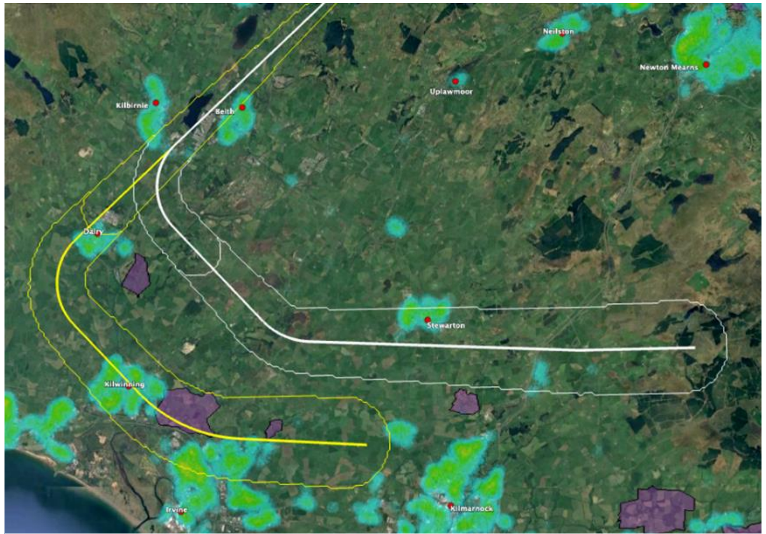


Figure 27 Overflight contours for arrivals from the south on easterly operations

Proposed arrival route centreline and overflight contour to 7000ft

Potential additional noise relief routes and overflight contour to 7000ft

Population density

Designated garden and landscape.

Table 8 Noise relief route comparison for arrivals from the south (LESMA) on easterly operations

Assessment category	LESMA RWY05	LESMA RWY05 RELIEF	Notes
Average number of arrivals per day (2036)	12	12	'Worst case' estimate based on all arrivals flying PBN route with no vectoring occurring
Noise Metric	Population		
Overflight 0 - 1000ft	3,100	3,100	No change below 3000ft therefore population within these areas would not benefit from a noise relief route.
Overflight 1000 - 2000ft	2,100	2,100	
Overflight 2000 - 3000ft	1,100	1,100	
Overflight 3000 - 4000ft	1,300	1,600	A small change between 3,000ft – 4000ft
Overflight 4000 - 5000ft	<100	4,000	Between 4000ft – 7000ft there is a significant increase in numbers overflown by the noise relief route, compared to the numbers experiencing a 50% reduction in overflight
Overflight 5000 - 6000ft	6,100	16,500	
Overflight 6000 - 7000ft	1,300	14,500	
Overflight 0 - 7000ft	15,000	42,900	
Saab 340 60dB L_{AMax}	22,700	22,700	The noise relief route is outside the scope of these contours.
Saab 340 65dB L_{AMax}	13,000	13,000	
A321 60dB L_{AMax}	26,400	26,400	The majority of the noise relief route is outside the scope of these contours and hence there is only a very small change to the A321 60dB L_{ASmax} contour which occurs from on average 1 night time arrival from the south to runway 05.
A321 65dB L_{AMax}	18,500	18,500	
Tranquillity		Difference	
Designated parks and gardens	n/a	+1	The noise relief route introduces additional overflight of Eglinton Castle
Track mileage		Additional mileage (nm)	
Mileage difference	n/a	+5.2	This would equate to around an additional 22776nm flight plannable track miles per year. Increases in track mileage will result in increased fuel burn and associated greenhouse gas emissions.
Impact on other Airspace users			
Controlled Airspace	The respite route would not require an additional Controlled Airspace however it comes within 1.5nm of Prestwick's airspace. This would require co-ordination of Glasgow's arrivals which may result in more of Glasgow's arrivals needing to be vectored off the noise relief arrival route.		

2.6.43 Based on the data within Table 8 Glasgow Airport concluded that a noise relief route would not be appropriate for arrivals from the south whilst on easterly operations as it would not offer any benefit in terms of the adverse effects on health and quality of life from noise (due to no change in exposure above the LOAEL contours). There would also be no change in the secondary daytime 65dB L_{ASMax} contour, and there would be very little benefit for those within the secondary 60dB L_{ASmax} nighttime contour. In addition to this, it would increase track mileage and associated fuel burn and greenhouse gas emissions. Finally, although it would not require additional CAS, ATC would sometimes need to vector traffic off this route due to the proximity to Prestwick Airport, and therefore any potential benefits of a noise relief route may be lost if aircraft are then vectored over the 'other' route area.

Consideration of a noise relief route for arrivals from the north on westerly operations

2.6.44 Approximately 21% of all Glasgow's annual arrivals arrive from the north whilst on westerly operations. Considering westerly operations occur 74% of the year on average, this equates to an annual average of 25 arrivals per day by 2036.

2.6.45 On days of westerly operations there would be in the region of 34 arrivals per day on average from this direction by 2036.

2.6.46 Figure 28 shows the proposed northerly arrival route on westerly operations (white) alongside the potential noise relief route (yellow). Considering the 60dB (Night) and 65dB (Day) single sound event L_{ASmax}, both the day and night contours extend around the turn of the white route onto final approach. This is due to a combination of high ground and the final approach joining point being slightly closer to the runway on westerlies compared to easterlies.

2.6.47 Although this does show that a very small amount of noise sharing could occur by implementing multiple routes, this broadly occurs over low populated areas. To understand the pros and cons further we then looked to the overflight contour information.

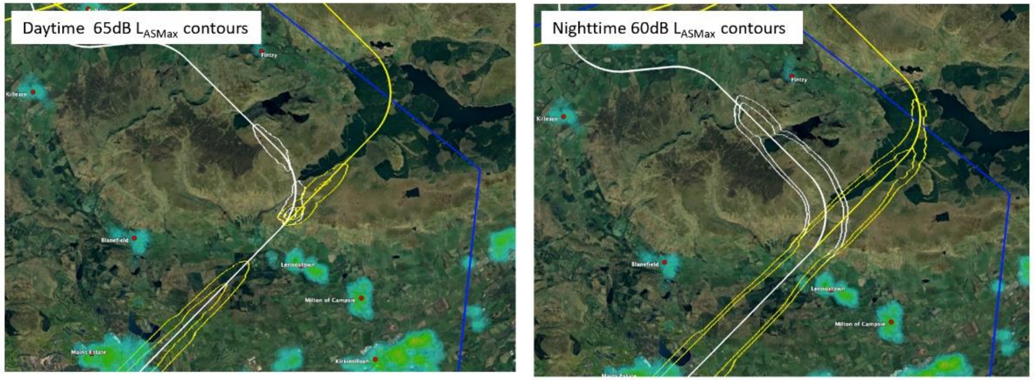


Figure 28 L_{AMax} contours for arrivals from the north on westerly operations

Proposed arrival route centreline and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Potential additional noise relief routes and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Population density

2.6.48 Figure 29 shows the change in areas overflown between 0-4000ft and 4000-7000ft against areas of population density. The optimised route centreline designed in white, aims to weave between Drymen, Balfon and Killearn, although parts of these communities will still be overflown. The noise relief routes (yellow) better avoids Killearn but more directly overflies Balfron and Drymen.

2.6.49 Whilst the images show the route centrelines and overflight cones, in reality traffic will still be vectored and shortcut by ATC in order to facilitate expeditious traffic flows as well as accurate final approach spacing. Therefore, whilst arrival routes would be alternated, communities underneath them would still experience frequent overflight even when the 'other' route was in operation.

2.6.50 Table 9 compares the proposed arrival route (white) against the noise relief route (yellow). It shows the main categories where there is differentiation between the proposed route and the noise relief route.

2.6.51 By 2036, there is expected to be c.25 arrivals per day on average from the north on westerly operations. The table shows how the average number of movements per day would change if alternating with a noise relief route **however this assumes all arrivals will fly the PBN route centrelines which would not be the case in reality as, whilst there would be a concentration of aircraft on the route centrelines, there would still be routine vectoring of arrivals away from those route centrelines** to provide accurate final approach spacing.

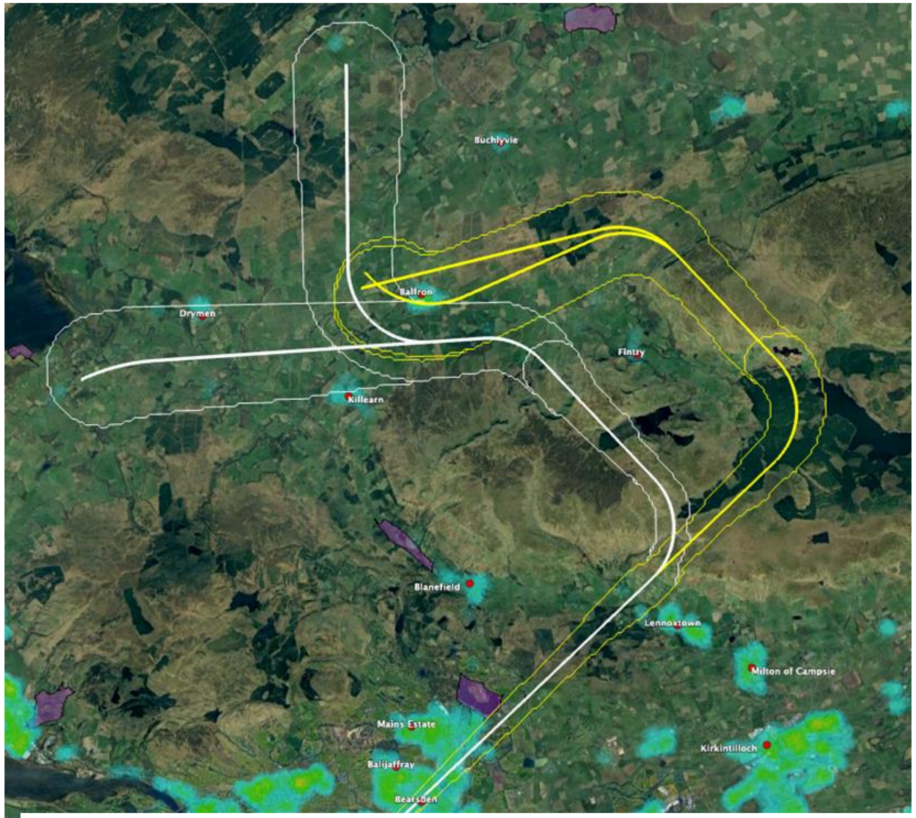


Figure 29 Overflight contours for arrivals from the north on westerly operations

Proposed arrival route centreline and overflight contour to 7000ft

Potential additional noise relief routes and overflight contour to 7000ft

Population density

Designated garden and landscape.

Table 9 Noise relief route comparison for arrivals from the north on westerly operations (COYLE/FYNER)

Assessment category	COYLE RWY23	COYLE RWY23 RELIEF	FYNER RWY23	FYNER RWY23 RELIEF	Notes
Average number of arrivals per day (2036)	4	4	8	8	'Worst case' estimate based on all arrivals flying PBN route with no vectoring occurring. Note numbers do not add up to 25 due to rounding.
Noise Metric	Population				
Overflight 0 - 1000ft	4,600	4,600	4,600	4,600	No change in population below 3000ft. Between 3000ft-4000ft, no population would benefit from a noise relief route however a very small number of people would be impacted.
Overflight 1000 - 2000ft	5,100	5,100	5,100	5,100	
Overflight 2000 - 3000ft	400	400	400	400	
Overflight 3000 - 4000ft	-	<100	-	<100	
Overflight 4000 - 5000ft	200	-	200	-	Between 4000ft – 7000ft there are variable changes in overflight. Overall, there is only a very small difference in the number of people overflown by the noise relief route.
Overflight 5000 - 6000ft	1000	<100	1,300	<100	
Overflight 6000 - 7000ft	<100	2,600	1,200	2,300	
Overflight 0 - 7000ft	11,300	12,800	12,700	12,400	
Saab 340 60dB L_{AMax}	38,400	38,400	38,400	38,400	The majority of the noise relief route is outside the scope of these contours and there are only very small areas of population within the parts of contours that differ. As such, there are very small changes to impacts or benefits to populations within these contours as a result of a noise relief route.
Saab 340 65dB L_{AMax}	22,500	22,500	22,400	22,500	
A321 60dB L_{AMax}	47,300	47,300	47,200	47,300	
A321 65dB L_{AMax}	31,300	31,200	31,300	31,300	
Track mileage		Additional mileage (nm)		Additional mileage (nm)	
Mileage difference		+4.5		+5.5	This would equate to around an additional 6570nm flight plannable track miles per year for COYLE and 16060nm for FYNER. Increases in track mileage will result in increased fuel burn and associated greenhouse gas emissions.
Impact on other Airspace users					
Controlled Airspace	The respite route would require an additional Controlled Airspace as the proposed route runs along the edge of the proposed 4500ft base.				

2.6.52 Based on the data within Table 9 Glasgow Airport concluded that a noise relief route would not be appropriate for arrivals from the north whilst on westerly operations as it would not offer any benefit in terms of the adverse effects on health and quality of life from noise (due to no change in exposure above the LOAEL contours). There would be only be very small positive benefits or negative impacts for those within the secondary 65dB L_{AMax} daytime and 60dB L_{AMax} nighttime contours. In terms of overflight, a noise relief route would not significantly benefit or impact any communities below 4000ft, and above 4000ft, where there are some variable changes in overflight, the number of population does not suggest that any benefits would be significant. In addition to this, it would increase track mileage and associated fuel burn and greenhouse gas emissions. Finally, it would also require additional Controlled Airspace.

Consideration of a noise relief route for arrivals from the south on westerly operations

2.6.53 Approximately 59% of all Glasgow's annual arrivals arrive from the south whilst on westerly operations. Considering westerly operations occur 74% of the year on average, this equates to an annual average of 69 arrivals per day by 2036.

2.6.54 On days of westerly operations there would be in the region of 93 arrivals per day on average from this direction by 2036.

2.6.55 Figure 30 shows the proposed southerly arrival route on westerly operations (white) alongside the potential noise relief route (yellow). Considering the 60dB (Night) and 65dB (Day) single sound event L_{ASmax}, both the day and night contours extend around the turn of the white route onto final approach. This is due to a combination of high ground and the final approach joining point being slightly closer to the runway on westerlies compared to easterlies.

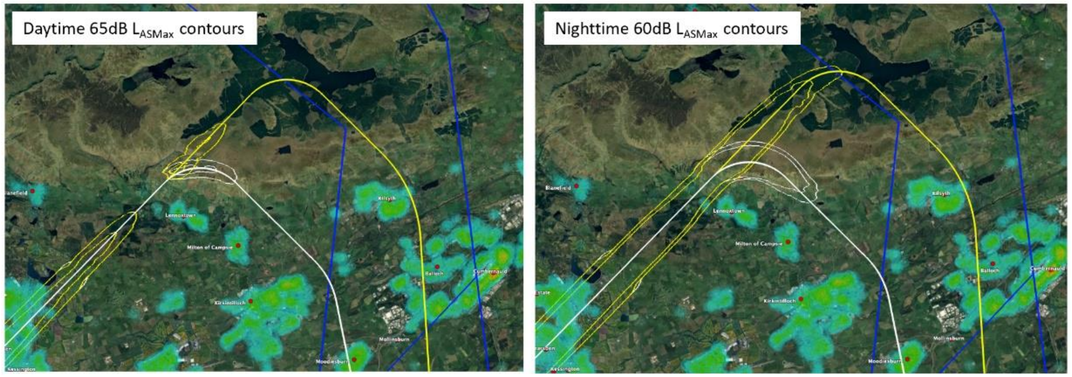


Figure 30 L_{AMax} contours for arrivals from the south on westerly operations

Proposed arrival route centreline and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Potential additional noise relief routes and 60dB and 65dB L_{AMax} single sound event contours for two aircraft types; A321 and SF34.

Population density

2.6.56 Although this does show that a very small amount of noise sharing could occur by implementing multiple routes, this occurs over very low populated areas. To understand the pros and cons further we then looked to the overflight contour information.

2.6.57 Figure 31 shows the change in areas overflown between 0-4000ft and 4000-7000ft against areas of population density. The optimised route centreline (white) aims to take the path which overflies the lowest population numbers between the LESMA holding stack and final approach. It does however still overfly some the western side of Whifflet/Coatbridge, Gartcosh, Moodiesburn and the eastern edge of Kirkintilloch. The noise relief route (yellow) would more directly overfly Whifflet/Coatbridge but then, avoiding Gartcosh and Moodiesburn, would overfly Cumbernauld and Kilstyh.

2.6.58 In order to be safely integrated into the wider airspace network, the noise relief route in yellow would be required to descend to 6000ft earlier than the proposed route in white due to the interactions with the Edinburgh Departures which cannot be safely resolved via any other mitigation.

2.6.59 Whilst the images show the route centrelines and overflight cones, in reality traffic will still be vectored and shortcut by ATC in order to facilitate expeditious traffic flows as well as accurate final approach spacing. Therefore, whilst arrival routes would be alternated, communities underneath them would still experience frequent overflight even when the 'other' route was in operation.

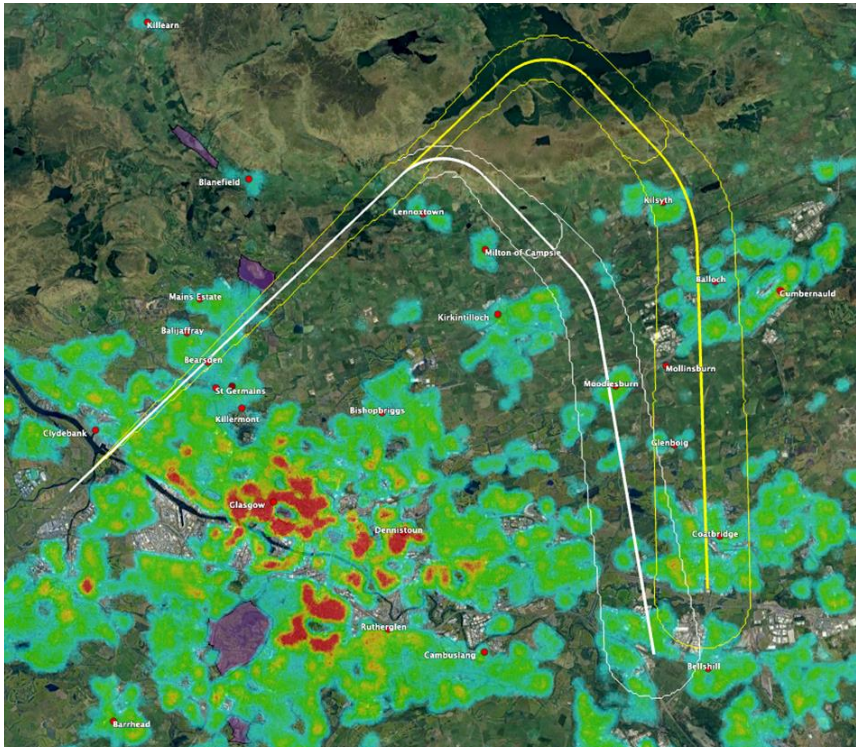


Figure 31 Overflight contours for arrivals from the south on westerly operations

Proposed arrival route centreline and overflight contour to 7000ft
Potential additional noise relief routes and overflight contour to 7000ft
Population density
Designated garden and landscape.

2.6.60 Table 10 Noise relief route comparison for arrivals from the south on westerly operations (LESMA)compares the proposed arrival route (white) against the noise relief route (yellow). It shows the main categories where there is differentiation between the proposed route and the noise relief route.

2.6.61 By 2036, there is expected to be c.69 arrivals per day on average from the south on westerly operations. The table shows how the average number of movements per day would change if alternating with a noise relief route **however this assumes all arrivals will fly the PBN route centrelines which would not be the case in reality as, whilst there would be a concentration of aircraft on the route centrelines, there would still be routine vectoring of arrivals away from those route centrelines** to provide accurate final approach spacing.

Table 10 Noise relief route comparison for arrivals from the south on westerly operations (LESMA)

Assessment category	LESMA RWY23	LESMA RWY23 RELIEF	Notes
Average number of arrivals per day (2036)	34.5	34.5	'Worst case' estimate based on all arrivals flying PBN route with no vectoring occurring
Noise Metric	Population		
Overflight 0 - 1000ft	4,600	4,600	No change in population below 3000ft. Between 3000ft-4000ft, a very small number of people (59) would benefit from the route.
Overflight 1000 - 2000ft	5,100	5,100	
Overflight 2000 - 3000ft	400	400	
Overflight 3000 - 4000ft	<100	-	
Overflight 4000 - 5000ft	2,400	500	Between 4000ft – 7000ft there are variable changes in overflight. Overall the noise relief route overflies almost double the number of people compared to the proposed route.
Overflight 5000 - 6000ft	15,800	67,900	
Overflight 6000 - 7000ft	30,100	29,500	
Overflight 0 - 7000ft	58,500	107,900	
Saab 340 60dB L_{AMax}	38,400	38,400	No change
Saab 340 65dB L_{AMax}	22,500	22,500	
A321 60dB L_{AMax}	47,300	47,300	The majority of the noise relief route is outside the scope of these contours and there are only very small areas of population within the parts of contours that differ. As such, there are very small changes to impacts or benefits to the number of people within these contours as a result of a noise relief route.
A321 65dB L_{AMax}	31,200	31,300	
Track mileage		Additional mileage (nm)	
Mileage difference		+4.8	This would equate to around an additional 60444 nm flight plannable track miles per year. Increases in track mileage will result in increased fuel burn and associated greenhouse gas emissions.
Impact on other Airspace users			
Controlled Airspace			None identified

2.6.62 Based on the data within Table 10 Glasgow Airport concluded that a noise relief route would not be appropriate for arrivals from the south whilst on westerly operations as it would not offer any benefit in terms of the adverse effects on health and quality of life from noise (due to no change in exposure above the LOAEL contours). There would be no benefits or impacts for those within the secondary 60dB L_{AMax} nighttime contours and negligible benefits or impacts for those within the 65dB L_{AMax} daytime contours.

2.6.63 In terms of overflight, a noise relief route would not materially benefit or impact any communities below 4000ft. Above 4,000ft, a route from the south to runway 23 is perhaps the region where a noise relief route could offer the most people with benefit however in doing so, it also would mean a very significant number of people negatively impacted, particularly in the 5,000ft – 6,000ft band. We therefore looked in further detail at the potential pros and cons of this option.

2.6.64 There were three main considerations which weighted the decision. Firstly, that an additional 60,444 of flight plannable miles per year was felt to be generating a disproportionate increase in fuel burn and associated greenhouse gas emissions. Secondly, aircraft will routinely be taken off the PBN arrival routes by ATC to facilitate accurate final approach spacing. This is more likely on these routes from the south because they are the busiest routes. Therefore, communities under both arrival routes would still experience fairly routine overflight even though only one route would be active at any one time. Finally, as with each of the noise relief routes, when compared to the 'without ACP' overflight swathes, they would be positioned in areas well outside of the areas typically overflown today, resulting in a much more fundamental change in arrival overflight patterns.

2.6.65 On balance following this investigation of the pros and cons of concentrating arriving aircraft on single routes, versus the use of multiple routes. The outcome was that the use of multiple arrival routes to provide an element of noise relief are not being proposed.

2.7 Summary and conclusion on the incorporation of noise relief routes

2.7.1 The sections above explain how Glasgow Airport has investigated the pros and cons concentrating arriving aircraft on single routes, versus the use of multiple routes within the scope of the Glasgow Airport operation where some aircraft will continue to be vectored around any PBN routes.

2.7.2 Overall, it was concluded that the use of multiple arrival routes to provide an element of noise relief are not being proposed and therefore have not been incorporated into this FOA of Consultation.

2.7.3 Respite and Relief for departures were investigated in Stage 2 with only those options that had a more even distribution of departures across the SIDs being progressed into Stage 3.

3. Full Options Appraisal Methodology

3.1 Baseline Inputs

3.1.1 As part of this FOA, CAP1616 requires airspace change sponsors to set a baseline which is used for environmental evaluation of the options. CAP1616 explains that this will be a 'do nothing' scenario and will largely reflect the current-day scenario, although taking due consideration of known or anticipated factors that might affect that baseline, for example a planned housing development close to an airport, forecast growth in air traffic, or expected changes in airlines' fleet mix.

3.1.2 The FOA must then, wherever possible quantitively and otherwise qualitatively, appraise the difference between a pre-implementation ('without airspace change') scenario and a post-implementation 'with airspace change' scenario, ensuring that the periods are comparable. The following subsections provide information which has been used to generate the baseline scenario. The full baseline appraisal is shown in the Full Options Appraisal section of this document.

3.1.3 Note that as part of the ACOG CAF process, for some assessments shared assumptions were made across the three ACPs which form part of Scottish Airspace Modernisation (SAM). For details of these, please see the ACOG CAF 2 document in Annex A.

Scenario years and traffic forecasts: Movement numbers and schedule

3.1.4 Airspace Change Sponsors must determine a 'current day' scenario which takes actual flight data and is typically based on the latest data available such as the latest published noise contours. This current day scenario is then used as a starting point when developing the baseline 'do nothing' pre-implementation scenario and a scenario 10 years following implementation, which are also required by CAP1616.

3.1.5 For noise, overflight and air quality we have defined the current-day scenario as 2022 as this was the latest available data at the time of undertaking the noise modelling. However, for fuel burn and greenhouse gas (GHG) emissions, we are restricted to using 2023 as the current-day scenario due to an interface with NERL ACP and the data generated by NERL. It is important to note that this does not affect the overall assessment of the options themselves as these are calculated based on comparison to a future baseline rather than current-day baseline. The noise and GHG data are also not comparable in any event as the GHG data is annual and the noise data is 92-day summer.

3.1.6 The Scottish Airspace Modernisation ACPs are expected to be implemented no earlier than 2027[8] and therefore this FOA will describe the baseline and the anticipated factors that are expected to impact it, such as any forecast growth, fleet mix changes and planned developments based on implementation in 2027.

3.1.7 CAP1616 also requires airspace change sponsors to forecast growth 10 years following the year of implementation and following guidance from the CAA, the 10 year post-implementation scenario has been based on 2036.

Traffic Forecast: Movement numbers and schedule

3.1.8 Glasgow Airport does not usually forecast out more than 5 years ahead. For the purposes of this FOA, we have taken actual Electronic Flight Progress Strip Data (EFPS data) from 2022 and then used Glasgow Airport's long term business plan 5-year traffic predictions to apply growth to this data. This 5 year forecast is based on business intelligence and information including frequency of route operated, new routes, stopping routes, anticipated changes in fleet mix and speed of covid recovery. Beyond 5 years, this forecast is grown by an annual average per annum, informed by previous years, given less certainty. Glasgow Airport has no planning/section 106 agreements which would affect our forecast.

3.1.9 The forecast was generated between September 2023 and February 2024 based on the long term business plan as of November 2023. The time taken to generate the forecast is due to the complex requirements and fidelity needed to meet the environmental modelling requirements of CAP1616 which go beyond any forecast fidelity the airport would typically generate. The FOA modelling work was then undertaken between February 2024 and submission in August 2024 (with preparation undertaken from September 2023 onwards once the 92 day summer data was available).

3.1.10 The forecast is based on the best and most up to date information available at the time of forecasting. Airport operations are continuously evolving with airline decisions around the introduction of new destinations, withdrawal existing destinations and changes fleet mix sometimes outside of the airports immediate control.

3.1.11 Just as we have between Stage 2 and Stage 3, as we progress through the airspace change process we will continue to review the forecasts and update. The next step will be to update the forecast ahead of the Stage 4 Final Options Appraisal. If you would like to see how movement numbers have changed since 2023, please see https://www.caa.co.uk/data-and-analysis/uk-aviation-market/airports/uk-airport-data/.

3.1.12 For the purposes of the more detailed analysis within the FOA, the annual modal split has been updated based on the average split over 20 years' of data (2003 – 2022) with runway 05 being used 26% of the year, and runway 23 being used 74% of the year. The 92-day summer period also has a slightly different long-term modal split with runway 05 being used 23% of the year, and runway 23 being used 77% of the year.

[8] The expected implementation year may change. This depends on the UK Government's airspace modernisation priorities and the aviation industry's ability to manage major changes safely and efficiently.

3.1.13 Table 11 below provides an overview of these forecast movement numbers. Note that whilst it presents annual movement numbers, the noise modelling uses the same source of data but considers only movements that occur within the 92-day summer period from 16 June to 15 September inclusive.

Table 11 Annual Forecast Movements for Glasgow Airport across the ACP assessment period

	2022 'Current day'	2023	2027 1	2028 2	2029 3	2030 4	2031 5	2032 6	2033 7	2034 8	2035 9	2036 10
						Per year						
Total movements (rounded to nearest 1000)	70,000	80,000	91,000	91,000	92,000	93,000	93,000	94,000	95,000	95,000	96,000	96,000

3.1.14 The options within the ACP do not enable any increase in forecast movements at Glasgow Airport and therefore the traffic forecast applied 'without ACP' is the same as 'with ACP'. Note that the expected growth at the airport is not affected by the proposal. This means that although the capacity assessments later in this document highlight improvements compared to the 'without airspace change' scenario, this is realised through reduced departure delay and reduced airborne holding (i.e. the 'with airspace change' scenarios accommodate expected growth with less delay). This means that the number of flights in the 'with airspace change' and 'without airspace change' scenarios are the same - they would just be subject to different amounts of delay.

Fleet Mix

3.1.15 As noted above, Glasgow Airport has taken flight data from 2022 and grown this to reflect a 2027 forecast for the year of implementation and a 2036 forecast for 10 years after implementation. The fleet mix of this data has been adjusted to account for expected airline fleet changes. The fleet mix at Glasgow airport is a mixture of jet and turboprop aircraft, with jet aircraft making up most of the fleet. The most common aircraft types include turboprop aircraft (50 – 70 seats), regional jets (50 – 90 seats), single-aisle 2 engine jets (125 – 180 seats) and twin-aisle jets (300 – 350 seats). Whilst the Airbus A380 (500 seat 4 engine jet) does operate at the airport, it accounts for less than 1% of the annual fleet.

3.1.16 Table 12 shows the expected fleet mix changes across the ACP assessment periods:

Table 12 Fleet mix percentages across the ACP assessment period

Aircraft type Current day (2022)	% of annual fleet mix	Cumulative % of annual fleet mix
Airbus A320	17%	17%

Aircraft type	% of annual fleet mix	Cumulative % of annual fleet mix
Boeing 737-800	16%	33%
Airbus A319	10%	44%
Embraer ERJ-145	7%	51%
Saab 340[9]	6%	57%
Airbus A320neo	5%	62%
De Havilland Canada DHC-6 Twin Otter	5%	67%
Embraer E190	4%	72%
Boeing 737 Max 8	4%	76%
ATR 72-600	4%	79%
Beechcraft King Air 200	3%	82%
Piper PA-28 Cherokee	2%	84%
Cessna 172	1%	85%
Airbus A321neo	1%	87%
Piper PA-38 Tomahawk	1%	88%
Boeing 777-300 ER	1%	89%
De Havilland Canada Dash 8	1%	90%
All other aircraft types each contribute less than 1% to the total fleet		
Year of implementation (2027)		
Airbus A320neo	22%	22%
Boeing 737-800	19%	41%
Airbus A320	8%	49%
Saab 340	6%	54%
De Havilland Canada DHC-6 Twin Otter	5%	59%

[9] At the time of producing the forecasts for the FOA, the Saab 340 was the most common twin propellor aircraft operating at Glasgow Airport. Since that time, the Saab fleet has been retired in favour of ATR-72s, also a twin propellor aircraft. However, it is still considered that the Saab is a representative aircraft for this exercise and can be considered representative of other turboprop aircraft such as the ATR-72s which will now make up a larger proportion of the fleet. Airport operations are continuously evolving with airline decisions around the introduction of new destinations, withdrawal existing destinations and changes fleet mix sometimes outside of the airports immediate control. Any further changes identified will be incorporated into the forecasting work undertaken in preparation for the Stage 4 final options appraisal.

Aircraft type	% of annual fleet mix	Cumulative % of annual fleet mix
Airbus A319	4%	64%
Embraer E190	4%	68%
Embraer ERJ-145	4%	72%
Boeing 737 Max 8	4%	75%
ATR 72-600	4%	79%
Beechcraft King Air 200	3%	81%
Piper PA-28 Cherokee	2%	83%
Airbus A321neo	2%	85%
Cessna 172	1%	86%
Airbus A321	1%	87%
Piper PA-38 Tomahawk	1%	88%
De Havilland Canada Dash 8	1%	89%
All other aircraft types each contribute less than 1% to the total fleet		
Year of implementation + 10 (2036)		
Airbus A320neo	22%	22%
Boeing 737-800	19%	41%
Airbus A320	8%	49%
Saab 340	6%	54%
De Havilland Canada DHC-6 Twin Otter	5%	59%
Airbus A319	4%	64%
Embraer E190	4%	68%
Embraer ERJ-145	4%	72%
Boeing 737 Max 8	4%	75%
ATR 72-600	4%	79%
Beechcraft King Air 200	3%	81%
Piper PA-28 Cherokee	2%	83%
Airbus A321neo	2%	85%
Cessna 172	1%	86%

Aircraft type	% of annual fleet mix	Cumulative % of annual fleet mix
Airbus A321	1%	87%
Piper PA-38 Tomahawk	1%	88%
De Havilland Canada Dash 8	1%	89%
All other aircraft types each contribute less than 1% to the total fleet		

Missed approaches

3.1.17 Missed approaches occur when it is judged that an approach cannot be continued to a safe landing. Aircraft may undertake a missed approach when the weather or visibility make it difficult to land, or when the aircraft is not correctly stabilised and aligned with the runway.

3.1.18 Sometimes missed approaches also occur if the runway is temporarily blocked, or it is unsafe to land. In the event of a missed approach, aircraft fly a defined procedure.

3.1.19 At Glasgow Airport there were 108 missed approaches in 2022 which is around 9 per month on average. As missed approaches are operated on an unplanned basis and owing to the low number of missed approaches per year, they do not form part of the noise and environmental analysis of our proposal, however details of the current missed approaches and proposed future missed approaches are included as part of the option description and have been considered as part of the safety and operability assessments.

Helicopters

3.1.20 A small percentage of movements to and from Glasgow Airport are from helicopter traffic (approximately 2-3%) When arriving or departing from Glasgow Airport, there are no specific helicopter routes although some helicopters may make use of the final approach procedures but would not make use of the SIDs and Approach Transitions. For helicopters following Visual Flight Rules (VFR), whenever possible helicopter flights in the Glasgow CTR/CTA will be cleared on direct routeings under VFR (or, when requested at night in the Glasgow Control Zone, on Special VFR clearance in accordance with the procedures for Special VFR flights). As such, this ACP does not propose to make any changes to the way helicopters arrive / depart, and any assessments have therefore assumed that this is the case.

Planned developments

3.1.21 As part of our preparation of the baseline, we have identified planned developments in the area surrounding Glasgow airport so that these can be considered as part of appraisal of the benefits and impacts of each option. As part of this work, we have searched local planning authority websites and then emailed the relevant local planning authorities to confirm details of the proposed developments within the area. Where these local authorities responded, we have incorporated any additional information provided where possible to do so. A map of planned developments is shown in Figure 32 and Table 13 provides further information about these. All the developments shown in Figure 32 and Table 13 have been incorporated into the baseline.

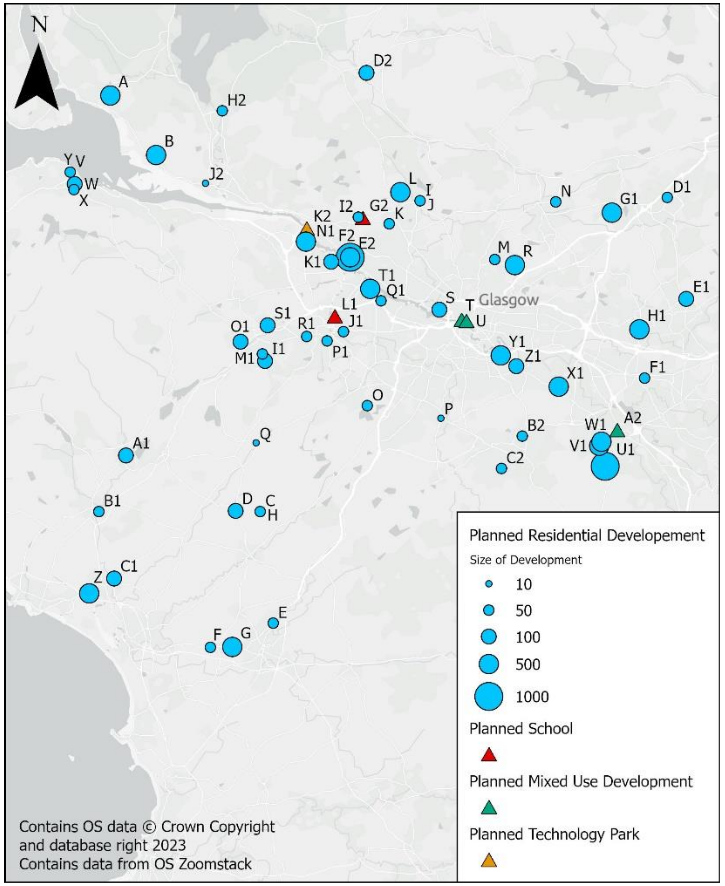


Figure 32 Planned Developments around Glasgow Airport

Table 13 Local developments identified

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
A	Argyll & Bute	Helensburgh Golf Course	G84 9HZ	Housing	307	Detailed planning submitted in January 2022	Planning Page Taylor Wimpey Website	230598	683027

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
B	Argyll & Bute	Cardross	G82 5PN	Housing	205	Application Submitted January 2023	Cala Homes	234310	678197
C	East Ayrshire	KA3 4BD	KA3 4BD	Housing	23	Approved, building began July 2023	Planning Page	242738	649311
D	East Ayrshire	Glasgow Road, Kilmarnock	KA3 6AE	Housing	84	Under consultation (August 2023)	Planning Page	240733	649359
E	East Ayrshire	KA3 1UT	KA3 1UT	Housing	29	Under consultation (August 2023)	Planning Page	243779	640260
F	East Ayrshire	KA2 0BQ	KA2 0BQ	Housing	39	Decided (December 2022)	Planning Page	238688	638316
G	East Ayrshire	KA2 0BB	KA2 0BB	Housing	Unknown	Awaiting Decision (August 2023)	Planning Page	240476	638344
H	East Ayrshire	KA3 4BD	KA3 4BD	Housing	23	Decided April 2023	Planning Page	242738	649311
I	East Dunbartonshire	G62 8BY	G62 8BY	Housing	15-20	Awaiting decision (Mar 22)	Planning Page	255703	674481
J	East Dunbartonshire	Milngavie Road, Bearsden	G62 8BY	Housing	25	Awaiting decision (Mar 22)	Planning Page	255703	674481
K	East Dunbartonshire	Nithsdale Crescent, Bearsden	G614HY	Housing	26	Planning/design phase	Update.	253191	672616
L	East Dunbartonshire	Craigton Road, Milngavie	G62 7RX	Housing	120	Unknown		254100	675203
M	East Dunbartonshire	Auchinairn, Bishopbriggs	G64 1TE	Housing	40	Unknown		261761	669732
N	East Dunbartonshire	Kirkintilloch	G66 2HR	Housing	22	Awaiting Decision (February 2023)	Planning Page	266688	674401
O	East Renfrewshire	Aurs Road, Barrhead	G78 2FA	Housing	39	Registered (January 2023)	Planning Page	251397	657885
P	East Renfrewshire	G76 7DJ	G76 7DJ	Residential Care & Nursing Home	-	Granted (October 2022)	Planning Page	257380	656879

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
Q	East Renfrewshire	G78 4BE	G78 4BE	Assisted Living Flats	Unknown	Potential resubmission (August 2023)	Planning Page	242404	654875
R	Glasgow City	G33 1TG	G33 1TG	Housing	300	Planning permission approved in principle (February 2022)	Developer	263372	669294
S	Glasgow City	Finnieston	G3 8LE	Flats	64	Pending Consideration (June 2023)	Planning Page	257243	665652
T	Glasgow City	St Enoch Shoppig Centre	G1 4BW	Re-development	Mixed	Granted (June 2023)	Planning Page	259064	664926
U	Glasgow City	Kings Street Car Park	G1 5QT	Re-development	Mixed	Planning permission in principle	Article	259446	664828
V	Inverclyde	PA16 8DA	PA16 8DA	Flats	22	Permission Granted (September 2022), work not yet started.	Planning Page	227350	676809
W	Inverclyde	Roxburgh St, Greenock	PA15 4LY	Housing	64	Pending Consideration	Planning Page	227710	675856
X	Inverclyde	Drumfrochar Road, Greenock	PA15 4BJ	Housing	47	Pending Consideration	Planning Page	227641	675409
Y	Inverclyde	PA16 8DA	PA16 8DA	Housing	22	Granted (September 2022)	Planning Page	227350	676809
Z	North Ayrshire	Byrehill Place, Kilwinning	KA13 6HN	Housing	426	Approved October 2022, under construction.	Planning Page	228873	642662
A1	North Ayrshire	Knoxville Road, Kilbirnie	KA25 7EG	Housing	62	Approved August 2022	Planning Page	231859	653858
B1	North Ayrshire	Bridgene Mill, Dalry	KA24 4DB	Housing	26	No updates	Planning Page	229645	649306
C1	North Ayrshire	Mossculloch Farn, Kilwinning	KA13 7HX	Housing	85	Pending Consideration	Planning Page	230879	643891

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
D1	North Lanarkshire	G67 1LL	G67 1LL	Housing	44	Pending Consideration	Planning Page	275739	674755
E1	North Lanarkshire	Airdriehill Street Rawyards Airdrie	ML6 7LH	Housing	62	Pending Consideration	Planning Page	277272	666528
F1	North Lanarkshire	Thorn Road, Bellshill	ML4 1QQ	Housing	26	Pending Consideration	Planning Page	273878	660133
G1	North Lanarkshire	Cumbernauld, G68 9LD	G68 9LD	Housing	Unknown	Pending Consideration	Planning Page	271226	673535
H1	North Lanarkshire	Coatbridge	ML5 4DA	Housing	131	Pending Consideration	Planning Page	273463	664070
I1	Renfrewshire	PA5 0SP	PA5 0SP	Housing	96	Approved January 2022	Planning Page	243133	661510
J1	Renfrewshire	East Lane, Paisley	PA1 1QN	Flats	48	Granted February 2023	Planning Page	249477	663881
K1	Renfrewshire	Erskine	PA8 7EA	Housing/Flats	59/24	Approved November 2022	Planning Page	248486	669557
L1	Renfrewshire	Renfrew Road, Paisley	PA3 4DY	New School	-	Planned opening date of August 2026 - update	Article	248787	665221
M1	Renfrewshire	Elm Drive, Johnstone	PA5 0AH	Housing/Flats	36/6	Now 60 homes due completion 2025. update.	Planning Page	242926	662082
N1	Renfrewshire	Glasgow River Hotel Erskine Harbour Erskine	PA8 6EU	Housing	Unknown	Awaiting decision	Planning Page	246447	671178
O1	Renfrewshire	Barrhill Crescent Kilbarchan Johnstone	PA10 2EU	Housing	Unknown	Awaiting decision	CALA Homes Planning Page	241125	663088
P1	Renfrewshire	Alexandra Nursing Home	PA2 6DB	Housing	35	Decided (March 2023)	Planning Page	248152	663141

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
		Calside Paisley PA2 6LX							
Q1	Renfrewshire	2 Row Avenue, Renfrew	G51 4FB	Housing	24	Awaiting Decision	Planning Page	252539	666386
R1	Renfrewshire	Ivy Gardens Station Road, Paisley	PA1 2SB	Housing	45	Awaiting Decision	Planning Page	246499	663510
S1	Renfrewshire	Stirling Drive, Linwood, Paisley	PA3 3PU	Housing	64	Awaiting Decision	Planning Page	243339	664394
T1	Renfrewshire	Laymoor Avenue King's Inch Road, Renfrew	PA4 8BS	Housing	119	Decided (April 2023)	Planning Page	251657	667344
U1	South Lanarkshire	Strathaven Road, Hamilton	ML3 8FD	Housing	650	Approved (October 2022)	Planning Page	270710	652978
V1	South Lanarkshire	Earnock Road, Hamilton	ML3 8RN	Housing	203	Approved (November 2022)	Planning Page	270213	654651
W1	South Lanarkshire	ML3 9BZ	ML3 9BZ	Housing	163	Under construction	Planning Page	270387	654969
X1	South Lanarkshire	Manse Brae Cambuslang	G72 7FS	Housing	190	Approved (2021) Not yet started	Planning Page	266919	659417
Y1	South Lanarkshire	Duchess Road, Rutherglen	G73 1DR	Housing	185	Approved (2021) Not yet started	Planning Page	262214	661973
Z1	South Lanarkshire	Dale Avenue, Cambuslang	G72 7EF	Housing	70	Approved (2021) Not yet started	Planning Page	263498	661081
A2	South Lanarkshire	Almada Street Hamilton South Lanarkshire	ML3 0JB	Mixed use development	285	Approved (September 2022)	Planning Page	271677	655988
B2	South Lanarkshire	Bosfield Corner East Kilbride Glasgow South Lanarkshire	G74 4AY	Housing	18	Decided (April 2022)	Planning Page	263968	655428

Ref	Local Authority	Location	Postcode	Type of Development	Size of Development	Latest Status (if known)	Further information	Easting	Northing
C2	South Lanarkshire	Laburnum Avenue East Kilbride	G75 9EX	Housing	15	Approved (June 2022)	Planning Page	262279	652799
D2	Stirling	Killearn	G63 9PT	Housing	89	Under construction	Due complete 2024 Website	251356	684872
E2	West Dunbartonshire	Queens Quay	G81 1BT	Housing/Flats	150	Under construction	Website	250031	669924
F2	West Dunbartonshire	Queens Quay Clydebank	G81 1BT	Major Development	1000	Planning Permission in principle		250031	669924
G2	West Dunbartonshire	Faifley	G81 5EY	New School	-	Approved	Article Planning Page	251056	673178
H2	West Dunbartonshire	G83 8BW	G83 8BW	Housing	15	Pending Consideration (July 2023)	Planning Page	239655	681780
I2	West Dunbartonshire	Faifley Bowling Club Abbeylands Road Clydebank	G81 5DU	Housing	27	Pending Consideration	Planning Page	250703	673183
J2	West Dunbartonshire	Hawthornhill Road Dumbarton	G82 5JN	Housing	Unknown	In progress	Planning Page Persimmon Homes	238291	675923
K2	West Dunbartonshire	Carlees, Old Kilpatrick	G60 5EU	Scottish Marine Technology Park	-	Planning application expected	Information from council	246511	672326

3.2 Full Options Appraisal Categories and Criteria

3.2.1 At Stage 3 CAP1616 requires sponsors to carry out a full assessment of the benefits and impacts of each option, tested against the 'do nothing' baseline scenario. The purpose of this full options appraisal (FOA) is to highlight the change to sponsors, stakeholders, and the CAA, the relative differences between the impacts, both positive and negative, of each option.

3.2.2 Our assessment criteria shown in Table 14 have been categorised based on the requirements outlined in CAP1616f (page 36 – 40), however we have added an additional category called 'Airspace Modernisation Strategy' to satisfy the indicators that the CAA will use to assess whether this Stage 3 submission accords with the AMS including iteration 3 of the Masterplan. We will follow this table structure across the appraisal of all of our options.

3.2.3 In stage 2, we also had a category called 'Interdependencies, conflicts and trade-offs'. Within stage 3, this information is contained within the ACOG CAF1 documentation.

Table 14 Full Options Appraisal Assessment Criteria (Based on CAP1616f)

Group	Impact
All	Safety
Communities	Noise
	Air Quality
Wider Society	Greenhouse gas emissions
	Tranquillity
	Biodiversity
	Capacity / Resilience
General Aviation	Access
General Aviation / Commercial airlines	Economic impact from increased effective capacity
	Fuel burn
Commercial airlines	Training costs
	Other costs
Airport / Air navigation service provider (ANSP)	Infrastructure costs
	Operational costs
	Deployment costs
	Other costs
All	Airspace Modernisation Strategy (AMS) (CAP1711)

3.3 Full Options Appraisal: Methodology

3.3.1 Table 15 presents the FOA methodology that will be followed. This includes whether the category has been quantitatively assessed and, if not, justification for the qualitative level of assessment.

3.3.2 This methodology will be used to compare the airspace change options against the baseline.

Table 15 FOA Methodology

Full Options Appraisal Methodology
Safety – All
Any proposed change to airspace requires detailed safety analysis. The ongoing safety work across Stage 3 and eventually into Stage 4 is being coordinated by ACOG as part of The Masterplan Safety Strategy (Appendix 4 of the Masterplan). This aims to ensure that coordinated safety assurance is carried out by the ScTMA ACP sponsors and evidenced to the CAA when the proposals are submitted for approval at Stage 5 of the CAP1616 process. The strategy offers guidance to the ACP sponsors on how a coherent approach to safety can be taken to ensure the overarching safety arguments for the overall ScTMA proposal are developed and understood. As part of Stage 3 and the wider Scottish Airspace Modernisation project, the Glasgow Airport designs were tested within an ATC development simulation and the safety outcomes of this simulation were used to guide the development of the proposals and the subsequent safety assessments. This safety work included working with NATS NSL to follow NSL's approved safety management system (SMS) processes. The following parts of the SMS have formed part of the safety process to date: NATS Safety Management Manual. SAF 004 Initiating Change. SAF005 Safety Assessments. SAF 006 ATC Procedures Safety Analysis. Detailed safety justifications will be provided as part of the airspace change submission at Stage 4 and as part of this FOA, the safety assessments will focus on highlighting any key differences in safety between the options and also any potential areas of benefit/impact as a result of the option.

The Stage 2B IOA identified some potential IFP flyability concerns with the offset departure options and noted that further investigation would be required in Stage 3 and Stage 4 around these options. As part of the work in Stage 3, initial flyability sims were performed on an A320 by easyjet. We checked both offset and none offset SIDs and there were no issues with their design, especially regarding no turns below 500ft although feedback from the sim did lead to some small refinements to waypoint positioning. Emirates also checked some designs on their A380 simulator. This led to some refinements in the positioning of the first fly over waypoint on the offset SIDs to ensure no turns below 500ft at maximum take-off weight. This flyability and refinement took place ahead of the FOA assessments and therefore these refinements are reflected in the route centrelines used to generate the noise and other analysis below.

Noise – Communities

The noise assessment has been undertaken using CAP1616 'primary', 'secondary' and 'additional' noise metrics. CAP1616i explains (at paragraph 5.16) *"When considering noise impacts, the CAA will weigh the outcomes from 'primary' metrics over 'secondary' metrics. Primary metrics will be those that are used to quantify total adverse noise effects, such as the Department for Transport's TAG outputs. Secondary metrics will be those that are not being used to determine total adverse noise effects, but which are still able to convey noise effects, such as number above contours. While not a noise metric, overflight contours will be a secondary metric for the purposes of decision-making."*

Primary noise metrics (L_{Aeq} and TAG)

CAP1616i explains (at paragraph 5.17): *"Adverse effects are considered to be those related to health and quality of life. These adverse effects must be assessed using a risk-based approach above the lowest observed adverse effect level (LOAEL), 51 dB $L_{Aeq,16h}$ daytime and 45 dB $L_{Aeq,8h}$ night-time. Adverse effects of noise are determined through TAG calculated on the basis of changes in L_{Aeq} noise exposure."* The primary metrics are therefore daytime $L_{Aeq,16h}$, night-time $L_{Aeq,8h}$ and the TAG assessment. These primary metrics have been calculated and L_{Aeq} noise contour maps have been provided for each airspace design option, as well as the 'current' 2022 baseline and the 'without airspace change' future baseline scenarios. Primary metric contour maps for all scenarios are presented in the Technical Appendix.

L_{Aeq} contours are the equivalent continuous sound level of aircraft noise in dBA. This is based on the daily average movements that take place in the 16-hour period (07:00-23:00 local time) or 8-hour period (23:00-07:00) during the 92-day summer period 16 June to 15 September inclusive. This metric is the measure of noise exposure adopted by the UK Government for the purposes of considering adverse effects from aircraft noise and it forms the basis of the UK Government's policies in relation to aircraft noise. The assessment of noise using L_{Aeq} also relies on the concept of the LOAEL and the SOAEL (significant observed adverse effect level). The LOAEL is the noise level above which *adverse* effects on health and quality of life can be detected. The SOAEL is the noise level above which *significant adverse* effects on health and quality of life can be detected. The LOAEL and SOAEL for aircraft noise during day and night periods are presented in Table 16. The LOAEL is defined in UK

Government airspace policy, and the SOAEL is defined with reference to the Aviation Policy Framework and following the approaches adopted in recent planning applications for UK airports.

Time Period	Threshold Levels dB $L_{Aeq,T}$ for 92-day summer average	
	LOAEL	SOAEL
Daytime (07:00 to 23:00)	51	63
Night-time (23:00 to 07:00)	45	55

Table 16 Aircraft noise LOAEL and SOAEL

The contours are generated based on all fixed-wing arrivals and departures to/from Glasgow Airport. L_{Aeq} contours have been generated in 3dB intervals from 51dB $L_{Aeq,16h}$ and 45dB $L_{Aeq,8h}$. The 55dB $L_{Aeq,8h}$ is also reported as this represents the night-time SOAEL.

TAG assessments have been conducted for each option as part of this Full Options Appraisal and are presented as an overall net present value (NPV, £) along with NPVs for different health effects.

Secondary noise metrics (N65, N60, Overflights and operational diagrams)
As described in the quote from CAP1616i paragraph 5.16 above, secondary metrics are those that are not used to determine total adverse noise effects, but which are still able to convey noise effects, such as number above contours (N65 and N60). CAP1616i also lists Overflight contours and operational diagrams as secondary metrics. The secondary noise metrics of N65, N60 and Overflights have been calculated for each airspace design option, as well as the 'current' 2022 baseline and the 'without airspace change' future baseline scenarios. As the CAA weights the outcome from primary metrics over secondary metrics, and because the secondary metrics do not determine total adverse noise effects, whilst these metrics have been calculated and tabulated in this FOA for every design option, N65, N60 and Overflight contour maps are only provided for the 2022 'current' baseline, the 'without airspace change' future baseline and the proposed option for consultation (Option 5). Secondary metric contour maps are presented in the Technical Appendix.

N65 and N60 are noise metrics which respectively describe the number (N) of aircraft noise events above a noise level of 65dB L_{ASmax} in the daytime period and 60dB L_{ASmax} for the night-time period. These are event-based metrics, which can be used to better understand the number of noise events that occur and their location.

'Overflight' is a metric that portrays areas that are perceived to be overflown and can be useful for describing the pattern and dispersion of aircraft below 7,000ft. Whilst they are useful as a means of communication of airspace change operations, it is important to note that they do not illustrate noise impacts.

Operational diagrams are presented within section 5 'Full Options Appraisal' as part of the description for each option. Further detailed operational diagrams based around the option for consultation are included within the consultation material.

Additional noise metrics (L_{ASmax} spot noise levels, 100% mode L_{Aeq} contours, 100% mode Overflight contours and difference contours)
Whilst it is not a requirement, CAP1616i recommends that additional noise metrics can be provided if they would aid stakeholders' understanding of the impacts. As these are additional optional metrics, and like secondary metrics they do not determine adverse noise effects, for reasons of proportionality, these additional noise metrics have only been calculated, and maps produced, for the 2036 'with airspace change' scenario for the option for consultation (Option 5). Additional metric maps are presented in the Technical Appendix.

L_{ASmax} is a measure of the maximum sound level from aircraft that is experienced at a particular location. These have been calculated for the noisiest aircraft at each location, and the most common aircraft type in the 2036 forecast – the Airbus A320neo. Maps are provided for these two aircraft types at various community locations within the 7,000ft overflight contours. A population density heatmap was used to identify the community locations.

100% mode L_{Aeq} and 100% mode Overflight contours are an alternative version of the L_{Aeq} and Overflight contours which represent the daytime or night-time noise exposure or Overflight that is experienced when a single runway direction is in use (rather than taking into account the average use of each runway over the 92-day summer period).

Difference contours show the changes in noise levels between two scenarios over a geographic area. Colours are used to indicate increases in noise (red) and decreases in noise (blue). Difference contours have been created using the $L_{Aeq,16h}$ and $L_{Aeq,8h}$ metrics by showing the difference between the 'without airspace change' and 'with airspace change' scenarios in 2036 for the option for consultation (Option 5). Whilst maps have only been produced for these scenarios, changes in noise levels have been tabulated and presented in this FOA for all eight design options and both 2027 and 2036 assessment years.

Noise modelling methodology

Noise modelling for this Full Options Appraisal has been conducted in accordance with the requirements and guidance outlined in CAP1616i and the minimum standards for noise modelling mandated in CAP2091[10].

As previously agreed through engagement with the CAA, all noise modelling has been conducted to meet CAP2091 'Category C' requirements. This has subsequently been confirmed based on the population within the LOAEL contours produced for this Full Options Appraisal. Consequently, the noise models include:

- Flight profiles incorporating adjustments in altitudes, speeds, climb rates, and approach angles based on local track-keeping data for major aircraft types.
- Arrival and departure track centrelines determined from local track-keeping data.
- Dispersion around the track centrelines derived from local track-keeping data.

All noise modelling has been conducted using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT) version 3e. AEDT is identified in CAP1616i as a “recognised and validated noise model” (paragraph 5.7). Version 3e was the current version at the time of starting the environmental modelling. The use of Version 3e is therefore consistent with how the FAA expects version control of AEDT to be used in practice, with the FAA memorandum on version control[11] noting that the version of AEDT that should be used is the latest approved version at the time where the environmental analysis is initiated. Since the release of version 3e there have been two updates to AEDT that primarily make improvements to the calculations of ground-based emissions and the updates would not be expected to affect the conclusions of the FOA. For analysis in the Final Options Appraisal, the latest version of AEDT at the time of commencing the Final Options Appraisal will be used.

[10] CAP2091: CAA Policy on Minimum Standards for Noise Modelling

[11] Federal Aviation Authority (2017), Memorandum: Guidance on determining which version of the Aviation Environmental Design Tool (AEDT) to use for FAA actions and studies.

The methodologies for noise, aircraft flight profile, and flight path computation in AEDT 3e adhere to the standards set by the European Civil Aviation Conference (ECAC) Doc 29 (4th Edition)[12] and the International Civil Aviation Organization (ICAO) Doc 9911 (2nd Edition)[13]. AEDT is also compatible with Commission Directive (EU) 2020/367 as the Directive mirrors the calculation method set out in ECAC Doc 29.

Aircraft noise modelling uses Noise-Power-Distance (NPD) data which are a function of the altitude and engine power settings of each aircraft type, for take off and landing. The NPD data utilised in AEDT 3e, which is the basis of the AEDT noise calculation method, is derived from the Aircraft Noise and Performance (ANP) Database v2.3.

The aircraft types, numbers of movements, track usage, and temporal distribution of operations used in the model have been derived from the 92-day summer period of the forecasts described in paragraphs 0 onwards.

All noise modelling has been undertaken for a 20-year (2003 – 2022) long term summer average 92 day (16 June to 15 September) modal split of 77% westerly and 23% easterly.

Terrain adjustments have been included in the noise calculations using the OS Terrain 50 product. As per the guidance in CAP1616i (paragraph 5.9), these adjustments are limited to geometrical corrections for aircraft-receiver distances and elevation angles.

In accordance with CAP2091, under Category C, aircraft flight profiles are adjusted based on the standard ICAO dataset for the primary noise-dominant aircraft types, covering over 75 percent of the total noise energy produced at the airport. The identification of the main noise-dominant aircraft types has been derived from the Quota Count (QC) values of the airport fleet and the 92-day summer 2022 (16 June 2022 to 15 September 2022) flight schedule. The top ten aircraft that contribute the most to the total QC account for 85% of the total QC and therefore comfortably exceed the requirement to cover over 75% of the total noise energy.

Figure 33 shows the cumulative percentage of total QC by aircraft type – the red box indicates the primary noise-dominant aircraft types identified. Flight profiles for these ten aircraft have been modified using local radar track data to align with Category C requirements.

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[12] European Civil Aviation Conference (2016). ECAC Doc 29 Report on Standard Method of Computing Noise Contours Around Civil Airports.

[13] ICAO Doc 9911, "Recommended Method for Computing Noise Contours around Airports", Second edition, 2018.

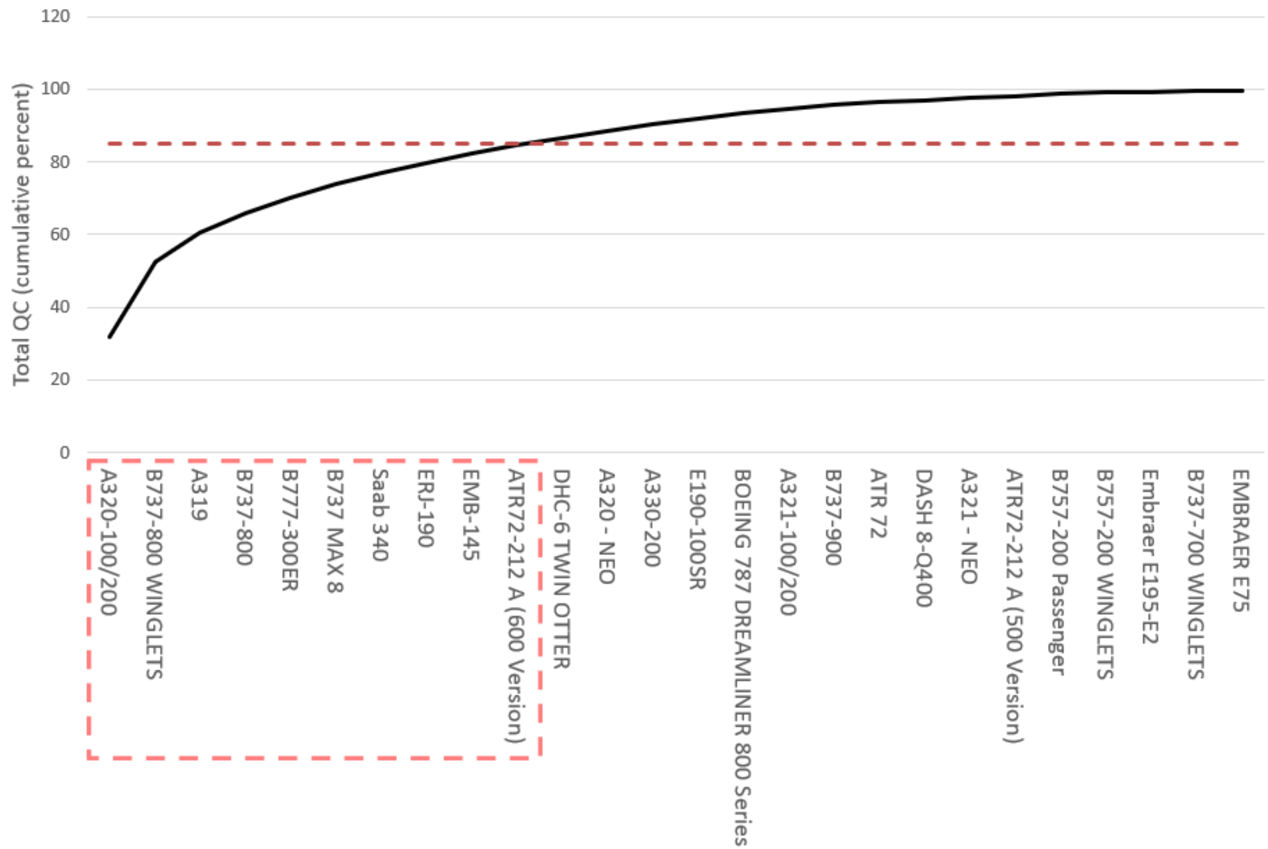


Figure 33 Primary noise-dominant aircraft types based on total QC

The flight profiles for the primary noise-dominant aircraft types have been adjusted to match the average vertical profile for each aircraft type. The average profiles have been calculated through analysis of Glasgow Airport's track-keeping data over the 92-day summer 2022 period (16 June 2022 to 15 September 2022). Adjustments have been made to the aircraft take-off weight, flap settings, climb rates, and airspeeds, utilising the closest matching standard ICAO profile for each aircraft as a starting point. Separate profiles have been created for different aircraft stage lengths (the length of flight from take-off to landing). As the modified parameters affect the climb profile of the aircraft over the entire procedure, priority has given to matching the profiles to track data below 4,000ft as this portion of the flight has a greater impact on the noise metrics. This means there tends to be greater divergence between the modified profiles at higher altitudes.

An example of a modified profile created for an Airbus A320 aircraft, compared to the calculated average profile and the standard ICAO profile, is shown in Figure 34. This demonstrates that the modified profile closely matches the average profile from track-keeping data and represents a substantial improvement compared to the standard ICAO profile. Each of the modified profiles is presented visually in the Technical Appendix.

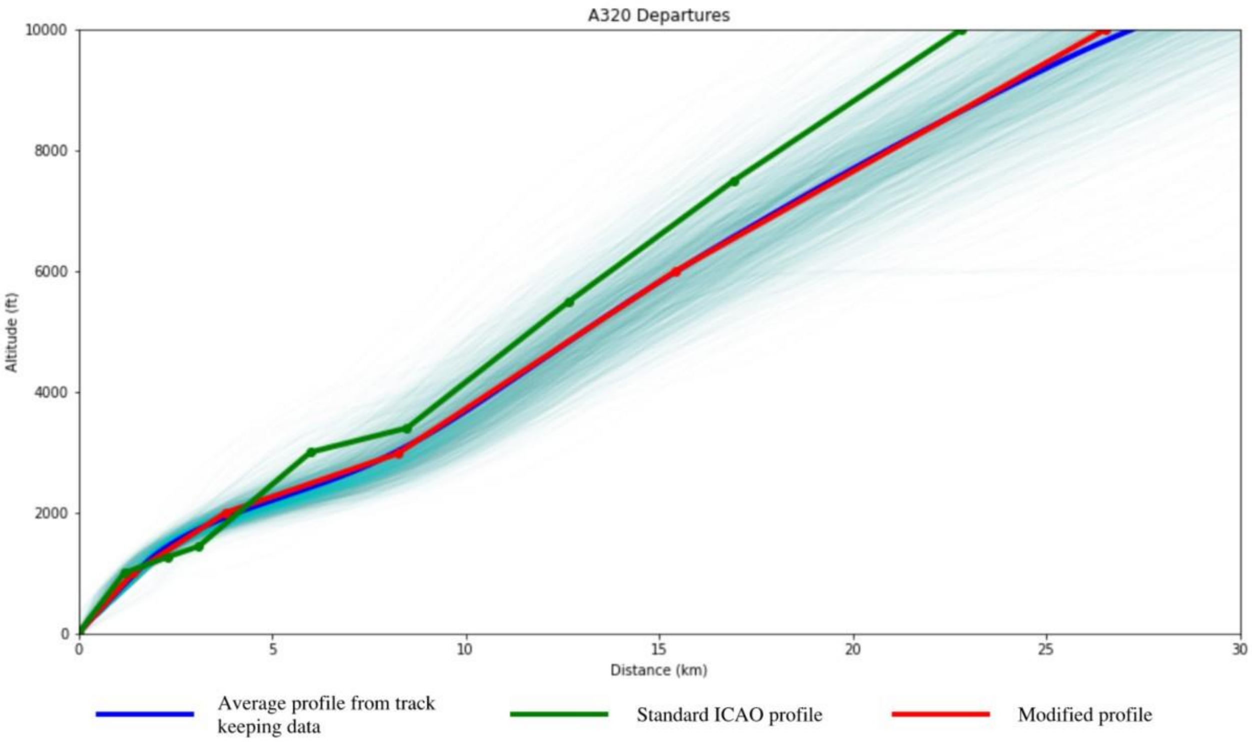


Figure 34 Modified vertical flight profile for an Airbus A320 aircraft

Departure and arrival centrelines, along with the typical lateral dispersion around the centrelines, have been calculated from Glasgow Airport's track-keeping data during the 92-day summer 2022 period (16 June 2022 to 15 September 2022). Lateral dispersion in the noise model is represented by up to four subtracks on either side of the track centreline. The centrelines and dispersed subtracks have been programmatically calculated using BridgeNet International's Volans software via the following method.

Using the runway orientation as an initial guide, a perpendicular 'gate' is formed at a user specified offset from the end of the runway. 'Gate penetrations' by each flight track through the gate are computed and statistical computations are formed to generate a new heading, based upon the distribution of penetration offsets from the gate centre point and the prior gate centre. This process is then repeated for a user-specified number of nautical miles, generating a “back-bone” Nominal Track. Processing parameters allow the user to specify gate width, gate width growth, and outlier rejection metrics as the algorithm progresses. Once a back-bone track has been established, another pass through the flight tracks is performed to compute sub-tracks. Based on the user-specified number of desired sub-tracks, a statistical distribution of gate penetrations is computed, and each track is assigned to a sub-track. A single representative nominal sub-track is then formed using all flight tracks within a given sub-track.

Where the track data has not been sufficiently uniform to programmatically generate a track centreline (i.e. in situations where multiple tracks intersect each other), the centreline has been drawn manually based on the density of tracks. Operations have been distributed across the subtracks based on a normal distribution. For departures, Figure 35 Shows the calculated departure centrelines (blue lines) and dispersed subtracks (white dashed lines), overlayed against the summer 2022 (16 June 2022 to 15 September 2022) radar track data (green lines). For arrivals, Figure 36 Shows the calculated arrival centrelines (green lines) and dispersed subtracks (white dashed lines), overlayed against the summer 2022 (16 June 2022 to 15 September 2022) radar track data (orange lines).

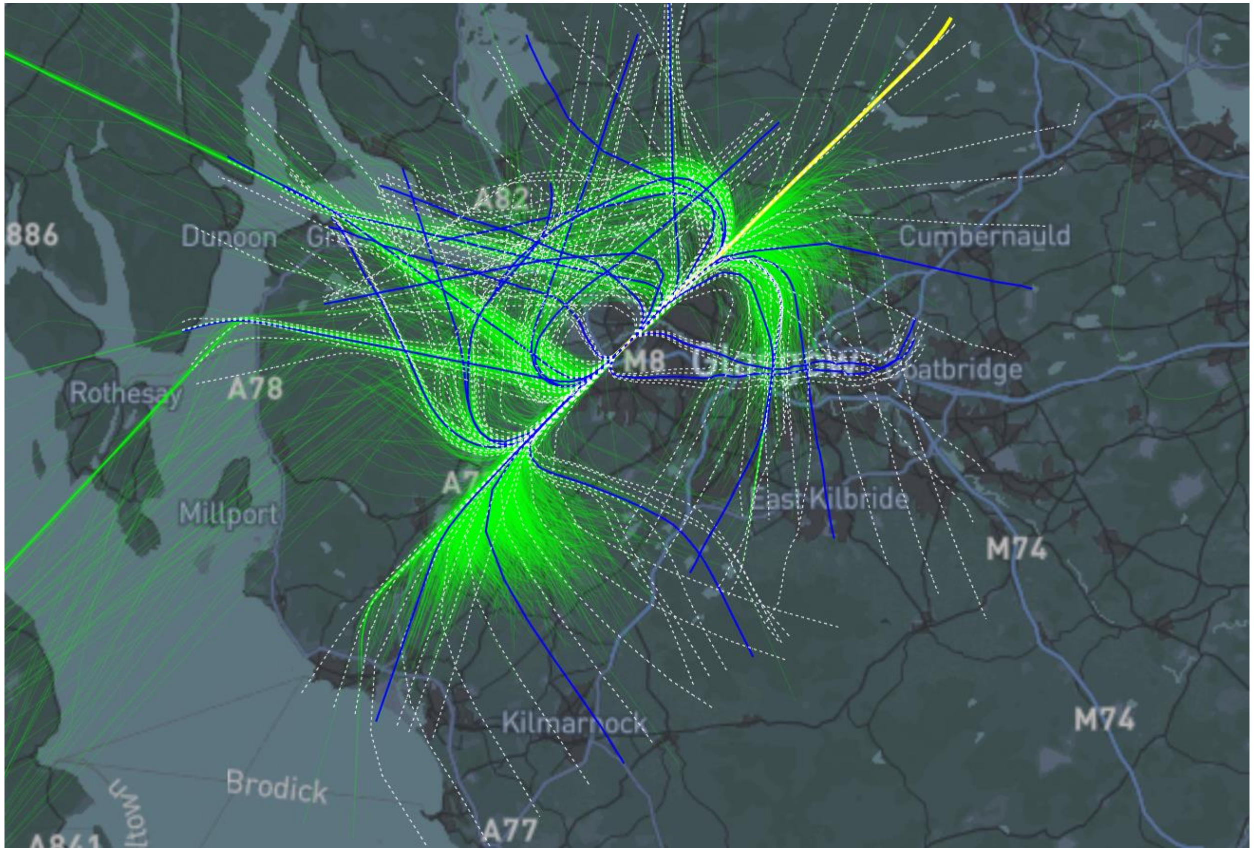


Figure 35 Departure track centrelines and dispersed subtracks

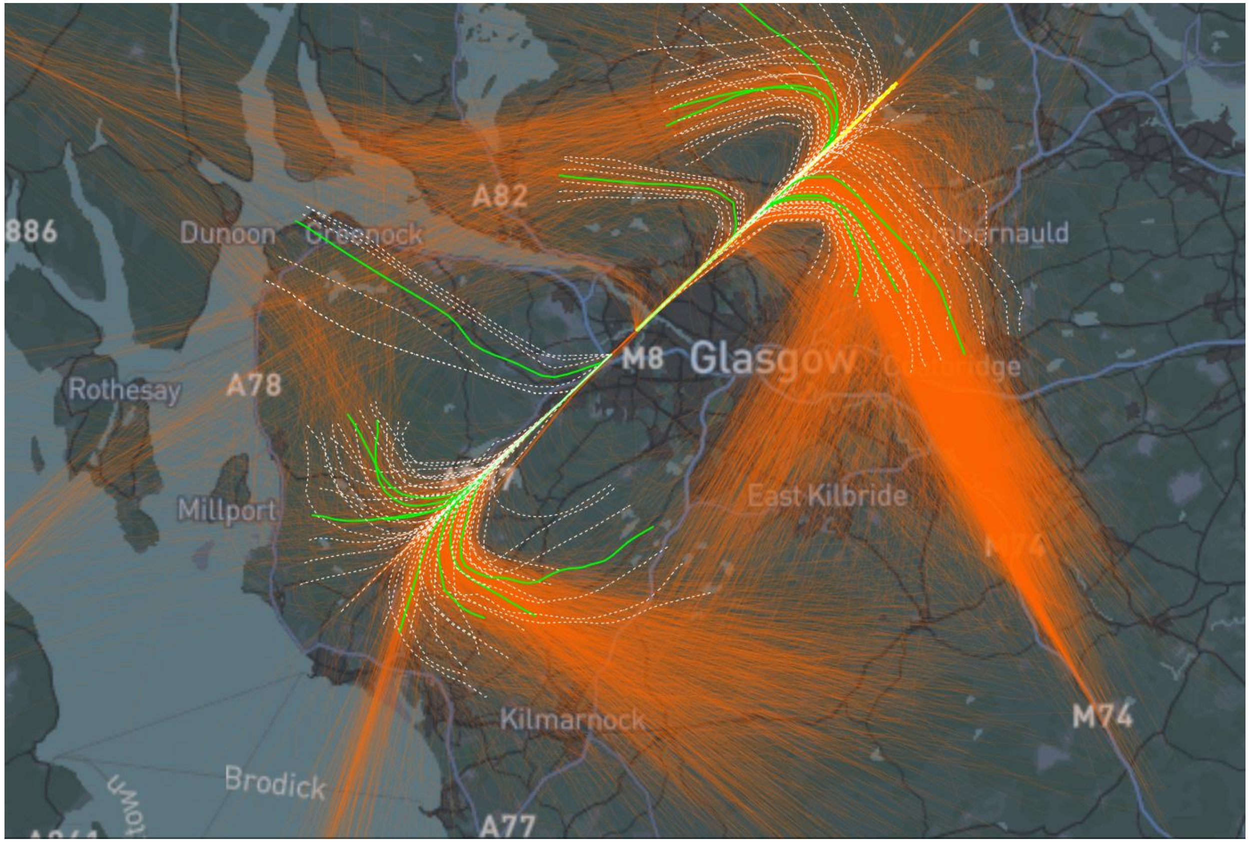


Figure 36 Arrival track centrelines and dispersed subtracks

Lateral dispersion assumptions for PBN arrivals and departures are a conservative estimate based on professional judgement, informed by track data for two airports with RNAV1 SIDS. Whilst this is not necessarily a direct correlation to PBN approaches and there is an absence of RF data, it has been used to help inform expected dispersion. For arrivals, this corresponds to a maximum dispersion of +/- 0.50 nm for fly-by turns, +/- 0.30 nm for RF curves, and +/- 0.10 nm on straight segments including final approach. For departures, this corresponds to a maximum dispersion of +/- 0.25 nm for RNAV1 curves, +/- 0.15 for RF curves and +/- 0.10 nm on straight segments.

For options that include a combination of vectoring and PBN arrivals (Options 5 – 8), the proportion of aircraft vectored off the PBN routes that has been assumed in the noise modelling is summarised in Figure 37. The figure shows the noise modelling centrelines which include the PBN transitions themselves and some ‘shortcuts’. Shortcuts are where aircraft may be routed directly to a waypoint along the PBN transition rather than flying the full transition. The % of aircraft expected to be vectored off the noise modelling centrelines is then shown in the labelled boxes. This vectoring is represented in the noise model by assigning a proportion of flights to the existing vectored baseline tracks.

These assumptions are based on information gathered as part of detailed Air Traffic Control development simulations and through input from ATC and aviation experts.

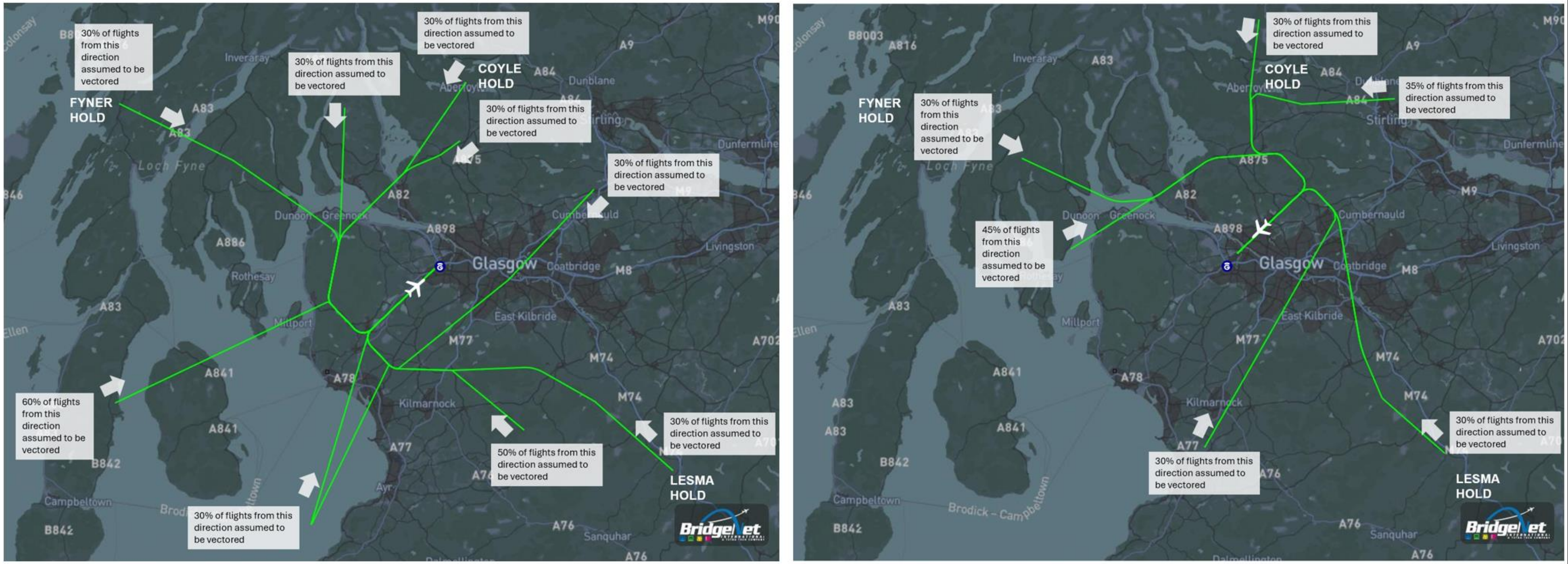


Figure 37 Noise modelling centrelines and assumed vectoring for runway 05 and runway 23. Images sourced from Bridgenet Volans software.

Currently, any departing propellor aircraft with a maximum take-off weight (MTOW) below 5,700kg are allowed to vector early off their SID at any time. Propeller aircraft with a MTOW under 23,000kg are permitted to do the same during daytime hours. In both the current day and future 'without airspace change' scenarios, this early vectoring is factored into the lateral dispersion assumptions, which are calculated from the 2022 track data as described above. Following discussions with Glasgow Airport and Air Traffic Control (ATC), it has been confirmed that these categories of aircraft will continue to be allowed to vector early post-airspace change. This has been accounted for in the 'with airspace change' noise and overflight modelling by utilising the lateral dispersion assumptions from the baseline scenario for all propellor aircraft with a MTOW below 5,700kg and 80% of all propellor aircraft with a MTOW below 23,000kg. The remaining 20% of propeller aircraft with a MTOW under 23,000kg are assumed to adhere to the 'with airspace changes' SIDs, using the PBN lateral dispersion assumptions outlined above.

Considering the above adjustments, it is considered that the modelling undertaken meets the noise modelling requirements of CAP2091 Category C and CAP1616i.

Meteorological data for the modelling has been sourced from historic METAR data for Glasgow Airport (accessed via the Iowa Environmental Mesonet). Meteorological conditions (temperature, relative humidity, pressure, sea level pressure, and wind speed) have been included in the noise calculations as a 10-year average over the 92-day summer period.

L_{Aeq} contours have been calculated over a 100m x 100m regularly spaced grid of receivers at a height of 1.2m from local ground level, as per the guidance on the use of AEDT contained in CAP1616a (no equivalent guidance is provided in CAP1616i). Due to the wider spatial extent of the N65 and N60 contours, these have been calculated over a 200m x 200m regularly spaced grid of receivers at a height of 1.2m from local ground level.

Overflight modelling methodology

Overflights have been calculated following the principles in CAP1498 for all aircraft operations below 7000ft. The same CAP2091 Category C standards used for the noise modelling described in the previous section have been applied in the calculation of overflights including modified flight profiles for the primary noise-dominant aircraft types, lateral dispersion, and terrain adjustments. As required by CAP1616i (paragraph 5.34), a threshold angle of 48.5° has been used in the calculation of overflights. Overflight contours have been calculated over a 200m x 200m regularly spaced grid of receivers at a height of 1.2m from local ground level.

Population and noise sensitive building counts

Population and household counts within the calculated noise contours have been generated from the latest 2023 population data supplied by CACI Ltd. This data has been supplemented with the planned residential developments described in paragraph 3.1.21. A population per dwelling of 2.09 (calculated from the CACI dataset) has been applied to each of the planned developments to estimate the number of individuals in each development.

Counts of noise sensitive buildings within the calculated noise contours have been generated from the latest 2023 PointX data. The PointX classification codes included in the assessment are shown in the Table 17 and cover schools, hospitals, care homes, and places of worship. This data has been supplemented with the planned non-residential developments described in paragraph 3.1.21

PointX classification code	Description	Noise sensitive building type
05310375	First, primary and infant schools	School
05310376	Further education establishments	
05310377	Independent and preparatory schools	
05310379	Broad age range and secondary state schools	
05310380	Special schools and colleges	
05310381	Higher education establishments	
05310382	Unspecified and other schools	
05310801	Pupil Referral Units	
05280780	Accident and Emergency hospitals	Hospital
05280371	Hospitals	
05280373	Nursing and residential care homes	Care home
06340459	Places of worship	Places of worship

Table 17 Noise sensitive building types considered in the assessment

TAG assessment

The May 2024 version of the TAG noise workbook - aviation has been used to calculate monetised noise impacts. As recommended in paragraph 5.28 of CAP1616i, noise exposure change has been calculated at individual postcode receptors directly, rather than being derived from noise contours. $L_{Aeq,16h}$ and $L_{Aeq,8h}$ have been calculated at individual population receptors at a height of 1.2m from local ground level for the 2027 and 2036 'without airspace change' and 'with airspace change' scenarios for each airspace change option. The number of individuals experiencing an increase or decrease in L_{Aeq} with airspace change and without airspace change for year 1 and year 10 have been input into the workbook in 1dB bands. As per paragraph 5.28 of CAP1616i, changes below the lowest observed adverse effect level (LOAEL) (51dB $L_{Aeq,16h}$ daytime and 45dB $L_{Aeq,8h}$ night-time) have not been input into the workbook. This assessment method in the workbook has been set to 'individual' and appraisal period has been set to 10-year. Monetised values have been output in 2024 prices. TAG outputs are calculated using a 2024 base year.

Assessment of significant noise effects – residential receptors

Whilst the TAG assessment quantifies the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it sums together the adverse and beneficial noise effects into a single value, so it does not provide information on the adverse and beneficial effects on individual communities. In addition, the Air Navigation Guidance 2017 requires that airspace change sponsors have adequately explained how communities will be affected as a result of the proposal, such as the expected change in noise exposure that communities will experience.

A further assessment has therefore been undertaken to quantify likely significant effects on an individual population and community basis. This assessment considers both the noise exposure in the 'with airspace change' scenario, and the noise change as a result of the difference between the 'without airspace change' and 'with airspace change' scenarios.

Where receptors are predicted to experience existing or future noise levels exceeding the LOAEL, an assessment of the impact due to a change in noise level has been undertaken. The criteria that have been used to define the significance of effect in terms of changes in aircraft noise are presented in Table 18. As there is no published guidance for identifying the significance of effect due to changes in aircraft noise, the criteria are based upon the Institute of Environmental Management and Assessment's (IEMA) 'Guidelines for Environmental Noise Impact'[14], Planning

[14] Institute of Environmental Management and Assessment (2014), *Guidelines for Environmental Noise Impact Assessment*

Practice Guidance Noise (PPG-N)[15] and professional judgement. The criteria for noise change below the SOAEL were also adopted in the Bristol Airport application to increase airport capacity[16] and were described as follows in the "Change Criteria" section of the Appeal Decision for the application, paragraph 258[17]: "the 3dB is current best practice for assessment within an ES. In light of this, the Panel consider it an appropriate threshold as part of the EIA process."

The criteria set different levels for identifying a significant effect depending on whether noise in the 'with airspace change' scenario is either above or below the SOAEL. This addresses the following point in PPG-N, which states:

"In cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise level may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur".

For 'with airspace change' noise levels between LOAEL and SOAEL, Moderate and Major Adverse effects due to changes in aircraft noise levels are defined as likely significant effects. For 'with airspace change' noise levels above SOAEL, Minor, Moderate and Major Adverse effects due to changes in aircraft noise levels are defined as likely significant effects. These apply to both likely significant *adverse* effects (due to noise increases) and likely significant *beneficial* effects (due to noise decreases). As for the TAG noise change assessment, the noise exposure change for the assessment of significant noise effects has been calculated at individual population receptors directly, rather than being derived from noise contours. This means that the total numbers may differ slightly from the summary tables of population within noise contour bands.

[15] Department for Communities and Local Government (2019), *Planning Practice Guidance: Noise*. (Whilst PPG-N is not Scottish Government guidance, it provides useful information on how to apply the concept of LOAELs which are part of UK airspace policy and hence apply to Scotland)

[16] Bristol Airport Limited (2018), *Development of Bristol Airport to Accommodate 12 Million Passengers Per Annum* (Reference 18/P/5118/ OUT).

[17] The Planning Inspectorate (2022), *Appeal Decision APP/D0121/W/20/3259234*

Table 18: Residential receptors magnitude of effect criteria for changes in aircraft noise (shaded cells indicate noise changes that are defined as likely significant effects)

Magnitude of Effect	Change in Noise Levels	
	'With airspace change' noise Between LOAEL and SOAEL[18]	'Without airspace change' Noise Exceeding SOAEL
Major	6.0dB or more	4.0dB or more
Moderate	3.0 – 5.9dB	2.0 – 3.9dB
Minor	2.0-2.9dB	1.0-1.9dB
Negligible	0.1-1.9dB	0.1-0.9dB
No Change	0.0dB	0.0dB

Assessment of significant noise effects – noise-sensitive buildings

The assessment criteria for noise sensitive buildings are provided in Table 19. Noise level and noise change have been calculated at every noise sensitive building in the study area. If both the noise level threshold and noise change threshold are exceeded then a significant effect (either adverse for noise increases or beneficial for noise decreases) is identified for the receptor in question.

The assessment criteria have been derived from relevant guidance and professional judgement as described below. Where guidance specifies a range of indoor noise levels, professional judgement has been used to select a value within the range based on the anticipated sensitivity of the receptor to noise intrusion and the resulting external noise level criteria. Where guidance specifies indoor noise levels, these have been

[18] Beneficial likely significant effects may be identified due to noise decreases that bring exposure from above the LOAEL 'without airspace change' to below the LOAEL 'with airspace change'

converted to an outdoor free-field level by assuming an outdoor to indoor reduction of 15dB representing a typical façade with an open window as a reasonable worst case, unless otherwise specified. The 15dB reduction has been applied based results of a Defra research study on open window façade sound insulation[19]. Change criteria have been defined following guidance in the Institute of Environmental Management and Assessment's (IEMA) 'Guidelines for Environmental Noise Impact'[20] and the approach adopted for residential receptors (see Table 18).

Table 19 Assessment criteria for noise sensitive buildings.

Receptor category	Noise level threshold		Noise change threshold (from 'without airspace change' to 'with airspace change'
	Day (07:00-23:00)	Night (23:00-07:00)	
Schools	≥55dB $L_{Aeq,16h}$	n/a	≥3.0
	≥63dB $L_{Aeq,16h}$	n/a	≥1.0
Hospitals	≥55dB $L_{Aeq,16h}$	≥45dB $L_{Aeq,8h}$	≥3.0
Places of worship	≥50dB $L_{Aeq,16h}$	n/a	≥3.0
Care homes	≥51dB $L_{Aeq,16h}$	n/a	≥3.0
	≥63dB $L_{Aeq,16h}$	n/a	≥1.0

Assessment criteria - schools

Recommended limits for indoor noise levels for schools are provided in Building Bulletin 93 Acoustic design of schools: performance standards[21]. The assessment criteria for schools have been informed by the internal ambient noise level limit of 40dB$L_{Aeq,30min}$ for naturally ventilated new builds (i.e. representing a scenario with an open window as a reasonable worst case). Due to the relative consistency of aircraft noise throughout the day it can be assumed that the 40dB$L_{Aeq,30min}$ is broadly equivalent to 40dB$L_{Aeq,16h}$ which is then converted to an outdoor

[19] The Building Performance Centre, Napier University (2007), NANR116: 'Open/closed window research' sound insulation through ventilated domestic windows
[20] Institute of Environmental Management and Assessment (2014), Guidelines for Environmental Noise Impact Assessment
[21] Department for Education (2015), Building bulletin 93 Acoustic design of schools: performance standards

free-field assessment criterion of 55dB$L_{Aeq,16h}$. This is supplemented by an additional higher level noise criterion of 63 dB$L_{Aeq,16h}$ to align with the noise threshold above which the UK Government expects airport operators to offer acoustic insulation to schools[22]. **Assessment criteria – hospitals** The assessment criteria for hospitals have been informed by the criteria for noise intrusion from external sources for "Single-bed ward, single-bed recovery areas and on-call room, relatives' overnight stay" in Scottish Health Technical Memorandum 08-01[23] of 40dB$L_{Aeq,1h}$ for daytime and 35dB$L_{Aeq,1h}$ for night-time. Due to the relative consistency of aircraft noise throughout the day it can be assumed that the 40dB$L_{Aeq,1h}$ is broadly equivalent to 40dB$L_{Aeq,16h}$ which is then converted to an outdoor façade free-field assessment criterion of 55dB$L_{Aeq,16h}$. At night, as there is less consistency between the $L_{Aeq,8h}$ and $L_{Aeq,1h}$ metric a 5dB penalty has been applied and then converted to a resulting outdoor free-field assessment criterion of 45dB$L_{Aeq,8h}$. **Assessment criteria – places of worship** The assessment criteria for places of worship has been informed by guidance from British Standard 8233:2014[24] which recommends that indoor noise levels should not normally exceed 30-35dB$L_{Aeq,T}$ for listening in places of worship. The upper value of this range has been converted to an outdoor free-field assessment criterion of 50dB$L_{Aeq,16h}$. There is no night-time criterion as these buildings are not expected to be regularly occupied at night. **Assessment criteria – care homes** As care homes can be considered residential receptors, the assessment criteria for significant effects is aligned with the criteria for residential receptors in Table 18.
Air Quality – Communities
Assessment methodology - overview An assessment of changes to air quality compared with the future baseline has been undertaken for the impacts of the oxides of nitrogen (NOx) and particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), as a result of the proposed airspace change design options. Air quality

[22] Her Majesty's Stationery Office (2013), The Aviation Policy Framework.
[23] NHS National Services Scotland (2015), Scottish Health Technical Memorandum 08-01: Specialist Services Acoustics
[24] British Standard Institute (2014), BS 8233:2014, Guidance on sound insulation and noise reduction for buildings.

modelling for this FOA has been conducted in accordance with the guidance outlined in CAP1616i, the ICAO airport air quality manual[25] and ADMS-Airport modelling guidance[26]. The assessment takes the following steps to assess each Option:

1. Identify whether the Option results in changes to emissions below 1,000 ft[27] of aerodrome level (AAL) with consideration of the following:
    a. Changes to departure or arrival procedures – both laterally or vertically (i.e. spatial changes of emissions);
    b. Changes to operating procedures that effect thrust and therefore emissions;
    c. Changes to the number of aircraft movements (air transport movements (ATMs));
    d. Changes to local transport as a result of the airspace change (i.e. road traffic volumes); and
    e. Changes occurring within or adjacent to a designated Air Quality Management Area (AQMA).
2. If there are changes below 1,000 ft AAL, undertake a quantitative assessment of local air quality changes as a result of the airspace change option undertaken using dispersion modelling. The significance of impacts are assessed using industry best practice guidance.
3. Identify whether a TAG assessment[28] is required to monetise the local air quality impact with consideration of the following criteria:
    a. The change causes an exceedance or worsening of an existing exceedance of a legal air quality limit/target value; and
    b. Air quality changes occur within or adjacent to a designated AQMA.
4. Identify whether concentration contours are required with consideration of the following:
    a. Whether significant impacts predicted by the dispersion modelling at sensitive receptors; and
    b. Whether exceedances of air quality legal limits/targets are predicted by the dispersion modelling at sensitive receptors.

Input data

Model inputs, including aircraft types, the numbers of movements, and track usage were derived from the forecasts detailed in paragraph 0 onwards. Input data specific to the air quality assessment is summarised in Table 20.

[25] ICAO (2020) Doc 9889 Airport Air Quality Manual. Second Edition.
[26] C8ERC (2020) ADMS-Airport Airport Air Quality Management System Version 5.0, User Guide
[27] Emissions from aircraft above 1,000 ft AAL are unlikely to have significant impacts on local air quality, as stated in CAP1616i paragraph 7.5.
[28] Department for Transport (2024) Guidance, TAG: environmental impacts worksheets, Air quality valuation workbook. Available at: TAG: environmental impacts worksheets - GOV.UK (www.gov.uk) [Accessed June 2024]

Table 20: Air quality modelling input data

Data	Source
Aircraft engine emission factors	International Civil Aviation Organization (ICAO) aircraft engine emissions databank Swedish Defence Research Agency (FOI) database for turboprop engine emissions Swiss Federal Office for Civil Association (FOCA) database for piston engines FOCA guidance on the determination of helicopter emissions
Meteorological data	Glasgow Airport Meteorological Station
Human receptor locations	Latest 2023 population data provided by CACI Ltd and address data from PointX
AQMA locations	Scottish Government's Air Quality in Scotland website[29]
Ecological receptor locations	Scottish Environment Protection Agency's (SEPA's), Scotland's Environment Map[30]

[29] https://www.scottishairquality.scot/ [Accessed June 2024]
[30] https://map.environment.gov.scot/sewebmap/ [Accessed June 2024]

Monitoring data	Glasgow City Council 2023 Air Quality Annual Progress Report Renfrewshire Council 2023 Air Quality Annual Progress Report West Dunbartonshire Council 2023 Air Quality Annual Progress Report
Background concentrations	Scottish Government's Air Quality in Scotland website (NOx, NO_2, PM_{10}) Defra UK Air Information Resource website ($PM_{2.5}$)[31]

Assessment methodology – qualitative assessment

As the Options would not result in changes to ATMs or road traffic volumes compared to the future baseline 'without airspace change' scenario, the assessment is limited to understanding the changes to lateral and vertical departure and arrival procedures. Departure and arrival centrelines, along with the typical lateral dispersion around the centrelines, have been calculated for the 2022 baseline using radar-track data as described in the noise modelling methodology. This has been compared to the 'with airspace design' tracks to identify which options will potentially result in changes to lateral and vertical profiles, and therefore emissions, below 1,000 ft of AAL, which have been taken forward to the quantitative assessment – dispersion modelling.

Air quality legal limits and targets

Table 21 below sets out the relevant air quality legal limits and targets for the pollutants of most relevance to this assessment, hereafter referred to as air quality standards. These standards have been used in the assessment. For ecological sites, where NOx concentrations are predicted to be below the air quality standard, no significant effects would be anticipated. For those sites where NOx concentrations are predicted to be above the air quality standard, then a judgment of significance, by an ecologist, can be made once an assessment of nitrogen deposition has been undertaken for the site. No NOx concentrations have been predicted to be above the air quality standard in this FOA.

Table 21: Relevant air quality standards from the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020

Pollutant	Averaging period	Air quality standard
Nitrogen dioxide (NO_2)	Annual mean	40µg/m^3
	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year
Particular matter (PM_{10})	Annual mean	18µg/m^3
	24-hour mean	50µg/m^3 not to be exceeded more than seven times a year
Fine particulate matter ($PM_{2.5}$)	Annual mean	10µg/m^3
Oxides of nitrogen (NOx)*	Annual mean	30µg/m^3
Notes: *For protection of vegetation and ecosystems rather than human health		

Air quality Zone of Influence

As the scope of modelling is limited to changes to emissions from aircraft below 1,000 ft AAL, the air quality Zone of Influence includes an area 500m from the relevant departure and arrival centrelines up to 1,000 ft AAL.

[31] SEPA based $PM_{2.5}$ estimated mapped backgrounds are not available, therefore Defra values have been used for $PM_{2.5}$, which are available for Scotland

2022 baseline assessment

To provide an assessment of the significance of any new proposal (in terms of air quality), it is necessary to identify and understand the baseline air quality conditions in and around the Zone of Influence. The baseline year for this assessment is 2022. This provides a reference level against which any potential changes in air quality can be assessed. The baseline pollutant concentrations are predicted to decrease in the future (mainly because road vehicle and aircraft future fleets are expected to become cleaner with respect to emissions). However, the future baseline has assumed 2022 levels for a conservative assessment.

A desk-based review has been undertaken to determine baseline conditions of air quality using the data sources detailed in Table 20.

Human receptors

2023 CACI Ltd population and household data was used to identify sensitive residential receptors within 500m of aircraft movements below 1,000 ft AAL. These modelled receptors are shown in Figure 38. The figure also shows that there are no assessed receptors within an AQMA. The closest AQMAs (Paisly AQMA and Renfrew Town Centre AQMA) are not within the defined Zone of Influence.

Ecological receptors

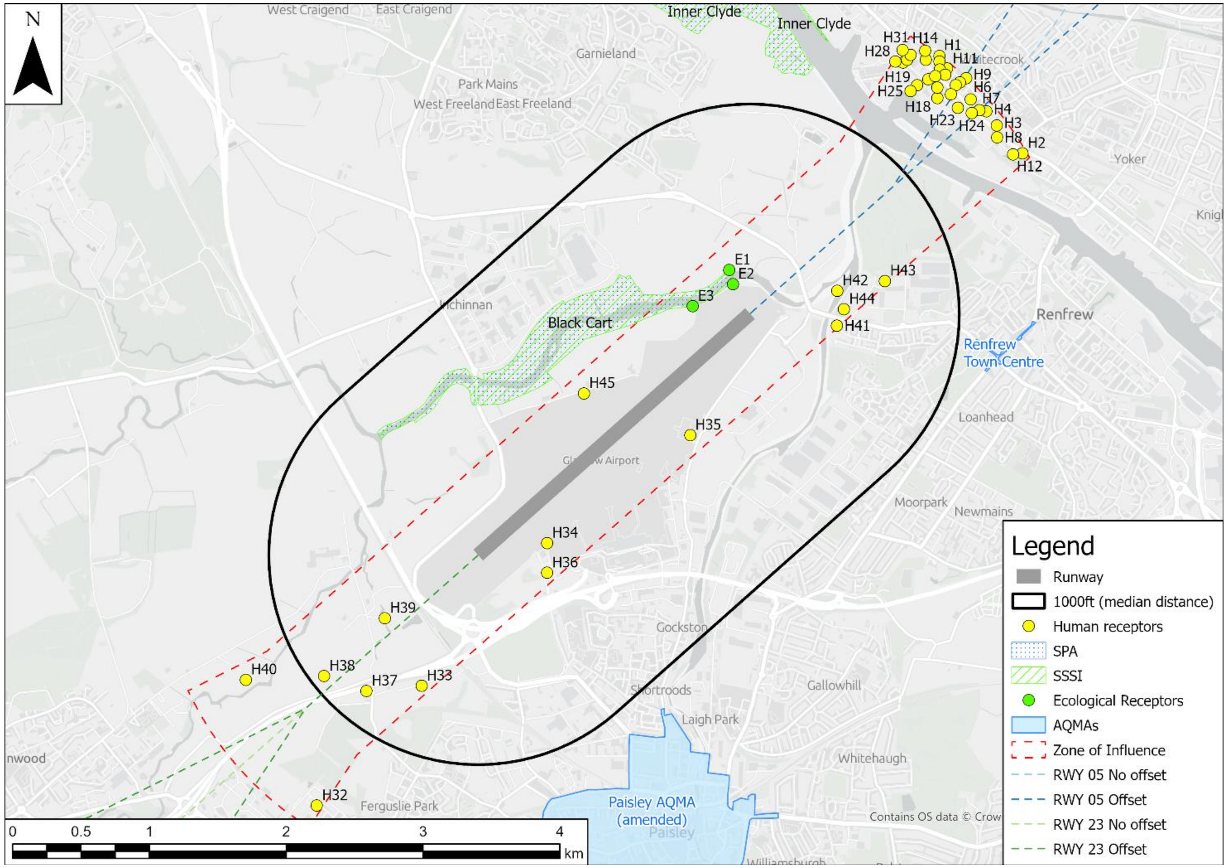
Sensitive ecological receptors are defined as those sites whose features have been designated as sensitive to air pollutants, either directly or indirectly. High levels of NOx can adversely affect vegetation, including leaf or needle damage and reduce plant growth. Deposition of pollutants derived from NOx emissions contribute to acidification and/or eutrophication of sensitive habitats leading to loss of biodiversity. To assess the impacts on ecosystems, the study area was reviewed to identify nationally designated ecological sites within 500m of aircraft movements below 1,000 ft AAL: Special Areas of Conservation (SAC), Special Protection Areas (SPA), Sites of Special Scientific Interest (SSSI) and Local Nature Reserves (LNR). The modelled ecological receptors are detailed in Table 22 and shown in Figure 38.

Table 22: Modelled sensitive ecological receptor locations

ID	Site Name	Easting (m)	Northing (m)	Height above ground (m)
E1	Black Cart SSSI & SPA	248666	668160	0

E2	Black Cart SSSI & SPA	248692	668056	0
E3	Black Cart SSSI & SPA	248398	667895	0

Figure 38: Human and ecological receptors assessed in the zone of influence



Aircraft emissions modelling

The methodology for calculating and modelling the aircraft emissions are substantially in accordance with the following relevant guidance documents, is informed by data in Table 20, and is supplemented by in-house aircraft fleet database holding data on aircraft engines for aircraft types:

- ICAO Airport Air Quality Manual;
- ADMS-Airport modelling guidance; and
- EMEP/EEA emissions guidebook.

Emissions from aircraft were calculated using 2022 fleet data (for a conservative assessment). The fleet data was used to build the emissions inventory. The ICAO Airport Air Quality Manual defines the Landing and Take Off (LTO) cycle as taxiing; hold; take-off roll; initial climb; climb out; approach; and landing. However, the Options being assessed only relate to changes in the following modes, up to 1,000 ft AAL:

- Initial Climb;
- Climb out; and
- Approach.

Therefore, only emissions for these modes in the LTO cycle have been calculated and modelled.

Emissions were calculated for the engines for each aircraft type. The detailed aircraft movement data provided was used to identify the main types of aircraft that used the airport in 2022. Forecast aircraft movement data was also provided. These were merged into modelling categories (MCATs) of similar aircraft types, relating to short/long haul and narrow/wide body aircraft, and number and type of engines, following ADMS-Airport modelling guidance. The MCATs are presented in Table 25, with the addition of a helicopter MCAT for which the Eurocopter EC145 is used as a representative aircraft[32]. Information on the commercial aircraft engines were taken from an in-house aircraft fleet database holding data from on aircraft engines for aircraft types, from multiple UK airports. Emissions were calculated for the engines for each aircraft type in each MCAT.

[32] Helicopters account for only approximately 2-3% of overall movements at Glasgow Airport and hence have not been included in the noise and greenhouse gas emissions assessments as is standard practice for airspace change assessments where the helicopter routes are not affected. However, as the methodology for undertaking air quality assessments for airspace change is less documented, helicopters have been included as a worst-case.

For each MCAT, information on the climb and approach vertical profiles were obtained from AEDT software. This was used to derive speeds and time in mode (TIM) for initial climb, climb out and approach. The emissions of NOx and fuel consumption rates were taken from the relevant emissions database (detailed in Table 20) dependent on aircraft type. Emissions of PM_{10} were derived from the smoke number, fuel flow and hydrocarbon emission indices following the methodology described in the ICAO Airport Air Quality Manual.

In relation to $PM_{2.5}$ emissions, the EMEP/EEA guidebook[33] states that, *"it is reasonable to assume that for aircraft, the particulate matter emissions can be considered as $PM_{2.5}$"*. Therefore, it was assumed that all particulate matter emissions from aircraft engines were in the $PM_{2.5}$ fraction.

Emissions (E) for each MCAT and each LTO mode were calculated using the following equation:

$$E\,[g] = EI \times FF \times TIM \times number\ of\ engines \times ATMs$$

Where *EI* is the emission factor in g/kg, *FF* is the fuel flow in kg/s and *TIM* is the time-in-mode in seconds.

NOx to NO_2 conversion

The model predicts NOx concentrations, which comprise principally nitric oxide (NO) and primary nitrogen dioxide (NO_2) (i.e. NO_2 that is emitted directly from the aircraft). The emitted NO reacts with oxidants in the air (mainly ozone) to form more NO_2 (known as secondary NO_2). Since only NO_2 has been associated with effects on human health, the air quality legal limits and targets for the protection of human health are based on NO_2 rather than NOx or NO. Thus, a suitable NOx to NO_2 conversion needs to be applied to the modelled NOx concentrations. The method taken for this conversion in the assessment follows a very conservative assumption that 100% of NOx is converted to NO_2.

Significance criteria

For the assessment of long-term impacts and significance at sensitive human receptors, the approach described in the EPUK/IAQM[34] guidance is used. This is best practice for undertaking air quality assessments. Impact descriptors are determined based on the magnitude of incremental change in pollutant concentrations as a proportion of the relevant assessment level; in this instance the air quality legal limits and

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[33] European Environment Agency EMEP/EEA (2023) Air Pollutant Emission Inventory Guidebook 2023 Technical Guidance to Prepare National Emission Inventories.

[34] Environmental Protection UK/Institute of Air Quality Management, 2017. Land-Use Planning & Development Control: Planning for Air Quality. Available at: https://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

targets. The change is then examined in relation to the predicted total pollutant concentrations in the assessment year and its relationship with the relevant air quality assessment level (AQAL) as shown in Table 23.

Table 23: Impact descriptors for individual receptors

Annual average concentration relative to AQAL	**% change in concentration relative to AQAL**			
	1%	**2-5%**	**6-10%**	**>10%**
<75%	Negligible	Negligible	Slight	Moderate
76-94%	Negligible	Slight	Moderate	Moderate
95-102%	Slight	Moderate	Moderate	Substantial
103-109%	Moderate	Moderate	Substantial	Substantial
>110%	Moderate	Substantial	Substantial	Substantial
Notes: Changes in pollutant concentrations of 0% i.e. <0.5% would be described as negligible				

The impact descriptors at each of the assessed receptors can be used as a starting point for making judgements on the effect of the airspace change option. However, other considerations need to be accounted for, such as:

- the existing and future air quality in the absence of the airspace change Option;
- the extent of current and future population exposure to the impacts; and
- the influence and validity of any assumptions adopted when undertaking the prediction of impacts.

Professional judgement should be used to determine the overall significance of effect of an Option, however in circumstances where the Option can be judged in isolation, it is likely that a ‘moderate’ or ‘substantial’ impact will give rise to a significant effect and a ‘negligible’ or ‘slight’ impact will result in an effect which is not significant.

With regards to the short term NO_2 and and PM_{10} standard, Local Air Quality Management Technical Guidance[35] (LAQM TG(22)) discusses the relationship between annual mean and hourly mean NO_2 and 24-hourly mean PM_{10} concentrations. It is considered that where annual mean NO_2 concentrations are lower than 60µg/m^3, it is unlikely that the hourly mean NO_2 standard will be exceeded. Similarly, for the 24-hourly mean PM_{10}, the following relationship is provided in the LAQM TG(22) guidance:

$$No.\,24\text{-}hour\ mean\ exceedances = -18.5 + 0.00145 \times annual\ mean^3 + (206/annual\ mean)$$

Meteorological data

The meteorological data used in this assessment were measured at Glasgow International Airport meteorological station. The data was collected over the period 1st January 2022 to 31st December 2022 (inclusive).

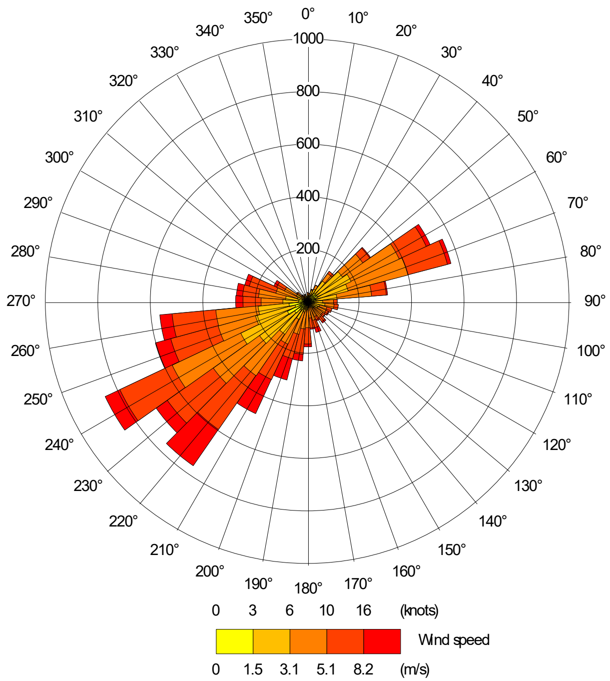
Most dispersion models do not use meteorological data if modelling calm wind conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Airports treats calm wind conditions by setting the minimum wind speed to 0.75m/s. Scottish Government's LAQM.TG22 guidance recommends that the meteorological data file is tested in a dispersion model and the relevant output log file checked to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. The guidance recommends that meteorological data should only be used if the percentage of usable hours is greater than 85%.

Hourly sequential observation data was used in this assessment. The dataset corresponds to 99.8% initial data of the year. This is above the 85% threshold, so meets the requirements of the Scottish Government technical guidance and is adequate for the dispersion modelling.

Figure 39 shows the wind rose for Glasgow International Airport for 2022. It can be seen that the predominant wind direction is south westerly.

[35] Defra (2022) Local Air Quality Management Technical Guidance (TG22) August 2022.

Figure 39: Glasgow International Airport 2022 wind rose



Summary of assumptions

Table 24 summaries the key assumptions required for the air quality assessment. The approach adopted provides a reasonable worst case assessment scenario accounting for uncertainty.

Table 24: Air quality assessment assumptions

Theme	Assumption and limitation
Aircraft spatial changes below 1,000 ft AAL	Departure and arrival centrelines, along with the typical lateral dispersion around the centrelines, have been calculated for the 2022 baseline, using radar-track data. The median vertical centreline was used to determine the ground distance that would be reached at 1,000 ft AAL. This calculated ground distance was then used to determine whether arrival and departure Options would change laterally before 1,000 ft AAL in the first step of the assessment. It was assumed that the vertical profile remained the same as the 2022 baseline for this step. For the dispersion modelling, more detailed vertical profiles were taken from AEDT to provide a robust assessment.
Aircraft emissions	The proportion of PM_{10} assumed to be $PM_{2.5}$ was 100%. The calculation of emissions was in accordance with ADMS-Airports and ICAO guidance, with respect to the use of MCATs, thrust settings and emission factors. Speeds and time in modes (TIMs) were taken from AEDT.
NOx to NO_2	The method taken for this conversion in the assessment follows a very conservative assumption that 100% of NOx is converted to NO_2.
	Future background concentrations are expected to improve due to technological advances and improvements in vehicle and aircraft

Background concentrations	emissions. However, this assessment assumed no continued improvement in future backgrounds from the 2022 baseline to provide a reasonable worst-case assessment.
	Modelled aircraft emissions ('without airspace change' and 'with airspace change') were added to the background concentrations to estimate the total concentrations as a result of all sources in the ('without airspace change' and 'with airspace change' scenarios. However, the background concentrations used already includes a 2022 predicted contribution from the airport, and therefore there will be a minor overestimation in the airport contribution to the total concentrations, as a result of double counting. This is approach has been used to provide a conservative assessment.
Model parameters	The extent of mechanical turbulence (and hence mixing) in the atmosphere is affected by the surface/ground over which the air is passing. Typical surface roughness values range from 0.0001m (for water or sandy deserts) to 1.5m (for cities, forests and industrial areas). In this assessment, a surface roughness of 0.5m (for open suburbia) was applied to the study area and meteorological site at the airport.
	Another model parameter is the minimum Monin-Obukhov length, which describes the minimum level of turbulence in the atmosphere, which is limited due to the urban heat island effect. Typical values range from 1m to 10m for rural and sparsely populated areas. In urban area, where traffic and buildings cause the generation and/or retention of more heat, these values are higher. In this assessment, a minimum length of 30m was used to represent an urban area. These values are considered suitable for the assessment area.

Screening assessment

The review of the arrival Options showed that there would be no spatial changes below 1,000 ft AAL and therefore no further assessment of arrivals are required.

For departure Options, departure and arrival centrelines, along with the typical lateral dispersion around the centrelines, have been calculated for the 2022 baseline, using radar-track data. The median vertical centreline (shown in Figure 40) was used to determine the ground distance that would be reached at 1,000 ft AAL (defined as '1000ft_median' in the figure). This calculated ground distance was then used to determine whether departure Options would change laterally before 1,000 ft AAL. It was assumed for this step that the vertical profile of the proposed Options remained the same as the 2022 baseline.

As shown in Figure 41, only the '05 Departure offset SIDs (Option H)' (defined as 'RWY 05 Offset' in the figure) were identified as potential changes below 1,000 ft AAL and these were taken forward to Step 2 of the assessment (dispersion modelling). These include:

- Option 2
- Option 4
- Option 6
- Option 8

For the Options without any changes below 1,000 ft AAL (Options 1, 3, 5 and 7), following CAP1616, these are unlikely to have a significant impact on local air quality and the impact is considered negligible, and not assessed any further.

Figure 40: Lateral changes of proposed SIDs compared to the baseline SIDs

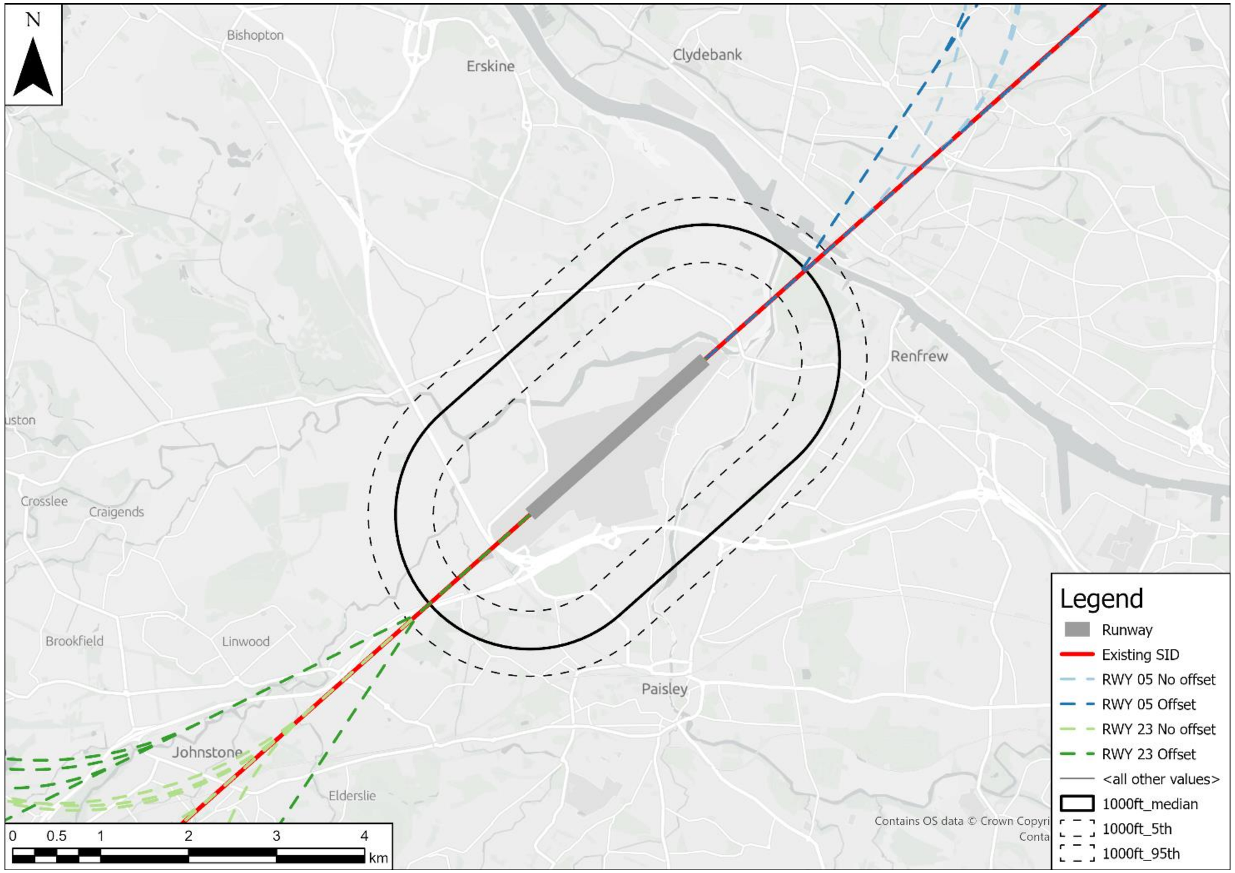
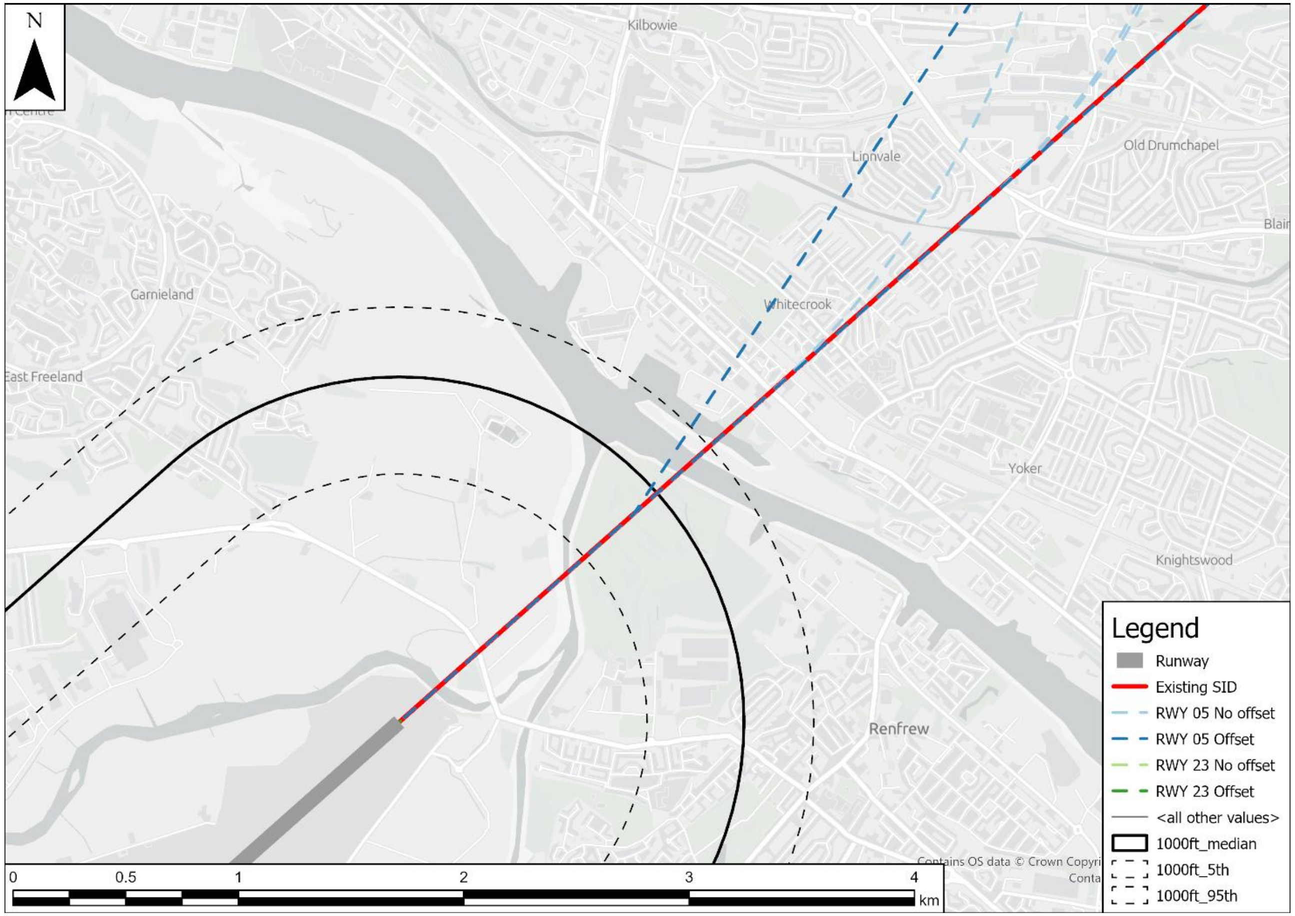


Figure 41: 05 Departure offset SIDs compared to baseline SIDs



Air quality TAG assessment

As the change as a result of any of the Options does not cause and exceedance or worsening of the assessed air quality standards, nor do they impact an AQMA, there is no requirement to undertake a TAG assessment to monetise the negligible, not significant air quality effect.

Air quality concentration contour plots
As the change as a result of any of the Options does not cause and exceedance or worsening of the assessed air quality standards and no significant impacts are predicted, there is no requirement to produce concentration contour plots.

Greenhouse gas emissions – Wider society

Combined green house gas emissions methodology
Greenhouse gas emissions have been calculated using a combined methodology between NERL and Glasgow Airport as described in Annex A of the ScTMA Cumulative Analysis Framework Part 2.

The approach to CO2e analysis for AMS clusters is described in the CAF2 methodology contained in Appendix 1 and 2 of Iteration 3 of the ScTMA Masterplan.
This involves a two-step process:

1. NERL's overall network analysis to show the difference between the preferred options and the baseline
2. Airport analysis of difference between individual sponsor options, to present a comparison between airport options.

The NERL network analysis utilises AirTop, an industry leading fast time modelling tool coupled with a combination of BADA 4.2 and 3.13. Glasgow Airport used BADA 3.15 in combination with AEDT version 3e.

The use of different models reflects the different focus of the analysis at each step as these models, with AirTop being appropriate for modelling the dynamic effect of the design on flows and holding, while AEDT and BADA are industry accepted tools for analysing individual trajectories (the results of which can then be aggregated).
Use of different BADA datasets is assumed to have a negligible effect on results and no bearing on the conclusions drawn. This is because up-issues of the BADA dataset generally involve adding data (e.g. more aircraft types and/or more performance parameters) rather than changing the data from previous versions. Note that Eurocontol did not grant access to airports for BADA4 on the basis that BADA 3 variants remain valid and were sufficient for the type of analyses being undertaken.

While these models and parameters differ, they are all individually robust enough for use in individual sponsor CAP1616 analyses. The CAF2 methodology recognises the validity of which states “It is assumed that the approach(es) agreed to meet CAP1616 will be sufficiently robust for use in the CAF.” [Appendix 2 Para 128].

It is important to note that the assessment of greenhouse gas emissions and fuel burn is based on calculated ‘enabled benefits’. An enabled benefit is one that relates to the fuel saving resulting from more efficient flight planned routes. This is not an exact representation of the actual change in fuel burn and CO_2e emissions. The actual impact can only be calculated following implementation of the change. This will allow a direct comparison between the pre-implementation trajectory data and actual trajectory data following the change. This will be provided within the Post Implementation Review of the Airspace Change.

Airport methodology

The greenhouse gas emissions for the 2023 baseline and 2027 and 2036 ‘without airspace change’ and ‘with airspace change’ scenarios for Option 5 were calculated by NERL following the methodology described in the NERL Stage 3 FOA. To determine the fuel burn and greenhouse gas emissions for the remaining options, the NERL calculated values for Option 5 were adjusted according to the differences in local fuel burn and greenhouse gas emissions calculated for each option as described below.

Local fuel burn for fixed wing aircraft has been calculated using the Aviation Environmental Design Tool (AEDT) version 3e. For fixed wing aircraft, AEDT calculates the fuel consumed over each flight path segment using the Base of Aircraft Data (BADA) version 3.15 model and the Senzig-Fleming-Iovinelli (SFI) method[36].

Model inputs, including aircraft types, the numbers of movements, and track usage were derived from the forecasts detailed in paragraph 0 onwards. The same departure and arrival centrelines used in the noise modelling have been used. To ensure a like for like comparison between the different airspace change design options, the proposed track centrelines used in the greenhouse gas assessment have been extended to common endpoints in the network. Aircraft flight profiles have been sourced from the ANP v2.3 database. Aircraft types in the fuel burn modelling have been categorised into Aircraft Modelling Categories (MCATs), grouping similar types based on short/long haul, narrow/wide body, and the number and type of engines. The ADMS-Airport (air quality modelling software) user guide[37] serves as the reference for these categories (pg98-99 and Table 6.35). The MCATs are shown in Table 25.

[36] FAA (2022). Aviation Environmental Design Tool (AEDT) Version 3e Technical Manual.

[37] Cambridge Environmental Research Consultants Ltd (2020). ADMS-Airport User Guide.

Table 25: Aircraft Modelling Categories (MCATs) used in the assessment of greenhouse gas emissions and air quality

Category	Description	Representative aircraft	Notes
1	Piston engine aircraft	P28A (Piper PA-28)	Representative of all piston engine aircraft
2	Turboprop aircraft	SF34 (Saab 340)	Representative of all turboprop aircraft
3	Small business jets (turbofan engines)	C56X (Cessna 560X Citation Excel)	Representative of all small business jets
4A	Narrow body, short to medium range aircraft	A20N (Airbus A320neo)	Representative of all Airbus short to medium range aircraft
4B		B738 (Boeing 737-800)	Representative of all Boeing short to medium range aircraft
5A	Wide body, medium to long range aircraft	B752 (Boeing 757-200)	Representative of all Boeing medium to long range aircraft and 2-engine Airbus medium to long range aircraft
5B		A388 (Airbus A380-800)	Representative of all Airbus 4-engine medium to long range aircraft
6A	Regional jets, short to medium range aircraft	E145 (Embraer ERJ-145)	Representative of Embraer ERJ-145 only
6B		E190 (Embraer E190)	Representative of all other Embraer aircraft and all other regional jets

The mass of carbon dioxide equivalent in tonnes (tCO_2e) emitted for the ‘with airspace change’ options has been calculated by multiplying the mass (in tonnes) of kerosene burned during flight by a factor of 3.18 (tonnes of CO_2e / tonne of aviation turbine fuel) as set out in the Greenhouse Gas Reporting Conversion Factors[38] (rounded to 3 decimal places). Throughout this FOA the term greenhouse gas emissions or GHG refers to carbon dioxide equivalent (CO_2e) emissions.

Emissions trading

Since 2021, greenhouse gas emissions from domestic flights, flights to and from Gibraltar, and certain flights departing from the UK such as those arriving in the European Economic Area (EEA, excluding the outermost regions) have been included in the UK Emissions Trading System (UK ETS). Therefore, greenhouse gas emissions subject to inclusion within the UK ETS have been categorised into ‘traded’, and the remainder categorised as ‘non-traded’. Non-traded emissions includes those associated with international flights that are not traded under the UK ETS. The classification of which airports are considered traded and non-traded depending on arrivals and departures is set out in Annex B of of the ScTMA Cumulative Analysis Framework Part 2. As agreed with the CAA, the traded and non-traded status of greenhouse gas emissions considers only the UK ETS and does not take into account other emissions trading systems such as the EU ETS and CORSIA.

TAG assessment

The change in emissions (from ‘without airspace change’ to ‘with airspace change’) for each option has been valued using the May 2024 TAG Greenhouse Gases Workbook. The TAG workbook is an excel tool developed by the Department for Transport to calculate the monetised impacts of CO_2e assessments, among other environmental assessments, in appraisal schemes and utilises the carbon appraisal values derived from the TAG data book. The TAG assessment has taken into account the traded and non-traded status of the emissions in the UK ETS as described above. TAG outputs are calculated using a 2024 base year and are presented in Market prices.

Supplementary methodology information for Scottish Airspace Modernisation CO_2e calculation

Background

The following information includes specifics on the technical methodology used by NERL to model future enabled CO_2e benefits brought by the proposals. An enabled CO_2e benefit correlates with the fuel saving resulting from more efficient routes within the new proposals.

[38] Department for Energy Security and Net Zero (2024) Conversion factors 2024: full set (for advanced users) - updated 8 July 2024. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024

To provide this analysis, modelling is used to simulate the design with the goal of understanding a proposal's performance verses the current airspace, referred to as the baseline. This is standard practice in all airspace change proposals, and an important step to ensure alignment is made to the CAA's Airspace Modernisation Strategy.

Providing background information to this analysis helps to highlight that aircraft profiles modelled many years ahead of implementation may differ from those flown in reality. There are always variables such as weather, world events, military activity and more, which cannot be predicted. To aid transparency, this annex has been produced to demonstrate that the methodology used provides a good indication of the enabled benefit of the proposed change. The actual impact can only be calculated following implementation of the change. This will allow a direct comparison between the baseline trajectory data and actual trajectory data following the change, as part of the Post-Implementation Review.

Modelling lateral profiles for CO_2e

For the lateral element of a flight, both arriving and departing aircraft are generally 'tactically'[39] routed by controllers to fly the most optimum trajectory possible given the traffic scenario and airspace limitations at that time. Tactical intervention is most notable in low traffic conditions close to the departure point or destination and reduces the track milage a given aircraft will fly, thereby reducing its emissions.

Furthermore, the difference is not the same for every flight. In reality, no two flights are ever the same and the differences are impossible to predict. While it is recognised that modelling the planned tracks may vary from the actual tracks seen in reality, the industry standard modelling process used (i.e. planned tracks and BADA performance database) provides a good assessment for the performance of a proposal.

In addition, tactical lateral shortcuts and, less often, lateral track extensions, are subject to a myriad of factors including interaction other aircraft, ATC workload, military activity, and weather which by their nature cannot be foreseen with a degree of certainty. So, for large scale airspace changes it is not possible to model this accurately or forecast exactly how this will change.

However, when a whole flight is modelled, the difference between flight planned routes and actual routes flown tend to average out - as illustrated in CAF2 Annex C. Therefore, for the lateral portion of a flight, the flight plan route is a good approximation. When the whole end-to-end flight plan route is modelled, with the addition of holding analysis, this provides a good indication of whether a proposed change will positively or negatively impact the CO_2e greenhouse gas emissions for a specific flight or flights.

Modelling vertical profiles for CO_2e

[39] Tactical intervention is where air traffic control instruct aircraft to fly away from their planned route. Tactical intervention typically occurs to provide more efficient/direct routes, to resolve conflicts between aircraft or to generate an efficient landing sequence.

Similarly, for the vertical element of a flight, no two flights are the same, climb and descent rates are based on engine type, aircraft weight, wind, temperature etc. As set out in the CAF2 Annex C, arrival profiles are more consistent than departure profiles as an economic descent rate is similar between all aircraft and descent restrictions on STARs are consistently applied by air traffic control (ATC).
However, for departures, level off restrictions on SIDs exist which may, in reality, not be required due to the traffic scenario at the time. For example, an aircraft can be tactically climbed by ATC above the SID restrictions. How many aircraft will be climbed above the SID profile in the future or how many will level off due to conflicting aircraft elsewhere in the climb is not possible to predict with accuracy. The modelling therefore assumes that level off restrictions are present in both scenarios described below.
It should be noted that there are some trends that are likely in a more systemised environment in future. With some SIDs climbing to higher levels it is expected that:

a) it is more likely that aircraft will fly the vertical restrictions on a SID and
b) the modelled CO_2e difference between an aircraft levelling off on the SID and not levelling off will be less (when comparing the vertical elements in isolation).

The following examples show the CO_2e generated by commonly flown single flight. These are modelled using BADA at a nominal weight in nil wind and are provided for context.

Example 1

Airbus A320 GLASGOW Runway 05 to PALMA cruise level of FL350. Portion of flight to CALDA (N of Manchester)		
SCENARIO	**RESTRICTED (as modelled)**	**UNRESTRICTED**
EXISTING AIRSPACE	6.08T	5.73T
PROPOSED AIRSPACE	5.62T	5.52T
DIFFERENCE	0.46T	0.21T

Based on the table above, the variance of Restricted vs Unrestricted benefits, in this example, is between 0.46T and 0.21T.

Example 2

Airbus A380 GLASGOW Runway 23 Cruise Level FL370. Portion of flight over North Sea to UK boundary at PETIL.		
SCENARIO	**RESTRICTED (as modelled)**	**UNRESTRICTED**
EXISTING AIRSPACE	49.05T	48.52T
PROPOSED AIRSPACE	47.98T	47.02T
DIFFERENCE	1.07T	1.50T

Summary

In these examples, it can be seen that assuming SID restrictions occur in both the with and without airspace change scenarios could be overestimating the CO_2e benefit per flight by up to 0.25t for the A320 example underestimating the CO_2e benefit per flight by up to 0.43t for the A380 example, compared to the situation in which unrestricted vertical climb occurs.

The examples show how, for both the existing departures and the proposed departures, unrestricted climb profiles would, in reality, generate less CO_2e than the restricted vertical profiles that are modelled. In these examples the differences are less when comparing the proposed SIDs versus the baseline SIDs partly due to the higher level off(s) in the ScTMA design. Therefore, we could be overestimating in some cases and underestimating in some cases the CO_2e impact of departures by using restricted existing SIDs by a greater degree than for restricted proposed SIDs however the differential varies depending on the design and so it is not possible to apply a single factor to the overall figures.

In all cases the actual outcome is likely to be somewhere between a restricted model and the perfect profile scenario however, as it's not possible to forecast this outcome precisely, the procedural SIDs are used as an approximation of benefit until real life track data can be used to corroborate findings through the post implementation review process. At this point the lateral tracks of aircraft trajectories will also be taken into account. It is important not to consider one factor in isolation.

Finally, it is important to note that because the proposed airspace change design enables a reduction in the per flight planned track mileage this would likely enable an overall CO_2e benefit for Glasgow Airport regardless of the modelling methodology used.

Tranquillity – Wider society
Though it is no longer current, CAP1616a provides a helpful summary of the status of tranquillity assessment methodologies, noting that "In terms of portraying 'tranquillity' or any impacts upon it, there is no universally accepted metric by which tranquillity can be measured, although some attempts have been made." The Air Navigation Guidance 2017 states that "where practicable, it is desirable that airspace routes below 7,000 feet should seek to avoid flying over Areas of Outstanding Natural Beauty (AONB) and National Parks". CAP1616i states that "The consideration of impacts upon tranquillity for airspace change proposals is with specific reference to National Parks, Areas of Outstanding Natural Beauty (AONB), National Scenic Areas (NSA) (broadly equivalent to AONBs in Scotland), the Norfolk and Suffolk Broads, plus any local 'tranquil' areas that are identified through community engagement and are subsequently reflected within an airspace change proposal's design principles." The assessment of tranquillity therefore focusses on overflight of National Scenic Areas and National Parks, supplemented by overflight and noise information for Candidate Quiet Areas, Country Parks, Gardens and Designated Landscapes. In the context of this ACP, there is only one National Scenic Area (NSA) and one National Park that are within the scope of the proposed changes. This is the Loch Lomond NSA and the Loch Lomond and the Loch Lomond and Trossochs National Park. These two designated areas overlap with the Loch Lomond NSA sitting entirely within the area designated as the National Park. The Glasgow Agglomeration Round 3 Action Plan identifies several Candidate Quiet Areas (CQA) and the Scottish Government's catalogue of spatial data provides information on the locations of Country Parks, Gardens and Designated landscapes. The potential impacts on these areas have been evaluated by calculating the total number of unique areas within the L_{Aeq}, N_x, and overflights below 7000ft contours, as well as the total area (in km^2) intersected by these contours. As tranquillity receptors are outdoors, they are more frequently occupied during the daytime. The frequency of overflight is also greater during the daytime. The consideration of the impact of noise and oveflight on tranquility therefore focusses on potential daytime effects, but night-time data is provided in the Technical Appendix for information.
Biodiversity – Wider society
The 'Habitats Regulations Assessment – Early Screening Criteria' from CAP1616i has been followed to determine whether a Habitats

Regulations Assessment (HRA) is required as part of the Glasgow Airport airspace change proposal. The screening criteria is derived from CAP2527[40] which provides a Habitats Regulations screening assessment of European Sites potentially affected by the Airspace Change Masterplan[41]. The report establishes a precautionary Zone of Influence (ZoI)[42] with a radius of 18km from each airport boundary in the Masterplan. This radius is based on the potential impacts listed below and the conservative assumption that all aircraft, whether departing or arriving, will be at altitudes greater than 3,000ft at distances greater than 18km from the airfield. A justification for the ZoI for each of the impacts is provided in CAP2527.

- Increases in the atmospheric concentration and deposition of nitrogen (18km ZoI);
- Aircraft collision with wildlife (birds and bats) (13km ZoI); and,
- Presence of aircraft / aircraft noise (18km ZoI).

The receptors that must be considered in the HRA screening are Special Areas of Conservation (SAC) and possible SACs, Special Protection Areas (SPAs) and possible SPAs and Ramsar sites (wetlands of international importance) and proposed Ramsar sites. These receptors are collectively know as European Sites and are protected by the Habitats Regulations. These sites have been identified using the Scottish Government's catalogue of spatial data. CAP1616i also requires that Compensatory habitats (areas secured to compensate for damage to SACs, SPAs and Ramsar sites) are considered but notes that there is no publicly available database for these sites and therefore recommends contacting the Statutory Nature Conservation bodies to enquire about compensatory habitats. Glasgow Airport contacted NatureScot who confirmed that they were not aware of any areas of compensatory habitats within the ZoI.

Table 26 details the three European Sites that are within the CAP2527 precautionary ZoI for Glasgow Airport.

European site	Approx distance from airport
Black Cart SPA	250 m

[40] CAA (2023) CAP2527 Airspace Change Masterplan: Habitats Regulations Screening Report

[41] At the time of publication, Aberdeen airport was part of the Airspace Change Masterplan. Aberdeen's ACP has subsequently been de-coupled from the masterplan because the proposal no longer has interdependencies with the NERL ACP for the airspace above 7000ft

[42] The Chartered Institute of Ecology and Environmental Management (CIEEM) defines a ZoI as "the area over which ecological features may be affected by biophysical changes as a result of the proposed project and associated activities".

Inner Clyde SPA and Ramsar site	1.8 km
Renfrewshire Heights SPA	14.0 km

Figure 42 shows the position of these European sites within the CAP2527 precautionary ZoI as well as the departure tracks from the airspace design option that has the greatest potential to result in changes to overflight of European sites at lower altitudes due to horizontal offsets (option 4/8). Within those departure tracks, the portion of the tracks that represent aircraft flying below 3,000ft are identified. This has been calculated from the 5th percentile of the altitude profiles of all departing aircraft over the 92-day summer 2022 period (16 June 2022 to 15 September 2022).

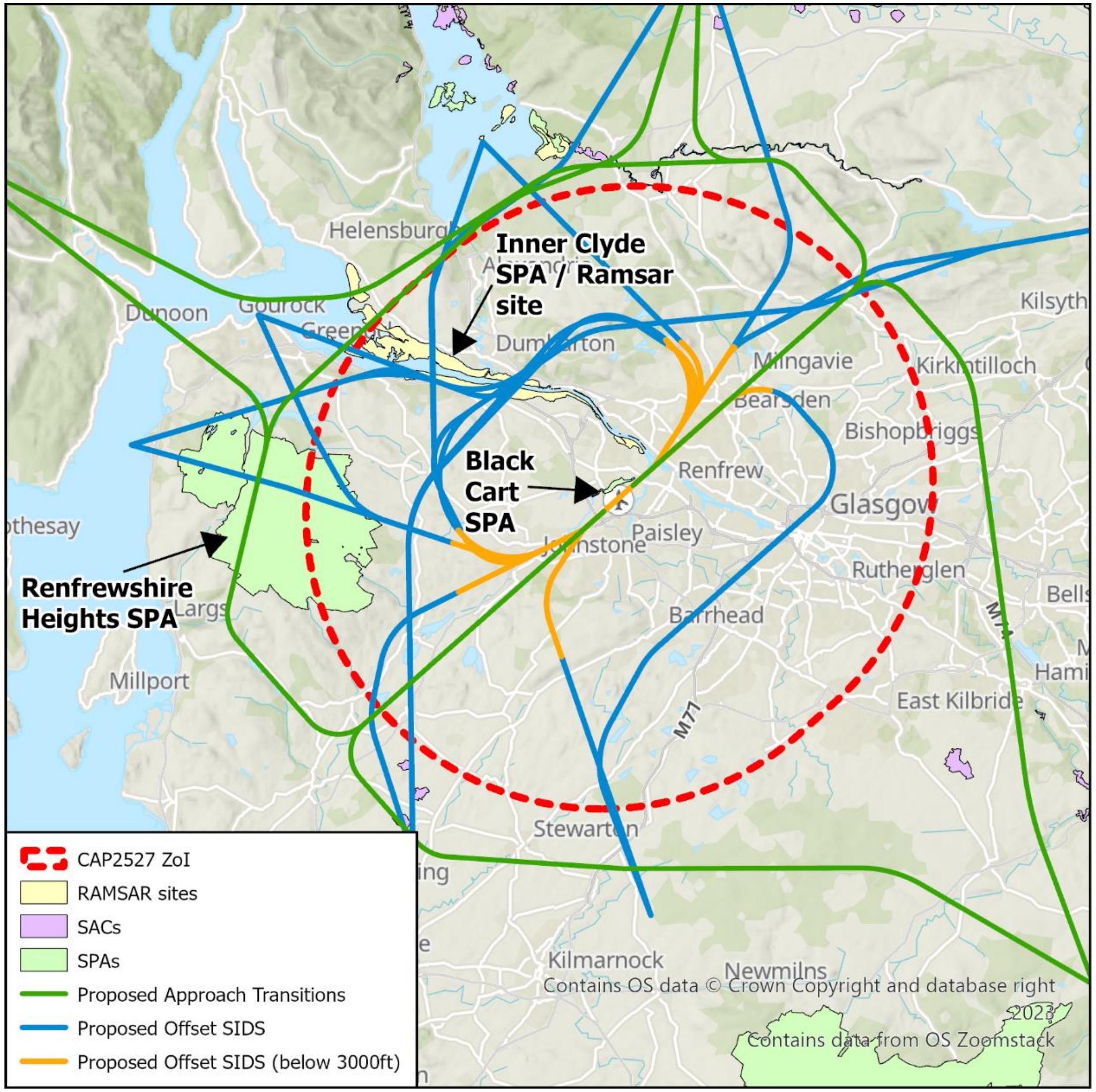


Figure 42 European Sites within the Glasgow Airport ZoI

Figure 42 demonstrates that the Renfrewshire Heights SPA would be overflown substantially above 3,000ft (as occurs in the 2022 baseline). The Renfrewshire Heights SPA therefore does not proceed past Q1 of the CAP1616i HRA Early Screening Criteria. The Inner Clyde SPA and Ramsar site is adjacent to flight tracks that could be below 3,000ft but the tracks are more than 2,655 feet offset from the site, so it does not proceed past Q2 of the CP1616i HRA Early Screening Criteria.

As the CAP1616i HRA Early Screening Criteria uses a more conservative definition of overflight (passing within 2,655 ft of a site regardless of altitude below 3,000ft) than CAP1498, it was not possible to screen out the need for an HRA on the Black Cart SPA using the Early Screening Criteria. As required by CAP1616f paragraph 4.18, Glasgow Airport contacted the CAA to confirm and clarify whether the Black Cart SPA needed to proceed to a Secondary Screening Assessment. In response, the CAA requested Glasgow Airport to describe any potential impacts on the European sites in question from the design options as compared to the baseline. The CAA confirmed that if no changes are anticipated over the site as a result of the ACP, then HRA is likely to be screened out.

Whilst the Black Cart SPA is in close proximity to the airport, it is positioned generally parallel to the runway and does not extant substantially beyond the length of the runways, as shown in Figure 43. This means that aircraft do not generally overfly the Black Cart SPA, in either the baseline or the ‘with airspace change’ design options’. This can be seen in the overflight and European site Figures TA8, TA16, TA24, TA48 and TA56 presented in the Technical Appendix. There may be some instances where a small number of very small aircraft (such as General Aviation aircraft) are able to turn and fly over the edges of the SPA on easterly departures, but this already occurs in the baseline and would not be affected by the proposed airspace design change options. This means that within the Black Cart SPA there would be no changes in lateral tracks, vertical profiles, number of movements and frequency of overflight as a result of the airspace change. It is therefore considered that there are no relevant changes for the Black Cart SPA, and therefore no impact, and the HRA for the Black Cart SPA can be screened out.

Figure 43 Black Cart SPA (hatched area) relative to the airport runway (© OpenStreetMap)

In conclusion, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no significant biodiversity impacts on any European Sites, and an HRA can be screened out for all European Sites. However, information is presented in the FOA and Technical Appendix showing the number and area of biodiversity sites (including National Nature Reserves and Local Nature Reserves) that are within each primary and secondary noise metric contour.

Capacity / resilience / Wider society
Capacity – Airborne Delay Airborne delay, which usually is caused by aircraft being held in 'holds' or 'stacks' forms part of the NATS NERL ACP as NATS are responsible for the holds and holding procedures. For more information about airborne delay, please see the NATS NERL FOA here. **Capacity – Ground Delay** Glasgow Airport currently has nine SIDs from each runway end but, due to their configuration, the required separation that must be applied between any two successive departures following the SIDs is a minimum two minutes. As well as different noise impacts, the SID configuration proposed in each of our eight options diverge from each other sooner and therefore also enable a decrease in departure delay. In order to identify the impact of each different SID configuration on departure delay, Trax's RunCAT (Runway Capacity Analysis Tool) was used to model the change that each SID configuration has on Glasgow Airport's departure delay. RunCAT is a spreadsheet based analysis tool that is able to closely approximate the runway operations at any airport. The tool has been tailored to represent operations at Glasgow Airport using the forecast schedule and applying all required separations between aircraft. The key performance metrics calculated by RunCAT are average hourly runway throughput and average hourly runway delay. Both metrics reference arrival and departure movements separately. Hourly runway throughput is defined as the number of air traffic movements using the runway within one hour. Hourly runway delay is defined as the difference between an aircraft's scheduled arrival or departure time compared to its actual arrival or departure time, averaged over all aircraft within one hour. Arrival delay represents the delay to an aircraft whilst waiting for an appropriate spacing in which to begin its approach. In the real-world, this would be the equivalent of an arrival aircraft which is instructed to hold, or given additional vectoring. The model used for this analysis assumes that changing runway, SID design, or varying tactical aircraft separations has no impact to arrival runway delay, as arrivals are prioritised based on demand. Airborne stack delay takes place in stacks above 7000ft and is captured as part of NATS NERL's Airtop analysis. More details of this can be found in NATS NERL's FOA. Departure delay represents the delay to an aircraft whilst waiting at the departure runway holding position. This is affected by the configuration of the SIDs immediately off the runway and is the subject of this assessment. The schedules from three busy days (06 July, 25 July, 28 July 2022), which are the same days used by NATS NERL in their greenhouse gas emissions assessments, were chosen for the departure delay modelling.

Schedules were grown from Glasgow's 2022 EFPS data, based on their projected movements, aircraft types, and origin/destinations to generate the same 3 days for 2023, 2027 and 2036. The hourly profiles for each of the three days has been maintained in the grown schedules, aircraft were then randomly assigned take-off and touchdown times within their assigned hour. These forecasts were run through the model for each option, including the baseline 'without airspace change' scenario. The model takes account of the tactical handling of turboprops by ATC, where they are often turned off their SID to the north early, which helps to provide efficient runway throughput. The baseline 'without airspace change' scenario allows tactical vectoring of turboprops <=23,000kg off SIDs H24. The 'with airspace change' options allows tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24, proposed as part of this ACP. The modal split used was the annual average (74% on runway 23 and 26% runway 05) The total number of minutes of modelled departure delay for each of the three forecast days were then averaged, for the baseline 'without airspace change' and each of the 'with airspace change' options, and 'average delay per departure per day' figures generated. This was then annualised based on Glasgow's annual forecast numbers. In order to monetise the outcome of the assessments, a cost was applied to the annualised delay minute data. This was sourced from EUROCONTROL Standard Inputs for Economic Analyses - 16 Cost of delay (ansperformance.eu) and is based on a ground flight phase, taxing in and out, with a <30 min delay, at a rate of €62 per minute (in 2022 prices). This was adjusted to 2024 prices, and then converted from EUR to GBP based on a 0.857948 conversion rate (taken on March 22, 2024). **Resilience** Subject matter experts will qualitatively assess any impacts to resilience against the baseline scenario. In the case of Glasgow airport, any impacts or benefits to resilience would not be experienced on a routine basis and as such they have not been monetised.
Access – General Aviation
Controlled airspace (CAS) is airspace of defined dimensions within which air traffic control (ATC) service is provided in accordance with the airspace classification. Its purpose is to create a known air traffic environment to achieve the objectives of the ATC service to prevent collisions between aircraft and to expedite and maintain an orderly flow of air traffic. As part of our Stage 2 IOA, we committed to quantifying impacts to CAS as part of this FOA assessment. There is no difference in impacts on CAS between any of the different SID groupings assessed within the options. The differences between the SIDs are low level and close to the airport and would not change the proposed CAS volumes. There is no difference in impacts to NERL or

Edinburgh's proposed CAS volumes as a result of Glasgow's different options. The small changes in CAS requirements between Glasgow's options come only from the presence, or not, of PBN Approach transitions, affecting volumes of Glasgow CTR/CTA below 6000ft. Therefore, for the purposes of assessing CAS impacts, our eight 'with airspace change' options can be grouped into just two: • Option1, Option 2, Option 3 and Option 4 which do not propose PBN approach transitions. • Option 5, Option 6, Option 7 and Option 8 which do propose PBN approach transitions. Given these groupings, to avoid duplication in the document, we have shown the General Aviation access assessment, and the quantified results of the CAS assessment, within Appendix C of this document. In determining the appropriate volume and classification of airspace, all 3 sponsors (Glasgow, Edinburgh and NERL) worked collaboratively to meet sponsor and CAA policy requirements. As a result, the following types of changes are being proposed: • Amendments to lateral dimensions of CAS • Amendments to vertical dimensions of CAS • Amendments to classifications CAS • Amendments to assignment (TMA/CTR/CTA) of CAS Due to reassignment of airspace, it would present an inaccurate picture to consider the Glasgow airspace changes in isolation. For example, what today is assigned as ScTMA or other CTAs below 6000ft is being proposed to be re-assigned to Glasgow and Edinburgh CTR/CTAs and parts of Glasgow CTA is proposed to be re-assigned to ScTMA. The quantitative part of the FOA assessment of impacts (Access) on General Aviation (GA) therefore considers the airspace change from all three ACPs as a holistic change. However, where practical, we have presented data for the CAS changes as a whole up to FL195, as a whole but just for where bases of CAS are below 7000ft and also a description of the differences in CAS volumes between the 'with airspace change' options.
Economic impact from increased effective capacity – General aviation / commercial airlines
The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. Subsequently economic impact from increased effective capacity has

not been monetised, as there is nothing that can be specifically attributed to the airspace change at Glasgow Airport. The assessment has however noted the opportunities for less delay as covered in the 'capacity and resilience' assessment above and this has been monetised. The assessment has also considered how the Glasgow Airport options contribute to the wider Scottish Airspace Modernisation airspace, where there may be some positive benefits or negative impacts which are outlined in the NATS NERL assessment (for more information, please see the NERL FOA).
Fuel burn – General aviation / commercial airlines
For details of the methodology used to assess fuel burn, please see the greenhouse gas emissions section above. Once fuel burn has been calculated as described in the greenhouse gas emissions section, it is then monetised by assuming a cost per tonne of £685.99. The derivation of this monetary value is set out in Annex B of ScTMA Cumulative Analysis Framework Part 2.
Training costs – commercial airlines
The FOA will consider whether any training costs would be incurred by Commercial airlines in order to implement the option.
Other costs – commercial airlines
The FOA will consider whether any other costs would be incurred by Commercial airlines in order to implement the option.
Infrastructure costs – Airport / ANSP
The FOA will consider any infrastructure costs that would be incurred by the airport or ANSP in order to implement the option.
Operational costs – Airport / ANSP
The FOA will consider any operational costs that would be incurred by the airport or ANSP in order to implement the option. This includes the cost of maintaining the airport's Instrument Flight Procedures (IFPs) and their Noise Insulation Scheme. Glasgow Airport currently operates a homeowner relocation scheme for residential properties within the 69dB $L_{Aeq,16h}$ contour area and a noise insulation scheme for schools, hospitals, and residential properties within the 63dB $L_{Aeq,16h}$ contour. As part of the Noise Action Plan 2024 – 2028 consultation, Glasgow Airport is proposing to extend the eligibility for the noise insulation scheme for residential properties to 60dB$L_{Aeq,16h}$. The options have the potential to change the number of eligible buildings within these contours and therefore we have looked to the results of the

$L_{Aeq\ 16hr}$ modelling to assess whether there would be a material difference to the cost of the noise insulation scheme for Glasgow Airport as a result of the options. The proposed extension of the residential noise insulation scheme has been taken into account in the cost benefit analysis.
Deployment costs – Airport / ANSP
The FOA will consider any deployment costs that would be incurred by the airport or ANSP in order to implement the option. As there are over 2 years before implementation, project and costs have not been quantified.
Other costs – Airport / ANSP
The FOA will describe any other costs that would be incurred by the airport or ANSP in order to implement the option.
Airspace Modernisation Strategy (AMS) CAP1711 - All

The FOA will assess each option against the vision and objectives of the Airspace Modernisation Strategy (AMS) by summarising some of the outcomes from the detailed assessment categories of the FOA.

The vision: *Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace*

The objectives:
Safety: Maintaining and, where possible, improving the UK's high levels of aviation safety has priority over all other 'ends' to be achieved by airspace modernisation

Integration of diverse users: Airspace modernisation should wherever possible satisfy the requirements of operators and owners of all classes of aircraft, including the accommodation of existing users (such as commercial, General Aviation, military, taking into account interests of national security) and new or rapidly developing users (such as remotely piloted aircraft systems, advanced air mobility, spacecraft, high-altitude platform systems)

Simplification, reducing complexity and improving efficiency: Consistent with the safe operation of aircraft, airspace modernisation should wherever possible secure the most efficient use of airspace and the expeditious flow of traffic[43], accommodating new demand and improving system resilience to the benefit of airspace users, thus improving choice and value for money for consumers

Environmental sustainability: Environmental sustainability will be an overarching principle applied through all airspace modernisation activities. Modernisation should deliver the Government's key environmental objectives with respect to air navigation as set out in the Government's Air Navigation Guidance and, in doing so, will take account of the interests of all stakeholders affected by the use of airspace

[43] 'most efficient use of airspace' and 'expeditious flow' are defined at the foot of page 22 of CAP1711

3.4 Evidence gaps following Stage 2

3.4.1 As part of the stage 2B submission, we explained that we planned to collect the following data and undertake the additional assessments as part of our Full Options Appraisal assessment. Table 26 provides details of this and where to find the information within this FOA document.

Table 26 Evidence gaps identified as part of Stage 2A and where to find information within this FOA

Evidence gap identified at Stage 2B	Where to find within this FOA
Quantify the baseline year (pre-implementation and 10 years post implementation, including 10 year traffic forecast)	Baseline information can be found in section 4.1 baseline inputs
Quantitative L_{Aeq} contours, population counts and size (km^2)	Details of the noise modelling methodology can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option using these noise metrics is included in section 5 Full Options Appraisal.
TAG assessment	Details of the TAG assessments undertaken for noise and greenhouse gas emissions can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option using these noise metrics is included in section 5 Full Options Appraisal.
Quantitative overflight contours that detail frequency of overflight including 100% easterlies and westerlies, and cumulative impacts from arrivals/departures and other airports	Details of the noise modelling methodology can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option using overflight metrics is included in section 5 Full Options Appraisal. 100% mode easterly and westerly overflight contours are provided for the Preferred Option (Option 5). Note there are no cumulative overflight impacts below 7000ft between Glasgow Airport and Edinburgh Airport.
Detailed fuel burn and equivalent CO_2 emissions data and track length comparison	Details of the methodology undertaken to assess fuel burn and greenhouse gas emissions can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option is included in section 5 Full Options Appraisal.
Further information around interdependencies with the upper network and neighbouring airports	There is also information about how our options have evolved between Stage 2 and Stage 3 within section 3. evolution of the options. Further

	information about interdepdencies, conflicts and trade-offs can be found within ACOG Annex A.
ATC deployment / training costs	Details of the methodology undertaken to assess ATC deployment and training costs can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option is included in section 5 Full Options Appraisal. Note that whilst the scale of ATC deployment and training costs have been described and quantified, they have not been monetised as there are over 2 years before implementation. Where possible and appropriate, these will be monetised as part of the Stage 4 Final Options Appraisal.
Quantitative capacity information	Details of the methodology undertaken to quantitatively assess capacity can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option is included in section 5 Full Options Appraisal.
Quantified Controlled Airspace (CAS) requirements	Details of the methodology undertaken to quantitatively assess controlled airspace can be found in section 4.3 Full Options Appraisal methodology. Assessment of each option is included in section 5 Full Options Appraisal.
Further information following engagement with gliding areas around airspace availability	Appendix C of this FOA document explains the potential benefits and impacts to CAS as a result of the options. We are aware of the value of controlled airspace to glider pilots in the 'Cumbernauld gap'[44]. We have included detailed information on proposed CAS dimensions, and we look forward to feedback from all of GA on the proposals, specific to their operations throughout the consultation process.

[44] The Cumbernauld gap is also referred to as the Edinburgh – Glasgow gap. It is a volume of airspace which allows GA traffic passage between the Class D Edinburgh and Glasgow airspace. This area is used by GA traffic transiting north - south to/from central Scotland, southern Scotland, Northern Ireland, and England, as well as for local pilots visiting Cumbernauld and Strathaven.

4. Full Options Appraisal

4.1.1 The following sub sections outline our Full Options Appraisal (FOA) for the baseline ‘without airspace change’ scenario and for each ‘with airspace change’ option compared against this baseline scenario.

4.2 Baseline 'Without airspace change'

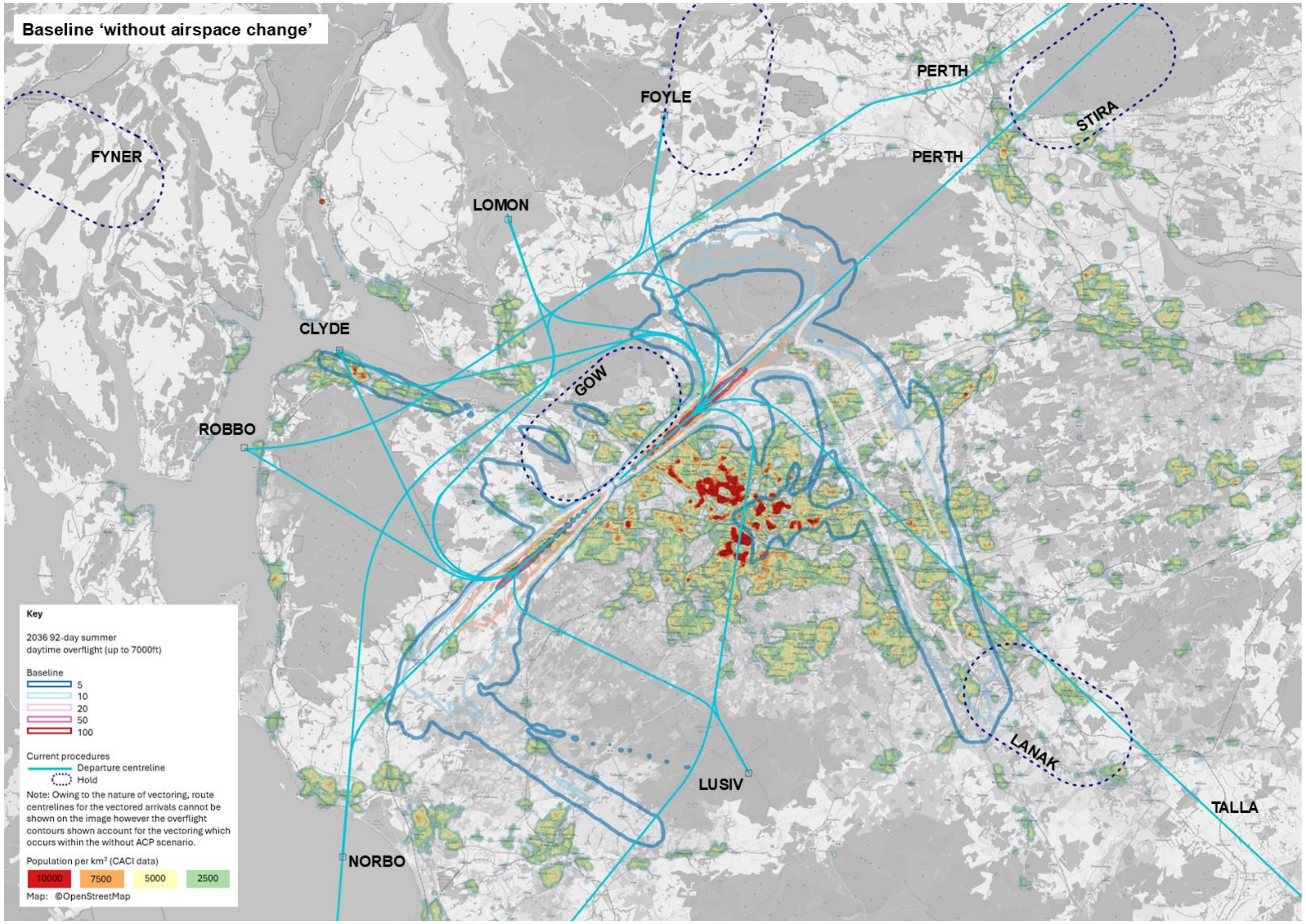


Figure 44 Baseline 'without airspace change' scenario. 2036 overflight contours overlaid with current route centrelines. Population data sourced from CACI

4.2.1 Procedure charts are published as part of the Aeronautical Information Publication (AIP) EGPF section 2.24: https://nats-uk.ead-it.com/cms-nats/opencms/en/Publications/AIP/

4.2.2 **Baseline departures:** In the existing airspace, the majority of Glasgow Airport Standard Instrument Departures (SIDs) climb straight ahead to 5nm before turning. Beyond 5nm, aircraft are typically vectored off the SID centrelines by Air Traffic Control (ATC), resulting in broad dispersion across the airspace. Some aircraft 23,000kg MTWA or less do not depart via the SIDs. These are usually non-jet aircraft and therefore slower than jet aircraft. These aircraft are vectored by ATC which helps them turn towards their destination early, reduces track miles and reduces departure delays.

4.2.3 Glasgow Airport's current SIDs are dependent on conventional ground-based navigation equipment (VORs) which are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNAV substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridge the gap ahead of FASI implementation. The AMS mandates airports implement IFPs based on PBN and doing nothing does not meet that national requirement.

Baseline 'Without airspace change' assessment
Safety – All
At current traffic levels, there are no safety concerns which require immediate resolution with the current arrangements at Glasgow. Future traffic growth could however result in increased complexity and workload for Air Traffic Controllers and pilots, which may lead to traffic levels within the Scottish TMA being capped, or increased aircraft holding on the ground, in order to maintain safety. 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.
Noise – Communities
Contour maps The contour maps for the without airspace change scenarios are shown in Figures TA1 to TA24 in the FOA Technical Appendix. **TAG outcomes** Information about the changes in L_{Aeq} contours compared to the baseline L_{Aeq} contours will be used to generate TAG outcomes for the options. There is no TAG outcome for the baseline given this is the 'without airspace change' scenario.

L_{Aeq} contours

The following tables show L_{Aeq} noise contour data for the 'without airspace change' pre-implementation scenario for 2022 (current day scenario), 2027 (year of implementation) and 2036 (10 years following implementation). For each contour band, the area of the contour is presented along with the total population, total households and number of potentially noise sensitive buildings within each band.

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022	Without airspace change	$L_{Aeq,16h}$	51	36.9	55900	26500	26	0	12	26
			54	18.9	23100	10900	5	0	4	10
			57	9.5	5200	2500	0	0	0	2
			60	4.8	900	500	0	0	0	1
			63	2.6	<100	<100	0	0	0	0
			66	1.5	0	0	0	0	0	0
			69	0.9	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027		$L_{Aeq,16h}$	51	44.7	68700	32400	35	0	14	30
			54	23.0	31000	14700	11	0	5	17

	Without airspace change		57	11.8	8600	4000	2	0	0	4
			60	5.8	1500	800	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.7	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	$L_{Aeq,16h}$	51	47.6	72600	34200	37	0	15	34
			54	24.9	34500	16300	14	0	6	19
			57	12.7	10400	4900	4	0	0	5
			60	6.3	1900	1000	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022	Without airspace change	$L_{Aeq,8h}$	45	67.8	89200	42000	47	0	19	45
			48	37.1	53800	25500	26	0	12	25
			51	18.3	20000	9800	8	0	4	12
			54	8.7	2100	1100	0	0	0	2
			55	6.9	1000	500	0	0	0	1
			57	4.5	<100	<100	0	0	0	0
			60	2.6	<100	<100	0	0	0	0
			63	1.5	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Without airspace change	$L_{Aeq,8h}$	45	71.7	92700	43600	48	0	20	49
			48	39.4	56800	27000	28	0	13	26
			51	19.5	22800	11100	9	0	5	14
			54	9.3	2800	1300	0	0	0	2
			55	7.4	1400	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.7	<100	<100	0	0	0	0

			63	1.5	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	$L_{Aeq,8h}$	45	75.5	97200	45600	48	0	21	52
			48	41.9	59800	28400	29	0	13	26
			51	20.9	26300	12700	11	0	5	16
			54	10.0	3500	1700	0	0	0	2
			55	7.9	1700	900	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.6	0	0	0	0	0	0

N60 and N65 contours

The following tables show N65 and N60 noise contour data for the 'without airspace change' pre-implementation scenario for 2022 (current day scenario), 2027 (year of implementation) and 2036 (10 years following implementation). For each contour band, the area within the contour is presented along with the population and number of potentially noise sensitive buildings within each band.

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022		N65	5	116.2	133000	63300	57	0	29	71

	Without airspace change	(daytime)	10	87.3	106500	50000	51	0	24	58
			20	63.5	84700	39800	46	0	19	45
			50	34.1	47200	22000	19	0	11	24
			100	3.4	<100	<100	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Without airspace change	N65 (daytime)	5	133.9	148100	70600	59	0	32	76
			10	101.3	114100	53900	52	0	26	59
			20	72.3	92000	43100	49	0	21	47
			50	41.0	55600	26100	23	0	12	31
			100	10.5	11300	5200	3	0	0	5
			200	0.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	N65 (daytime)	5	138.6	150500	71600	60	0	32	78
			10	104.8	117700	55800	52	0	28	60
			20	76.0	94800	44500	50	0	21	49
			50	43.6	58700	27600	25	0	13	32

			100	13.2	16800	7600	4	0	1	7
			200	0.8	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022	Without airspace change	N60 (night-time)	5	124.7	138700	66900	59	0	30	77
			10	70.2	88400	41800	48	0	20	44
			20	5.9	500	300	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Without airspace change	N60 (night-time)	5	132.0	144500	69700	62	0	30	83
			10	74.9	98400	46700	50	0	20	50
			20	11.5	3000	1400	1	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	N60 (night-time)	5	136.7	146900	70700	63	0	30	84
			10	81.8	101800	48300	50	0	22	52
			20	13.4	4400	2100	6	0	0	1

Overflights

The following tables show Day and Night overflight contour data for the 'without airspace change' pre-implementation scenario for 2022 (current day scenario), 2027 (year of implementation) and 2036 (10 years following implementation). For each contour band, the area within the contour is presented along with the population and number of potentially noise sensitive buildings within each band.

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022	Without airspace change	Overflights (daytime)	5	476.6	398000	186100	172	2	66	218
			10	231.9	236200	108700	108	1	46	136
			20	126.7	151200	69300	63	1	33	84
			50	22.0	22700	10500	11	0	2	9

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Without airspace change	Overflights (daytime)	5	591.9	518300	243600	217	5	83	285
			10	288.5	267900	123100	124	1	52	155
			20	158.8	181200	82900	78	1	41	98
			50	35.0	32000	15200	13	0	4	16
			100	2.7	5400	2400	1	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	Overflights (daytime)	5	630.2	554700	260200	234	8	90	301
			10	312.4	275200	126400	128	1	55	157
			20	167.3	188300	86400	82	1	43	102
			50	37.3	34400	16400	13	0	4	16
			100	5.6	8500	3700	4	0	1	3

Metric – Overflights (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2022	Without airspace change	Overflights (night-time)	5	51.9	44500	21300	16	0	11	23
			10	20.3	19200	9000	9	0	4	7

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Without airspace change	Overflights (night-time)	5	57.1	50900	24200	16	0	12	28
			10	27.0	25700	12200	12	0	4	11

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Without airspace change	Overflights (night-time)	5	60.9	55300	26100	20	0	13	35
			10	29.2	27600	13100	13	0	4	12

Air Quality – Communities
Industrial processes Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met and ensuring that any releases to the environment are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A(1), A(2), Part B or Medium Combustion Plant (MCP) processes, and are regulated through the Pollution Prevention and Control (PPC) system[45,46]. The larger more polluting processes are regulated by the Environment Agency, and the smaller, less polluting ones by the local authorities. Local authorities regulate only for emissions to air, whereas the Environment Agency regulates emissions to air, water and land According to the Environment Agency website[47], there are no regulated industrial installation within 2km of the airport. However, any existing regulated industrial processes would be captured in monitoring and Scottish Government and Defra predicted background concentrations. **Local Air Quality** The Environment Act 2021 requires local authorities to review and assess air quality with respect to the objectives for the pollutants specified in the National Air Quality Strategy. Where objectives are not predicted to be met, local authorities must declare the area as an AQMA. In addition, local authorities are required to produce an AQAP, which includes measures to improve air quality in the AQMA. The nearest AQMAs are the following: • Renfrew Town Centre AQMA, declared for exceedances of the 1-hour and annual mean NO_2 standards, located 1.4km east from the airport; and • Paisley AQMA, declared for exceedances of the 1-hour and annual mean NO_2 and annual mean PM_{10} standards, located 1.2km south from the airport. The AQMAs are shown in Figure 38, but are not located in the zone of influence.

45 The Environmental Permitting (England and Wales) (Amendment) Regulations 2013, SI 2013/390.

46 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

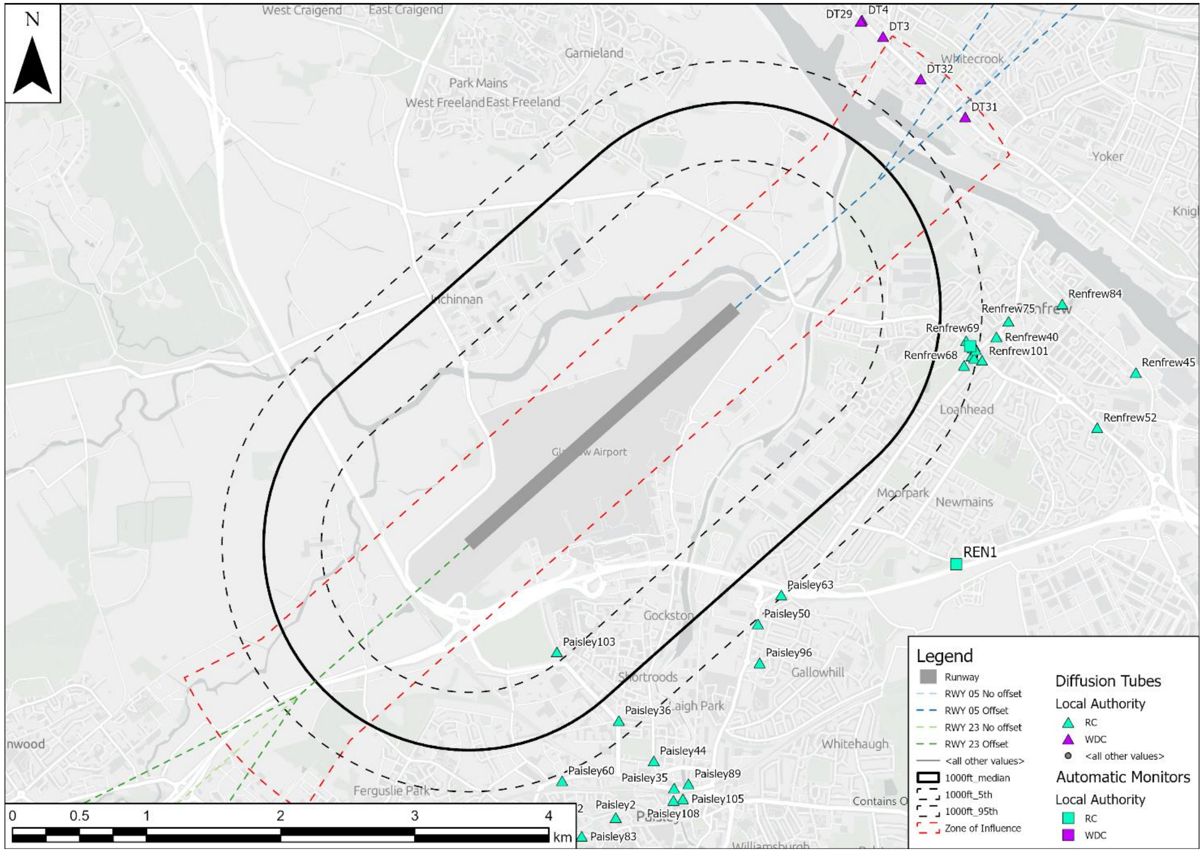
47 Environment Agency, 2023. Environmental Permitting Regulations – Installations. Available at: https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed June 2024]

Local Monitoring

The most recently available monitoring data for Glasgow City Council, Renfrewshire Council and West Dunbartonshire Council is for the year 2022. The Councils undertake monitoring of NO_2, PM_{10} and $PM_{2.5}$ and has both automatic monitoring stations and diffusion tube monitoring.

The 2023 Air Quality Annual Progress Reports for the Councils show that there are four automatic monitoring sites and 39 diffusion tube sites located within 2km of the airport as shown in Figure 45.

Figure 45: Monitoring locations within 2km of the airport



Automatic monitoring

Automatic monitoring involves drawing air in through an analyser continuously to obtain near real-time pollutant concentration data. There are a total of four automatic monitoring sites within 2km of the airport. The details of these automatic monitoring locations are included in Table 27 and their locations are shown in Figure 45.

It should be noted that monitoring data from 2020 and 2021 is not considered to be representative of typical conditions due to impacts from the Covid-19 pandemic, however this data is included in the baseline for completeness.

Table 28 shows that there are no exceedances of the NO_2 annual mean standard or 1-hour standard from 2018 to 2022 and that concentrations are generally decreasing at the three automatic monitoring sites that monitor NO_2.

Table 29 shows that there are no exceedances of the annual mean PM_{10} and $PM_{2.5}$ annual mean standards, but one exceedances of the 24-hour mean PM_{10} objective at site REN02 in 2019. This has been attributed to road vehicle emissions along the B789 (High Street). There is no discernible trend in the PM_{10} and $PM_{2.5}$ results.

Table 27: Details of automatic monitoring sites within 2km of the airport

Local Authority	Site ID	Site name	Site type	OS Grid reference (m)	
				Easting	Northing
RC	REN1	Renfrew, Cockels Loan	Roadside	250464	665933
RC	REN02	Renfrewshire, Johnstone	Roadside	242984	663178
RC	REN03	Renfrew, Inchinnan Road	Roadside	250567	667558
WDC	CM1	Clydebank	Roadside	249723	672044

Table 28: Automatic monitor NO_2 results

Site ID	NO_2 annual mean concentration (µg/m³)				
	2018	**2019**	**2020**	**2021**	**2022**
REN1	31.2	31.1	20.9	24.5	22.4
REN03	n/a	24.1	19.9	19	19.7
CM1	22.1	28.2	21.0	17.4	17.6
Air Quality Objective	40				
Site ID	**NO_2 1-hour mean exceedances**				
REN1	0	0	0	0	0
REN03	n/a	0	0	0	0
CM1	0	0	0	0	0
Air Quality Objective	200 µg/m³, not to be exceeded more than 18 times a year				
Notes: Exceedances of the air quality objective are highlighted in bold. n/a = no monitoring data available for this year					

Table 29: Automatic monitor PM_{10} and $PM_{2.5}$ results

Site ID	PM_{10} annual mean concentration (µg/m³)				
	2018	**2019**	**2020**	**2021**	**2022**
REN02	14.8	17.9	11.3	15.1	14.2
CM1	10.0	11.0	9.0	10.0	10.0

Air Quality Objective	18				
Site ID	**PM_{10} 24-hour mean exceedances**				
REN02	1	**14**	0	1	0
CM1	0	4	0	0	0
Air Quality Objective	50 µg/m^3, not to be exceeded more than 7 times a year				
Site ID	**$PM_{2.5}$ annual mean concentration (µg/m^3)**				
REN02	7.7	8.4	5.9	6.3	6.5
CM1	6.0	7.0	5.0	6.0	6.0
Air Quality Target	10				
Notes: Exceedances of the air quality objective are highlighted in bold. n/a = no monitoring data available for this year					

Diffusion tube monitoring

The Councils carry out passive diffusion tube monitoring throughout the area. The available monitoring data shows that within 2km of the airport there are 39 diffusion tubes. Details of the diffusion tube monitoring sites and monitoring data are shown in Table 30 and Table 31 respectively. The monitoring locations are shown in Figure 45.

Table 31 shows that there were three exceedances of the NO_2 annual mean standard in 2018 to 2020 at site Renfrew8 (Inchinnan Road, A8). Renfrew8 is located at a four-way traffic light junction and the exceedances are considered to be attributed to the related vehicle emissions at the junction. However, there were not any exceedances recorded in 2022.

In the last five years, there were no recorded annual mean NO_2 concentrations above 60µg/m^3, indicating exceedances of the hourly mean objective for NO_2 concentrations are unlikely.

Table 30: Diffusion tube monitoring sites within 2km of Glasgow International Airport

Local Authority	Site ID	Site name	Site type	Grid reference	
				Easting	Northing
RC	Paisley2	Oakshaw Street	Urban Background	247925	664052
RC	Renfrew8	Inchinnan Road	Kerbside	250589	667547
RC	Paisley19	Linwood Road	Roadside	245701	663603
RC	Paisley35	Old Sneedon Street	Roadside	248360	664272
RC	Paisley36	Caledonia Street	Roadside	247948	664774
RC	Renfrew40	Hairst Street	Roadside	250763	667631
RC	Paisley44	Love Street	Roadside	248209	664474
RC	Renfrew45	Xscape	Kerbside	251803	667365
RC	Paisley50	Renfrew Road	Roadside	248985	665494
RC	Renfrew52	Glasgow Road	Roadside	251515	666955
RC	Renfrew56	Paisley Road	Roadside	250579	667488
RC	Renfrew57	Paisley Road	Roadside	250597	667473
RC	Paisley60	Underwood Road	Roadside	247525	664326
RC	Paisley63	Renfrew Road	Roadside	249159	665710
RC	Renfrew68	Paisley Road	Roadside	250522	667419
RC	Renfrew69	Inchinnan Road	Roadside	250537	667602
RC	Renfrew70	Inchinnan Road	Roadside	250599	667561

RC	Renfrew75	Canal Street	Roadside	250853	667747
RC	Paisley82	Well Street	Roadside	247513	664024
RC	Paisley83	Wellmeadow Street	Kerbside	247671	663913
RC	Renfrew84	Ferry Village	Roadside	251254	667876
RC	Paisley89	Abercorn Street	Roadside	248467	664303
RC	Renfrew90	Renfrew Monitor (triplicate)	Roadside	250567	667558
RC	Paisley96	McDonalds Renfrew Road	Roadside	248998	665204
RC	Renfrew97	Inchinnan Road	Kerbside	250610	667534
RC	Renfrew101	Glebe Street	Roadside	250656	667457
RC	Paisley103	Greenock Road	Roadside	247486	665285
RC	Paisley105	Central Road 2	Roadside	248425	664192
RC	Paisley108	Central Road	Roadside	248355	664180
WDC	DT1	Clydebank 1	Kerbside	248479	671115
WDC	DT3	Clydebank 7	Kerbside	249918	669868
WDC	DT4	Clydebank 9	Kerbside	249761	669990
WDC	DT7	Clydebank 12	Kerbside	249747	671665
WDC	DT9	Clydebank 14	Kerbside	249872	671854
WDC	DT24	Briar Drive 3	Kerbside	248479	671115
WDC	DT29	Clydebank 19	Kerbside	249752	669981

WDC	DT31	Clydebank 21	Kerbside	250531	669269
WDC	DT32	Clydebank 22	Kerbside	250199	669551
WDC	DT36	Clydebank 23	Kerbside	249868	671267

Table 31: Annual mean NO_2 monitoring data within 2km of Glasgow International Airport

Site ID	NO_2 annual mean concentration (µg/m³)				
	2018	2019	2020	2021	2022
Paisley2	14.4	14.6	10.9	9.6	11.9
Paisley19	28.3	24.9	24.1	22.5	17.9
Paisley35	34.7	31.1	31.5	25.7	21.9
Paisley36	30.4	28.2	27.7	26.5	20.5
Paisley44	23.6	21.9	16.3	16.1	15.5
Paisley50	29.4	24.3	21.8	17.9	17.3
Paisley60	34.4	33.6	30.1	24.5	22.3
Paisley63	33.2	29.4	25.2	25.2	20.9
Paisley82	33.2	28.9	36.1	28.1	24.3
Paisley83	31.1	33.2	25.1	22.7	21.8
Paisley89	22.4	30.4	24.9	23.2	20.0
Paisley96	-	-	24.2	21.2	16.9
Paisley103	-	-	-	-	13.1

Paisley105	-	-	-	-	16.6
Paisley108	-	-	-	-	14.7
Renfrew8	41.1	41.4	40.2	29.8	30.2
Renfrew40	27.4	25.8	21.6	18.7	16.4
Renfrew45	25.8	21.5	20.3	18.4	14.9
Renfrew52	31.8	25.3	24.9	21.2	17.3
Renfrew56	30.3	26.3	24.4	20.9	19.5
Renfrew57	24.1	24.4	18.1	19.0	12.9
Renfrew68	27.4	23.8	21.0	16.4	17.4
Renfrew69	30.7	29.9	25.0	32.4	25.3
Renfrew70	31.7	25.4	26.9	17.4	18.1
Renfrew75	22.6	22.1	21.1	20.2	13.9
Renfrew84	24.3	23.1	16.8	14.9	13.1
Renfrew90	-	24.4	21.4	20.1	17.2
Renfrew97	-	-	-	30.5	28.5
Renfrew101	-	-	-	19.5	17.8
DT1	22.5	22.5	19.1	17.2	19.2
DT3	20.6	23.9	15.4	13.0	16.2
DT4	22.0	20.7	14.0	14.9	16.2
DT7	19.9	19.3	14.9	15.4	20.1

DT9	11.0	13.8	9.1	8.4	8.7
DT24	19.3	17.0	14.1	14.2	15.1
DT29	19.9	21.7	12.3	11.6	14.8
DT31	20.2	20.4	11.0	12.0	14.2
DT32	15.5	19.3	13.4	13.0	13.2
DT36	n/a	n/a	n/a	n/a	18.1
Air Quality Objective	40				
Notes: Exceedances of the NO_2 annual mean objective are highlighted in bold. NO_2 annual means exceeding 60µg/m^3, indicating a potential exceedance of the NO_2 1-hour mean objective are shown in bold and underlined. n/a = no monitoring data available for this year					

Background concentrations

Background concentrations refer to the existing levels of pollution in the atmosphere, produced by a variety of stationary and non-stationary sources, such as roads and industrial processes. The Scottish Government[29] and Defra website. includes estimated background pollutant concentrations for NOx, NO_2, PM_{10} and $PM_{2.5}$ for each 1km by 1km OS grid square in the UK. Data for the existing baseline year 2022 and also the future years 2027 and 2036 are provided below.

The background pollutant concentrations for 2022 have been obtained for the grid squares containing the airport and are shown below in Table 32. The only urban background monitor within 2km of the airport, available for comparison with the estimated backgrounds, is located in Paisley and not in the vicinity of any assessed receptors (the majority of which are located northeast at Whitecrook). Therefore, a relevant comparison has not been undertaken. However, all concentrations are estimated to be below the annual air quality standards, which aligns with the 2022 monitoring data.

Table 32: Estimated background annual mean pollutant concentrations for 2022

Easting	Northing	Annual mean concentration (µg/m^3)			
		NOx	NO_2	PM_{10}	$PM_{2.5}$
246500	665500	21.4	14.7	10.8	6.3
246500	666500	19.4	13.2	8.8	5.4
247500	666500	21.2	14.3	9.1	5.4
247500	667500	23.5	15.6	8.9	5.4
248500	667500	21.0	14.1	8.6	5.2

Background concentrations in 2027 and 2036 are expected to reduce in the future, for NOx, NO_2, PM_{10} and $PM_{2.5}$ as shown below in Table 33 (predictions only go up to 2030 so 2036 data is not available). All pollutants are not expected to exceed the annual air quality objectives.

Table 33: Estimated background annual mean pollutant concentrations for 2027

Easting	Northing	Annual mean concentration (µg/m^3)			
		NOx	NO_2	PM_{10}	$PM_{2.5}$
246500	665500	15.8	11.0	10.5	6.1
246500	666500	16.4	11.2	8.5	5.2
247500	666500	18.5	12.5	8.8	5.2
247500	667500	21.2	14.2	8.6	5.2
248500	667500	18.8	12.7	8.3	5.0

Both monitoring and estimated backgrounds are not expected to exceed standards in 2022 and background concentrations are expected to reduce in the future as a result of technological advances and improvements in vehicle and aircraft emissions. Therefore, the 2022 estimated predictions are considered to be appropriate for the assessment. Using the 2022 to represent the future scenarios (2027 and 2036) is considered to provide a conservative assessment and appropriately accounts for any uncertainty with regards to future predicted total concentrations. The background concentrations used for the receptor locations are provided in Table 34.

Table 34: 2022 background concentrations used at receptor locations (μg/m³)

Receptor ID	Postcode	NOx	NO_2	PM_{10}	$PM_{2.5}$
H1	G81 1BQ	16.0	11.0	9.4	5.6
H2	G81 1JA	16.0	11.0	9.4	5.6
H3	G81 1JP	16.0	11.0	9.4	5.6
H4	G81 1LG	16.0	11.0	9.4	5.6
H5	G81 1LQ	16.0	11.0	9.4	5.6
H6	G81 1LU	16.0	11.0	9.4	5.6
H7	G81 1LW	16.0	11.0	9.4	5.6
H8	G81 1LX	16.0	11.0	9.4	5.6
H9	G81 1NA	16.0	11.0	9.4	5.6
H10	G81 1ND	16.0	11.0	9.4	5.6
H11	G81 1NE	16.0	11.0	9.4	5.6
H12	G81 1NH	16.0	11.0	9.4	5.6
H13	G81 1NJ	16.0	11.0	9.4	5.6
H14	G81 1NP	16.0	11.0	9.4	5.6

H15	G81 1NQ	16.0	11.0	9.4	5.6
H16	G81 1NR	16.0	11.0	9.4	5.6
H17	G81 1NT	16.0	11.0	9.4	5.6
H18	G81 1NW	16.0	11.0	9.4	5.6
H19	G81 1PD	16.0	11.0	9.4	5.6
H20	G81 1PF	16.0	11.0	9.4	5.6
H21	G81 1PG	16.0	11.0	9.4	5.6
H22	G81 1PH	16.0	11.0	9.4	5.6
H23	G81 1PJ	16.0	11.0	9.4	5.6
H24	G81 1PW	16.0	11.0	9.4	5.6
H25	G81 1QB	14.0	9.7	8.6	5.2
H26	G81 1QD	14.0	9.7	8.6	5.2
H27	G81 1QG	14.0	9.7	8.6	5.2
H28	G81 1QJ	14.0	9.7	8.6	5.2
H29	G81 1QQ	14.0	9.7	8.6	5.2
H30	G81 1XP	16.0	11.0	9.4	5.6
H31	G81 1YW	14.0	9.7	8.6	5.2
H32	PA1 2FP	12.5	8.8	9.3	5.5
H33	PA3 1BF	21.4	14.7	10.8	6.3
H34	PA3 2BF	21.2	14.3	9.1	5.4

H35	PA3 2RY	21.4	14.4	8.9	5.4
H36	PA3 2TQ	21.8	15.0	10.9	6.3
H37	PA3 3AA	21.4	14.7	10.8	6.3
H38	PA3 3AB	11.5	8.1	8.5	5.2
H39	PA3 3AD	21.4	14.7	10.8	6.3
H40	PA3 3AG	11.5	8.1	8.5	5.2
H41	PA4 9DL	17.5	12.0	9.2	5.5
H42	PA4 9EE	12.8	9.0	8.6	5.2
H43	PA4 9EG	12.8	9.0	8.6	5.2
H44	PA4 9EJ	17.5	12.0	9.2	5.5
H45	PA4 9LP	23.5	15.6	8.9	5.4
E1	Black Cart SSSI & SPA	13.0	9.1	8.6	5.2
E2	Black Cart SSSI & SPA	13.0	9.1	8.6	5.2
E3	Black Cart SSSI & SPA	21.0	14.1	8.6	5.2

Greenhouse gas emissions – Wider society

TAG outcomes

Information about the changes in greenhouse gas emissions will be used to generate TAG outcomes for the options. There is no TAG outcome for the baseline given this is the 'without airspace change' scenario.

Greenhouse gas emissions

As noted in paragraph 3.1.5 for noise, overflight and air quality we have defined the current-day scenario as 2022 as this was the latest available data at the time of undertaking the relevant modelling. However, for fuel burn and greenhouse gas (GHG) emissions, we are restricted to using 2023 as the current-day scenario due to an interface with the NERL ACP and the data generated by NERL. It is important to note that this does not affect the overall assessment of the options themselves as these are calculated based on comparison to a future baseline rather than current-day baseline.

Annual and per flight greenhouse gas emissions are presented in Table 35 for the 'without airspace change' scenario.

Table 35: Without airspace change greenhouse gas emissions

Scenario	Year	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
Without airspace change	2023	393,541	5,753
	2027	521,287	5,737
	2028	525,266	5,742
	2029	529,245	5,747
	2030	533,223	5,752
	2031	537,202	5,756
	2032	541,180	5,760
	2033	545,159	5,764

	2034	549,137	5,768
	2035	553,116	5,771
	2036	557,095	5,774

Tranquillity – Wider society

Tranquillity Data

There are no National Parks or National Scenic Areas (NSA) within the 51dB $L_{Aeq,16h}$ LOAEL contours for the current-day 2022 baseline, the 2027 'without airspace change' future baseline, or the 2036 'without airspace change' future baseline. No National Parks or National Scenic Areas (NSA) are overflown five or more times a day below 7,000ft in the current-day 2022 baseline, the 2027 'without airspace change' future baseline, or the 2036 'without airspace change' future baseline.

Table 36 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the current-day 2022 baseline, the 2027 'without airspace change' future baseline, or the 2036 'without airspace change' future baseline.

Table 36 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 'without airspace change' 51dB $L_{Aeq,16h}$ LOAEL contour	Number of CQAs overflown five or more times a day below 7,000ft in the 'without airspace change' scenario
2022 (current day)	4	22
2027	4	26
2036	5	27

The locations of CQAs, National Parks and National Scenic Areas are shown in Figures TA7, TA15, TA23, TA47 and TA55 of the Technical Appendix.

The following tables show the area and number of locations/spaces that are relevant to the consideration of tranquillity and sit within the overflight and L_{Aeq} contours. Whilst the assessment of tranquillity follows CAP1616 guidance and therefore focuses on CQAs, National Parks and National Scenic Areas, information is also presented on Country Parks and Gardens and Designated Landscapes. These data cover the 'without airspace change' pre-implementation scenario for 2022 (current day scenario), 2027 (year of implementation) and 2036 (10 years following implementation) periods.

Metric – LAeq16HR:

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2022	Without airspace change	LAeq16HR	51	0	0	0	0	4	1.0	0	0	0	0
			54	0	0	0	0	2	0.1	0	0	0	0
			57	0	0	0	0	1	<0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	Without airspace change	LAeq16HR	51	0	0	0	0	4	1.2	0	0	1	<0.1
			54	0	0	0	0	2	0.1	0	0	0	0
			57	0	0	0	0	1	<0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2036	Without airspace change	LAeq16HR	51	0	0	0	0	5	1.3	0	0	1	0.1
			54	0	0	0	0	3	0.2	0	0	0	0
			57	0	0	0	0	1	0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0

			69	0	0	0	0	0	0	0	0	0	0

Metric – Overflights_Day:

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2022	Without airspace change	Overflights_Day	5	0	0	0	0	22	8.5	5	13.4	8	8.8
			10	0	0	0	0	15	4.6	4	9.3	4	4.4
			20	0	0	0	0	12	2.2	2	3.7	2	0.6
			50	0	0	0	0	5	0.7	0	0	1	0.1

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	Without airspace change	Overflights_Day	5	0	0	0	0	26	10.1	5	14.2	10	9.7
			10	0	0	0	0	18	5.5	5	9.9	4	4.2
			20	0	0	0	0	13	2.8	3	6.2	2	0.4
			50	0	0	0	0	5	1.0	0	0	1	0.1
			100	0	0	0	0	2	0.3	0	0	0	0

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2036	Without airspace change	Overflights_Day	5	0	0	0	0	27	10.3	5	14.3	11	10.7
			10	0	0	0	0	18	7.0	5	11.5	4	5.0
			20	0	0	0	0	13	3.1	3	6.7	2	0.7
			50	0	0	0	0	5	1.0	0	0	1	0.1
			100	0	0	0	0	2	0.4	0	0	0	0

Metric – Overflights_Night:

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2022	Without airspace change	Overflights_Night	5	0	0	0	0	5	1.1	0	0	1	0.1
			10	0	0	0	0	4	0.5	0	0	0	0

Year	Scenario	Metric	Contour	National Scenic Area	National Parks	Candidate Quiet Area	Country Parks	Gardens and Designated Landscapes

				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	Without airspace change	Overflights_Night	5	0	0	0	0	5	1.2	1	<0.1	1	0.1
			10	0	0	0	0	4	0.9	0	0	0	0

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2036	Without airspace change	Overflights_Night	5	0	0	0	0	5	1.3	1	<0.1	1	0.2
			10	0	0	0	0	4	1.0	0	0	1	<0.1

Biodiversity – Wider society

Biodiversity Data

As outlined in the methodology section, no impacts are predicted for any biodiversity receptors. However, to provide information, and as required by CAP1616i, the following tables identify the number and area of European Sites that are overflown below 7,000ft for the 'without airspace change' pre-implementation scenario for 2022 (current day scenario), 2027 (year of implementation) and 2036 (10 years following implementation) periods. As can be seen in the tables there are a number of European sites that are overflown below 7,000ft more than 5 times a day/night in the baseline. These receptors are shown in Figures TA8, TA16, TA24, TA48 and TA56 in the Technical Appendix.

Metric – Overflights Day:

Year	Scenario	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2022	Without airspace change	Overflights_Day	5	1	<0.1	4	1.5	0	0
			10	0	0	2	0.4	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0

Year	Scenario	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	Without airspace change	Overflights_Day	5	2	0.1	5	2.7	1	0.1
			10	1	0.01	3	0.5	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scenario	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2036	Without airspace change	Overflights_Day	5	2	0.3	5	2.8	1	0.3
			10	1	<0.1	4	0.6	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Metric – Overflights_Night:

Year	Scenario	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2022	Without airspace change	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Year	Scenario	Metric	Contour	SPA	SAC	RAMSAR

				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	Without airspace change	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Year	Scenario	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2036	Without airspace change	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

Glasgow's current SID configuration, with the majority of departures flying straight ahead to 5nm before turning, results in a capacity constraint on the airport as aircraft are only able to depart with at least 2-minute intervals. This leads to holding on the ground which results in increased emissions and delays. Any future increases in movement numbers at the airport will result in increases in ground holding and delay and therefore the SIDs in the existing configuration are not fit for purpose for future growth at the airport. The runway capacity analysis shows the number of minutes of departure delay per year for the baseline 'without airspace change' scenario in Table 37:

Table 37 Without airspace change - Number of minutes of departure delay per year

	Number of minutes of departure delay per year		
Option	**2023**	**2027**	**2036**
Without airspace change	18114	46988	62320

Each option will be compared against the outcomes to understand any positive benefits to departure delay.

Resilience
This baseline 'without airspace change' is dependent on conventional ground-based navigation aids called VORs. This equipment is due to be decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term[48] resilience for Glasgow's SIDs when NERL decommissions the VORs, which will result in critical operational issues and significant loss of revenue.

Access – General Aviation

This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be quantitatively compared against this existing scenario.

[48] Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-N

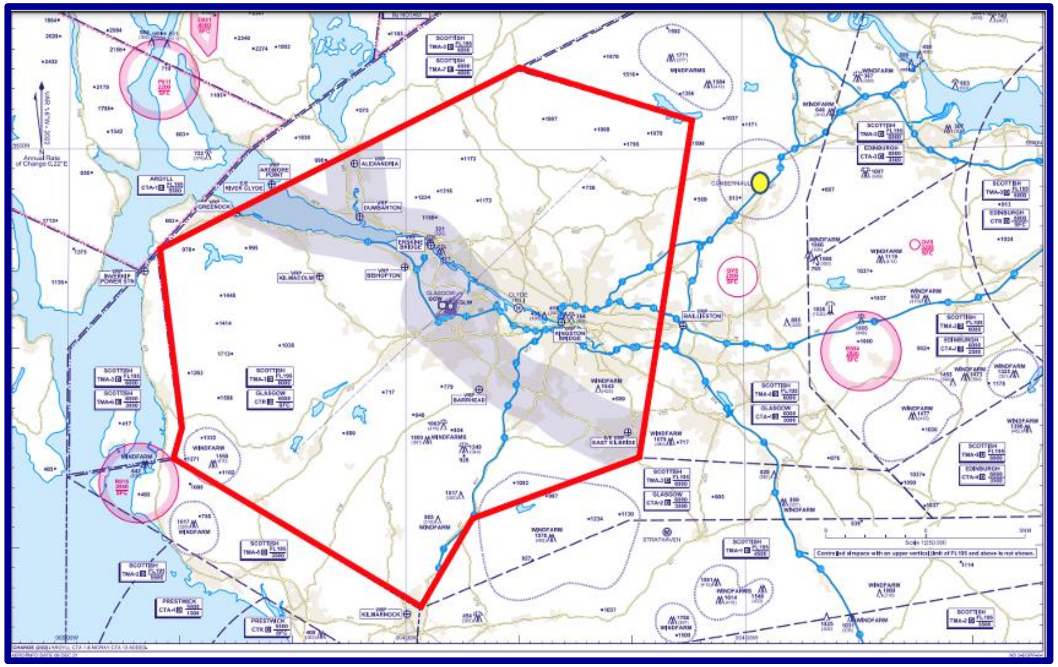


Figure 46 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)

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 46. 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. 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.

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 there is an expectation that the CTR itself can likely be reduced in size.

Whilst the existing baseline scenario will not result in the requirement for more airspace, this option offers no opportunity to reduce the size of CAS.

Economic impact from increased effective capacity – General aviation / commercial airlines

Capacity – Ground delay

The runway capacity analysis shows the estimated number of minutes of departure delay per year for the baseline 'without airspace change' scenario in the table below. This has been monetised to provide a cost for the economic impact of the delay minutes:

	Number of minutes of departure delay per year		
Option	**2023**	**2027**	**2036**
Without airspace change	18114	46988	62320
Cost (in £ 2024 prices)	£1,222,186	£3,170,438	£4,204,947

Each option will be compared against these outcomes to understand any positive benefits to departure delay.

Fuel burn – General aviation / commercial airlines

As noted in paragraph 3.1.5 for noise, overflight and air quality we have defined the current-day scenario as 2022 as this was the latest available data at the time of undertaking the relevant modelling. However, for fuel burn and greenhouse gas (GHG) emissions, we are restricted to using 2023 as the current-day scenario due to an interface with the NERL ACP and the data generated by NERL. It is important to note that this does not affect the overall assessment of the options themselves as these are calculated based on comparison to a future baseline rather than current-day baseline.

Annual and per flight fuel burn is presented in Table 38 for the 'without airspace change' scenario.

Table 38: Without airspace change fuel burn

Scenario	Year	Annual fuel burn (t)	Annual fuel burn cost (£)	Fuel burn per flight (kg)
Without airspace change	2023	123,755	£84,894,789	1,809
	2027	163,927	£112,452,196	1,804
	2028	165,178	£113,310,454	1,806
	2029	166,429	£114,168,711	1,807
	2030	167,680	£115,026,969	1,809
	2031	168,931	£115,885,226	1,810
	2032	170,182	£116,743,484	1,811
	2033	171,434	£117,601,741	1,813
	2034	172,685	£118,459,999	1,814
	2035	173,936	£119,318,256	1,815
	2036	175,187	£120,176,514	1,816

Training costs – commercial airlines

As the baseline is already in operation, there are no training costs anticipated as there will be no change; later in this FOA we will estimate the difference between our options and this baseline.

Other costs – commercial airlines

As the baseline is already in operation, there are no other costs anticipated as there will be no change; later in this FOA we will estimate the difference between our options and this baseline.

Infrastructure costs – Airport / ANSP

As the baseline is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this FOA we will estimate the difference between our options and this baseline.
Operational costs – Airport / ANSP
There is a cost to Glasgow Airport to operate the noise insulation scheme. This cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices). Maintenance of the IFPs is budgeted to cost £70,000 every 5 years (based on 2024 prices).
Deployment costs – Airport / ANSP
As the baseline is already in operation, there are no deployment costs; later in this FOA we will estimate the difference between our options and this baseline.
Other costs – Airport / ANSP
As the baseline is already in operation, there are no other costs anticipated as there will be no change; later in this FOA we will estimate the difference between our options and this baseline.
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** the baseline would maintain safety at current traffic levels however future forecasts may require traffic capping to maintain safety. There would be no opportunities for improvement **Integration of diverse users -** The baseline would offer no improvements to the existing airspace arrangements at Glasgow Airport. There would be no opportunity to release CAS. **Simplification, reducing complexity and improving efficiency -** The baseline would not provide any opportunities to reduce complexity and improve efficiency. **Environmental sustainability -** The baseline would not enable any environmental benefits.

4.3 Option 1

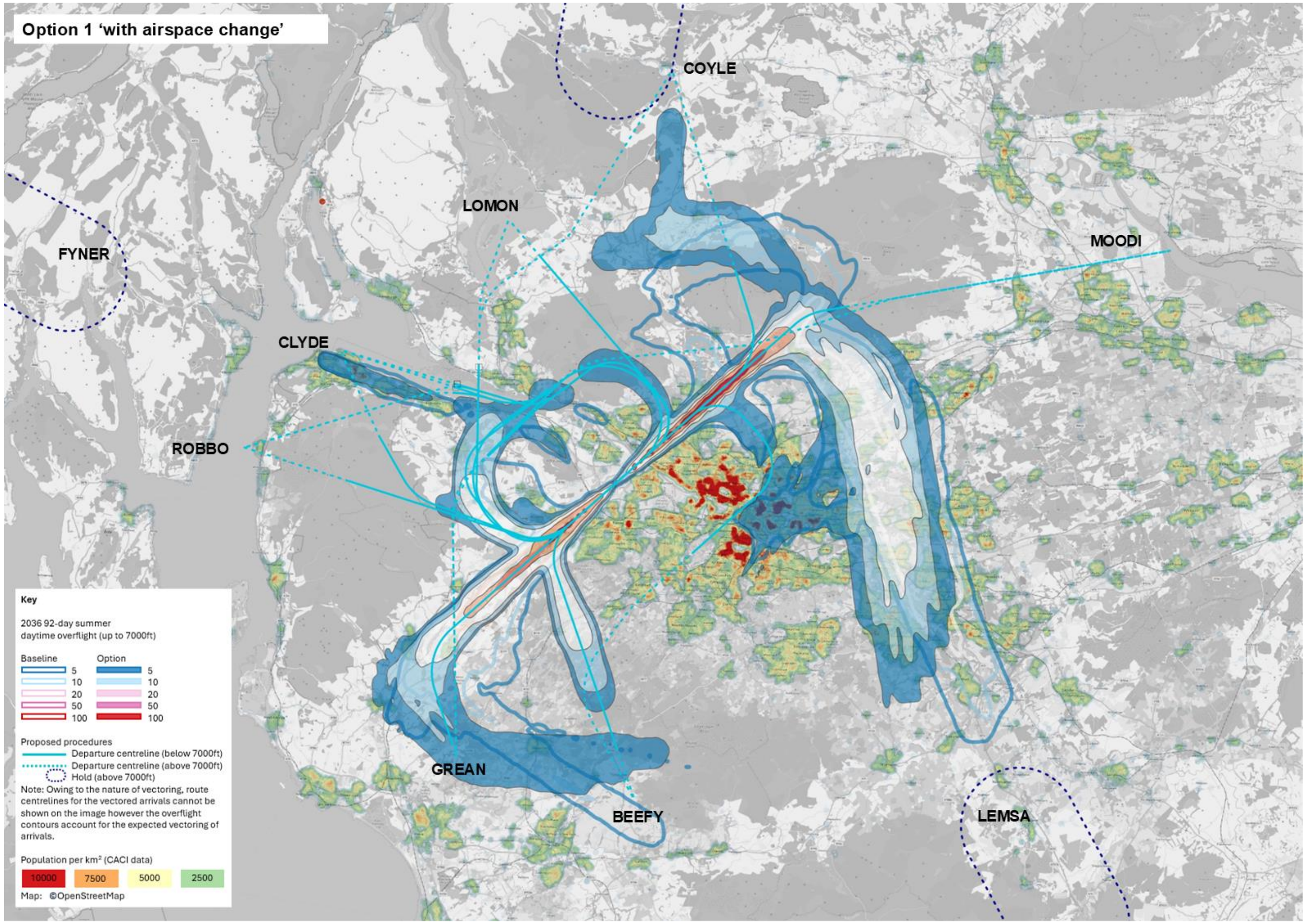


Figure 47 Option 1 'with airspace change' scenario. 2036 baseline and option overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 1	Vectors	Vectors	No offset SIDs	No offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an annual average day	Description
Runway 23 – Straight ahead (no offsets)			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that routes straight ahead until turning at c.9nm called the GREAN departure, and one that initially flies straight ahead and then turns at c.2nm called the BEEFY departure. The overflight (5) contour shows that this largely follows the areas where NORBO departures fly today. This includes overflight of the more densely populated areas of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID turns at c.2nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows that this largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies straight ahead over the same areas as final approach for c2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see

			increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	2%	The LOMON SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[49]	Description
Runway 05 – Straight ahead (no offsets)			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure.

[49] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

			The RNP GREAN SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.
ROBBO	ROBBO	1%	The RNP ROBBO SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies straight ahead for c. 3nm before turning and this overflies Whitecrook and Drumchapel. These areas will see increased overflight compared to today. Beyond this

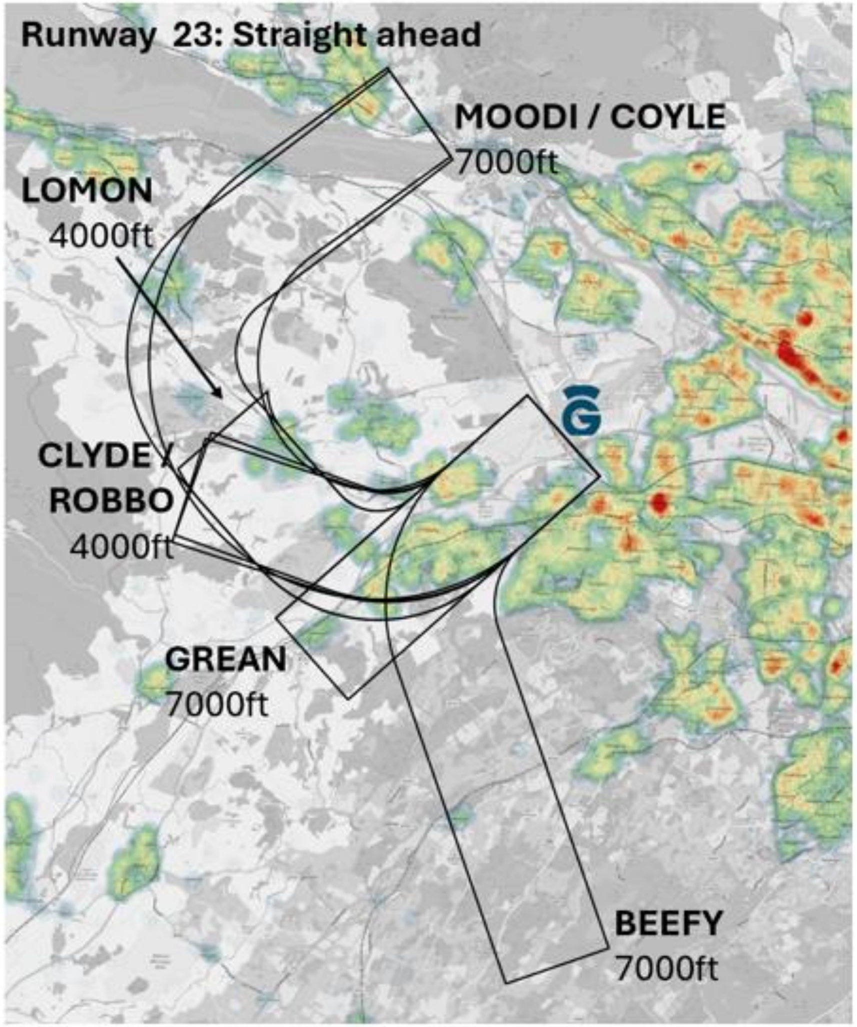
			point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies straight ahead before turning at c.7nm. The overflight (5) contour shown in figure -- above shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. Once aircraft have turned, the route overflies areas of low population density.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies straight ahead before turning at c.10nm. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. At higher altitudes, the route overflies the western parts of Lennoxtown.

Aviation Industry Technical Information

4.3.1 Draft procedure information can be found in Appendix A.

Noise abatement procedures:

4.3.2 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:



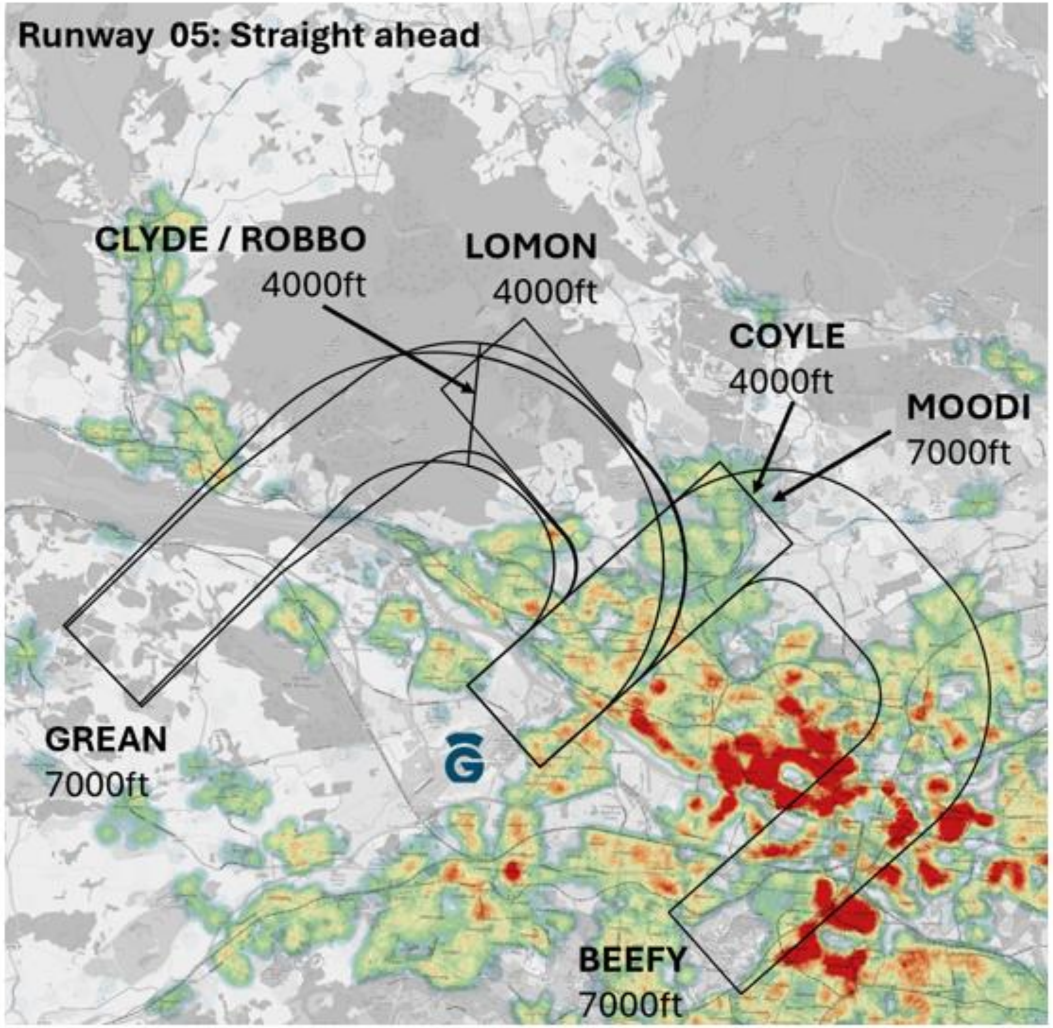


Figure 48 Option 1 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes a vectoring only arrival component which is considered as safe as the 'without airspace change' baseline as vectoring already routinely occurs today. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures offers reduced ATC and pilot workload. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. The continued use of vectoring for arrivals is expected to result in similar workload as today for ATC and pilots. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 1 are shown in Figures TA25 to TA28 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £10,957,107 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 39.

Table 39 Option 1 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 1	£10,957,107	£6,893,216	£2,893,411	£5,026	£464,561	£700,893	4,707	16,422	12,455	32,592

L_{Aeq} noise tables

The following tables show L_{Aeq} noise contour data for Option 1 scenario in 2027 (year of implementation) and 2036 (10 years following implementation). For each contour band, the area of the contour is presented along with the total population, total households and number of potentially noise sensitive buildings within each band.

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 1	$L_{Aeq,16h}$	51	41.1	64200	30300	33	0	14	30
			54	22.0	27800	13200	10	0	6	16
			57	11.7	7900	3700	2	0	0	3
			60	5.9	1600	800	0	0	0	2
			63	3.1	<100	<100	0	0	0	0

			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 1	$L_{Aeq,16h}$	51	43.9	70700	33400	38	0	15	31
			54	23.5	31700	15000	12	0	7	17
			57	12.6	9700	4500	3	0	0	4
			60	6.3	1800	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 1	$L_{Aeq,8h}$	45	66.2	92800	43800	45	0	21	47
			48	34.2	53100	25200	24	0	12	23
			51	18.3	19600	9600	6	0	5	10
			54	9.3	2800	1400	0	0	0	2

			55	7.4	1400	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0
			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 1	$L_{Aeq,8h}$	45	70.3	96600	45600	46	0	21	51
			48	36.6	56800	26800	29	0	12	24
			51	19.5	22300	10900	6	0	5	12
			54	10.0	3300	1600	0	0	0	2
			55	7.9	1700	900	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL
Table 40 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 1:

- in 2027, during the daytime there is a <u>reduction</u> in the total number of people exposed between the LOAEL and SOAEL and <u>no change</u> to the total number of people exposed above the SOAEL; and

- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL.

Table 40 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 1

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	64,000	-4,200
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	91,000	+200
Above SOAEL	1,500	1,500	0

2027 Assessment of significant noise effects, residential receptors

Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 41 summarises how noise increases are experienced across the population and Table 42 summarises how noise decreases are experienced across the population.

These tables show that for Option 1:

- in 2027, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2027, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 43 and the postcode receptors representing these locations are presented in Figure 49.

Table 41 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 1 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	20,900	31,300
Minor adverse	2.0 - 2.9dB	0	<100
Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	300
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 42 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 1 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	46,900	59,500
Minor beneficial	2.0 - 2.9dB	1,100	2,400
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 43 2027 community areas experiencing likely significant effects, Option 1

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

To the south-west of the airport	Isolated properties to the south of Howwood, broadly between Barcraigs Reservoir and Broadhead Hill	Night-time beneficial likely significant effect

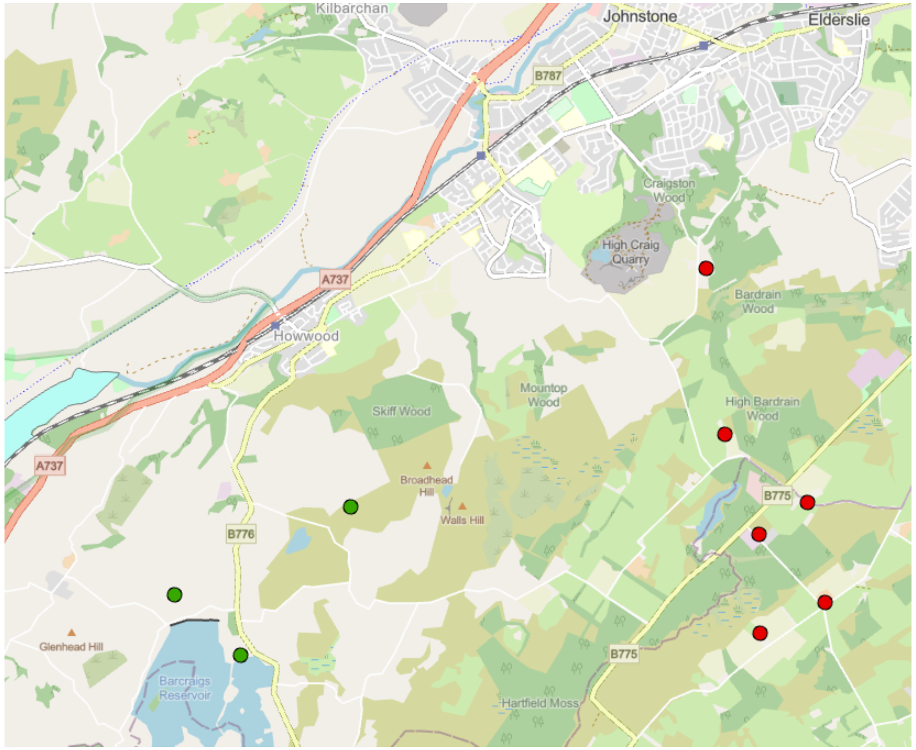


Figure 49 2027 Option 1, postcode receptors experiencing nigh-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green). Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 1.

2036 Noise exposure above LOAEL and SOAEL

Table 44 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 1:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is a reduction in the total number of people exposed between the LOAEL and SOAEL and a reduction to the total number of people exposed above the SOAEL.

Table 44 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 1

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	70,400	-1,800
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	94,500	-200
Above SOAEL	1,900	1,800	-100

2036 Assessment of significant noise effects, residential receptors
Table 45 summarises how noise increases are experienced across the population and Table 46 summarises how noise decreases are experienced across the population.

These tables show that for Option 1:
- in 2036, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 47 and the postcode receptors representing these locations are presented in Figure 50.

Table 45 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 1 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	22,600	32,700
Minor adverse	2.0 - 2.9dB	<100	100
Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	500
Minor adverse	1.0 - 1.9dB	0	0

Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 46 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 1 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	49,200	62,400
Minor beneficial	2.0 - 2.9dB	1,400	2,300
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,200
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 47 2036 community areas experiencing likely significant effects, Option 1

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
To the south-west of the airport	isolated properties to the south of Howwood, broadly between Lochlands Hill and Broadhead Hill	Night-time beneficial likely significant effect

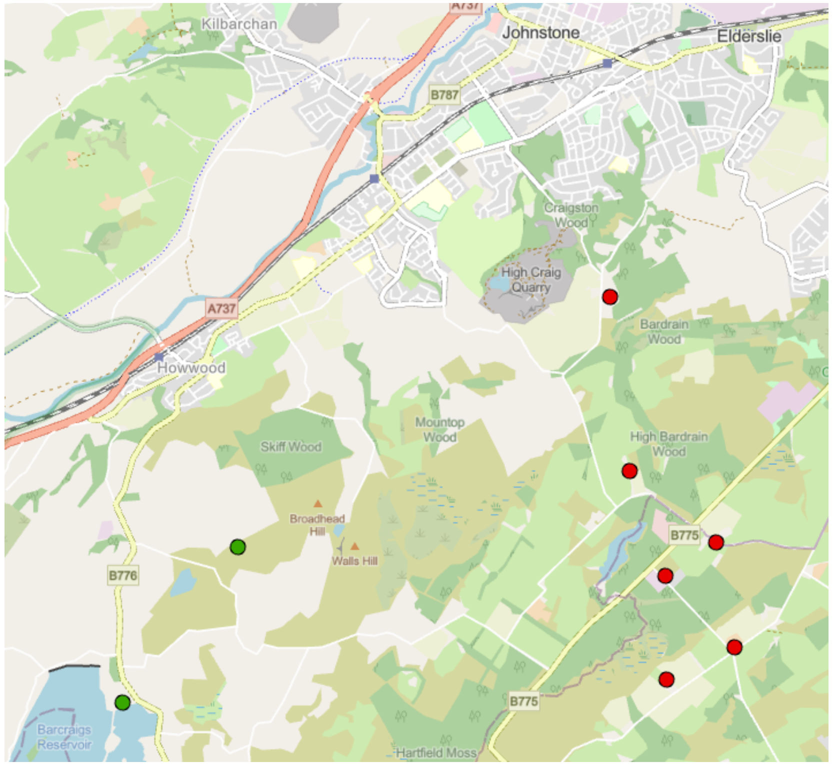


Figure 50 2036 Option 1, postcode receptors experiencing nigh-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 1.

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 48 and Table 49 respectively.

Table 48 2027 population newly overflown and no longer overflown (five times or more), Option 1

	Daytime	Night-time
Number of people newly overflown >=5	163,300	1,500
Number of people no longer overflown >=5	107,200	9,800

Table 49 2036 population newly overflown and no longer overflown (five times or more), Option 1

	Daytime	Night-time
Number of people newly overflown >=5	163,500	1,500
Number of people no longer overflown >=5	99,700	13,100

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_1*	N65	5	41.5	-700	-200	0	0	4	5
			10	7.3	1500	700	2	0	-1	2
			20	-4.9	500	300	1	0	0	0
			50	-4.4	-3500	-1700	-3	0	0	-2
			100	-0.3	-1500	-600	0	0	0	0

			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_1*	N65	5	43.6	700	500	-1	0	5	4
			10	8.8	2300	1000	2	0	-3	2
			20	-6.1	400	300	0	0	0	-1
			50	-5.2	-3400	-1500	-4	0	-1	-2
			100	-0.4	-1200	-500	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_1*	N60	5	-16.8	-3700	-1800	-1	0	-2	-4
			10	-16.8	-2600	-1200	-2	0	1	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_1*	N60	5	-16.9	-3300	-1500	-2	0	-2	-5
			10	-17.8	-1100	-400	0	0	0	-2
			20	0.2	100	<100	0	0	0	0

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship

2027	*DS_Option_1*	Overflights_Day	5	122.0	55500	24800	32	5	21	23
			10	50.1	-2500	-2200	-7	0	11	0
			20	-0.6	-52000	-24400	-22	-1	-6	-33
			50	-8.4	-1400	-500	-1	0	1	0
			100	0.9	-700	-300	0	0	0	1
2036	*DS_Option_1*	Overflights_Day	5	123.7	67000	30500	27	3	23	41
			10	45.1	8200	3100	-6	0	11	5
			20	10.1	-41900	-20100	-21	-1	-3	-26
			50	-8.6	-1200	-400	0	0	2	0
			100	0.1	-500	-200	-2	0	-1	-2

Metric – Overflights (night time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_1*	Overflights_Night	5	4.2	-7200	-3200	-1	0	-2	-9
			10	-17.3	-9100	-4100	-6	0	0	-3
2036	*DS_Option_1*	Overflights_Night	5	4.2	-9200	-4000	-4	0	-3	-16
			10	-17.2	-8700	-3900	-5	0	0	-3

Air Quality – Communities

As set out in the Full Options Appraisal methodology, this option is unlikely to have a significant impact on local air quality and the impact is considered negligible, and not assessed any further.

Greenhouse gas emissions – Wider society

TAG outcomes

TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 110,558t, of which 89,146t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £24,597,919 for Option 1.

Greenhouse gas emissions

Table 50 shows the annual total and per flight greenhouse gas emissions of Option 1 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 1[50].

Table 50 greenhouse gas emissions, Option 1

Year	Without Airspace Change		With Airspace Change		Difference	
	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	511,456	5,629	-9,832	-108
2028	525,266	5,742	515,163	5,632	-10,104	-110
2029	529,245	5,747	518,869	5,635	-10,375	-113
2030	533,223	5,752	522,576	5,637	-10,647	-115

[50] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

2031	537,202	5,756	526,283	5,639	-10,919	-117
2032	541,180	5,760	529,990	5,641	-11,191	-119
2033	545,159	5,764	533,696	5,643	-11,463	-121
2034	549,137	5,768	537,403	5,644	-11,734	-123
2035	553,116	5,771	541,110	5,646	-12,006	-125
2036	557,095	5,774	544,808	5,646	-12,287	-127

Tranquillity – Wider society

There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "*...noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA.

This option results in an area of 6.0km^2 (0.32% of the total area) and 6.8km^2 (0.36% of the total area) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively.

The option also results in an area of 0.04km^2 (0.01% of the total area) and 0.05km^2 (0.02% of the total area) of the Loch Lomond NSA to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively.

Figure 51 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park and NSA are currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park and NSA are already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA.

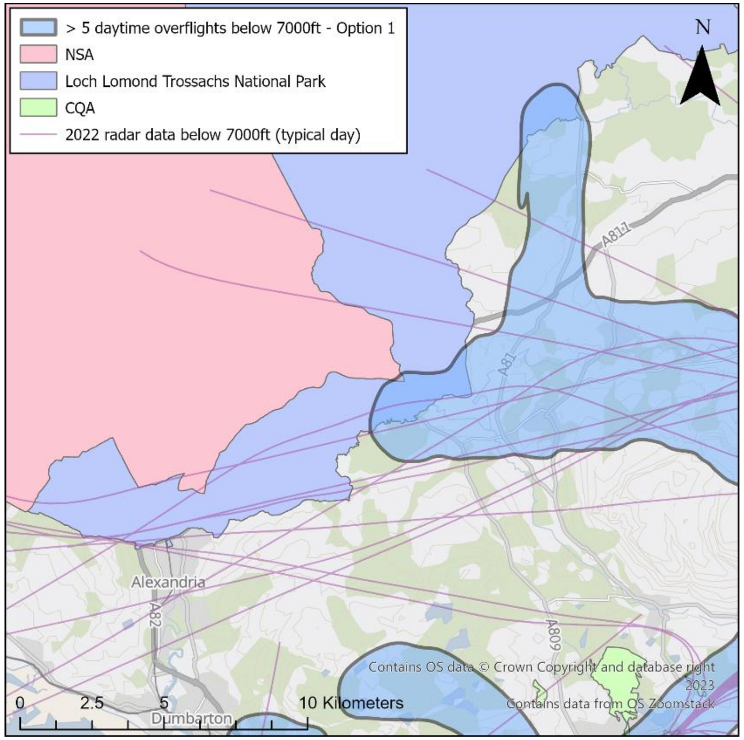


Figure 51 Areas of the Loch Lomond & The Trossachs National Park and Loch Lomond NSA intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 51 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 'with airspace change' scenarios.

Table 51 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	5	4	26	26
2036	5	5	28	27

Table 52 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 52 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	6	Springburn Park Bothwell Castle Grounds Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	6	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Craigends Highmainshead Wood
2036	6	Springburn Park Bothwell Castle Grounds Possil Marsh Cardowan Moss	5	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood

		High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn		Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 1.

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_1*	$L_{Aeq,16h}$	51	0	0	0	0	1	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_1*	$L_{Aeq,16h}$	51	0	0	0	0	0	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0

			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_1*	Overflights_Day	5	1	<0.1	1	6.0	0	-2.0	0	-2.5	0	-0.3
			10	0	0.0	0	0.0	-5	-1.0	-1	-1.3	-1	-2.9
			20	0	0.0	0	0.0	-2	<0.1	0	-3.5	-1	-0.1
			50	0	0.0	0	0.0	0	-0.4	0	0.0	0	<0.1
			100	0	0.0	0	0.0	0	<-0.1	0	0.0	0	0.0
2036	*DS_Option_1*	Overflights_Day	5	1	0.1	1	6.8	1	-2.0	0	-2.5	-1	-0.6
			10	0	0.0	0	0.0	-4	-2.5	0	-2.5	-1	-3.5
			20	0	0.0	0	0.0	-2	<0.1	0	-3.9	0	-0.4
			50	0	0.0	0	0.0	0	-0.4	0	0.0	0	<-0.1
			100	0	0.0	0	0.0	0	<0.1	0	0.0	0	0.0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_1	Overflights_Day	5	0	2.0	1	-0.2	0	2.0
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_1	Overflights_Day	5	0	3.1	1	-0.2	0	3.1
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_1	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_1	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Changes to noise distribution as a result of other airspace users
The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Capacity / resilience / Wider society

Capacity – Ground delay
This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 53:

Table 53 Option 1 - Departure delay per year

	Number of Mins of Departure delay per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 1	13801	35772	52337
Reduction	-4313	-11217	-9983

Resilience
The introduction of PBN SIDs also removes Glasgow's dependency on some conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see the NERL FOA.

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less departure delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of minutes of departure delay per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 1	13801	35772	52337
Reduction	-4313	-11217	-9983
£ (in 2024 prices)	**-£249,660**	**-£649,307**	**-£577,921**

Fuel burn – General aviation / commercial airlines

Table 54 shows the annual total and per flight fuel burn of Option 1 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 1.

Table 54 2027 fuel burn, Option 1

Year	Without Airspace Change			With Airspace Change			Difference		
	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per fligh t (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	160,835	£110,331,301	1,770	-3,092	-£2,120,896	-34
2028	165,178	£113,310,454	1,806	162,000	£111,130,705	1,771	-3,178	-£2,179,749	-35
2029	166,429	£114,168,711	1,807	163,166	£111,930,110	1,772	-3,263	-£2,238,601	-35
2030	167,680	£115,026,969	1,809	164,331	£112,729,515	1,773	-3,349	-£2,297,454	-36
2031	168,931	£115,885,226	1,810	165,496	£113,528,919	1,773	-3,435	-£2,356,307	-37
2032	170,182	£116,743,484	1,811	166,662	£114,328,324	1,774	-3,521	-£2,415,160	-37
2033	171,434	£117,601,741	1,813	167,827	£115,127,729	1,775	-3,606	-£2,474,013	-38
2034	172,685	£118,459,999	1,814	168,992	£115,927,133	1,775	-3,692	-£2,532,865	-39
2035	173,936	£119,318,256	1,815	170,158	£116,726,538	1,775	-3,778	-£2,591,718	-39

2036	175,187	£120,176,514	1,816	171,323	£117,525,943	1,776	-3,864	-£2,650,571	-40

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP

This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system.
The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.

Operational costs – Airport / ANSP

There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £74,000 every 5 years (based on 2024 prices). This is an increase of £4000 every 5 years compared to the baseline.

Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 1-4 (without PBN transitions) are expected to require less training than those with PBN transitions however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline. **Integration of diverse users -** The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft. **Simplification, reducing complexity and improving efficiency -** The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays. **Environmental sustainability -** The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.4 Option 2

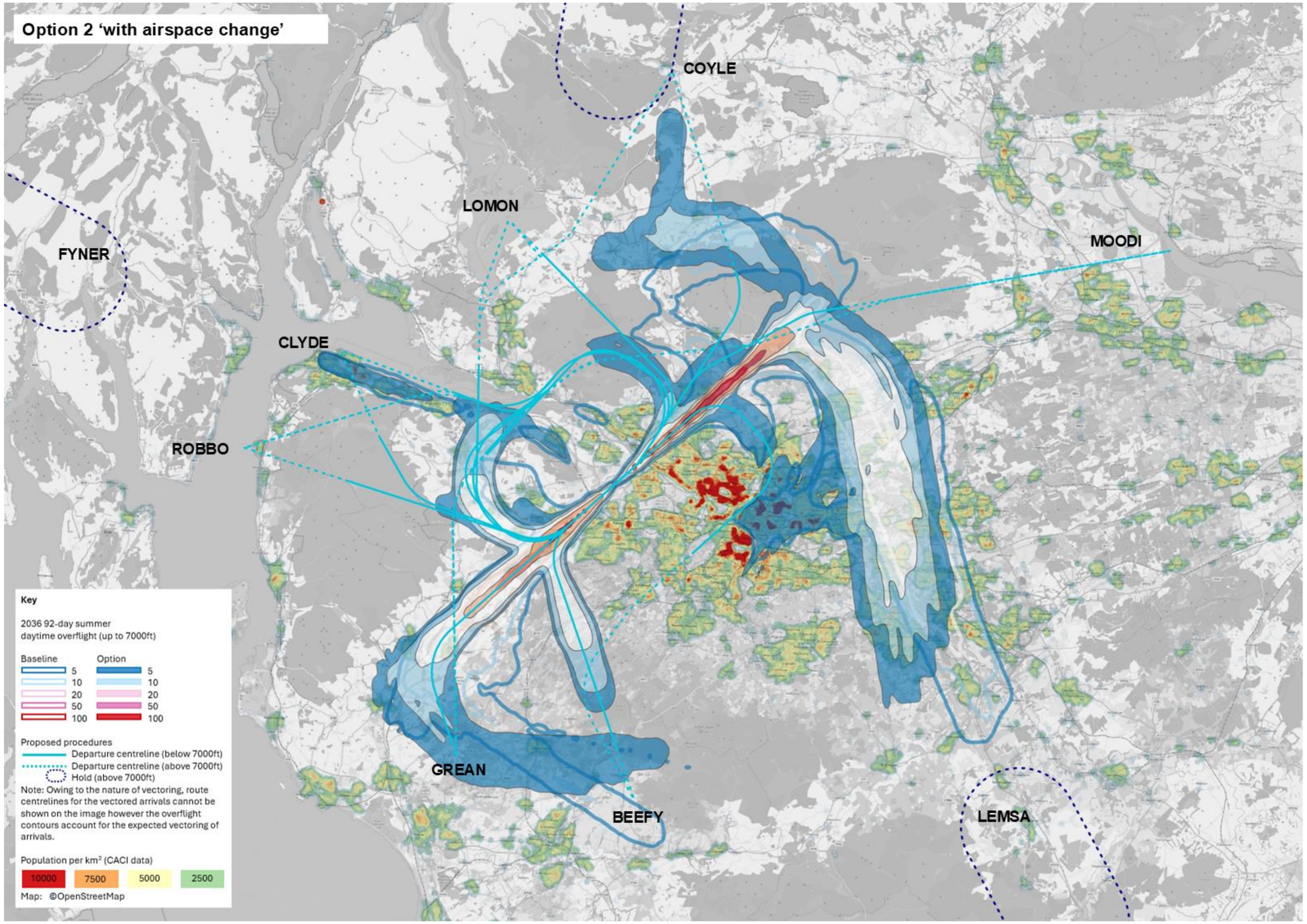


Figure 52 Option 2 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 2	Vectors	Vectors	Offset SIDs	No offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day [51]	Description
Runway 05 – Offsets			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the

[51] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

			route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.
ROBBO	ROBBO	1%	The RNP ROBBO SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies an offset departure before turning at c.8nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies an offset departure before turning at c.4nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[52]	Description
Runway 23 – Straight ahead (no offsets)			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that routes straight ahead until turning at c.9nm called the GREAN departure, and one that initially flies straight ahead and then turns at c.2nm called the BEEFY departure. The overflight (5) contour shown in figure – shows that this largely follows the areas where NORBO departures fly today. This includes overflight of the more densely populated areas of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID turns at c.2nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shown in figure -- above shows that this largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies straight ahead over the same areas as final approach for c2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see

[52] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

			increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	2%	The LOMON SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank . These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.

Aviation Industry Technical Information

4.4.1 Draft procedure information can be found in Appendix A.

Noise Abatement Procedures:

4.4.2 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:

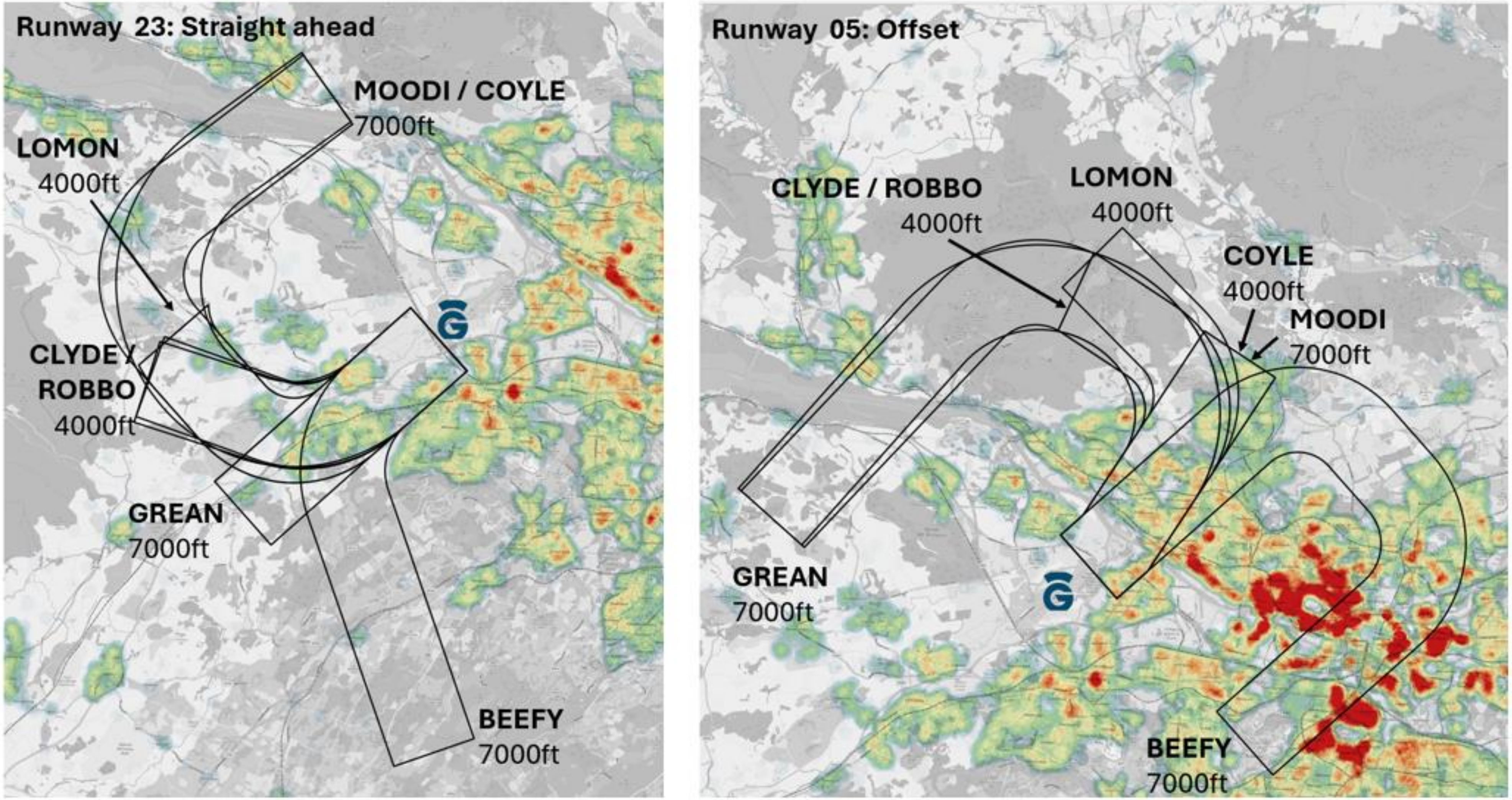


Figure 53 Option 2 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data).

Full Options Appraisal
Safety – All
This option includes a vectoring only arrival component which is considered as safe as the 'without airspace change' baseline as vectoring already routinely occurs today. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures offers reduced ATC and pilot workload. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. The continued use of vectoring for arrivals is expected to result in similar workload as today for ATC and pilots. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 2 are shown in Figures TA29 to TA32 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £11,321,318 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 55. *Table 55 Option 2 TAG noise assessment results*

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 2	£11,321,318	£6,988,712	£3,103,092	£10,271	£486,146	£733,097	10,119	22,727	17,290	38,328

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 2	$L_{Aeq,16h}$	51	40.8	66500	31400	33	0	13	29
			54	21.7	27100	12900	10	0	6	15
			57	11.6	7700	3600	2	0	0	4
			60	5.8	1400	700	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 2	$L_{Aeq,16h}$	51	43.6	70900	33500	36	0	14	32
			54	23.2	30900	14700	12	0	7	18
			57	12.5	9300	4400	3	0	0	5
			60	6.3	1700	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 2	$L_{Aeq,8h}$	45	66.5	93200	43800	45	0	20	46
			48	34.1	52800	25200	28	0	12	23
			51	18.2	19100	9400	6	0	5	11
			54	9.2	2600	1300	0	0	0	2
			55	7.4	1300	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1

			60	2.8	<100	<100	0	0	0	0
			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 2	$L_{Aeq,8h}$	45	70.6	96300	45400	47	0	20	51
			48	36.5	59400	28200	31	0	12	24
			51	19.4	21900	10800	6	0	5	13
			54	9.9	3300	1600	0	0	0	2
			55	7.9	1600	800	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL

Table 56 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 2:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a decrease in the total number of people exposed above the SOAEL.

Table 56 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 2

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	66,300	-1,900
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	91600	+800
Above SOAEL	1,500	1,400	-100

2027 Assessment of significant noise effects, residential receptors

Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 57 summarises how noise increases are experienced across the population and Table 58 summarises how noise decreases are experienced across the population.

These tables show that for Option 2:

- in 2027, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are no likely significant beneficial effects due to noise decreases; and

- in 2027, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 59 and the postcode receptors representing these locations are presented in Figure 54.

Table 57 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 2 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	22,900	31,300
Minor adverse	2.0 - 2.9dB	0	1,700
Moderate adverse	3.0 - 5.9dB	0	**200**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 58 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 2 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	46,500	59,300
Minor beneficial	2.0 - 2.9dB	1,100	2,400
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,500
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 59 2027 community areas experiencing likely significant effects, Option 2

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time <u>adverse</u> likely significant effect

	Isolated properties to the south of Howwood, broadly between Barcraigs Reservoir and Broadhead Hill	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

Figure 54 2027 Option 2, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 2.

2036 Noise exposure above LOAEL and SOAEL

Table 60 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 2:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is a reduction in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 60 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 2

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	70,500	-1,700
Above SOAEL	<100	<100	0
Night-time			

Above LOAEL and below SOAEL	94,700	94,200	-500
Above SOAEL	1,900	1,700	-200

2036 Assessment of significant noise effects, residential receptors
Table 61 summarises how noise increases are experienced across the population and Table 62 summarises how noise decreases are experienced across the population.

These tables show that for Option 2:

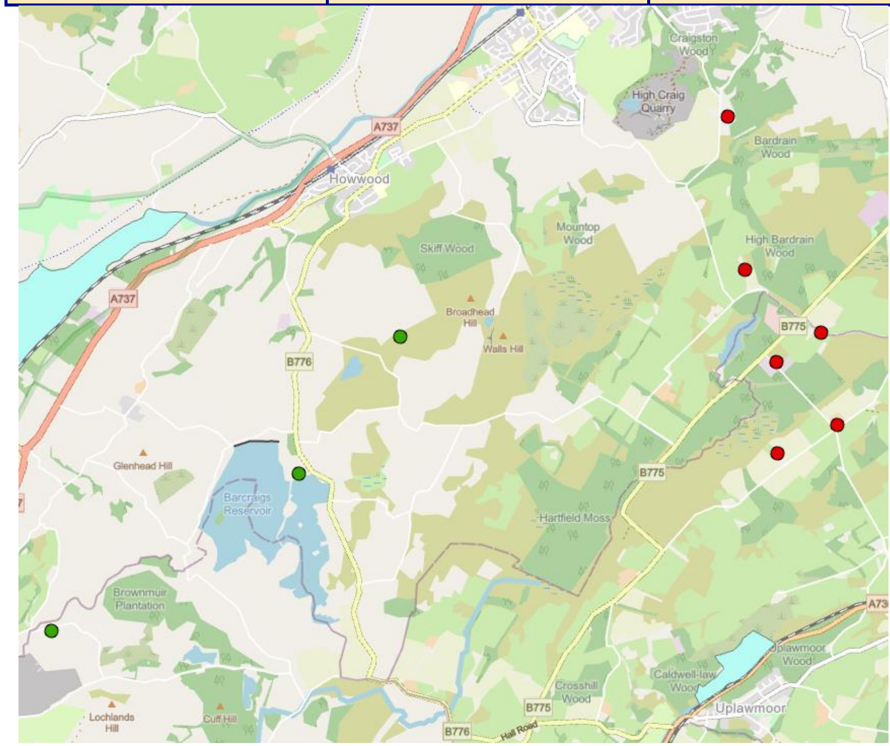
- in 2036, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 63 and the postcode receptors representing these locations are presented in Figure 55.

Table 61 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 2 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	24,600	33,200
Minor adverse	2.0 - 2.9dB	<100	1,700

Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
‘with airspace change’ noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0



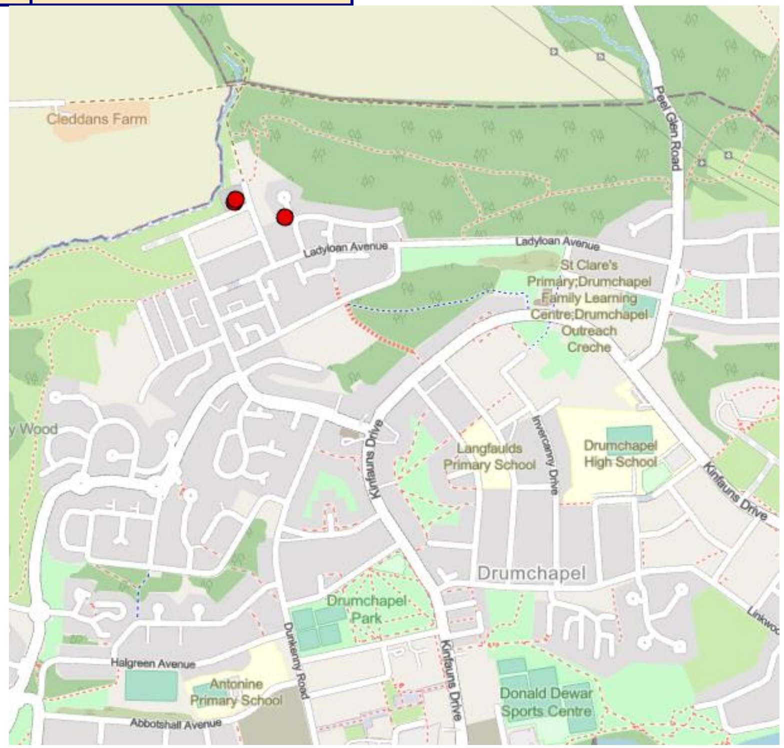


Figure 55 2036 Option 2, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

Table 62 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 2 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	48,900	61,400
Minor beneficial	2.0 - 2.9dB	1,400	2,300
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,900
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 63 2036 community areas experiencing likely significant effects, Option 2

Location	Community area	Effect

To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
	isolated properties to the south of Howwood, broadly between Lochlands Hill and Broadhead Hill	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 2.

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 64 and Table 65 respectively.

Table 64 2027 population newly overflown and no longer overflown (five times or more), Option 2

	Daytime	Night-time
Number of people newly overflown >=5	165,000	1,500
Number of people no longer overflown >=5	106,100	14,000

Table 65 2036 population newly overflown and no longer overflown (five times or more), Option 2

	Daytime	Night-time
Number of people newly overflown >=5	165,900	1,500
Number of people no longer overflown >=5	98,800	17,000

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_2*	N65	5	45.1	700	200	3	0	4	8
			10	8.2	3300	1400	2	0	0	3
			20	-5.3	-<100	100	1	0	0	1
			50	-4.6	-4400	-2000	-3	0	0	-3
			100	-0.6	-2200	-900	0	0	0	0
			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_2*	N65	5	47.1	2400	1100	3	0	5	7
			10	10.0	2700	1000	2	0	-2	3
			20	-6.4	-400	-100	0	0	0	0
			50	-5.4	-3900	-1800	-3	0	-1	-2
			100	-1.1	-3100	-1400	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_2*	N60	5	-17.2	-4100	-2000	-1	0	-2	-4
			10	-18.3	-2700	-1300	-2	0	1	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_2*	N60	5	-17.2	-3800	-1700	-2	0	-2	-5
			10	-18.4	-1500	-600	-1	0	0	-1
			20	0.2	100	<100	0	0	0	0

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_2*	Overflights_Day	5	126.4	63000	27900	32	5	19	25
			10	50.9	1200	-600	-5	0	11	1
			20	-1.3	-53300	-24900	-19	-1	-7	-32
			50	-9.0	-2500	-1100	-1	0	1	-1
			100	-0.8	-2000	-800	-1	0	0	1
2036	*DS_Option_2*	Overflights_Day	5	126.9	73700	33300	27	3	21	43

			10	46.0	14500	5800	-4	0	12	7
			20	9.4	-42400	-20200	-17	-1	-5	-23
			50	-9.2	-2500	-1100	0	0	2	-1
			100	-0.8	-2200	-900	-2	0	-1	-2

Metric – Overflights (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_2*	Overflights_Night	5	3.4	-9000	-3900	-2	0	-3	-9
			10	-18.9	-11300	-5000	-6	0	0	-3
2036	*DS_Option_2*	Overflights_Night	5	3.4	-10500	-4600	-5	0	-3	-13
			10	-18.9	-10300	-4600	-5	0	0	-3

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Air Quality – Communities
Pollutant concentrations for annual mean NOx, NO_2, PM_{10} and $PM_{2.5}$ predicted negligible impact at all assessed receptor locations. The maximum change predicted for each pollutant at any receptor in each assessment year was <0.01 µg/m^3. The maximum concentration predicted for each pollutant at any relevant receptor, provided below, which is the same result for 2027 and 2036[53]: • A maximum annual mean NOx of 23.6 µg/m^3 was predicted at the Black Cart SPA; • A maximum annual mean NO_2 of 15.6 µg/m^3 was predicted at PA4 9LP, on Walkinshaw Road at the northwestern boundary of the airport; • A maximum annual mean PM_{10} of 10.9 µg/m^3 was predicted at PA3 2TQ, on St Andrew' Crescent, around 150m south of the airport boundary; and • A maximum annual mean $PM_{2.5}$ of 6.3 µg/m^3 was predicted at PA3 3AD, on Blackstone Road, around 300m from the southwestern boundary of the airport. The full results from the dispersion modelling are provided in Appendix B. The results show there were no exceedances of NOx, NO_2, PM_{10} and $PM_{2.5}$ relevant annual mean and short term standards predicted at any of the assessed receptors, in any assessment year. Therefore, the effects of NOx, NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors, as a result of option 2, are predicted to be not significant, in any assessment year.
Greenhouse gas emissions – Wider society
TAG outcomes TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 108,339 t, of which 87,829 t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £24,056,994 for Option 2. **Greenhouse gas emissions** Table 66 shows the annual total and per flight greenhouse gas emissions of Option 2 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 2[54].

[53] This is as a result of the negligible change as a result of the aircraft emissions changes and assuming to improvement in background concentrations for the 2022 baseline.
[54] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

Table 66 greenhouse gas emissions, Option 2

Year	Without Airspace Change		With Airspace Change		Difference	
	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	511,674	5,631	-9,613	-106
2028	525,266	5,742	515,382	5,634	-9,884	-108
2029	529,245	5,747	519,089	5,637	-10,156	-110
2030	533,223	5,752	522,796	5,640	-10,427	-112
2031	537,202	5,756	526,503	5,642	-10,698	-115
2032	541,180	5,760	530,211	5,644	-10,970	-117
2033	545,159	5,764	533,918	5,645	-11,241	-119
2034	549,137	5,768	537,625	5,647	-11,512	-121
2035	553,116	5,771	541,332	5,648	-11,784	-123
2036	557,095	5,774	545,040	5,649	-12,055	-125

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an

increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.
Tranquillity – Wider society
There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA. This option results in an area of 6.0km² (0.32% of the total area) and 6.8km² (0.36% of the total area) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. The option also results in an area of 0.04km² (0.01% of the total area) and 0.05km² (0.02% of the total area) of the Loch Lomond NSA to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. Figure 56 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park and NSA are currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park and NSA are already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA

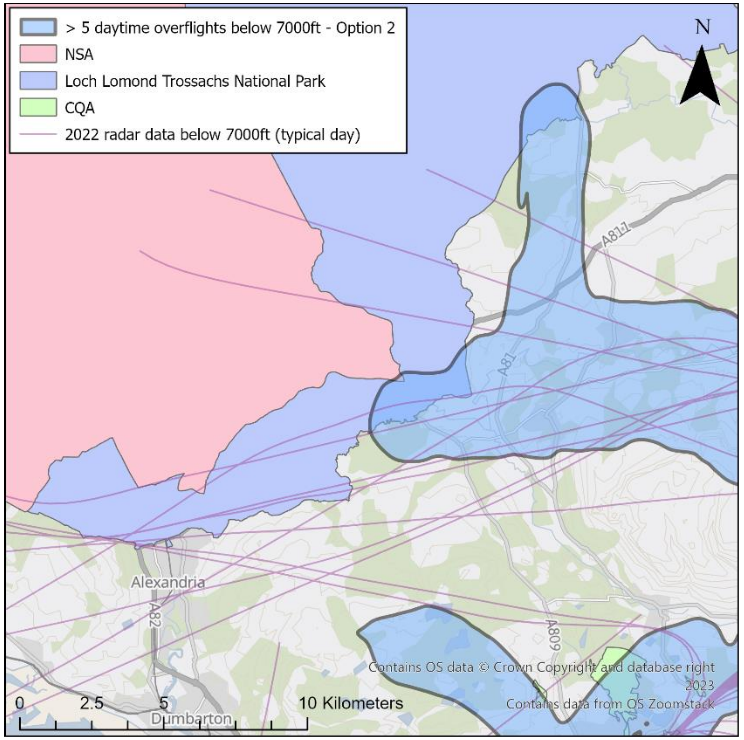


Figure 56 Areas of the Loch Lomond & The Trossachs National Park and Loch Lomond NSA intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 67 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 67 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	4	4	27	26
2036	5	5	29	27

Table 68 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 68 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	7	Springburn Park Bothwell Castle Grounds Carneddans Wood Mains Plantation Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	6	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Craigends Highmainshead Wood

2036	7	King's Park Springburn Park Bothwell Castle Grounds Carneddans Wood Mains Plantation Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	5	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 2.

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_2*	$L_{Aeq,16h}$	51	0	0	0	0	0	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0

			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_2*	$L_{Aeq,16h}$	51	0	0	0	0	0	-0.4	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_2*	Overflights_Day	5	1	<0.1	1	6.0	1	0.4	1	-0.9	-1	0.1
			10	0	0	0	0	-4	-0.9	-1	-1.3	-1	-3.0
			20	0	0	0	0	-2	<0.1	0	-3.5	-1	-0.2
			50	0	0	0	0	0	-0.5	0	0	0	<-0.1
			100	0	0	0	0	-1	-0.1	0	0	0	0
2036	*DS_Option_2*	Overflights_Day	5	1	0.1	1	6.8	2	0.5	1	-0.8	-2	-0.3
			10	0	0	0	0	-3	-2.3	0	-2.5	-1	-3.6
			20	0	0	0	0	-2	0.1	0	-3.9	0	-0.5
			50	0	0	0	0	0	-0.4	0	0	0	<-0.1

			100	0	0	0	0	0	<-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_2	Overflights_Day	5	0	0.5	1	-0.2	0	0.5
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_2	Overflights_Day	5	0	0.7	1	-0.2	0	0.7
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA	SAC	RAMSAR

				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_2	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_2	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 69:

Table 69 Option 2 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 2	14376	37287	53547
Reduction	-3738	-9701	-8773

Resilience

The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

Access – General Aviation
For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.
Economic impact from increased effective capacity – General aviation / commercial airlines
The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see the NERL FOA). The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 2	14376	37287	53547
Reduction	-3738	-9701	-8773
£ (in 2024 prices)	**-£216,372**	**-£561,563**	**-£507,870**

Fuel burn – General aviation / commercial airlines
Table 70 shows the annual total and per flight fuel burn of Option 2 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 2.

Table 70 fuel burn, Option 2

Year	Without Airspace Change	With Airspace Change	Difference

	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	160,904	£110,378,472	1,771	-3,023	-£2,073,724	-33
2028	165,178	£113,310,454	1,806	162,070	£111,178,202	1,772	-3,108	-£2,132,252	-34
2029	166,429	£114,168,711	1,807	163,236	£111,977,931	1,773	-3,194	-£2,190,780	-35
2030	167,680	£115,026,969	1,809	164,401	£112,777,661	1,773	-3,279	-£2,249,308	-35
2031	168,931	£115,885,226	1,810	165,567	£113,577,390	1,774	-3,364	-£2,307,836	-36
2032	170,182	£116,743,484	1,811	166,733	£114,377,120	1,775	-3,450	-£2,366,364	-37
2033	171,434	£117,601,741	1,813	167,899	£115,176,849	1,775	-3,535	-£2,424,892	-37
2034	172,685	£118,459,999	1,814	169,065	£115,976,579	1,776	-3,620	-£2,483,420	-38
2035	173,936	£119,318,256	1,815	170,230	£116,776,309	1,776	-3,706	-£2,541,947	-39
2036	175,187	£120,176,514	1,816	171,396	£117,576,038	1,776	-3,791	-£2,600,475	-39

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP
This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system. The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.
Operational costs – Airport / ANSP
There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £74,000 every 5 years (based on 2024 prices). This is an increase of £4000 every 5 years compared to the baseline. Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 1-4 (without PBN transitions) are expected to require less training than those with PBN transitions however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline.

Integration of diverse users - The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft. **Simplification, reducing complexity and improving efficiency -** The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays. **Environmental sustainability -** The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.5 Option 3

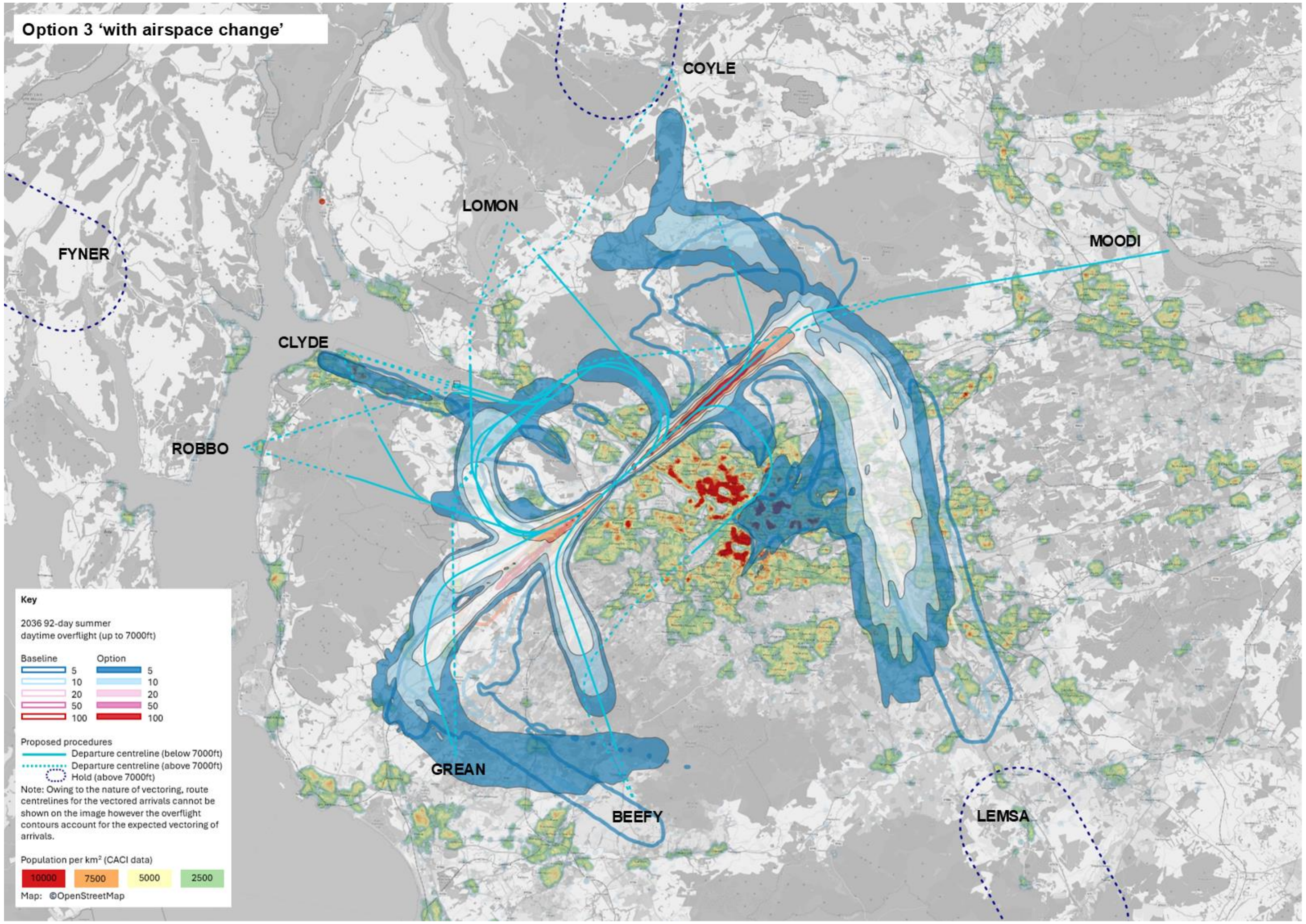


Figure 57 Option 3 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 3	Vectors	Vectors	No offset SIDs	Offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[55]	Description
Runway 05 – Straight ahead (no offsets)			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the

[55] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

			route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.
ROBBO	ROBBO	1%	The RNP ROBBO SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies straight ahead for c. 3nm before turning and this overflies Whitecrook and Drumchapel. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies straight ahead before turning at c.7nm. The overflight (5) contour shown in figure -- above shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. Once aircraft have turned, the route overflies areas of low population density.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies straight ahead before turning at c.10nm. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. At higher altitudes, the route overflies the western parts of Lennoxtown.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[56]	Description
Runway 23 – Offset departures			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that initially flies and offset departure and then turns at c.7nm called the GREAN departure, and the BEEFY departure described below. The overflight (5) contour shows that the GREAN departure initially overflies Linwood and Johnstone, before overflying Howwodd, Lochwinnoch and, at higher altitudes, Kilbirnie and Beith.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID would fly an offset departure before turning at c.2nm. This offset and turn to the south introduces overflight over some new areas including Edlerslie. The overflight (5) contour shown in figure -- above shows that beyond Edlerslie, overflight largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[56] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, and Kilmacolm. At higher altitudes, it overflies the eastern parts of Dumbarton and Milton. All these areas are overflown today however they would see increased overflight as a result of this option. Note two MOODI SIDs are proposed; One designed to RNP1 and one to RNAV1 specification. Although the lateral paths of these two SIDs vary slightly around the first and second turns, they do not materially alter the description above.

Aviation Industry Technical Information

4.5.1 Draft procedure information can be found in Appendix A.

Noise abatement procedures:

4.5.2 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:

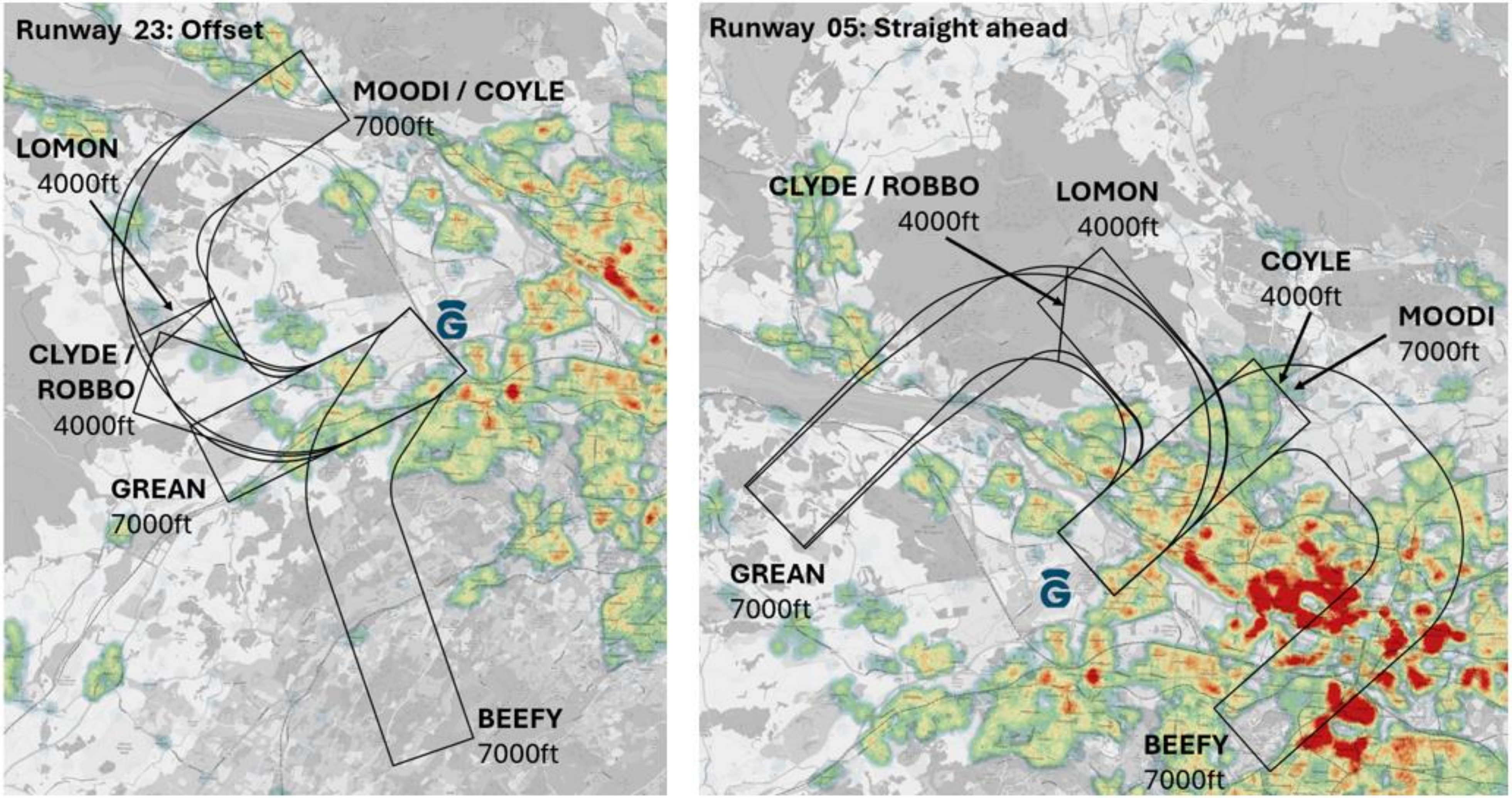


Figure 58 Option 3 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes a vectoring only arrival component which is considered as safe as the 'without airspace change' baseline as vectoring already routinely occurs today. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures offers reduced ATC and pilot workload. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. The continued use of vectoring for arrivals is expected to result in similar workload as today for ATC and pilots. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 3 are shown in Figures TA33 to TA36 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £15,982,511 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 71.

Table 71 Option 3 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 3	£15,982,511	£9,815,598	£4,331,816	£6,512	£729,038	£1,099,546	11,668	23,870	24,540	36,872

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 3	$L_{Aeq,16h}$	51	40.9	63900	30200	34	0	13	30
			54	21.4	26700	12700	7	0	5	13
			57	11.3	6900	3200	2	0	0	3
			60	5.8	1600	800	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 3	$L_{Aeq,16h}$	51	43.7	71300	33600	38	0	15	32
			54	23.0	30700	14500	9	0	5	13
			57	12.2	8400	3900	2	0	0	4
			60	6.2	1800	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 3	$L_{Aeq,8h}$	45	66.7	95500	45000	46	0	21	49
			48	33.9	51100	24400	24	0	12	23
			51	17.4	16100	7800	6	0	0	6
			54	8.9	2400	1200	0	0	0	2
			55	7.2	1400	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0

			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 3	$L_{Aeq,8h}$	45	70.9	99800	47100	48	0	21	53
			48	36.2	56200	26600	28	0	12	23
			51	18.5	19000	9100	6	0	4	8
			54	9.5	2700	1400	0	0	0	2
			55	7.7	1700	900	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL
Table 72 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 3:
- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL.

Table 72 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 3

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	63,800	-4,400
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	93,700	+2,900
Above SOAEL	1,500	1,500	0

2027 Assessment of significant noise effects, residential receptors

Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 73 summarises how noise increases are experienced across the population and

Table 74 summarises how noise decreases are experienced across the population.

These tables show that for Option 3:

- in 2027, during the daytime, there are likely significant adverse effects due to moderate noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;

- in 2027, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and
- in 2027, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 75 and the postcode receptors representing these locations are presented in Figure 59 and Figure 60.

Table 73 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 3 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	17,000	37,300
Minor adverse	2.0 - 2.9dB	1,500	1,200
Moderate adverse	3.0 - 5.9dB	**800**	**2,200**
Major adverse	6.0dB or more	0	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	300
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 74 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 3 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	44,100	46,400
Minor beneficial	2.0 - 2.9dB	6,100	3,800
Moderate beneficial	3.0 - 5.9dB	**2,300**	**6,500**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 75 2027 community areas experiencing likely significant effects, Option 3

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect

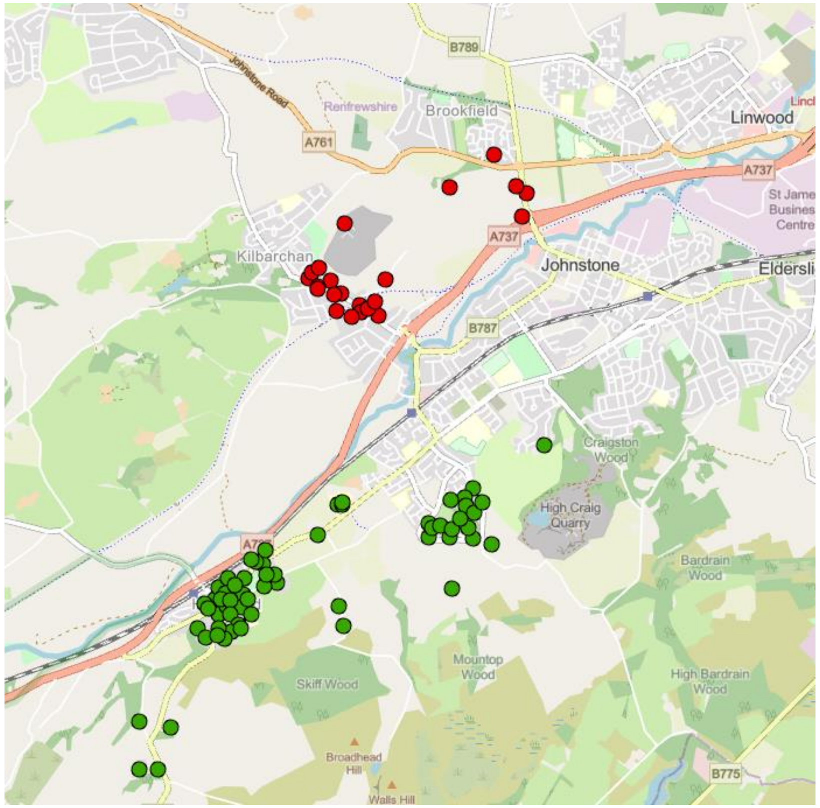


Figure 59 2027 Option 3, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](https://www.openstreetmap.org/copyright))

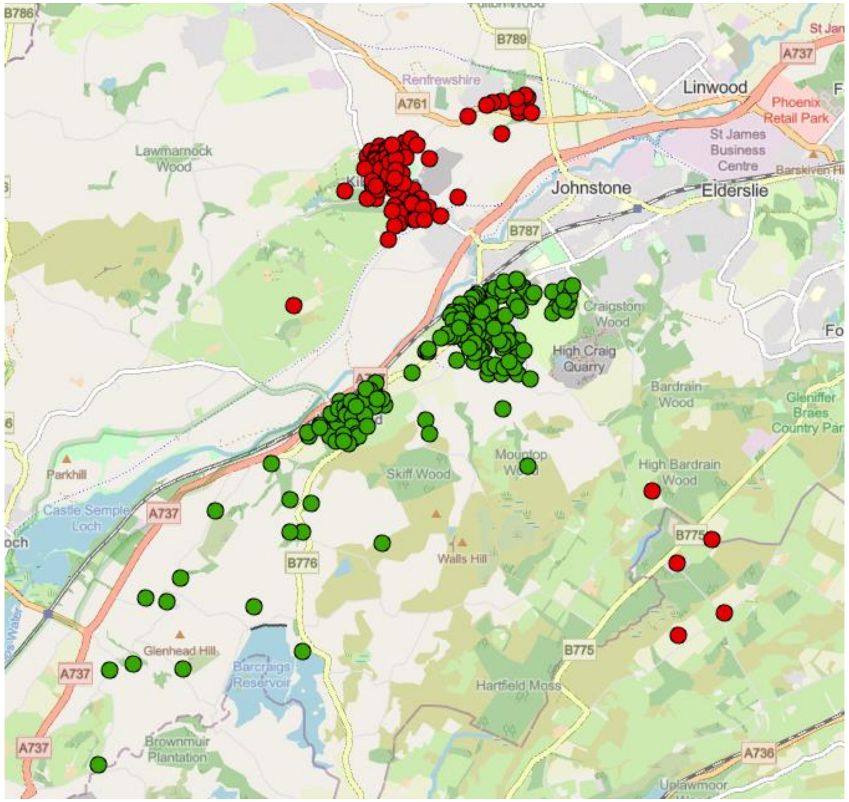


Figure 60 2027 Option 3, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, likely significant effects have been identified for the receptors shown in Table 76 for Option 3.

Table 76 2027 noise sensitive building likely significant effects Option 3

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.2	50.8	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	43.7	50.4	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.3	49.1	-3.3	Daytime beneficial likely significant effect

2036 Noise exposure above LOAEL and SOAEL

Table 77 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 3:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 77 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 3

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	71,200	-1,000
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	97,700	3,000
Above SOAEL	1,900	1,700	-200

2036 Assessment of significant noise effects, residential receptors
Table 78 summarises how noise increases are experienced across the population and Table 79 summarises how noise decreases are experienced across the population.

These tables show that for Option 3:

- in 2036, during the daytime, there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and

- in 2036, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 80 and the postcode receptors representing these locations are presented in Figure 61 and Figure 62.

Table 78 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 3 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	18,800	38,600
Minor adverse	2.0 - 2.9dB	1,700	1,100
Moderate adverse	3.0 - 5.9dB	**1,200**	**2,500**
Major adverse	6.0dB or more	**200**	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	500
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0

Major adverse	4.0dB or more	0	0

Table 79 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 3 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	44,900	49,100
Minor beneficial	2.0 - 2.9dB	6,300	3,800
Moderate beneficial	3.0 - 5.9dB	**2,400**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 80 2036 community areas experiencing likely significant effects, Option 3

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect

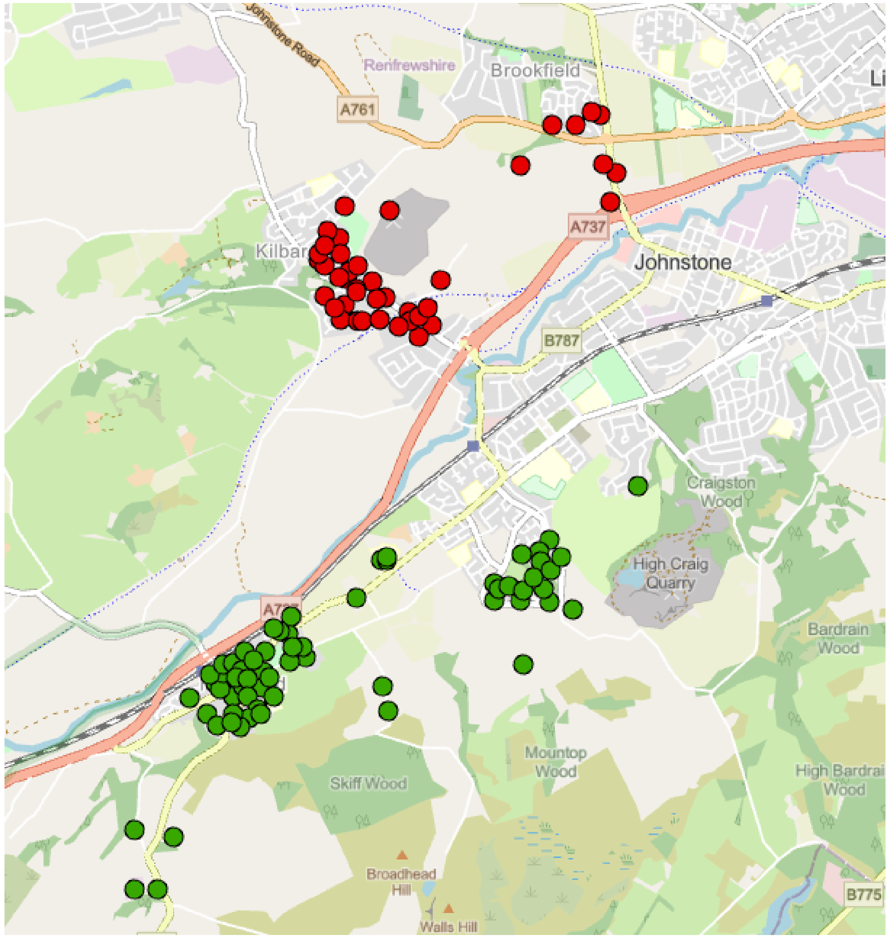


Figure 61 2036 Option 3, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

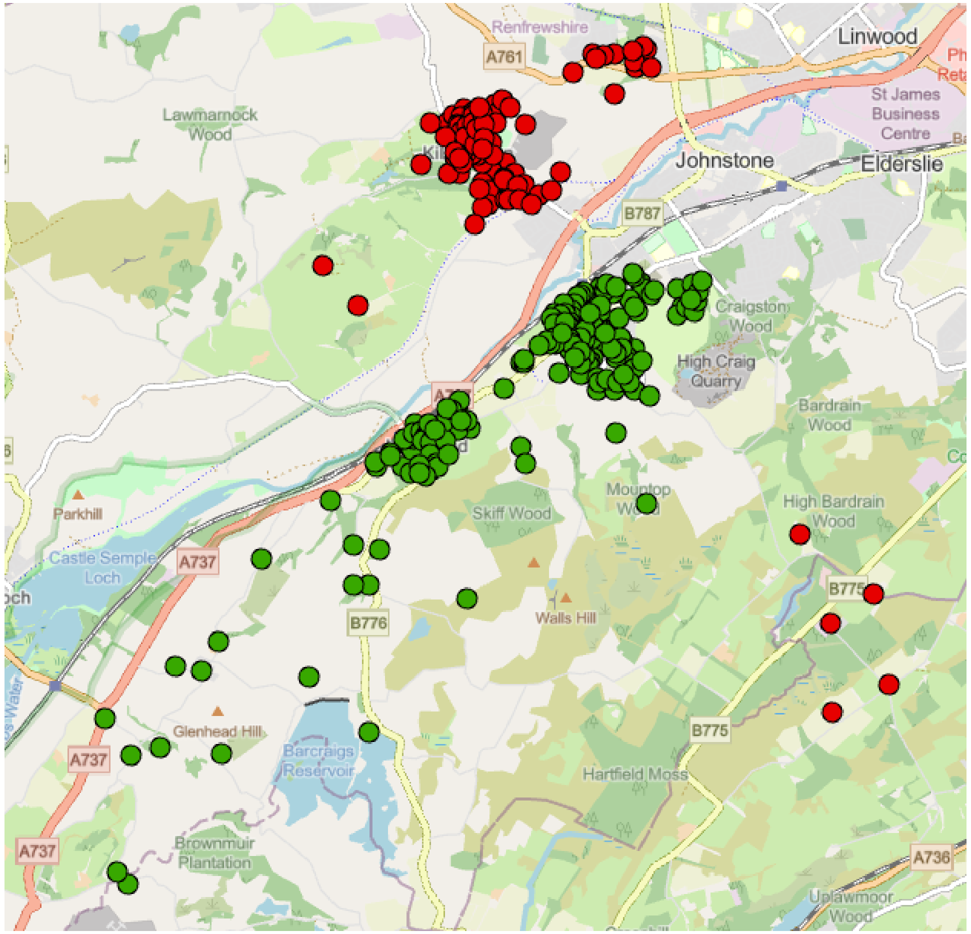


Figure 62 2036 Option 3, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, likely significant effects have been identified for the receptors shown in Table 81 for Option 3.

Table 81 2036 noise sensitive building likely significant effects Option 3

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.5	51.1	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	44.0	50.7	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.7	49.4	-3.3	Daytime beneficial likely significant effect

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 82 and Table 83 respectively.

Table 82 2027 population newly overflown and no longer overflown (five times or more), Option 3

	Daytime	Night-time
Number of people newly overflown >=5	170,000	11,500
Number of people no longer overflown >=5	103,200	18,600

Table 83 2036 population newly overflown and no longer overflown (five times or more), Option 3

	Daytime	Night-time
Number of people newly overflown >5	170,500	12,200
Number of people no longer overflown >5	96,500	23,200

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_3*	N65	5	53.0	1200	800	2	0	2	7
			10	7.1	2900	1400	2	0	-1	2
			20	-5.1	3200	1700	3	0	-1	3
			50	-5.6	-7500	-3700	-5	0	0	-2
			100	-0.3	-1500	-600	0	0	0	0
			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_3*	N65	5	55.0	2200	1300	1	0	2	5
			10	9.4	3800	1700	2	0	-3	2
			20	-6.1	3200	1600	2	0	0	2
			50	-6.4	-7000	-3300	-4	0	-1	-3

			100	-0.4	-1200	-500	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_3*	N60	5	-31.7	-6100	-2900	-1	0	-3	-6
			10	-19.9	-4600	-2000	-2	0	0	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_3*	N60	5	-29.5	-6800	-3100	-2	0	-3	-7
			10	-21.1	-2500	-800	0	0	-1	-2
			20	0.2	100	<100	1	0	0	0

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_3*	Overflights_Day	5	147.5	66000	29400	34	5	22	24
			10	67.1	8100	2800	-2	0	11	5

			20	5.1	-47000	-22200	-18	-1	-8	-34
			50	-14.5	-8600	-3800	-7	0	-2	-5
			100	0.7	-1200	-500	0	0	0	0
2036	*DS_Option_3*	Overflights_Day	5	148.3	77500	35200	29	3	24	43
			10	61.9	18900	8100	-1	0	10	9
			20	16.8	-36500	-17600	-16	-1	-4	-27
			50	-14.9	-8000	-3500	-7	0	-2	-5
			100	-0.7	-2400	-1000	-3	0	-1	-3

Metric – Overflights (night-7time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_3*	Overflights_Night	5	1.1	-6700	-2800	-2	0	-3	-6
			10	-20.3	-17600	-8500	-11	0	-4	-10
2036	*DS_Option_3*	Overflights_Night	5	0.9	-9300	-3900	-4	0	-3	-13
			10	-19.2	-15400	-7300	-12	0	-3	-10

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Air Quality – Communities

As set out in the Full Options Appraisal methodology, this option is unlikely to have a significant impact on local air quality and the impact is considered negligible, and not assessed any further.

Greenhouse gas emissions – Wider society

TAG outcomes

TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 106,301 t, of which 86,619t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £23,560,119 for Option 3.

Greenhouse gas emissions

Table 84 shows the annual total and per flight greenhouse gas emissions of Option 3 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 3[57].

Table 84 greenhouse gas emissions, Option 3

Year	Without Airspace Change		With Airspace Change		Difference	
	Annual total GHG	Total GHG emissions per	Annual total GHG	Total GHG emissions per	Annual total GHG	Total GHG emissions per

[57] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

	emissions (tCO_2e)	flight ($kgCO_2e$)	emissions (tCO_2e)	flight ($kgCO_2e$)	emissions (tCO_2e)	flight ($kgCO_2e$)
2027	521,287	5,737	511,872	5,634	-9,415	-104
2028	525,266	5,742	515,581	5,637	-9,685	-106
2029	529,245	5,747	519,289	5,639	-9,955	-108
2030	533,223	5,752	522,998	5,642	-10,225	-110
2031	537,202	5,756	526,707	5,644	-10,495	-112
2032	541,180	5,760	530,415	5,646	-10,765	-115
2033	545,159	5,764	534,124	5,648	-11,035	-117
2034	549,137	5,768	537,832	5,649	-11,305	-119
2035	553,116	5,771	541,541	5,650	-11,575	-121
2036	557,095	5,774	545,250	5,651	-11,845	-123

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Tranquillity – Wider society
There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA. This option results in an area of 6.0km^2 (0.32% of the total area) and 6.8km^2 (0.36% of the total area) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. The option also results in an area of 0.04km^2 (0.01% of the total area) and 0.05km^2 (0.02% of the total area) of the Loch Lomond NSA to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. Figure 63 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park and NSA are currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park and NSA are already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA

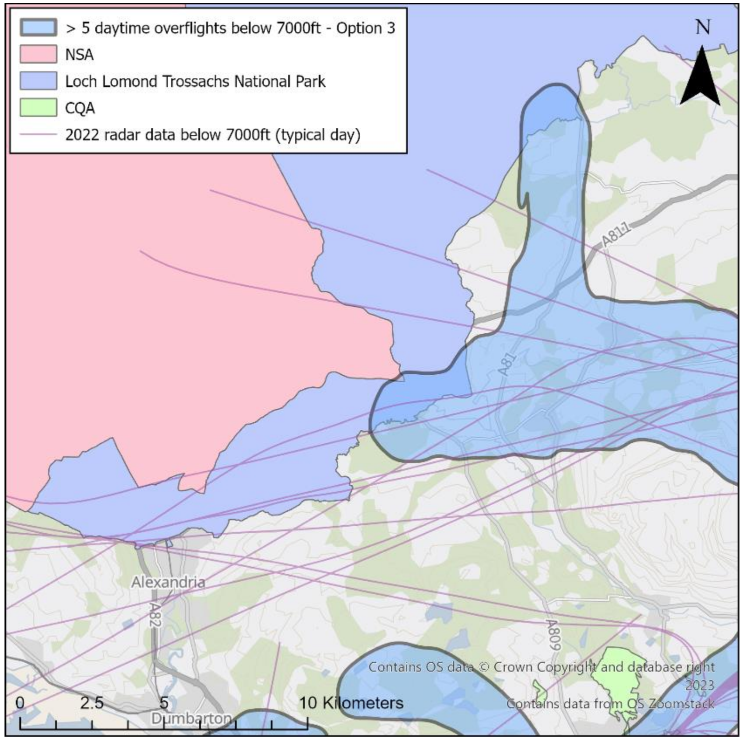


Figure 63 Areas of the Loch Lomond & The Trossachs National Park and Loch Lomond NSA intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 85 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 85 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	5	4	26	26
2036	5	5	28	27

The Barhill Wood CQA (see Figure 64), close to Kilbarchan, is newly within the $L_{Aeq,16h}$ LOAEL contour in the 2027 and 2036 'with airspace change' scenarios for this option compared to the 2027 and 2036 'without airspace change' future baseline scenarios. Consequently, there could be an adverse impact on the perception of tranquillity for this CQA. This is consistent with the daytime adverse likely significant noise effects identified for the majority of the community of Kilbarchan in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113).

The Skiff Wood CQA (see Figure 64), close to the community of Howwood, is within the $L_{Aeq,16h}$ LOAEL contour in the 'without airspace change' 2027 and 2036 future baseline scenarios but is no longer within the 2027 and 2036 $L_{Aeq,16h}$ LOAEL in the 'with airspace change' scenarios for this option. Consequently, there could be a beneficial impact on the perception of tranquillity for this CQA. This is consistent with the daytime beneficial likely significant noise effect identified for the community of Howwood in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113).

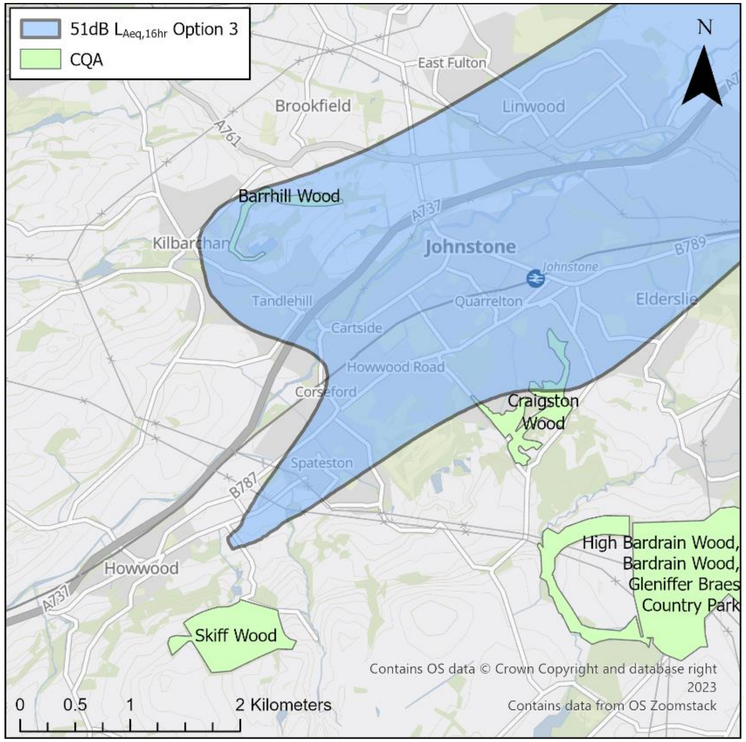


Figure 64 Barrhill Wood and Skiff Wood CQAs

Table 86 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 86 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	6	Springburn Park Bothwell Castle Grounds Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	6	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Craigends Highmainshead Wood

2036	6	King's Park Springburn Park Bothwell Castle Grounds Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	5	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 3.

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_3*	$L_{Aeq,16h}$	51	0	0	0	0	1	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0

			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_3*	$L_{Aeq,16h}$	51	0	0	0	0	0	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_3*	Overflights_Day	5	1	<0.1	1	6.0	0	-2.0	0	-1.9	0	-0.4
			10	0	0	0	0	-5	-1.2	-1	-0.4	-1	-3.1
			20	0	0	0	0	-2	-0.2	0	-2.4	0	-0.1
			50	0	0	0	0	-2	-0.5	0	0	0	<0.1

			100	0	0	0	0	0	<-0.1	0	0	0	0
2036	*DS_Option_3*	Overflights_Day	5	1	0.1	1	6.8	1	-2.0	0	-1.9	-1	-0.8
			10	0	0	0	0	-4	-2.5	0	-1.7	-1	-3.7
			20	0	0	0	0	-2	-0.2	0	-2.8	0	-0.4
			50	0	0	0	0	-1	-0.5	0	0	0	<-0.1
			100	0	0	0	0	0	<0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_3*	Overflights_Day	5	0	4.3	1	-0.3	0	4.3
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	*DS_Option_3*	Overflights_Day	5	1	4.5	1	-0.2	0	4.5
			10	0	<-0.1	-3	-0.3	0	0
			20	0	0	0	0	0	0

			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_3*	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	*DS_Option_3*	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 87:

Table 87 Option 3 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 3	14376	37590	54455
Reduction	-3738	-9398	-7866

Resilience

The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see the NERL FOA)

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 3	14376	37590	54455
Reduction	-3738	-9398	-7866
£ (in 2024 prices)	**-£216,372**	**-£544,014**	**-£455,331**

Fuel burn – General aviation / commercial airlines

Table 88 shows the annual total and per flight fuel burn of Option 3 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 1.

Table 88 fuel burn, Option 3

Year	Without Airspace Change			With Airspace Change			Difference		
	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	160,966	£110,421,123	1,772	-2,961	-£2,031,074	-33
2028	165,178	£113,310,454	1,806	162,132	£111,221,146	1,773	-3,046	-£2,089,308	-33
2029	166,429	£114,168,711	1,807	163,299	£112,021,169	1,773	-3,131	-£2,147,543	-34
2030	167,680	£115,026,969	1,809	164,465	£112,821,191	1,774	-3,215	-£2,205,777	-35
2031	168,931	£115,885,226	1,810	165,631	£113,621,214	1,775	-3,300	-£2,264,012	-35
2032	170,182	£116,743,484	1,811	166,797	£114,421,237	1,775	-3,385	-£2,322,247	-36
2033	171,434	£117,601,741	1,813	167,963	£115,221,260	1,776	-3,470	-£2,380,481	-37
2034	172,685	£118,459,999	1,814	169,130	£116,021,283	1,776	-3,555	-£2,438,716	-37
2035	173,936	£119,318,256	1,815	170,296	£116,821,305	1,777	-3,640	-£2,496,951	-38
2036	175,187	£120,176,514	1,816	171,462	£117,621,328	1,777	-3,725	-£2,555,185	-39

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.
Infrastructure costs – Airport / ANSP
This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system. The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.
Operational costs – Airport / ANSP
There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £74,000 every 5 years (based on 2024 prices). This is an increase of £4000 every 5 years compared to the baseline. Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 1-4 (without PBN transitions) are expected to require less training than those with PBN transitions however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above.

Safety – The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the ‘without airspace change’ baseline.
Integration of diverse users - The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft.
Simplification, reducing complexity and improving efficiency - The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays.
Environmental sustainability - The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.6 Option 4

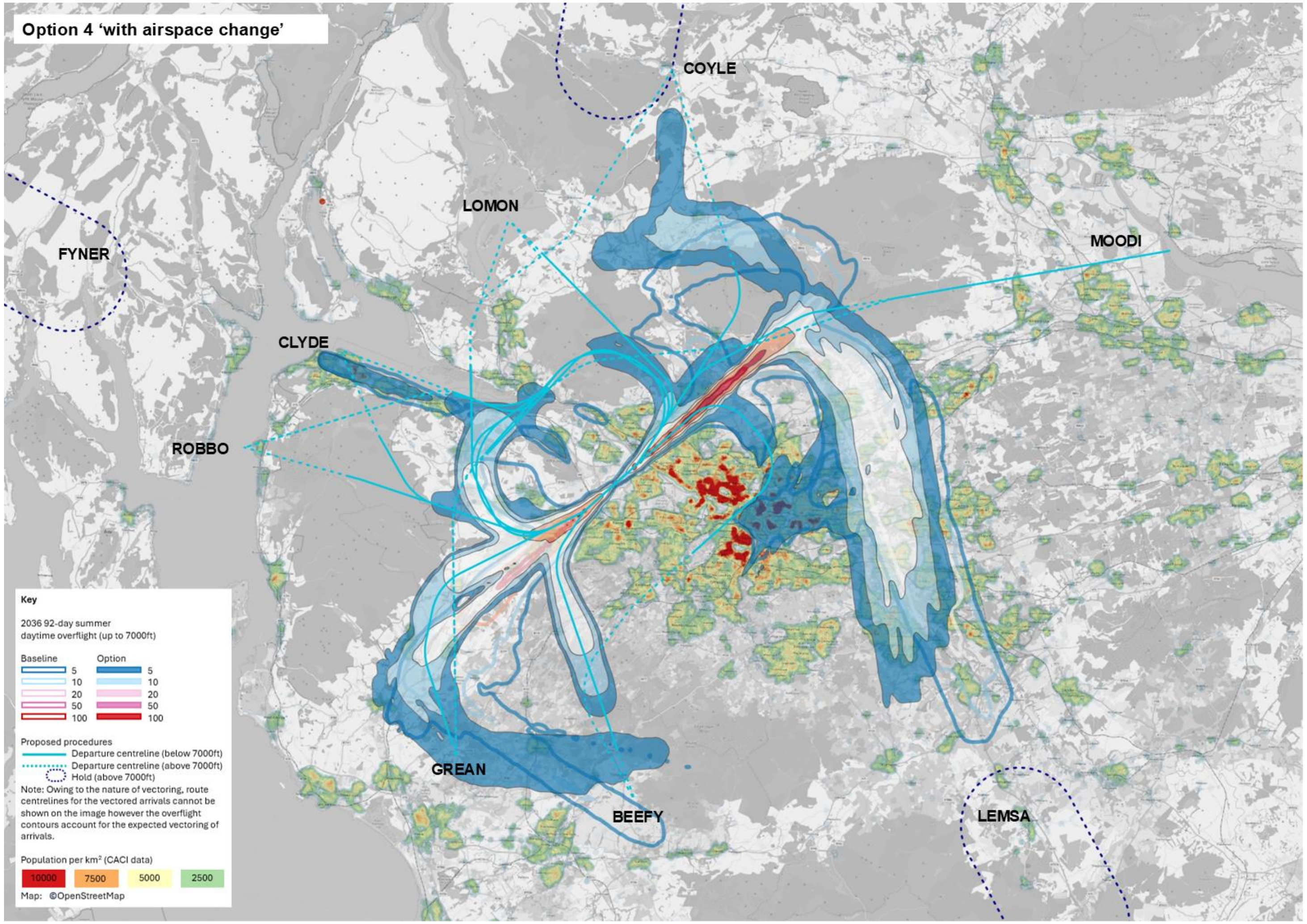


Figure 65 Option 4 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 4	Vectors	Vectors	Offset SIDs	Offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day [58]	Description
Runway 05 – Offsets			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.

[58] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

ROBBO	ROBBO	1%	The RNP ROBBO SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies an offset departure before turning at c.8nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies an offset departure before turning at c.4nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[59]	Description
Runway 23 – Offset departures			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that initially flies and offset departure and then turns at c.7nm called the GREAN departure, and the BEEFY departure described below. The overflight (5) contour shows that the GREAN departure initially overflies Linwood and Johnstone, before overflying Howwodd, Lochwinnoch and, at higher altitudes, Kilbirnie and Beith.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID would fly an offset departure before turning at c.2nm. This offset and turn to the south introduces overflight over some new areas including Edlerslie. The overflight (5) contour shows that beyond Edlerslie, overflight largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[59] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, and Kilmacolm. At higher altitudes, it overflies the eastern parts of Dumbarton and Milton. All these areas are overflown today however they would see increased overflight as a result of this option. Note two MOODI SIDs are proposed; One designed to RNP1 and one to RNAV1 specification. Although the lateral paths of these two SIDs vary slightly around the first and second turns, they do not materially alter the description above.

Aviation Industry Technical Information

4.6.1 Draft procedure information can be found in Appendix A.

Noise abatement procedures:

4.6.2 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:

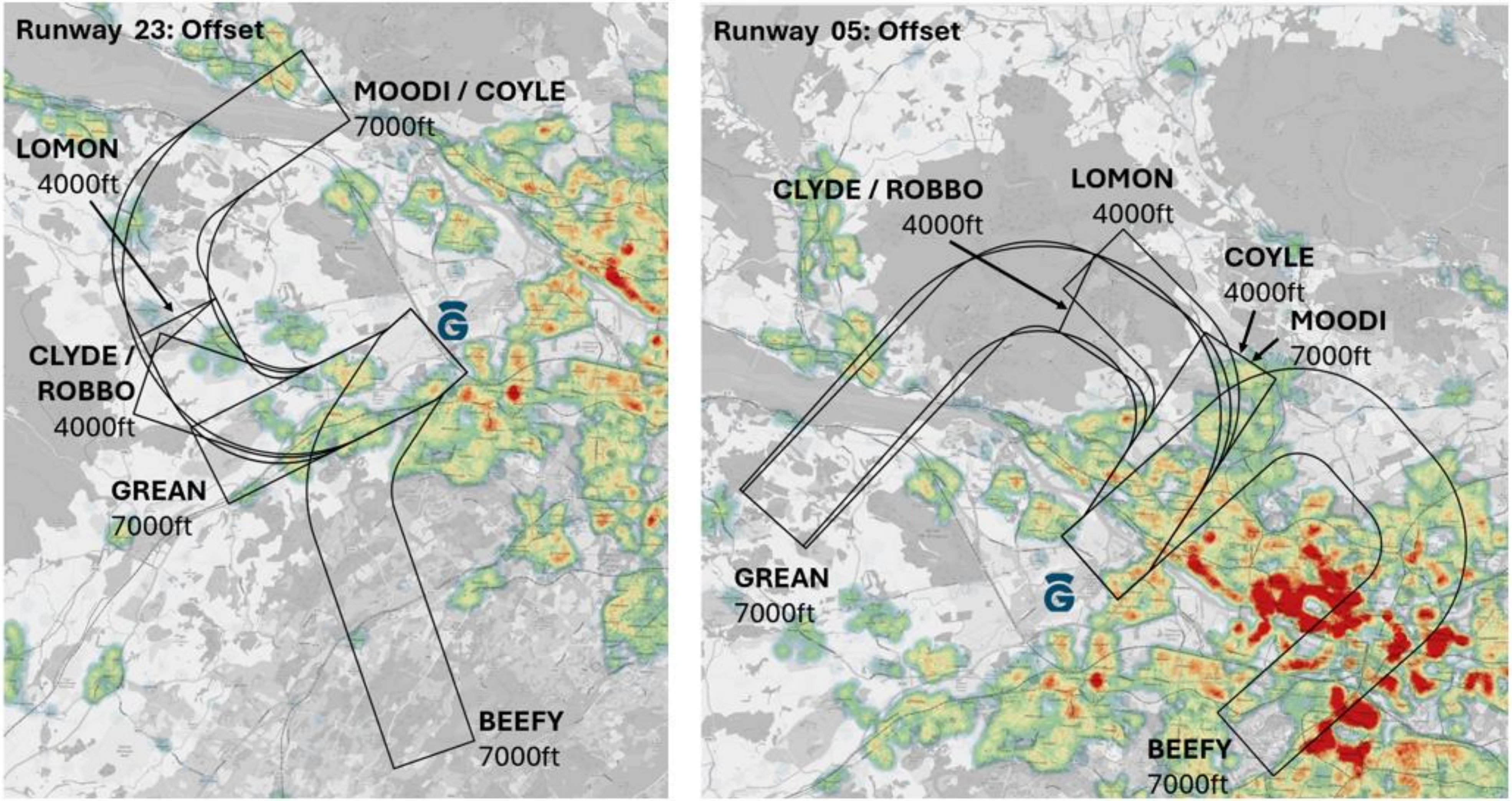


Figure 66 Option 4 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes a vectoring only arrival component which is considered as safe as the 'without airspace change' baseline as vectoring already routinely occurs today. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures offers reduced ATC and pilot workload. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. The continued use of vectoring for arrivals is expected to result in similar workload as today for ATC and pilots. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 4 are shown in Figures TA37 to TA40 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £16,339,763 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 89.

Table 89 Option 4 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 4	£16,339,763	£9,910,300	£4,537,300	£11,758	£749,839	£1,130,565	17,094	30,108	29,376	42,574

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 4	$L_{Aeq,16h}$	51	40.6	66200	31300	34	0	12	29
			54	21.2	25900	12300	7	0	5	12
			57	11.2	6700	3200	2	0	0	4
			60	5.8	1400	700	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.7	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 4	$L_{Aeq,16h}$	51	43.4	71400	33700	36	0	14	33
			54	22.7	30000	14200	9	0	5	14
			57	12.1	8000	3700	2	0	0	5
			60	6.2	1700	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 4	$L_{Aeq,8h}$	45	67.0	96000	45100	46	0	20	48
			48	33.7	50800	24300	28	0	12	23
			51	17.3	15700	7700	6	0	0	7
			54	8.9	2300	1200	0	0	0	2
			55	7.2	1300	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0

			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 4	$L_{Aeq,8h}$	45	71.2	99500	46800	49	0	20	53
			48	36.1	58800	27900	30	0	12	23
			51	18.4	18600	9000	6	0	4	9
			54	9.4	2700	1400	0	0	0	2
			55	7.7	1600	800	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL

Table 90 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 4:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 90 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 4

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	66,200	-2,000
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	94,300	3,500
Above SOAEL	1,500	1,400	-100

2027 Assessment of significant noise effects, residential receptors
Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 91 summarises how noise increases are experienced across the population and Table 92 summarises how noise decreases are experienced across the population.

These tables show that for Option 4:

- in 2027, during the daytime, there are likely significant adverse effects due to moderate noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and

- in 2027, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 93 and the postcode receptors representing these locations are presented in Figure 67 and Figure 68.

Table 91 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 4 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	19,000	37,100
Minor adverse	2.0 - 2.9dB	1,500	2,800
Moderate adverse	3.0 - 5.9dB	**800**	**2,400**
Major adverse	6.0dB or more	0	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0

Major adverse	4.0dB or more	0	0

Table 92 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 4 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	43,700	46,200
Minor beneficial	2.0 - 2.9dB	6,100	3,800
Moderate beneficial	3.0 - 5.9dB	**2,300**	**6,500**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,500
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 93 2027 community areas experiencing likely significant effects, Option 4

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect

To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

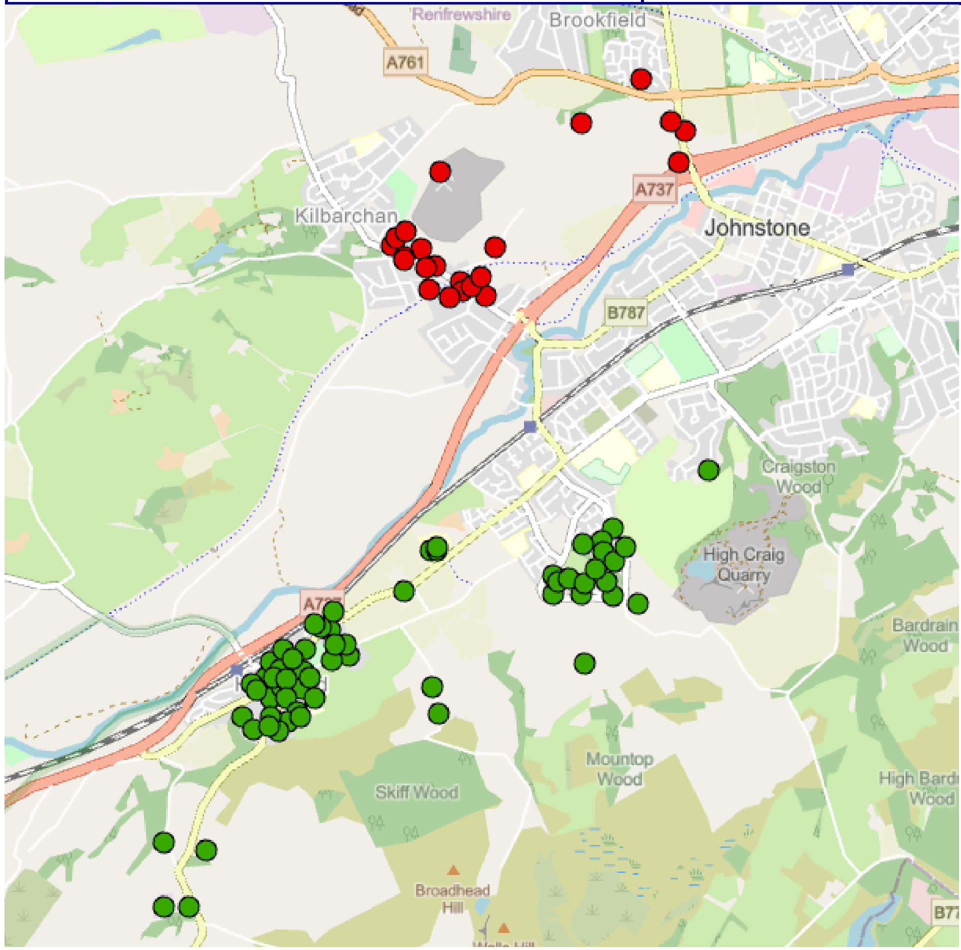


Figure 67 2027 Option 4, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](#))

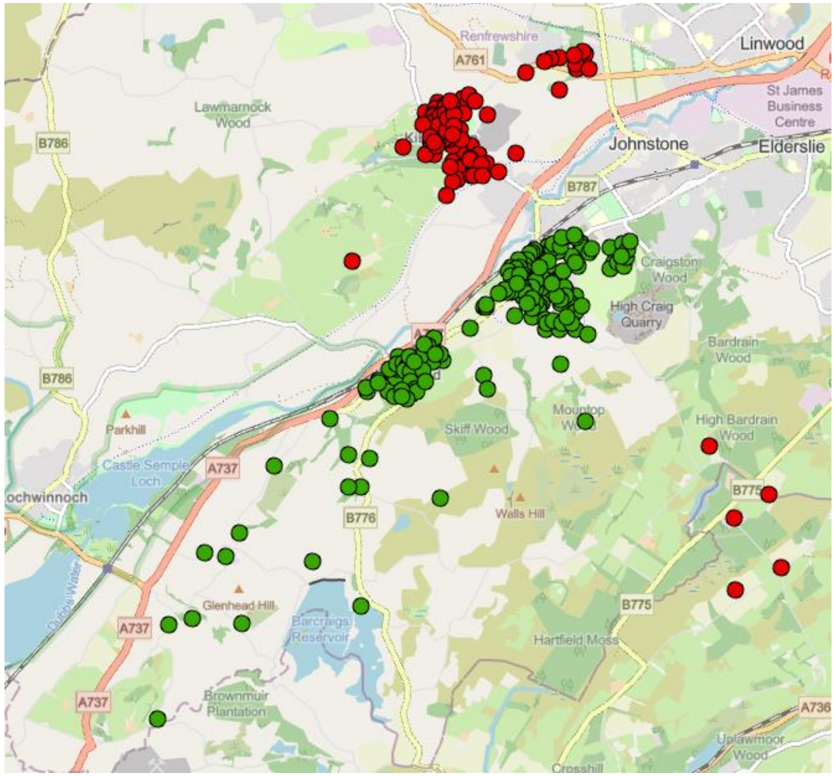


Figure 68 2027 Option 4, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, likely significant effects have been identified for the receptors shown in Table 94 for Option 4.

Table 94 2027 noise sensitive building likely significant effects Option 4

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.2	50.8	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	43.7	50.4	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.3	49.1	-3.3	Daytime beneficial likely significant effect

2036 Noise exposure above LOAEL and SOAEL

Table 95 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 4:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 95 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 4

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	71,300	-900
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	97,400	+2,700
Above SOAEL	1,900	1,600	-300

2036 Assessment of significant noise effects, residential receptors
Table 96 summarises how noise increases are experienced across the population and Table 97 summarises how noise decreases are experienced across the population.

These tables show that for Option 4:

- in 2036, during the daytime, there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and

- in 2036, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 98 and the postcode receptors representing these locations are presented in Figure 69 and Figure 70.

Table 96 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 4 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	20,800	39,100
Minor adverse	2.0 - 2.9dB	1,700	2,700
Moderate adverse	3.0 - 5.9dB	**1,200**	**2,600**
Major adverse	6.0dB or more	**200**	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0

Major adverse	4.0dB or more	0	0

Table 97 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 4 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	44,600	48,100
Minor beneficial	2.0 - 2.9dB	6,300	3,800
Moderate beneficial	3.0 - 5.9dB	**2,400**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,800
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 98 2036 community areas experiencing likely significant effects, Option 4

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

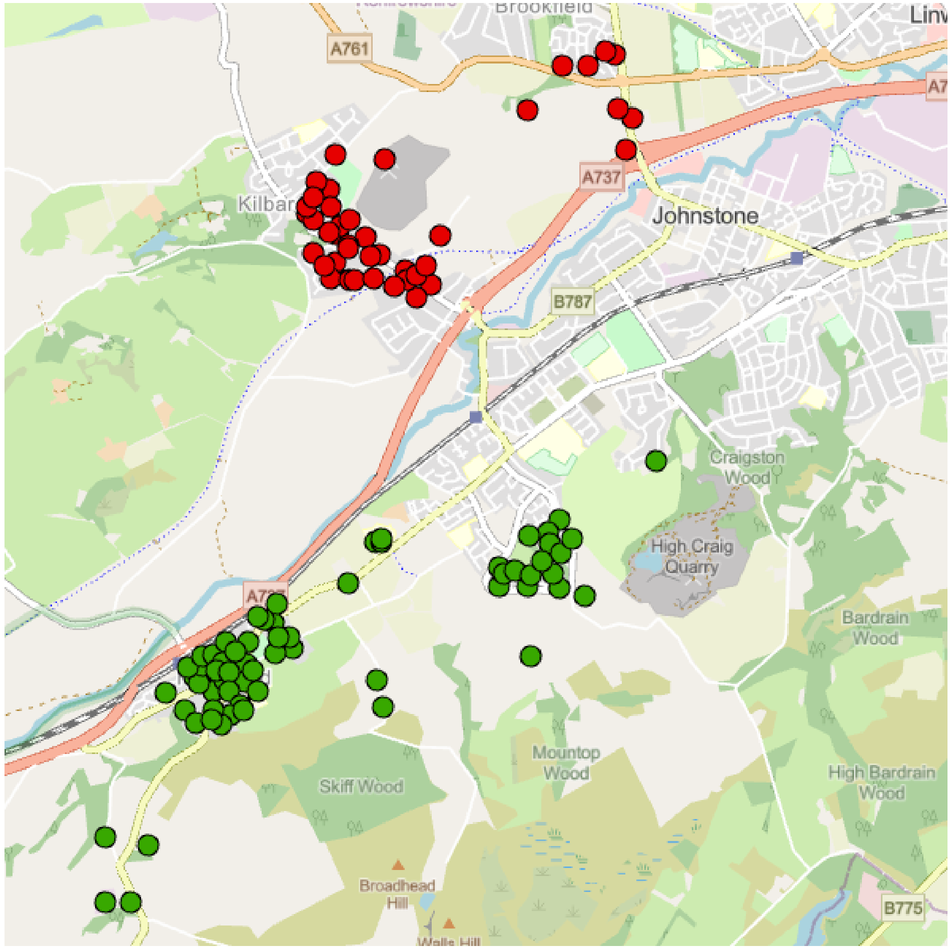


Figure 69 2036 Option 4, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](#))

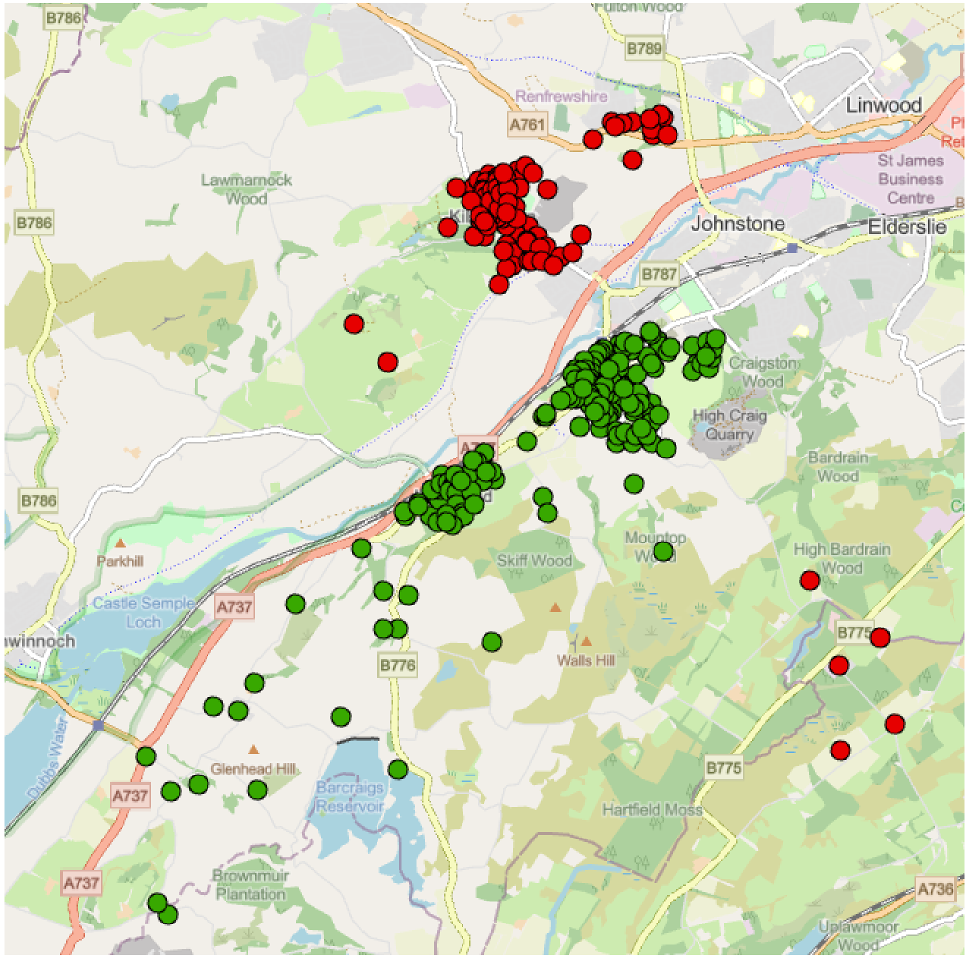


Figure 70 2036 Option 4, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, likely significant effects have been identified for the receptors shown in Table 99 for Option 4.

Table 99 2036 noise sensitive building likely significant effects Option 4

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.5	51.1	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	44.0	50.7	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.7	49.4	-3.3	Daytime beneficial likely significant effect

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 100 and Table 101 respectively.

Table 100 2027 population newly overflown and no longer overflown (five times or more), Option 4

	Daytime	Night-time
Number of people newly overflown >=5	173,900	11,500
Number of people no longer overflown >=5	102,100	22,800

Table 101 2036 population newly overflown and no longer overflown (five times or more), Option 4

	Daytime	Night-time
Number of people newly overflown >=5	175,600	12,200
Number of people no longer overflown >=5	95,500	27,100

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_4*	N65	5	56.6	2500	1100	5	0	2	10
			10	8.1	4800	2100	2	0	0	3
			20	-5.5	2700	1500	3	0	-1	4
			50	-5.8	-8400	-4000	-5	0	0	-3
			100	-0.6	-2200	-900	0	0	0	0
			200	<0.1	0	0	0	0	0	0

2036	*DS_Option_4*	N65	5	58.3	4000	1900	5	0	2	8
			10	10.6	4300	1700	2	0	-2	3
			20	-6.4	2500	1300	2	0	0	3
			50	-6.7	-7600	-3500	-3	0	-1	-3
			100	-1.1	-3100	-1400	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_4*	N60	5	-32.1	-6500	-3100	-1	0	-3	-6
			10	-21.3	-4700	-2100	-2	0	0	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_4*	N60	5	-29.8	-7300	-3400	-2	0	-3	-7
			10	-21.6	-2900	-1000	-1	0	-1	-1
			20	0.2	100	<100	1	0	0	0

Metric – Overflight (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_4*	Overflights_Day	5	152.8	75200	33400	34	5	20	26
			10	67.7	11700	4400	0	0	11	6
			20	4.4	-48200	-22600	-15	-1	-9	-33
			50	-15.1	-9700	-4400	-7	0	-2	-6
			100	-1.0	-2500	-1100	-1	0	0	0
2036	*DS_Option_4*	Overflights_Day	5	154.9	86800	39200	29	3	22	45
			10	62.6	25100	10800	1	0	11	11
			20	16.1	-36900	-17700	-12	-1	-6	-24
			50	-15.5	-9300	-4100	-7	0	-2	-6
			100	-1.7	-4000	-1700	-3	0	-1	-3

Metric – Overflights (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_4*	Overflights_Night	5	0.4	-8400	-3500	-3	0	-4	-6

			10	-22.0	-19800	-9400	-11	0	-4	-10
2036	*DS_Option_4*	Overflights_Night	5	0.1	-10700	-4500	-5	0	-3	-10
			10	-20.9	-17000	-8000	-12	0	-3	-10

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Air Quality – Communities

- Pollutant concentrations for annual mean NOx, NO_2, PM_{10} and $PM_{2.5}$ predicted negligible impact at all assessed receptor locations. The maximum change predicted for each pollutant at any receptor in each assessment year was <0.01 μg/m^3. The maximum concentration predicted for each pollutant at any relevant receptor, provided below, which is the same result for 2027 and 2036[60]:
- A maximum annual mean NOx of 23.6 μg/m^3 was predicted at the Black Cart SPA;
- A maximum annual mean NO_2 of 15.6 μg/m^3 was predicted at PA4 9LP, on Walkinshaw Road at the northwestern boundary of the airport;
- A maximum annual mean PM_{10} of 10.9 μg/m^3 was predicted at PA3 2TQ, on St Andrew' Crescent, around 150m south of the airport boundary; and
- A maximum annual mean $PM_{2.5}$ of 6.3 μg/m^3 was predicted at PA3 3AD, on Blackstone Road, around 300m from the southwestern boundary of the airport.
- The full results from the dispersion modelling are provided in Appendix B. The results show there were no exceedances of NOx, NO_2, PM_{10} and $PM_{2.5}$ relevant annual mean and short term standards predicted at any of the assessed receptors, in any assessment year. Therefore,

[60] This is as a result of the negligible change as a result of the aircraft emissions changes and assuming to improvement in background concentrations for the 2022 baseline.

the effects of NOx, NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors, as a result of option 4, are predicted to be not significant, in any assessment year.

Greenhouse gas emissions – Wider society

TAG outcomes

TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 104,047t, of which 85,281t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £23,010,552 for Option 4.

Greenhouse gas emissions

Table 102 shows the annual total and per flight greenhouse gas emissions of Option 4 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 4[61].

Table 102 greenhouse gas emissions, Option 4

	Without Airspace Change		With Airspace Change		Difference	
Year	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	512,091	5,636	-9,197	-101
2028	525,266	5,742	515,801	5,639	-9,465	-103
2029	529,245	5,747	519,511	5,642	-9,734	-106
2030	533,223	5,752	523,221	5,644	-10,002	-108

[61] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

2031	537,202	5,756	526,931	5,646	-10,270	-110
2032	541,180	5,760	530,641	5,648	-10,539	-112
2033	545,159	5,764	534,352	5,650	-10,807	-114
2034	549,137	5,768	538,062	5,651	-11,076	-116
2035	553,116	5,771	541,772	5,652	-11,344	-118
2036	557,095	5,774	545,482	5,653	-11,613	-120

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 93) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Tranquillity – Wider society

There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "*...noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA.

This option results in an area of 6.0km^2 (0.32% of the total area) and 6.8km^2 (0.36% of the total area) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively.

The option also results in an area of 0.04km^2 (0.01% of the total area) and 0.05km^2 (0.02% of the total area) of the Loch Lomond NSA to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively.

Figure 71 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park and NSA are currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park and NSA are already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA.

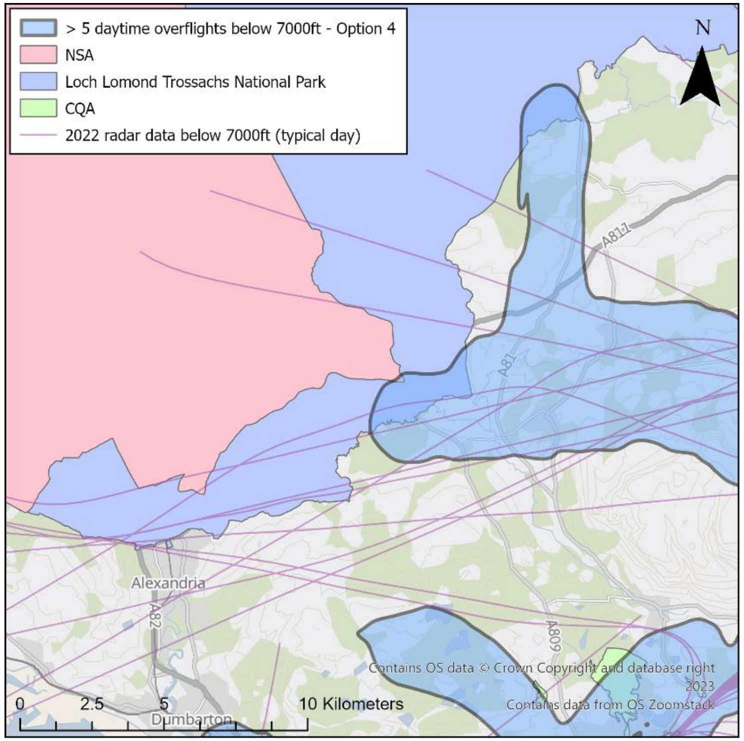


Figure 71 Areas of the Loch Lomond & The Trossachs National Park and Loch Lomond NSA intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 103 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 103 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	5	4	27	26
2036	5	5	29	27

The Barhill Wood CQA (see Figure 72), close to Kilbarchan, is newly within the $L_{Aeq,16h}$ LOAEL contour in the 2027 and 2036 'with airspace change' scenarios for this option compared to the 2027 and 2036 'without airspace change' future baseline scenarios. Consequently, there could be an adverse impact on the perception of tranquillity for this CQA. This is consistent with the daytime adverse likely significant noise effects identified for: the majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail, including isolated properties to the west of Kibbleston in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113); and, parts of the community of Brookfield, broadly between the A761 and B789 in the 2036 'with airspace change' scenario (see Table 113)

The Skiff Wood CQA (see Figure 72), close to the community of Howwood, is within the $L_{Aeq,16h}$ LOAEL contour in the 'without airspace change' 2027 and 2036 future baseline scenarios but is no longer within the 2027 and 2036 $L_{Aeq,16h}$ LOAEL in the 'with airspace change' scenarios for this option. Consequently, there could be a beneficial impact on the perception of tranquillity for this CQA. This is consistent with the daytime beneficial likely significant noise effect identified for the community of Howwood in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113).

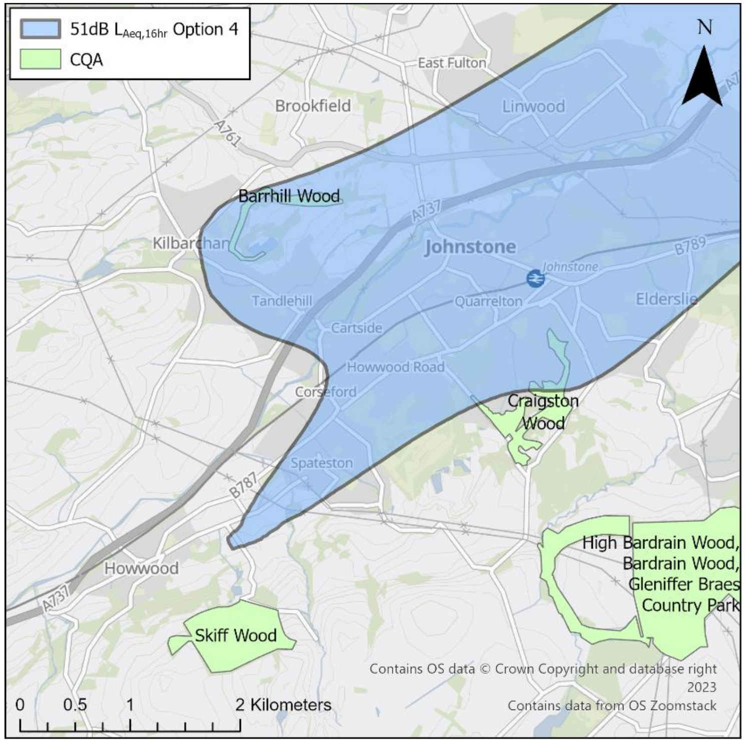


Figure 72 Barrhill Wood and Skiff Wood CQAs

Table 104 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 104 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	7	Springburn Park Bothwell Castle Grounds Carneddans Wood Mains Plantation Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	6	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood Craigends Highmainshead Wood
2036	7	King's Park Springburn Park Bothwell Castle Grounds Carneddans Wood Mains Plantation Cardowan Moss	5	Skellyton Woods Carbarns Wood Orchardbank Shields Glen public park, Dalzell Burn, Adder's Gill Wood

		High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park		Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 4.

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_4*	$L_{Aeq,16h}$	51	0	0	0	0	1	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_4*	$L_{Aeq,16h}$	51	0	0	0	0	0	-0.5	0	0	0	<-0.1

			54	0	0	0	0	-2	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_4*	Overflights_Day	5	1	<0.1	1	6.0	1	0.5	1	-0.3	-1	-0.2
			10	0	0	0	0	-4	-1.0	-1	-0.4	-1	-3.2
			20	0	0	0	0	-2	-0.2	0	-2.4	0	-0.2
			50	0	0	0	0	-2	-0.5	0	0	0	<-0.1
			100	0	0	0	0	-1	-0.1	0	0	0	0
2036	*DS_Option_4*	Overflights_Day	5	1	0.1	1	6.8	2	0.6	1	-0.2	-1	-0.6
			10	0	0	0	0	-3	-2.4	0	-1.7	-1	-3.8
			20	0	0	0	0	-2	-0.2	0	-2.8	0	-0.4
			50	0	0	0	0	-1	-0.5	0	0	0	<-0.1

			100	0	0	0	0	0	<-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_4	Overflights_Day	5	0	2.7	1	-0.3	0	2.7
			10	0	<-0.1	-2	-0.2	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_4	Overflights_Day	5	1	3.6	1	-0.2	0	3.6
			10	0	<-0.1	-3	-0.3	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0

			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_4	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_4	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 105:

Table 105 Option 4 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 4	14951	39106	55665
Reduction	-3163	-7882	-6656

Resilience

The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see the NERL FOA)

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 4	14951	39106	55665
Reduction	-3163	-7882	-6656
£ (in 2024 prices)	**-£183,084**	**-£456,270**	**-£385,280**

Fuel burn – General aviation / commercial airlines

Table 106 shows the annual total and per flight fuel burn of Option 4 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 4.

Table 106 fuel burn, Option 4

	Without Airspace Change			With Airspace Change			Difference		
Year	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	161,035	£110,468,294	1,772	-2,892	-£1,983,902	-32
2028	165,178	£113,310,454	1,806	162,202	£111,268,642	1,773	-2,976	-£2,041,812	-33
2029	166,429	£114,168,711	1,807	163,368	£112,068,990	1,774	-3,061	-£2,099,722	-33
2030	167,680	£115,026,969	1,809	164,535	£112,869,338	1,775	-3,145	-£2,157,631	-34
2031	168,931	£115,885,226	1,810	165,702	£113,669,685	1,776	-3,230	-£2,215,541	-35
2032	170,182	£116,743,484	1,811	166,868	£114,470,033	1,776	-3,314	-£2,273,451	-35
2033	171,434	£117,601,741	1,813	168,035	£115,270,381	1,777	-3,399	-£2,331,360	-36
2034	172,685	£118,459,999	1,814	169,202	£116,070,728	1,777	-3,483	-£2,389,270	-37
2035	173,936	£119,318,256	1,815	170,368	£116,871,076	1,777	-3,567	-£2,447,180	-37
2036	175,187	£120,176,514	1,816	171,535	£117,671,424	1,778	-3,652	-£2,505,090	-38

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.
Other costs – commercial airlines
No other airline costs are foreseen.
Infrastructure costs – Airport / ANSP
This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system. The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.
Operational costs – Airport / ANSP
There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £74,000 every 5 years (based on 2024 prices). This is an increase of £4000 every 5 years compared to the baseline. Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 1-4 (without PBN transitions) are expected to require less training than those with PBN transitions however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen.

Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline. **Integration of diverse users -** The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft. **Simplification, reducing complexity and improving efficiency -** The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays. **Environmental sustainability -** The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.7 Option 5

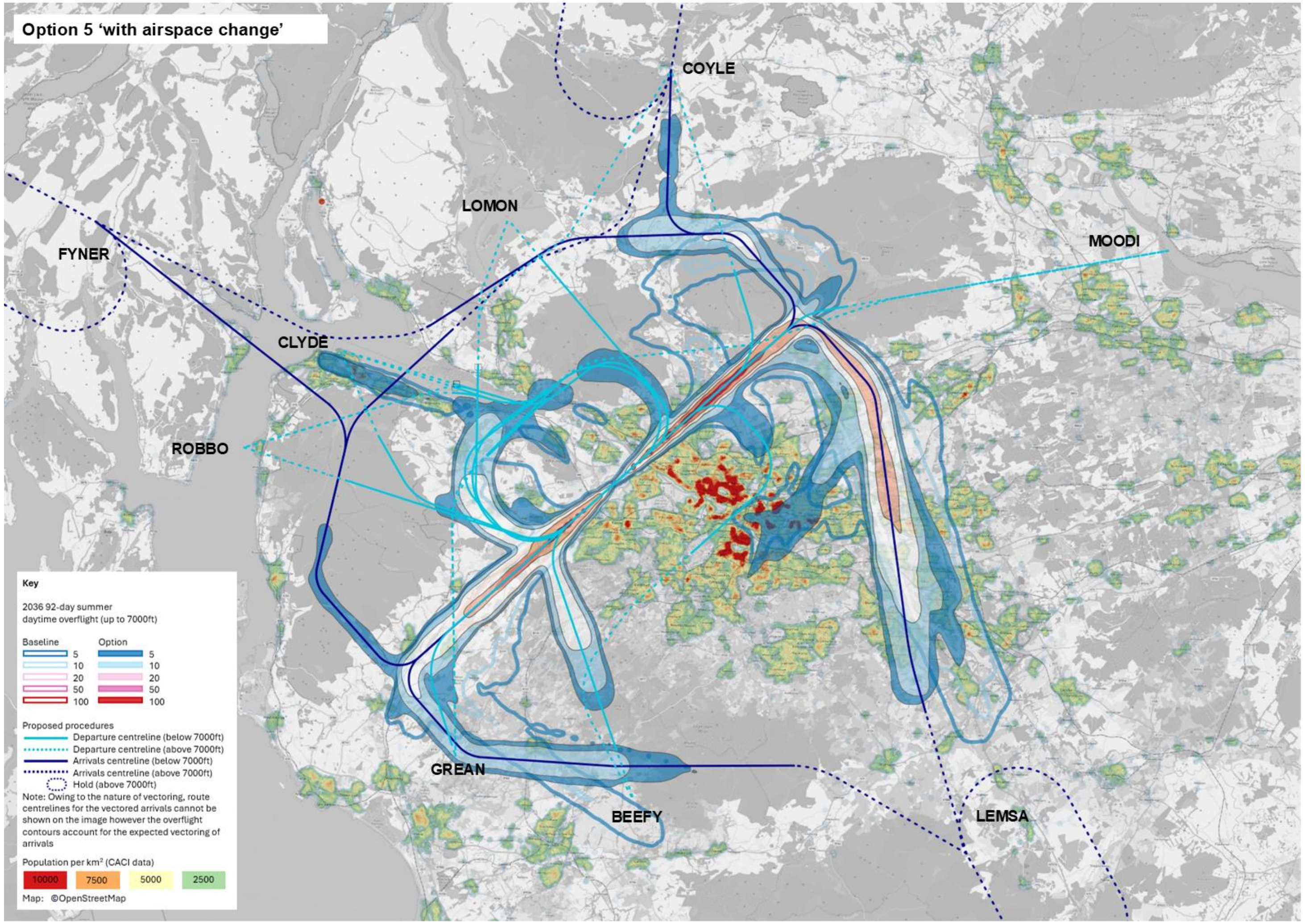


Figure 73 Option 5 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 5	PBN and Vectors	PBN and Vectors	No offset SIDs	No offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[62]	Description
Runway 05 – Straight ahead (no offsets)			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the

[62] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

			route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.
ROBBO	ROBBO	1%	The RNP ROBBO SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies straight ahead for c. 3nm before turning and this overflies Whitecrook and Drumchapel. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies straight ahead before turning at c.7nm. The overflight (5) contour shown in figure -- above shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. Once aircraft have turned, the route overflies areas of low population density.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies straight ahead before turning at c.10nm. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. At higher altitudes, the route overflies the western parts of Lennoxtown.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[63]	Description
Runway 23 – Straight ahead (no offsets)			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that routes straight ahead until turning at c.9nm called the GREAN departure, and one that initially flies straight ahead and then turns at c.2nm called the BEEFY departure. The overflight (5) contour shows that this largely follows the areas where NORBO departures fly today. This includes overflight of the more densely populated areas of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID turns at c.2nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows that this largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies straight ahead over the same areas as final approach for c2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[63] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.

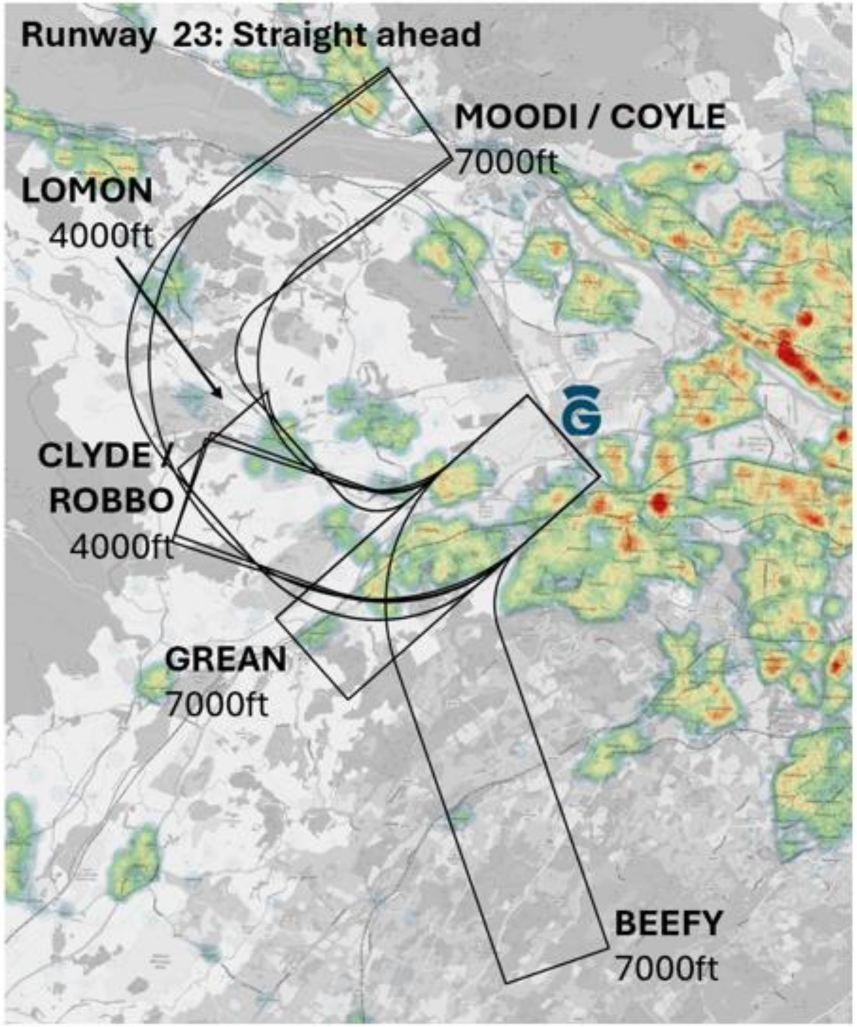
Aviation Industry Technical Information

4.7.1 Draft procedure information including proposed missed approach procedures can be found in Appendix A.

4.7.2 Note that the position of the Final Approach Fix (FAF) for the Runway 23 ILS procedure has been amended as a result of this option due to the requirements for the PBN arrival transitions to link with both an RNP and ILS approach. Draft information is included in Appendix A.

Noise abatement procedures:

4.7.3 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:



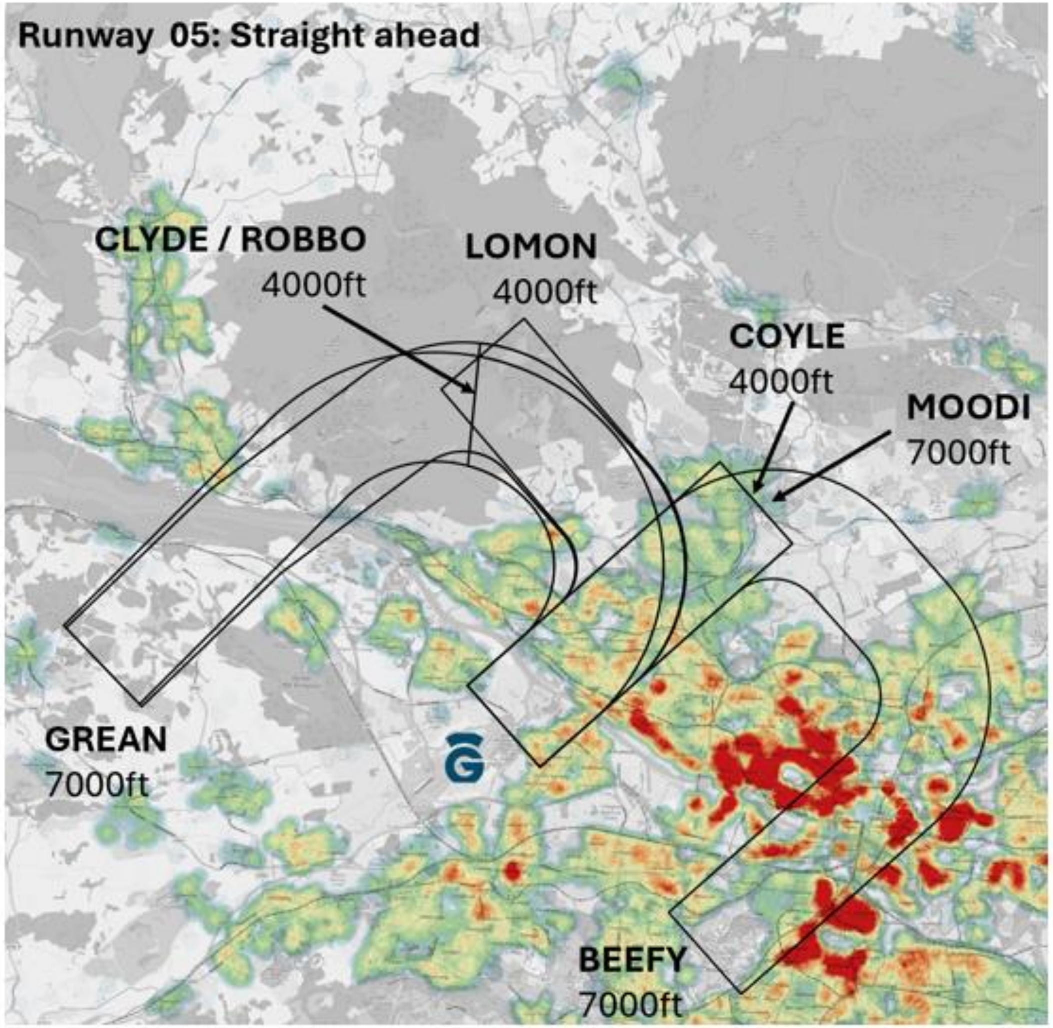


Figure 74 Option 5 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes PBN arrival transitions alongside vectoring. This is a change to the way that arrivals are handled today, and whilst there is no evidence to suggest that this is unsafe, there would be greater safety assurance work compared to the options which only look to vector arrivals. In in the long term, PBN arrival transitions offer reduced workload for ATC and pilots compared to the vectoring which occurs within the 'without airspace change' scenario. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. The introduction of PBN arrival transition to RWY 23 is also expected to deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures also offers reduced ATC and pilot workload due to the reduction in instructions. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 5 are shown in Figures TA41 to TA70 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £10,676,929 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 107.

Table 107 Option 5 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 5	£10,676,929	£6,754,774	£2,794,248	£5,244	£447,511	£675,151	4,846	16,111	12,463	32,182

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 5	$L_{Aeq,16h}$	51	41.1	64400	30400	33	0	14	30
			54	22.0	27800	13200	10	0	6	16
			57	11.8	8000	3700	2	0	0	3
			60	5.9	1600	800	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 5	$L_{Aeq,16h}$	51	43.9	71000	33500	38	0	15	31
			54	23.5	31600	15000	12	0	7	17
			57	12.6	9800	4600	3	0	0	5
			60	6.3	1800	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 5	$L_{Aeq,8h}$	45	66.3	92800	43700	45	0	21	47
			48	34.2	53100	25300	24	0	12	23
			51	18.3	19500	9600	6	0	5	10
			54	9.3	2800	1300	0	0	0	2
			55	7.4	1400	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0

			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 5	$L_{Aeq,8h}$	45	70.4	96900	45700	46	0	21	51
			48	36.6	56900	26900	29	0	12	24
			51	19.5	22200	10800	6	0	5	12
			54	10.0	3300	1600	0	0	0	2
			55	7.9	1700	900	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	<100	<100	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL

Table 108 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 5:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL.

Table 108 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 5

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	64,000	-4,200
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	91,000	+200
Above SOAEL	1,500	1,500	0

2027 Assessment of significant noise effects, residential receptors

Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 109 summarises how noise increases are experienced across the population and Table 110 summarises how noise decreases are experienced across the population.

These tables show that for Option 5:

- in 2027, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are no likely significant beneficial effects due to noise decreases; and

- in 2027, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 111 and the postcode receptors representing these locations are presented in Figure 75.

Table 109 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 5 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	21,100	31,600
Minor adverse	2.0 - 2.9dB	0	<100
Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	300
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 110 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 5 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	46,800	59,400
Minor beneficial	2.0 - 2.9dB	900	2,300
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 111 2027 community areas experiencing likely significant effects, Option 5

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

To the south-west of the airport	Isolated properties to the south of Howwood, broadly between Barcraigs Reservoir and Broadhead Hill	Night-time beneficial likely significant effect

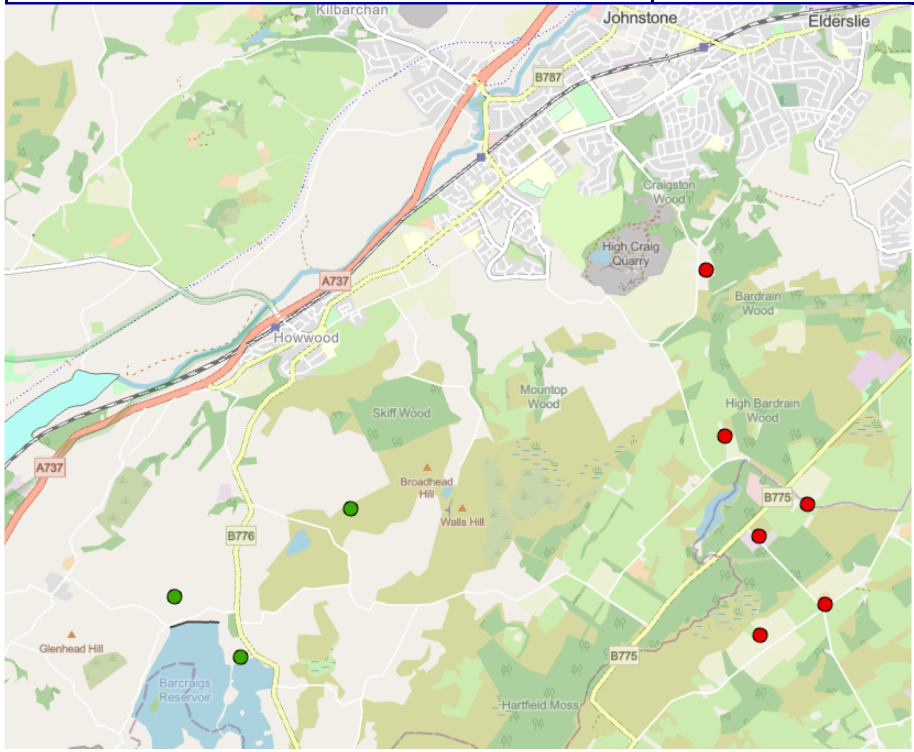


Figure 75 2027 Option 5, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 5.

2036 Noise exposure above LOAEL and SOAEL

Table 112 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the ‘without airspace change’ scenario to the ‘with airspace change scenario in 2036.

These tables show that for Option 5:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is no change in the total number of people exposed between the LOAEL and SOAEL and a reduction to the total number of people exposed above the SOAEL.

Table 112 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 5

Noise exposure	Total Population		
	2036 ‘without airspace change’	2036 ‘with airspace change’	Change from ‘without’ to ‘with’ airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	70,700	-1,500
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	94,700	0
Above SOAEL	1,900	1,800	-100

2036 Assessment of significant noise effects, residential receptors
Table 113 summarises how noise increases are experienced across the population and Table 114 summarises how noise decreases are experienced across the population.

These tables show that for Option 5:

- in 2036, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 115 and the postcode receptors representing these locations are presented in Figure 76.

Table 113 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 5 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	22,800	32,900
Minor adverse	2.0 - 2.9dB	<100	100
Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			

Negligible	0.1 - 0.9dB	0	500
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 114 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 5 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	49,000	62,300
Minor beneficial	2.0 - 2.9dB	1,300	2,100
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 115 2036 community areas experiencing likely significant effects, Option 5

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
To the south-west of the airport	isolated properties to the south of Howwood, broadly between Lochlands Hill and Broadhead Hill	Night-time beneficial likely significant effect

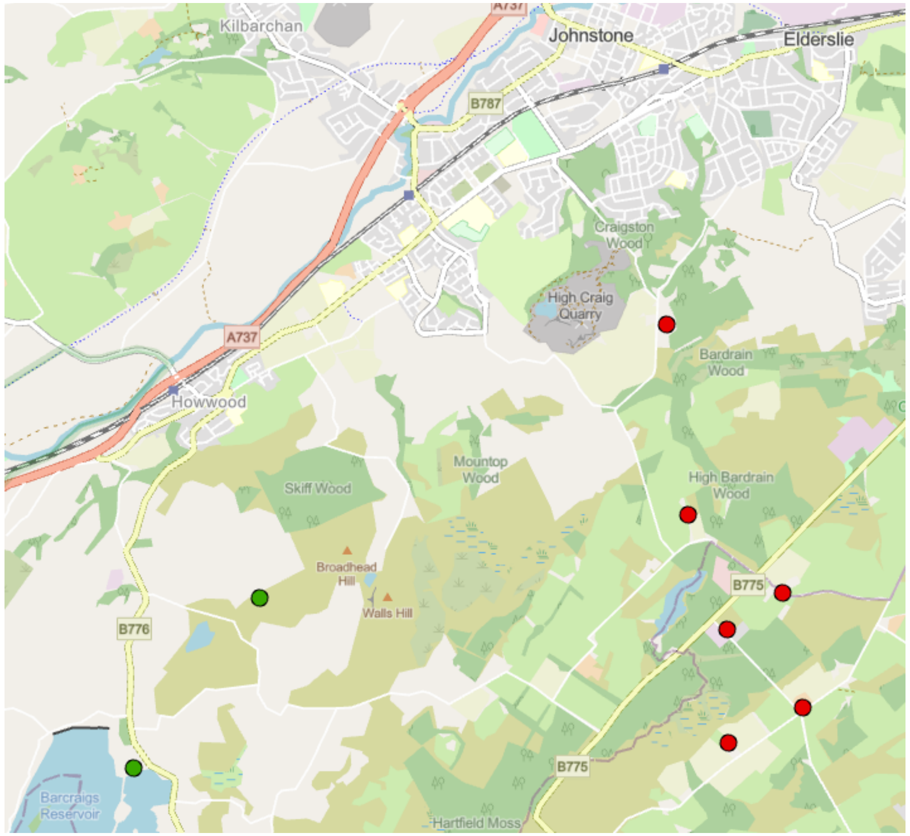


Figure 76 2036 Option 5, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 5.

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 116 and Table 117 respectively.

Table 116 2027 population newly overflown and no longer overflown (five times or more), Option 5

	Daytime	Night-time
Number of people newly overflown >=5	101,800	23,900
Number of people no longer overflown >=5	178,200	9,900

Table 117 2036 population newly overflown and no longer overflown (five times or more), Option 5

	Daytime	Night-time
Number of people newly overflown >=5	100,600	27,700
Number of people no longer overflown >=5	175,800	13,600

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_5*	N65	5	40.6	-400	0	0	0	4	5

2027	*DS_Option_5*	N65	10	6.3	2000	900	2	0	-1	2
2027	*DS_Option_5*	N65	20	-2.8	1000	600	1	0	0	0
2027	*DS_Option_5*	N65	50	-4.3	-3500	-1700	-3	0	0	-3
2027	*DS_Option_5*	N65	100	-0.4	-1500	-600	0	0	0	0
2027	*DS_Option_5*	N65	200	<0.1	0	0	0	0	0	0
2036	*DS_Option_5*	N65	5	42.6	700	500	-1	0	5	4
2036	*DS_Option_5*	N65	10	7.7	2200	1000	2	0	-3	2
2036	*DS_Option_5*	N65	20	-3.9	900	500	0	0	0	-1
2036	*DS_Option_5*	N65	50	-4.9	-3000	-1400	-3	0	0	-2
2036	*DS_Option_5*	N65	100	-0.5	-1200	-500	-1	0	0	0
2036	*DS_Option_5*	N65	200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_5*	N60	5	-10.4	-3700	-1700	-1	0	-2	-4
2027	*DS_Option_5*	N60	10	-17.3	-2600	-1200	-2	0	1	-1
2027	*DS_Option_5*	N60	20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_5*	N60	5	-10.1	-3400	-1600	-2	0	-2	-5
2036	*DS_Option_5*	N60	10	-18.3	-1400	-600	0	0	0	-2
2036	*DS_Option_5*	N60	20	0.2	100	<100	0	0	0	0

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_5*	Overflights_Day	5	-23.9	-82700	-38300	-28	-2	4	-41
2027	*DS_Option_5*	Overflights_Day	10	52.5	-36200	-17100	-22	-1	7	-20
2027	*DS_Option_5*	Overflights_Day	20	-1.9	-67700	-31000	-35	-1	-9	-43
2027	*DS_Option_5*	Overflights_Day	50	6.5	2000	900	0	0	1	1
2027	*DS_Option_5*	Overflights_Day	100	0.1	-1300	-500	0	0	0	1
2036	*DS_Option_5*	Overflights_Day	5	-19.0	-78600	-35200	-28	-5	1	-18
2036	*DS_Option_5*	Overflights_Day	10	46.2	-27800	-13100	-20	-1	6	-16
2036	*DS_Option_5*	Overflights_Day	20	2.0	-67700	-31100	-34	-1	-10	-41
2036	*DS_Option_5*	Overflights_Day	50	14.0	9700	4200	2	0	3	3
2036	*DS_Option_5*	Overflights_Day	100	-0.5	-1400	-500	-2	0	-1	-2

Metric – Overflights (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_5*	Overflights_Night	5	33.6	13700	6000	6	0	3	-3
2027	*DS_Option_5*	Overflights_Night	10	-17.9	-9800	-4400	-6	0	0	-3

2036	*DS_Option_5*	Overflights_Night	5	37.6	15500	6600	6	0	2	-7
2036	*DS_Option_5*	Overflights_Night	10	-17.9	-9200	-4100	-5	0	0	-3

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.

Air Quality – Communities

As set out in the Full Options Appraisal methodology, this option is unlikely to have a significant impact on local air quality and the impact is considered negligible and not assessed any further.

Greenhouse gas emissions – Wider society

TAG outcomes

TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 108,390t, of which 87,859t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £24,069,202 for Option 5.

Greenhouse gas emissions

Table 118 shows the annual total and per flight greenhouse gas emissions of Option 5 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 5[64].

Table 118 greenhouse gas emissions, Option 5

	Without Airspace Change		With Airspace Change		Difference	
Year	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	511,670	5,631	-9,618	-106
2028	525,266	5,742	515,377	5,634	-9,889	-108
2029	529,245	5,747	519,084	5,637	-10,161	-110
2030	533,223	5,752	522,791	5,640	-10,432	-113
2031	537,202	5,756	526,498	5,642	-10,703	-115
2032	541,180	5,760	530,206	5,644	-10,975	-117
2033	545,159	5,764	533,913	5,645	-11,246	-119
2034	549,137	5,768	537,620	5,647	-11,517	-121
2035	553,116	5,771	541,327	5,648	-11,789	-123
2036	557,095	5,774	545,035	5,649	-12,060	-125

[64] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

Changes to fuel burn for other airspace users The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits. Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users. Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.
Tranquillity – Wider society
There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA. This option results in an area of 1.7km^2 (0.09% of the total area of the National Park) and 2.7km^2 (0.15% of the total area of the National Park) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. Figure 77 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park is currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park is already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA.

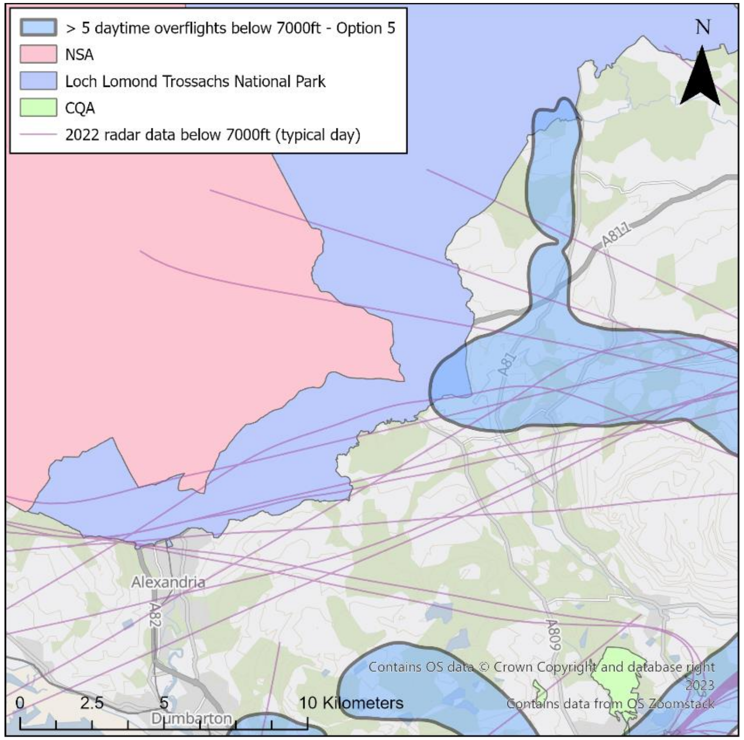


Figure 77 Area of the Loch Lomond & The Trossachs National Park intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 119 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 119 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	5	4	26	26
2036	5	5	28	27

Table 120 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 120 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	5	Bothwell Castle Grounds Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	5	Skellyton Woods Carbarns Wood Orchardbank Craigends Highmainshead Wood
2036	5	King's Park Bothwell Castle Grounds Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	4	Skellyton Woods Carbarns Wood Orchardbank Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 5.

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_5*	LAEQ16HR	51	0	0	0	0	1	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_5*	LAEQ16HR	51	0	0	0	0	0	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area	National Parks	Candidate Quiet Area	Country Parks	Gardens and Designated Landscapes

				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_5*	Overflights_Day	5	0	0	1	1.7	0	-2.6	0	-2.3	-1	-0.4
			10	0	0	1	0.3	-5	-1.6	0	0.4	0	0.2
			20	0	0	0	0	-2	-0.2	0	-0.9	-1	-0.2
			50	0	0	0	0	2	-0.3	1	1.4	0	<-0.1
			100	0	0	0	0	0	-0.1	0	0	0	0
2036	*DS_Option_5*	Overflights_Day	5	0	0	1	2.7	1	-2.4	0	-2.3	-2	-0.9
			10	0	0	1	0.5	-3	-2.7	0	-0.9	0	-0.3
			20	0	0	0	0	-2	-0.4	0	-0.9	0	-0.4
			50	0	0	0	0	2	-0.2	1	1.8	0	<-0.1
			100	0	0	0	0	0	<-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_5	Overflights_Day	5	1	2.7	-1	-0.9	0	2.0

			10	0	<-0.1	0	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_5	Overflights_Day	5	1	5.1	-1	-1.0	0	3.2
			10	0	<-0.1	-1	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_5	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_5	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 121:

Table 121 Option 5 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 5	13801	35772	52337
Reduction	-4313	-11217	-9983

Resilience

The introduction of PBN SIDs also removes Glasgow Airport's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

The introduction of PBN approaches will improve Glasgow Airport's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C: General Aviation – Access – Controlled Airspace Assessment.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see the NERL FOA)

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow

Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 5	13801	35772	52337
Reduction	-4313	-11217	-9983
£ (in 2024 prices)	**-£249,660**	**-£649,307**	**-£577,921**

Fuel burn – General aviation / commercial airlines

Table 122 shows the annual total and per flight fuel burn of Option 5 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 5.

Table 122 fuel burn, Option 5

	Without Airspace Change			With Airspace Change			Difference		
Year	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	160,902	£110,377,425	1,771	-3,024	-£2,074,771	-33
2028	165,178	£113,310,454	1,806	162,068	£111,177,147	1,772	-3,110	-£2,133,307	-34
2029	166,429	£114,168,711	1,807	163,234	£111,976,870	1,773	-3,195	-£2,191,842	-35

2030	167,680	£115,026,969	1,809	164,400	£112,776,592	1,773	-3,280	-£2,250,377	-35
2031	168,931	£115,885,226	1,810	165,566	£113,576,314	1,774	-3,366	-£2,308,913	-36
2032	170,182	£116,743,484	1,811	166,731	£114,376,036	1,775	-3,451	-£2,367,448	-37
2033	171,434	£117,601,741	1,813	167,897	£115,175,758	1,775	-3,536	-£2,425,983	-37
2034	172,685	£118,459,999	1,814	169,063	£115,975,480	1,776	-3,622	-£2,484,519	-38
2035	173,936	£119,318,256	1,815	170,229	£116,775,202	1,776	-3,707	-£2,543,054	-39
2036	175,187	£120,176,514	1,816	171,395	£117,574,924	1,776	-3,792	-£2,601,589	-39

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP

This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system.
The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.

Operational costs – Airport / ANSP

There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £80,000 every 5 years (based on 2024 prices). This is an increase of £10,000 every 5 years compared to the baseline.

Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 5-8 (with PBN transitions) are expected to require more training than those with only vectoring however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the ‘without airspace change’ baseline. **Integration of diverse users -** The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft. **Simplification, reducing complexity and improving efficiency -** The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays. **Environmental sustainability -** The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.8 Option 6

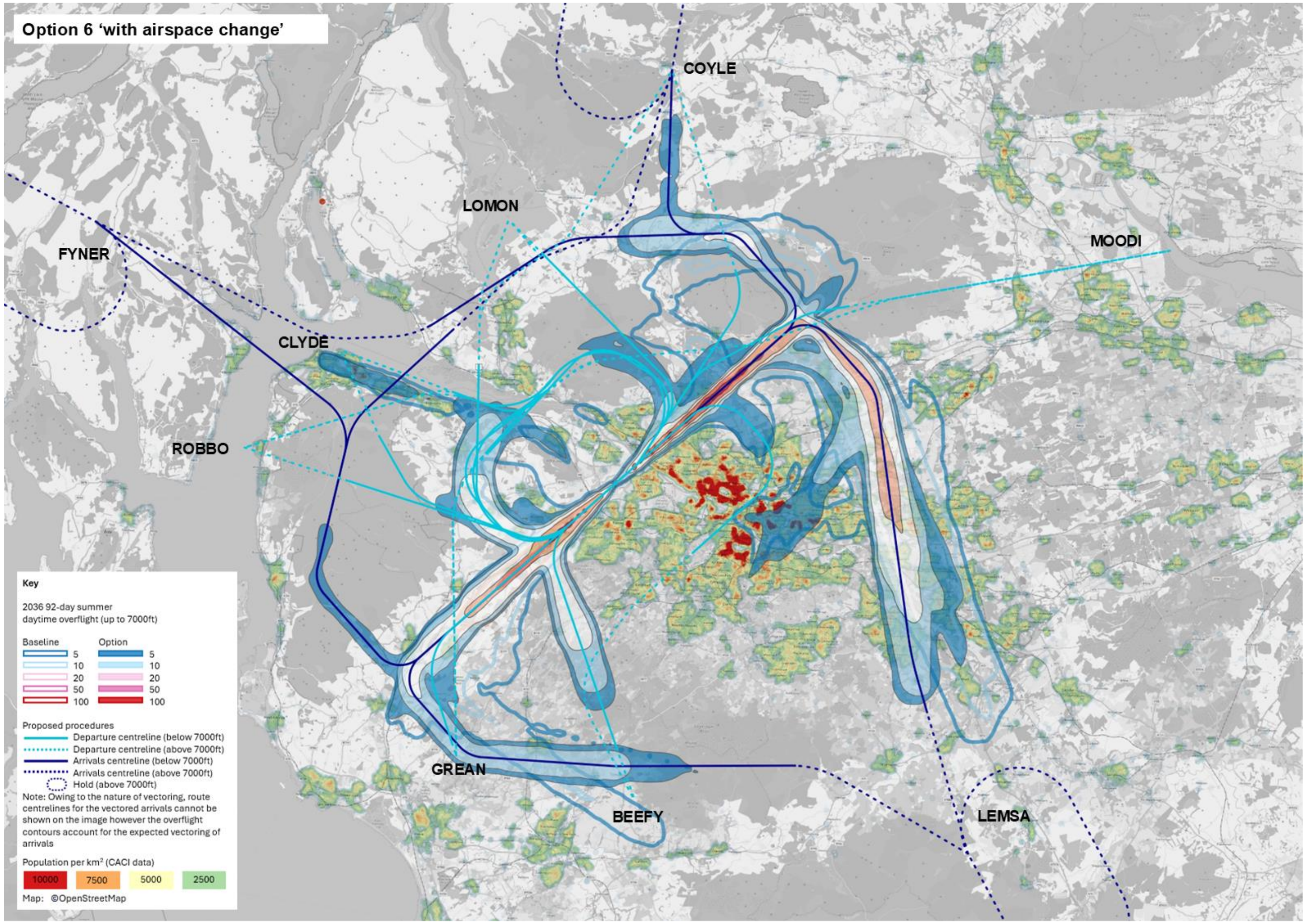


Figure 78 Option 6 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 6	PBN and Vectors	PBN and Vectors	Offset SIDs	No offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day [65]	Description
Runway 05 – Offsets			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.

[65] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

ROBBO	ROBBO	1%	The RNP ROBBO SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies an offset departure before turning at c.8nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies an offset departure before turning at c.4nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.

SID Name	Equivalent Baseline SID	Percentage of overall departure	Description

		traffic on an average day[66]	
Runway 23 – Straight ahead (no offsets)			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that routes straight ahead until turning at c.9nm called the GREAN departure, and one that initially flies straight ahead and then turns at c.2nm called the BEEFY departure. The overflight (5) contour shows that this largely follows the areas where NORBO departures fly today. This includes overflight of the more densely populated areas of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID turns at c.2nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shown in figure -- above shows that this largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies straight ahead over the same areas as final approach for c2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[66] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies straight ahead over the same areas as final approach for c.2nm before turning right. This initial part of the right turn routes over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank . These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies straight ahead over the same areas as final approach for c.2nm before turning right over Kilbarchan, Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.

Aviation Industry Technical Information

4.8.1 Draft procedure information including proposed missed approach procedures can be found in Appendix A.

4.8.2 Note that the position of the Final Approach Fix (FAF) for the Runway 23 ILS procedure has been amended as a result of this option due to the requirements for the PBN arrival transitions to link with both an RNP and ILS approach. Draft information is included in Appendix A.

Noise abatement procedures:

4.8.3 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:

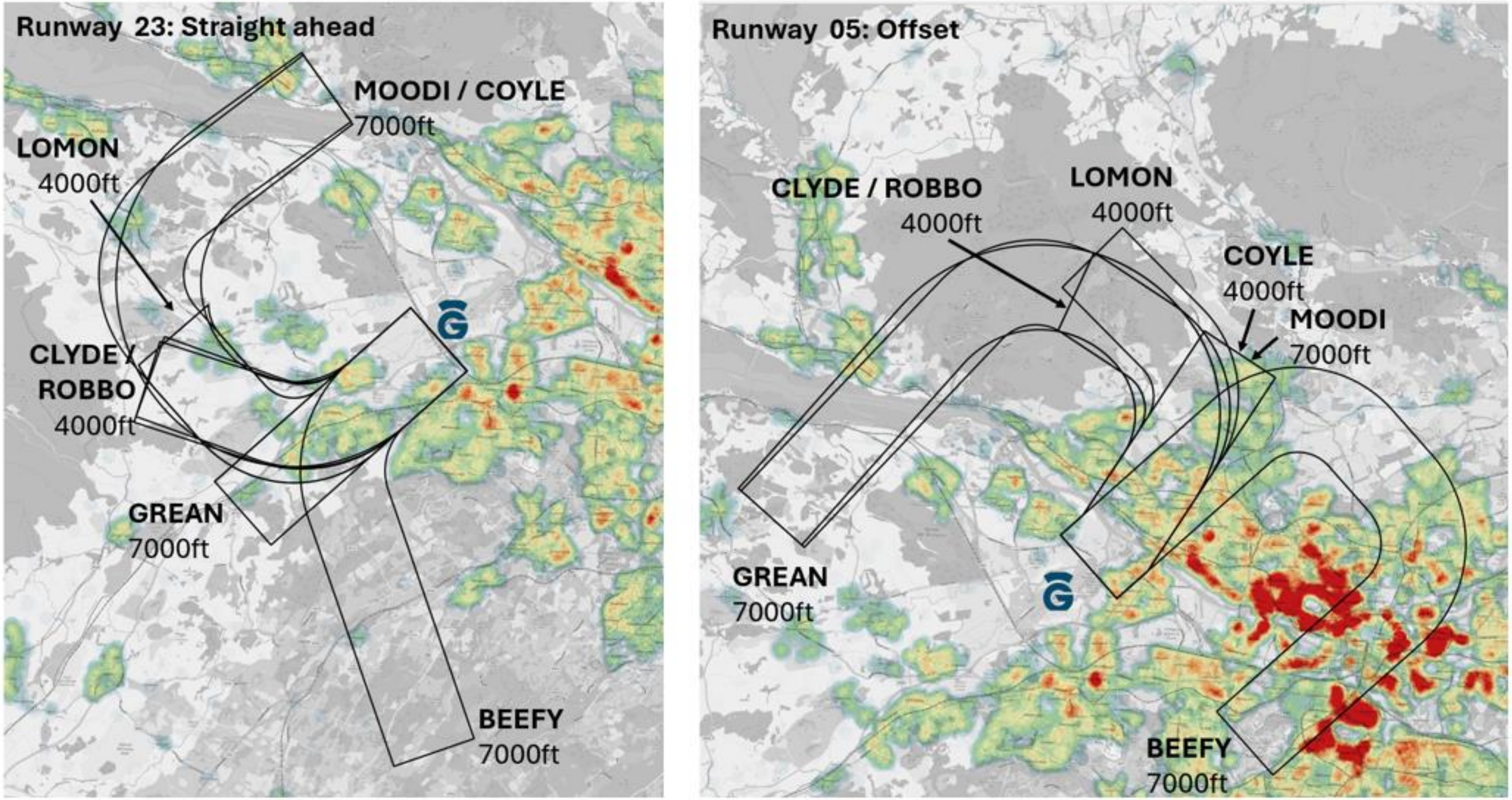


Figure 79 Option 6 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes PBN arrival transitions alongside vectoring. This is a change to the way that arrivals are handled today, and whilst there is no evidence to suggest that this is unsafe, there would be greater safety assurance work compared to the options which only look to vector arrivals. In in the long term, PBN arrival transitions offer reduced workload for ATC and pilots compared to the vectoring which occurs within the 'without airspace change' scenario. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. The introduction of PBN arrival transition to RWY 23 is also expected to deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures also offers reduced ATC and pilot workload due to the reduction in instructions. -As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 6 are shown in Figures TA71 to TA74 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £11,156,944 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 123.

Table 123 Option 6 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 6	£11,156,944	£6,901,759	£3,048,070	£10,213	£477,241	£719,662	10,245	22,504	17,290	38,050

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 6	$L_{Aeq,16h}$	51	40.8	66800	31600	33	0	13	29
			54	21.8	27300	13000	10	0	6	15
			57	11.6	7800	3700	2	0	0	4
			60	5.8	1400	700	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0

			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 6	$L_{Aeq,16h}$	51	43.6	71000	33500	36	0	14	33
			54	23.2	30900	14700	12	0	7	18
			57	12.5	9300	4400	3	0	0	5
			60	6.3	1700	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 6	$L_{Aeq,8h}$	45	66.6	93400	44000	45	0	20	46
			48	34.1	52800	25200	28	0	12	23
			51	18.2	19100	9400	6	0	5	11
			54	9.2	2600	1300	0	0	0	2
			55	7.4	1300	700	0	0	0	2

			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0
			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 6	$L_{Aeq,8h}$	45	70.7	96300	45400	47	0	20	51
			48	36.5	59500	28300	31	0	12	24
			51	19.4	21900	10800	6	0	5	13
			54	9.9	3300	1600	0	0	0	2
			55	7.9	1600	800	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL

Table 124 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the ‘without airspace change’ scenario to the ‘with airspace change scenario in 2027.

These tables show that for Option 6:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a decrease in the total number of people exposed above the SOAEL.

Table 124 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 6

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	66,300	-1,900
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	91,800	+1,000
Above SOAEL	1,500	1,400	-100

2027 Assessment of significant noise effects, residential receptors
Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 125 summarises how noise increases are experienced across the population and Table 126 summarises how noise decreases are experienced across the population.

These tables show that for Option 6:

- in 2027, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;

- in 2027, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2027, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 127 and the postcode receptors representing these locations are presented in Figure 80.

Table 125 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 6 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	23,400	31,500
Minor adverse	2.0 - 2.9dB	0	1,700
Moderate adverse	3.0 - 5.9dB	0	**200**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 126 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 6 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	46,200	59,200
Minor beneficial	2.0 - 2.9dB	900	2,300
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,500
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 127 2027 community areas experiencing likely significant effects, Option 6

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	Isolated properties to the south of Howwood, broadly between Barcraigs Reservoir and Broadhead Hill	Night-time <u>beneficial</u> likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time <u>adverse</u> likely significant effect

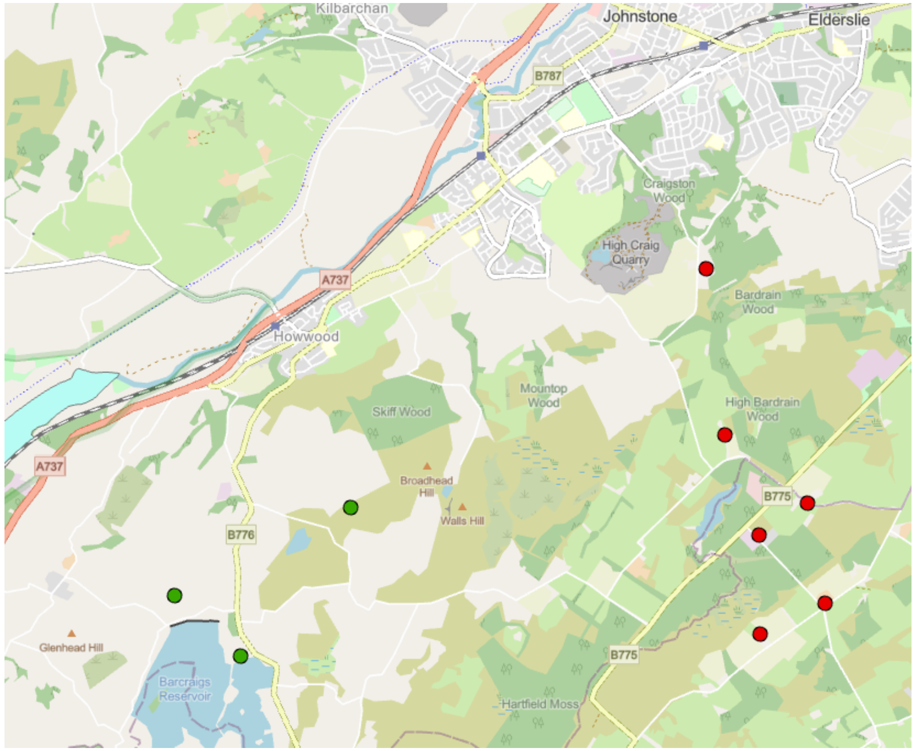


Figure 80 2027 Option 6, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 6.

2036 Noise exposure above LOAEL and SOAEL

Table 128 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 6:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is a reduction in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 128 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 6

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	70,700	-1,500
Above SOAEL	<100	<100	0

Night-time			
Above LOAEL and below SOAEL	94,700	94,200	-500
Above SOAEL	1,900	1,700	-200

2036 Assessment of significant noise effects, residential receptors
Table 129 summarises how noise increases are experienced across the population and Table 130 summarises how noise decreases are experienced across the population.

These tables show that for Option 6:

- in 2036, during the daytime, there are no likely significant adverse effects due to noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are no likely significant beneficial effects due to noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 131 and the postcode receptors representing these locations are presented in Figure 81.

Table 129 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 6 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	24,800	33,300

Minor adverse	2.0 - 2.9dB	<100	1,700
Moderate adverse	3.0 - 5.9dB	0	**<100**
Major adverse	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 130 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 6 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	48,900	61,500
Minor beneficial	2.0 - 2.9dB	1,300	2,100
Moderate beneficial	3.0 - 5.9dB	0	**<100**
Major beneficial	6.0dB or more	0	0
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,800

Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 131 2036 community areas experiencing likely significant effects, Option 6

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect
	isolated properties to the south of Howwood, broadly between Lochlands Hill and Broadhead Hill	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

Figure 81 2036 Option 6, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](#))

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, no significant effects (adverse or beneficial) have been identified for any noise sensitive buildings for Option 6.

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 116 and Table 117 respectively.

Table 132 2027 population newly overflown and no longer overflown (five times or more), Option 6

	Daytime	Night-time
Number of people newly overflown >=5	103,500	23,900
Number of people no longer overflown >=5	177,000	13,500

Table 133 2036 population newly overflown and no longer overflown (five times or more), Option 6

	Daytime	Night-time
Number of people newly overflown >=5	103,000	27,700
Number of people no longer overflown >=5	174,800	17,100

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_6*	N65	5	43.9	700	200	3	0	4	8
			10	7.3	3600	1500	2	0	0	3
			20	-3.1	500	300	1	0	0	1

			50	-4.5	-4100	-2000	-3	0	0	-4
			100	-0.6	-2300	-1000	0	0	0	0
			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_6*	N65	5	45.7	2500	1100	3	0	5	7
			10	8.9	2800	1000	2	0	-2	3
			20	-4.3	0	100	0	0	0	0
			50	-5.2	-3500	-1600	-3	0	0	-2
			100	-1.1	-3200	-1400	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_6*	N60	5	-10.7	-3700	-1800	-1	0	-2	-4
			10	-18.6	-2800	-1300	-2	0	1	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_6*	N60	5	-10.4	-3900	-1800	-2	0	-2	-5
			10	-18.9	-1700	-700	-1	0	0	-1

			20	0.2	100	<100	0	0	0	0

Metric – Overflights (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
			5	-19.4	-75100	-35100	-28	-2	2	-39
			10	52.8	-33000	-15800	-20	-1	6	-19
2027	*DS_Option_6*	Overflights_Day	20	-2.6	-68600	-31300	-32	-1	-10	-41
			50	5.8	1000	500	0	0	1	-1
			100	-1.2	-2600	-1100	-1	0	0	1
			5	-15.2	-71900	-32500	-28	-5	-1	-16
			10	46.7	-21900	-10500	-17	-1	7	-14
2036	*DS_Option_6*	Overflights_Day	20	1.3	-67700	-31000	-31	-1	-12	-39
			50	13.3	8400	3600	2	0	3	3
			100	-1.6	-2700	-1100	-2	0	-1	-2

Metric – Overflights (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_6*	Overflights_Night	5	32.8	12000	5300	5	0	2	-4
			10	-19.3	-11900	-5300	-6	0	0	-3
2036	*DS_Option_6*	Overflights_Night	5	36.7	14300	6100	5	0	2	-4
			10	-19.8	-11100	-4900	-5	0	0	-3

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.

Air Quality – Communities
Pollutant concentrations for annual mean NOx, NO_2, PM_{10} and $PM_{2.5}$ predicted negligible impact at all assessed receptor locations. The maximum change predicted for each pollutant at any receptor in each assessment year was <0.01 µg/m^3. The maximum concentration predicted for each pollutant at any relevant receptor, provided below, which is the same result for 2027 and 2036[67]: • A maximum annual mean NOx of 23.6 µg/m^3 was predicted at the Black Cart SPA; • A maximum annual mean NO_2 of 15.6 µg/m^3 was predicted at PA4 9LP, on Walkinshaw Road at the northwestern boundary of the airport; • A maximum annual mean PM_{10} of 10.9 µg/m^3 was predicted at PA3 2TQ, on St Andrew' Crescent, around 150m south of the airport boundary; and • A maximum annual mean $PM_{2.5}$ of 6.3 µg/m^3 was predicted at PA3 3AD, on Blackstone Road, around 300m from the southwestern boundary of the airport. The full results from the dispersion modelling are provided in Appendix B. The results show there were no exceedances of NOx, NO_2, PM_{10} and $PM_{2.5}$ relevant annual mean and short term standards predicted at any of the assessed receptors, in any assessment year. Therefore, the effects of NOx, NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors, as a result of option 6, are predicted to be not significant, in any assessment year.
Greenhouse gas emissions – Wider society
TAG outcomes TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 106,135t, of which 86,520t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £23,519,634 for Option 6. **Greenhouse gas emissions** Table 134 shows the annual total and per flight greenhouse gas emissions of Option 6 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 6[68].

[67] This is as a result of the negligible change as a result of the aircraft emissions changes and assuming to improvement in background concentrations for the 2022 baseline.
[68] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

Table 134 greenhouse gas emissions, Option 6

Year	Without Airspace Change		With Airspace Change		Difference	
	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	511,888	5,634	-9,399	-103
2028	525,266	5,742	515,597	5,637	-9,669	-106
2029	529,245	5,747	519,306	5,640	-9,939	-108
2030	533,223	5,752	523,014	5,642	-10,209	-110
2031	537,202	5,756	526,723	5,644	-10,479	-112
2032	541,180	5,760	530,432	5,646	-10,748	-114
2033	545,159	5,764	534,141	5,648	-11,018	-117
2034	549,137	5,768	537,849	5,649	-11,288	-119
2035	553,116	5,771	541,558	5,650	-11,558	-121
2036	557,095	5,774	545,267	5,651	-11,828	-123

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users. Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.
Tranquillity – Wider society
There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA. This option results in an area of 1.7km^2 (0.09% of the total area of the National Park) and 2.7km^2 (0.15% of the total area of the National Park) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. Figure 82 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park is currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park is already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA.

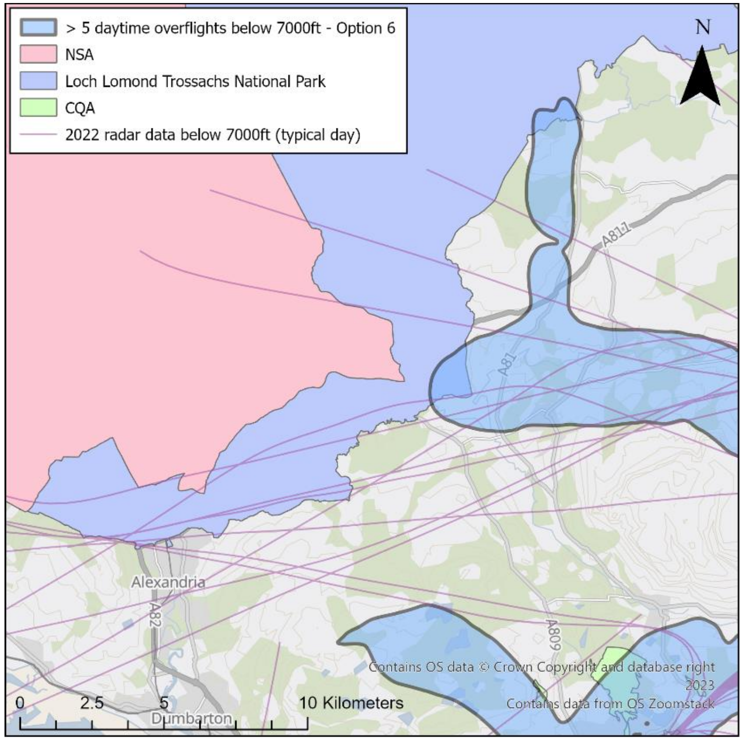


Figure 82 Area of the Loch Lomond & The Trossachs National Park intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 135 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 135 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	4	4	27	26
2036	5	5	29	27

Table 136 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 136 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	6	Bothwell Castle Grounds Carneddans Wood Mains Plantation Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	5	Skellyton Woods Carbarns Wood Orchardbank Craigends Highmainshead Wood
2036	6	King's Park Bothwell Castle Grounds Carneddans Wood Mains Plantation Cardowan Moss	4	Skellyton Woods Carbarns Wood Orchardbank Highmainshead Wood

		High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park		

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 6.

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_6*	LAEQ16HR	51	0	0	0	0	0	-0.4	0	0	0	<-0.1
			54	0	0	0	0	0	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_6*	LAEQ16HR	51	0	0	0	0	0	-0.4	0	0	0	<-0.1

			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_6*	Overflights_Day	5	0	0	1	1.7	1	-0.1	1	-0.7	-2	<-0.1
			10	0	0	1	0.3	-4	-1.5	0	0.4	0	0.2
			20	0	0	0	0	-2	-0.3	0	-0.9	-1	-0.2
			50	0	0	0	0	2	-0.3	1	1.4	0	<-0.1
			100	0	0	0	0	-1	-0.1	0	0	0	0
2036	*DS_Option_6*	Overflights_Day	5	0	0	1	2.7	2	0.2	1	-0.6	-3	-0.5
			10	0	0	1	0.5	-2	-2.5	0	-0.9	0	-0.4
			20	0	0	0	0	-2	-0.4	0	-0.9	0	-0.5
			50	0	0	0	0	2	-0.2	1	1.8	0	<-0.1
			100	0	0	0	0	0	-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_6	Overflights_Day	5	1	1.2	-1	-0.9	0	0.6
			10	0	<-0.1	0	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_6	Overflights_Day	5	1	2.6	-1	-1.0	0	0.7
			10	0	<-0.1	-1	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)

2027	DS_Option_6	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_6	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 137:

Table 137 Option 6 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 6	14376	37287	53547
Reduction	-3738	-9701	-8773

Resilience

The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

The introduction of PBN approaches will improve Glasgow Airport's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have ILS precision approach and NDB and visual non precision approaches available.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see NERL FOA).

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 6	14376	37287	53547
Reduction	-3738	-9701	-8773
£ (in 2024 prices)	**-£216,372**	**-£561,563**	**-£507,870**

Fuel burn – General aviation / commercial airlines

Table 138 shows the annual total and per flight fuel burn of Option 6 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 6.

Table 138 fuel burn, Option 6

Year	Without Airspace Change			With Airspace Change			Difference		
	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	160,971	£110,424,597	1,772	-2,956	-£2,027,600	-33
2028	165,178	£113,310,454	1,806	162,137	£111,224,644	1,773	-3,041	-£2,085,810	-33
2029	166,429	£114,168,711	1,807	163,304	£112,024,691	1,773	-3,125	-£2,144,021	-34
2030	167,680	£115,026,969	1,809	164,470	£112,824,738	1,774	-3,210	-£2,202,231	-35
2031	168,931	£115,885,226	1,810	165,636	£113,624,785	1,775	-3,295	-£2,260,441	-35
2032	170,182	£116,743,484	1,811	166,802	£114,424,832	1,775	-3,380	-£2,318,652	-36
2033	171,434	£117,601,741	1,813	167,969	£115,224,879	1,776	-3,465	-£2,376,862	-37
2034	172,685	£118,459,999	1,814	169,135	£116,024,926	1,776	-3,550	-£2,435,073	-37
2035	173,936	£119,318,256	1,815	170,301	£116,824,973	1,777	-3,635	-£2,493,283	-38
2036	175,187	£120,176,514	1,816	171,468	£117,625,020	1,777	-3,719	-£2,551,494	-39

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP

This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system.

The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.
Operational costs – Airport / ANSP
There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £80,000 every 5 years (based on 2024 prices). This is an increase of £10,000 every 5 years compared to the baseline. Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 5-8 (with PBN transitions) are expected to require more training than those with only vectoring however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline. **Integration of diverse users -** The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft.

Simplification, reducing complexity and improving efficiency - The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays.
Environmental sustainability - The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.9 Option 7

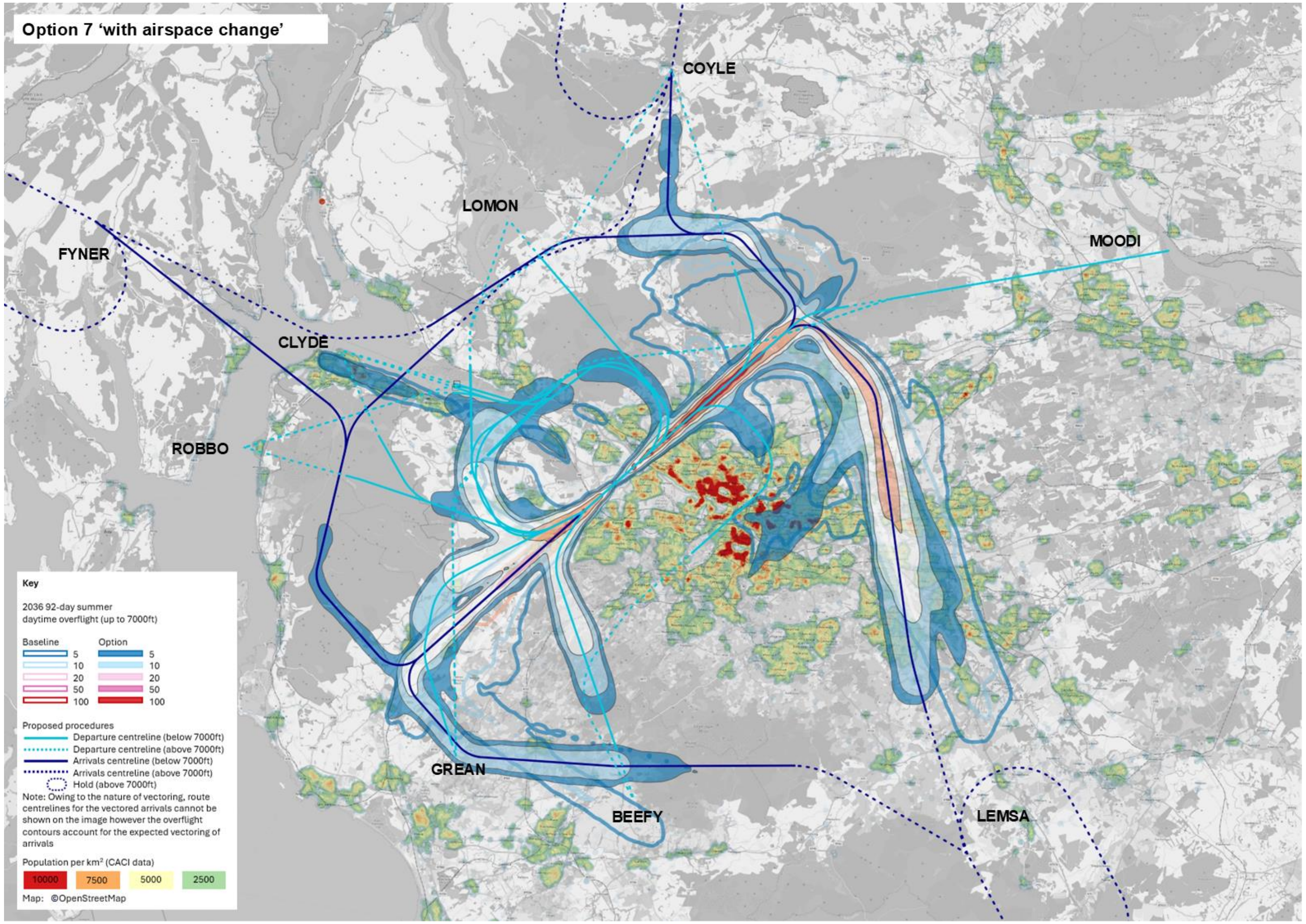


Figure 83 Option 7 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 7	PBN and Vectors	PBN and Vectors	No offset SIDs	Offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[69]	Description
Runway 05 – Straight ahead (no offsets)			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the

[69] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

			route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.
ROBBO	ROBBO	1%	The RNP ROBBO SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies straight ahead over the same areas as final approach for c.1nm before turning. This initial part of the turn routes over Whitecrook, Linnvale. These areas are already overflown today. Beyond this Drumchapel and the eastern parts of Faifley would see increased overflight compared today. The RNAV 1 SID flies straight ahead for c. 3nm overfying Whitecrook, before turning and overflying Drumchapel. This area will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies straight ahead for c. 3nm before turning and this overflies Whitecrook and Drumchapel. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies straight ahead before turning at c.7nm. The overflight (5) contour shown in figure -- above shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. Once aircraft have turned, the route overflies areas of low population density.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies straight ahead before turning at c.10nm. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel, Bearsden and Milngavie. At higher altitudes, the route overflies the western parts of Lennoxtown.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[70]	Description
Runway 23 – Offset departures			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that initially flies and offset departure and then turns at c.7nm called the GREAN departure, and the BEEFY departure described below. The overflight (5) contour shown in figure – shows that the GREAN departure initially overflies Linwood and Johnstone, before overflying Howwodd, Lochwinnoch and, at higher altitudes, Kilbirnie and Beith.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID would fly an offset departure before turning at c.2nm. This offset and turn to the south introduces overflight over some new areas including Edlerslie. The overflight (5) contour shows that beyond Edlerslie, overflight largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[70] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, and Kilmacolm. At higher altitudes, it overflies the eastern parts of Dumbarton and Milton. All these areas are overflown today however they would see increased overflight as a result of this option. Note two MOODI SIDs are proposed; One designed to RNP1 and one to RNAV1 specification. Although the lateral paths of these two SIDs vary slightly around the first and second turns, they do not materially alter the description above.

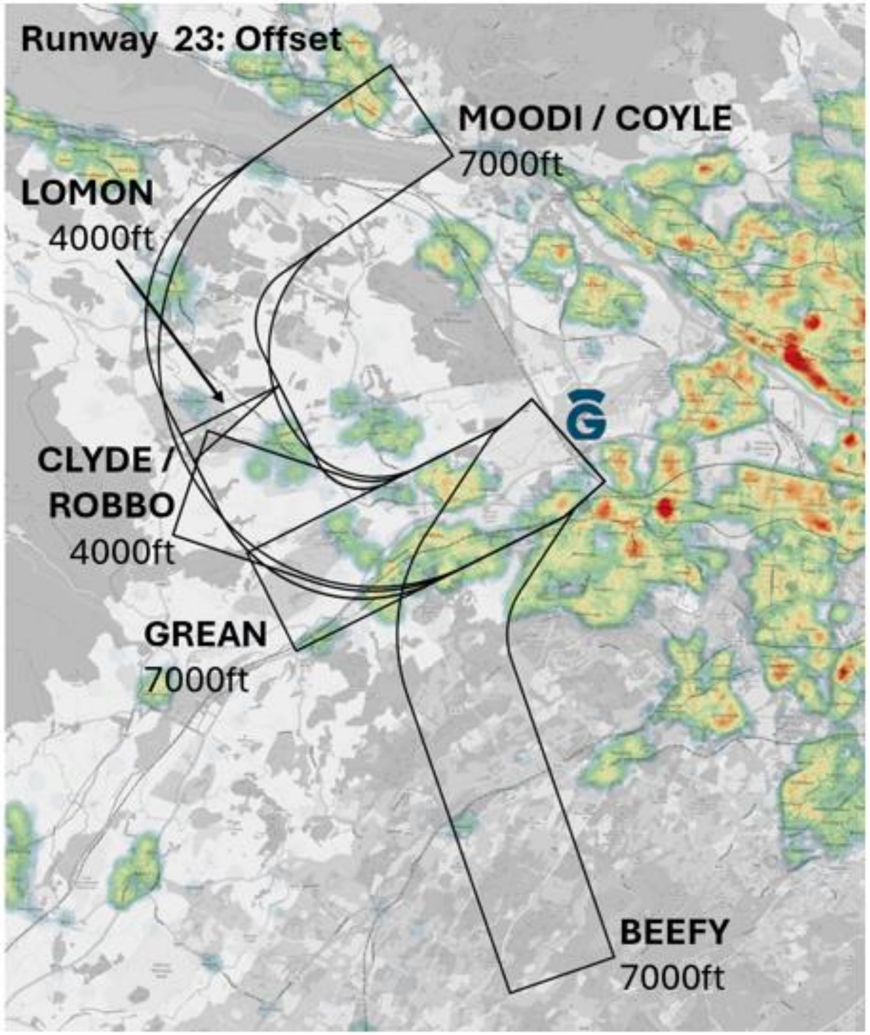
Aviation Industry Technical Information

4.9.1 Draft procedure information including proposed missed approach procedures can be found in Appendix A.

4.9.2 Note that the position of the Final Approach Fix (FAF) for the Runway 23 ILS procedure has been amended as a result of this option due to the requirements for the PBN arrival transitions to link with both an RNP and ILS approach. Draft information is included in Appendix A.

Noise abatement procedures:

4.9.3 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:



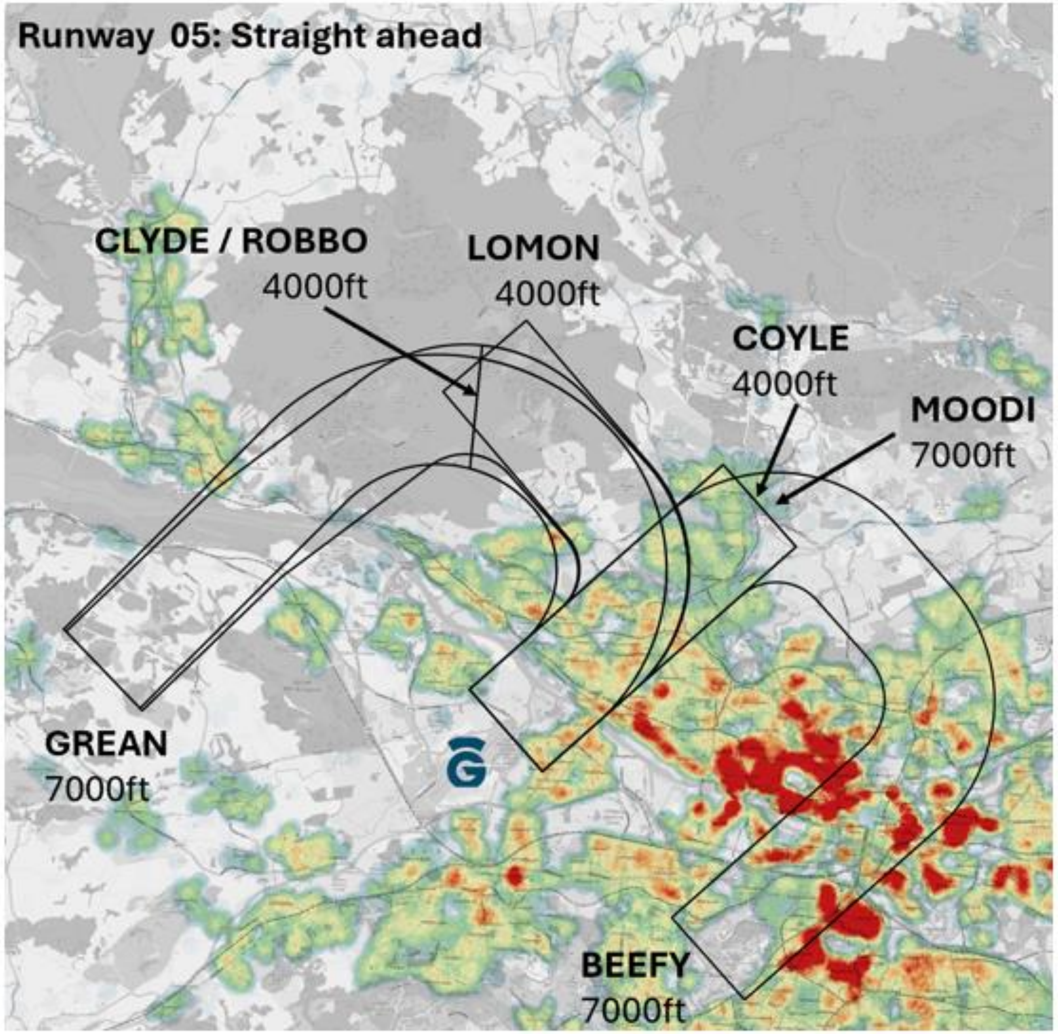


Figure 84 Option 7 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes PBN arrival transitions alongside vectoring. This is a change to the way that arrivals are handled today, and whilst there is no evidence to suggest that this is unsafe, there would be greater safety assurance work compared to the options which only look to vector arrivals. In in the long term, PBN arrival transitions offer reduced workload for ATC and pilots compared to the vectoring which occurs within the 'without airspace change' scenario. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. The introduction of PBN arrival transition to RWY 23 is also expected to deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures also offers reduced ATC and pilot workload due to the reduction in instructions. As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 7 are shown in Figures TA75 to TA78 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £15,750,714 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 139.

Table 139 Option 7 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 7	£15,750,714	£9,684,942	£4,260,856	£6,731	£716,933	£1,081,252	11,694	23,578	24,548	36,500

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 7	$L_{Aeq,16h}$	51	40.9	64100	30300	34	0	13	30
			54	21.4	26600	12700	7	0	5	13
			57	11.4	6900	3200	2	0	0	3
			60	5.8	1600	800	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 7	$L_{Aeq,16h}$	51	43.7	71500	33700	38	0	15	32
			54	23.0	30600	14500	9	0	5	13
			57	12.2	8500	3900	2	0	0	5
			60	6.2	1800	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 7	$L_{Aeq,8h}$	45	66.7	95500	45000	46	0	21	49
			48	33.9	51200	24400	24	0	12	23
			51	17.4	16100	7800	6	0	0	6
			54	8.9	2400	1200	0	0	0	2
			55	7.2	1400	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	0	0	0	0	0	0

			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 7	$L_{Aeq,8h}$	45	71.0	100100	47200	48	0	21	53
			48	36.2	56300	26600	28	0	12	23
			51	18.5	18900	9100	6	0	4	8
			54	9.5	2700	1400	0	0	0	2
			55	7.7	1700	900	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL
Table 140 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 7:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL.

Table 140 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 7

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	63,900	-4,300
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	93,800	+3,000
Above SOAEL	1,500	1,500	0

2027 Assessment of significant noise effects, residential receptors

Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 141 summarises how noise increases are experienced across the population and Table 142 summarises how noise decreases are experienced across the population.

These tables show that for Option 7:

- in 2027, during the daytime, there are likely significant adverse effects due to moderate noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and

- in 2027, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 143 and the postcode receptors representing these locations are presented in Figure 85 and Figure 86.

Table 141 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 7 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	17,000	37,300
Minor adverse	2.0 - 2.9dB	1,500	1,200
Moderate adverse	3.0 - 5.9dB	**800**	**2,200**
Major adverse	6.0dB or more	0	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	300
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 142 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 7 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	43,900	46,200
Minor beneficial	2.0 - 2.9dB	6,100	3,900
Moderate beneficial	3.0 - 5.9dB	**2,300**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 143 2027 community areas experiencing likely significant effects, Option 7

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect

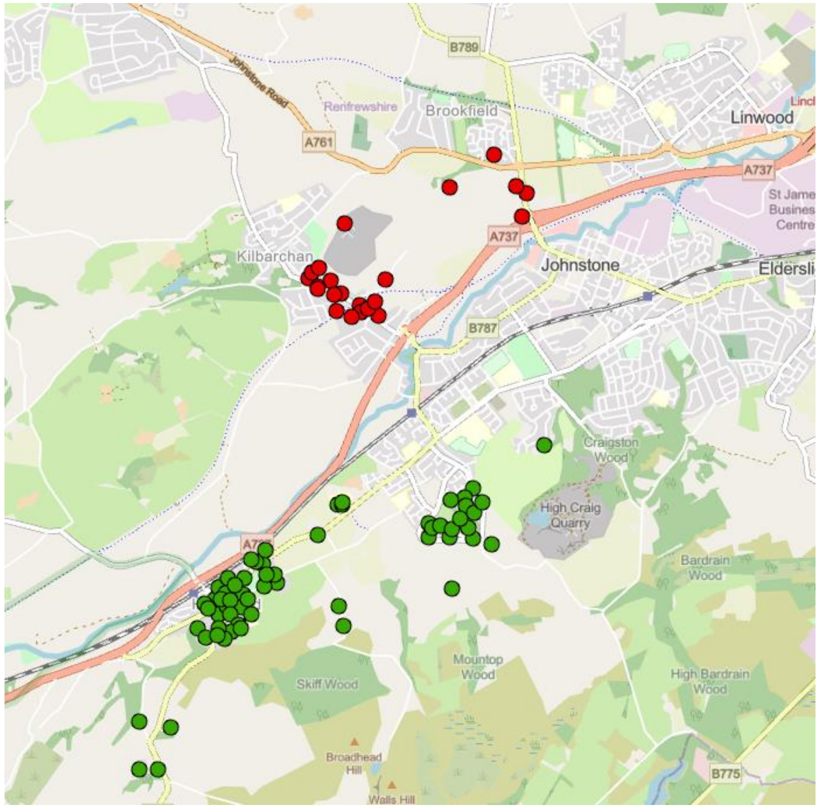


Figure 85 2027 Option 7, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

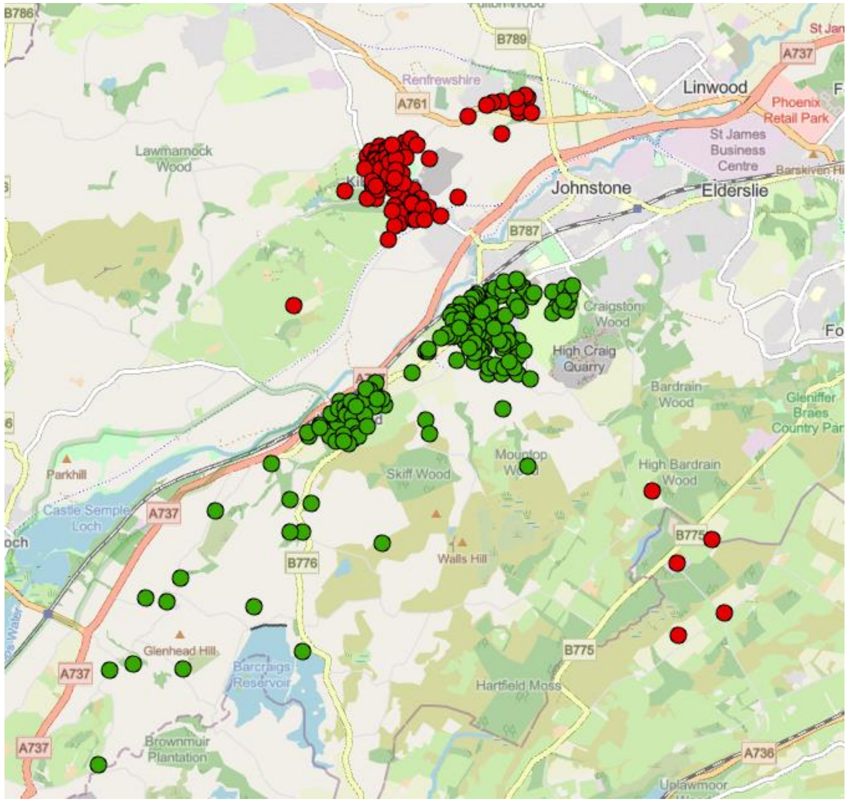


Figure 86 2027 Option 7, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, likely significant effects have been identified for the receptors shown in Table 144 for Option 7.

Table 144 2027 noise sensitive building likely significant effects Option 7

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.2	50.8	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	43.7	50.4	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.3	49.1	-3.3	Daytime beneficial likely significant effect

2036 Noise exposure above LOAEL and SOAEL

Table 145 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 7:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 145 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 7

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	71,400	-800
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	97,900	+3,200
Above SOAEL	1,900	1,800	-100

2036 Assessment of significant noise effects, residential receptors
Table 146 summarises how noise increases are experienced across the population and Table 147 summarises how noise decreases are experienced across the population.

These tables show that for Option 7:

- in 2036, during the daytime, there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 148 and the postcode receptors representing these locations are presented in Figure 87 and Figure 88.

Table 146 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 7 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	18,900	38,800
Minor adverse	2.0 - 2.9dB	1,700	1,100
Moderate adverse	3.0 - 5.9dB	**1,200**	**2,500**
Major adverse	6.0dB or more	**200**	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	500
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 147 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 7 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	44,500	48,800
Minor beneficial	2.0 - 2.9dB	6,400	3,800
Moderate beneficial	3.0 - 5.9dB	**2,400**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,100
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 148 2036 community areas experiencing likely significant effects, Option 7

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect

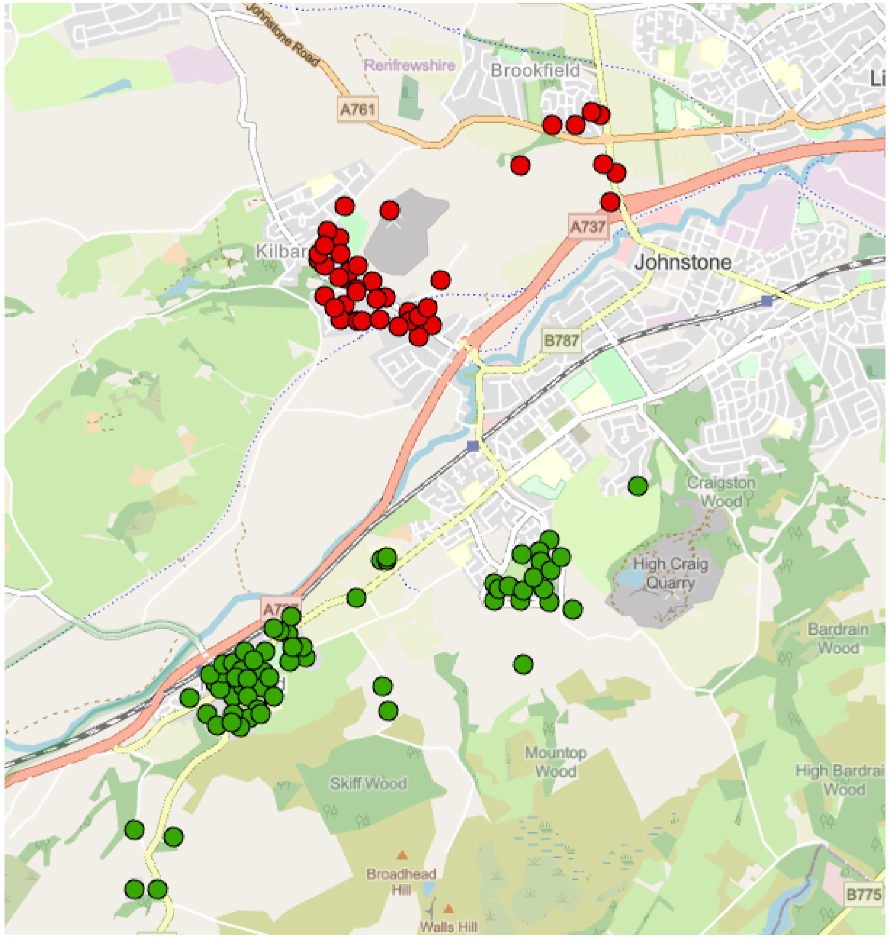


Figure 87 2036 Option 7, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](https://www.openstreetmap.org/copyright))

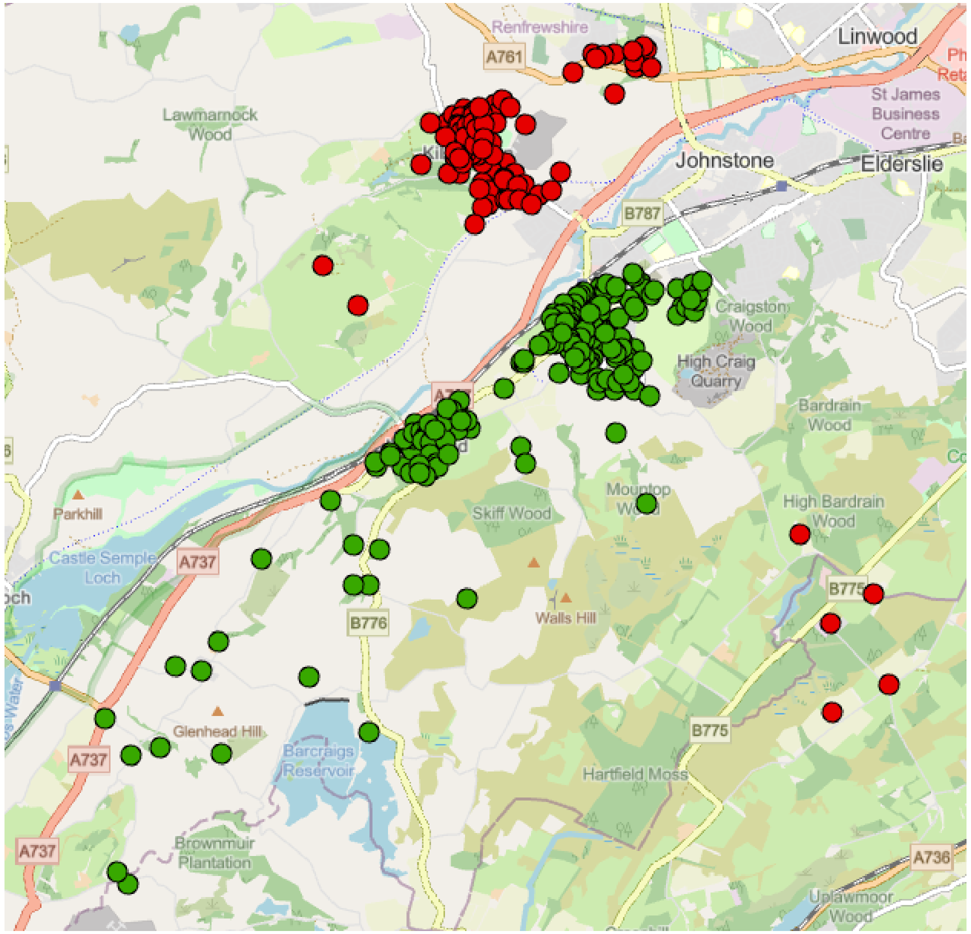


Figure 88 2036 Option 7, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap])

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, likely significant effects have been identified for the receptors shown in Table 149 for Option 7.

Table 149 2036 noise sensitive building likely significant effects Option 7

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.5	51.1	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	44.0	50.7	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.7	49.4	-3.3	Daytime beneficial likely significant effect

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 150 and Table 151 respectively.

Table 150 2027 population newly overflown and no longer overflown (five times or more), Option 7

	Daytime	Night-time
Number of people newly overflown >=5	109,500	33,900
Number of people no longer overflown >=5	174,200	18,700

Table 151 2036 population newly overflown and no longer overflown (five times or more), Option 7

	Daytime	Night-time
Number of people newly overflown >=5	108,300	38,400
Number of people no longer overflown >=5	172,500	22,900

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_7*	N65	5	52.1	1500	900	2	0	2	7
			10	5.9	3400	1600	2	0	-1	2
			20	-3.2	3600	1900	3	0	-1	3
			50	-5.5	-7200	-3500	-5	0	0	-3
			100	-0.4	-1500	-600	0	0	0	0
			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_7*	N65	5	54.1	2300	1300	1	0	2	5
			10	8.1	3900	1800	2	0	-3	2
			20	-4.1	4100	1900	2	0	0	2
			50	-6.1	-6900	-3300	-3	0	0	-3
			100	-0.5	-1200	-500	-1	0	0	0

			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_7*	N60	5	-25.5	-6200	-3000	-1	0	-3	-6
			10	-20.3	-4700	-2100	-2	0	0	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_7*	N60	5	-21.7	-6600	-3100	-2	0	-3	-7
			10	-21.5	-2900	-1000	0	0	-1	-2
			20	0.2	100	<100	0	0	0	0

Metric – Overflight (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_7*	Overflights_Day	5	0.7	-71400	-33300	-26	-2	6	-40
			10	70.3	-28800	-13700	-19	-1	4	-18

			20	4.4	-60900	-27900	-30	-1	-10	-41
			50	0.4	-5000	-2300	-6	0	-2	-4
			100	-0.2	-1700	-700	0	0	0	0
2036	*DS_Option_7*	Overflights_Day	5	5.0	-67200	-30000	-26	-5	3	-16
			10	64.1	-20100	-9600	-17	-1	3	-15
			20	8.9	-61000	-28000	-28	-1	-10	-40
			50	7.6	2600	1000	-5	0	-1	-1
			100	-1.4	-3300	-1400	-3	0	-1	-3

Metric – Overflight (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_7*	Overflights_Night	5	30.4	14600	6600	5	0	2	1
			10	-20.9	-18300	-8800	-11	0	-4	-10
2036	*DS_Option_7*	Overflights_Night	5	34.4	16000	7100	4	0	2	-4
			10	-19.9	-15900	-7500	-12	0	-3	-10

Changes to noise distribution as a result of other airspace users

The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users. Whilst this options sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.
Air Quality – Communities
As set out in the Full Options Appraisal methodology, this option is unlikely to have a significant impact on local air quality and the impact is considered negligible, and not assessed any further.
Greenhouse gas emissions – Wider society
TAG outcomes TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 104,097t, of which 85,311t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £23,022,760 for Option 7. **Greenhouse gas emissions** Table 152 shows the annual total and per flight greenhouse gas emissions of Option 7 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 7[71].

[71] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

Table 152 greenhouse gas emissions, Option 7

Year	Without Airspace Change		With Airspace Change		Difference	
	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	512,086	5,636	-9,202	-101
2028	525,266	5,742	515,796	5,639	-9,470	-104
2029	529,245	5,747	519,506	5,642	-9,738	-106
2030	533,223	5,752	523,216	5,644	-10,007	-108
2031	537,202	5,756	526,926	5,646	-10,275	-110
2032	541,180	5,760	530,636	5,648	-10,544	-112
2033	545,159	5,764	534,346	5,650	-10,812	-114
2034	549,137	5,768	538,057	5,651	-11,081	-116
2035	553,116	5,771	541,767	5,652	-11,349	-118
2036	557,095	5,774	545,477	5,653	-11,618	-120

Changes to fuel burn for other airspace users

The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users. Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.
Tranquillity – Wider society
There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA. This option results in an area of 1.7km^2 (0.09% of the total area of the National Park) and 2.7km^2 (0.15% of the total area of the National Park) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively. Figure 89 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park is currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park is already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA.

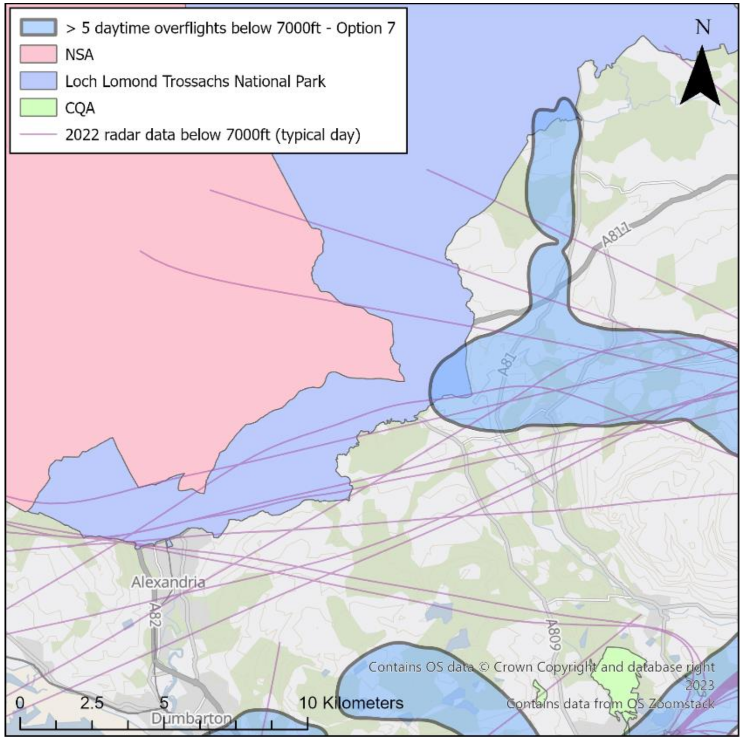


Figure 89 Area of the Loch Lomond & The Trossachs National Park intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 153 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 'with airspace change' scenarios.

Table 153 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	5	4	26	26
2036	5	5	28	27

The Barhill Wood CQA (see Figure 90), close to Kilbarchan, is newly within the $L_{Aeq,16h}$ LOAEL contour in the 2027 and 2036 'with airspace change' scenarios for this option compared to the 2027 and 2036 'without airspace change' future baseline scenarios. Consequently, there could be an adverse impact on the perception of tranquillity for this CQA. This is consistent with the daytime adverse likely significant noise effects identified for the majority of the community of Kilbarchan in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113).
The Skiff Wood CQA (see Figure 90), close to the community of Howwood, is within the $L_{Aeq,16h}$ LOAEL contour in the 'without airspace change' 2027 and 2036 future baseline scenarios but is no longer within the 2027 and 2036 $L_{Aeq,16h}$ LOAEL in the 'with airspace change' scenarios for this option. Consequently, there could be a beneficial impact on the perception of tranquillity for this CQA. This is consistent with the daytime beneficial likely significant noise effect identified for the community of Howwood in the 2027 and 2036 'with airspace change' scenarios (see Table 108 and Table 113).

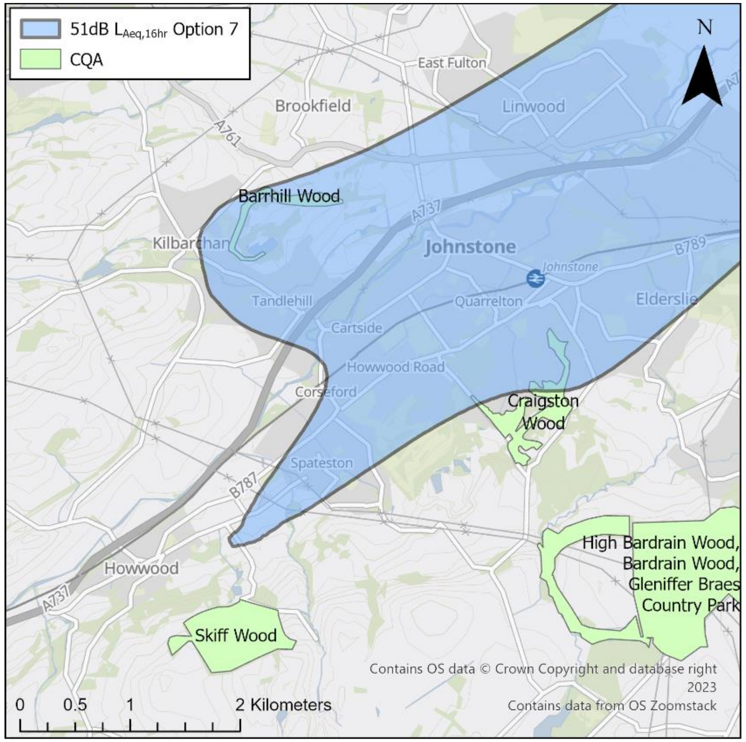


Figure 90 Barrhill Wood and Skiff Wood CQAs

Table 154 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 154 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	5	Bothwell Castle Grounds Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	5	Skellyton Woods Carbarns Wood Orchardbank Craigends Highmainshead Wood
2036	5	King's Park Bothwell Castle Grounds Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park Near Cochno Burn	4	Skellyton Woods Carbarns Wood Orchardbank Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 7.

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_7*	LAEQ16HR	51	0	0	0	0	1	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_7*	LAEQ16HR	51	0	0	0	0	0	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_7*	Overflights_Day	5	0	0	1	1.7	0	-2.5	0	-1.7	-1	-0.6
			10	0	0	1	0.3	-5	-1.8	0	1.2	0	<0.1
			20	0	0	0	0	-2	-0.5	0	0.2	0	-0.1
			50	0	0	0	0	0	-0.4	1	1.4	0	<-0.1
			100	0	0	0	0	0	-0.1	0	0	0	0
2036	*DS_Option_7*	Overflights_Day	5	0	0	1	2.7	1	-2.3	0	-1.7	-2	-1.0
			10	0	0	1	0.5	-3	-2.7	0	-0.2	0	-0.5
			20	0	0	0	0	-2	-0.6	0	0.2	0	-0.4
			50	0	0	0	0	1	-0.3	1	1.8	0	<-0.1
			100	0	0	0	0	0	<-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_7	Overflights_Day	5	1	5.0	-1	-1.0	0	4.3
			10	0	<-0.1	0	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_7	Overflights_Day	5	1	6.4	-1	-1.1	0	4.6
			10	0	<-0.1	-1	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_7	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0
2036	DS_Option_7	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 155:

Table 155 Option 7 - Departure delay per year

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 7	14376	37590	54455
Reduction	-3738	-9398	-7866

Resilience

The introduction of PBN SIDs also removes Glasgow Airport's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

The introduction of PBN approaches will improve Glasgow Airport's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow Airport will only have ILS precision approach and NDB and visual non precision approaches available.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see NERL FOA)

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of Mins of Departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 7	14376	37590	54455
Reduction	-3738	-9398	-7866
£ (in 2024 prices)	**-£216,372**	**-£544,014**	**-£455,331**

Fuel burn – General aviation / commercial airlines

Table 156 shows the annual total and per flight fuel burn of Option 7 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 7.

Table 156 fuel burn, Option 7

	Without Airspace Change			With Airspace Change			Difference		
Year	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	161,033	£110,467,248	1,772	-2,894	-£1,984,949	-32
2028	165,178	£113,310,454	1,806	162,200	£111,267,588	1,773	-2,978	-£2,042,866	-33

2029	166,429	£114,168,711	1,807	163,367	£112,067,928	1,774	-3,062	-£2,100,783	-33
2030	167,680	£115,026,969	1,809	164,533	£112,868,268	1,775	-3,147	-£2,158,701	-34
2031	168,931	£115,885,226	1,810	165,700	£113,668,609	1,776	-3,231	-£2,216,618	-35
2032	170,182	£116,743,484	1,811	166,867	£114,468,949	1,776	-3,316	-£2,274,535	-35
2033	171,434	£117,601,741	1,813	168,033	£115,269,289	1,777	-3,400	-£2,332,452	-36
2034	172,685	£118,459,999	1,814	169,200	£116,069,629	1,777	-3,485	-£2,390,369	-37
2035	173,936	£119,318,256	1,815	170,367	£116,869,970	1,777	-3,569	-£2,448,286	-37
2036	175,187	£120,176,514	1,816	171,534	£117,670,310	1,778	-3,653	-£2,506,204	-38

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP

This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system.
The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.

Operational costs – Airport / ANSP

There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £80,000 every 5 years (based on 2024 prices). This is an increase of £10,000 every 5 years compared to the baseline.

Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 5-8 (with PBN transitions) are expected to require more training than those with only vectoring however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline. **Integration of diverse users -** The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft. **Simplification, reducing complexity and improving efficiency -** The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays. **Environmental sustainability -** The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

4.10 Option 8

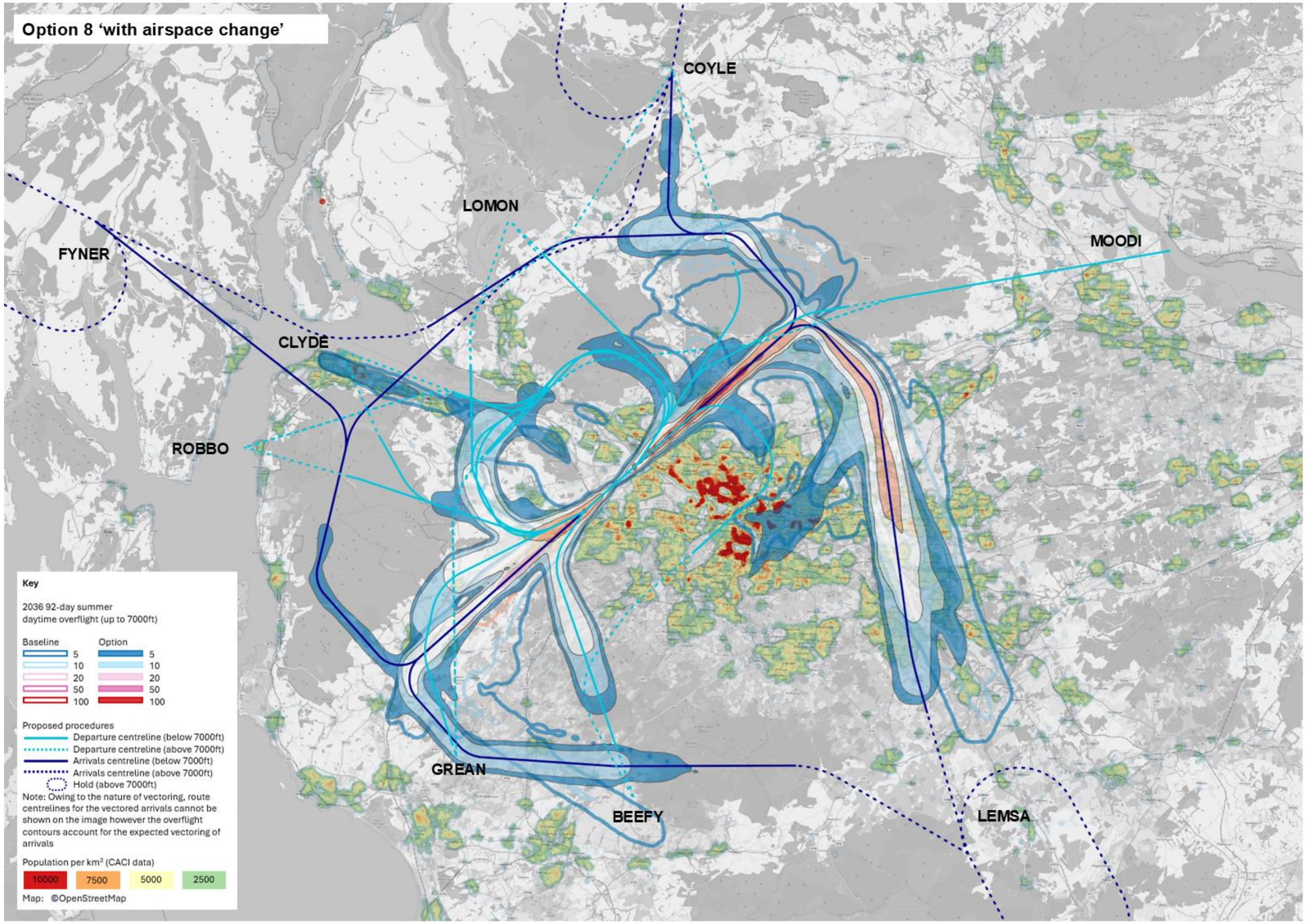


Figure 91 Option 8 'with airspace change' scenario. 2036 overflight contours overlaid with proposed route centrelines. Population data sourced from CACI

FOA Option Name	Option Component			
	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 8	PBN and Vectors	PBN and Vectors	Offset SIDs	Offset SIDs

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day [72]	Description
Runway 05 – Offsets			
GREAN	NORBO	8%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one the GREAN departure, and one called the BEEFY departure. The RNP GREAN SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
BEEFY	NORBO / LUSIV / TALLA	7%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID flies straight ahead and turns right at c.5nm and this turn to the south introduces overflight over some new areas. The overflight (5) contour shows initial overflight of Whitecrook, Old Drumchapel and Bearsden. Once aircraft have turned, the route overflies areas of low population density, with the exception of the western parts of Bishopbriggs and Colston at high altitudes.

[72] Note other traffic not flying the SIDs accounts for c.2% of overall runway 05 departure traffic on an average day. Percentages based on an annual average day.

ROBBO	ROBBO	1%	The RNP ROBBO SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	2%	The RNP CLYDE SID flies an offset departure before turning at c.1nm. This initial part routes over Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel. The RNAV 1 SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
LOMON	LOMON	1%	The LOMON SID flies an offset departure before turning at c.3nm and this overflies Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel and Bonnaughton. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
COYLE	FOYLE	1%	The COYLE SID flies an offset departure before turning at c.8nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.
MOODI	n/a – new route across the firth of forth	4%	The MOODI SID flies an offset departure before turning at c.4nm. The overflight (5) contour shows overflight of Clydebank, Whitecrook, Linnvale, Drumry, and Drumchapel, Bonnaughton and the western parts of Milngavie.

SID Name	Equivalent Baseline SID	Percentage of overall departure traffic on an average day[73]	Description
Runway 23 – Offset departures			
GREAN	NORBO	23%	The largest percentage of aircraft departing from Glasgow currently utilise the NORBO SID which routes to the south. In this option, the NORBO traffic is permanently split between two routes; one that initially flies and offset departure and then turns at c.7nm called the GREAN departure, and the BEEFY departure described below. The overflight (5) contour shows that the GREAN departure initially overflies Linwood and Johnstone, before overflying Howwodd, Lochwinnoch and, at higher altitudes, Kilbirnie and Beith.
BEEFY	NORBO / LUSIV / TALLA	20%	The BEEFY SID would be flown by the remaining NORBO/LUSIV/TALLA traffic that do not use the GREAN SID. The BEEFY SID would fly an offset departure before turning at c.2nm. This offset and turn to the south introduces overflight over some new areas including Edlerslie. The overflight (5) contour shows that beyond Edlerslie, overflight largely occurs over areas of low population density with the exception of Uplawmoor.
ROBBO	ROBBO	3%	The ROBBO SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.
CLYDE	CLYDE	5%	The CLYDE SID flies an offset departure before turning at c.2nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan. These areas will see increased overflight compared to today. Beyond this point, based on the overflight (5) contours, the SID routes over new areas however it avoids areas of dense population.

[73] Note other traffic not flying the SIDs accounts for c.6% of overall runway 23 departure traffic on an average day. Overall percentages do not add up to 74% due to rounding. Percentages based on an annual average day.

LOMON	LOMON	2%	The LOMON SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
COYLE	FOYLE	2%	The COYLE SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, Kilmacolm and the western parts of Langbank. These areas are overflown today however they would see increased overflight as a result of this option.
MOODI	n/a – new route across the firth of forth	12%	The MOODI SID flies an offset departure before turning at c.3nm. This initial part of the right turn routes over Linwood, Johnstone and Kilbarchan before then overflying Bridge of Weir, Quarriers village, and Kilmacolm. At higher altitudes, it overflies the eastern parts of Dumbarton and Milton. All these areas are overflown today however they would see increased overflight as a result of this option. Note two MOODI SIDs are proposed; One designed to RNP1 and one to RNAV1 specification. Although the lateral paths of these two SIDs vary slightly around the first and second turns, they do not materially alter the description above.

Aviation Industry Technical Information

4.10.1 Draft procedure information including proposed missed approach procedures can be found in Appendix A.

4.10.2 Note that the position of the Final Approach Fix (FAF) for the Runway 23 ILS procedure has been amended as a result of this option due to the requirements for the PBN arrival transitions to link with both an RNP and ILS approach. Draft information is included in Appendix A.

Noise abatement procedures:

4.10.3 This option proposes tactical vectoring of turboprops <=23,000kg off SIDs between 0700-2300 local & <=5,700kg H24. All other aircraft are required to remain within 1.5km either side of the SID centrelines until the following altitudes or noise corridor end points:

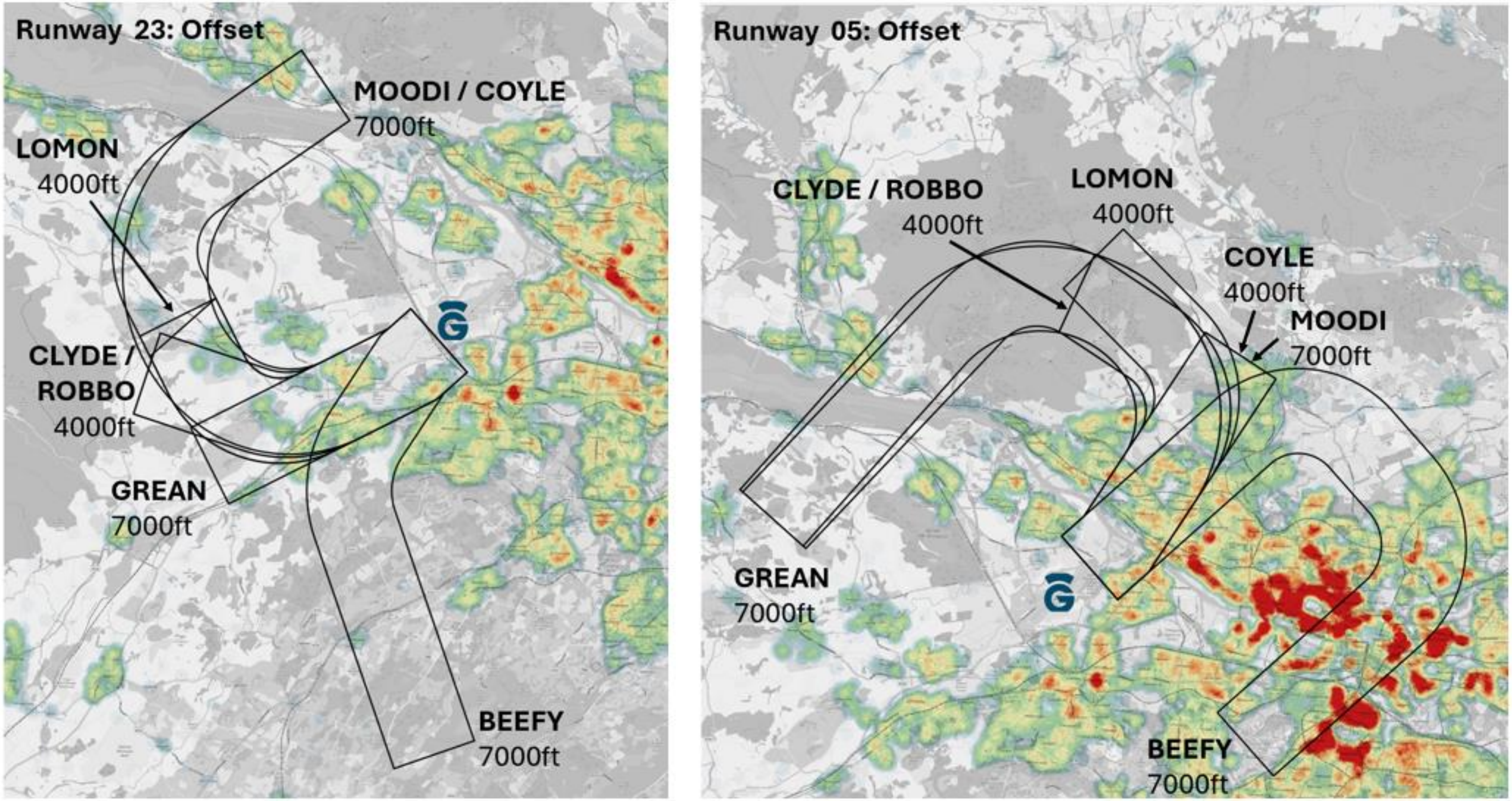


Figure 92 Option 8 proposed noise abatement procedures (Map source ©OpenStreetMap overlaid on population density data)

Full Options Appraisal
Safety – All
This option includes PBN arrival transitions alongside vectoring. This is a change to the way that arrivals are handled today, and whilst there is no evidence to suggest that this is unsafe, there would be greater safety assurance work compared to the options which only look to vector arrivals. In in the long term, PBN arrival transitions offer reduced workload for ATC and pilots compared to the vectoring which occurs within the 'without airspace change' scenario. This is because PBN routes reduce the number of times ATC have to provide pilots instructions. The introduction of PBN arrival transition to RWY 23 is also expected to deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. No specific safety issues have been raised about the departure components and the assessment identified that the introduction of PBN departures also offers reduced ATC and pilot workload due to the reduction in instructions. -As part of the Stage 2B IOA, a safety concern was raised around the waypoint configuration of the offset departures however further safety assessments in Stage 3, through flyability assessments, has resolved these concerns. Overall the safety assessment work to date has identified some hazards that require further mitigation however these are expected to be resolved at the time of project implementation. Further safety assessments and justifications will be submitted in Stage 4 should this option be proposed to be implemented.
Noise – Communities
Contour maps The contour maps for Option 1 are shown in Figures TA79 to TA82 in the FOA Technical Appendix. **Primary noise metrics** **TAG noise assessment** TAG has been used to assess total adverse noise effects over a 10-year appraisal period (2027 – 2036). The monetised net present value (NPV) of noise changes of this option is £16,229,349 (2024 prices). This positive value reflects a net benefit (i.e. a reduction in total adverse effects on health and quality of life from noise). The full TAG assessment results are presented in Table 157.

Table 157 Option 8 TAG noise assessment results

Scenario	NPV Total	NPV Sleep disturbance	NPV Amenity	NPV Acute Myocardial Infarction	NPV Stroke	NPV Dementia	Individuals experiencing increased daytime noise in forecast year	Individuals experiencing reduced daytime noise in forecast year	Individuals experiencing increased nighttime noise in forecast year	Individuals experiencing reduced nighttime noise in forecast year
Option 8	£16,229,349	£9,830,547	£4,514,678	£11,700	£746,662	£1,125,763	17,094	29,971	29,376	42,368

L_{Aeq} noise tables

Metric – $L_{Aeq,16h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 8	$L_{Aeq,16h}$	51	40.5	66500	31400	34	0	12	29
			54	21.2	26100	12400	7	0	5	12
			57	11.2	6700	3100	2	0	0	4
			60	5.8	1400	700	0	0	0	2
			63	3.1	<100	<100	0	0	0	0
			66	1.8	0	0	0	0	0	0
			69	1.0	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 8	$L_{Aeq,16h}$	51	43.4	71500	33700	36	0	14	34
			54	22.7	30000	14200	9	0	5	14
			57	12.1	8000	3700	2	0	0	5
			60	6.2	1700	900	0	0	0	2
			63	3.3	<100	<100	0	0	0	0
			66	1.9	0	0	0	0	0	0
			69	1.1	0	0	0	0	0	0

Metric – $L_{Aeq,8h}$

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	Option 8	$L_{Aeq,8h}$	45	67.0	96200	45200	46	0	20	48
			48	33.7	50800	24300	28	0	12	23
			51	17.3	15700	7700	6	0	0	7
			54	8.9	2300	1200	0	0	0	2
			55	7.2	1300	700	0	0	0	2
			57	4.8	<100	<100	0	0	0	1
			60	2.8	<100	<100	0	0	0	0

			63	1.6	0	0	0	0	0	0

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2036	Option 8	$L_{Aeq,8h}$	45	71.3	99500	46800	49	0	20	53
			48	36.1	58900	28000	30	0	12	23
			51	18.4	18600	9000	6	0	4	9
			54	9.4	2700	1400	0	0	0	2
			55	7.7	1600	800	0	0	0	2
			57	5.1	100	100	0	0	0	1
			60	2.9	<100	<100	0	0	0	0
			63	1.7	0	0	0	0	0	0

2027 Noise exposure above LOAEL and SOAEL

Table 158 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2027.

These tables show that for Option 8:

- in 2027, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change in the total number of people exposed above the SOAEL; and
- in 2027, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 158 2027 Population exposed above LOAEL and SOAEL with and without airspace change Option 8

Noise exposure	Total Population		
	2027 'without airspace change'	2027 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	68,200	66,200	-2,000
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	90,800	94,500	+3,700
Above SOAEL	1,500	1,400	-100

2027 Assessment of significant noise effects, residential receptors
Whilst the TAG assessment and LOAEL/SOAEL tables above quantify the total adverse effects on health and quality of life from noise across the entire population exposed above the LOAEL, it does not provide information on the adverse and beneficial effects on individuals within that total. A further assessment has therefore been undertaken to quantify likely significant effects on an individual basis by assessing the noise change and noise exposure at each residential receptor location. Table 159 summarises how noise increases are experienced across the population and Table 160 summarises how noise decreases are experienced across the population.

These tables show that for Option 8:

- in 2027, during the daytime, there are likely significant adverse effects due to moderate noise increases;
- in 2027, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2027, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and

- in 2027, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 161 and the postcode receptors representing these locations are presented in Figure 93 and Figure 94.

Table 159 2027 Population experiencing noise increases from 'without' to 'with' airspace change Option 8 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	19,400	37,100
Minor adverse	2.0 - 2.9dB	1,500	2,800
Moderate adverse	3.0 - 5.9dB	**800**	**2,400**
Major adverse	6.0dB or more	0	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 160 2027 Population experiencing noise decreases from 'without' to 'with' airspace change Option 8 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	43,300	46,100
Minor beneficial	2.0 - 2.9dB	6,100	3,900
Moderate beneficial	3.0 - 5.9dB	**2,300**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,500
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 161 2027 community areas experiencing likely significant effects, Option 8

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Large parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

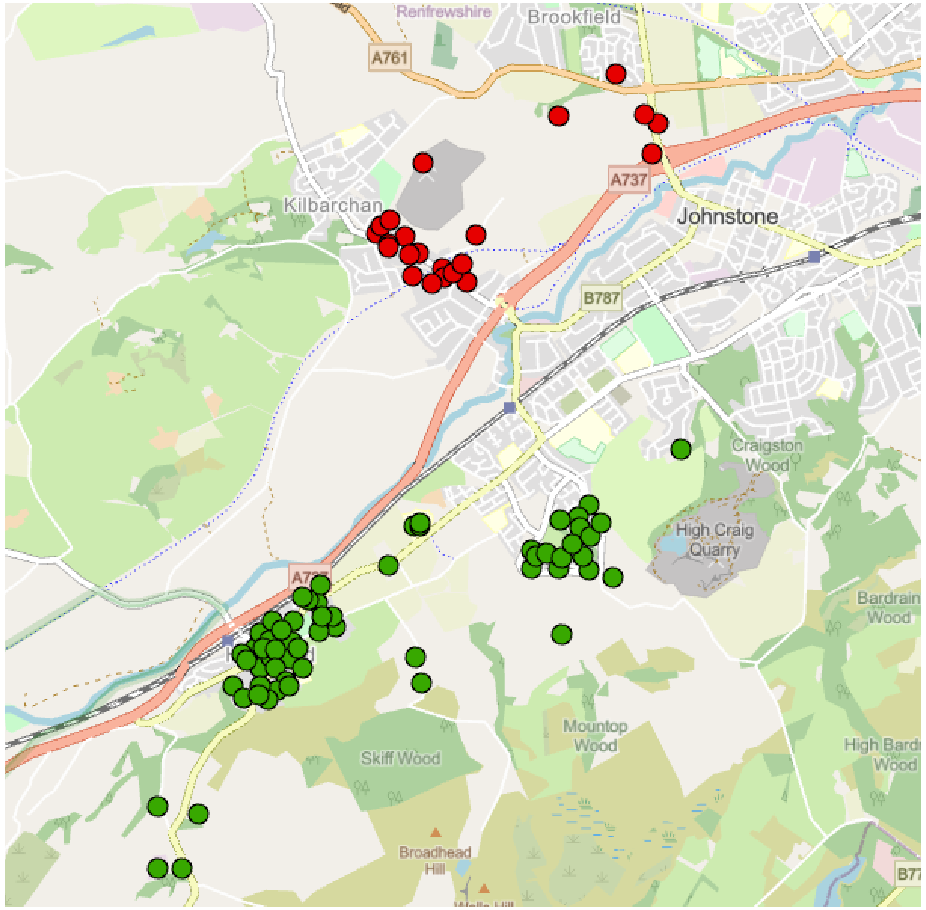


Figure 93 2027 Option 8, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](https://www.openstreetmap.org/copyright))

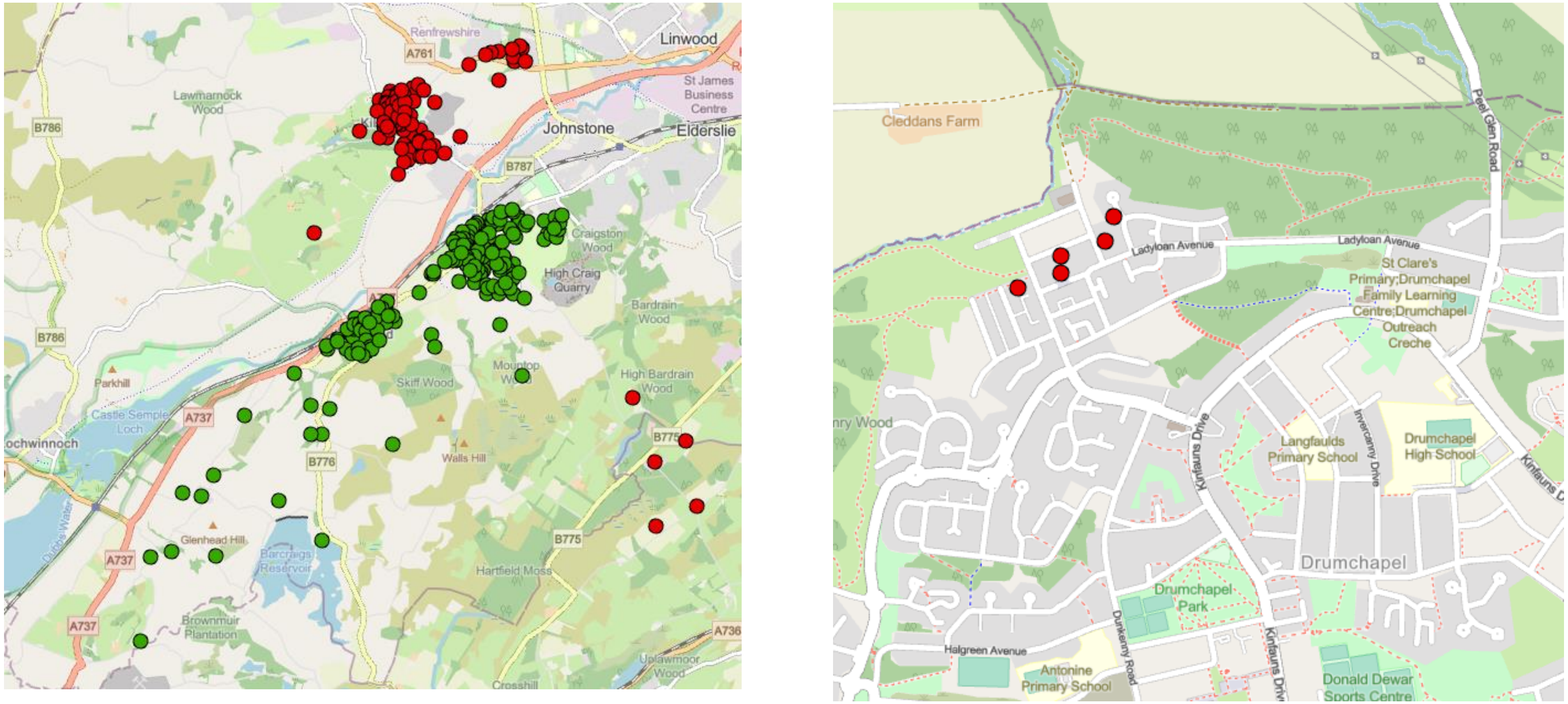


Figure 94 2027 Option 8, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2027 Assessment of significant noise effects, noise sensitive buildings

In 2027, likely significant effects have been identified for the receptors shown in Table 162 for Option 8.

Table 162 2027 noise sensitive building likely significant effects Option 8

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.2	50.8	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	43.7	50.4	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.3	49.1	-3.3	Daytime beneficial likely significant effect

2036 Noise exposure above LOAEL and SOAEL

Table 163 shows how the total number of people exposed above the LOAEL and SOAEL changes when comparing the 'without airspace change' scenario to the 'with airspace change scenario in 2036.

These tables show that for Option 8:

- in 2036, during the daytime there is a reduction in the total number of people exposed between the LOAEL and SOAEL and no change to the total number of people exposed above the SOAEL; and
- in 2036, during the night-time there is an increase in the total number of people exposed between the LOAEL and SOAEL and a reduction in the total number of people exposed above the SOAEL.

Table 163 2036 Population exposed above LOAEL and SOAEL with and without airspace change Option 8

Noise exposure	Total Population		
	2036 'without airspace change'	2036 'with airspace change'	Change from 'without' to 'with' airspace change
Daytime			
Above LOAEL and below SOAEL	72,200	71,400	-800
Above SOAEL	<100	<100	0
Night-time			
Above LOAEL and below SOAEL	94,700	97,400	+2,700
Above SOAEL	1,900	1,600	-300

2036 Assessment of significant noise effects, residential receptors
Table 164 summarises how noise increases are experienced across the population and Table 165 summarises how noise decreases are experienced across the population.

These tables show that for Option 8:

- in 2036, during the daytime, there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the night-time there are likely significant adverse effects due to moderate and major noise increases;
- in 2036, during the daytime, there are likely significant beneficial effects due to moderate noise decreases; and
- in 2036, during the night-time, there are likely significant beneficial effects due to moderate and major noise decreases.

The location of community areas that experience these likely significant effects are summarised in Table 166 and the postcode receptors representing these locations are presented in Figure 95 and Figure 96.

Table 164 2036 Population experiencing noise increases from 'without' to 'with' airspace change Option 8 (shaded cells and bold numbers indicate noise changes that are defined as likely significant adverse effects)

Magnitude of effect	Noise increase from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	21,000	39,200
Minor adverse	2.0 - 2.9dB	1,700	2,700
Moderate adverse	3.0 - 5.9dB	**1,200**	**2,600**
Major adverse	6.0dB or more	**200**	**400**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	0	<100
Minor adverse	1.0 - 1.9dB	0	0
Moderate adverse	2.0 - 3.9dB	0	0
Major adverse	4.0dB or more	0	0

Table 165 2036 Population experiencing noise decreases from 'without' to 'with' airspace change Option 8 (shaded cells and bold numbers indicate noise changes that are defined as likely significant beneficial effects)

Magnitude of effect	Noise decrease from 'without' to 'with' airspace change	Population experiencing change	
		Day	Night
'with airspace change' noise above LOAEL and below SOAEL			
Negligible	0.1 - 1.9dB	44,400	48,100
Minor beneficial	2.0 - 2.9dB	6,400	3,800
Moderate beneficial	3.0 - 5.9dB	**2,400**	**6,400**
Major beneficial	6.0dB or more	0	**<100**
'with airspace change' noise above SOAEL			
Negligible	0.1 - 0.9dB	<100	1,800
Minor beneficial	1.0 - 1.9dB	0	0
Moderate beneficial	2.0 - 2.9dB	0	0
Major beneficial	4.0dB or more	0	0

Table 166 2036 community areas experiencing likely significant effects, Option 8

Location	Community area	Effect
To the south-west of the airport	Isolated properties to the south of Johnstone, broadly between Craigston Wood and Sergeant Law Road	Night-time adverse likely significant effect

	The majority of the community of Kilbarchan, to the north of the Dairy and North Johnstone rail trail. Including isolated properties to the west of Kibbleston	Daytime and Night-time adverse likely significant effect
	Parts of the community of Brookfield, broadly between the A761 and B789	Daytime and Night-time adverse likely significant effect
	Isolated properties between the A761 and A737	Daytime and Night-time adverse likely significant effect
	Parts of Johnstone, broadly between Castle Woods and Corseford School	Daytime and night-time beneficial likely significant effect
	The community of Howwood	Daytime and night-time beneficial likely significant effect
	Isolated properties broadly between the B776 and A737	Night-time beneficial likely significant effect
To the north-west of the airport	Properties in Drumchapel, to the north of Ladyloan Avenue	Night-time adverse likely significant effect

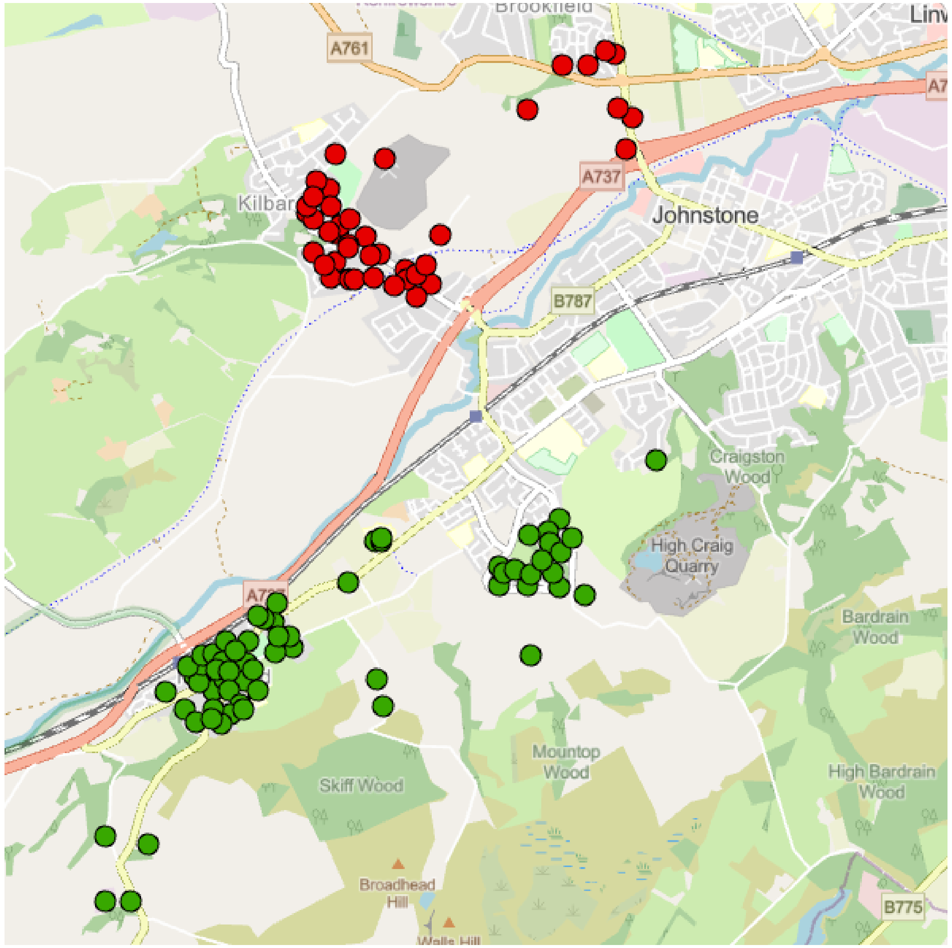


Figure 95 2036 Option 8, postcode receptors experiencing daytime adverse likely significant effects (red) and daytime beneficial likely significant effect (green) Note that each postcode can represent multiple properties. ([© OpenStreetMap](#))

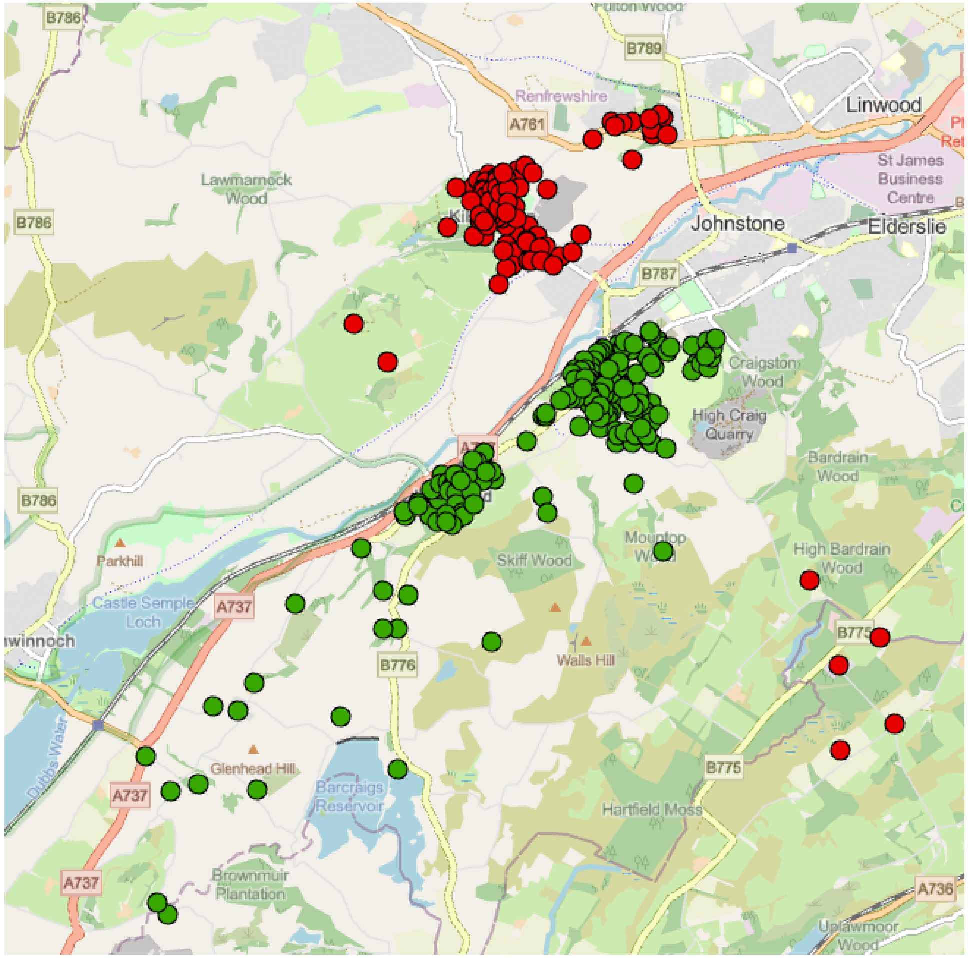


Figure 96 2036 Option 8, postcode receptors experiencing night-time adverse likely significant effects (red) and night-time beneficial likely significant effect (green) Note that each postcode can represent multiple properties. (© OpenStreetMap)

2036 Assessment of significant noise effects, noise sensitive buildings

In 2036, likely significant effects have been identified for the receptors shown in Table 167 for Option 8.

Table 167 2036 noise sensitive building likely significant effects Option 8

Receptor	'Without airspace change' noise level, dBLAeq,16h	'With airspace change' noise level, dBLAeq,16h	Noise change, dB	Effect
Kilbarchan East Church, PA10 2JD	44.5	51.1	+6.6	Daytime adverse likely significant effect
Kilbarchan Old Parish Church, PA10 2JD	44.0	50.7	+6.7	Daytime adverse likely significant effect
Church of Christ the King, PA9 1BZ	52.7	49.4	-3.3	Daytime beneficial likely significant effect

Secondary noise metrics

Secondary noise metrics are not used to determine total adverse noise effects and are presented below for additional information. The tables below show the difference in each contour band compared to the 'without airspace change' scenario.

In addition, CAP1616f requires consideration of the number of people newly overflown. The number of people newly overflown five times or more, and no longer overflown five times or more, is presented in Table 168 and Table 169 respectively.

Table 168 2027 population newly overflown and no longer overflown (five times or more), Option 8

	Daytime	Night-time
Number of people newly overflown >=5	112,900	33,900

Number of people no longer overflown >=5	173,000	22,300

Table 169 2036 population newly overflown and no longer overflown (five times or more), Option 8

	Daytime	Night-time
Number of people newly overflown >=5	113,300	38,400
Number of people no longer overflown >=5	171,600	26,500

Metric – N65 (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_8*	N65	5	55.4	2600	1100	5	0	2	10
			10	6.9	5000	2200	2	0	0	3
			20	-3.5	3200	1700	3	0	-1	4
			50	-5.8	-7900	-3800	-5	0	0	-4
			100	-0.6	-2300	-1000	0	0	0	0
			200	<0.1	0	0	0	0	0	0
2036	*DS_Option_8*	N65	5	57.1	4100	1900	5	0	2	8
			10	9.3	4500	1800	2	0	-2	3
			20	-4.4	3200	1600	2	0	0	3

			50	-6.4	-7300	-3400	-3	0	0	-3
			100	-1.1	-3200	-1400	-1	0	0	0
			200	0.3	0	0	0	0	0	0

Metric – N60 (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_8*	N60	5	-25.8	-6300	-3000	-1	0	-3	-6
			10	-21.6	-4800	-2200	-2	0	0	-1
			20	0.1	<100	<100	0	0	0	0
2036	*DS_Option_8*	N60	5	-22.0	-7000	-3300	-2	0	-3	-7
			10	-22.2	-3200	-1200	-1	0	-1	-1
			20	0.2	100	<100	0	0	0	0

Metric – Overflight (daytime)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship

2027	*DS_Option_8*	Overflights_Day	5	6.3	-62000	-29200	-26	-2	4	-38
			10	70.4	-25600	-12400	-17	-1	3	-17
			20	3.7	-61800	-28200	-27	-1	-11	-39
			50	-0.3	-6000	-2700	-6	0	-2	-6
			100	-1.5	-3100	-1300	-1	0	0	0
2036	*DS_Option_8*	Overflights_Day	5	12.3	-57800	-25900	-26	-5	1	-14
			10	64.4	-14200	-7000	-14	-1	4	-13
			20	8.3	-61000	-28000	-25	-1	-12	-38
			50	6.9	1300	400	-5	0	-1	-1
			100	-2.5	-4500	-1900	-3	0	-1	-3

Metric – Overflight (night-time)

Year	Scenario	Metric	Contour	Area (km2)	Total population	Total households	Number of schools	Number of hospitals	Number of care homes	Number of places of worship
2027	*DS_Option_8*	Overflights_Night	5	29.6	12900	5900	4	0	1	0
			10	-22.3	-20400	-9700	-11	0	-4	-10
2036	*DS_Option_8*	Overflights_Night	5	33.5	14800	6600	3	0	2	-1
			10	-21.7	-17800	-8300	-12	0	-3	-10

Changes to noise distribution as a result of other airspace users The reclassification of airspace volumes as shown in Appendix C is likely to result in changes to traffic patterns of General Aviation aircraft. General aviation are 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, helicopters and private corporate jet flights. Any changes in noise from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified noise modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users. Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.
Air Quality – Communities
Pollutant concentrations for annual mean NOx, NO_2, PM_{10} and $PM_{2.5}$ predicted negligible impact at all assessed receptor locations. The maximum change predicted for each pollutant at any receptor in each assessment year was <0.01 µg/m^3. The maximum concentration predicted for each pollutant at any relevant receptor, provided below, which is the same result for 2027 and 2036[74]: • A maximum annual mean NOx of 23.6 µg/m^3 was predicted at the Black Cart SPA; • A maximum annual mean NO_2 of 15.6 µg/m^3 was predicted at PA4 9LP, on Walkinshaw Road at the northwestern boundary of the airport; • A maximum annual mean PM_{10} of 10.9 µg/m^3 was predicted at PA3 2TQ, on St Andrew' Crescent, around 150m south of the airport boundary; and • A maximum annual mean $PM_{2.5}$ of 6.3 µg/m^3 was predicted at PA3 3AD, on Blackstone Road, around 300m from the southwestern boundary of the airport. The full results from the dispersion modelling are provided in Appendix B. The results show there were no exceedances of NOx, NO_2, PM_{10} and $PM_{2.5}$ relevant annual mean and short term standards predicted at any of the assessed receptors, in any assessment year. Therefore, the effects of NOx, NO_2, PM_{10} and $PM_{2.5}$ at sensitive receptors, as a result of option 8, are predicted to be not significant, in any assessment year.

[74] This is as a result of the negligible change as a result of the aircraft emissions changes and assuming to improvement in background concentrations for the 2022 baseline.

Greenhouse gas emissions – Wider society

TAG outcomes

TAG has been used to assess the greenhouse gas impact over a 10-year appraisal period. The change in CO_2e emissions over the 10-year appraisal period is a reduction of 101,842t, of which 83,972t is traded in the UK ETS. This results in a monetised net present value (NPV) benefit of £22,473,192 for Option 8.

Greenhouse gas emissions

Table 170 shows the annual total and per flight greenhouse gas emissions of Option 8 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight greenhouse gas emissions as a result of Option 8[75].

Table 170 greenhouse gas emissions, Option 8

	Without Airspace Change		With Airspace Change		Difference	
Year	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)	Annual total GHG emissions (tCO_2e)	Total GHG emissions per flight ($kgCO_2e$)
2027	521,287	5,737	512,305	5,638	-8,983	-99
2028	525,266	5,742	516,016	5,641	-9,250	-101
2029	529,245	5,747	519,728	5,644	-9,517	-103
2030	533,223	5,752	523,439	5,647	-9,784	-106
2031	537,202	5,756	527,151	5,649	-10,051	-108
2032	541,180	5,760	530,863	5,651	-10,318	-110

[75] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

2033	545,159	5,764	534,574	5,652	-10,585	-112
2034	549,137	5,768	538,286	5,654	-10,852	-114
2035	553,116	5,771	541,997	5,655	-11,119	-116
2036	557,095	5,774	545,709	5,656	-11,386	-118

Changes to fuel burn for other airspace users
The proposed reclassification of airspace volumes, shown in Appendix C. results in an overall increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) along with higher base levels. Higher base levels are expected to offer more efficient routes and profiles for General Aviation traffic which enables fuel burn benefits.

Any changes in fuel burn from GA activity is unpredictable, not the responsibility of Glasgow ATC and are not as a result of scheduled aircraft arriving or departing from Glasgow Airport. It therefore does not form part of the quantified fuel burn modelling. Overall, the option sees an increase in the volume of Class G airspace to the north, west of south of the CTR (see Figure 107) and therefore this is likely to enable improved vertical and lateral profiles by some GA airspace users.

Whilst this option sees Glasgow's CTR, which is down to ground level, decrease in volume, there are some small extensions required in areas 4, 5 and 8 (see Figure 97). These extensions could see some displacement of GA operations from area 8 into area 9 and from areas 4 and 5 into area 3. However, we are proposing areas 9 and 3 increase their existing bases by 500ft which would allow GA operations to be higher from the ground, should those airspace users wish to fly higher.

Tranquillity – Wider society

There are no National Parks or National Scenic Areas (NSA) within the 2027 or 2036 'with airspace change' 51dB $L_{Aeq,16h}$ LOAEL contours for this option. With reference to Planning Practice Guidance Noise, below the LOAEL "...*noise may slightly affect the acoustic character of an area but not to the extent there is a change in quality of life*". This option is therefore not expected to have a material impact on the acoustic character of any National Park or NSA.
This option results in an area of 1.7km^2 (0.09% of the total area of the National Park) and 2.7km^2 (0.15% of the total area of the National Park) of the Loch Lomond & The Trossachs National Park to be overflown five or more times a day below 7,000ft in the 2027 and 2036 'with airspace change' scenarios respectively.

Figure 97 below shows the area that is overflown by this option in the 2036 'with airspace change' scenario along with the radar track data for flights below 7,000ft on a typical summer day in 2022 (16th June). From this it can be seen that the National Park is currently overflown below 7,000ft, but the concentration of flights is not sufficient to be reflected in the 'without airspace change' future baseline overflight contours. Given the small area intersected by the overflight contour for this option and that the National Park is already regularly overflown, it is unlikely that this option will result in a significant change to the perception of tranquillity within the National Park or NSA

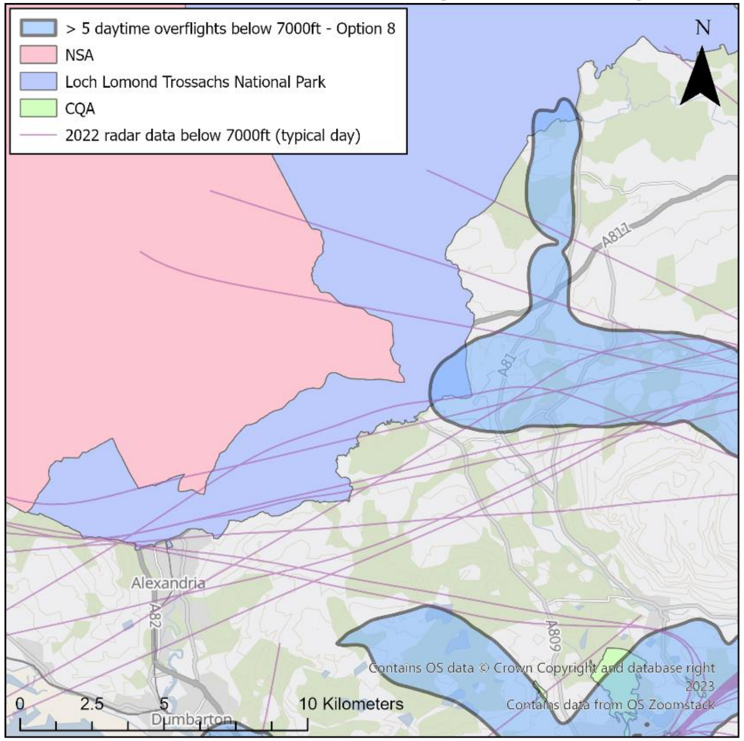


Figure 97 Area of the Loch Lomond & The Trossachs National Park intersected by the 2036 'with airspace change' scenario daytime overflight contour

Table 171 below shows the number of Candidate Quiet Areas (CQAs) in the 51dB $L_{Aeq,16h}$ LOAEL contour or overflown five or more times a day below 7,000ft for the 2027 and 2036 ‘with airspace change’ scenarios.

Table 171 CQAs in the 51dB LAeq,16h LOAEL contour or overflown five or more times a day below 7,000ft

Year	Number of CQAs in 51dB $L_{Aeq,16h}$ LOAEL contour		Number of CQAs overflown five or more times a day below 7,000ft	
	With airspace change	Without airspace change	With airspace change	Without airspace change
2027	4	4	27	26
2036	5	5	29	27

The Barhill Wood CQA (see Figure 98), close to Kilbarchan, is newly within the $L_{Aeq,16h}$ LOAEL contour in the 2027 and 2036 'with airspace change' scenarios for this option compared to the 2027 and 2036 'without airspace change' future baseline scenarios. Consequently, there could be an adverse impact on the perception of tranquillity for this CQA. This is consistent with the daytime adverse likely significant noise effects identified for the majority of the community of Kilbarchan in the 2027 and 2036 'with airspace change' scenarios (see Table 161 and Table 166)
The Skiff Wood CQA (see Figure 98), close to the community of Howwood, is within the $L_{Aeq,16h}$ LOAEL contour in the 'without airspace change' 2027 and 2036 future baseline scenarios but is no longer within the 2027 and 2036 $L_{Aeq,16h}$ LOAEL in the 'with airspace change' scenarios for this option. Consequently, there could be a beneficial impact on the perception of tranquillity for this CQA. This is consistent with the daytime beneficial likely significant noise effect identified for the community of Howwood in the 2027 and 2036 'with airspace change' scenarios (see Table 160 and Table 165).

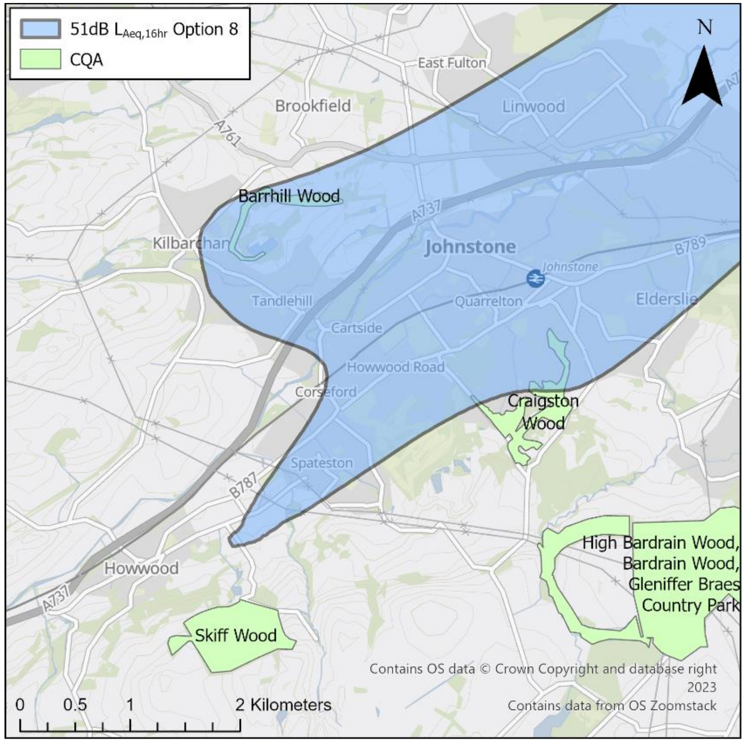


Figure 98 Barrhill Wood and Skiff Wood CQAs

Table 172 below summarises the CQAs that are either newly overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario or no longer overflown five or more times a day below 7,000ft in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario.

Table 172 Newly overflown and no longer overflown CQAs

Year	Number of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs newly overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Number of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario	Description of CQAs no longer overflown (five times or more) in the 'with airspace change' scenario compared to the 'without airspace change' future baseline scenario
2027	6	Bothwell Castle Grounds Carneddans Wood Mains Plantation Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	5	Skellyton Woods Carbarns Wood Orchardbank Craigends Highmainshead Wood
2036	6	Bothwell Castle Grounds Carneddans Wood Mains Plantation Possil Marsh Cardowan Moss High Bardrain Wood, Bardrain Wood, Gleniffer Braes Country Park	4	Skellyton Woods Carbarns Wood Orchardbank Highmainshead Wood

The following tables show the difference in the area and number of locations/spaces that are relevant to the consideration of tranquillity when comparing the with and without airspace change scenario for Option 8.

Year	Scenario	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_8*	LAEQ16HR	51	0	0	0	0	0	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-1	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0
			69	0	0	0	0	0	0	0	0	0	0
2036	*DS_Option_8*	LAEQ16HR	51	0	0	0	0	0	-0.5	0	0	0	<-0.1
			54	0	0	0	0	-2	<-0.1	0	0	0	0
			57	0	0	0	0	0	<-0.1	0	0	0	0
			60	0	0	0	0	0	0	0	0	0	0
			63	0	0	0	0	0	0	0	0	0	0
			66	0	0	0	0	0	0	0	0	0	0

			69	0	0	0	0	0	0	0	0	0	0	

Year	Scen.	Metric	Contour	National Scenic Area		National Parks		Candidate Quiet Area		Country Parks		Gardens and Designated Landscapes	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	*DS_Option_8*	Overflights_Day	5	0	0	1	1.7	1	-0.1	1	-0.1	-2	-0.3
			10	0	0	1	0.3	-4	-1.6	0	1.2	0	<-0.1
			20	0	0	0	0	-2	-0.5	0	0.2	0	-0.2
			50	0	0	0	0	0	-0.4	1	1.4	0	<-0.1
			100	0	0	0	0	-1	-0.1	0	0	0	0
2036	*DS_Option_8*	Overflights_Day	5	0	0	1	2.7	2	0.2	1	<0.1	-2	-0.8
			10	0	0	1	0.5	-2	-2.6	0	-0.2	0	-0.6
			20	0	0	0	0	-2	-0.6	0	0.2	0	-0.4
			50	0	0	0	0	1	-0.3	1	1.8	0	<-0.1
			100	0	0	0	0	0	-0.1	0	0	0	0

Biodiversity – Wider society

As outlined in the Full Options Appraisal methodology, following the CAP1616i HRA Early Screening Criteria, and the provision of additional information for the Black Cart SPA as described above, it is considered that there are no biodiversity impacts on any European Sites. Though no impacts are predicted, the tables below provide information on the number and area of European sites overflown below 7,000ft for information.

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_8	Overflights_Day	5	1	3.5	-1	-1.0	0	2.8
			10	0	<-0.1	0	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0
2036	DS_Option_8	Overflights_Day	5	1	5.5	-1	-1.1	0	3.6
			10	0	<-0.1	-1	0.7	0	0
			20	0	0	0	0	0	0
			50	0	0	0	0	0	0
			100	0	0	0	0	0	0

Year	Scen.	Metric	Contour	SPA		SAC		RAMSAR	
				Total	Area (km2)	Total	Area (km2)	Total	Area (km2)
2027	DS_Option_8	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

2036	DS_Option_8	Overflights_Night	5	0	0	0	0	0	0
			10	0	0	0	0	0	0

Capacity / resilience / Wider society

Capacity – Ground delay

This option sees the SIDs splitting before 5nm, which will improve capacity compared to the baseline as aircraft will be able to depart in intervals 1 minutes apart (subject to safety case approvals). The outcomes of the runway capacity analysis are shown in Table 173:

Table 173 Option 8 - Departure delay per year

	Number of minutes of departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 7	14951	39106	55665
Reduction	-3163	-7882	-6656

Resilience

The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. This equipment is due to decommissioned as part of a NERL UK wide programme under the Airspace Modernisation programme. There is currently no long term resilience for Glasgow's SIDs when NERL decommissions the VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NERL's VOR withdrawal programme.

The introduction of PBN approaches will improve Glasgow Airport's resilience, as following the decommission of the VORs as part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow Airport will only have ILS precision approach and NDB and visual non precision approaches available.

Access – General Aviation

For the general aviation (GA) access assessment of Controlled Airspace (CAS) benefits and impacts, please see Appendix C.

Economic impact from increased effective capacity – General aviation / commercial airlines

The main purpose of this ACP is to meet the requirements of the Government's Airspace Modernisation Strategy (AMS) and as part of this, there will be increased capacity within the ScTMA airspace which provides an opportunity for positive economic impacts (for more information, please see NERL FOA.

The growth of Glasgow Airport is not dependent on this airspace change and the ACP does not increase the total annual movements at Glasgow Airport compared to the do nothing 'without airspace change' scenario. The ACP does however offer opportunities for less delay and the monetisation of the capacity assessment (details in the section above) identified the following economic benefit:

	Number of minutes of departure delay per flight per year		
Option	**2023**	**2027**	**2036**
Do Nothing	18114	46988	62320
Option 7	14951	39106	55665
Reduction	-3163	-7882	-6656
£ (in 2024 prices)	**-£183,084**	**-£456,270**	**-£385,280**

Fuel burn – General aviation / commercial airlines

Table 174 shows the annual total and per flight fuel burn of Option 8 from 2027 to 2036. These tables show that, in all years, there is a reduction in the annual total and per flight fuel burn as a result of Option 8.

Table 174 fuel burn, Option 8

Year	Without Airspace Change	With Airspace Change	Difference

	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)	Annual total fuel burn (t)	Total annual fuel cost (£)	Fuel burn per flight (kg)
2027	163,927	£112,452,196	1,804	161,102	£110,514,419	1,773	-2,825	-£1,937,777	-31
2028	165,178	£113,310,454	1,806	162,269	£111,315,084	1,774	-2,909	-£1,995,370	-32
2029	166,429	£114,168,711	1,807	163,436	£112,115,749	1,775	-2,993	-£2,052,962	-32
2030	167,680	£115,026,969	1,809	164,604	£112,916,415	1,776	-3,077	-£2,110,554	-33
2031	168,931	£115,885,226	1,810	165,771	£113,717,080	1,776	-3,161	-£2,168,147	-34
2032	170,182	£116,743,484	1,811	166,938	£114,517,745	1,777	-3,245	-£2,225,739	-35
2033	171,434	£117,601,741	1,813	168,105	£115,318,410	1,777	-3,329	-£2,283,331	-35
2034	172,685	£118,459,999	1,814	169,272	£116,119,075	1,778	-3,412	-£2,340,923	-36
2035	173,936	£119,318,256	1,815	170,439	£116,919,740	1,778	-3,496	-£2,398,516	-36
2036	175,187	£120,176,514	1,816	171,607	£117,720,406	1,778	-3,580	-£2,456,108	-37

Training costs – commercial airlines

Flight procedures worldwide are updated with each aeronautical information regulation and control (AIRAC) cycle and airlines update their procedures accordingly, training as required. This proposal is not anticipated to require additional training costs for airlines.

Other costs – commercial airlines

No other airline costs are foreseen.

Infrastructure costs – Airport / ANSP

This proposal is not expected to change Airport or ANSP infrastructure beyond the initial deployment phase which will require some ATC systems engineering amendments and some amendments with Glasgow Airport's noise track keeping software system. The implementation of Performance Based Navigation (PBN) procedures removes Glasgow's dependencies on conventional ground based DVORs which contributes to a reduction in NATS NERL's operating costs as it enables VOR rationalisation.
Operational costs – Airport / ANSP
There will be an ongoing cost for Glasgow Airport to maintain the IFPs. This is estimated to cost £80,000 every 5 years (based on 2024 prices). This is an increase of £10,000 every 5 years compared to the baseline. Implementing this airspace change option is not expected to materially alter the cost to Glasgow Airport to operate the noise insultation scheme compared to the without airspace change scenario. The cost is estimated to be £238,700 per year in 2027 and £93,800 per year by 2036 (based on 2024 prices).
Deployment costs – Airport / ANSP
The overall proposed Scottish Airspace Modernisation change is expected to require ATC familiarisation training, in the order of c.25-30 air traffic controllers and c.5 assistants at Glasgow Airport, including development of detailed training plans and extensive use of NATS simulator facilities. Support staff are required to run the simulator in terms of planning, training staff, data preparation and testing, pseudo pilots, safety analysts, and recording of outputs. Options 5-8 (with PBN transitions) are expected to require more training than those with only vectoring however given the extent of the overall changes this is expected to be marginal.
Other costs – Airport / ANSP
No other costs are foreseen
Airspace Modernisation Strategy (AMS) CAP1711 - All
The following assessment against the four objectives of the AMS is based upon the detailed information in the sections above. **Safety –** The safety assessments have indicated that the proposed option will maintain, and in some areas enhance safety compared to the 'without airspace change' baseline.

Integration of diverse users - The proposed option is expected to meet the requirements of existing airspace users such as commercial airlines. The airspace will be classified to support access to users as appropriate. General Aviation and new and rapidly developing users are expected to benefit from the overall release of CAS volumes below 7000ft.
Simplification, reducing complexity and improving efficiency - The proposed designs will efficiently use the airspace to enable the expeditious flow of traffic, including all classes of aircraft across the commercial, General Aviation and military sectors. The capacity and resilience assessments have shown that the proposed option would offer benefits in these areas, helping to reduce delays.
Environmental sustainability - The proposed option offers a net benefit i.e. a reduction in total adverse effects on health and quality of life from noise. The proposed option also offers an expected improvement in Greenhouse Gas emissions.

5. FOA Summary and Conclusion

5.1.1 The following sections provide an overview of the outcome of the FOA before explaining whether which option has been chosen by Glasgow Airport to be the subject of the Stage 3 Consultation and the rationale around this.

5.2 Cost benefit analysis

5.2.1 As part of the FOA, Airspace Change Sponsors are required to produce a Cost Benefit Analysis (CBA) which looks at the monetised costs associated with the ACP and produces a Net Present Value (NPV) for each option. The NPV tables on the following pages contain an analysis of all relevant monetised cost and monetised benefits associated with each option. NPVs are based on the following assumptions:

- All 'nominal' costs and benefits have been adjusted into 2024 'real' costs and benefits (using published Web TAG Databook GDP deflators) and converted into GBP when necessary, using spot rates as at 22nd March 2024.
- All 'real' figures have been discounted using the Social Time Preference Rate (STPR) set by the UK Government and contained in the WebTAG Databooks. The standard STPR of 3.5% has been used for all costs and benefits discounting, apart from 'Noise' costs and benefits, which have been discounted using the Health STPR figure of 1.5%.
- 2024 is used as the base year for NPV discounting.
- Noise and CO_2e costs and benefits are calculated directly using WebTAG workbooks. Please refer to the methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect the CO_2e costs result.
- Delay costs and benefits are calculated based on a review of average number of departures per day on July 6th, 25th and 28th. These departure averages are compared to minutes of departure delay per day, to obtain a number of delay minutes per flight per day. This is then annualised using number of flights per year. The 2022 Eurocontrol Tactical delay cost with network effect per minute (Flight Phase: Ground / Taxiing in/out / Short Delay) of €62 has been used to monetise delay costs and benefits (this figure was inflated to 2024 prices and converted to GBP as per the points above)
- For fuel burn, the jet fuel price used in the NPV calculations is based on the Average Cost per Tonne of USD $861.39 (sourced from: IATA Fuel Monitor for week ending 22nd March 2024). To convert into GBP, the USD to GBP spot exchange rate from March 24, 2024 of £0.79637298, which convert the price to GBP £685.99. Fuel prices and exchange rates are volatile, and will have changed since the analysis was undertaken. However, it is important to note that there is a forecast fuel reduction per flight for all options and so there would always be an NPV benefit, regardless of the price and conversion rates applied. This Full Options Appraisal was undertaken on the most up to date sources of data at the time, and as part of the Final Options Appraisal in CAP1616 Stage 4, the fuel prices and exchange rates will be updated.

Option 1

		Option 1 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	Delay Benefits	£649,307	£641,907	£634,371	£626,704	£618,905	£610,986	£602,919	£594,728	£586,398	£577,921	£6,144,146
		Airport Operational Costs	£0	£0	£0	£0	-£3,499	£0	£0	£0	£0	-£3,123	-£6,621
		GHG Emissions (Non-traded)	£324,175	£429,045	£537,988	£651,119	£768,554	£890,414	£1,016,822	£1,147,903	£1,283,785	£1,426,128	£8,475,932
		GHG Emissions (Traded)	£2,202,212	£2,241,161	£2,388,225	£2,459,714	£2,434,105	£2,408,631	£2,383,320	£2,401,180	£2,344,024	£2,320,760	£23,583,332
		Fuel Benefits	£2,120,896	£2,179,749	£2,238,601	£2,297,454	£2,356,307	£2,415,160	£2,474,013	£2,532,865	£2,591,718	£2,650,571	£23,857,334
		Sum	*£5,296,591*	*£5,491,862*	*£5,799,184*	*£6,034,990*	*£6,174,373*	*£6,325,191*	*£6,477,074*	*£6,676,675*	*£6,805,925*	*£6,972,257*	*£62,054,123*
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	0.90	0.87	0.84	0.81	0.79	0.76	0.73	0.71	0.68	0.66	
		Net Present Value	**£4,777,221**	**£4,785,840**	**£4,882,757**	**£4,909,468**	**£4,853,001**	**£4,803,424**	**£4,752,430**	**£4,733,221**	**£4,661,689**	**£4,614,123**	**£47,773,175**
HEALTH STPR	Real Values (2024 Prices)	Noise Tag Benefits	£1,240,219	£1,236,522	£1,232,824	£1,229,127	£1,225,431	£1,221,733	£1,218,037	£1,214,339	£1,210,642	£1,206,945	£12,235,820
		Sum	*£1,240,219*	*£1,236,522*	*£1,232,824*	*£1,229,127*	*£1,225,431*	*£1,221,733*	*£1,218,037*	*£1,214,339*	*£1,210,642*	*£1,206,945*	*£12,235,820*
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	0.96	0.94	0.93	0.91	0.90	0.89	0.87	0.86	0.85	0.84	
		Net Present Value	**£1,186,043**	**£1,165,031**	**£1,144,382**	**£1,124,089**	**£1,104,146**	**£1,084,546**	**£1,065,285**	**£1,046,356**	**£1,027,754**	**£1,009,473**	**£10,957,106**
		FINAL OPTION 1 NPV	**£5,963,264**	**£5,950,872**	**£6,027,139**	**£6,033,557**	**£5,957,147**	**£5,887,970**	**£5,817,715**	**£5,779,577**	**£5,689,443**	**£5,623,597**	**£58,730,282**

Option 2

		Option 2 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£561,563	£556,010	£550,351	£544,591	£538,728	£532,773	£526,701	£520,535	£514,260	£507,870	**£5,353,382**
		Airport Operational Costs	£0	£0	£0	£0	-£3,499	£0	£0	£0	£0	-£3,123	**-£6,621**
		GHG Emissions (Non-traded)	£291,655	£396,003	£504,415	£617,007	£733,895	£855,200	£981,043	£1,111,550	£1,246,851	£1,387,075	**£8,124,693**
		GHG Emissions (Traded)	£2,170,383	£2,208,666	£2,353,479	£2,423,794	£2,398,417	£2,373,165	£2,348,067	£2,365,490	£2,309,005	£2,284,505	**£23,234,971**
		Fuel Benefits	£2,073,724	£2,132,252	£2,190,780	£2,249,308	£2,307,836	£2,366,364	£2,424,892	£2,483,420	£2,541,947	£2,600,475	**£23,370,998**
		Sum	***£5,097,325***	***£5,292,931***	***£5,599,025***	***£5,834,700***	***£5,975,378***	***£6,127,502***	***£6,280,703***	***£6,480,995***	***£6,612,062***	***£6,776,802***	***£60,077,422***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,597,495**	**£4,612,484**	**£4,714,228**	**£4,746,532**	**£4,696,593**	**£4,653,296**	**£4,608,346**	**£4,594,499**	**£4,528,904**	**£4,484,774**	**£46,237,152**
HEALTH STPR	Real Values (2024 Prices)	**Noise Tag Benefits**	£1,292,881	£1,286,448	£1,280,015	£1,273,582	£1,267,149	£1,260,716	£1,254,283	£1,247,850	£1,241,417	£1,234,985	**£12,639,327**
		Sum	***£1,292,881***	***£1,286,448***	***£1,280,015***	***£1,273,582***	***£1,267,149***	***£1,260,716***	***£1,254,283***	***£1,247,850***	***£1,241,417***	***£1,234,985***	***£12,639,327***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,236,404**	**£1,212,071**	**£1,188,187**	**£1,164,745**	**£1,141,735**	**£1,119,152**	**£1,096,987**	**£1,075,231**	**£1,053,880**	**£1,032,926**	**£11,321,318**
		FINAL OPTION 2 NPV	**£5,833,899**	**£5,824,555**	**£5,902,415**	**£5,911,277**	**£5,838,328**	**£5,772,447**	**£5,705,333**	**£5,669,731**	**£5,582,784**	**£5,517,701**	**£57,558,470**

Option 3

		Option 3 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£544,014	£534,773	£525,377	£515,830	£506,132	£496,290	£486,282	£476,127	£465,813	£455,331	**£5,005,969**
		Airport Operational Costs	£0	£0	£0	£0	-£3,499	£0	£0	£0	£0	-£3,123	**-£6,621**
		GHG Emissions (Non-traded)	£262,252	£365,990	£473,781	£585,741	£701,986	£822,635	£947,811	£1,077,640	£1,212,249	£1,351,769	**£7,801,854**
		GHG Emissions (Traded)	£2,141,604	£2,179,151	£2,321,774	£2,390,872	£2,365,561	£2,340,369	£2,315,324	£2,332,198	£2,276,197	£2,251,727	**£22,914,776**
		Fuel Benefits	£2,031,074	£2,089,308	£2,147,543	£2,205,777	£2,264,012	£2,322,247	£2,380,481	£2,438,716	£2,496,951	£2,555,185	**£22,931,294**
		Sum	***£4,978,944***	***£5,169,221***	***£5,468,475***	***£5,698,220***	***£5,834,192***	***£5,981,541***	***£6,129,898***	***£6,324,680***	***£6,451,209***	***£6,610,890***	***£58,647,272***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,490,722**	**£4,504,678**	**£4,604,309**	**£4,635,506**	**£4,585,622**	**£4,542,452**	**£4,497,696**	**£4,483,685**	**£4,418,728**	**£4,374,977**	**£45,138,375**
HEALTH STPR	Real Values (2024 Prices)	**Noise Tag Benefits**	£1,840,103	£1,827,613	£1,815,123	£1,802,633	£1,790,143	£1,777,653	£1,765,163	£1,752,673	£1,740,183	£1,727,694	**£17,838,984**
		Sum	***£1,840,103***	***£1,827,613***	***£1,815,123***	***£1,802,633***	***£1,790,143***	***£1,777,653***	***£1,765,163***	***£1,752,673***	***£1,740,183***	***£1,727,694***	***£17,838,984***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,759,722**	**£1,721,948**	**£1,684,907**	**£1,648,584**	**£1,612,967**	**£1,578,042**	**£1,543,798**	**£1,510,221**	**£1,477,300**	**£1,445,021**	**£15,982,512**
		FINAL OPTION 3 NPV	**£6,250,444**	**£6,226,626**	**£6,289,216**	**£6,284,090**	**£6,198,589**	**£6,120,494**	**£6,041,495**	**£5,993,906**	**£5,896,028**	**£5,819,998**	**£61,120,886**

Option 4

		Option 4 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£456,270	£448,876	£441,357	£433,717	£425,955	£418,077	£410,064	£401,934	£393,675	£385,280	**£4,215,205**
		Airport Operational Costs	£0	£0	£0	£0	-£3,499	£0	£0	£0	£0	-£3,123	**-£6,621**
		GHG Emissions (Non-traded)	£229,732	£332,795	£439,900	£551,161	£666,693	£786,617	£911,055	£1,040,132	£1,173,975	£1,312,717	**£7,444,778**
		GHG Emissions (Traded)	£2,109,774	£2,146,507	£2,286,709	£2,354,458	£2,329,221	£2,304,094	£2,279,108	£2,295,373	£2,239,909	£2,215,471	**£22,560,624**
		Fuel Benefits	£1,983,902	£2,041,812	£2,099,722	£2,157,631	£2,215,541	£2,273,451	£2,331,360	£2,389,270	£2,447,180	£2,505,090	**£22,444,959**
		Sum	***£4,779,678***	***£4,969,990***	***£5,267,688***	***£5,496,967***	***£5,633,911***	***£5,782,239***	***£5,931,587***	***£6,126,709***	***£6,254,738***	***£6,415,436***	**£56,658,944**
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,310,996**	**£4,331,059**	**£4,435,252**	**£4,471,786**	**£4,428,203**	**£4,391,099**	**£4,352,189**	**£4,343,339**	**£4,284,156**	**£4,245,628**	**£43,593,709**
HEALTH STPR	Real Values (2024 Prices)	**Noise Tag Benefits**	£1,894,143	£1,878,424	£1,862,706	£1,846,988	£1,831,270	£1,815,553	£1,799,834	£1,784,116	£1,768,398	£1,752,680	**£18,234,112**
		Sum	***£1,894,143***	***£1,878,424***	***£1,862,706***	***£1,846,988***	***£1,831,270***	***£1,815,553***	***£1,799,834***	***£1,784,116***	***£1,768,398***	***£1,752,680***	**£18,234,112**
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,811,401**	**£1,769,821**	**£1,729,076**	**£1,689,149**	**£1,650,023**	**£1,611,686**	**£1,574,121**	**£1,537,314**	**£1,501,252**	**£1,465,920**	**£16,339,763**
		FINAL OPTION 4 NPV	**£6,122,397**	**£6,100,880**	**£6,164,328**	**£6,160,935**	**£6,078,226**	**£6,002,786**	**£5,926,310**	**£5,880,654**	**£5,785,408**	**£5,711,548**	**£59,933,472**

Option 5

		Option 5 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£649,307	£641,907	£634,371	£626,704	£618,905	£610,986	£602,919	£594,728	£586,398	£577,921	**£6,144,146**
		Airport Operational Costs	£0	£0	£0	£0	-£8,747	£0	£0	£0	£0	-£7,806	**-£16,553**
		GHG Emissions (Non-traded)	£292,377	£396,739	£505,167	£617,775	£734,679	£856,000	£981,860	£1,112,384	£1,247,702	£1,387,944	**£8,132,626**
		GHG Emissions (Traded)	£2,171,089	£2,209,391	£2,354,257	£2,424,603	£2,399,225	£2,373,971	£2,348,872	£2,366,309	£2,309,812	£2,285,311	**£23,242,838**
		Fuel Benefits	£2,074,771	£2,133,307	£2,191,842	£2,250,377	£2,308,913	£2,367,448	£2,425,983	£2,484,519	£2,543,054	£2,601,589	**£23,381,803**
		Sum	***£5,187,544***	***£5,381,344***	***£5,685,637***	***£5,919,458***	***£6,052,975***	***£6,208,405***	***£6,359,633***	***£6,557,939***	***£6,686,965***	***£6,844,958***	***£60,884,860***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,678,868**	**£4,689,531**	**£4,787,154**	**£4,815,483**	**£4,757,584**	**£4,714,735**	**£4,666,260**	**£4,649,047**	**£4,580,208**	**£4,529,879**	**£46,868,747**
HEALTH STPR	Real Values (2024 Prices)	**Noise Tag Benefits**	£1,199,338	£1,197,830	£1,196,322	£1,194,814	£1,193,305	£1,191,798	£1,190,290	£1,188,782	£1,187,273	£1,185,765	**£11,925,517**
		Sum	***£1,199,338***	***£1,197,830***	***£1,196,322***	***£1,194,814***	***£1,193,305***	***£1,191,798***	***£1,190,290***	***£1,188,782***	***£1,187,273***	***£1,185,765***	***£11,925,517***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,146,947**	**£1,128,577**	**£1,110,498**	**£1,092,708**	**£1,075,200**	**£1,057,972**	**£1,041,018**	**£1,024,334**	**£1,007,916**	**£991,759**	**£10,676,929**
		FINAL OPTION 5 NPV	**£5,825,815**	**£5,818,107**	**£5,897,652**	**£5,908,191**	**£5,832,784**	**£5,772,707**	**£5,707,278**	**£5,673,381**	**£5,588,124**	**£5,521,638**	**£57,545,676**

Option 6

		Option 6 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£561,563	£556,010	£550,351	£544,591	£538,728	£532,773	£526,701	£520,535	£514,260	£507,870	**£5,353,382**
		Airport Operational Costs	£0	£0	£0	£0	-£8,747	£0	£0	£0	£0	-£7,806	**-£16,553**
		GHG Emissions (Non-traded)	£259,857	£363,545	£471,286	£583,194	£699,386	£819,982	£945,103	£1,074,876	£1,209,428	£1,348,892	**£7,775,549**
		GHG Emissions (Traded)	£2,139,260	£2,176,747	£2,319,192	£2,388,190	£2,362,884	£2,337,697	£2,312,656	£2,329,485	£2,273,523	£2,249,055	**£22,888,686**
		Fuel Benefits	£2,027,600	£2,085,810	£2,144,021	£2,202,231	£2,260,441	£2,318,652	£2,376,862	£2,435,073	£2,493,283	£2,551,494	**£22,895,467**
		Sum	***£4,988,280***	***£5,182,112***	***£5,484,850***	***£5,718,205***	***£5,852,693***	***£6,009,103***	***£6,161,322***	***£6,359,968***	***£6,490,494***	***£6,649,504***	***£58,896,531***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,499,143**	**£4,515,911**	**£4,618,096**	**£4,651,764**	**£4,600,163**	**£4,563,383**	**£4,520,753**	**£4,508,701**	**£4,445,636**	**£4,400,531**	**£45,324,080**
HEALTH STPR	Real Values (2024 Prices)	**Noise Tag Benefits**	£1,276,857	£1,269,890	£1,262,922	£1,255,955	£1,248,988	£1,242,021	£1,235,053	£1,228,087	£1,221,119	£1,214,152	**£12,455,045**
		Sum	***£1,276,857***	***£1,269,890***	***£1,262,922***	***£1,255,955***	***£1,248,988***	***£1,242,021***	***£1,235,053***	***£1,228,087***	***£1,221,119***	***£1,214,152***	***£12,455,045***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,221,080**	**£1,196,470**	**£1,172,321**	**£1,148,624**	**£1,125,372**	**£1,102,556**	**£1,080,168**	**£1,058,202**	**£1,036,649**	**£1,015,502**	**£11,156,943**
		FINAL OPTION 6 NPV	**£5,720,223**	**£5,712,381**	**£5,790,417**	**£5,800,387**	**£5,725,535**	**£5,665,938**	**£5,600,921**	**£5,566,903**	**£5,482,285**	**£5,416,032**	**£56,481,023**

Option 7

		Option 7 NPV	1 2027	2 2028	3 2029	4 2030	5 2031	6 2032	7 2033	8 2034	9 2035	10 2036	Total
STANDARD STPR	Real Values (2024 prices)	**Delay Benefits**	£544,014	£534,773	£525,377	£515,830	£506,132	£496,290	£486,282	£476,127	£465,813	£455,331	**£5,005,969**
		Airport Operational Costs	£0	£0	£0	£0	-£8,747	£0	£0	£0	£0	-£7,806	**-£16,553**
		GHG Emissions (Non-traded)	£230,454	£333,532	£440,652	£551,929	£667,477	£787,418	£911,872	£1,040,966	£1,174,826	£1,313,585	**£7,452,710**
		GHG Emissions (Traded)	£2,110,481	£2,147,231	£2,287,488	£2,355,267	£2,330,028	£2,304,900	£2,279,913	£2,296,192	£2,240,715	£2,216,277	**£22,568,492**
		Fuel Benefits	£1,984,949	£2,042,866	£2,100,783	£2,158,701	£2,216,618	£2,274,535	£2,332,452	£2,390,369	£2,448,286	£2,506,204	**£22,455,763**
		Sum	***£4,869,898***	***£5,058,402***	***£5,354,299***	***£5,581,727***	***£5,711,508***	***£5,863,143***	***£6,010,519***	***£6,203,654***	***£6,329,640***	***£6,483,591***	***£57,466,380***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,392,369**	**£4,408,105**	**£4,508,176**	**£4,540,738**	**£4,489,193**	**£4,452,538**	**£4,410,104**	**£4,397,887**	**£4,335,460**	**£4,290,733**	**£44,225,303**
HEALTH STPR	Real Values (2024	**Noise Tag Benefits**	£1,808,940	£1,797,654	£1,786,367	£1,775,081	£1,763,795	£1,752,509	£1,741,222	£1,729,936	£1,718,650	£1,707,364	**£17,581,517**
		Sum	***£1,808,940***	***£1,797,654***	***£1,786,367***	***£1,775,081***	***£1,763,795***	***£1,752,509***	***£1,741,222***	***£1,729,936***	***£1,718,650***	***£1,707,364***	***£17,581,517***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,729,920**	**£1,693,721**	**£1,658,214**	**£1,623,386**	**£1,589,226**	**£1,555,721**	**£1,522,859**	**£1,490,629**	**£1,459,019**	**£1,428,018**	**£15,750,714**
		FINAL OPTION 7 NPV	**£6,122,289**	**£6,101,826**	**£6,166,390**	**£6,164,125**	**£6,078,420**	**£6,008,260**	**£5,932,963**	**£5,888,516**	**£5,794,479**	**£5,718,750**	**£59,976,018**

Option 8

		Option 8 NPV	1	2	3	4	5	6	7	8	9	10	
			2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**Total**
STANDARD STPR	**Real Values** (2024 prices)	**Delay Benefits**	£456,270	£448,876	£441,357	£433,717	£425,955	£418,077	£410,064	£401,934	£393,675	£385,280	**£4,215,205**
		Airport Operational Costs	£0	£0	£0	£0	-£8,747	£0	£0	£0	£0	-£7,806	**-£16,553**
		GHG Emissions (Non-traded)	£197,934	£300,337	£406,771	£517,348	£632,184	£751,400	£875,116	£1,003,458	£1,136,553	£1,274,533	**£7,095,634**
		GHG Emissions (Traded)	£2,078,651	£2,114,587	£2,252,422	£2,318,854	£2,293,687	£2,268,626	£2,243,697	£2,259,368	£2,204,427	£2,180,021	**£22,214,340**
		Fuel Benefits	£1,937,777	£1,995,370	£2,052,962	£2,110,554	£2,168,147	£2,225,739	£2,283,331	£2,340,923	£2,398,516	£2,456,108	**£21,969,427**
		Sum	***£4,670,632***	***£4,859,170***	***£5,153,512***	***£5,380,473***	***£5,511,226***	***£5,663,841***	***£5,812,208***	***£6,005,682***	***£6,133,170***	***£6,288,136***	***£55,478,052***
	Net Present Value	***STANDARD STPR Discount Factor*** *(Note 2 & 3)*	*0.90*	*0.87*	*0.84*	*0.81*	*0.79*	*0.76*	*0.73*	*0.71*	*0.68*	*0.66*	
		Net Present Value	**£4,212,643**	**£4,234,486**	**£4,339,119**	**£4,377,018**	**£4,331,774**	**£4,301,186**	**£4,264,597**	**£4,257,541**	**£4,200,889**	**£4,161,384**	**£42,680,637**
HEALTH STPR	**Real Values** (2024 Prices)	**Noise Tag Benefits**	£1,886,159	£1,869,447	£1,852,735	£1,836,022	£1,819,311	£1,802,599	£1,785,887	£1,769,174	£1,752,463	£1,735,750	**£18,109,547**
		Sum	***£1,886,159***	***£1,869,447***	***£1,852,735***	***£1,836,022***	***£1,819,311***	***£1,802,599***	***£1,785,887***	***£1,769,174***	***£1,752,463***	***£1,735,750***	***£18,109,547***
	Net Present Value	***HEALTH STPR Discount Factor*** *(Note 2 & 3)*	*0.96*	*0.94*	*0.93*	*0.91*	*0.90*	*0.89*	*0.87*	*0.86*	*0.85*	*0.84*	
		Net Present Value	**£1,803,766**	**£1,761,363**	**£1,719,821**	**£1,679,120**	**£1,639,248**	**£1,600,187**	**£1,561,923**	**£1,524,440**	**£1,487,724**	**£1,451,760**	**£16,229,351**
		FINAL OPTION 8 NPV	**£6,016,409**	**£5,995,850**	**£6,058,940**	**£6,056,138**	**£5,971,022**	**£5,901,373**	**£5,826,520**	**£5,781,981**	**£5,688,612**	**£5,613,143**	**£58,909,987**

5.3 Option Performance – Summary

5.3.1 We're cognisant that the noise, greenhouse gas emissions and other sections of this FOA include a significant amount of information and data tables that are required by the CAP1616 process. Ahead of discontinuing options, we have therefore summarised some of the key assessment outcomes which play an important part in our option selection rationale detailed below. Table 175 summarises the primary noise metric assessment outcomes and Table 176 summarises the greenhouse gas emissions, biodiversity, air quality and tranquillity assessment outcomes.

5.3.2 Note that this data has had conditional formatting applied to compare performance between the different options, as opposed to comparison against the 'without airspace change' baseline. In addition, whilst population data has generally been rounded to the nearest 100 in the FOA, as required by CAP1616i, we have provided unrounded population data in this section to help differentiate between options, particularly as some of the differences are relatively small.

5.3.3 For ease of comparison, we have only provided the summary data for 2036. As the options do not influence the number of ATMs or the fleet mix, the relative performance between options is the same in 2027 as it is in 2036.

Table 175 2036 Summary of option performance in terms of primary noise metrics. Note conditional formatting applied to show variation between the options, not how the options perform agains the 'without airspace change' baseline

Option	Total adverse noise effects					Community noise effects			
	Number of people experiencing adverse effects due to noise exposure above LOAEL and below SOAEL		Number of people experiencing significant adverse effects due to noise exposure above SOAEL		TAG monetised value of reduction in total noise effects (£)	Number of people experiencing likely significant adverse effects due to noise increases		Number of people experiencing likely significant beneficial effects due to noise decreases	
	Daytime	Night-time	Daytime	Night-time		Daytime	Night-time	Daytime	Night-time
Without airspace change	72,226	94,674	6	1,909	-	-	-	-	-
Option 1	70,419	94,516	6	1,750	£10,957,107	0	23	0	31
Option 2	70,522	94,206	6	1,656	£11,321,318	0	98	0	31
Option 3	71,154	97,730	6	1,737	£15,982,511	1,398	2950	2,424	6,497

Option	Total adverse noise effects					Community noise effects			
	Number of people experiencing adverse effects due to noise exposure above LOAEL and below SOAEL		Number of people experiencing significant adverse effects due to noise exposure above SOAEL		TAG monetised value of reduction in total noise effects (£)	Number of people experiencing likely significant adverse effects due to noise increases		Number of people experiencing likely significant beneficial effects due to noise decreases	
	Daytime	Night-time	Daytime	Night-time		Daytime	Night-time	Daytime	Night-time
Option 4	71,324	97,420	6	1,643	£16,339,763	1,398	3025	2,424	6,497
Option 5	70,667	94,735	6	1,796	£10,676,929	0	23	0	19
Option 6	70,650	94,227	6	1,656	£11,156,944	0	98	0	19
Option 7	71,422	97,949	6	1,783	£15,750,714	1,398	2,950	2,424	6,434
Option 8	71,405	97,441	6	1,643	£16,229,349	1,398	3,025	2,424	6,434

Table 176 2036 Summary of option performance in terms of greenhouse gas emissions, biodiversty, air quality and tranquillity. Note conditional formatting applied to show variation between the options, not how the options perform agains the 'without airspace change' baseline

Option	Greenhouse gas emissions		Biodiversity	Air Quality	Tranquillity	
	Annual total GHG emissions (tCO_2e)[76]	TAG monetised value of reduction in GHG emissions (£)			Predicted significant adverse impact to the perception of tranquillity	Predicted significant beneficial impact to the perception of tranquillity
Without airspace change	557,095	-	-	-	-	-
Option 1	544,808	£24,597,919	No predicted significant impacts on	No predicted significant impacts	None predicted	None predicted
Option 2	545,040	£24,056,994			None predicted	None predicted
Option 3	545,250	£23,560,119			1 Candidate Quiet Area	1 Candidate Quiet Area
Option 4	545,482	£23,010,552			1 Candidate Quiet Area	1 Candidate Quiet Area

[76] Please refer to the FOA methodology section for greenhouse gas emissions for contextual information on how the use of planned flight data in the NERL modelling may affect this result

Option 5	545,035	£24,069,202	biodiversity for any option	on air quality for any option	None predicted	None predicted
Option 6	545,267	£23,519,634			None predicted	None predicted
Option 7	545,477	£23,022,760			1 Candidate Quiet Area	1 Candidate Quiet Area
Option 8	545,709	£22,473,192			1 Candidate Quiet Area	1 Candidate Quiet Area

5.4 Preferred Option for Consultation and rationale

Option discontinuing methodology and preferred option for consultation

5.4.1 At the end of the Full Options Appraisal, we look to the outcomes of the assessments to understand which option(s), to take to consultation. A key part of the CAP1616 process is to have a transparent approach when establishing which options to take forward, although CAP1616 does not define a shortlisting methodology.

5.4.2 When determining which option(s) to take to consultation, Glasgow Airport has considered outcomes of the cost benefit analysis and the detailed assessments undertaken against each FOA category to understand the options positive benefits and negative impacts. In some cases, if multiple options perform similarly against the 'without airspace change' baseline, we have also looked at the comparative performance of each option. It's really important to note that the threshold for discontinuing an option cannot be based on quantitative assessments alone but must also come down to the qualitative appraisals and professional judgment, as there are many factors and FOA categories to balance.

5.4.3 When considering the environmental assessments within the FOA, we have looked to the Air Navigation Guidance (ANG) 2017 (https://www.gov.uk/government/publications/uk-airnavigation-guidance-2017). The ANG is guidance to the CAA on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management. The ANG outlines the Government's altitude based priorities for consideration of the environmental impacts arising from airspace change proposals.

5.4.4 Table 177 outlines these altitude based priorities and how they have applied to the environmental assessments within the FOA.

Table 177 Altitude based priorities and how they have been applied in the discontinuing methodology

Altitude Based Priority (See B29, CAP1616 and ANG 2017)	How it's assessed within the FOA	How it's considered when shortlisting
In the airspace from the ground to below 4,000 feet, the Government's environmental priority is to limit and, where possible, reduce the total adverse noise effects on people	Total adverse noise effects for each option are assessed and reported using L_{Aeq} noise exposure. Total *adverse* noise effects are quantified by the number of people exposed above the LOAEL and below the SOAEL. Total *significant adverse* effects are quantified by the number of people exposed above the SOAEL. Differences in total adverse effects compared to the 'without airspace change' scenario are assessed and reported using TAG.	The discontinuing methodology quantifies the total number of people experiencing adverse effects, the total number of people experiencing significant adverse effects, and the TAG monetary value of all the adverse and beneficial effects combined. We have considered how each option performs against the 'without airspace change' baseline, and how the options comparatively perform amongst each other.
Where options for route design from the ground to below 4,000 feet are similar in terms of the number of people affected by total adverse noise effects, preference should be given to that option which is most consistent with existing published airspace arrangements	Changes in L_{Aeq} noise exposure at each postcode have been calculated to determine locally where significant noise effects (as a result of moderate to major increases or decreases in noise) occur due to options which include more substantial changes to the existing airspace design. We have also calculated the number of people that are newly overflown, or no longer overflown, as a result of changes to airspace design, which allows us to understand which options result in more	When options perform similarly in terms of total adverse noise effects, we have considered how options compare against the 'without airspace change' baseline airspace arrangements in terms of significant noise effects and the secondary noise metrics of overflight, N65 and N60.

Altitude Based Priority (See B29, CAP1616 and ANG 2017)	How it's assessed within the FOA	How it's considered when shortlisting
	substantial changes to the existing airspace design in terms of perception of overflight. We have also considered how the secondary noise metrics, N65 and N60, change when compared to the 'without airspace change' baseline.	
In the airspace at or above 4,000 feet to below 7,000 feet, the environmental priority should continue to be minimising the impact of aviation noise in a manner consistent with the Government's overall policy on aviation noise, unless the CAA is satisfied that the evidence presented by the sponsor demonstrates this would disproportionately increase CO2 emissions	Within the FOA, we have compared the potential greenhouse gas emissions from each option to the 'without airspace change' baseline to understand if it results in a positive benefit or negative impact.	When options perform similarly in terms of total adverse noise effects, we have considered the greenhouse gas assessments to understand whether any option would result in disproportionately higher level of greenhouse gas emissions.

5.4.5 Alongside the ANG2017, we have also looked to the Airspace Modernisation Strategy (AMS) which is one of the main drivers behind the overall Scottish Airspace Modernisation change. The AMS has an overall vision to *'Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace'* and four objectives:

- Safety: Maintaining and, where possible, improving the UK's high levels of aviation safety has priority over all other 'ends' to be achieved by airspace modernisation
- Integration of diverse users: Airspace modernisation should wherever possible satisfy the requirements of operators and owners of all classes of aircraft, including the accommodation of existing users (such as commercial, General Aviation, military, taking into account interests of national security) and new or rapidly developing users (such as remotely piloted aircraft systems, advanced air mobility, spacecraft, high-altitude platform systems)

- Simplification, reducing complexity and improving efficiency: Consistent with the safe operation of aircraft, airspace modernisation should wherever possible secure the most efficient use of airspace and the expeditious flow of traffic , accommodating new demand and improving system resilience to the benefit of airspace users, thus improving choice and value for money for consumers
- Environmental sustainability: Environmental sustainability will be an overarching principle applied through all airspace modernisation activities. Modernisation should deliver the Government's key environmental objectives with respect to air navigation as set out in the Government's Air Navigation Guidance and, in doing so, will take account of the interests of all stakeholders affected by the use of airspace

5.4.6 In the first instance, as per the Government's altitude based priorities and CAP1616 requirements, we have looked at each option's performance in terms of the total adverse noise effects on people. As mentioned above, this is measured by the population exposed above the LOAEL and below the SOAEL (for adverse effects) and above the SOAEL (for significant adverse effects) and the subsequent net present value (NPV) which is a monetised outcome.

5.4.7 The NPV outcomes for noise showed that all options result in a substantial reduction of total adverse effects compared to the 'without airspace change' baseline with a monetised value of the reduction in noise effects of between £10.7 and £16.3 million. This valuation effectively adds all of the noise effects (adverse effects, significant adverse effects, beneficial effects and significant beneficial effects) into a single value, so it is necessary to look in more detail at the noise effects using the L_{Aeq} metrics to understand the balance of positive and negative effects and their significance. As the following paragraphs will demonstrate, this total monetised value is driven by a very large number of negligible to minor noise changes and a relatively smaller number of moderate to major noise changes.

5.4.8 When considering the total number of adverse effects and adverse significant effects, there is only a very small difference due to the arrivals component as all aircraft are generally aligned with final approach within the noise exposure contours that determine adverse effects. The small differences between the options that are vectored (Options 1 – 4) vs those that have PBN transitions (options 5 – 6) is due to a small influence that the PBN concentration has on the shape of the edges of the noise contours. This means that the differences in the total number of adverse effects and adverse significant effects is influenced more by aircraft departures than arrivals.

5.4.9 For the total significant adverse effects (due to exposure above the SOAEL), there are only small differences between the options: there is no difference during the daytime and for the night-time the difference is approximately 150 people between the best and worst performing options. It is important to note that this change in affected population is due to negligible differences in noise levels (0.1 to 0.3 dB) that are just enough to move eight postcodes in a densely populated area from one side of the SOAEL contour to the other.

5.4.10 For the total adverse effects (due to exposure above the LOAEL and below the SOAEL), there is a difference of approximately 1,000 people between the best performing and worst performing options which equates to around a 1% difference. The difference in night-time total adverse effects shows slightly more variation between options, with a difference of approximately 3,700 people between the best and the worst performing options which equates to around a 4% difference.

5.4.11 Given that the options show broadly very similar performance, we therefore looked to the second section of the altitude based priorities; *where options for route design from the ground to below 4,000 feet are similar in terms of the number of people affected by total adverse noise effects, preference should be given to that option which is most consistent with existing published airspace arrangements.*

5.4.12 To assess this, we calculated the number of people that experience significant beneficial noise impacts and significant adverse noise impacts i.e. data which helps us to understand the scale of the noise change experienced at individual postcodes and community areas. What the data largely shows is that the options with only the offset departures (Option 3, 4, 7 and 8) performed well in terms of the number of people experiencing significant beneficial noise impacts but they also had the most people experiencing significant adverse noise impacts. This is because of the substantial change in the airspace design for these options which moves flightpaths from being over one community to being over another.

5.4.13 On the runway 23 end (to the southwest of the airport), the offset departures provide significant beneficial effects (due to moderate and major noise decreases), to large parts of Johnstone (broadly between Castle Woods and Corseford School), the community of Howwood and a small number of isolated properties broadly between the B776 and A737. This benefit is brought about because the departures in the offset departure options turn to the left or right before reaching Johnstone. However, this also has the effect of introducing significant adverse effects (due to moderate and major noise increases) to the majority of the community of Kilbarchan, parts of the community of Brookfield (broadly between the A761 and B789) and a small number of isolated properties to the south of Johnstone (broadly between Craigston Wood and Sergeant Law Road) and between the A761 and B789. This adverse effect is brought about because these community areas would be underneath a departure SID centreline for the first time.

5.4.14 On the runway 05 end (to the northeast of the airport), the offset departures do not result in any significant beneficial effects, but do result in significant adverse effects (due to moderate and major noise increases) for a small number of properties in Drumchapel, to the north of Ladyloan Avenue. This is because of the early turn west for the offset 05 departures which brings aircraft more to the north and west over Drumchapel, increasing the proportion of aircraft that would overfly these areas compared to the 'without airspace change' design options. The extent of the adverse and beneficial effects is less pronounced for the runway 05 departures, as these routes would only be in operation approximately 26% of the year and hence noise exposure and noise effects on the runway 05 end tend to be dominated by arrivals.

5.4.15 When considering this against the second line of the altitude based priorities, this shows that the options with offset departures are the least consistent with the existing published airspace arrangements. For example comparing option 4, which uses offset departures against option 5 which doesn't, Option 5 shows a very small change in the number of people experiencing either significant benefits or impacts, whereas option 4 shows that the change would affect thousands of people.

5.4.16 It's important to note that we did consider the other benefits and/or impacts below 4000ft as part of the discontinuing process; there was no difference in air quality emissions between the options, and there are no predicted biodiversity impacts on any European Sites for all options. In terms of fuel burn and greenhouse gas emissions, there is approximately 900 annual tCO_2e difference between the best and worst performing option which equates to around a 0.2% difference. In terms of tranquillity, the assessment shows a similar story to that for noise, as the runway 23 offset departures result in potential significant beneficial impact to the perception of tranquillity for the Skiff Wood Candidate Quiet Area, which is close to the community of Howwood, and a potential significant adverse impact to the perception of tranquillity for the Barhill Wood Candidate Quiet Area, which is close to the community of Kilbarchan.

5.4.17 Considering all this in combination, it was found that Options 1, 2, 5, and 6 were more consistent with the existing published airspace arrangements, whereas Options 3, 4, 7, and 8 were the least consistent. Therefore, on the basis of the ANG2017 and how the options performed in terms of both total adverse noise affects and community adverse noise effects and consistency with the existing airspace arrangements, we discontinued options 3, 4, 7 and 8.

5.4.18 There were no other specific assessments (such as safety, capacity, etc) below 4000ft which would differentiate between the four options discontinued, and the four taken forward for further consideration at this stage. In terms of Controlled Airspace (CAS), although options 3 and 4 require less CAS than options 5 and 6, Options 1 and 2 have the same CAS volumes as 3 and 4 and Options 5 and 6 have the same CAS volumes as 7 and 8. Therefore by progressing options 1,2,5,and 6 we are still considering the larger and smaller CAS volumes possible.

5.4.19 To help with articulating the next part of the discontinuing, the components of option 1, 2, 5 and 6 are shown in Table 178 below.

Table 178 Departure and arrival components for options 1,2,5 and 6

Option #	05 Arrival	23 Arrival	05 Departure	23 Departure
Option 1	Vectors	Vectors	No offset SIDs	No offset SIDs
Option 2	Vectors	Vectors	Offset SIDs	No offset SIDs
Option 5	PBN and Vectors	PBN and Vectors	No offset SIDs	No offset SIDs
Option 6	PBN and Vectors	PBN and Vectors	Offset SIDs	No offset SIDs

5.4.20 Having considered impacts below 4000ft we next looked at the options performance between 4000ft and 7000ft. This is where the ANG2017 says that noise remains the priority unless there is a disproportionate increase in GHG emissions and where noise secondary metrics provide additional information beyond the scope of adverse noise effects. In particular, for the secondary noise metrics we have looked at the total population overflown and the number of people newly overflown. This is because CAP1616f suggests that one way of demonstrating that an airspace design limits and, where possible, reduces the number of people in the UK significantly affected by adverse impacts from aircraft noise, is to show that it minimises the total population overflown and minimises the number of people newly overflown. As the night-time overflight contours sit entirely within the daytime overflight contours, the daytime overflight data represents the total overflight data when day and night are considered together. We have also looked at the N65 and N60 metrics, but these are very similar across the options and are primarily a communication metric, so are not considered further in terms of selecting a preferred option.

5.4.21 Table 179 summarises the main assessments categories where the outcomes are different between the four options, as opposed to summarising the whole of the FOA:

Table 179 2036 Summary of option performance in terms of secondary noise metrics and other assessment categories. Note conditional formatting applied to show variation between the options, not how the options perform agains the 'without airspace change' baseline

Option	**Total population overflown, >=5**		**Population newly overflown, >=5**		**Population no longer overflown, >=5**		**Total population N65 >= 5**	**Total population N60 >= 5**	**Annual total GHG emissions (tCO_2e)**	**Capacity, annual delay minutes**	**CAS**
	Daytime	**Night-time**	**Daytime**	**Night-time**	**Daytime**	**Night-time**	**Daytime**	**Night-time**			
Without Airspace Change	554,714	55,318	-	-	-	-	150,502	70,745	557,095		
Option 1	621,755	46,133	163,466	1,524	99,720	13,117	151,170	69,290	544,808	c.52300	Requires slightly less than O5 and O6
Option 2	628,440	44,823	165,910	1,524	98,769	17,007	152,950	69,058	545,040	c.53500	Requires slightly less than O5 and O6
Option 5	476,086	70,840	100,559	27,679	175,766	13,557	151,157	69,188	545,035	c.52300	Requires slightly more than O1 and O2
Option 6	482,782	69,630	103,003	27,679	174,815	17,093	152,954	68,952	545,267	c.53500	Requires slightly more than O1 and O2

5.4.22 As outlined above, all options perform broadly similarly in terms of GHG emissions which means that a 'disproportionate increase' in GHG was not identified between the options. We therefore looked to the secondary noise metrics, and the wider assessment categories within the FOA, to understand the overall performance of the remaining options. In addition to this, we also looked at how well the options aligned with the objectives of the Airspace Modernisation Strategy (AMS) and our Design Principles. Similar to the table above, the assessment against the AMS is not an exhaustive repetition of all assessments already contained within this FOA, but instead it looks to identify where the four options perform differently from one another.

5.4.23 Table 180 explains the next stages and outcomes of our conclusion assessment:

Table 180 Conclusion assessment

Conclusion assessment		**Option**			
		1	**2**	**5**	**6**
AMS objective: Safety	All of the remaining options at least maintain safety but the options with PBN arrivals transitions offer improved safety performance compared to the 'without airspace change' baseline. This meant that options 5 and 6, which have PBN arrivals transitions and vectoring, offer marginally more benefits than option 1 and 2 which only use vectoring for arrivals. At this stage, option 1 and 2 were not discontinued but their performance was balanced against the other objectives of the AMS.				
AMS objective: Integration of diverse users	When considering integration of diverse users, we looked to the General Aviation and Controlled Airspace assessments. All options offered a reduction in the volume of CAS required which is an improvement compared to the without airspace change scenario. Regulatory guidance is not currently available around the integration of new and rapidly users such as remotely piloted aircraft systems and advanced air mobility. For the purposes of this FOA, we have assumed that the release of controlled airspace would benefit these users. Although all options offered less CAS than today, options 5 and 6 require slightly more airspace than option 1 and option 2. At this stage, option 5 and 6 were not discontinued but their performance was balanced against the other objectives of the AMS as, for example, the safety assessment above had highlighted that they offered opportunities for improvement to safety.				
AMS objective: Simplification, reducing complexity & improving efficiency	All options offer improvements to capacity and aim to simplify and reduce complexity in the airspace compared to the 'without airspace change' scenario. The departure delay analysis showed that option 1 and option 5 offer fewer delay minutes per annum than option 2 and 6. Just like with the safety and CAS assessments above, this didn't mean option 2 and 6 were immediately discontinued, but we balanced the outcomes of this assessment against the other objectives of the AMS.				

<table>
<tr><th rowspan="2">Conclusion assessment</th><th rowspan="2"></th><th colspan="4">Option</th></tr>
<tr><th>1</th><th>2</th><th>5</th><th>6</th></tr>
<tr><td>AMS objective: Environmental sustainability - Greenhouse Gas emissions</td><td>In terms of fuel burn and greenhouse gas emissions, there is a very small difference of around 0.2% between the best and worst performing option (all options improved compared to the ‘without airspace change’ scenario).

The ANG 2017 says: In the airspace at or above 4,000 feet to below 7,000 feet, the environmental priority should continue to be minimising the impact of aviation noise in a manner consistent with the Government’s overall policy on aviation noise, unless the CAA is satisfied that the evidence presented by the sponsor demonstrates this would disproportionately increase CO2 emissions.
Based on the greenhouse gas assessment, we knew that none of the options would result in a disproportionate increase in greenhouse gas emissions and therefore we looked to the secondary noise assessments.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>AMS objective: Environmental sustainability – Secondary noise metrics</td><td>In the case of the N60 and N65 noise metrics, there were very small differences between the options. In the case of N65 (daytime), all options were within c.1% of each other. In the case of N60 (nighttime) all options were within <1% of each other.

There was however more differentiation between the options when looking at the overflight metrics. Here there were two key metrics; total population overflown and population newly overflown for both daytime and nighttime.

- Option 1 had the second highest population overflown in total and the second highest population newly overflown (considering day and night together).
- Option 2 had the highest population overflown in total and the highest population newly overflown (considering day and night together).
- Option 5 has the lowest population overflown in total and the lowest population newly overflown (considering day and night together).
- Option 6 has the second lowest population overflown in total and the second lowest population newly overflown (considering day and night together).</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Overall</td><td>When taking the various conclusions above into account and balancing how the options performed against the objectives of the AMS, Glasgow Airport elected to take Option 5 through to consultation. This was because:
- Option 5 provides a reduction in the total adverse effects of noise: a reduction in adverse noise effects, significant adverse noise effects and the total adverse noise effects as measured by the TAG methodology. It is acknowledged that option 5 was not the highest performing option when looking at the TAG valuation. However, it is important to note that this valuation effectively adds all of the noise effects (adverse effects, significant adverse effects, beneficial effects and significant beneficial effects) into a single value, so it is necessary to look in more detail at the noise effects using the L_{Aeq} metrics to understand the balance of positive and negative effects and their significance. The options with the larger TAG valuations (3,4, 7 and 8) are driven by a very large number of negligible to minor noise changes and a number of moderate to major noise changes that would result in significant adverse effects for thousands of people. By contrast, Option 5 has a lower TAG valuation but results in significant adverse effects for less than 100 people. This is explained in detail in paragraphs 5.4.7 to 5.4.18 above.</td><td></td><td></td><td></td><td></td></tr>
</table>

Conclusion assessment		Option 1	Option 2	Option 5	Option 6
	- When looking at the secondary noise metrics for overflight, Option 5 was the top performing option with the lowest population overflown in total and the lowest population newly overflown (considering day and night together). - Option 5 offers a greenhouse gas emissions reduction compared to the 'without airspace change' scenario and provides the second greatest reduction in emissions across the options - This option offered improvements to safety which is a key objective of the AMS. - In terms of integration of diverse users, Option 5 would require less CAS than today. It is acknowledged that Option 5 would require 14.4nm^3 of extra controlled airspace compared to option 1 and option 2 which is due to a combination of optimal PBN flight path positioning for environmental and operational purposes and adherence to the CAA Policy for the Design of Controlled Airspace Structures, however overall, the option still offers a CAS benefit compared to the 'without airspace change' baseline and the option offers benefits in several other AMS objective areas. - Option 5 offered high performance in departure delay minutes and was joint highest performing for Simplification, reducing complexity & improving efficiency, another key objective of the AMS.				

5.5 What happens next

5.5.1 As outlined above, following a thorough review of the outcomes of the FOA against the requirements of the Air Navigation Guidance 2017, the objectives of the Airspace Modernisation Strategy, the Statement of Need and the Design Principles, Glasgow Airport decided to take Option 5 to consultation as the preferred option. The full public Consultation document can be found on the CAA's Citizen Space portal here: https://airspacechange.caa.co.uk/PublicProposalArea?pID=175 and on the Consultation website: www.scottishairspacemodernisation.co.uk

5.5.2 In preparation for consultation, we generated some additional noise information where we felt it would be useful to aid stakeholders understanding of the benefits and impacts of the proposal. This includes:

- L_{ASmax} spot noise levels
- 100% mode L_{Aeq} and 100% mode Overflight contours
- L_{Aeq} difference contours which show the difference in noise level exposures between the 'with' and 'without' airspace change scenario over a geographic area.

5.5.3 More information about how these have been generated can be found in the noise methodology section of this document.

5.5.4 The contour maps are shown in Figures TA58 to TA70 in the Technical Appendix and have been compiled into a separate information pack that forms part of the main consultation document. This can be found here.

5.5.5 In addition to the noise metrics, a draft Controlled Airspace chart was created and this is shown in section 11.4 of Appendix A.

5.5.6 The preferred option has also been fed into the 'Description of the proposed system-wide design for the Scottish (ScTMA) Cluster of the Airspace Change Masterplan' [here] produced by ACOG. Please see this document for details of the overall system benefits and impacts including our change alongside those of Edinburgh Airport and NERL.

6. Technical Appendix

6.1.1 Due to file size, the technical appendix showing the full environmental data tables and the noise contour figures is published separately on the CAA's Airspace Change Portal. Please use the following link to access the document: https://airspacechange.caa.co.uk/PublicProposalArea?pID=175

7. Appendix A: Draft Procedure Information

Please note the CAA do not allow sponsors to publish draft procedure charts. Any airlines wishing to see the charts for the options developed as part of this FOA, please contact airspace@glasgowairport.com.
For technical information about the option for consultation (Option 5), please see Annex 1 of the main Consultation document.

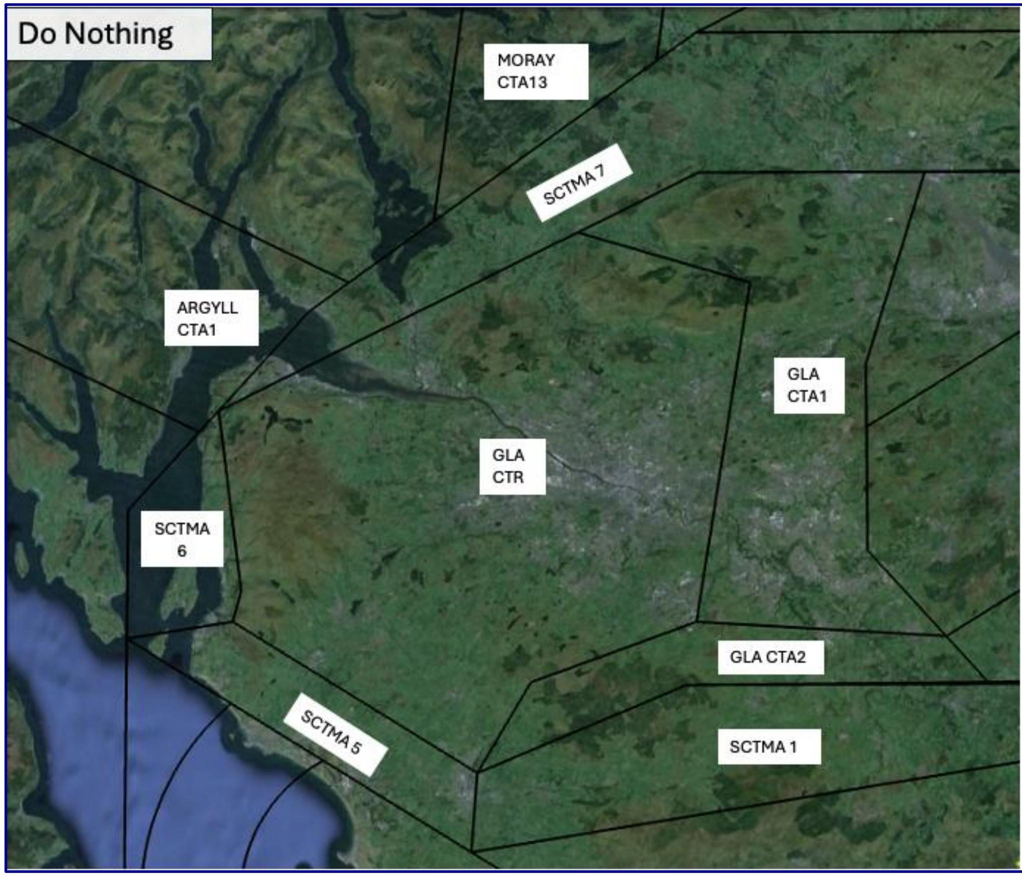
8. Appendix B: Air Quality Assessment

Please see separate Appendix B document.

9. Appendix C: General Aviation – Access – Controlled Airspace Assessment

9.1 Options 1 – 4 vectoring only (without PBN transitions)

9.1.1 Figure 99 to Figure 103 illustrate the section of Glasgow CAS volumes required to support Options 1, 2, 3 and 4 compared to the without airspace change scenario.



DO NOTHING		
DESIGNATION	CLASS	BASE
GLA CTR	D	0
GLA CTA1	D	3000
GLA CTA2	D	3500
SCTMA1	D	4500
SCTMA5	D	3500
SCTMA6	E	3000
SCTMA7	E	4000
ARGYLL CTA1	E	5500
MORAY CTA13	E	5500

Figure 99 Existing CAS volumes in the vicinity of Glasgow

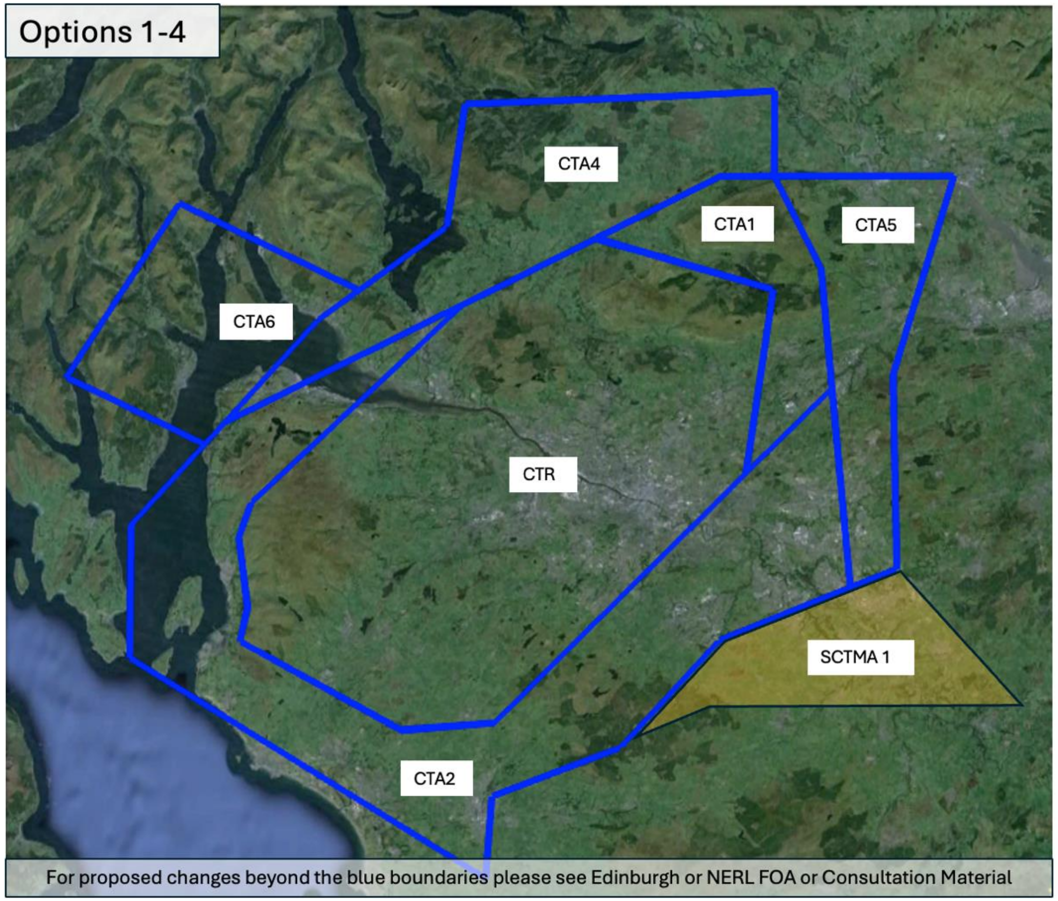
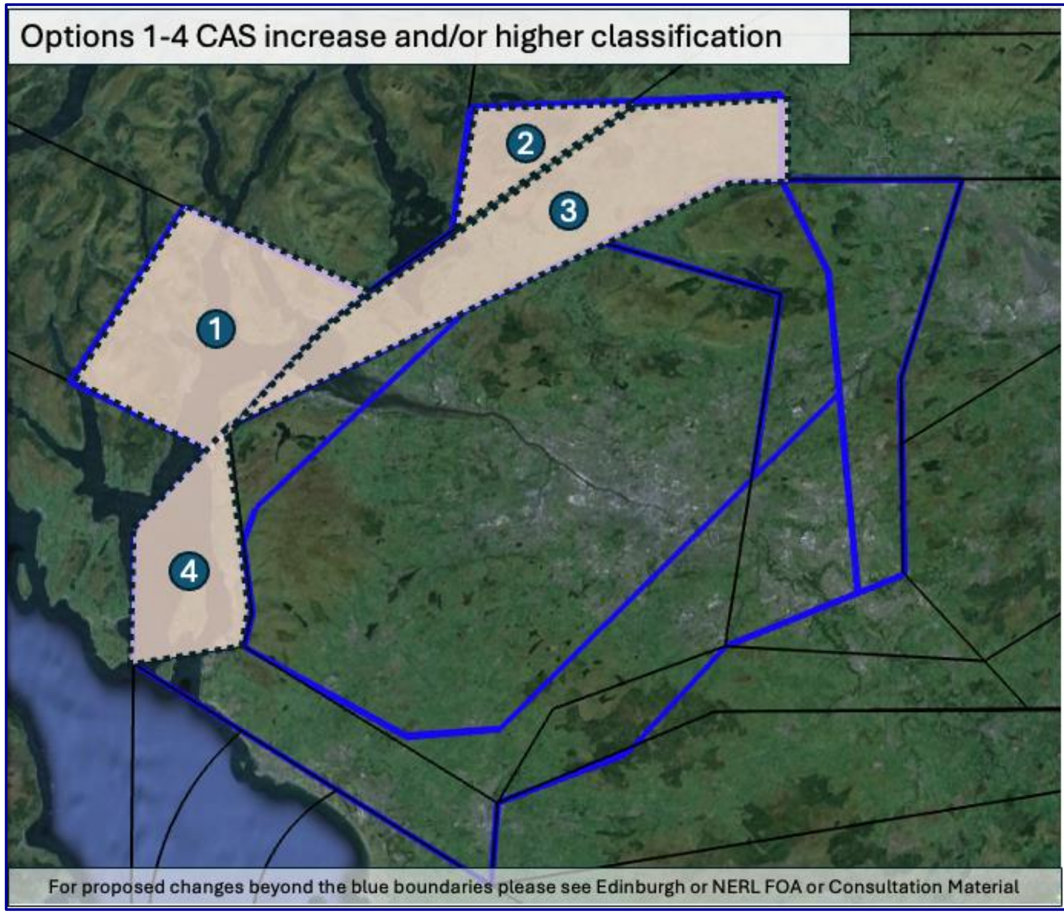


Figure 100 Proposed CAS volumes in the vicinity of Glasgow to support Options 1-4

Options 1-4		
DESIGNATION	**CLASS**	**BASE**
GLA CTR	D	0
GLA CTA1	D	3000
GLA CTA2	D	3500
GLA CTA4	D	4500
GLA CTA5	D	4500
GLA CTA6	D	4500
SCTMA1	D	4500

Proposed increases and/or higher classifications of Controlled Airspace (negative impacts compared to the 'without ACP' scenario)

9.1.2 The following figure shows the areas where there would be an increase in volume of CAS, or in higher classification. These are considered to be the parts where there is a negative impact compared to the 'without ACP' scenario.

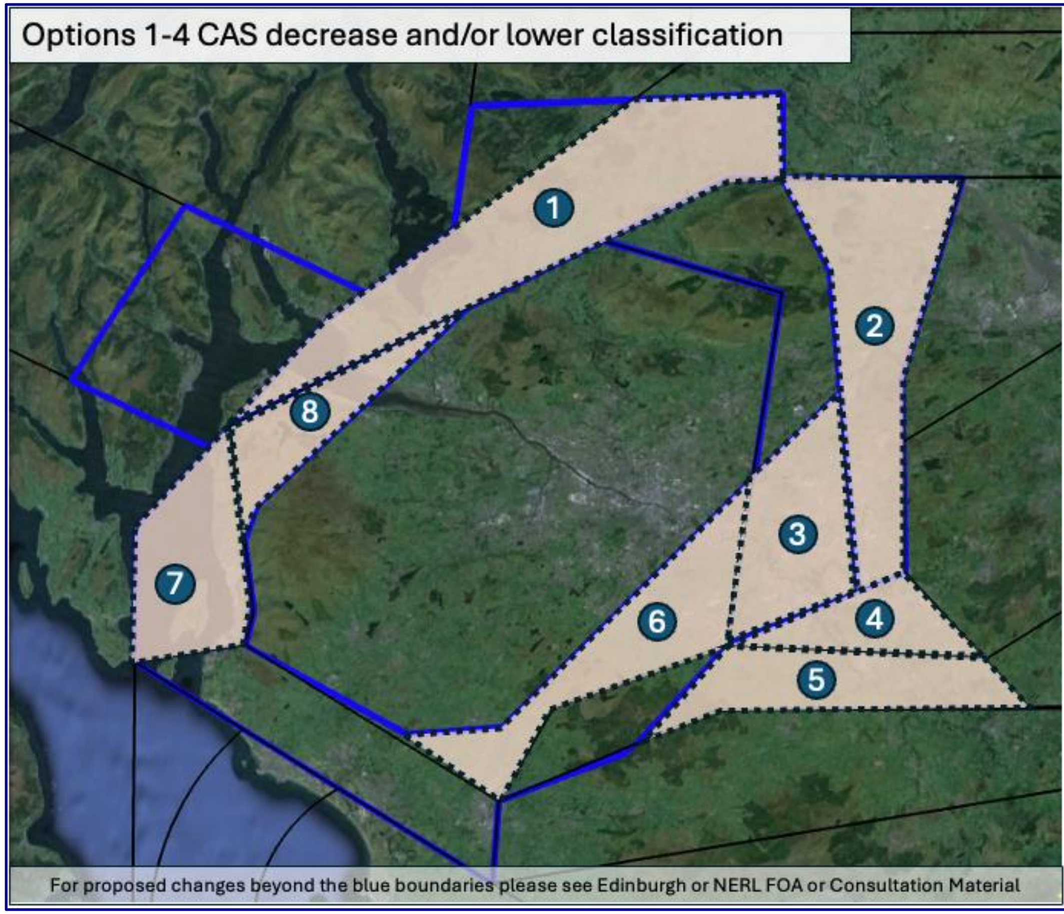


	Currently	Proposed
1	ARGYLL CTA1 CLASS E 5500ft base	GLA CTA6 CLASS D 4500ft base
2	MORAY CTA Class E 5500ft base (by NOTAM)	GLA CTA4 CLASS D 4500ft base
3	ScTMA Class E 4000ft base	GLA CTA4 CLASS D 4500ft base
4	ScTMA6 CLASS E 3000ft base	GLA CTA2 CLASS D 3500fT base

Figure 101 Changes to existing CAS structures to support Options 1-4 which require additional CAS and/or a higher classification

Proposed decreases and/or lower classifications of Controlled Airspace (Positive benefits compared to the 'without ACP' scenario)

9.1.3 The following figure shows the areas where there would be a decrease in volume of CAS, or in lower classification. These are considered to be the parts where there is a positive benefit compared to the 'without ACP' scenario.

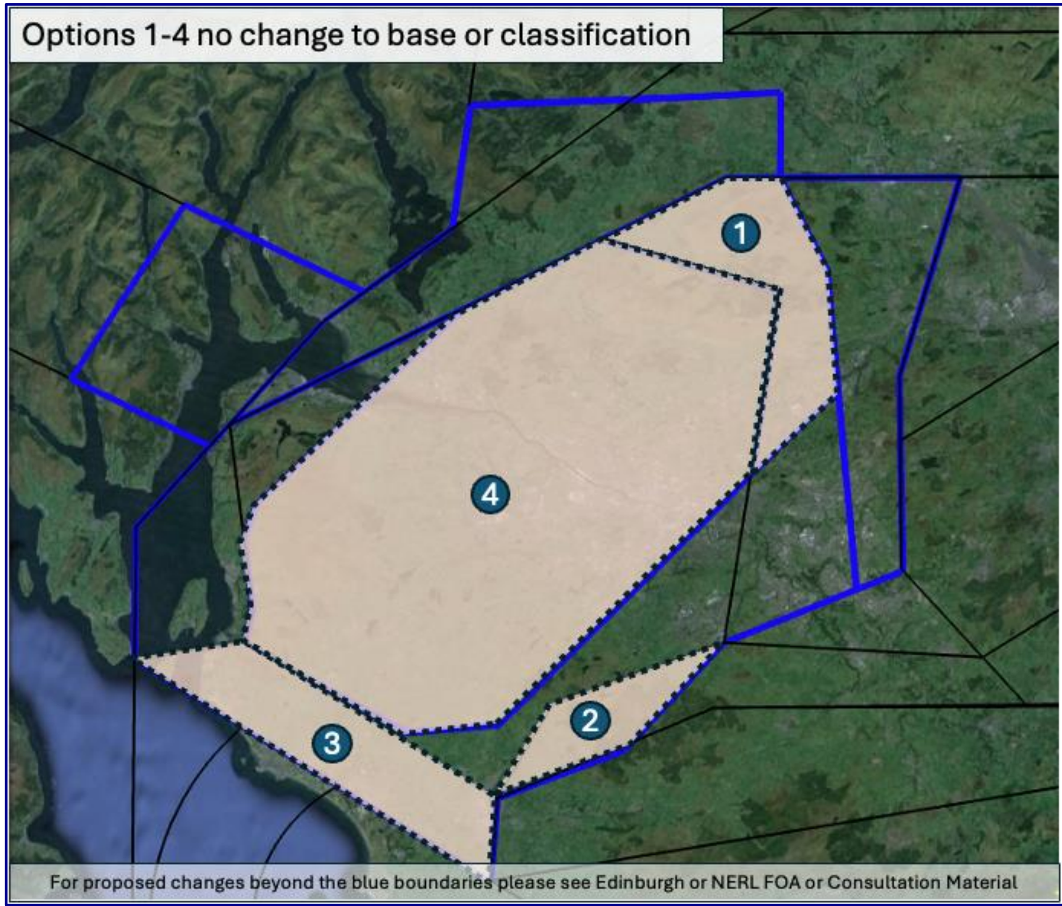


	Currently	Proposed
1	ScTMA Class E 4000ft base	GLA CTA4 Class D 4500ft base
2	GLA CTA1 Class D 3000FT base	GLA CTA5 Class D 4500ft base
3	GLA CTA1 Class D 3000FT base	GLA CTA2 Class D 3500ft base
4	GLA CTA1 Class D 3000FT base	ScTMA1 Class D 4500ft base
5	GLA CTA2 Class D 3500FT base	ScTMA1 Class D 4500ft base
6	GLA CTR Class D SFC base	GLA CTA2 Class D 3500ft base
7	ScTMA6 Class E 3000ft base	GLA CTA2 Class D 3500ft base
8	GLA CTR Class D SFC base	GLA CTA2 Class D 3500ft base

Figure 102 Changes to existing CAS structures to support Options 1-4 which enable a reduction in CAS and/or a lower classification

No change to Controlled Airspace (Neutral impacts/benefits compared to the 'without ACP' scenario)

9.1.4 The following figure shows the areas where there would be no change to the base of CAS or the classification. These are considered to be the parts where there is a neutral impact/benefit compared to the ‘without ACP’ scenario.



	Currently	Proposed
1	GLA CTA1 Class D 3000FT base	GLA CTA1 Class D 3000FT base
2	GLA CTA2 Class D 3500FT base	GLA CTA2 Class D 3500FT base
3	ScTMA5 Class D 3500ft base	GLA CTA2 Class D 3500FT base
4	GLA CTR Class D SFC base	GLA CTR Class D SFC base

Figure 103 Parts of CAS structures to support Options 1-4 would not require a change

9.1.5 Table 181 shows the total change in volume of airspace types and classifications for the combined Glasgow, Edinburgh and NATS NERL ACPs.

9.1.6 Overall, the proposed, combined design will require an additional 644.4 nm^3 of CAS. However, in isolation, 1038.9 nm^3 of new CAS is required by NATS NERL above 7000ft to provide more efficient en-route connectivity which demonstrates that a substantial airspace release has been achieved in the remainder of the design.

9.1.7 In addition to the CAS release, the classification of a substantial volume of CAS is proposed to be lowered increasing accessibility to all airspace users.

Table 181 Volume of each type and classification of CAS in the baseline and proposed, combined Glasgow, Edinburgh and NERL ACPs.

Airspace Type	Baseline Volume	Option Volume	Volume Change (nm^3)
CTR	**773.2**	**720.9**	**-52.3**
CTA	**26129.4**	**26781.1**	**651.7**
TMA	**9467.3**	**9512.3**	**45.1**
Total	**36369.8**	**37014.3**	**644.4**
Airspace Classification	**Baseline Volume**	**Option Volume**	**Volume Change (nm^3)**
Class A	**6714**	**1417.8**	**-5296.2**
Class C		**3713.2**	**3713.2**
Class D	**17691.7**	**19293.1**	**1601.4**
Class E	**11964.2**	**12590.1**	**626**
Total	**36369.8**	**37014.3**	**644.4**

9.1.8 As described above, separating out just changes to Glasgow designated airspace would not present an accurate picture. However, Table 182 below presents the same data as in Table 181 but for all CAS with a base of 7000ft or lower.

9.1.9 Overall, the proposed, combined design will result in a reduction of 616.1 nm^3 of CAS where bases are below 7000ft.

Table 182 Volume of each type and classification of CAS in the baseline and proposed, combined Glasgow, Edinburgh and NERL ACPs which have bases below 7000ft

Airspace Type	Baseline Volume	Option Volume	Volume Change (nm^3)

CTR	773.2	720.9	-52.3
CTA	7667.8	7102.5	-565.3
TMA	9467.3	9468.8	1.5
Total	17908.2	17292.1	-616.1
Airspace Classification	Baseline Volume	Option Volume	Volume Change (nm³)
Class A	404.4	95.2	-309.2
Class C		0	0
Class D	13389	13552.4	163.4
Class E	4114.9	3644.6	-470.3
Total	17908.2	17292.1	-616.1

9.1.10 The changes to Glasgow and Edinburgh's proposed CTR volumes are unrelated to each other. Table 183 presents the proposed change in volume of just Glasgow's CTR.

Table 183 Proposed change in volume of Glasgow's CTR

Airspace Type	Baseline Volume	Option 1-4 Volume	Volume Change (nm³)
GLA CTR	464.1	381.2	-82.9

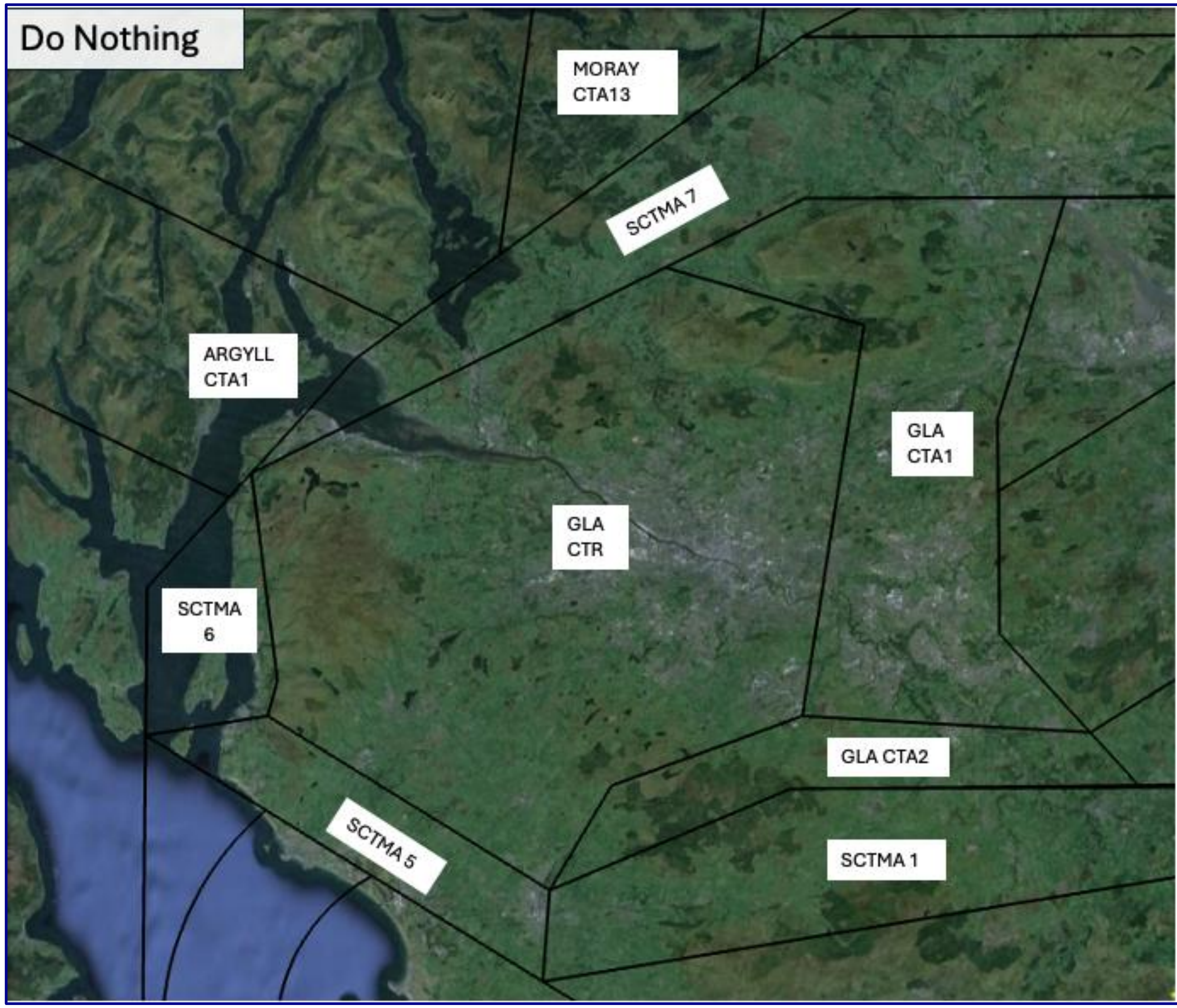
9.1.11 In terms of the overall value to General Aviation, previous engagement with GA stakeholders as part of Stage 2 highlighted that there was a desire to release as much CAS as possible and, broadly speaking, less CAS results in improved access for General Aviation.

9.1.12 As outlined in the section above, whilst overall there is a CAS release benefit below 7000ft, including a release for the GLA CTR, there are some areas which will be negatively impacted and other areas which will see improvements.

9.1.13 We are aware of the value of controlled airspace to glider pilots in the 'Cumbernauld gap' and this has been considered as part of the CAS development. We have included detailed information on proposed CAS dimensions, and we look forward to feedback from all of GA on the proposals, specific to their operations throughout the consultation process.

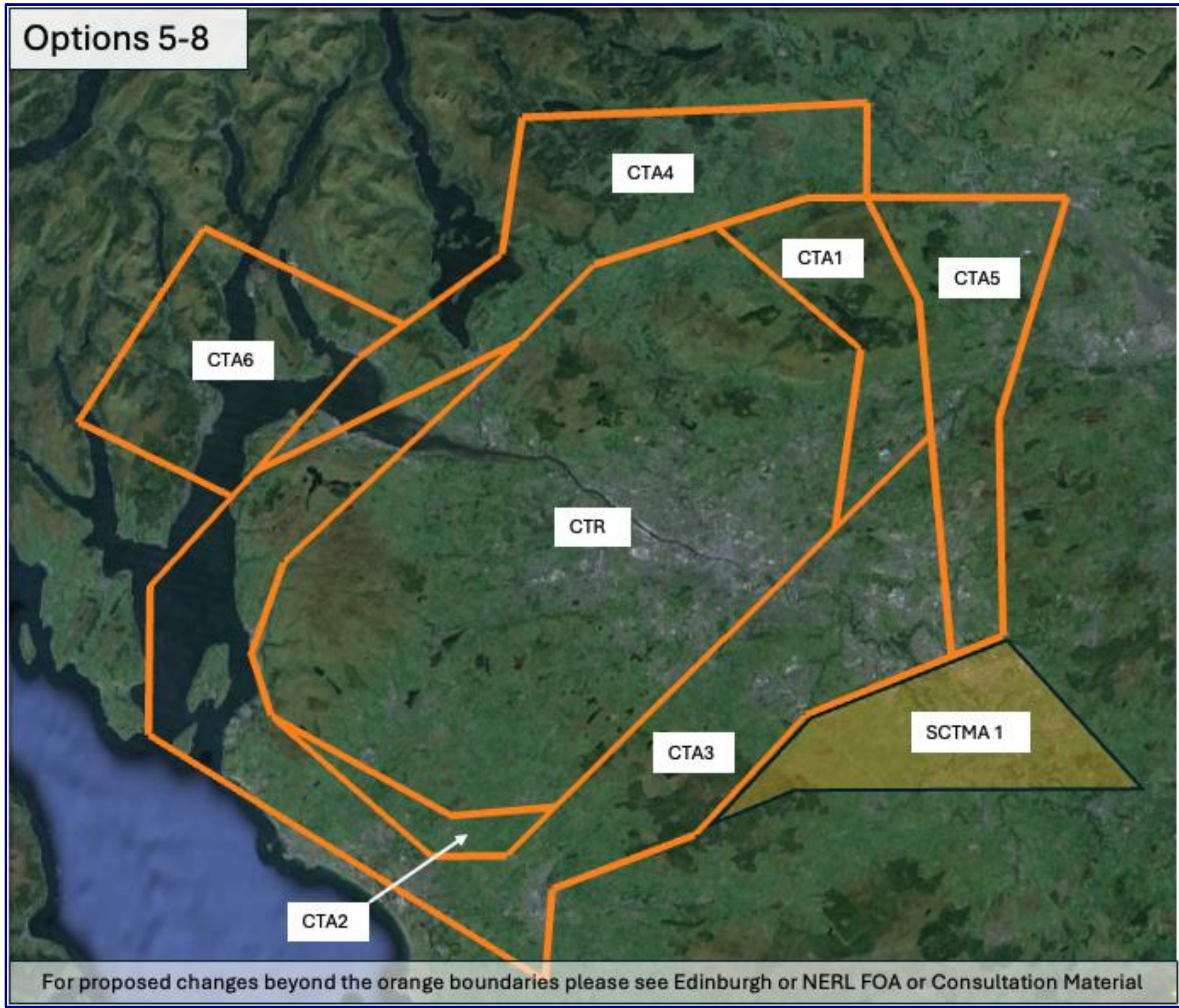
9.2 Options 5 – 8 with PBN transitions

9.2.1 Figure 104 to Figure 108 illustrate the section of Glasgow CAS volumes required to support Options 1, 2, 3 and 4 compared to the Do Nothing scenario.



DO NOTHING		
DESIGNATION	CLASS	BASE
GLA CTR	D	0
GLA CTA1	D	3000
GLA CTA2	D	3500
SCTMA1	D	4500
SCTMA5	D	3500
SCTMA6	E	3000
SCTMA7	E	4000
ARGYLL CTA1	E	5500
MORAY CTA13	E	5500

Figure 104 Existing CAS volumes in the vicinity of Glasgow

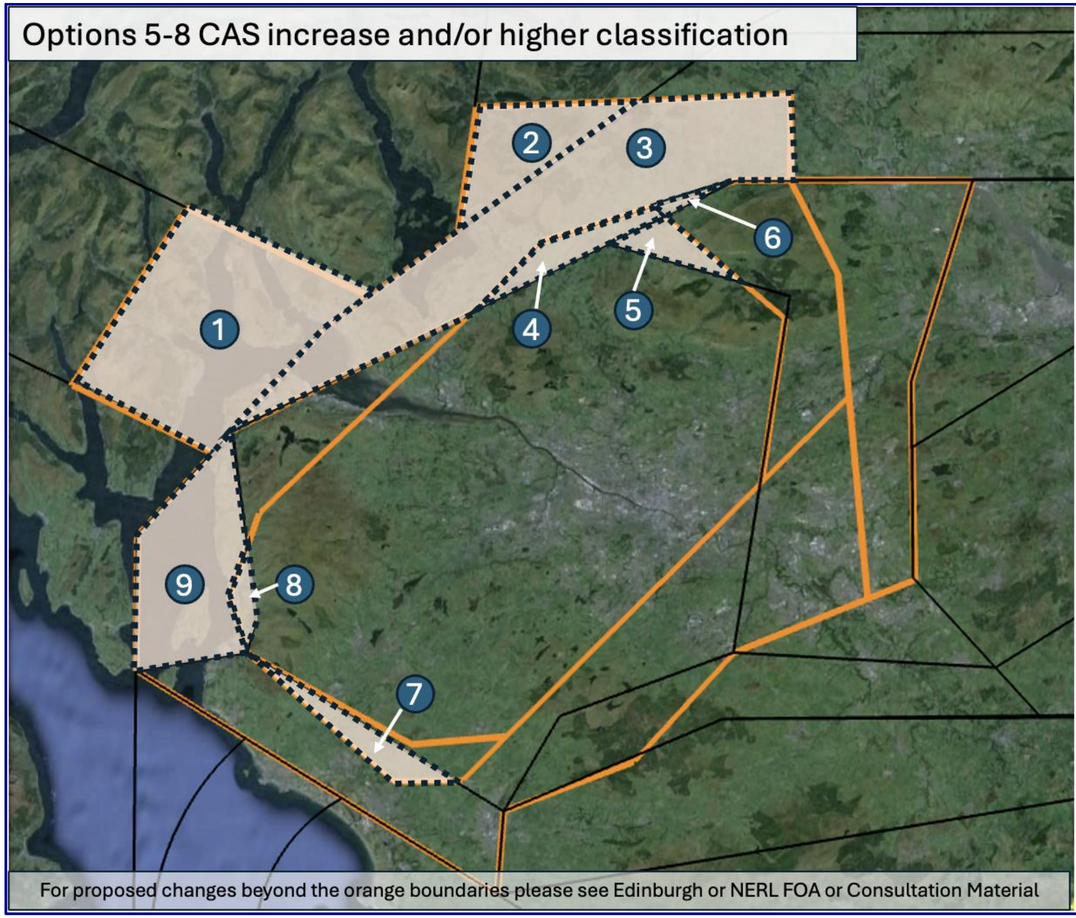


Options 5-8		
DESIGNATION	CLASS	BASE
GLA CTR	D	0
GLA CTA1	D	3000
GLA CTA2	D	2500
GLA CTA3	D	3500
GLA CTA4	D	4500
GLA CTA5	D	4500
GLA CTA6	D	4500
SCTMA1	D	4500

Figure 105 Proposed CAS volumes in the vicinity of Glasgow to support Options 5-8

Proposed increases and/or higher classifications of Controlled Airspace (negative impacts compared to the 'without ACP' scenario)

9.2.2 The following figure shows the areas where there would be an increase in volume of CAS, or in higher classification. These are considered to be the parts where there is a negative impact compared to the 'without ACP' scenario.

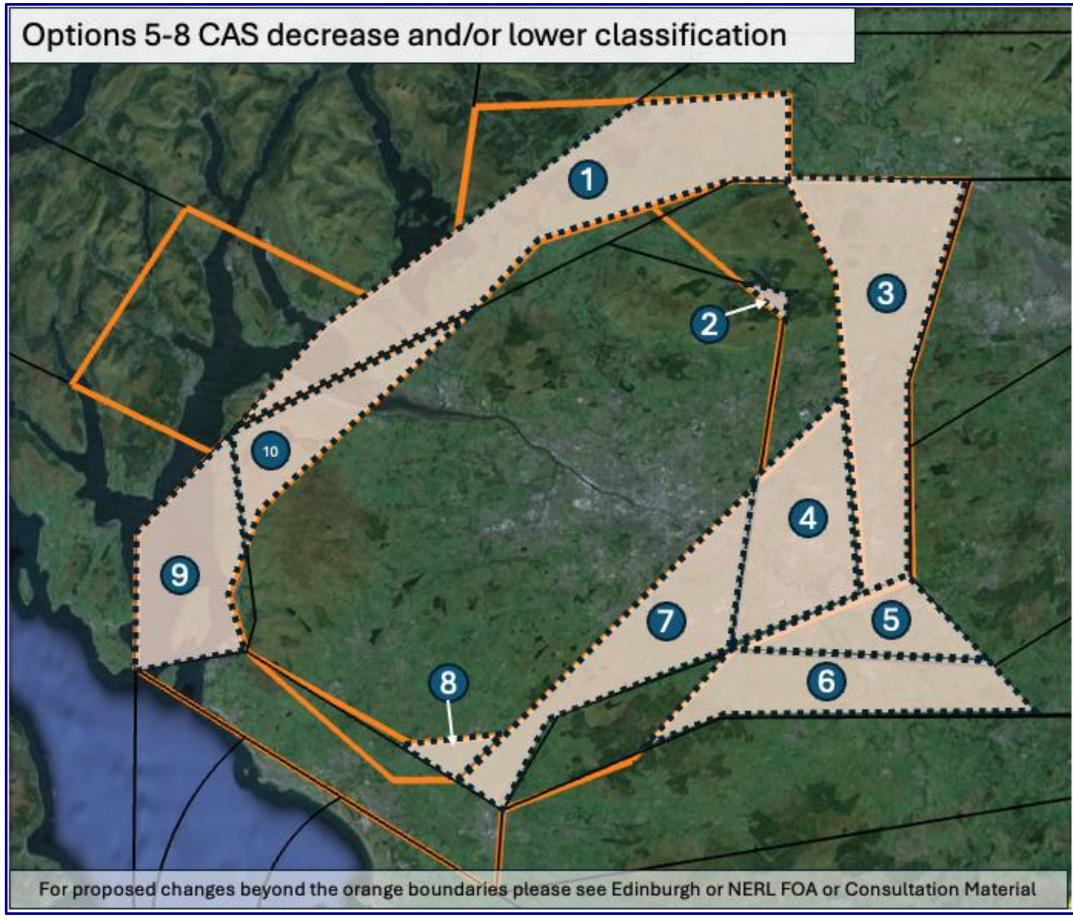


	Currently	Proposed
1	ARGYLL CTA1 CLASS E 5500ft base	GLA CTA6 CLASS D 4500ft base
2	MORAY CTA Class E 5500ft base (by NOTAM)	GLA CTA4 CLASS D 4500ft base
3	ScTMA Class E 4000ft base	GLA CTA4 CLASS D 4500ft base
4	ScTMA Class E 4000ft base	GLA CTR Class D SFC base
5	GLA CTA1 Class D 3000FT base	GLA CTR Class D SFC base
6	ScTMA Class E 4000ft base	GLA CTA1 Class D 3000FT base
7	ScTMA5 Class D 3500ft base	GLA CTA3 Class D 2500FT base
8	ScTMA6 CLASS E 3000ft base	GLA CTR Class D SFC base
9	ScTMA6 CLASS E 3000ft base	GLA CTA2 Class D 3500ft base

Figure 106 Changes to existing CAS structures to support Options 5-8 which require additional CAS and/or a higher classification

Proposed decreases and/or lower classifications of Controlled Airspace (Positive benefits compared to the 'without ACP' scenario)

9.2.3 The following figure shows the areas where there would be a decrease in volume of CAS, or in lower classification. These are considered to be the parts where there is a positive benefit compared to the 'without ACP' scenario.

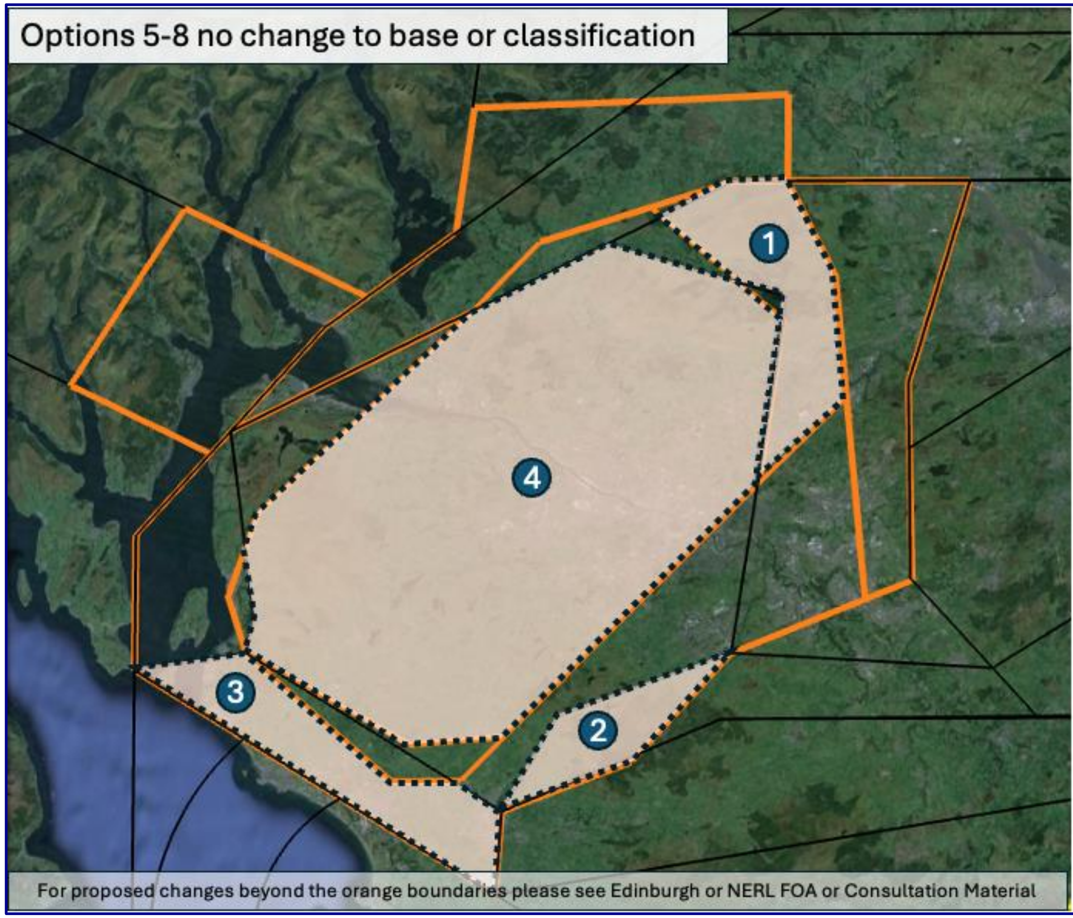


	Currently	Proposed
1	ScTMA Class E 4000ft base	GLA CTA4 Class D 4500ft base
2	GLA CTR Class D SFC base	GLA CTA1 Class D 3000FT base
3	GLA CTA1 Class D 3000FT base	GLA CTA5 Class D 4500FT base
4	GLA CTA1 Class D 3000FT base	GLA CTA2 Class D 3500FT base
5	GLA CTA1 Class D 3000FT base	ScTMA1 Class D 4500ft
6	GLA CTA2 Class D 3500FT base	ScTMA1 Class D 4500ft
7	GLA CTR Class D SFC base	GLA CTA2 Class D 3500FT base
8	GLA CTR Class D SFC base	GLA CTA3 Class D 2500ft base
9	ScTMA6 Class E 3000ft base	GLA CTA2 Class D 3500FT base
10	GLA CTR Class D SFC base	GLA CTA2 Class D 3500FT base

Figure 107 Changes to existing CAS structures to support Options 5-8 which enable a reduction in CAS and/or a lower classification

No change to Controlled Airspace (Neutral impacts/benefits compared to the 'without ACP' scenario)

9.2.4 The following figure shows the areas where there would be no change to the base of CAS or the classification. These are considered to be the parts where there is a neutral impact/benefit compared to the 'without ACP' scenario.



	Currently	Proposed
1	GLA CTA1 Class D 3000FT base	GLA CTA1 Class D 3000FT base
2	GLA CTA2 Class D 3500FT base	GLA CTA2 Class D 3500FT base
3	ScTMA5 Class D 3500ft base	GLA CTA2 Class D 3500FT base
4	GLA CTR Class D SFC base	GLA CTR Class D SFC base

Figure 108 Parts of CAS structures to support Options 5-8 would not require a change

9.2.5 Table 184 shows the total change in volume of airspace types and classifications for the combined Glasgow, Edinburgh and NERL ACPs.

9.2.6 Overall, the proposed, combined design will require an additional 658.8 nm^3 of CAS. However, in isolation, 1038.9 nm^3 of new CAS is required by NERL above 7000ft to provide more efficient en-route connectivity which demonstrates that a substantial airspace release has been achieved in the remainder of the design.

9.2.7 In addition to the CAS release, the classification of a substantial volume of CAS is proposed to be lowered increasing accessibility to all airspace users.

Table 184 Volume of each type and classification of CAS in the baseline and proposed, combined Glasgow, Edinburgh and NERL ACPs.

Airspace Type	Baseline Volume	Option Volume	Volume Change (nm^3)
CTR	**773.2**	**737.6**	**-35.5**
CTA	**26129.4**	**26778.7**	**649.3**
TMA	**9467.3**	**9512.3**	**45.1**
Total	**36369.8**	**37028.7**	**658.8**
Airspace Classification	**Baseline Volume**	**Option Volume**	**Volume Change (nm^3)**
Class A	**6714**	**1417.8**	**-5296.2**
Class C		**3713.2**	**3713.2**
Class D	**17691.7**	**19307.5**	**1615.8**
Class E	**11964.2**	**12590.1**	**626**
Total	**36369.8**	**37028.7**	**658.8**

9.2.8 As described above, separating out just changes to Glasgow designated airspace would not present an accurate picture. However, Table 185 below presents the same data as in Table 184 but for all CAS with a base of 7000ft or lower. Overall, the proposed, combined design will result in a reduction of 601.7 nm^3 of CAS where bases are below 7000ft.

Table 185 Volume of each type and classification of CAS in the baseline and proposed, combined Glasgow, Edinburgh and NERL ACPs which have bases below 7000ft.

Airspace Type	Baseline Volume	Option Volume	Volume Change (nm^3)
CTR	**773.2**	**737.6**	**-35.5**
CTA	**7667.8**	**7100.1**	**-567.7**
TMA	**9467.3**	**9468.8**	**1.5**

Total	**17908.2**	**17306.5**	**-601.7**
Airspace Classification	**Baseline Volume**	**Option Volume**	**Volume Change (nm^3)**
Class A	**404.4**	**95.2**	**-309.2**
Class C			
Class D	**13389**	**13566.8**	**177.8**
Class E	**4114.9**	**3644.6**	**-470.3**
Total	**17908.2**	**17306.5**	**-601.7**

9.2.9 The changes to Glasgow and Edinburgh's proposed CTR volumes are unrelated to each other. Table 186 presents the proposed change in volume of just Glasgow's CTR.

Table 186 Proposed change in volume of Glasgow's CTR

Airspace Type	Baseline Volume	Option 5-8 Volume	Volume Change (nm^3)
GLA CTR	464.1	398	-66.1

9.2.10 In terms of the overall value to General Aviation, previous engagement with GA stakeholders as part of Stage 2 highlighted that there was a desire to release as much CAS as possible and, broadly speaking, less CAS results in improved access for General Aviation.

9.2.11 As outlined in the section above, whilst overall there is a CAS release benefit below 7000ft, including a release for the GLA CTR, there are some areas which will be negatively impacted and other areas which will see improvements.

9.2.12 We are aware of the value of controlled airspace to glider pilots in the 'Cumbernauld gap' and this has been considered as part of the CAS development. We have included detailed information on proposed CAS dimensions, and we look forward to feedback from all of GA on the proposals, specific to their operations throughout the consultation process.

9.3 Comparisons 1-4 v 5-8

9.3.1 Table 187 illustrates the impact of having PBN arrivals compared to a reliance on just vectoring of arrivals. A combination of optimal PBN flight path positioning for environmental and operational purposes and adherence to the CAA Policy for the Design of Controlled Airspace Structures, results in an additional 14.4nm^3 of CAS to support Options 5-8 compared to Options 1-4.

Table 187 Comparison of options 1-4 and 5-8

ADDITIONAL CAS NEEDED FOR PBN ARRIVALS			
Airspace Type	Option 1 to 4 Volume	Option 5 to 8 Volume	Volume Change (nm^3)
GLA CTR	381.2	398	16.8
GLA CTA 1	27.8	26.1	-1.7
GLA CTA 2	107.8	100.4	-7.4
GLA CTA 3	0.0	9.2	9.2
GLA CTA 4	31.6	29.1	-2.5
GLA CTA 5	19.2	19.2	0
GLA CTA 6	13.8	13.8	0
Total	581.3	595.7	14.4

9.4 Proposed Airspace for Consultation

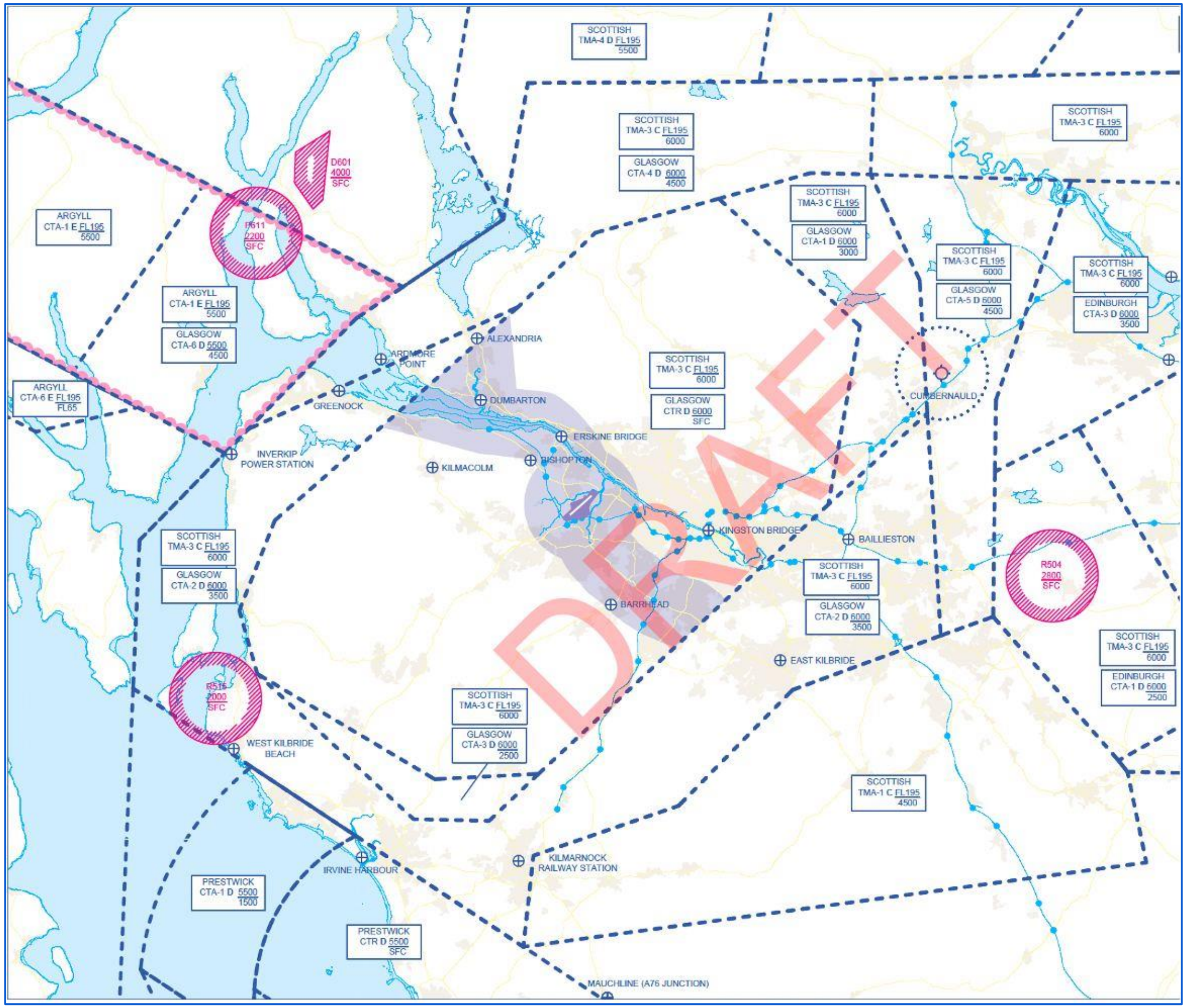


Figure 109 Proposed airspace chart for consultation. Map underlay sourced from existing AD 2.EGPF-4-1 and overlaid with proposed future airspace