

Glasgow Airport FASI-N Airspace Change Proposal Step 2B Initial Options Appraisal

Date:	July 2022
Document Version:	V1.2
Status:	Final document for CAA Submission (Public)
Document History:	 V1.0 Submitted to the CAA in April 2022 V1.1 Submitted to the CAA in July 2022 (Please see Change Record on CAA Airspace Change Portal for details of updates) V1.2 Following CAA request, text changes between V1.0 and V1.1 highlighted. We would recommend reading the change record in order to understand the requirement for and the context of the clarifications.

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1. Introduction

Airspace Modernisation Strategy

Following the publication of the strategic rationale for airspace modernisation¹, the Government directed the Civil Aviation Authority (CAA) to "prepare and maintain a coordinated strategy and plan for the use of UK airspace up to 2040, including its modernisation". As a result, in 2018 the CAA published the Airspace Modernisation Strategy (AMS)², which replaced the earlier 2011 Future Airspace Strategy. The AMS sets out the initiatives required to modernise the existing Airspace System by upgrading the airspace design, technology, and operations. The CAA is in the process of reviewing the AMS and expects to publish an updated version of the strategy in early 2022.

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

Performance Based Navigation (PBN)

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 Some of these beacons are outdated and reaching their end of life.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

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

Airspace Change Organising Group (ACOG) and the Masterplan

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

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

Masterplan Iteration 2³ was accepted by CAA on 27th January 2022. The purpose of Iteration 2 is to provide a system-wide view of the scope of the constituent ACPs and identify the potential interdependencies between the proposals. Collectively, the ACPs that are included in the Masterplan are referred to as the 'constituent airspace change proposals'. Each individual ACP is developed following the same detailed process steps laid out in the CAA's guidance for changing the airspace design – known as CAP1616⁴. The CAA evaluates the progress of every ACP through each stage of the process, via a series of (seven) regulatory gateways and make decisions on whether to approve further development and ultimately the implementation of the proposed changes. A summary of the CAP1616 process is available in the <u>next section</u>.

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

Our Airspace Change

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

This document forms part of the GAL Stage 2 submission to the CAA. It takes the options that progressed from the Design Principle Evaluation at Step2A and undertakes a more rigorous qualitative appraisal of their benefits and impacts as part of what's called an Initial Options Appraisal (IOA). The IOA is the first of three appraisals that will take place as part of the Airspace Change Process with each appraisal increasing in quantitative analysis.

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

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

1.1. CAP1616

In December 2017 the Civil Aviation Authority (CAA) published CAP1616⁵ Airspace Design: Guidance on the regulatory process for changing airspace design, including community engagement requirements. The guidance sets out the process for the airspace change process, which a change sponsor of any permanent change to the published airspace design must follow. The airspace change process is split into 7 Stages;

Stage 1	Step 1A	Assess requirement
DEFINE	Step 1B	Design principles
		DEFINE GATEWAY
Stage 2	Step 2A	Option development
DEVELOP and ASSESS	Step 2B	Options appraisal
		DEVELOP AND ASSESS GATEWAY
Stage 3	Step 3A	Consultation preparation
CONSULT	Step 3B	Consultation approval
		CONSULT GATEWAY
	Step 3C	Commence consultation
	Step 3D	Collate & review responses
Stage 4	Step 4A	Update design
UPDATE and SUBMIT	Step 4B	Submit proposal to CAA
Stage 5	Step 5A	CAA assessment
DECIDE	Step 5B	CAA decision
		DECIDE GATEWAY
Stage 6 IMPLEMENT	Step 6	Implement
Stage 7 PIR	Step 7	Post-implementation review
Figure 1 CAP1616 7 Sta	ges	

1.2. Glasgow Airspace Change Proposal

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

Table 1 ACP progress to date

Airspace Change Stage	Summary	Link to Documents (Also available on the ACP portal)
	In June 2019, Glasgow Airport submitted their following statement of need (SoN) to the CAA	Statement of Need on CAA's Airspace Change Portal
Stage 1A	Glasgow Airport participated in an assessment meeting with the CAA on the 18 th 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
	At Stage 1B Glasgow developed a set of design principles with identified Stakeholders.	
Stage 1B	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 requires change sponsors to develop and assess options for the airspace change.	
Stage 2A	In Stage 2A, the change sponsor develops a comprehensive list of options that address the Statement of Need and that align with the design principles from Stage 1. We then share those options with our Stakeholder representatives (the same ones engaged with on the Design Principles). Feedback from the engagement may then be used to refine and/or generate further options where feasible at this stage or later in the process. Finally, we qualitatively assess all options developed against the Design Principles and produce a Design Principle Evaluation (DPE). Our comprehensive list of options is then shortlisted before progressing to Stage 2B.	Stage 2A DPE Submission Document
	Our Stage 2A document provides details of this process, and our shortlisted options following the DPE. Our shortlist is also shown in the 'Overview of options under assessment' part of this document.	
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. This is where we are now. The following sections of the document initially describe 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 explain, based on the IOA, the options which we intend to take forward to Stage 3 and our preferred option(s).	This document

2. Overview of options under assessment

Our comprehensive list of options included 32 options. These are split into easterlies and westerlies, arrivals, and departures.

As part of Stage 2A, we undertook a <u>Design Principle Evaluation</u> where we evaluated each option against each Design Principle. This was the first opportunity to shortlist options before we progress to this IOA. The outcome of our Stage 2A Design Principle Evaluation was that some options were discontinued including the baseline 'Do Nothing' options.

Although the 4 baseline 'do nothing' scenarios (easterly departures, easterly arrivals, westerly departures, and westerly arrivals) did not progress as options, CAP1616 requires the baseline scenario to be appraised in this IOA as it provides a means of testing the options against the current day operations to better understand and highlight the benefits and impacts of each new option. The baseline will also continue to be appraised as part of the Full Options Appraisal and Final Options Appraisal at Stage 3 and Stage 4.

Use of pure PBN for arrivals into Glasgow did not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. However, the option of a mix of PBN and vectoring does come through very favourable. In this scenario, we would want to use the best performing PBN routes, so we have taken the remaining PBN arrival options into the Initial Options Appraisal for further assessment.

The following sections summarise the airspace change options we have taken through to this IOA. More information about how we have developed and evaluated these options is available in our Stage 2A submission document on the <u>CAA Airspace Change Portal</u>. The <u>Initial Options Appraisal section</u> of this document and technical appendix A also contain larger images and a more details of each option.

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

2.1. Runway 23 Westerly Departures

Table 2 Runway 23 Westerly Departure Options

Option name	Summary	Image
RWY 23 Dep Option A	Offset right departures with turns at 2nm and 7nm from the runway. Offset left departures with turns at 1nm from the runway. NORBO traffic is shared between a left turn departure route and the departure route that offsets right and then turns left at 7nm with both routes available at the same time.	
RWY 23 Dep Option B	Offset right departures with turns at 2nm from the runway. Offset left departures with turns at 1nm and 5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until 5nm from the runway.	
RWY 23 Dep Option C	This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use different flight path which offsets to the left, with the rest of the routes remaining the same.	
RWY 23 Dep Option D	This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure periods. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different flight path which follows a straight line from the runway until splitting at 5nm, with the rest of the routes remaining the same. This option is similar to Option C except that the non-peak NORBO route is different.	
RWY 23 Dep Option E	Straight ahead departures only (no offsets) with turns at 1nm and 9nm from the runway NORBO is traffic is shared between a route that turns left at 1nm and one	LOMONFOYLE CLYDE ROBBO



Further information around our Options can be found in our Stage 2A submission document on the <u>CAA Airspace Change Portal</u>

2.2. Runway 05 Easterly Departures

Table 3 Runway 05 Easterly Departure Options

Option name	Summary	Image
		TOTICLANON INTER
RWY 05 Dep Option A	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 3nm from the runway. NORBO is offset left with turn at 1nm	
RWY 05 Dep Option B	Offset right departures with turns at 2nm from the runway. Offset left departures with turns at 1nm and 5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until 5nm from the runway.	
RWY 05 Dep Option C	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 4nm from the runway.	
RWY 05 Dep Option D	Straight ahead departures only (no offsets) with turns at 1nm, 4nm and 6nm from the runway.	
RWY 05 Dep Option E	Offset left departures with turns at 1nm from the runway. Straight ahead departures with turns at 2nm and 6.5nm from the runway. NORBO is straight ahead to 2nm with a right turn.	
RWY 05 Dep Option F	This option shares NORBO traffic between a left and right turn with only one of those routes in use at a time. The rest of the routes remain in the same configuration. When turning left, the NORBO would offset left then turn further left at 1nm When turning right, the NORBO would go straight ahead to 2nm then a right turn	
RWY 05 Dep Option G	This option has two, quite different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between a left turn departure and a right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a single flight path turning right, but that path could be different to the one used for the peak periods.	
RWY 05 Dep Option H	This option was generated as a result of Community and ATC feedback in our engagement. They proposed that ROBBO/CLYDE/LOMON SIDs could also turn left immediately, together with the left turn NORBO SID. Predictable respite is not a feature.	
RWY 05 Dep Option I	This option is the same as Option H except that track adjustments do not feature. This is due to a concern that a track adjustment followed by an immediate left 180° turn for the NORBO/ROBBO/CLYDE/LOMON departure could be too technically challenging. This has a knock-on impact in that the PERTH/FOYLE would also not feature a track adjustment.	

2.3. Runway 23 Westerly Arrivals

Table 4 Runway 23 Westerly Arrival Options

Option name	Summary	Image
RWY 23 Arrival Option C	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 8nm.	
RWY 23 Arrival Option D	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 9nm.	
RWY 23 Arrival Option E	PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 10nm.	
RWY 23 Arrival Vectors only	 This option would see all arrivals continuing to be vectored with no PBN paths available for routine use. Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet, so there is not an illustration for this option. For the Design Principle Evaluation and this Initial Options Appraisal, we will assume similar impacts as the baseline however for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft. 	Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known, alongside more information about departures and CAS arrangements.
RWY 23 Arrival Vectors and PBN hybrid	This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options C-E above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.	Note: Image shows existing vectoring swathe alongside the centrelines for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.

Further information around our Options can be found in our Stage 2A submission document on the <u>CAA Airspace Change Portal</u>

2.4. Runway 05 Easterly Arrivals

Table 5 Runway 05 Easterly Arrival Options

Option name	Summary	Image
RWY 05 Arrival Option A	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway.	
RWY 05 Arrival Option B	PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm.	
RWY 05 Arrival Option C	PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway. Slightly different track to Option A above 5000ft.	
RWY 05 Arrival Option D	PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm. Slightly different track to Option B above 5000ft	
RWY 05 Arrival Vectors only	 This option would see all arrivals continuing to be vectored with no PBN paths available for routine use. Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet so there is not an illustration for this option. For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however, for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft. 	Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known, alongside more information about departures and CAS arrangements.
RWY 05	This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing.	Note: Image shows existing vectoring swathe alongside the overflight contours for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there

Arrival

The PBN arrival(s) would likely be the 'best performing' of Options A-D above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through Vectors and PBN hybrid stakeholder engagement and consultation.



once PBN shortlist is known and there is further information around vectoring arrangements.

Further information around our Options can be found in our Stage 2A submission document on the CAA Airspace Change Portal

3. Initial Options Appraisal Methodology

The Initial Options Appraisal (IOA) is the first stage in a three-phase appraisal of airspace change options. It involves the mainly qualitative appraisal of the airspace change options that have proceeded from Stage 2A (outlined in <u>Section 2</u> of this document). As options progress through the airspace change process, the two following appraisals, the Full Options Appraisal and Final Options Appraisal undertaken at Stage 3 and 4, will quantitively evaluate options in further detail. The following sections outline the methodology we have followed whilst appraising our airspace change options as part of this IOA.

3.1. Baseline and Year of Implementation

As part of this IOA, 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. Therefore, all environmental assessments must illustrate the difference between a pre-implementation ('do nothing') scenario and a post-implementation scenario, ensuring that the periods are comparable.

Owing to the impact of COVID-19 on the aviation industry throughout 2020 and 2021, we have selected to use 2019 movement data as the baseline data that we will use as the basis for the environmental assessment as part of this initial appraisal, as this is most representative of a recovered COVID-19 scenario. We will qualitatively describe the growth of this baseline to the year of implementation (see below).

Year of Implementation

At present the exact implementation date for the FASI-S airspace changes is unknown as the timeline for implementation will be dependent on a number of factors, including the airspace changes above 7000ft which form part of a separate ACP sponsored by NATS NERL. Current deployments of the Scottish-TMA within Masterplan Iteration 2 suggest to expect an implementation date of around 2025, however this will be subject to alignment with masterplan iteration 3. For the purpose of this IOA, we will qualitatively describe the anticipated factors that are expected to impact the baseline, such as any forecast growth, fleet mix changes and planned developments based on implementation in 2025.

Traffic Forecast: Movement numbers and schedule

For the purposes of environmental assessment, Airspace Change sponsors are required to use a 92-day summer period between 16 June to 15 September inclusive. In 2019, there were 25,275 movements during this 92-day period to/from Glasgow Airport. A movement is considered either an arrival or a departure.

Runway	Number of operations	Percentage
23 (Westerly Operations)	20,658	81.7
05 (Easterly Operations)	4,617	18.3
Total	25,275	

Table 6 GLA 2019 92-day summer movements

When reviewing the movement data in table 6, in 2019 82% of flights operated on runway 23 (westerly operations when aircraft take off and land towards the south-west), and 18% of flights operated on runway 05 (easterly operations when aircraft take off and land towards the north-east). This modal split will be used for this IOA. We have also analysed the 92-day 2019 data to find out information about SID usage and existing departure directions.

Traffic Forecast

2019 is considered the year that most reflects a scenario where Glasgow airport has recovered from the impacts of COVID-19. We expect this recovery to have occurred by 2025 and therefore, as part of this IOA, we do not currently expect any fundamental changes to the movement numbers outlined above at the year of implementation. Owing to the uncertain nature of the aviation sector as a result of COVID-19, this approach to forecasting is considered proportionate at this stage of the CAP1616 process. When considering the future forecast (10 years after the year of implementation), given the number of options that form part of this appraisal, the qualitative nature of large parts of the appraisal, and the methodology applied where quantified information has been used, it is not considered proportionate to also appraise all options against this future traffic scenario in Stage 2; as part of our Stage 3 Full Options Appraisal, we will fully quantitatively appraise the pre-implementation baseline and options for the year of implementation and future scenarios (plus 10 years).

The methodology applied to appraise each option as part of this Initial Options Appraisal focuses on the % split of movements distributed across Glasgow's arrival and departure routes. These % are derived from the actual flight track data and known factors which will influence the baseline in 2025 (see sections below). We expect the southerly directional bias will continue for any future forecast given the geographic location of Glasgow compared to London and Europe. Specific numbers of movements have not been applied to the assessments; this will form part of the detailed quantitative noise and environmental modelling that will be undertaken as part of the Stage 3 Full Options Appraisal.

Fleet Mix

In 2019 Turbo prop aircraft made up around 25% of traffic arriving and departing from Glasgow Airport. Due to factors such as the change in aircraft operators and passenger habits, Glasgow Airport expect to see a shift towards more jet aircraft going forward than was the norm in 2019 and preceding years. This will be considered as part of our qualitative appraisal of the options. In Stage 3 we will quantify the changes to the baseline as a result of the expected fleet mix at the year of implementation.

Planned developments

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:

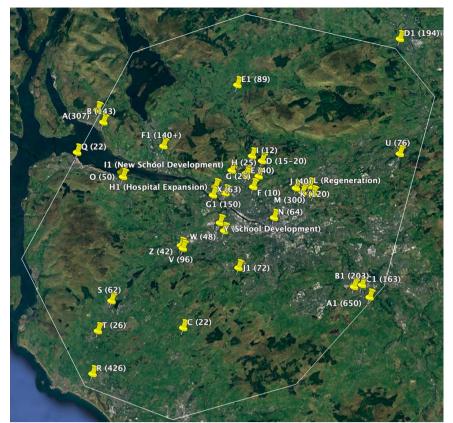


Table 7 Planned Developments around Glasgow Figure 2 Planned Developments around Glasgow Airport

Ref	Local Authority	Location	Type of Development	Size of Development	Status (if known)	Further information
А	Argyll & Bute	Helensburgh Golf Course	Housing	307	Approved (Feb 21)	Planning Page
В	Argyll & Bute	Hermitage Academy, Helensburgh	Housing	143	Nearly complete	Developer
С	East Ayrshire	KA3 4BD	Housing	23	Registered (Mar 22)	Planning Page
D	East Dunbartonshire	G62 8BY	Housing	15-20	Awaiting decision (Mar 22)	Planning Page
Е	East Dunbartonshire	Bearsden Golf Course	Housing	40	Unknown	Planning Page
F	East Dunbartonshire	Crarae Avenue, Bearsden	Housing	10	Decided	Planning Page
G	East Dunbartonshire	Milngavie Road, Bearsden	Housing	25	Awaiting decision (Mar 22)	Planning Page
H	East Dunbartonshire	Nithsdale Crescent, Bearsden	Housing	26	Awaiting decision (Mar 2020)	<u>Planning Page</u>
-	East Dunbartonshire	Craigton Road, Milngavie	Housing	120	Unknown	_1
J	East Dunbartonshire	Auchinairn, Bishopbriggs	Housing	40	Unknown	_1
K	East Dunbartonshire	Bishopbriggs Town Centre	Housing	220	Public Consultation (2021)	<u>Article</u>
L	East Dunbartonshire	Westerhill, Bishopbriggs	Regeneration	TBC	Public Consultation (2021)	<u>Article</u>
М	Glasgow City	G33 1TG	Housing	300	Awaiting Approval (Feb 22)	<u>Developer</u>
Ν	Glasgow City	Finnieston	Flats	64	Submitted (Nov 21)	Planning Page
0	Inverclyde	PA14 6PP	Housing/Flats	50	Nearly complete (Apr 22)	Planning Page
Р	Inverclyde	PA14 6PR	Housing/Flats	40	Nearly complete (Apr 22)	Planning Portal
Q	Inverclyde	PA16 8DA	Flats	22	Pending consideration (Mar 22)	Planning Page
R	North Ayrshire	Byrehill Place, Kilwinning	Housing	426	Pending consideration (Feb 22)	Planning Page
S	North Ayrshire	Knoxville Road, Kilbirnie	Housing	62	Pending consideration (Feb 22)	Planning Page
Т	North Ayrshire	Bridgene Mill, Dalry	Housing	26	Approved (Dec 21)	Planning Page
U	North Lanarkshire	Kildrum, Cumbernauld	Flats	76	Unknown	Planning Page
V	Renfrewshire	PA5 0SP	Housing	96	Awaiting Decision (Mar 22)	Planning Page
W	Renfrewshire	East Lane, Paisley	Flats	48	Awaiting Decision (Mar 22) Awaiting Decision (Mar 22)	Planning Page
Х	Renfrewshire	Erskine	Housing/Flats	59/24	Awaiting Decision (Mar 22)	Planning Page
Y	Renfrewshire	Renfrew Road, Paisley	New School	-	Approved	Article
Z	Renfrewshire	Elm Drive, Johnstone	Housing/Flats	36/6	Awaiting Decision (Mar 22)	Planning Page
A1	South Lanarkshire	Strathaven Road, Hamilton	Housing	650	Registered (Oct 21)	Planning Page
B1	South Lanarkshire	Earnock Road, Hamilton	Housing	203	Awaiting Decision (Jul 21)	Planning Page
C1	South Lanarkshire	ML3 9BZ	Housing	163	Approved (Sep 21)	Planning Page
D1	Stirling	Cambusbarron	Housing	194	Under construction	Website
E1	Stirling	Killearn	Housing	89	Under construction	Website
F1	West Dunbartonshire	Bellsmyre	Housing	140+	Under construction	Regeneration Plan
G1	West Dunbartonshire	Queens Quay	Housing/Flats	150	Under construction	Website
H1	West Dunbartonshire	Clydebank	Golden Jubilee Hospital Expansion	-	Permission issued	
11	West Dunbartonshire	Faifley	New School	-	Post consultation (Sep 21) period	Article
J1	East Renfrewshire	Lyoncross Farm, Barrhead	Housing	72	Registered (Jan 22)	Planning Page

¹ Information provided by email from East Dunbartonshire council – no information available online

3.2. Initial Options Appraisal Categories and Criteria

At Stage 2B CAP1616 requires sponsors to carry out an initial qualitative assessment of the benefits and impacts of each option, tested against the 'do nothing' baseline scenario. The purpose of this initial appraisal is to highlight the change to sponsors, stakeholders and the CAA and the relative differences between the impacts, both positive and negative, of each option.

Our assessment criteria shown in table 8 below have been categorised based on the example in CAP1616 Appendix E, however we have added an additional category called 'Interdependencies, conflicts and trade-offs' to satisfy the requirements to outline potential interdependencies with other FASI-N ACPs, and 'Airspace Modernisation Strategy' to satisfy the 7 confirmed indicators that the CAA will use to assess whether this Stage 2 submission accords with the AMS including iteration 2 of the Masterplan. We will follow this table structure across the appraisal of all of our options.

Table 8 Initial Options Appraisal Assessment Criteria (Based on CAP1616 Appendix E)

Group	Impact
Communities	Noise impact on health and quality of life
Communities	Noise impact on health and quality of lifeAir QualityGreenhouse gas impactCapacity / resilienceTranquillityBiodiversityAccessInesEconomic impact from increased effective capacityFuel burnTraining costsOther costsInfrastructure costsDeployment costsDeployment costsSafetyInterdependencies, conflicts, and trade-offs
	Greenhouse gas impact
Wider Seciety	Capacity / resilience
Wider Society	Tranquillity
	Biodiversity
General Aviation	Access
General Aviation / Commercial airlines	Economic impact from increased effective capacity
General Aviation / Commercial arrines	Fuel burn
Commercial airlines	Training costs
Commercial armies	Other costs
	Infrastructure costs
Airport / Air navigation service provider	Operational costs
	Deployment costs
All	Safety
All	Interdependencies, conflicts, and trade-offs
All	Airspace Modernisation Strategy (AMS) (CAP1711)

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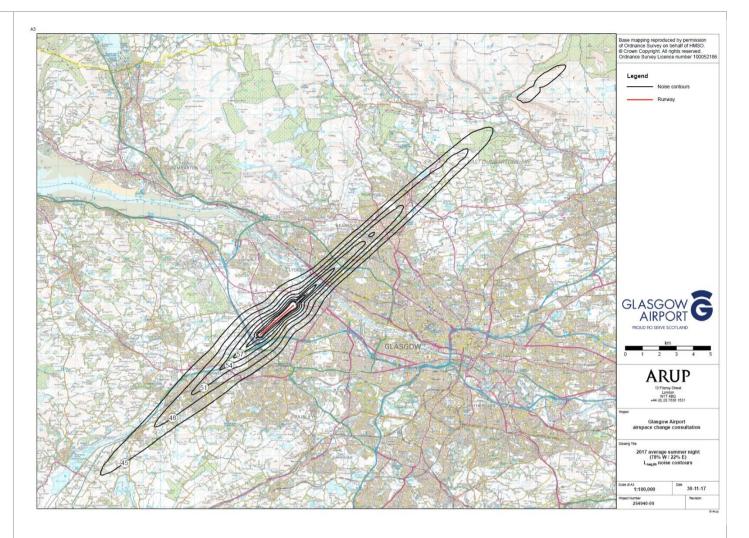
3.3. Initial Options Appraisal: Methodology

Table 9 below presents the IOA methodology that will be followed. This methodology will be used to compare the airspace change options against the baseline.

Table 9 IOA Methodology

IOA Methodolo	gy	
Group	Impact	Qualitative Assessment
Communities	Noise impact on health and quality of life	Our noise assessment for each airspace change option includes a qualitative description of the expected benefits and impacts of noise on health and quality of life, supported by some proportionate quantitative analysis: Laeq Contours 51dB LAeq.16hr (daytime noise) and 45dB LAeq.8hr (night time noise) contours form part of the primary CAP1616 metrics used to evaluate the benefits and impacts of airspace changes. These contours represent the daytime and night time lowest observable adverse effect level (LOAEL) contour defined in UK airspace policy. Laeq contours, are the equivalent 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 period 16 June to 15 September inclusive. This metric is the measure of noise exposure adopted by Government for the purposes of considering adverse effects from aircraft noise. It forms the basis of the Government's policies in relation to aircraft noise. To determine the size of the forecast contours based on the new airspace design options, requires noise modelling ai a system level. This requires a complet system design of arrivals and departures modelled with a forecast schedule and fleet mix which is very detailed and complex work. At this stage in the process, given the number of arrival and departure options and the subsequent permutations when combining these, it is not proportionate to quantify the Laeq metrics. We will however make a qualitative assessment of the anticipated benefits or impacts to the daytime Laeq as a result of each option. Full quantitative analysis will be undertaken in the Full Options Appraisal in Stage 3 on Glasgow's shortlisted options.
		A Construction of the state and exploration of the state showing below.
		Arspace change consultation arspace change consultati

18



WebTAG

The data from LAeq,16hr (daytime noise) and LAeq,8hr (night time noise) contours form part of a key input into WebTAG. WebTAG is the Department for Transport's suite of guidance on how to assess the expected impacts of transport policy proposals and projects. These workbooks can be used to monetise certain aspects of the noise impact, given the correct inputs are available.

As explained above, owing to the number of permutations and the complexity of the noise modelling, we will qualitatively describe the expected changes to the LAeq contours as part of this IOA. As we do not have the quantitative information, we are unable to use the WebTAG workbook at this stage, however this analysis will be undertaken as part of our Stage 3 Full Options Appraisal.

Overflight Contours

Technical Appendix A includes images and data tables of overflight information which we have used to inform our qualitative assessment of each option. There are two types of overflight information that we have termed 'centreline' and 'vectoring'.

Centreline Overflight Data

The centreline overflight contours are based on a single event, i.e. one departure or one arrival using the CAA's 48.5 degree definition of overflight as defined in CAP1498. This departure is assumed to follow the SID route from 0-7000ft therefore this data does not take into account any vectoring. This is particularly important to note when considering the baseline data, as we know that the majority of aircraft today are typically vectored rather than following the full SID centreline.

The contours are generated using a standard AEDT (Aviation Environmental Design tool) profile of an 737-800 aircraft and we have added qualitative statements as part of this IOA assessment (particularly for departures) about how the overflight contours may change when considering Glasgow's fleet mix. We chose the B738 as it is one of the largest and noisier aircraft that regularly flies at GLA and therefore tends towards the worst case.

The contour images shown in this IOA and in Technical Appendix A include an indication of the anticipated use of each route which has been based on actual 2019 data, with adjustments made on an option-by-option basis (for example where the option introduces a respite route).

The data-tables use the latest available CACI population data for 2021. PointX data to identify noise sensitive buildings (schools, hospitals, and places of worship). National Parks, National Scenic Areas, Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest have been collected from the Scottish Government's catalogue of spatial data (https://www.spatialdata.gov.scot/geonetwork/srv/eng/catalog.search#/home). In addition, designated quiet areas in Glasgow City were mapped using information taken from the Glasgow City Development Plan (http://www.glasgow.gov.uk/CHttpHandler.ashx?id=35882&p=0)

It's important to note that the overflight contours only look at a single overflight along the PBN centreline, and therefore at this stage the data does not take into account frequency of overflight. This will be qualitatively described as part of this IOA and then fully quantified at Stage 3 Full Options Appraisal.

Data includes overflight counts and areas (km²) of: Population, National Scenic Areas (NSA), Parks and gardens, special areas of conservation (SAC), sites of special scientific interest (SSSI), special protection areas (SPA), national parks, designated quiet areas (DQA), schools, hospitals, and places of worship.

At this stage, owing to the complexity of modelling vectoring, we have modelled each option based on aircraft flying the PBN centreline however vectoring below 7000ft may still occur. We have noted throughout the IOA where this applies and added a qualitative assessment alongside the data. As part of our Stage 3 Full Options Appraisal noise modelling of the vectoring will be investigated.

When considering the centreline data for the arrivals baseline, it's important to note that a centreline for the existing arrivals does not actually exist in reality; we created one based on the area's most frequently overflown by arrivals in today's airspace arrangement for comparative purposes.

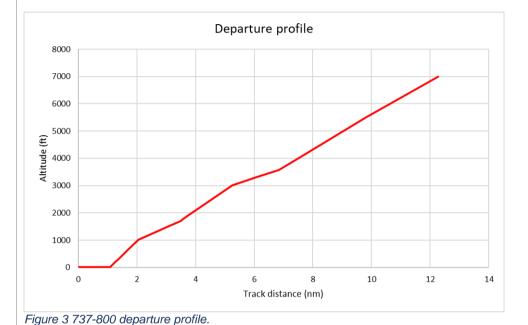
Vectoring (Baseline) Overflight data

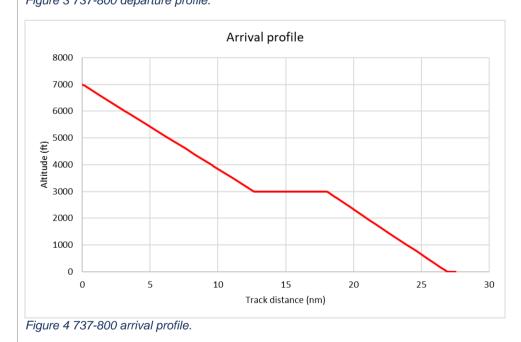
As described above, owing to the nature of vectoring, it is very complex to model and at this stage of the process, given the number of options, it is not proportionate to undertake full modelling.

In order to illustrate the difference between the today's baseline flight tracks over the ground (also known as a vectoring swathe) and the PBN options, we have included some information about the baseline vectoring scenario. This has been generated using noise track keeping (NTK) data for the 92-day period, and therefore is not generated in the same way as the overflight contours which use a standard vertical profile of one aircraft. We have however applied the CAA's 48.5 degree overflight cone to the NTK data. The outcome are the baseline heatmaps, which are shown in Technical Appendix A, which help us to articulate the current vectoring swathe and any areas of concentration which occur today. Alongside the images, we have included overflight data as part of our Technical Appendix and IOA. This data does not consider frequency of overflight but instead takes account of any areas that are overflown at least once, based on the NTK data; this allows some preliminary comparison to be drawn between the option's overflight contours and what happens today.

60dB and 65dB LAMax

As part of this IOA, we have calculated 65dB L_{Amax} (day) and 60dB L_{Amax} (night) contours and data using an Airspace Optioneering Tool. The indicative noise calculations in the tool are based on the methods set out in ECAC Doc 29 (https://www.ecac-ceac.org/images/documents/ECAC-Doc_29_4th_edition_Dec_2016_Volume_1.pdf) and have been verified against calculations using the FAA's Aviation Environmental Design Tool (AEDT) (<u>https://aedt.faa.gov/</u>). The optioneering tool is not a full noise model complying to the standards required by CAP2091, but we have agreed with the CAA that it is a proportional method to use at this stage of the analysis. The optioneering tool does not take airport specific atmospheric conditions into account and assumes standard atmospheric attenuation rates set out in SAE-AIR-1845. The source of the acoustic data used in the tool is the international Aircraft Noise and Performance (ANP) database (<u>https://www.aircraftnoisemodel.org/</u>). Arrival and departure flight profiles for a Boeing 737-800 have been calculated as a function of track distance using the default departure / arrival procedural steps for Aircraft ID 737800 in the ANP database. The procedure for maximum take-off weight has been used as this is the most conservative profile in noise terms due to the low climb rate. The departure and arrival profiles are shown as a function of track distance in the figures below.





Similar to the overflight contours, these are based on a single noise event i.e. based on one departure or one arrival. 60dB and 65dB L_{Amax} contours are an indication of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. These are required by the CAA to help with engagement on noise and airspace change, and to further differentiate between airspace options which have a similar impact with respect to the L_{Aeq} metrics.

The 60dB and 65dB L_{AMax} data contained within the Technical Appendix is based only on centreline data and assumes no dispersion around the centreline; this means that for the baseline, it does not reflect the vectoring that occurs today. As explained above, to model vectoring is complex and something that we will do as part of our Stage 3 Full Options Appraisal. As part of this IOA, we will use the data as a starting point for comparison between the baseline and the options and we will also provide some additional qualitative analysis.

		CAP2091
		At this stage in the airspace change process, we have not calculated L _{Aeq} contours (see section above) and instead we will qualitatively describe anticipated changes based on the most recent contours generated for Glasgow's 2017 noise action plan. The contours in the noise action plan were generated to CAP2091 category D/E standards however the output shows that the airport should move to category C for future noise modelling as there were 83,200 people within the 51dB _{LAeq,16h} contour which is above the mandated minimum threshold of 25,000 (and below the maximum threshold of 200,000) for category C. In Stage 3, when the L _{Aeq} contours are fully quantified, all noise modelling will therefore be undertaken to category C standards. When considering future forecast 10 years from implementation, although a full quantified <u>10 year forecast</u> is not available at this stage, given the current population levels are 116,800 below the maximum daytime category C threshold (76,800 below the recommended minimum daytime threshold for category B) and also given the low density of conurbations outside of the 51dB contour, it is expected that the daytime contours will remain within the category C threshold as it would require at least a doubling of population within the 51dBLAeq,16h contour to be required to move up a category. The night-time contour differences are a similar magnitude. The CAP2091 category will be confirmed at Stage 3 when full quantified noise modelling takes place and a 10 year forecast will be available.
		Continuous Climb As part of some of the departure options, we describe how they are anticipated to continuously climb to above 6000ft. The scope of this Level 1 ACP is up to 7000ft and therefore typically we would seek continuous climb to 7000ft. As discussed in our Stage 2A document, even with a redesign and modernisation of the airspace there is another significant and fixed constraint that requires consideration when looking at continuous climb up to 7000ft. This is the Transition Altitude (TA), which is 6000ft in the Scottish TMA.
		In summary, any SIDs that climb above 6,000ft need to climb continuously from the runway, to at least FL90 in order to guarantee continuous climb above 7000ft. As the NATS NERL ACP, which looks at the airspace above 7000ft, is not yet at the stage to be able to inform whether climb to FL90 is achievable, for the basis of this IOA we have assumed that aircraft will be able to continuously climb to 7000ft for the purposes of the noise modelling at this stage. We will revisit this as part of our Full Options Appraisal when we have further information from NERL around the upper airspace network.
		Due to the effects of mixing and dispersion, emissions of NOx, PM10 and PM2.5 from aircraft travelling from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality. The DfT's Air Navigation Guidance (2017) states that: "Studies have shown that NOx emissions from aviation related operations reduce rapidly beyond the immediate area around the runway. Due to the effects of mixing and dispersion, emissions from aircraft above 1,000 feet are unlikely to have a significant impact on local air quality. Therefore, the impact of airspace design on local air quality is generally negligible compared to changes in the volume of air traffic and that of the local transport infrastructures feeding the airport." ICAO's Airport Air Quality Manual (International Civil Aviation Organization. Doc 9889 Airport Air Quality Manual. Second Edition, 2020. ICAO, Canada.) similarly states that 1,000ft is the typical limiting altitude for ground-level NO2 impacts from aircraft emissions.
	Air Quality	Assessment of Arrival Options As part of this IOA we will qualitatively describe any expected changes below 1000ft. Aircraft arriving at Glasgow fly a standard 3-degree angle of approach and descend through 1000ft whilst aligned with the extended runway centreline. This is in the last stages of the final approach. It's therefore very unlikely that any arrivals options will offer any significant impact air quality however we will review each option for changes below 1000ft.
		Assessment of Departure Options Aircraft departing Glasgow have varying climb performance depending on aircraft type and therefore different aircraft reach 1000ft at different locations. Today, virtually all Glasgow departures climb straight ahead for 5nm and during this they climb above 1000ft. Our IOA will qualitatively describe any changes to the lateral locations of flight paths which could occur below 1000ft; whilst a change in route will not impact the totality of emissions, it may result in a change in location of the emissions which we will qualitatively describe.
	Greenhouse gas impact	As emissions of greenhouse gases arise from the combustion of aviation fuel and fuel burn is linked to track mileage, for this IOA we have estimated the differences in track miles between the baseline and each route which forms part of the options. We have then applied a percentage weighting, based on the anticipated usage of the routes, to understand the overall performance of the option. This weighting is based on 2019 movement data. A table with full details is shown in Technical Appendix A.
		As part of the Full Options Appraisal (Stage 3A), we appraise track mileage, fuel burn and the associated greenhouse gas impact in further detail.
	Capacity / resilience	Subject matter experts will qualitatively assess any impacts to capacity and/or resilience against the baseline scenario.
Wider Society		CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB), plus any locally identified 'tranquil' areas that are identified through community engagement and are subsequently reflected within an airspace change proposal's design principles.
	Tranquillity	In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks, and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP, we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB.
	Biodiversity	The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance states that "In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not involve ground-based infrastructure. As such they are unlikely to have a direct impact that would engage the Birds or Habitats legislation." Though there is limited research available on the effects of aircraft noise on wildlife, there is some evidence that disturbance effects associated with aircraft can occur during take-off and landing where aircraft are below around 500m (~1,640ft). [Drewitt, A. (1999) Disturbance effects of aircraft on birds. English Nature Birds Network Information Note]. Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft.
General Aviation	Access	As part of this IOA, we will qualitatively describe the potential impacts and benefits to general aviation access as a result of each option. This will be partially informed by the engagement undertaken with GA users during Stage 2. At the full options appraisal stage, we will have detailed plans for CAS and will quantify any increase or decreases in CAS volume.
General Aviation / Commercial airlines	Economic impact from increased effective capacity	The IOA will qualitatively estimate the differences between the option and the baseline. As part of the FOA at Stage 3 we will quantitively appraise any economic benefits or impacts in further detail. 21

	Fuel burn	As the combustion of aviation fuel is linked to track mileage, for this IOA we have estimated the differences in track miles between the baseline and each route which forms part of the options. We have then applied a percentage weighting, based on the anticipated usage of the routes, to understand the overall performance of the option. This weighting is based on 2019 movement data. Tables with full details are shown in Technical Appendix A. Alongside the estimated quantitative information, we will provide a qualitative statement around continuous climb and continuous descent operations which also have the potential to impact fuel burn.				
Commercial	Training costs	The IOA will qualitatively estimate whether any training costs would be incurred by Commercial airlines in order to implement the option.				
airlines	Other costs	The IOA will qualitatively estimate whether any other costs would be incurred by Commercial airlines in order to implement the option.				
	Infrastructure costs	The IOA will qualitatively estimate whether any infrastructure costs would be incurred by the airport or ANSP in order to implement the option.				
Airport / Air navigation service	Operational costs	The IOA will qualitatively estimate whether any operational costs would be incurred by the airport or ANSP in order to applement the option.				
provider	Deployment costs	The IOA will qualitatively estimate whether any deployment costs would be incurred by the airport or ANSP in order to implement the option.				
All	Safety	A qualitative safety assessment of each option will be undertaken which compares against the baseline.				
All	Interdependenci es, conflicts, and trade-offs	An airspace change proposal at a Stage 2 gateway in the CAP 1616 process should specify any interdependencies with other airspace change Masterplan. This IOA will take the information contained within the masterplan document around potential areas of conflict/ interdependencies and identify if the option falls within these areas. This will give an indication of whether there is the potential for trade-offs with other airspace change sponsors required during Stage 3. The figure below shows the illustration provided within the masterplan that outlines Glasgow's potential interdependencies. $Fjure 5 Potential Scottish TMA GLA EDI Interactions (From ACOG Masterplan)$				
All	Airspace Modernisation Strategy	 part of our IOA. Our IOA will include a qualitative, high level, assessment of how the design options perform against the vision and parameters/strategic objectives of the <u>Airspace Modernisation Strategy</u>. CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. And the parameters as: create sufficient airspace capacity to deliver safe and efficient growth of commercial aviation progressively reduce the noise of individual flights, through quieter operating procedures and, in situations where planning decisions have enabled growth which may adversely affect noise, require that noise impacts are considered through the airspace design process and clearly communicated 				

	are considered through the airspace design process and clearly communicated
	 use the minimum volume of controlled airspace consistent with safe and efficient air traffic operations
	• in aiming for a shared and integrated airspace, facilitate safe and ready access to airspace for all legitimate
	classes of airspace users, including commercial traffic, General Aviation, and the military, and new entrants
	such as drones and spacecraft
	• not conflict with national security requirements (temporary or permanent) specified by the Secretary of State for
	Defence.

4. Initial Options Appraisal

The following tables outline our Initial Options Appraisal for each option and provide an assessment of the four baseline scenarios.

4.1. Runway 23 Westerly Departures Baseline

Runway 23 Westerly Departures Baseline

	X	LOMON	FOYLE/PERTII	//
	SLYDE			
K			8//	
ROBBO	X		K)	
X			A	0
X	IM			
\searrow	(\land)	UK. Q.		LUSIV/TLA
	ORBOITRN		1	LUSIWITA

This option represents the do-nothing scenario for Glasgow Westerly SIDs. Today, all Glasgow SIDs climb straight ahead to 5nm before turning. This means that the minimum departure interval between successive departing aircraft is at least 2 minutes. The result is that during peak departure times, aircraft are held on the runway and at the runway holding points, leading to increased emissions and delay. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC, resulting in broad swathes.

Some aircraft less than 5700kg MTWA do not have to 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.

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.

For more information on our do-nothing scenario, which was discontinued as part of the Design Principle Evaluation, please see our Stage 2A document on the CAA's Airspace Change Portal.

		Evaluation, please see our Stage 2A document on the CAA's Airspace Change Portal.			
Group	Impact	Qualitative Assessment			
		Due to wind direction, westerly operations on qualitative assessment has considered this m Aircraft above 5700kg departing from Glasgo are typically vectored off the SID centrelines vectoring heatmaps below which have been g	odal split with daily movements av w climb straight ahead to 5nm be by ATC resulting in dispersion. T	eraged across the year. fore turning. Beyond 5nm, aircraft	
				1	
Communities	Noise impact on health and quality of life	Figure 6 Runway 23 Departure Vectoring Swa The Technical Appendix to this document in important to note that this vectoring data is n however it does provide a preliminary mean options. Table 10 below includes data based of for if aircraft were to follow the centreline of the	cludes a larger version of this m not modelled in the same way as no of comparison between this ba on this NTK vectoring map and data e current published SID:	the centreline overflight contours, aseline and the airspace change	
		Table 10 Westerly departures baseline overfli	ght data		
	1				

RWY23	
Baseline (Centreline – optioneering tool)	

RWY 23 Baseline – Vectoring (NTK data)

141.18

547.32

163216

The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline.

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals, and places of worship; the full data around these is shown in Technical Appendix A, and as part of this IOA we will provide a qualitative statement around this data.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours and data for the centreline baseline, to aid comparison between the baseline and the options. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal.

Table 11 Runway 23 Departures Baseline LAMax Data

	60dB L _{Amax}		65dB L _{Amax}	
System	Area (km²)	Population	Area (km²)	Population

		RWY23							
			ntreline – 285.: ol)	37	99120	95.69	53704		
		The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline.							
	L_{Aeq} The westerly departures make up a component of the overall L_{Aeq} daytime and night time of the overall contours from 2017, as an indicative contour for 2025 as it is expected that contained and size.								
		Noise Abatemer As this baseline	nt Procedures reflects current day, there	would be	no changes to NAP	s as a result of th	is option.		
	Noise Mitigation The existing SIDs configuration does not offer any opportunities for predictable respite. Furthe underneath final approach within 5nm of the airport currently experience all departures and airport.								
			ality are considered for cha ant impact on local ground	0		00m). Aircraft flyin	g above this are unlikely		
	Air Quality	aircraft reach 100 during this they c	g Glasgow have varying 00ft at different locations. ∃ limb above 1000ft. Our IC d occur below 1000ft.	Γoday, virtι	ally all Glasgow de	partures climb str	aight ahead for 5nm and		
		is linked to track	enhouse gases arise from c length, we have initially assessment is therefore li	looked at	the track length for	or the baseline w	esterly departures. The		
		Table 12 Wester	ly departure baseline – Ind						
		RWY 23			e (Centreline)	to balantina a	0		
			TDN	nm		Veighting	Score		
l			TRN NORBO – SUBUK		38.50 93.40	3.69 26.2	142.065 2447.08		
	Greenhouse gas impact		NORBO – LAKEY		93.40	32	2988.8		
		0	LUSIV-DCS		84.80	10.66	903.968		
			TLA		54.70	0.41	22.427		
		52.0	PERTH		69.80	1.23	85.854		
			FOYLE		33.00	0.82	27.06		
			LOMON		26.70	2.05	54.735		
			CLYDE		19.50	2.87	55.965		
			ROBBO		19.60	2.05	40.18		
			ROBBO		Total	82%	6768.134		
		We will estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today. As CO ₂ emissions are linked to the difference in aviation fuel burnt, this will allow us to qualitatively describe anticipated greenhouse gas impacts as a result of the option. Full data tables are shown in Technical Appendix A. Glasgow's current SID configuration, with the majority of departures flying straight ahead to 5nm before turning							
Wider Society		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.							
	Capacity / resilience	In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. As traffic increases, flow restrictions are likely to be put in place in order for ATC and pilots to manage the additional complexity and workload. Flow regulations stabilise the number of movements until the peak in traffic subsides, however in doing so they generate ground delay for Glasgow.							
		It is therefore possible that, with future traffic levels, this baseline scenario would result in increases in departure delay at Glasgow airport. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme.							
		This baseline 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 ² resilience for Glasgow's SIDs when NERL decommissions the VORs, which will result in critical operational issues and significant loss of revenue.							
		CAP1616 outlines the consideration of impacts upon tranquillity with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks, and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP, we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB.							
	Tranquillity	follow Glasgow's baseline.	data on the overflight of th existing SID centrelines. ly departure baseline – Tr	The data f	rom this table will be				
		System		NSA coun	+ National	National DQ	A area DQA count		
		RWY 23 Bas	aline –		Parks area Pa	arks count			
		Vectoring (NT	0.02	1	1.68	1	0 0		

² 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-S

		RWY23 Baseline (Centrel Optioneering to		0	0		0	0		0	0	
		In addition to the da alongside the depart			•••		s maps wh	iich show l	NSAs, Na	tional Pa	rks and I	DQAs
		The effects of airspa "In general, airspace ground-based infras Habitats legislation." some evidence that are below around 50 where aircraft overfl Areas, and Sites of 5 Table 14 shows data	change p structure. ' Though disturban 00m (~1,6 y Specia Special S	oroposals a As such th there is lim ce effects a 540ft). Cons I Protection icientific Inte	re unlikely f ney are unli ited resear associated v sideration w o Areas, Sp erest, partic	to have ar ikely to h ich availa with aircra vill therefo becial Are cularly at	n impact up have a dire ble on the aft can occo ore be give eas of Con altitudes b	oon biodive ect impact effects of ur during ta n to the ef servation, elow 2,000	ersity beca that wou aircraft no ake-off an fects on e National Oft.	ause they ld engag bise on w d landing cology a Parks, N	do not in e the Bir ildlife, th where a nd biodiv ational S	volve ds or ere is ircraft ersity scenic
		follow Glasgow's ex westerly departure b Table 14 Biodiversit	isting SIE baseline.	D centreline	es. The dat							
	Biodiversity	System	SAC count	SAC area	SSSI count	SSSI area	SPA count	SPA area	National Park count	Nationa park area	NSA count	NSA area
		RWY 23 Baseline – Vectoring (NTK data)	3	1.42	32	65.82	12	58.95	1	1.68	1.00	0.02
		RWY 23 Baseline (Centreline – Optioneering tool)	0	0	3	23.69	1	21.89	0	0	0	0
		Below 2000ft based Conservation, Nation of aircraft. Lower an Barr Lochs SSSI, ho to follow the NAP an	nal Parks d slower wever th d will the	s, National S aircraft, clin is is likely to refore be ta	Scenic Area mbing at be o be infrequ actically tur	as, and S elow a 6% uently as ned befor	ites of Spe % climb gra lower and e reaching	ecial Scien adient, ma slower air the site.	tific Intere y overfly craft will t	est for the the Castl ypically n	e vast ma e Semple ot be rec	ajority e and quired
General Aviation	Access	This baseline scena place today. The opti- tion of the opti- tion of the opti- tion of the opti- tion of the opti- Figure 7 Glasgow Airpor Within c.35nm of GI Airspace (CAS) volu- which generates the limits with the volum outline. Also, in this which sits outside C.	tions will	be qualitative be qualitative of the second be qualitative of the second t	vely compa vely compa of the second control Area C Edinburgh a nis, the Sco Figure 5. The port going of Cumbernal	Arred again	eAIP for ful gow Presty airspace s led airspace ground lev rt approxin	sting scena with details) With Airpore sits above ce at Glasgell. This is nately 15n	ario.	th their c nd the air arying lo gow CTR east of G	wn Cont ports' airs wer and shown i	rolled space upper n red

		It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size. Whilst the existing baseline scenario will not result in the requirement for more airspace, this option offers no opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve.
	Economic impact from increased effective capacity	There will be no change from today as a result of this option; later in this IOA we will qualitatively estimate the differences between this, and the airspace change options.
General Aviation / Commercial airlines	Fuel burn	As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline westerly departures. When departing from Glasgow, the majority of aircraft fly straight ahead until 5nm and then are vectored by air traffic control, this means that track length is varied from flight to flight. For the purposes of comparing our westerly SID options against the baseline scenario, we have taken the track length of the SID centerlines as an initial indication of 'do nothing' track length. We have then applied a weighting based on SID usage to provide an overall total track mileage for the system. At the Stage 3 full options appraisal track length and fuel burn will be modelled

		in further detail						
		Table 15 West	erly SID Track Mileage					
				Baseline (Centrelin	ne)			
		RWY 23		nm	Score			
			TRN	38.50	3.69	142.065		
			NORBO – SUBUK	93.40	26.2	2447.08		
			NORBO – LAKEY	93.40	32	2988.8		
			LUSIV-DCS	84.80	10.66	903.968		
		0500	TLA	54.70	0.41	22.427		
		DEPS	PERTH	69.80	1.23	85.854		
			FOYLE	33.00	0.82	27.06		
			LOMON	26.70	2.05	54.735		
			CLYDE	19.50	2.87	55.965		
			ROBBO	19.60	2.05	40.18		
			- 1	otal	-	6768.134		
		coordination will we will qualitate anticipated adv	ing from Glasgow are so th other traffic in the airspa- tively estimate the differenc vantages/disadvantages of t vill be longer or shorter than	ce. es between this base he option against curr	line and the option, to rent day. This estimatic	understand if there are any on will consider whether the		
Commercial	Training costs	As this option is already in operation, there are no training costs anticipated as there will be no change; late IOA we will estimate the difference between our options and this baseline.						
airlines	Other costs	As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.						
	Infrastructure costs	As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.						
Airport / Air navigation service provider	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later this IOA we will estimate the difference between our options and this baseline. Glasgow Airport's current SIDs are dependent on conventional ground-based navigation equipment (VORs) whic are currently undergoing a rationalisation programme by NATS NERL. Glasgow is currently investigating RNA substitution to mitigate VOR rationalisation however this is an interim measure that only can only be used to bridg the gap ahead of FASI implementation. Failure to mitigate the impacts of VOR rationalisation in the long term w result in critical operational issues and significant loss of revenue, as well as not meeting the requirements of th AMS						
	Deployment costs		s already in operation, ther will estimate the difference l			ere will be no change; later		
All	Safety	At current traffic levels, there are no safety concerns 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, on increased aircraft holding on the ground, in order to maintain safety.						
All	Interdependencies, conflicts, and trade- offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with Westerly departures which are separated from Prestwick's airspace and do not conflict with Edinburgh's traffic below 7000ft. The existing ScTMA route structure shares airways for use by both Edinburgh and Glasgow results in higher ATC workload and less efficient profiles in the airspace above 7000ft.						
All	AMS CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use a by UK airspace. Doing nothing with Westerly departures will not align with the AMS. It will not enable any environme					y environmental benefits or		
		maximise bene	efits from NÉRL's re-design uction in the volume of cont	of the ScTMA. No c				

4.2. Runway 23 Westerly Departure Option A

Runway 23 Westerly Departures (Do	o Nothing Baseline)
	Offset right departures with turns at c.2nm and c.7nm from the runway. Offset left departures with turns at c.1nm from the runway. NORBO traffic is shared between a left turn departure route and the departure route that offsets right and then turns left at c.7nm with both routes available at the same time. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group Impact	Qualitative Assessment
Communitie S Noise impact on health and quality of life	Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Overflight This option would see the NORBO route which accounts for 58% of Glasgow's overall movements, split into two with offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some noise relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas not currently overflown frequently by departures will now be overflown on a more frequent basis. Out out however mean that areas not currently overflown frequently by departures will now be overflown on a more frequent basis. Out out of the transmitter of the t

future would be expected to concentrate traffic, albeit at comparatively low percentages compared to other routes such as NORBO. At higher altitudes the CLYDE/LOMON/FOYLE SIDs overfly areas not currently overflown by westerly departures and this occurs over areas with lower population density.

mainly route over areas already overflown today, however there is currently broad dispersion, whereas PBN routes in

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the Highlands and Islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, it is not expected that the contours would increase in size to overfly any additional dense areas of population with the exception of the CLYDE/LOMON/FOYLE routes, which may overfly Cardross although they are currently positioned over the River Clyde where possible.

The Technical Appendix to this document includes images and data which illustrate the NTK vectoring baseline data, the baseline centreline overflight contour data and the option's centreline overflight contour data. It's important to note that the vectoring baseline data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between the baseline, and the airspace change option.

Overflight data

Table 16 gives an overview of the Option A overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown

more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is an increase in the area of the overflight contours and the number of population overflown which can be attributed to introducing an additional NORBO SID to split the traffic; the benefits and impacts of this will be quantified at Stage 3 should this option progress.

Table 16 Westerly departures option A overflight data

System	Area (km²)	Population	
RWY 23 Baseline (Vectoring)	547.32	163216	
RWY23 Baseline (Centreline)	141.18	29838	
RWY23 Option A	262.55	58671	

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number overflown compared to the baseline centreline data. Compared to the vectoring data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option A against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 17 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline, however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 17 60dB and 65dB LAMax Data – Rwy23 Dep Option A

	60dE	3 L _{Amax}	65dB L _{Amax}		
System	Area (km²)	Population	Area (km²)	Population	
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704	
RWY 23 Dep Option A	493.41	143425	178.62	77760	

L_{Aeq}

The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall shape of the L_{Aeq} contours. The offset departures deviate from current day, and it is expected that this change will result in the daytime L_{Aeq} contours shortening compared to current day, however also extending further north-west and south-east to reflect the offset tracks. Review of the population density suggests that this may reduce the shape/size over Howwood, however it may result in population within Linwood and Elderslie being in a higher dB contour than today. Some areas of Linwood, and Foxbar, not currently within the L_{Aeq} contours may now fall into the lower dB contours.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise mitigations

The option offers noise relief for those communities currently located under immediate climb out and final approach, as the offset departures route aircraft away from the final approach track. It also aims to share the impacts of noise by splitting the NORBO departures (which make up 58% of Glasgow's overall movements). Unlike other options, it does not offer respite configurations that would be alternated and achieve predictable respite.

Air Quality Air Quality This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be

		slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option A will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Wider Society	Capacity / resilience	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 and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. In addition to this, this option splits the NORBO departures across two routes which will enhance operational performance throughout the day and reduce ground delays and CO ₂ contributions. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be 'lined up' in the correct order before take-off however this is not within scope of an Airspace Change project. 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 ³ resilience for Glasgow's SIDs when NERL

³ 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-S

		decommissions the NERL's VOR withdr			of PBN S	IDs is ab	solutely e	essential fo	or the Gla	asgow op	eration	following
		Table 18 shows da follow Glasgow's ex				as, base	d on the I	NTK vecto	ring base	line and i	f aircraf	t were to
		Table 18 RWY 23 Westerly Departures Option A – Tranquillity overflown										
		System		NSA area	NSA cou	nt	tional s count	National Parks are		count	DQA aı	rea
	Tranquillity	RWY 23 Baselin Vectoring (NTK of		0.02	1		1.68	1		0	0	
		RWY23 Baseline (Centre		0	0		0	0		0	0	
		Optioneering to RWY 23 Option		0	0		0	0		0	0	
		The data shows tha National parks com contour of this optio	pared to	the vectoring	baseline.	Technica	al appendix	A contair	ns a map	which sho		
		Table 19 shows data to follow Glasgow's				areas up	to 7000ft k	based on th	ne NTK h	eatmap ar	nd if airc	raft wer
		Table 19 Runway 2	3 Depar	ture Option A	– Biodiver	sity – are	eas overflo	own betwee	ən 0-7000	Oft		
		System	SAC count	SAC area	SSSI count	SSSI area	SPA count	SPA area	Nationa Park count	National park area	NSA count	NSA area
		RWY 23 Baseline – Vectoring (NTK data) RWY 23	3	1.42	32	65.82	12	58.95	1	1.68	1.00	0.02
	Biodiversity	Baseline (Centreline – Optioneering tool)	0	0	3	23.69	1	21.89	0	0	0	0
		RWY 23 Dep Option A	0	0	26	34.66	13	33.33	0	0	0	0
		Below 2000ft no ove Areas, and Sites of Castle Semple and	Special	Scientific Inte	rests is ex	pected fo						
		Barmufflock Dam an SID and the vast ma will be very minimal We will fully quantif Appraisal at Stage 3	ajority of fy the ov	aircraft will c	limb above	e 2000ft k	pefore ove	rflying the	site, it is	expected	that any	/ impact
		Option A is likely to existing CAS whilst							e this optio	on can be	contain	ed withi
General Aviation	Access	We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compared to existing CAS in the same lateral area is c.100nm ³ smaller than currently exists. The Glasgow CTR is c.47nm ³ smaller.										
	Economic impact from increased effective capacity	We expect the increased effective capacity detailed in the section above will result in a positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.										
		We estimate that O track mileage. This reductions in the Lt frequently than the	is mainl JSIV, TA	y driven by th ALLA, PERTH	ne reductio	on in trac	k mileage	of the NO	RBO LAI	KEY route	. There	are als
		RWY 23					(Centrelin			A		0
			TR	RN		m 8.50	<mark>% Weig</mark> 3.69		ore 2.065	nm 39.4		Score 145.386
Seneral				DRBO – SUB		3.40	26.2		47.08	94.3		2470.66
viation / commercial						3.40	32		88.8	84.4		2700.8
irlines	Fuel burn		LU TL	ISIV-DCS		4.80 4.70	10.66 0.41		3.968 .427	81.3 47.9		866.658 19.639
		DEPS		RTH		4.70 9.80	1.23		.854	60.2		74.046
				DYLE		3.00	0.82		.06	26.3		21.566
				MON YDE		6.70 9.50	2.05 2.87		.735 .965	18.1 16.1		37.105 47.929
				DBBO		9.50 9.60	2.07		.905 .18	17.		47.929 35.055
		Total							68.134			6418.84
			nont in t	rook miloogo	and the	opiratior	for all ai	roroft to ol	imb conti	a second second		st 6000
		Given the improver (subject to the NA ⁻ improvement in fuel	rs ner									

	Other costs	No other airline costs are foreseen.
Airport / Air navigation service provider	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB L _{Aeq,16h} contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB L _{Aeq,16h} contour area and residential properties within the 66dB L _{Aeq,16h} contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB L _{Aeq,16h} noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L _{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB L _{Aeq,16h} area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow, with regards funding their Noise Insultation Scheme.
provider	Operational costs	This airspace change proposal is not anticipated to change airport nor ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick Centre and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal, when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER.
		Other than the use of track adjustments on departure no safety issues are expected. The early right turn on ROBBO/FOYLE/LOMON/CLYDE/PERTH departures replicated what is tactically achieved today for most of those departures (excluding PERTH).
	Interdependencies, conflicts, and trade- offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options on their proposed shortlist which would cater for a duel NORBO southbound track structure. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to
All		be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
		CAP1711 describes the objective as:
		Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
All	AMS	This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO2 reductions, provide relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure).
		However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise.
		This option could be expected to result in reductions in the volume of Glasgow's CAS.

⁴ 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-S

4.3. Runway 23 Westerly Departure Option B

Runway 23 Wes	terly Departures – Optic	on B
CI YDE ROBBO NORBOTTEN	LOMONFOYLE PERH PERH NORBO	Offset right departures with turns at c.2nm from the runway. Offset left departures with turns at c.1nm and c.5nm from the runway. NORBO traffic is shared between two departure routes however they are the same route until c.5nm from the runway. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Overflight This option would see offset left and right departures. This would mean that westerly departures would not overfly
		the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis. The heatmap (Figure 9) shows that the offset left departure, which equates for the largest % of departures, deviates away from the area's most frequently overflown today.
		The NORBO route, which accounts for approximately 58% of overall traffic, offsets to the left which results in the overflight contour picking up some areas not currently overflown today. The NORBO route initially follows the same track and then splits into two however based on the 737-800 climb profile, the benefits of this split mostly occur beyond 7000ft. The route initially flies over Elderslie however then endeavours to avoid areas of dense population with the exception of Barrmill which is overflown at higher altitudes. Unlike other options, this option does not share the impacts of the NORBO route, and therefore this option will result in populations overflown at low frequencies today, being overflown at a higher frequency in future without any other mitigations.
		Option Overflight Contours (Black overall departure 2019 baseline aver swathe: 1
Communities	Noise impact on health and quality of	
	life	Figure 9 Westerly Option B Overflight and 2019 baseline NTK data
		The LUSIV and TALLA SIDs also offset left and routes over Neilston.
		The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow. Dumbarton, and Alexandria. The heatmap demonstrates that

do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic, albeit at comparatively low percentages compared to other routes such as NORBO.

Overflight data

The Technical Appendix to this document includes images and data which illustrate the NTK vectoring baseline data, the baseline centreline overflight contour data and the option's centreline overflight contour data. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 20 gives an overview of the Option B overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is an increase in the area of the overflight contours and the number of population overflown.

Table 20 Westerly departures option B overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option B	225.76	37664

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of care homes and places of worship overflown compared to the centreline baseline and an increase in the number of schools overflown. Number of hospitals remains the same. Compared to the vectoring data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis, should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option B against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 21 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today. We'd expect to see a decrease in population compared to the 2019 vectored L_{Amax} contours.

Table 21 60dB and 65dB LAMax Data - Rwy23 Dep Option A

	60dB L _{Amax}		65dB L _{Amax}	
System	Area (km²)	Population	Area (km²)	Population
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option B	433.35	121890	160.28	70853

L_{Aeq}

The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day. The offset departure to the left, which would operate around 68% of departure movements, is expected to result in the L_{aeq} contour extending further to the south-west to reflect the offset track. When reviewing population density, this suggests there may be some benefit to Howwood and Johnstone, however the lobe would now potentially extend over Foxbar and parts of Ferguslie. The equivalent ROBBO/CLYDE/LOMON/FOYLE/ PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the offset route may result in some areas of Linwood, which currently sit in the lower dB L_{Aeq} contours, to move into a higher dB contour.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation

The option offers relief for those communities currently located under immediate climb out and final approach as the offset departures route aircraft away from the final approach track. Unlike other options, it does not offer respite configurations that would be alternated and achieve predictable respite. This option would not mitigate the effects for those newly overflown by a NORBO departure by splitting the NORBO departures across 2 tracks.

This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral

		tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option B will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Wider Society		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 and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.
	Capacity / resilience⁵	However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. Splitting the NORBO departures across two routes would enhance operational performance and reduce ground delays and CO ₂ contributions, particularly at peak periods. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation and the matrix and the periods.

⁵ Summary colour corrected

Air Quality

		Glasgow's SIDs when N Glasgow operation follow						
		Table 22 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines.						
		Table 22 RWY 23 Weste	erly Departure	es Option B – Ti	anquillity overfl	own		
		System	NSA are	a NSA coun	t National Parks area	National Parks count	DQA area	DQA count
	Tranquillity	RWY 23 Baseline – Vectoring (NTK data)	0.02	1	1.68	1	0	0
		RWY23 Baseline (Centreline - Optioneering tool)	- 0	0	0	0	0	0
		RWY 23 Option B	0	0	0	0	0	0
		The data shows that there is no change in overflight of DQA's and there is a reduction in overflight of NSAs an National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows th overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.						
		Below 2000ft no overflig Scenic Areas, and Sites the baseline Castle Sem	of Special So	cientific Interest	s is expected for	or the vast majo		
	Biodiversity	Lower slower aircraft, clin and Barmufflock Dam S vast majority of aircraft v very minimal.	SSIs below 2	000ft. Given the	e low overall %	of aircraft expe	ected to fly the	e SID, and th
		We will fully quantify the Appraisal at Stage 3.	overflight of t	biodiverse sites	using the full G	lasgow fleet mi	x, as part of o	ur Full Option
		Option B is likely to con- within existing CAS while					this option car	n be containe
General Aviation	Access	We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival an departure options combined to help stakeholder engagement on potential impacts. We have also used this volume to understand if there is scope to reduce the total volume of CAS. The total volume of the "illustrative airspace volume compared to existing CAS in the same lateral area is c.100nm ³ smaller than currently exists. The Glasgow CTR was c.47nm ³ smaller.						
		The Glasgow CTR was o	2.47nm³ smal					
	Economic impact from increased effective capacity	We expect the small in economic impact on cor however the continuation We estimate that Option	creased effect nmercial air t n of NORBO c B, when com	ler. tive capacity d raffic compared lepartures in a s pared to baselir	with the basel ingle track wou ne nominal cent	ine do nothing Id not deliver th relines, will resu	westerly depa e biggest ecor ult in an overa	arture baselir nomic benefit Il improveme
	increased effective	We expect the small in economic impact on cor however the continuation	creased effect nmercial air t o of NORBO c B, when com mainly driven the TRN, N Calculations –	ler. trive capacity d raffic compared lepartures in a s pared to baselin by the reductio ORBO SUBUK <i>Fuel Burn Opti</i>	with the basel ingle track wou ne nominal cent on in track milea , LUSIV, TALL on B	ine do nothing Id not deliver th relines, will resu age of the NOR A, PERTH, LO	westerly depa e biggest ecor ult in an overa BO LAKEY ro	arture baselir nomic benefit Il improveme ute. There a
	increased effective	We expect the small in economic impact on cor however the continuation We estimate that Option in track mileage. This is also small reductions in routes.	creased effect nmercial air t of NORBO of B, when com mainly driven the TRN, N Calculations –	tive capacity d raffic compared lepartures in a s pared to baselin by the reductio ORBO SUBUK <i>Fuel Burn Opti</i> Baseline (Cent	with the basel ingle track wou ne nominal cent on in track milea , LUSIV, TALL on B	ine do nothing Id not deliver th relines, will resu age of the NOR A, PERTH, LO	westerly depa e biggest ecor ult in an overa BO LAKEY ro MON, CLYDE	arture baselir nomic benefit Il improveme oute. There a
	increased effective	We expect the small in economic impact on cor however the continuation We estimate that Option in track mileage. This is also small reductions in routes. Table 23 Track Length C	creased effect nmercial air t of NORBO of B, when com mainly driven the TRN, N Calculations –	tive capacity d raffic compared lepartures in a s pared to baselin by the reductio ORBO SUBUK <i>Fuel Burn Opti</i> Baseline (Cent	with the basel ingle track wou ne nominal cent on in track milea , LUSIV, TALL on B	ine do nothing Id not deliver th relines, will resu age of the NOR A, PERTH, LO B nm	westerly depa e biggest ecor ult in an overa BO LAKEY ro	arture baselir nomic benefit Il improveme oute. There a
	increased effective	We expect the small in economic impact on cor however the continuation We estimate that Option in track mileage. This is also small reductions in routes. Table 23 Track Length C	creased effect nmercial air t of NORBO c B, when com mainly driven the TRN, N Calculations – TRN 3 NORBO – SUBUK	tive capacity d raffic compared lepartures in a s pared to baselin by the reductio ORBO SUBUK <i>Fuel Burn Opti</i> Baseline (Cent	i with the basel ingle track wou ne nominal cent on in track milea , LUSIV, TALL on <i>B</i> reline) ighting Score	ine do nothing Id not deliver th relines, will resu age of the NOR A, PERTH, LO B nm 37.5	westerly depa e biggest ecor ult in an overa BO LAKEY ro MON, CLYDE	arture baselir nomic benefit Il improveme ute. There a
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Aviation / Commercial	increased effective capacity	We expect the small in economic impact on cor however the continuation We estimate that Option in track mileage. This is also small reductions in routes. Table 23 Track Length C	Creased effect nmercial air to of NORBO of B, when com mainly driven the TRN, N Calculations – Calculations – TRN 3 NORBO – SUBUK NORBO – LAKEY LUSIV- DCS 5	Ier.etrive capacity d raffic compared departures in a s pared to baselin by the reduction ORBO SUBUKFuel Burn OptionBaseline (Cent 0m03.4026.203.403203.403203.400.41	i with the basel ingle track wou ne nominal cent on in track milea , LUSIV, TALL on B reline) ighting Score 142.06 2447.0 2988.8 903.96 22.427	ine do nothing Id not deliver th relines, will resu age of the NOR A, PERTH, LO B 15 15 18 16 16 16 16 16 16 16 16 16 16 16 16 16	westerly depa e biggest ecor JIt in an overa BO LAKEY ro MON, CLYDE 138.375 2399.92 2723.2 866.658 19.639	arture baselin nomic benefit Il improvemen ute. There ar
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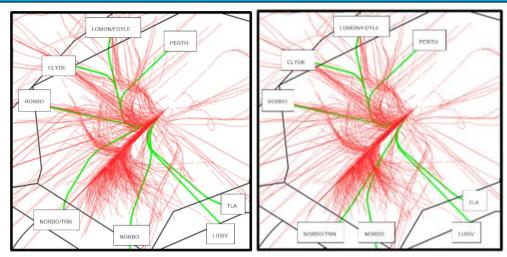
⁶ Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

		proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their
		Noise Insultation Scheme.
		The initial deployment phase of the ACP may require some ATC system engineering amendments.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁷ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick Centre and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER.
		Other than the use of track adjustments on departure no safety issues are expected. The early right turn on ROBBO/FOYLE/LOMON/CLYDE/PERTH departures replicated what is tactically achieved today for most of those departures (excluding PERTH)
All	Interdependencies, conflicts, and trade-	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options ion their proposed shortlist which would cater for a duel NORBO southbound track structure, noting that the split of NORBO traffic takes place above 7000ft in this option. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need
	offs	to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
		This option is dependent on changes to the network.
		CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
		This option would be expected to generate significant CO ₂ reductions, provide relief from noise to those most frequently overflown by Glasgow arrivals and departures.
All	AMS	However, this option would not accommodate future demand in the most effective manner as a single initial NORBO departure would likely generate future ground delay. In addition, positioning all NORBO departures over the same newly overflown communities would not mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to sharing across a dual NORBO SID structure).
		However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise.
		This option could be expected to result in reductions in the volume of Glasgow's CAS

⁷ 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-S

4.4. Runway 23 Westerly Departure Option C

Runway 23 Westerly Departures – Option C

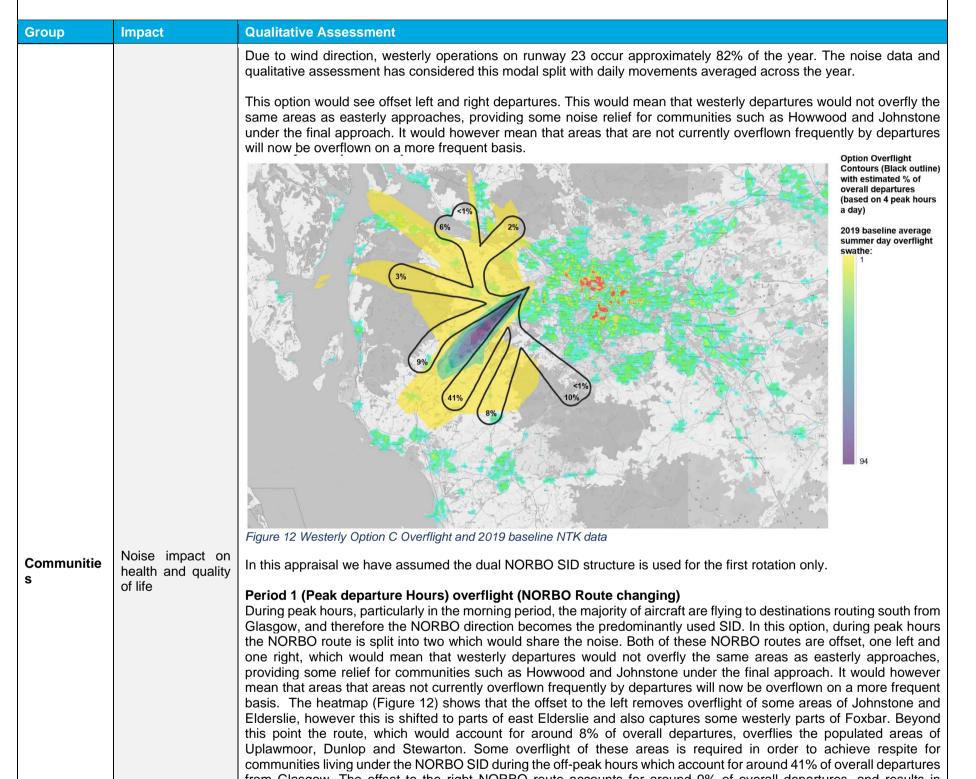


This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure periods. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different NORBO flight path which offsets to the left, with the rest of the routes remaining the same. The reason for this would be to mitigate the small increase in mileage of a NORBO route which offsets to the right, compared to the baseline SID.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Figure 11 Option C Peak Hours

Figure 10 Option C Rest of the day



overflight of Linwood and Kilbarchan at lower levels, and overflight of parts of Lochwinnoch and Kilbarchan at lower levels.

Period 2 overflight

During the off-peak periods the NORBO departure, which accounts for approximately 41% of overall traffic (assuming this route is used all day after the first rotation), offsets to the left but follows a different path than the peak hours offset-left SID. The initial section of the NORBO route follows the same path as the peak period configuration, and therefore there is very limited respite for communities living under the early parts of these routes who will experience around 49% of departures overall. From the heatmap, this level of overflight would be a significant change from current day, where those areas are typically experiencing somewhere between 1 - 10 flights per day on average. The route initially flies over Elderslie however then endeavours to avoid areas of dense population with the exception of Barrmill which is overflown at higher altitudes. The LUSIV and TALLA SIDs also offset left and route over Neilston; beyond this they largely avoid dense areas of population.

The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, it is not expected that the contours would increase in size to overfly any additional dense areas of population.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option C. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Overflight data

Table 24 gives an overview of the Option C overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population and noise sensitive sites overflown; this is due to the nature of having multiple NORBO routes, an additional NORBO respite route and also avoiding the easterly final approach track whereby more people are overflown. However, the noise is shared and therefore it is overflight on a less frequent basis than for those who live under easterly final approach currently experience.

Table 24 Westerly departures option C overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option C	305.53	60931

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option C against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 25 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 25 60dB and 65dB LAMax Data – Rwy23 Dep Option C

	60dB L _{Amax}		65dB L _{Amax}	
System	Area (km²)	Population	Area (km²)	Population
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704
RWY 23 Dep Option C	563.66	146232	206.59	80377

LAeq

The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day. The offset departure to the left, which would operate around 60% of departure movements, is expected to result in the L_{Aeq} contour extending further to the south-west to reflect the offset track. When reviewing population density, this suggests there may be some benefit to Howwood and Johnstone, however the lobe would now potentially extend over Foxbar and parts of Ferguslie. The equivalent ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the offset route may result in some areas of Linwood, which currently sit in the lower dB L_{Aeq} bands, to move into a higher dB contour.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation

The option offers relief for those communities currently located under immediate climb out and final approach as the offset departures route aircraft away from the final approach track. Having 2 NORBO SIDs also reduces the frequency of overflight for communities situated under just one NORBO SID, but only for the first rotation. It also offers an alternative respite configuration during peak departure periods for communities who live under the NORBO departure which accounts for the majority of departures from Glasgow airport however the benefits of this are minor as the respite configuration mainly benefits communities to the north-west (See overflight section above).

The introduction of alternative predictable respite arrangements also increases population overflown and the 60dB and 65dB L_{Amax} outcomes compared to other options; the benefits and impacts of this will be further analysed as part of the Full Options Appraisal at Stage 3 when we have quantitative information about the frequency of overflight should this option progress.

	Air Quality	This option has a change emissions in their totality, quality. Where lateral trac 1000ft today there may be overflying areas to the sic increases in the concentra be small compared to the	there will be a ks are moving slight decreas le of the straig ations below th	a change in the away from the es in the conce ght-ahead dep nese flightpath	e location of en le standard 'str entrations below arture route (k s. However, it	nissions below raight ahead' o w these flightpa nown as 'offse should be note	1000ft which of departure that a aths. Where late et departures')	could affect local air aircraft follow below eral tracks are newly there may be sligh				
	Greenhouse gas impact	Our fuel burn assessmen compared to the baseline This will be explored in fur	. We therefore	e expect to see	e a correspond	ding improvem	ent to greenho	ouse gas emissions				
	Capacity / resilience ⁸	This option sees the SIDs able to depart in intervals This is expected to reduce of this will be seen particul However, this option only gain the full benefits of this be 'lined up' in the correct availability of the dual NOI daily peaks in demand out The introduction of PBN S which provides resilience. the Airspace Modernisation decommissions the VORs. VOR withdrawal programm	1 minutes apa ground holdin larly in future s splits the NOF s, future inves corder before RBO structure side of these p SIDs also rem This equipment on programme Introduction c	art (subject to ng which in tur scenarios with RBO departure tment may be take-off howey during the exi beak times. oves Glasgow nt is due to be . There is cur	safety case and n will reduce g increased traff es across two not required in add ver this is not sting peak dep r's dependency decommission rently no long	nd NERL ability round-based e ic levels. routes during p ditional taxiway within scope of parture hours o y on convention term ⁹ resilienc	y to accept 1-r missions and o beak departure i infrastructure an Airspace (nly would not a nal ground-bas NERL UK wid e for Glasgow	ninute separations) delays. The benefits periods. In order to to enable aircraft to Change project. The accommodate future sed navigation aids le programme under 's SIDs when NERL				
		Glasgow's existing SID ce	Table 26 shows data on the overflight of these areas, based on the NTK vectoring baseline and if aircraft were to follow Glasgow's existing SID centrelines. Table 26 RWY 23 Westerly Departures Option C – Tranquillity overflown									
Wider Society			System NSA area NSA count National National DOA area DOA count									
	Tranquillity	System RWY 23 Baseline –		NSA count	Parks area	Parks count						
		Vectoring (NTK data) RWY23	0.02	1	1.68	1	0	0				
		Baseline (Centreline – Optioneering tool)	0	0	0	0	0	0				
		RWY 23 Option C 0 0 0 0 0 0										
		The data shows that there is no change in overflight of DQA's and there is a reduction in overflight of NSAs and National parks compared to the vectoring baseline. Technical Appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.										
	Biodiversity	 Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided. Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal. We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3. 										
		Option C is likely to contril existing CAS whilst offerin					his option can	be contained within				
General Aviation	Access	existing CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS required to contain ALL arrival and depa options combined to help stakeholder engagement on potential impacts. We have also used this volume to under if there is scope to reduce the total volume of CAS. The total volume of the "illustrative" airspace volume compar existing CAS in the same lateral area is c.100nm ³ smaller than currently exists. The Glasgow CTR was c.47nm ³ sm										
	Economic impact from increased effective capacity	We expect the increased e commercial air traffic com NORBO departures in a si	pared with the	e baseline do	nothing weste	rly departure b	baseline. Howe	ever, the merging o				
		We estimate that Option 0 track mileage. This is main overall reductions in all rou	nly driven by t									
		Table 27 Track Length Calcu	lations – Fuel B	urn Option C								
			Baseline	(Centreline)			C					

			Baselir	ne (Centreline	e)			C		
General Aviation /		RWY 23	RWY 23		% Weighting	Score	nm P1	nm P2	Average	Score
Commercial			TRN	38.50	3.69	142.065	39.4	37.5	38.45	141.8805
airlines	Fuel burn		NORBO - SUBUK			2447.08	94.3	91.6	92.95	2435.29
			NORBO - LAKEY	93.40	32	2988.8	84.4	85.1	84.75	2712
			LUSIV- DCS	84.80	10.66	903.968	81.3	81.3	81.3	866.658
			TLA	54.70	0.41	22.427	47.9	47.9	47.9	19.639
			PERTH	69.80	1.23	85.854	60.2	60.2	60.2	74.046
			FOYLE	33.00	0.82	27.06	26.3	26.3	26.3	21.566
			LOMON	26.70	2.05	54.735	18.1	18.1	18.1	37.105

 ⁸ Summary colour corrected
 ⁹ 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-S
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				19.50 19.60	2.87 2.05	55.965 40.18	16.7 17.1	16.7 17.1	16.7 17.1	47.929 35.055	
		-	JBBO	19.60	2.05	<u> </u>	17.1	17.1	17.1	6391.169	
		Total				6768.134					
		Given the improvement to the NATS NERL AC fuel burn. In the Full O	CP for th	ie airspa	ace above	7000ft), it is ant	icipated	that this c	ption woul	d see an improvem	
Commercial airlines	Training costs	Flight procedures are u their procedures accor any additional training	rdingly a	and und	ertake trai						
	Other costs	No other airline costs a	are fores	seen.							
Airport / Air navigation	Infrastructure costs	Glasgow currently ope area and noise insula contour area and resic policy now requires fina LAeq,16h noise contour of 2022, which will cover will determine if there a of the track adjustmen there will be an increas	tion sch dential p ancial a or above the vari are any i ats on de sed cost	nemes for propertie ssistance. There ied prop ncrease eparture t for Glas	or sensitiv s within the to be off fore, Glass erty types s in house to If it does sgow with	e buildings, suc e 66dB L _{Aeq,16h} ered towards th jow Airport are situated within holds within the and track adju- regards funding	ch as so contour e noise currently the 63dl 63dB L/ stments their No	chools and area. The insulation / developin 3 contour acontour are propo pise Insulta	I hospitals e UK Gove of resident ng a new N area. The as a result sed in Gla ation Scher	, within the 63dB L rnment's current av ial properties in the loise Insulation Pol LAeq modelling in St of this options as a sgow's ACP submi me.	-Aeq,1 viatio 63d icy fe tage resu
service provider		The initial deployment					-		•		
	Operational costs	This airspace change PBN SIDs removes C contributes to a reduct	Glasgow	ı's depe	endency o	n conventional	ground-	based na	vigation e		
Deployment costs This option is expected to require air traffic controller training for the controllers and assistants to Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part Full Options Appraisal when we are appraising our shortlist of options and once further information is knetwork above 7000ft and interdependencies with Edinburgh. Owing to the respite configuration, ther training required for this option, compared to other options that form part of this IOA.							ion as part of the St nation is known abo	tage out th			
All	Safety	This option requires a CAA IFP department w the aircraft doesn't turn required during IFP gro DER. A SID structure from t expected that perhaps an option where a SID after departure introdu introducing other issue wrong SIDs and the wr *As an example, mitiga with completely different going to the same place SID names to match the	vanted a n before ound val he same a much utilisati uces ha: es*. Suc rong tim ations id nt name ces in th	e runwa nore s ion woul zards to h hazar le of day lentified es. Howe	ow 500ft ² f d of the ru o ensure t ubtle chan d change o the opera ds are not but also f for SIDs s ever, flight ork are req	lyover WP posit nway. PANS O ne WP is accept anges during t ge to a SID stru- significantly fror ation which at t just associated luman Factor (H witching to fund planning and A	ioned at PS does table, es he day i cture ca n a left his stag with air IF) issue amental	the Decla sn't require pecially fo s uncharte in be safel turn to a ri le cannot craft inadv es associa different c es previous	red End of this. Add llowing and ered territo y accommon ght turn (o considered vertently fly ted with A directions a sly identifie	Runway (DER) to entrin the turn shortly affective turn shortly affec	ensui will b ter th ed th diate vitho ed) th e SIE
All	Interdependencies , conflicts, and trade-offs	There are few interdep NORBO departures are In NERL's ScTMA ACF track structure, noting As highlighted in Glasg cognisant of their airsp In addition, the cumula the ScTMA need to be This option is depende	e separa P, they h these Sl gow Pre- pace. ative effe co-ordin	ated fron lave opti IDs wou stwick A ect on o nated ar	n Prestwic ons ion the ld then me sirport's fee ther airspa nd conside	k's airspace and eir proposed sho erge into one init edback in Stage ace users as a r red.	l does no ortlist wh tial track 2A, the	ot conflict v ich would for the res final prope	vith Edinbu cater for a c st of the da osed CAS	argh's traffic below 7 dual NORBO south y arrangements need	7000f boun I to b
		CAP1711 describes th Deliver quicker, quiete UK airspace. This option would be e	r, and c	leaner jo d to ger	erate sign	ificant CO ₂ redu	uctions,	provide re	lief and re		
All	AMS	most frequently overflo However, this option w	own by C vould no	Glasgow ot accom	arrivals a	nd departures liv	ving und the mo	er final ap	proach. e manner a	as a single initial NO	ORB

All	AMS	departure track for the majority of the day would likely generate future ground delay. In addition, positioning that single NORBO departure over the same newly overflown communities for the rest of the day would not mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a dual NORBO SID structure).	
		However, as mentioned in the Noise impact on health and quality of life section above, it is currently unknown as to whether the use of track adjustments on departure would result in an increase in the numbers of people adversely affected by aircraft noise. This option could be expected to result in reductions in the volume of Glasgow's CAS.	

¹⁰ 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-S

4.5. Runway 23 Westerly Departure Option D

Runway 23 Wes	sterly Departures – Opt	tion D
	IONFOYLE PERTH TLA NORBO	This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period. The configuration would then switch for the rest of the day. In the peak periods, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time. For the rest of the day, all the NORBO traffic would then use a different NORBO flight path which follows a straight line from the runway until splitting at 5nm, with the rest of the routes remaining the same. The reason for this would be to mitigate the small increase in mileage of a NORBO route which offsets to the right, compared to the baseline SID as well as mitigating the effects for those newly overflown by the peak NORBO SIDs. This option is similar to Option C except that the daytime (non-peak) NORBO route is different.
Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see offset left and right departures. This would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis.
		In this appraisal we have assumed the dual NORBO SID structure is used for the first rotation only. Period 1 (Peak departure Hours) overflight (NORBO Route changing) During peak hours, particularly in the morning period, the majority of aircraft are flying to destinations routing south from Glasgow, and therefore the NORBO direction becomes the predominantly used SID. In this option, during peak hours the NORBO route is split into two, which would share the noise. Both of these NORBO routes are offset, one left and one right, which would mean that westerly departures would not overfly the same areas as easterly approaches, providing some relief for communities such as Howwood and Johnstone under the final approach. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis. The heatmap Figure 13 shows that the offset to the left removes overflight of some areas of Johnstone and Elderslie, however this is shifted to parts of east Elderslie and also captures some westerly parts of Foxbar. Beyond this point the route, which would account for around 8% of overall flights, overflies the populated areas of Uplawmoor, Dunlop and Stewarton. Some overflight of these areas is required in order to achieve respite for communities living under the NORBO SID during the off-peak hours which account for around 42% of overall departures from Glasgow. The offset to the right route accounts for around 9% of overall departures, and results in overflight of Linwood and Kilbarchan at lower levels, and overflight of parts of Lochwinnoch and Kilbirine at higher levels.
Communities	Noise impact on health and quality of life	Construction of the second sec

Figure 13 Westerly Option D Overflight and 2019 baseline NTK data

Period 2 overflight

During the off-peak periods the NORBO departure, which accounts for approximately 42% of overall traffic (assuming this route is used all day after the first rotation) would fly straight ahead, similar to how aircraft fly the NORBO route today. At 5nm the route would then split into two, with 21% of departures continuing straight ahead and 21% turning south. The initial straight-ahead section between the runway and 5nm overflies Johnstone, Elderslie and Howwood as the majority of departures do today. The straight-ahead section beyond 5nm overflies Beith and parts of Kilbirnie however this will be different to current day owing to the concentration of traffic along the PBN routes. From the NTK data we can see that the route to the south route would increase the frequency of overflight compared to today however this route largely avoids areas of dense population with the exception of parts of Dunlop at around 7000ft.

In both periods, the ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs offset right, moving the overflight contours closer to the populated area of Linwood and the Bridge of Weir. Above 4000ft, the routes largely avoid dense areas of population instead routing across Loch Lomond National Park, and along the River Clyde. The overflight contours do however overfly parts of the port of Glasgow, Dumbarton, and Alexandria. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option D. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Overflight data

Table 28 gives an overview of the Option D overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population overflown; this is partially due to the nature of the respite routes whereby more people are overflown, however the noise is shared and therefore it is overflight on a less frequent basis.

Table 28 Westerly departures option D overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option D	332.84	82804

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring data, there is a decrease in potentially noise sensitive buildings overflown, but it's important to note that at this stage the data does not consider the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option D against the baseline. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in Table 29 shows a significant increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 29 60dB and 65dB LAMax Data - Rwy23 Dep Option D

	60dE	3 L _{Amax}	65dB L _{Amax}		
System	Area (km²)	Population	Area (km²)	Population	
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704	
RWY 23 Dep Option D	583.18	153095	214.24	84120	

L_{Aeq}

The westerly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the offset departures that form part of this option deviate from current day. Unlike some other options, the NORBO offset routes are only used for a small part of the day, with the majority of the NORBO departures continuing to fly straight ahead to 5nm as they do today. The introduction of the offset routes overall may result in a small change in the LAeq contours shortening compared to current day. The offset departures to the left, which would operate around 19% of departure movements, is expected to result in the LAeq contour extending slightly further to the south-west to reflect the offset track, this change is likely to occur over an area with low population however it would require further quantitative investigation at Stage 3 should this option progress. The offset departures to right, which would operate around 21% of departure movements, is expected to result in the LAeq contour extending slightly further to the north-east to reflect the offset track, this change is likely to occur over Linwood however it would require further quantitative investigation at Stage 3 should this option progress.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

	Noise Abatement Procedures A change to the existing NAPs would be required to accommodate the offset departures and turns.
	Noise Mitigations The option offers an alternative respite configuration during peak departure periods for communities who live under the NORBO departure which accounts for the majority of departures from Glasgow airport. This means that overall, the NORBO noise is shared across three different routes although the straight-ahead off-peak route, which is similar to current day, sees the majority of the traffic.
	The other routes remain the same during peak and off-peak periods however they have comparatively lower percentages of overall flights operating.
	The introduction of alternative predictable respite arrangements (for those communities newly overflown by the peak NORBO) increases population overflown and the 60dB and 65dB L _{Amax} outcomes compared to other options; the benefits and impacts of this will be further analysed as part of the Full Options Appraisal at Stage 3 when we have quantitative information about the frequency of overflight (should this option progress).
Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral

		tracks are newly ove there may be slight ir changes are likely to	ncreases	s in the cor	centrations l	below these	flightpath	ns. Howeve	r, it should	be noted that these		
	Greenhouse gas impact	Our fuel burn assess compared to the base This will be explored	eline. Ŵ	e therefore	expect to se	e a correspo	onding im	provement	to greenho	ouse gas emissions		
		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 and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.										
	Capacity / resilience ¹¹	However, this option only splits the NORBO departures across two routes during peak departure periods. In order to gain the full benefits of this, future investment may be required in additional taxiway infrastructure to enable aircraft to be 'lined up' in the correct order before take-off however this is not within scope of an Airspace Change project. The availability of the dual NORBO structure during the existing peak departure hours only would not accommodate future daily peaks in demand outside of these peak times.										
		The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. 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 ¹² 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.										
		Table 30 shows data follow Glasgow's exis				s, based on	the NTK	vectoring	baseline ar	nd if aircraft were to		
		Table 30 RWY 23 Wes	sterly Dep	partures Opt	ion D – Tranq	uillity overflov	vn					
Wider Society		System		NSA area	NSA cou	nt Natio		National	DQA ar	ea DQA count		
		RWY 23 Baseline		0.02	1	1.6		arks count 1	0	0		
	Tranquillity	Vectoring (NTK d RWY23		0	0	0		0	0	0		
		Baseline (Centreli Optioneering to	ol)	0	0	0		0	0	0		
		RWY 23 Option	D	0	0	0		0	0	0		
		The data shows that there is no change in overflight of DQA's and there is a reduction in overflight of National parks compared to the vectoring baseline. Technical Appendix A contains a map which so overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.										
		Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas, and Sites of Special Scientific Interests is expected for the vast majority of aircraft. Compared to the baseline Castle Semple and Barr Lochs SSSI would be avoided.										
	Biodiversity	Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.										
		We will fully quantify Appraisal at Stage 3.		erflight of b	iodiverse site	es using the	full Glas	gow fleet n	t mix, as part of our Full Options			
		Option D is likely to within existing CAS v							e this optio	n can be containe		
General Aviation	Access	We created an "illust departure options control to understand if there volume compared to CTR was c.47nm ³ sr	mbined e is sco existing	to help sta pe to redu	keholder eng	agement on volume of C	n potentia AS. The	l impacts. V total volum	We have al ne of the "i	so used this volume Ilustrative" airspace		
	Economic impact from increased	We expect the increasion commercial air tra	ffic com	pared with	the baseline	do nothing v	westerly o	departure b	aseline. Ho	wever, the merging		
	effective capacity	of NORBO departure We estimate that Op		<u> </u>		•	-					
		in track mileage. This are also some small	s is main	ly driven b	y the reduction	on in track m	nileage of	the NORB	O LAKEY I	oute however there		
		Table 31 Track Length	Calculati	ions – Fuel	Burn Option D)						
				i i	e (Centreline	e)			D			
General		RWY 23		nm	% Weighting	Score		1 nm P2		e Score		
Aviation / Commercial		٦	TRN NORBO	_	3.69 26.2	142.065	39.4	37.8	38.6	142.434		
airlines	Fuel burn	S	SUBUK NORBO	93.40	26.2	2447.08	94.3	92.5	93.4	2447.08		
		L	_AKEY _USIV-	93.40	32	2988.8	84.4	85.6	85	2720		
		DEPS [DCS		10.66	903.968	81.3	81.3	81.3	866.658		
			TLA PERTH		0.41 1.23	22.427 85.854	47.9 60.2	47.9 60.2	47.9 60.2	19.639 74.046		
			OYLE		0.82	27.06	26.3	26.3	26.3	21.566		
			LOMON		2.05	54.735 55.965	18.1 16.7	18.1 16.7	18.1	37.105		
					2.87				16.7	47.929		

 ¹¹ Summary colour corrected
 ¹² 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-S
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			ROBBO	19.60	2.05	40.18	17.1	17.1	17.1	35.055
		Total				6768.134				6411.512
		Given the improve (subject to the NA improvement in fue	TS NERL /	ACP for t	he airspa	ce above 7000	ft), it is a	anticipated	that this c	ption would see a
Commercial airlines	Training costs	Flight procedures a update their procedure their procedure to require any additional statements of the statement of the state	dures accoi	rdingly ar	nd underta	ke training if re				
	Other costs	No other airline cos	sts are fore	eseen.						
Airport / Air navigation service	Infrastructure costs	Glasgow currently contour area and n LAeq.16h contour are aviation policy now in the 63dB LAeq.16 Insulation Policy fo LAeq modelling in S result of this option in Glasgow's ACP Insultation Scheme The initial deploym	oise insula a and resid requires fin h noise cor or 2022, wh tage 3 will o s as a resul submission o.	Ition sche lential pro nancial as ntour or a nich will c determine lt of the tra on, there	mes for so operties wi ssistance above. Th over the v e if there a ack adjust will be an	ensitive building thin the 66dB L to be offered to erefore, Glasgo aried property re any increase ments on depar n increased co	s, such a Aeq,16h COI wards the ow Airpo types sit s in hou: ture. If it st for GI	as schools ntour area e noise ins rt are cur uated with seholds w does and asgow with	and hospir The UK G sulation of r rently deve in the 63dl ithin the 63 rrack adjust th regards	tals, within the 63c overnment's curre esidential propertie loping a new Nois 3 contour area. The dB LAeq, 16h area as ments are propose funding their Nois
provider	Operational costs	This airspace chan of PBN SIDs remove contributes to a reco	ge proposa /es Glasgo	al is not ai w's deper	nticipated	to change airpc conventional g	rt or ANS round-ba	SP operati ased navig	onal costs. ation equip	The implementation
	Deployment costs	This option is expe Prestwick and Gla Stage 3 Full Optio known about the ne there may be more	ected to rec sgow Airpo ns Apprais etwork abo	quire air t ort. The s al when ve 7000ft	raffic cont cale and we are ap and inter	roller training fon nature of this training our shopraising our shoppendencies v	or the co aining re nortlist of vith Edin	ntrollers a equires fu f options a burgh. Ow	nd assistar ther explor and once fu ing to the r	ation as part of th arther information espite configuratio
All	Safety	This option require the CAA IFP depart to ensure the airc assurances will be another turn shorth A SID structure fro is expected that pe that an option whe immediately after mitigated without in (or being issued) th *As an example, m SIDs with complete requires SIDs goin would mean simila	tment wan raft doesn' a required of a fter the I m the same rhaps a mu re a SID uti departure i ntroducing of he wrong S itigations id aly different g to the sar	ted a 'not 't turn be during IFI DER. e runway ich more s ilisation w introduce other issu IDs and t dentified f t names. me places	t below 50 fore the e P ground which ch subtle cha vould char s hazards ues*. Such he wrong for SIDs s However, s in the ne	Off' flyover WP and of the runv validation to en anges during the nge to a SID stru- ge significantly to the operation hazards are n time of day but witching to fund flight planning a twork are requi	e day is acture ca from a le on which ot just as also HF amental and ATM red to te	ed at the E NS OPS of WP is a uncharter an be safel eft turn to at this s ssociated issues as different of issues pr	eclared Er doesn't req cceptable, ed territory y accommo a straight a tage canno with aircraf sociated with lirections at eviously ide	d of Runway (DE uire this. Addition especially followin for the UK. Whilst bdated, ATC advise head (or vice-vers of considered to b t inadvertently flyin th ATC confusion.
All	Interdependencies, conflicts, and trade- offs	There are few inter hand NORBO dep below 7000ft. In NI NORBO southbounday. As highlighted in G to be cognisant of the In addition, the cur and the ScTMA ne This option is depe	dependend artures are ERL's ScTI nd track str Glasgow Pre their airspa mulative eff ed to be co	cies, conf separate MA ACP, ructure, n estwick A ice. fect on ot p-ordinate	licts, or tra ed from P they have oting thes irport's fe ther airspa	de-offs with rou restwick's airsp e options on the e SIDs would t edback in Stage ce users as a sidered.	ites to/fro ace and ir proposi nen merg e 2A, the	does not sed shortli ge into on final prop	conflict with st which we e initial trac	h Edinburgh's traf buld cater for a du ck for the rest of th arrangements nee
AII	AMS	CAP1711 describe Deliver quicker, qu by UK airspace. This option would I those communities expense of then ov under final approad This option would departure track for However, as menti as to whether the adversely affected This option could b	s the object ieter, and c be expected that would verflying the ch the rest of not accom the majorit oned in the use of trac by aircraft	d to gene be newly commu of the day nmodate ty of the d e Noise in ck adjustr noise.	urneys an erate signif y overflow nities mos y. future de lay would npact on h nents on	d more capacity icant CO ₂ redu n by the peak N t frequently ove mand in the m likely generate ealth and qualit departure would	ctions ar IORBO I erflown b ost effec future gr y of life s d result i	nd provide Routes. He by Glasgov ctive mani ound dela section ab in an incre	relief and r owever, tha w arrivals a ner as a si y. ove, it is cu ease in the	espite from noise it would come at th nd departures livin ngle initial NORB rrently unknown

¹³ 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-S

4.6. Runway 23 Westerly Departure Option E

Runway 23 Wes	terly Departures – Optic	on E
CLYDE ROBBO NORBO/TRN	DNFOYLE PERTH TLA NORBO	Straight ahead departures only (no offsets) with turns at c.1nm and c.9nm from the runway NORBO is traffic is shared between a route that turns left at c.1nm and one that doesn't turn until c.9nm from the runway. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures going straight ahead, however compared to today, some departures would turn at c.1nm, c.2nm and c.9nm rather than all turning at 5nm. Option Overflight Contours (Black With estimate) with estimate the straight of the year of the year of the year of the year of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures going straight ahead, however compared to today, some departures would turn at c.1nm, c.2nm and c.9nm rather than all turning at 5nm. Option Overflight control (the year) of the year of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
Communities	Noise impact on health and quality of life	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 and one that initially flies straight ahead and then turns at c.2nm. Unlike other options, these routes are not offset and so the straight-ahead sections overfly similar areas to today such as Johnstone and Elderslie, which are the same populations as under final approach. Around 32% of overall departure movements would fly the route that climbs straight ahead before turning at 9nm although this is a significantly lower % than experiences today. The NTK heatmap shown in figure 14 shows that this largely follows the areas where departures fly today. This includes overflight of Johnstone, Elderslie and Howwood, and at higher altitudes, Beith and the south of Kilbirnie. The other 26% of NORBO departures will fly the route that turns at c.2nm. Beyond the 2nm, the turn to the south introduces overflight over some new areas although figure 14 shows these are not densely populated. Aircraft would then route over areas that are currently overflown today including the populated areas of Lugton, Dunlop, western parts of Uplawmoor, and the northwestern parts of Stewarton at 7000ft. From the heatmap, this level of overflight would be a change from current day, where those areas are typically experiencing somewhere between around 1–10 flights per day, on average.

The LUSIV and TALLA SIDs, which account for 10% and <1% of traffic respectively, also turn earlier today

resulting in some new areas of overflight. Figure 14 shows that this largely avoids dense areas of population with the exception of western Neilston which will mainly be overflown by the TALLA departures.

The ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs fly straight ahead before turning right. This initial part of the right turn routes over parts of Johnston and Kilbarchan. Beyond this point, the ROBBO SID which is estimated to be operated by 3% of overall Glasgow departures, routes over areas overflown today, and avoids dense areas of populations. The CLYDE, LOMON and PERTH SIDS turn north and overfly parts of the Bridge of Weir and Quarriers village – these areas will see the cumulative impact of all three SIDs. Beyond this point, the CLYDE SID, which accounts for around 6% of overall Glasgow departures, routes over Kilmacolm before reaching the eastern parts of Port Glasgow. The LOMON SID overflies eastern areas of Kilmacolm, before reaching Langbank and the western parts of Dumbarton at higher altitudes. Finally, the PERTH SID largely avoids areas of dense population with the exception of the easter parts of Dumbarton which are overflown around 7000ft. The heatmap demonstrates that these SIDs route over areas already overflown today, however there is currently broad dispersion whereas PBN routes in future would be expected to concentrate traffic albeit at comparatively low percentages compared to other routes such as NORBO.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LOMON and PERTH SIDs may increase in size and overfly additional parts of Dumbarton and

may extend as far as Alexandria.

Overflight data

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option E. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

As shown in Table 32, against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, there is a significant increase in the area of the contours and the number of population overflow; this is due to the routes turning earlier than they do today alongside splitting the NORBO route into two. This does however mean that the noise from the busiest departure route is shared.

Table 32 Westerly departures option E overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	547.32	163216
RWY23 Baseline (Centreline)	141.18	29838
RWY23 Option E	248.01	69308

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools, care homes and places of worship overflown compared to the centreline baseline. Number of hospitals remains the same. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option E against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 33 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 33 60dB and 65dB LAMax Data – Rwy23 Dep Option E

	60dE	3 L _{Amax}	65dB L _{Amax}		
System	Area (km²)	Population	Area (km²)	Population	
RWY23 Baseline (Centreline – Optioneering tool)	285.37	99120	95.69	53704	
RWY 23 Dep Option E	458.27	139426	161.26	64472	

The westerly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on westerlies 82% of the year and therefore the westerly departures will have a large influence on the overall L_{Aeq} contours.

Most aircraft today fly straight ahead for 5nm before turning and the departures which turn before 5nm will influence the shape of the L_{Aeq} contour. It is expected that this change will result in the L_{Aeq} contours shortening compared to current day although 32% of NORBO traffic will continue straight ahead and so this reduction is expected to be less than some other options. This may benefit some parts of Howwodd. The NORBO, LUSIV and TALLA turns to the left, which overall account for around 37% of Glasgow departures are expected to result in the L_{Aeq} contour extending further to the south; the heatmap data suggests that this will occur over areas where there are not high levels of population density. The equivalent ROBBO/CLYDE/LOMON/FOYLE/PERTH SIDs operate a far lower percentage of flights and so are likely to have less influence on the overall shape of L_{Aeq} contours however the turns may result in some areas of Johnstone, which currently sit in the lower dB L_{Aeq} bands, to move into a higher dB contour.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option E will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Air Quality	This option has a change to how aircraft will fly laterally below 1000ft; the majority of departures will climb above 1000ft whilst flying straight ahead as today. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic (M8/A737) to local air quality.
	Noise Mitigation The option shares the noise from the existing most heavily used NORBO route into two routes. This offers some noise relief for those communities currently located under immediate climb out and final approach however this would not be predictable respite; having 2 NORBO SIDs reduces the frequency of overflight for communities situated under just one NORBO SID. This option helps to reduce the numbers of newly overflown by having approximately half of the NORBO departures flying straight ahead, as today.
	Greenhouse gas

		relies on achievin			en particularl between the	y in future s	cenarios			emissions and ls. This option
	Capacity / resilience	In addition to this performance throu of this, future inve the correct order l	ughout the construction	day and ro y be requ	educe ground uired in additio	delays and onal taxiway	CO ₂ contr infrastru	tributions. In cture to enab	order to gain t ole aircraft to	he full benefits
		The introduction of aids, which provi programme unde Glasgow's SIDs v Glasgow operatio	des resilier r the Airsp vhen NERL	nce. This ace Moo decomm	equipment in dernisation provide the second se	is due to be rogramme. 'ORs. Introd	e decoming There is uction of	missioned as currently no	s part of a N o long term ¹⁴	ERL UK wide resilience for
		Table 34 shows of to follow Glasgow				eas, based o	on the NT	K vectoring I	baseline and	if aircraft were
		Table 34 RWY 23 V	Vesterly Dep	artures O _l	ption E – Tran					
		System		NSA are	a NSA co	unt Parks		National arks count	DQA area	DQA count
	Tranquillity	RWY 23 Base Vectoring (NTI		0.02	1	1.6	68	1	0	0
		RWY23 Baseline (Cent Optioneering		0	0	C)	0	0	0
		RWY 23 Opti	on E	0	0	C)	0	0	0
		The data shows to National parks co overflight contour	ompared to	the vect	toring baselir	ne. Technica	al Appen	dix A contair	ns a map wh	ich shows the
		Below 2000ft no o Scenic Areas, and the baseline Cast	d Sites of S	Special So	cientific Intere	ests is exped	cted for th			
	Biodiversity	Lower slower aircraft, climbing at below a 6% climb gradient and flying the ROBBO SID, may overfly Whinnerston and Barmufflock Dam SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SID, and the vast majority of aircraft will climb above 2000ft before overflying the site, it is expected that any impacts will be very minimal.								
		We will fully quantify the overflight of biodiverse sites using the full Glasgow fleet mix, as part of our Full Options Appraisal at Stage 3.								
		Option E is likely within existing CA							his option car	n be contained
General Aviation	Access We created an "illustrative CAS volume" which was a single volume of CAS require departure options combined to help stakeholder engagement on potential impact volume to understand if there is scope to reduce the total volume of CAS. The tot airspace volume compared to existing CAS in the same lateral area is c.100nm ³ so The Glasgow CTR was c.47nm ³ smaller.						ential impact AS. The tota	s. We have al volume of t	also used this ne "illustrative"	
	Economic impact from increased effective capacity	We expect the inc on commercial air								onomic impact
		We estimate that in track mileage. there are also sor	This is mai	nly drivei	n by the redu	ction in trac				
		Table 35 Track Len	gth Calculati	ions – Fue	el Burn Option	E				
		RWY 23		Baselir	ne (Centrelin %	e)				
			TDN	nm	Weighting	Score		1 Score		
			TRN NORBO	38.50 293.40	3.69 26.2	142.065 2447.08	37.8 92.5	139.482 2423.5		
General Aviation /			NORBO – SUBUK NORBO – LAKEY	02 40	32	2988.8	92.5 83	2656		
Commercial airlines	Fuel burn		LUSIV-	84.80	10.66	903.968	81.7	870.922		
	Fuerbum	DEPS	DCS TLA	54.70	0.41	22.427	49	20.09		
			PERTH	69.80	1.23	85.854	62.6	76.998		
			FOYLE	33.00	0.82	27.06	27.7	22.714		
			LOMON CLYDE	26.70 19.50	2.05 2.87	54.735 55.965	19.5 17.6	39.975 50.512		
			ROBBO		2.87	40.18	17.6	35.67		
		Total			_	6768.134		6335.863		
									-	

¹⁴ 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-S

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB L _{Aeq,16h} noise contour and therefore not affect Glasgow's noise insultation scheme costs.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ¹⁵ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	No safety issues have been identified.
AII	Interdependencies, conflicts, and trade- offs	There are few interdependencies, conflicts, or trade-offs with routes to/from other airports with this option. The left hand NORBO departure is separated from Prestwick's airspace and does not conflict with Edinburgh's traffic below 7000ft. In NERL's ScTMA ACP, they have options ion their proposed shortlist which would cater for a duel NORBO southbound track structure. As highlighted in Glasgow Prestwick Airport's feedback in Stage 2A, the final proposed CAS arrangements need to be cognisant of their airspace. In addition, the cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered. This option is dependent on changes to the network.
AII	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). This option could be expected to result in reductions in the volume of Glasgow's CAS

¹⁵ 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-S

4.7. Runway 05 Easterly Departures Baseline

Runway 05 East	erly Departures Basel	ine
		This option represents the do-nothing scenario for Glasgow Easterly SIDs. Today, all Glasgow SIDs climb straight ahead to 5nm before turning. This means that the minimum departure interval between successive departing aircraft is at least 2 minutes. The result is that during peak departure times, aircraft are held on the runway and at the runway holding points, leading to increased emissions and delay. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC, resulting in broad swathes. Some aircraft less than 5700kg MTWA do not have to 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. 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.
O 1000	lunnent	Change Portal.
Group	Impact	Qualitative Assessment Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. Aircraft above 5700kg departing from Glasgow climb straight ahead to 5nm before turning. Beyond 5nm, aircraft are typically vectored off the SID centrelines by ATC resulting in dispersion. These swathes can be seen in the vectoring heatmaps below which have been generated using NTK data:
		The second secon
	Noise impact on	20
Communities	health and quality of life	<i>Figure 15 Runway 05 Departure Vectoring Swathe 2019</i> The Technical Appendix to this document includes a larger version of this map along with overflight data. It's important to note that this data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options. Table 36 below includes data based on this NTK heat map and data output from the optioneering tool for if aircraft were to follow the centreline of the current published SID: <i>Table 36 Easterly departures baseline overflight data</i>
		System Area (km ²) Population

RWY 05 Baseline - Vectoring (NTK data)246.99364763RWY 05 Baseline (Centreline - Optioneering tool)186.52173213The data from these tables will be used to compare the westerly departure optionsagainst the 'do nothing' baseline.In addition to population overflown, we also have data on the overflight of noise such as schools, hospitals, and places of worship; the full data around these is shown in technical Appendix A, and as part of this loA we will provide a qualitative statement around this data.60dB and 65dB LAmax Technical Appendix A includes 60dB and 65dB LAmax contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB LAmax contours are an indicator of the N60/N65 metrics which will be grantified at the Stage 3 Full Options Appraisal.
The data from these tables will be used to compare the westerly departure options against the 'do nothing' baseline. In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals, and places of worship; the full data around these is shown in technical appendix A, and as part of this IOA we will provide a qualitative statement around this data. 60dB and 65dB L Amax Technical Appendix A includes 60dB and 65dB LAmax contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB LAmax contours are an indicator of the N60/N65 metrics which will be
In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals, and places of worship; the full data around these is shown in technical appendix A, and as part of this IOA we will provide a qualitative statement around this data. 60dB and 65dB L Amax Technical Appendix A includes 60dB and 65dB L _{Amax} contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB L _{Amax} contours are an indicator of the N60/N65 metrics which will be
 hospitals, and places of worship; the full data around these is shown in technical appendix A, and as part of this IOA we will provide a qualitative statement around this data. 60dB and 65dB L_{Amax} Technical Appendix A includes 60dB and 65dB L_{Amax} contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be
Technical Appendix A includes 60dB and 65dB L _{Amax} contours and data for the baseline, to aid comparison between the baseline and the options. 60dB and 65dB L _{Amax} contours are an indicator of the N60/N65 metrics which will be

			60dE	3 L _{Amax}	65dB	B L _{Amax}			
		System	Area (km²)	Population	Area (km²)	Population			
		RWY 05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793			
		The data from these tables will	be used to compare th	ne easterly departure o	ptions against the 'de	o nothing' baseline			
		L _{Aeq} The easterly departures make the overall contours from 2017 shape and size.							
		Noise Abatement Procedure: As this baseline reflects current		no changes to NAPs a	as a result of this opt	tion.			
		Noise Mitigation The existing SIDs configuration underneath final approach wit airport.							
		Impacts to air quality are consid to have a significant impact on			n). Aircraft flying abo	ove this are unlikely			
	Air Quality	Aircraft departing Glasgow ha aircraft reach 1000ft at differen during this they climb above 10 of flight paths which could occu	t locations. Today, virt 00ft. Our IOA will there	tually all Glasgow depa	rtures climb straight	ahead for 5nm and			
		Emissions of greenhouse gase is linked to track length, we h greenhouse gas assessment is	ave initially looked a s therefore linked to th	t the track length for the fuel burn assessment	the baseline wester	ly departures. The			
		Table 37 Easterly departure base							
		RWY 05	Baseline (C						
		TRN	nm 50.00	% Weighting 0.81	Sco 40.5				
		NORBO – SUE		5.75	644				
		NORBO – LAK		7.03	787				
		LUSIV-DCS	88.80	2.34	207				
	Greenhouse gas	ТГА	49.20	0.09	4.43				
	impact	DEPS PERTH	50.30	0.27	13.5				
		FOYLE	19.10	0.18	3.44				
		LOMON	20.00	0.45	9.00				
		CLYDE	25.00	0.63	15.7				
		ROBBO	33.50	0.45	15.0				
		Total			174	0.92			
		We will estimate the difference advantages/disadvantages of t shorter than a typical flight toda us to qualitatively describe anti in Technical Appendix A.	he option. This estim ay. As CO ₂ emissions cipated greenhouse g	ation will consider whe are linked to the differe as impacts as a result o	ther the aircraft trac ence in aviation fuel l of the option. Full dat	ks will be longer o burnt, this will allov ta tables are shown			
Wider Society		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 interval. This leads to holding on the ground which results in increased emissions and delays. Any future increases 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.							
	Capacity / resilience	In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. As traffic increases, flow restrictions are likely to be put in place in order for ATC and pilots to manage the additional complexity and workload. Flow regulations stabilise the number of movements until the peak in traffic subsides, however in doing so they generate ground delay for Glasgow.							
		It is therefore possible that, with future traffic levels, this baseline scenario would result in increases in departure delay at Glasgow airport. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme.							
		This baseline 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 ¹⁶ resilience for Glasgow's SIDs when NERL decommissions the VORs which will result in critical operational issues and significant loss of revenue.							
	Tranquillity	CAP1616 outlines the conside Areas of Outstanding Natural (NSA) and we've therefore in (DQA) as part of our Tranquill option differs from current day AONB.	Beauty (AONB). In S cluded overflight data ity assessment. At th	Scotland, the equivalen a around these, Nation is stage of the ACP w	nt of AONB are National Parks, and design re will qualitatively a	ional Scenic Areas gnated quiet areas assess whether the			
		Table 38 shows data on the of Glasgow's existing SID centrel departure baseline.							

¹⁶ 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-S

		System	NSA area	NSA cou		ional count	National Parks area	DQA count	DQA aı	rea
		RWY 05 Baseline – Vectoring (NTK data)	0	0		0	0	4	0.66	
		RWY 05 Baseline (Centreline - Optioneering tool)	- 0	0		0	0	2	0.38	
		"In general, airspace cha ground-based infrastruct Habitats legislation." The some evidence that distu are below around 500m where aircraft overfly Sp Areas, and Sites of Spec Table 39 shows data on Glasgow's existing SID of departure baseline.	 The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance states "In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not inv ground-based infrastructure. As such they are unlikely to have a direct impact that would engage the Bird Habitats legislation." Though there is limited research available on the effects of aircraft noise on wildlife, there some evidence that disturbance effects associated with aircraft can occur during take-off and landing where airc are below around 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodive where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Sc Areas, and Sites of Special Scientific Interest, particularly at altitudes below 2000ft. Table 39 shows data on the overflight of these areas, based on the NTK heatmap and if aircraft were to fo Glasgow's existing SID centrelines. The data from this table will be used to compare options against the easi departure baseline. 						nvolve irds o here is aircraf versity Scenio	
		Table 39 Biodiversity – area						National Nation	al	
	Biodiversity	System	AC SAC ea count	SSSI count	SSSI area	SPA count	SPA area	Park park count area		NS are
		RWY 05 Baseline – Vectoring (NTK data)	0 0	24	10.46	11	6.37	0 0	0	0
		RWY 05 Baseline	0 0	10	3.31	0	0	0 0	0	0
		Below 2000ft there is no overflight of Special Protection Areas, Special Areas of Conservation, Na National Scenic Areas, and Sites of Special Scientific Interest for the vast majority of aircraft. Low aircraft, climbing at below a 6% climb gradient, may overfly the Manse Burn and Mugdock Wood St this is likely to be infrequently, as lower and slower aircraft will typically not be required to follow the therefore be tactically turned left before reaching the sites.							wer and s SSSIs ho	slowe weve
General Aviation	Access	This baseline scenario w place today. The options			ed agains				arrangeme	ints ir
		Figure 16 Glasgow Airport C Within c.35nm of Glasgo Airspace (CAS) volumes which generates the volu limits with the volume cl outline. Also, in this figure	ow airports are . In addition to th mes shown in F osest to the air	Edinburgh a his, the Scott Figure 16. Th port going d	nd Glasgo tish TMA a le controllo own to gr	ow Prest airspace ed airspa ound lev	wick Airport sits above an ace at Glasgo vel. This is th	nd around the a ow has varying ne Glasgow C1	irports' air lower and ʿR shown	spac uppe in re

			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 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 simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to achieve.
		Economic impact from increased effective capacity	There will be no increase to capacity from today as a result of this option; later in this IOA we will qualitatively estimate the differences between this baseline and the airspace change options.
General Aviation Commercial	1		As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline easterly departures.
airlines		Fuel burn	When departing from Glasgow, the majority of aircraft fly straight ahead until 5nm and then are vectored by air traffic control, this means that track length is varied from flight to flight. For the purposes of comparing our easterly SID options against the baseline scenario, we have taken the track length of the SID centerlines as an initial indication of 'do nothing' track length. We have then applied a weighting based on SID usage to provide an overall

		total track mil in further deta	o ,	he Stage 3 Full (Options Appraisal, track len	gth and fuel burn will be modelled		
		Table 40 Easte	erly SID Track Mileage					
				Baseline (Centreline)				
		RWY 05		nm	% Weighting	Score		
			TRN	50.00	0.81	40.50		
			NORBO – SUBUK	112.00	5.75	644.00		
			NORBO – LAKEY	112.00	7.03	787.36		
			LUSIV-DCS	88.80	2.34	207.79		
			TLA	49.20	0.09	4.43		
		DEPS	PERTH	50.30	0.03	13.58		
			FOYLE	19.10	0.18	3.44		
			LOMON CLYDE	20.00	0.45	9.00		
				25.00	0.63	15.75		
			ROBBO	33.50	0.45	15.08		
					Total 18%	1740.92		
		anticipated a	dvantages/disadvantage	s of the option a	gainst current day. This es	on, to understand if there are any timation will consider whether the der the opportunity for continuous		
Commercial	Training costs		is already in operation, stimate the difference be			ere will be no change; later in this		
airlines	Other costs	Other costs As this option is already in operation, there are no other costs anticipated as there will be no chang IOA we will estimate the difference between our options and this baseline.						
	Infrastructure costs				astructure costs anticipated r options and this baseline.	d as there will be no change; later		
Airport / Air navigation service provider	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline. 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. Failure to mitigate the impacts of VOR rationalisation in the long term will result in critical operational issues and significant loss of revenue, as well as not meeting the requirements of the AMS.						
	Deployment costs	As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.						
All	Safety	At current traffic levels, there are no safety concerns 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, on increased aircraft holding on the ground, in order to maintain safety.						
All	Interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's G departures. Laterally deconflicting these would be optimal.							
	offs		ScTMA route structure s l less efficient profiles in			nd Glasgow results in higher ATC		
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and an by UK airspace.						
		Doing nothing with Easterly departures will not align with the AMS. It will not enable any environmental benefits or maximise benefits from NERL's re-design of the ScTMA. No change and therefore no ACP submission will not enable any reduction in the volume of controlled airspace.						

4.8. Runway 05 Easterly Departure Option A

Runway 05 Ea	sterly Departures – (Option A	
ROBOVCI	YDE FOYLELOMON PERTH	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 3nm from the runway. NORBO is offset left with turn at 1nm For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	
Group	Impact	Qualitative Assessment	
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise da qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see some departures offset to the left with turns at c.1nm and c.6nm, and some departures straight ahead before turning at c.3nm. This would mean that all easterly departures would no longer overfly the areas as westerly approaches, providing some noise sharing for communities under the final approach. It however mean that areas that are not currently overflown frequently by departures will now be overflown on a	s flying e same would
		frequent basis. Option Overfice of the stimate overall department overall departme	ilight ack outline) ed % of
		Figure 17 Easterly Option A Overflight and 2019 baseline NTK data	
Communitie s	Noise impact on health and quality of life	The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. option, the NORBO route offsets left and turns at c.1nm, which means that some noise is relocated from comm under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milr It would however mean that areas that are not currently overflown frequently by departures will now be overflow more frequent basis; the heatmap in figure 17 shows that the offset left overflies the populated areas of Drum Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoid overflight of populated areas with the exception of Milton and western parts of Bowling. This option does not i any noise sharing/mitigation therefore these communities will be overflown on a more frequent basis than today. The ROBBO/CLYDE/LOMON/FOYLE/PERTH departures also offset to the left however these departures to c.6nm. This again shares noise from communities under the westerly final approach such as Old Drum or Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other pop areas. The route initially flies over Dumry and the western parts of Drumchapel before also routing over the w parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblan equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 7000ft. Figure 17 that the latter parts of these routes fly over areas not currently overflown today however these largely avoid	unities ngavie. yn on a nry and ids the involve y. turn at chapel, pulated yestern ie. The shows

areas of population.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for c.3nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at c.3nm rather than 5nm. This results in overflight of some areas that are already overflown today however this would be at a higher frequency in future. Review of the population data shows that this route would overfly large areas of the city of Glasgow where there is a high density of population. Although this is not dissimilar to what happens today (the heatmap shows a large swathe across parts of the city), in future concentration of overflight would be expected to occur. The latter parts of the routes will overfly dense areas of population not typically overflown by easterly departures today.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE contour may also extend further over Killearn.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option A. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 41 gives an overview of the Option A overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing

SID centreline data, the area of the contours remains similar however there is a significant increase in the number of population and noise sensitive sites overflown which can be attributed to the offset routes, early turns than today, and the overflight of Glasgow city centre by the LUSIV/TALLA SID. At present, the baseline and option overflight contours do not take into account frequency of overflight which will be important when considering total population overflown; this will be further explored at Stage 3 should this option progress.

Table 41 Easterly departures option A overflight data

System	Area (km²)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option A	184.58	254041

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of hospitals, care homes and places of worship overflown compared to the centreline baseline. The number of schools overflown reduces. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

In our Stage 2A engagement, the Mains Estate Residents' Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward, we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option A against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 42 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. This is due to the earlier divergence of SIDs compared to the baseline however the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today.

Table 42 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option A

	60dE	3 L _{Amax}	65dB L _{Amax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option A	363.53	458336	129.97	179689		

L_{Aeq}

The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces offset departures and turns at 3nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full L_{Aeq} contours will be quantified as part of our Stage 3 Full Options Appraisal, if this option is taken forward.

Noise Abatement Procedures

			A change to the existing NAPs would be required to accommodate the offset departures and turns.
			Noise Mitigation The option does not offer an alternative, predictable respite configuration however it does aim to share the noise by relocating the majority of easterly departures to an offset track, rather than climbing straight ahead over the same areas as final approach, as they do today. This option would put all NORBO departures over newly overflown communities as well as the right turn LUSIV/TLA. The L _{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.
	Air Quality		This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse impact	gas	Our fuel burn assessment (see below) has anticipated that Option A will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.

		some aircr minute sep	aft will be a arations).	able to This is	splitting before depart in in expected to will be seen	tervals 1 n	ninutes ap ound hold	bart (subje ling which	ct to safety in turn will	/ case and reduce gr	d NERL ound-ba	ability to a	accept 1-
	Capacity / resilience ¹⁷	However, l departure		this op	tion has all	NORBO de	epartures	on one ini	tial route v	vhich wou	ld not ca	ater for fut	ure peak
		which prov the Airspa	ides resilie ce Moderni sions the V	ence. T isation ORs. I	Ds also rem his equipme programme ntroduction (e.	nt is due to . There is (be decor	nmissione no long ter	d as part o m ¹⁸ resilie	f a NERL	UK wide asgow's	programi SIDs wh	me under en NERL
					overflight o SID centrel		ranquillity	based on	the NTK v	ectoring b	aseline	and if airc	raft were
		Table 43 Ea	asterly depa	rture –	Tranquil area	s overflown							
			system		NSA area	NSA co		ational ks count	Nationa Parks are		count	DQA ar	ea
		Vectorin	5 Baseline ng (NTK da		0	0		0	0		4	0.66	
	Tranquillity	Baseline	WY 05 (Centrelineering too		0	0		0	0		2	0.38	
			05 Option		0	0		0	0		3	0.94	
		At this stag the full ber Appendix A with tranqu Table 44 s to follow G	ge, the frec hefits and ir A contains a uil sites also hows data lasgow's e	quency mpacts a map o show on the xisting	overflight o SID centrel	t has not b n; we will e s the overfl f biodiverse	een articu explore thi ight conto	Ilated in th s further a our of this o	e data and t Stage 3 s ption along	this will I hould this gside the t	pe impor option p paseline	tant to un progress. ⁻ centreline	derstand Fechnical contour,
		Table 44 Bi	odiversity –							National	Nationa	1	
		Syst	em	SAC area	SAC count	SSSI count	SSSI area	SPA count	SPA area	Park	park area	NSA count	NSA area
		RWY 05 E – Vectori dat RWY	ng (NTK a)	0	0	24	10.46	11	6.37	0	0	0	0
	Biodiversity	Base (Centre Option too	line eline – eering	0	0	10	3.31	0	0	0	0	0	0
		RWY 05 (Option A	0	0	16	5.84	4	3.25	0	0	0	0
					f Special Pro Scientific In						onal Parl	ks, Nation	al Scenic
		the Marise and the va be very mi	Burn and st majority nimal.	Mugdo of airc	ng at below ck Wood SS raft will clim verflight of t	SSIs below b above 20	2000ft. G 000ft befo	iven the lo re overflyi	w overall 9 ng the sites	% of aircra s, it is exp	aft expec ected th	ted to fly t at any im	the SIDs, pacts will
			s likely to c		ite to a redu					e this opti	on can b	e contain	ed within
General Aviation	Access	We create departure understand	d an "illus options cor d if there is to existing	trative mbined	Opportunity CAS volum to help stal to reduce to the same	e" which v keholder er he total vol	vas a sin ngagemer lume of C	gle volum nt on poter AS. The to	e of CAS itial impact	ts. We have a of the "il	ve also u lustrative	ised this v e" airspac	volume to e volume
	Economic impact from increased effective capacity	commercia	al air traffic	compa	ective capa ared with the uld not deliv	e baseline	do nothin	g westerly	departure				
General Aviation / Commercial		track milea LUSIV, TL	age. This o A and FOY hen consid	ption s /LE rou dered a	when comp shows small utes. There against the c	reductions are also sn	in track nall increa	mileage fo ases to the	r the TRN PERTH, L	, NORBO OMON, (SUNUK LYDE a	i, NORBC	LAKEY,
airlines	Fuel burn	Table 45 Tr	ack Length	Calcula	tions – Fuel E	Burn RWY 0	5 Easterly	Departure (Option A				
		RWY 05		Ba nm	seline (Cen	treline) Weighting		ore	A	Scol	·o		
		DEPS	ΓRN	50.		81	40.		nm 49.20	39.8			
			NORBO	-11	2.00 5.	75	644	4.00	103.60	595.	70		

¹⁷ Summary colour corrected
 ¹⁸ 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-S
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		SUBUK									
		NORBO	112.00	7.03	787.36	103.60	728.31				
		LAKEY									
		LUSIV-DCS	88.80	2.34	207.79	87.25	204.17				
		TLA	49.20	0.09	4.43	47.25	4.25				
		PERTH	50.30	0.27	13.58	50.50	13.64				
		FOYLE	19.10	0.18	3.44	18.50	3.33				
		LOMON	20.00	0.45	9.00	20.30	9.14				
		CLYDE	25.00	0.63	15.75	28.80	18.14				
		ROBBO	33.50	0.45	15.08	34.60	15.57				
		Total			1740.92		1632.09				
		Given the improvemen (subject to the NATS improvement in fuel bur	NERL ACP f	for the airspac	aspiration for all e above 7000ft),	it is anticipat	mb continuously to ted that this optio	n would see a			
Commercial airlines	Training costs	Flight procedures are up their procedures accord any additional training o	lingly and un	dertake training							
	Other costs	No other airline costs a	e foreseen.								
		Glasgow currently operation	ates a home	wner relocation	n scheme for resid	lential proper	ies within the 69d	B LAeg 16h CONTO			
Airport / Air navigation service	Infrastructure costs	area and noise insulati contour area and reside policy now requires fina LAeq,16h noise contour or 2022, which will cover t will determine if there a result of the track adju submission, there will b	ential propert ncial assistar above. Ther he varied pro are any increa ustments on e an increase	ies within the 6 nce to be offere efore, Glasgow operty types situ ases in househ departure. If i ed cost for Glas	66dB L _{Aeq,16h} conto ed towards the nois 7 Airport are curren uated within the 65 nolds within the 65 t does and track sgow with regards	bur area. The se insulation of htly developin 3dB contour a 3dB L _{Aeq,16h} ar adjustments funding their	UK Government's of residential prope g a new Noise Ins irea. The L _{Aeq} mod rea as a result of t are proposed in Noise Insultation S	current aviati rties in the 63 ulation Policy f elling in Stage his options as Glasgow's A0			
provider	Operational costs	This airspace change p PBN SIDs removes G	The initial deployment phase of the ACP may require some ATC system engineering amendments. This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ¹⁹ ;								
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.									
		This option requires a T CAA IFP department wa the aircraft doesn't turn required during IFP gro the DER.	anted a 'not b before the e	elow 500ft' flyo nd of the runw	ver WP positioned ay. PANS OPS do	at the Declar besn't require	ed End of Runway this. Additional as	(DER) to ensu surances will b			
All	Safety	More detailed IFP inves the early left turn depa perhaps of the Twin Ot would not usually be ex	rtures which ter aircraft fo pected to ope	is considered or which alterna erate on the NC	achievable for the ative tactical arrar DRBO SIDs.	e majority of gements may	Glasgow traffic wi / be required how	th the exception ever that aircra			
		There is a lack of global left turn NORBO agains between the interaction potentially more CAS.	st the later tu	rn RÓBBO/CL	YDE departure. T	he illustration	s created so far ha	ave at least 6n			
		There are no interdepe below 7000ft however E departures. Having an ROBBO/CLYDE traffic	asterly depar earlier turn	rtures are some to the West c	etimes required to on NORBO depar	be 'stepped up tures reduce	o' underneath Edin s this interaction.	burgh's GOSA			
	Interdependencies , conflicts, and	This option is expected ScTMA route design b	ut would not	make the mos	at of their propose	d dual south	bound track struct	ure in the upp			
All	trade-offs	network. In their Stage option is progressed, w						ine luiule. Il il			
AII	trade-offs		e will explore n other airspa	the possibility ace users as a	to remove one of	these SIDs in	Stage 3.				
AII	trade-offs	option is progressed, w The cumulative effect o	e will explore n other airspa l and conside	the possibility ace users as a pred.	to remove one of	these SIDs in	Stage 3.				

		UK airspace.
All	AMS	This option would support the modernisation of the airspace. The option would be expected to generate significant CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities.
		This option could be expected to result in reductions in the volume of Glasgow's CAS.

¹⁹ 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-S

4.9. Runway 05 Easterly Departure Option B

Runway 05 Ea	sterly Departures	s – Option B	
ROBOCI	LYDE FOYLEA.OMON PE	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 4nm from the runway. NORBO is offset left with turn at 1nm For more information, please see our Stage 2A document on the CAA's Airspace Change P	ortal.
Group	Impact	Qualitative Assessment	
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. T qualitative assessment has considered this modal split with daily movements averaged across the year	
		This option would see some departures offset to the left with turns at c.1nm and c.6nm, and some depa ahead before turning at c.4nm. This would mean that easterly departures would not overfly the same approaches, providing some noise sharing for communities under the final approach. It would however that are not currently overflown frequently by departures will now be overflown on a more frequent based of the same state of	rtures flying straight e areas as westerly ver mean that areas
			2019 baseline average summer day overflight swathe:
		Figure 18 Easterly Option B Overflight and 2019 baseline NTK data	
Communiti	Noise impact on health and quality of life	The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow at the NORBO route offsets left and turns at c.1nm, which means that some noise is relocated from convesterly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of however mean that areas that are not currently overflown frequently by departures will now be over frequent basis; the heatmap in Figure 18 shows that the offset left overflies the populated areas of I Beyond this point the route, which would account for around 13% of overall departures, largely avo populated areas with the exception of Milton and western parts of Bowling. This option does not sharing/mitigation therefore these communities will be overflown on a more frequent basis than today.	nmunities under the Milngavie. It would verflown on a more Drumry and Faifley. ids the overflight of t involve any noise
		The ROBBO/CLYDE/LOMON/FOYLE/PERTH departures also offset to the left however these depart This again shares noise from communities under the westerly final approach such as Old Drum Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other por route initially flies over Drumry and the western parts of Drumchapel before also routing over the wester and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblar CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 7000ft. Figure 18 s parts of these routes fly over areas not currently overflown today however these largely avoid dense a Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly	chapel, Bearsden, opulated areas. The rn parts of Baljaffray ne. The equivalent hows that the latter areas of population.

Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for c.4nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning at c.4nm rather than 5nm. When reviewed against the heatmap shown in Figure 16, compared to Option A, this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at c.4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route would overfly areas of the city of Glasgow however by turning at 4nm there is more opportunity to avoid the most dense areas of population as aircraft are slightly further north. The route also heads towards the south-east rather than turning south as it does today; this too helps to avoid some of the most dense areas of population however it should be noted that the LUSIV route will overfly the Dennistoun and Craigend areas more frequently than today.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE contour may also extend further over Killearn.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and Option B. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 46 gives an overview of Option B overflight data. Against the NTK baseline vectoring data, there is a decrease in

population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces and there is also a decrease in the number of population overflown compared to the centreline data. This can be attributed to the LUSIV/TALLA SID turning at 4nm and aiming to avoid areas of dense population.

Table 46 Easterly departures option B overflight data

System	Area (km²)	Population		
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763		
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213		
RWY 05 Option B	174.94	169398		

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of schools overflown compared to the centreline baseline. The number of hospitals remains the same and the cares homes and places of worship reduces. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 Full Options Appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

In our Stage 2A engagement, the Mains Estate Residents' Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are any adverse effects as a result of aircraft overflight.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option B against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 47 shows an decrease in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 47 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option B

	60dE	3 L _{Amax}	65dB L _{Amax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option B	349.85	369502	125.22	141512		

LAeq

The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces offset departures and turns at 4nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

		Noise Mitigation The option does not offer an alternative, predictable respite configuration however it does aim to share the noise by relocating the majority of easterly departures to an offset track, rather than climbing straight ahead over the same areas as final approach as they do today. This option would put all NORBO departures over newly overflown communities. The L _{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.
	Air Quality	This option has a change to how aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option B will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
	Capacity /	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute

resilience ²⁰	The benefits of this	will be see	n particula	arly in future	scenario	s with inc	reased traff	fic levels.				-
	The introduction of provides resilience Airspace Modernis decommissions the	PBN SIDs a . This equi ation prog VORs. Int	pment is r ramme. T	due to be d here is cur	ecommis rently no	sioned as o long ter	s part of a m ²¹ resilie	NERL U	K wide p Glasgow	orogramm 's SIDs	ie unde when N	r the
	Table 48 shows da	ita on the o			anquillity	based on	the NTK v	ectoring I	baseline	and if air	craft we	re to
	Table 48 Easterly de	parture – Tra	inquil areas	s overflown								
	System	N	SA area	NSA cou			National Parks area	DQA	count	DQA are	ea	
			0	0		0	0		4	0.66		
Tranquillity	RWY 05 Baseline (Centre	eline –	0	0		0	0	:	2	0.38		
	Runway 05 Opt	ion B	0	0		0	0	:	3	1.01		
	the number of DQ/ this stage, the freq benefits and impac	As overflow uency of ov ts of this op	n compare erflight hat ition; we w	ed to the ve as not been a vill explore th	ctoring ba articulated is further	aseline ho d in the da r at Stage	owever ther ata and this 3 should th	re is an ir s will be ir his option	ncrease i mportant progress	n the ove to unders s. Technie	erall areastand the cal Appe	a. At e ful endix
					areas up	to 7000ft	based on t	he NTK ł	neatmap	and if air	craft we	re to
	Table 49 Biodiversity							National	National			
	System	area	SAC count	SSSI count	SSSI area	SPA count	SPA area	Park count	park area	NSA count	NSA area	
Biodiversity	 Vectoring (NTK data) 		0	24	10.46	11	6.37	0	0	0	0	
	Baseline (Centreline – Optioneering	0	0	10	3.31	0	0	0	0	0	0	
		0	0	16	5.93	4	3.25	0	0	0	0	
									ational P	arks, Nat	ional So	cenio
	Lower slower aircraft, climbing at below a 6% climb gradient on the CLYDE/LOMON/FOYLE/PERTH SIDs, may overfly the Marise Burn and Mugdock Wood SSSIs below 2000ft. Given the low overall % of aircraft expected to fly the SIDs, and the vast majority of aircraft will climb above 2000ft before overflying the sites, it is expected that any impacts will be very minimal.											
	We will full quantify at Stage 3.	the overflig	ght of biod	liverse sites	using the	e full Glas	gow fleet m	iix, as pai	rt of our f	Full Optio	ns Appr	aisa
								se this o	ption car	n be con	ained w	vithir
Access	options combined t there is scope to re-	o help stak duce the tot	eholder er al volume	ngagement of CAS. The	on potent total volu	tial impact ume of the	s. We have "illustrative	e also use e" airspac	ed this vo e volume	lume to u compare	indersta ed to exi	and i
Economic impact from increased effective capacity	commercial air tra	ffic compar	ed with th	ne baseline	do nothi	ng wester	rly departu					
	mileage. This optic FOYLE routes. The	on shows sr ere are also	nall reduc	tions in trac eases to the	k mileage LUSIV, F	e for the T PERTH, Lo	FRN, NORE OMON, CL	30 SUNL YDE and	JK, NOR ROBBO	BO LAKE routes ho	EY, TLA wever v	anc wher
Fuel burn	Table 50 Track Leng				Easterly D	Departure C				_		
	RWY 05				0	*0	B nm	Scor	·•			
		nm	/0	Weighting	Sco	re		000	e			
	TRN DEPS NORBO	50.00 - 112.0	0.8	81	40.5 644.	50	49.20 103.60	39.85 595.7	5			
	Image: series of the series	The benefits of this However, like toda departure demand. The introduction of provides resilience Airspace Modernis decommissions the VOR withdrawal price Table 48 shows date follow Glasgow's er Table 49 BiodiversityBiodiversityRWY 05 Baseline (Centreline - Optioneering tr data) RWY 05 Option B Baseline (Centreline - Optioneering tr data) RWY 05 Opti	The benefits of this will be see However, like today, this optic departure demand. The introduction of PBN SIDs. provides resilience. This equid Airspace Modernisation prog decommissions the VORs. Int VOR withdrawal programme. Table 48 shows data on the of follow Glasgow's existing SID Table 48 shows data on the of follow Glasgow's existing SID Table 48 Easterly departure – Trais as the number of DQAs overflow this stage, the frequency of or benefits and impacts of this optic and impacts of this stage, the frequency of or benefits and impacts of this stage. Table 49 shows data on the or follow Glasgow's existing SID RWY 05 Baseline (Centreline – Optioneering tool) Rumway 05 Option B Table 49 shows data on the or follow Glasgow's existing SID Table 49 shows data on the or follow Glasgow's existing SID Table 49 shows data on the or follow Glasgow's existing SID Table 49 shows data on the or follow Glasgow's existing SID Table 49 shows data on the or follow Glasgow's existing SID Table 49 shows data on the or follow Glasgow's existing SID Biodiversity Table 49 shows data on the or follow Glasgow's existing SID We yo S Baseline (Centreline – 0 Optioneering 0 WWY 05 Baseline (Centreline – 0 Optioneering 0 Optioneering 0 RWY 05 Option B 0	The benefitie of this will be seen particul However, like today, this option has all departure demand. The introduction of PBN SIDs also remo provides resilience. This equipment is Airspace Modernisation programme. T decommissions the VORs. Introduction VOR withdrawal programme. Table 48 shows data on the overflight of follow Clasgow's existing SID centreline Table 48 Easterly departure - Tranquil area: WY 05 Baseline - 0 RWY 05 Baseline - 0 Baseline (Centreline - 0) Optioneering tool) Runway 05 Option B The data shows that there is no change the number of DQAs overflown comparting stage, the frequency of overflight to benefits and impacts of this option; we vA contains a map which shows the oversites also shown. Table 49 shows data on the overflight of follow Glasgow's existing SID centreline Table 49 shows data on the overflight of follow Glasgow's existing SID centreline - Vectoring (NTK 0 0 Biodiversity System SAC SAC RWY 05 Baseline - Vectoring (NTK 0 0 0 0 0 RWY 05 Option B 0 0 0 Biodiversity System SAC SAC RWY 05 Baseline - Vectoring (NTK 0 0 0 0 0 RWY 05 Option B 0 0 0 0 RWY 05 Option B 0 0	Trie benefits of this will be seen particularly in future However, like today, this option has all NORBO de departure demand. The introduction of PBN SIDs also removes Glasgow provides resilience. This equipment is due to be de dispace Modernisation programme. There is our decommissions the VORs. Introduction of PBN SIDs VOR withdrawal programme. Table 48 shows data on the overflight of areas of the follow Glasgow's existing SID centrelines: Table 48 Easterly departure - Tranquil areas overflown System NSA area NWY 05 Baseline (Centreline - 0 0 RWY 05 Baseline (Centreline - 0 0 RWY 05 Baseline (Centreline - 0 0 RWY 05 Baseline (Centreline - 0 0 The data shows that there is no change in National the number of DQAs overflown compared to the verthis stage, the frequency of overflight has not been a benefits and impacts of this option; we will explore the A contains a map which shows the overflight contour sites also shown. Table 49 Biodiversity – areas overflown Biodiversity Table 49 Biodiversity – areas overflown Biodiversity System SAC Souther explored and the number of DQAs overflown compared to be verflight of biodiverse inflow Glasgow's existing SID centrelines. Biodiversity System SAC	The benefits of this will be seen particularly in future scenario. However, like today, his option has all NORBO departures departure demand. The introduction of PBN SIDs also removes Glasgow's depar- provides resilience. This equipment is due to be decommis Airspace Modernisation programme. There is currently m decommissions the VORs. Introduction of PBN SIDs is absorved VOR withdrawal programme. There is currently m decommissions the VORs. Introduction of PBN SIDs is absorved VOR withdrawal programme. Table 48 shows data on the overflight of areas of tranquillity follow Clasgow's existing SID centrelines: Table 48 casterly departure - Tranquil areas overflown accommissions the VORs of a scenario of a scenario of the number of DOAs overflown compared to the vectoring to put the number of DOAs overflown compared to the vectoring to this stage, the frequency of overflight has not been articulate benefits and impacts of this option, we will explore this further A contains a map which shows the overflight of biodiverse areas up follow Clasgow's existing SID centrelines. Table 49 shows data on the overflight of biodiverse areas up follow Clasgow's existing SID centrelines. Table 49 shows data on the overflight of biodiverse areas up follow Clasgow's existing SID centrelines. Table 49 shows data on the overflight of biodiverse areas up follow Clasgow's existing SID centrelines. Table 49 shows data on the overflight of the count of the wast majority of aircraft, climbing at below a 6% climb gradien - Vectoring (NTK data) Below 2000ft no overflight of Special Protection Areas, Spe Areas, and Sites of Special Scientific Interests is expected for Lower slower aircraft, climbing at below a 6% climb gradien the Waris op to increase of	Tranquilliy The benefits of this will be seen particularly in future scenarios with indeparture demand. The introduction of PBN SIDs also removes Glasgow's dependency on provides resilience. This equipment is due to be decomissioned at Airspace. Modernisation programme. There is currently no long ted decomissions the VCRs. Introduction of PBN SIDs is absolutely easy VCR withdrawal programme. Table 48 shows data on the overflight of areas overflowr Table 48 shows data on the overflight of areas overflowr Table 48 classifier overflight of areas overflowr Tranquilliy System NA area NA count Parits count WW 05 Baseline - 0 0 0 0 RWW 05 Baseline - 0 0 0 0 RWW 05 Baseline - Vectoring (NTK data) 0 0 0 RWW 05 Baseline - 0 0 0 0 0 RWW 05 Baseline - Vectoring (NTK data) 0 0 0 0 RWW 05 Baseline - Vectoring (NTK data) 0 0 0 0 RWW 05 Baseline - Vectoring (NTK data) 0 0 0 0 RWW 05 Baseline - Vectoring (NTK data) 0 0 0 0 Table 49 shows data on the overflight of biodiverse areas up to 7000th follow Clasgow's existing SID centrelines. 734 104 RWW 05 Baseline - Vectoring (NTK do 0 0 10 3.31 0 Biodiversity - System	The benefits of this will be seen particularly in future scianaics with increased trait However, like today, this option has all NORBO departures on one initial route departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on convention provides residence. This equipment is due to the decommission be VORS. Introduction of PBN SIDs is absolute sesnetial for the decommission be VORS. Introduction of PBN SIDs is absolute sesnetial for the VOR withdraval programme. There is currently no long term? Teslie decommission be VORS. Introduction of PBN SIDs is absolute sesnetial for the VOR withdraval programme. Tranquility Table 48 baseting SID certrelines: Table value service of the option set overflight of areas oreflown Tranquility System NSA area NSA count Parks count Parks count Parks count Tranquility System NSA area NSA count Parks count Par	The benefits of this will be seen particularly in future scenarios with increased ratific levels. However, like today, this option has all NORBO departures on one initial route which will be departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional group breaks and detarisation programme. The base is be demand in the SID of the Convent in the state of the SID of th	The benefits of the will be seen particularly in future scanarios with increased traffic levels. However, its doal, which agoin has all NOBED departures on one initial route which would not departure domand. The introduction of PBN SIDs also renoves Glaspavi's dependency on conventional ground-based in provides realines. This enumement is due to be decommissioned as part of a NER. UK wold of Japace. Model approximes. There is convent in one particularly increased transpatility based on the NTK vectoring baseline follow Glaspow series SID. Center Heles: Transpatibility of the series of transpatibility of a series of transpatibility of the Glaspow oper VOR withforward programme. The series of transpatibility of the Glaspow oper VOR withforward programme. Transpatibility of the series of transpatibility of the Glaspow oper VOR withforward programme. The series of transpatibility of the Glaspow oper VOR withforward programme. Transpatibility of the series of transpatibility of the Series of transpatibility of the Series of the Series of transpatibility of the Series of the VOR withform operation of the Series of the S	The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not catter for departure demand. The introduction of PEN SIDs also removes Glasgow's depandency on conventional ground-based navigation provides realismon. The is aujurneth to be decommissioned as part of a NERL LK wide programm Arapace Modentization programme. There is a curringly no long glasmin" realismon at for Glasgow's BiOs. Table 48 aboves data on the overflight of areas of tranquility based on the NTK vectoring baseline and if air follow Glasgow's setting SIO content lenses. Table 48 aboves data on the overflight of areas of tranquility baseline and if air follow Glasgow's setting SIO content lenses. Tranuellity of the will be setting SIO content lenses. Table 48 aboves data on the overflight of areas of tranquility basel on the NTK vectoring Moden Modentization of 0 o 0 o 0 o 0 o 0 o 0 o 0 o 0 o 0 o	The benefits of this will be seen particularly in future scripticatios with increased traditicities. However, like today, thise option has all NORBO departures on one initial out which would not caller for huber departure domaid. The infordiation of PDN SIDs also removes Glaspow's dependency on conventional ground-based manipation also. <i>y</i> provides realiance. This equipment is due to be decommissioned as purt of a NEEA LW wide programme under Advance Mediation programme. There is currently to long term? Teachene for Glaspow's SiDs when how of the VORE. Infracture on PDN SIDs is absorbing vesserial for the Glaspow operation following NE WOR Mediation of EDN SIDs and accurre to the NTK vectoring based for the ODA with a due to the OVER him development of the VORE. Infracture on the instruction of the NTK vectoring to the VORE. Infracture on the instrument of the Component of the Componen

 ²⁰ Summary colour corrected
 ²¹ 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-S
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		1.4	AKEY									
			JSIV-DCS	88.80	2.34	207.79	89.10	208.49				
			_A	49.20	0.09	4.43	48.20	4.34				
			ERTH	50.30	0.27	13.58	50.50	13.64				
			OYLE OMON	19.10 20.00	0.18 0.45	3.44 9.00	18.50 20.30	3.33 9.14				
				20.00	0.45	15.75	20.30	18.14				
			OBBO	33.50	0.03	15.08	34.60	15.57				
		Total				1740.92		1636.51				
		to the NATS	NERL ACP	for the airs	space above 70		d that this o	ption would see ar	e least 6000ft (subject n improvement in fuel			
Commercia I airlines	Training costs		ures accord	ingly and u	ndertake traini				cycle, airlines update ipated to require any			
	Other costs	No other air	line costs ar	e foreseen.								
Airport / Air navigation serviceAirport / Air navigationGlasgow currently operates a homeowner relocation scheme for residential properties within the 6dB LAeq.16h contour area. The UK Government's current a financial assistance to be offered towards the noise insulation of residential properties in the 6 or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for varied property types situated within the 63dB contour area. The LAeq modelling in Stage 3 will increases in households within the 63dB LAeq.16h area as a result of this options as a result of departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there we Glasgow with regards funding their Noise Insulation Scheme.							ls, within the 63dB nt's current aviatio erties in the 63dB ion Policy for 2022 Stage 3 will deter as a result of the ssion, there will be	^B L _{Aeq,16h} contour area n policy now requires L _{Aeq,16h} noise contour 2, which will cover the mine if there are any track adjustments on				
provider	Operational costs	SIDs remov	The initial deployment phase of the ACP may require some ATC system engineering amendments. This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ²² .									
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.										
AII	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACF IFP department wanted a 'not below 500ft; flyover WP positioned at the Declared End of Runway (DER) to e aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the I More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 140 early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception p the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would reduce to operate on the NORBO SIDs. There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nn the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO ₂ and potenticAS.						(DER) to ensure the ances will be required y after the DER. ed up to 1400ft on the exception perhaps of raft would not usually Namely the early left at least 6nm between				
All	Interdependenci es, conflicts, and trade-offs	7000ft how departures. ROBBO/CL This option ScTMA rout In their Stag progressed,	ever Easter Having an YDE traffic r is expected e design, bu ge 2A feedb we will expl tive effect or	ly departur earlier tur outing furth to be poss t would not ack NERL ore the abil	res are somet rn to the West er to the East sible within the make the mos questioned the lity to remove of bace users as a	imes required to b st on NORBO dep may increase this int existing network but tof their proposed du e requirement for bo one of these SIDs in	e 'stepped artures redu eraction, alb It can also b Jal southbou oth a LUSIV/ Stage 3.	up' underneath E uces this interact peit above 7000ft. pe accommodated and track structure /TLA SID in the fu	erly departures below Edinburgh's GOSAM ion. Conversely the within NERL's FASI in the upper network. iture. If this option is and the ScTMA need			
		CAP1711 de	escribes the	objective a	IS:							
All	AMS	airspace. This option reductions, single NOR	would suppo provide som BO departu	ort the mod le relief fror re route do	ernisation of th m noise to thos es not meet fu	he airspace. The opt se most frequently o	ion would be verflown by nerefore offe	e expected to gen Glasgow arrivals a er the most econo	nd are affected by UK erate significant CO ₂ and departures but a pmic benefit. It would			
		This option	could be exp	pected to re	sult in reductio	ns in the volume of (Glasgow's C	AS.				

²² 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-S

4.10. Runway 05 Easterly Departure Option C

Runway 05 I	Easterly Departure	es – Option C
NOREO	TOYLELOMON ROBBOCLYDD	Offset left departures with turns at 1nm and 6nm from the runway. Straight ahead departures with turns at 4nm from the runway. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see all departures initially fly straight ahead before turns at 1nm, 3nm and 6nm from the runway. Today, the majority of departures fly straight ahead until at least 5nm before turning and therefore turns at 1nm and 3nm are a change from current day. As aircraft will fly straight ahead, communities living under the final approach will be overflown by both arrivals and departures.
Communiti es	Noise impact on health and quality of life	 Figure 19 Easterly Option C Overflight and 2019 baseline NTK data The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap data (Figure 19) suggests that a left turn at 1nm would overfly the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 13% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. The ROBBO/CLYDE/LOMON/FOYLE departures fly straight ahead before turning left at 6nm. This means that they overfly the same areas as the final approach track before turning and up to around 5nm, this reflects what happens today. Figure 19 shows today's vectoring swathe turning at around 5nm and therefore a turn at 6nm will result in some areas not currently overflown being overflown in future however the population data suggests that these areas have very low population levels. The PERTH, which accounts for less than 1% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures. The contour suggests that at 6000-7000ft it may overfly new areas however these are sparsely populated. Finally, the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 3nm rather than 5nm. This results in overflight of some areas that are already overflown today however this would be at a higher

where there is a high density of population. Although this is not dissimilar to what happens today (the heatmap shows a large swathe across parts of the city), in future concentration of overflight would occur. The latter parts of the routes will overfly dense areas of population not typically overflown by easterly departures today.

frequency in future. Review of the population data shows that this route would overfly large areas of the city of Glasgow

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option C. It's important to note that the vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data 51 gives an overview of the Option C overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces however there is an increase in the number of population overflown compared to the centreline data. This can be attributed to the earlier turns than today and the LUSIV/TALLA SID turning at 3nm and routing over the centre of Glasgow.

Table 51 Easterly departures option C overflight data

Sustam	Area (km²)	Population
System	Area (KIII-)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option C	172.34	251000

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of schools overflown compared to the centreline data. The number of hospitals, care homes and places of worship increases. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB LAmax

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option C against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as shown in table 52 shows an increase in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 52 60dB and 65dB L_{Amax} Data – Rwy05 Dep Option C

	60dE	B L _{Amax}	65dB	LAmax
System	Area (km²)	Population	Area (km²)	Population
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option C	339.28	453932	121.06	175911

L_{Aeq}

The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located northeast of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces turns at 1nm, 3nm and 6nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the left may result in the component part of the contour extending further to the northwest to reflect the earlier turn; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the turns at 1nm, 3nm.

Noise Mitigation

The option does not offer an alternative, predictable respite configuration and would continue to see all departures (except NORBO) to climb straight ahead as today. The early left turn on NORBO departures would reduce the volume of traffic that climbs straight ahead however it would be positioned over newly overflown communities as well as the right turn LUSIV/TLA. The L_{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.

This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.

			compared to the contribution of road traffic to local air quality.
		Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option C will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Wid Soc	ler Siety	Capacity / resilience ²³	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. 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 ²⁴ 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

²³ Summary colour corrected

Air Quality

²⁴ 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-S

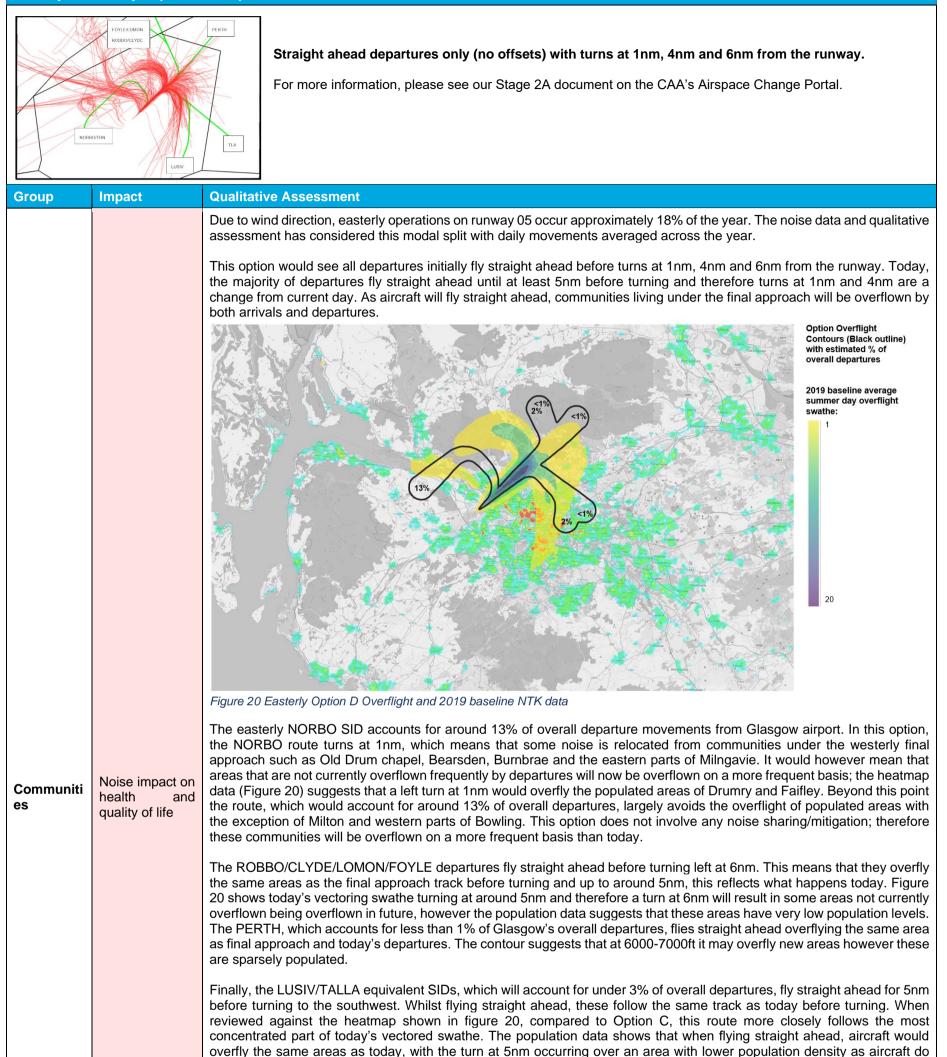
		nnoram	me										
		programme. Table 53 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and if aircraft were to											
		follow Glasgow's existing SID centrelines:											
		Table 53	Easterly depart	ure – Tranqi	uil areas	overflown							
	Tranquillity		System	NSA	A area	NSA cou		tional s count	National Parks area	DQA	count	DQA ar	ea
			05 Baseline ring (NTK dat		0	0	Park	0			4	0.66	
			RWY 05 ne (Centreline		0	0		0	0		2	0.38	
			oneering tool vay 05 Option		0	0		0	0		3	0.94	
		number stage, th and impa	a shows that th of DQAs over he frequency of acts of this opt which shows th	flown com overflight ion; we will	pared to has not explore	o the vecto been articu e this furthe	ring base lated in th r at Stage	line howe ne data ar 3 should	ever there is nd this will b this option	s an incr e importa progress	ease in tl ant to und 5. Technic	he overa lerstand t cal Appen	ll area. At t he full bene idix A conta
			4 shows data o lasgow's exist				areas u	o to 7000	ft based on	the NTK	(heatmap	p and if a	ircraft were
		Table 54	Biodiversity – a	reas overflo	wn								
		Sy	/stem		SAC count	SSSI count	SSSI area	SPA count	SPA area	National Park count	lNationa park area	NSA count	NSA area
	Biodiversity	– Vecto d	5 Baseline pring (NTK lata)	0	0	24	10.46	11	6.37	0	0	0	0
		Ba (Cen Optic	WY 05 seline treline – pneering	0	0	10	3.31	0	0	0	0	0	0
			ool) 5 Option C	0	0	14	5.57	4	3.32	0	0	0	0
			000ft no overl										
0		Option C is likely to contribute to a reduction in bottlenecks outside CAS beca CAS whilst offering opportunity to reduce the total volume of CAS. We created an "illustrative CAS volume" which was a single volume of CAS options combined to help stakeholder engagement on potential impacts. W					because th	is option	i can be c	ontained	within exist		
	Access	options	combined to h	elp stakeh	older er	which was	a single on poten	volume c itial impac	cts. We hav	e also us	sed this v	volume to	understan
General Aviation		options of there is s CAS in t	combined to h scope to reduc he same later	elp stakeh e the total al area is c	older er volume .100nm	which was ngagement of CAS. Th ³ smaller th	a single on poten e total vo an currer	volume o itial impao lume of th ntly exists	cts. We hav ne "illustrativ . The Glasg	e also us /e" airspa /ow CTR	sed this v ace volum was c.47	volume to ne compa 7nm ³ sma	understan ared to exist aller.
	Access Economic impact from increased effective capacity	options of there is s CAS in t We expe	combined to h scope to reduc	elp stakeh e the total al area is c ed effective ompared w	older er volume 100nm e capac vith the b	which was ngagement of CAS. Th ³ smaller th ity detailed paseline do	a single on poten e total vo an currer in the se nothing v	volume of tial impac lume of th ntly exists ction abo vesterly d	ots. We hav ne "illustrativ . The Glasg ve will resul	e also us /e" airspa low CTR t in a pos	sed this v ace volum was c.47 sitive eco	volume to ne compa 7nm ³ sma nomic im	understan ared to exist aller. pact on
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Airport /	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB LAeq,16h noise contour and therefore not affect Glasgow's noise insultation scheme costs.
Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ²⁵ ;
provider	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs.
~ "	Culoty	There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO ₂ and potentially more CAS.
		There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft.
All	Interdependenci es, conflicts, and trade-offs	This option is expected to be possible within the existing network and can also be accommodated within NERL's FASI ScTMA route design but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3.
		The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
		CAP1711 describes the objective as:
		Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
All	AMS	This option would support the modernisation of the airspace. The option would be expected to generate significant CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities.
		This option could be expected to result in reductions in the volume of Glasgow's CAS.

²⁵ 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-S

4.11. Runway 05 Easterly Departure Option D

Runway 05 Easterly Departures – Option D
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today. Beyond the turn, aircraft would fly towards the south-east, rather than turning towards the south/south-west as they do today. This results in avoidance of some of the most densely populated parts of Glasgow city centre although it results in overflight of Bishopbriggs and other densely populated areas of north-east of Glasgow city centre. The NTK heatmaps show that overflight already occurs in these areas today. The latter parts of the LUSIV/TALLA routes at higher altitudes overfly areas not currently overflown by Glasgow departures such as Dennistoun and Craigend.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the LUSIV/TALLA contours may extend slightly over additional areas of dense population within the city of Glasgow.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option D. The vectoring data is not modelled in the same way as the overflight contours; however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 56 gives an overview of the Option D overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contours reduces and there is a decrease in the number of population overflown compared to the

centreline data.

Table 56 Easterly departures option D overflight data

System	Area (km²)	Population
RWY 05 Baseline – Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option D	158.16	158513

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows a decrease in the number of hospitals, care homes and places of worship being overflown and schools remaining the same for centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{Amax}

Technical Appendix A includes 60dB and 65dB L_{Amax} contours which compare Option D against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 57 shows a decrease in the population within the 60dB L_{Amax} contour and an increase in population within the 65dB L_{Amax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 57 60dB and 65dB LAmax Data – Rwy05 Dep Option D

	60dE	3 L _{Amax}	65dB	L _{Amax}
System	Area (km²)	Population	Area (km²)	Population
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793
RWY 05 Dep Option D	320.66	364573	111.91	133584

LAeq

The easterly departures make up a component of the overall L_{Aeq} day ime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located northeast of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces turns at 1nm, 3nm and 6nm and therefore deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the left may result in the component part of the contour extending further to the northwest to reflect the earlier turn; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the turns at 1nm and 3nm.

	Noise Mitigation The option does not offer an alternative, predictable respite configuration and would continue to see all departures (except NORBO) to climb straight ahead as today. The early left turn on NORBO departures would reduce the volume of traffic that climbs straight ahead, however it would be positioned over newly overflown communities. The L _{Amax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.
Air Quality	This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths are likely to be small compared to the contribution of road traffic to local air quality.

	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option D will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Wider Society	Capacity / resilience ²⁶	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels. However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. 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 ²⁷ 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.

²⁶ Summary colour corrected

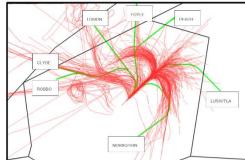
²⁷ Glasgow is currently investigating RNAV Substitution to mitigate VOR rationalisation however this is a temporary solution for the interim period before the deployment of the FASI-S

			3 shows data				tranquillity	/ based o	n the NTK	vectoring	g baseline	e and if a	ircraft were
			lasgow's exis Easterly depai	U									
					-		Na	tional	National				
	Tranquillity	DWW	System		ISA area	NSA cou		s count	Parks area	a DQA	count	DQA ar	ea
			05 Baseline		0	0		0	0		4	0.66	
			RWY 05 ne (Centrelir		0	0		0	0		2	0.38	
			oneering too ay 05 Option		0	0		0	0		3	1.01	
		The data	a shows that t	there is r	no change	in National	Scenic A	reas and I	National Pa	rks overf	lown. The	ere is a d	ecrease in t
		stage, th and impa	of DQAs ove the frequency of acts of this op which shows t	of overflig otion; we	ght has not will explor	t been articu e this furthe	ulated in there	he data ar e 3 should	d this will b this option	e importa progress	ant to und 5. Technic	erstand t al appen	he full benef Idix A contai
) shows data lasgow's exis				e areas u	p to 70001	t based on	the NTK	(heatmap	o and if a	ircraft were
		Table 59	Biodiversity –	areas ove	erflown								
			vstem	SAC area	SAC count	SSSI count	SSSI area	SPA count	SPA area	National Park count	Nationa park area	NSA count	NSA area
	Biodiversity	– Vecto d	5 Baseline pring (NTK lata) VY 05	0	0	24	10.46	11	6.37	0	0	0	0
		Bas (Cent Optio	seline treline – oneering	0	0	10	3.31	0	0	0	0	0	0
			ool) 5 Option D	0	0	14	5.66	4	3.32	0	0	0	0
			000ft no ove nd Sites of Sj										
) is likely to co ilst offering o						because th	nis option	can be c	ontained	within existi
Seneral Aviation	Access	We creat options of there is s	ted an "illustr combined to scope to redu he same late	ative CA help stal ce the to	S volume' keholder e tal volume	" which was ngagement of CAS. Th	a single on poten ne total vo	volume o ntial impac lume of th	ts. We hav e "illustrativ	e also us /e" airspa	sed this v ace volum	olume to ne compa	understand red to existi
	Economic impact from increased effective capacity	commer	ect the increa cial air traffic e track would	compare	d with the	baseline do	nothing v	vesterly d					
		mileage. routes. T the same decrease	e estimate that Option D, when compared to baseline nominal centrelines, will result in an overall improve eage. This option shows small reductions in track mileage for the TRN, NORBO SUNUK, NORBO LA ites. There are also small increases to the LUSIV, FOYLE, LOMON, CLYDE and ROBBO routes. The Pl e same. When considered against the overall % movements at GLA, any increase in track miles is outwork creases elsewhere.								KEY and TI ERTH remai		
		RWY 05		Base	eline (Cen	treline)				D			
eneral				nm		Weighting			nm	Sco			
viation / ommerci			TRN NORBO	50.00 - 112.0			40.5 644		49.40 103.90	40.0 597			
airlines	Fuel burn		SUBUK NORBO	-112.0			787		103.90	730.			
	Fuerburn		LAKEY LUSIV-DCS				207		89.10	208.4			
		DEPS	TLA	49.20	0.0	09	4.43	3	48.20	4.34			
			DEDTU	50.30			13.5		50.30	13.5	8		
			PERTH		0.1		3.44		20.40 24.10	3.67 10.8	5		
			FOYLE	19.10 20.00) 04	40	9.00)	24.10				
				19.10 20.00 25.00		45 63	9.00 15.7		33.10	20.8			
			FOYLE LOMON	20.0	0.0			75			5		
		Total	FOYLE LOMON CLYDE	20.00 25.00	0.0	63	15.7 15.0	75	33.10	20.8	5 5		
		Given the	FOYLE LOMON CLYDE ROBBO e improveme S NERL ACI	20.00 25.00 33.50 nt in trac P for the	0 0.0 0 0.4 ck mileage airspace	63 45 , and the as above 700	15.7 15.0 174 piration fo Oft), it is a	75 08 0.92 or all aircra	33.10 39.00 aft to climb	20.8 17.5 1647 continuo ption wo	5 5 7.19 usly to at puld see a		
	Training costs	Given the the NAT burn. In the Flight pro-	FOYLE LOMON CLYDE ROBBO e improveme S NERL ACI the Full Optic ocedures are res according	20.00 25.00 33.50 nt in trac of for the ons Appr updated gly and	0 0.0 0 0.4 0 0.4	63 45 , and the as above 700 age 3 we w	15.7 15.0 174 piration fo Oft), it is a ill investig ide as pa	75 08 0.92 or all aircra anticipated jate track rt of an Al	33.10 39.00 aft to climb t that this c mileage in f RAC cycle.	20.8 17.5 1647 continuo ption wo urther de As part o	5 5 7.19 usly to at buld see a etail. of this cyc	an impro	vement in fu
Commerci I airlines	Training costs Other costs	Given the the NAT burn. In t Flight pro procedur additiona	FOYLE LOMON CLYDE ROBBO e improveme S NERL ACI the Full Optic ocedures are	20.00 25.00 33.50 at in trac ons Appr updatec gly and ats for ain	0 0.0 0 0.4 ck mileage airspace aisal at Sta I or introdu undertake lines.	63 45 , and the as above 700 age 3 we w	15.7 15.0 174 piration fo Oft), it is a ill investig ide as pa	75 08 0.92 or all aircra anticipated jate track rt of an Al	33.10 39.00 aft to climb t that this c mileage in f RAC cycle.	20.8 17.5 1647 continuo ption wo urther de As part o	5 5 7.19 usly to at buld see a etail. of this cyc	an impro	vement in fu

Air	costs	there are not expected to be any changes to infrastructure for the airport or the ANSP.
navigation service provider		Unlike options that propose track adjustments on departure, this option is unlikely to change the populations within the 63dB LAeq,16h noise contour and therefore not affect Glasgow's noise insultation scheme costs.
	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ²⁸ .
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
A11	Sofoty	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required however that aircraft would not usually be expected to operate on the NORBO SIDs.
AII	Safety	There is a lack of global/UK PBN Route Spacing Guidance for some of the interactions in this option. Namely the early left turn NORBO against the later turn ROBBO/CLYDE departure. The illustrations created so far have at least 6nm between the interactions but if this is deemed not sufficient, a wider turn would be required incurring more CO ₂ and potentially more CAS.
		There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having an earlier turn to the West on NORBO departures reduces this interaction. Conversely the ROBBO/CLYDE traffic routing further to the East may increase this interaction, albeit above 7000ft.
All	Interdependenci es, conflicts, and trade-offs	This option is expected to be possible within the existing network but can also be accommodated within NERL's FASI ScTMA route design but would not make the most of their proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3.
		The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
		CAP1711 describes the objective as:
		Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
All	AMS	This option would support the modernisation of the airspace. The option would be expected to generate significant CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities.
		This option could be expected to result in reductions in the volume of Glasgow's CAS.

²⁸ 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-S

4.12. Runway 05 Easterly Departure Option E



Offset left departures with turns at 1nm from the runway. Straight ahead departures with turns at 2nm and 6.5nm from the runway. NORBO is straight ahead to 2nm with a right turn. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

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Group	Impact	Qualitative Assessment
Group		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see some departures offset to the left with turns at 1nm, and some departures flying straight ahead before turning at 2nm and 6.5nm. Today, the majority of departures fly straight ahead until at least 5nm before turning and therefore the offset departures and turns at 2nm are a change from current day. As around 15% if aircraft will fly straight ahead, communities living under the final approach will be overflown by both arrivals and departures. Option Overflight Contours (Black outline) with estimated % of departures when on easterlies 2019 baseline average sumer day overflight swathe: 1
		Figure 21 Easterly Option E Overflight and 2019 baseline NTK data
Communiti es	Noise impact on health and quality of life	The easterly NORBO SID accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route turns right at 2nm which is a change from the left turn today at 5nm today. This means that some noise is relocated from communities under the westerly final approach such as the northern parts of Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas of high population that are not currently overflown frequently by departures will now be overflown on a more frequent basis by 13% of overall traffic. The heatmap data (figure 21) shows that this overflight would occur over large parts of the city of Glasgow.
		The LUSIV route, which accounts for around 2% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures before turning at 6.5nm to head east. The contour suggests that it will route over areas already overflown today and will overfly the densely populated areas of Lennoxtown and Milton of Campsie.
		The ROBBO/CLYDE/LOMON/FOYLE departures all offset left before turning at 1nm. This means that around 4-5% of departures will no longer fly along the final approach resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 21 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the NORBO contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option E. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 61 gives an overview of the Option E overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour increases as does the number of population overflown compared to the centreline data. This can be attributed to the overall increase in contour area and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

System	Area (km²)	Population
RWY 05 Baseline Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option E	232.04	249498

Data on the number of noise sensitive buildings (schools, hospitals, and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in Technical Appendix A.

60dB and 65dB L_{aMax}

Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option E against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 62 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. The centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 62 60dB and 65dB LaMax Data – Rwy05 Dep Option E

	60dE	3 L _{aMax}	65dB L _{aMax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option E	427.82	468436	162.05	195679		

LAeq

The easterly departures make up a component of the overall L_{Aeq} daytime and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located northeast of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm and straight-ahead departures with turns at 2nm and 6.5nm and therefore the option deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, due to the offset and turns, the contour may shorten compared to current day which may benefit parts of Milngavie. The NORBO departure to the right may result in the component part of the contour extending further to the southeast to reflect the earlier turn; this may result in northern parts of Westerton moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore, the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigation

The option does not offer an alternative, predictable respite configuration. The majority of the SIDs in this option overfly new communities with the right turn, single NORBO SID potentially having the biggest effect in terms of increasing the numbers of people overflown with a relatively high frequency.

This option has a change to how some lower slower aircraft will fly laterally below 1000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight-ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths are moving away from the standard that these changes are likely to be small in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small

			compared to the contribution of road traffic to local air quality.
		Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option E will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Wide Soc	er : iety		This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1-minute separations). This is expected to reduce ground holding which in turn will reduce ground-based emissions and delays. The benefits of this will be seen particularly in future scenarios with increased traffic levels.
	,	Capacity / resilience ²⁹	However, like today, this option has all NORBO departures on one initial route which would not cater for future peak departure demand. The introduction of PBN SIDs also removes Glasgow's dependency on conventional ground-based navigation aids, which provides resilience. 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 ³⁰ resilience for Glasgow's SIDs when NERL decommissions the
			VORs. Introduction of PBN SIDs is absolutely essential for the Glasgow operation following NER's VOR withdrawa

²⁹ Summary colour corrected

Air Quality

³⁰ 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-S

		Table 62	me. 8 shows data	on the r		of areas of	tranquillit	v hased o	n the NTK .	ectoria	1 haseling	and if a	ircraft v	IP
			asgow's exist				aanquillit	y Jaseu O		COUNT	Jaseiine	, anu 11 8	moralt W	v.G
		Table 63	Easterly depart	ure – Tra	anquil areas	s overflown	Option E							
			System	Ν	NSA area	NSA co		ational	National	DQA	count	DQA ar	ea	
			05 Baseline-	-	0	0	Park	ks count 0	Parks area		4	0.66		
	Tranquillity		ring (NTK dat RWY 05											
			ne (Centrelin oneering tool		0	0		0	0		2	0.38		
		Runw	ay 05 Option	E	2.91	1		1	14.3		2	1.27		
		compare Appendi	a shows that t ed to the vecto x A contains a sites also show	ring dat map w	a however	this data d	oes not ta	ake into ac	count frequ	ency of c	overflight	at this sta	age. Teo	ch
			shows data o asgow's exist				e areas u	ip to 7000	ft based on	the NTK	(heatmap	and if a	ircraft w	ve
		Table 64	Biodiversity - al	reas ove	erflown Optio	on E								
				SAC	SAC	SSSI	SSSI	SPA	SPA		National	NSA	NSA	
			stem	area	count	count	area	count	area	Park count	park area	count	area	
	Biodiversity	Base Vector	VY 05 eline–- ing (NTK ata)	0	0	24	10.46	11	6.37	0	0	0	0	
		RV Bas (Cent	VY 05 seline treline – oneering	0	0	10	3.31	0	0	0	0	0	0	
			ool) 5 Option E	1	0.46	22	12.6	9	7.73	1	14.3	1	2.91	
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	Other costs	No other airline costs are foreseen.
Airport / Air navigation service	Infrastructure costs	Glasgow currently operates a homeowner relocation scheme for residential properties within the 69dB L _{Aeq,16h} contour area and noise insulation schemes for sensitive buildings, such as schools and hospitals, within the 63dB L _{Aeq,16h} contour area and residential properties within the 66dB L _{Aeq,16h} contour area. The UK Government's current aviation policy now requires financial assistance to be offered towards the noise insulation of residential properties in the 63dB L _{Aeq,16h} noise contour or above. Therefore, Glasgow Airport are currently developing a new Noise Insulation Policy for 2022, which will cover the varied property types situated within the 63dB contour area. The L _{Aeq} modelling in Stage 3 will determine if there are any increases in households within the 63dB L _{Aeq,16h} area as a result of this options as a result of the track adjustments on departure. If it does and track adjustments are proposed in Glasgow's ACP submission, there will be an increased cost for Glasgow with regards funding their Noise Insultation Scheme.
provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN SIDs removes Glasgow's dependency on conventional ground-based navigation equipment (VORs), which contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ³¹ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	This option requires a Track Adjustment on departure. These are possible within PANS OPS but in a recent ACP, the CAA IFP department wanted a 'not below 500ft' flyover WP positioned at the Declared End of Runway (DER) to ensure the aircraft doesn't turn before the end of the runway. PANS OPS doesn't require this. Additional assurances will be required during IFP ground validation to ensure the WP is acceptable, especially following another turn shortly after the DER. More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required.
All	Interdependenci es, conflicts, and trade-offs	There are no interdependencies, conflicts, or trade-offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Conversely the LUSIV/TLA traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is not expected to be possible within the existing network as it could require a move of the LANAK hold. It would not make the most of NERL's proposed dual southbound track structure in the upper network. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter, and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

³¹ 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-S

4.13. Runway 05 Easterly Departure Option F

Runway 05 Easterly Departures – Option F								
FOYLELOMON PCRTH	This option shares NORBO traffic between a left and right turn with only one of those routes in use at a time. The rest of the routes remain in the same configuration. When turning left, the NORBO would offset left then turn further left at 1nm When turning right, the NORBO would go straight ahead to 2nm then a right turn. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal. Period 1 (Left), Period 2 (Right)	ROBOCZYPE ROBOCZYPE USIVILA NORDOTRN						

Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		This option has been designed to enable the busiest NORBO departure route to switch from a left turn (with track adjustment) to a right turn to provide predictable respite to communities under both SID tracks. In both of these scenarios, the NORBO SID would overfly new communities. The other routes remain the same between period 1 and period 2.
		Period 1 (NORBO to the left) Period 1 would see the NORBO SID offset to the left and turn at 1nm. This would account for around 6.5% of overall departure movements from Glasgow airport. In this option, the NORBO route offsets left and turns at 1nm, which means that some noise is shared from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 22 shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling.
		Period 2 (NORBO to the right) Period 2 would see the NORBO route turn right at 2nm which is a change from the left turn today at 5nm today. This means that some noise is relocated from communities under the westerly final approach such as the northern parts of Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis by 6.5% of overall traffic. The heatmap data (figure 22) shows that this overflight would occur over large parts of the city of Glasgow:
		Option Overflight Contours (Black outline) with estimated % of overall departures 2019 baseline average
Commun ities	Noise impact on health and quality of life	summer day overflight swatte: 1 1 20
		Figure 22 Easterly Option F Overflight and 2019 baseline NTK data
		In both configurations, the ROBBO/CLYDE/LOMON/FOYLE/PERTH departures offset to the left however these departures turn at 6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The routes

The LUSIV route, which accounts for around 2% of Glasgow's overall departures, flies straight ahead overflying the same area as final approach and today's departures before turning at 6.5nm to head east. The contour suggests that it will route over areas already overflown today and will overfly the densely populated areas of Lennoxtown and Milton of Campsie.

initially overfly Drumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 6000-7000ft. Figure 22 shows that the latter parts of these routes fly over

areas not currently overflown today however these largely avoid dense areas of population.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the right turn NORBO contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend over further parts of Killearn.

The Technical Appendix to this document includes an image which compares the existing SID centrelines and option F. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 66 gives an overview of the Option F overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created

by having alternative respite configurations and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 66 Easterly departures option F overflight data

System	Area (km²)	Population
RWY 05 Baseline— Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option F	203.99	246626

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

In our Stage 2A engagement, the Mains Estate Resident Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB LaMax

Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option F against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 67 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be partially attributed to introducing an alternative respite route and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight.

Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 67 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option F

	60dI	B L _{aMax}	65dB L _{aMax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option F	386.14	453065	147.12	200769		

LAeq

The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm and straight ahead departures with turns at 2nm and 6.5nm and therefore the option deviates from current day. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the contour may shorten compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Dumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigations

The option offers an alternative respite configuration via two NORBO SIDs which could be alternated. For the purposes of this

		IOA we have assumed that this is split 50/50 between the two SIDs on a daily basis however this can be explored in further detail with stakeholders as part of the Stage 3 consultation if this option progresses. Our overflight and L_{aMax} data has shown an increase in the overall population and noise sensitive sites overflown however the impacts of noise are now shared and so there are decreases in the frequency of overflight where the frequency of overflight is currently high. This is something that was requested by stakeholders and formed part of the design principles. The benefits and impacts of this would require further quantitative analysis as part of the Stage 3 Full Options Appraisal should this option progress.
	Air Quality	This option has a change to how some aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option F will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.
Society	Capacity /	This option sees the SIDs splitting before 5nm which will marginally improve capacity compared to the baseline as some aircraft will be able to depart in intervals 1 minutes apart (subject to safety case and NERL ability to accept 1 minute separations). This is expected to reduce ground holding which in turn will reduce ground based emissions and delays. The benefits of this will be

	resilience ³²					increased r future pea				day, this c	ption ha	s all NOR	BO depa	rtures
		provides ro Modernisa	esilience. T ation progra	his equip mme. Th	oment is d here is cu	noves Glas ue to be de rrently no lo utely essen	commiss	ioned as p ³³ resilienc	part of a N ce for Glas	ERL UK v sgow's SII	vide prog Ds when	ramme u NERL de	nder the a	Airspa sions
			shows data s existing S			areas of tra	anquillity	based on	the NTK v	ectoring b	aseline a	and if airc	raft were	to foll
		Table 68 Ea	asterly depa	rture – Tra	anquil areas	s overflown C	ption F							
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 ³² Summary colour corrected
 ³³ 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-S
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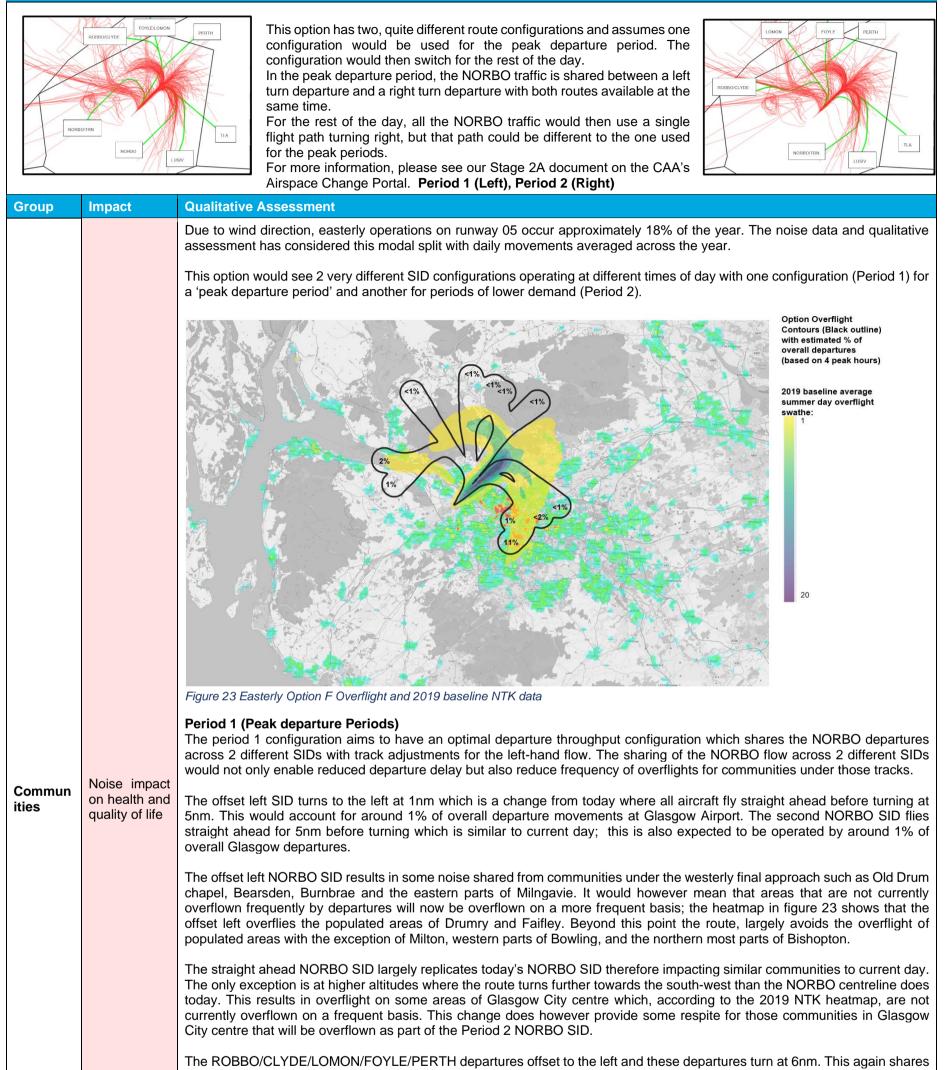
		FOYLE	19.10	0.18	3.44	17.60	17.60	17.60	3.17
		LOMON	20.00	0.45	9.00	20.30	20.30	20.30	9.14
		CLYDE	25.00	0.63	15.75	28.80	28.80	28.80	18.14
		ROBBO	33.50	0.45	15.08	34.60	34.60	34.60	15.57
		Total			1740.92				1663.79
		Given the improveme NATS NERL ACP for Full Options Appraisa	the airspace I at Stage 3	e above 7000ft), we will investiga	it is anticipated that the track mileage in	t this option w further detail.	vould see an in	nprovement in f	uel burn. In the
Commer cial airlines	Training costs	Flight procedures are procedures according training costs for airlir	ly and unde						
annics	Other costs	No other airline costs	are foresee	າ.					
Airport / Air navigatio	Infrastructure costs	Glasgow currently op noise insulation sche residential properties assistance to be offe Therefore, Glasgow A types situated within th within the 63dB LAeq.1 adjustments are propo Noise Insultation Sche The initial deployment	mes for ser within the 66 red towards irport are cu he 63dB con 6h area as a osed in Glas eme.	sitive buildings odB L _{Aeq,16h} cont the noise insu rrently developin tour area. The L result of this of gow's ACP subr	, such as schools our area. The UK C lation of residentia ng a new Noise Ins Aeq modelling in Sta ptions as a result c nission, there will b	and hospitals Government's Il properties ir ulation Policy ge 3 will deter of the track ac be an increase	a, within the 6 current aviatio n the 63dB LA for 2022, whic mine if there an ljustments on d cost for Glas	3dB L _{Aeq,16h} con n policy now re eq,16h noise cor h will cover the re any increases departure. If it gow with regard	ntour area and quires financia ntour or above varied property s in households does and track
n service provider	Operational costs	This airspace change removes Glasgow's d in NERL's operationa	ependency of	on conventional	ground based navi				
	Deployment costs	This option is expected Glasgow Airport. The when we are apprais interdependencies with compared to other op	ed to require scale and n ing our sho th Edinburg	air traffic contro ature of this train tlist of options a h. Owing to the	oller training for the ning requires furthe and once further ir respite configurat	er exploration	as part of the \$ known about t	Stage 3 Full Op he network abo	tions Appraisa
AII	Safety	This option requires a department wanted a turn before the end o validation to ensure th More detailed IFP invi- left turn departures w Otter aircraft for which operate on the NORB There is a lack of glob NORBO against the interactions but if this A SID structure from that perhaps a much a SID utilisation would hazards to the operat are not just associated issues associated with *As an example, mitic completely different n same places in the ne the SID termination por	not below 50 f the runway he WP is acc estigation su- hich is consi- nalternative O SIDs. bal/UK PBN later turn R is deemed ru more subtle d change sig ion which at d with aircra- h ATC confu- gations iden ames. Howe etwork are re- point.	Doft flyover WP j 2. PANS OPS de reptable, especi- reggests a minimi- idered achievati- tactical arranger Route Spacing O OBBO/CLYDE not sufficient, a within the endange to a SI nificantly from a this stage canno- ft inadvertently f sion. tified for SIDs sever flight planni- equired to termini-	positioned at the De positioned at the De positioned at the De positive require this. ally following anoth um climb gradient of ole for the majority ments may be required Guidance for some departure. The illu wider turn would be unges during the da D structure can be a left turn to a right of considered to be lying (or being issues mate at the same po-	eclared End or Additional as per turn shortly of 5.7% climb of Glasgow tr ired however of the interac estrations create required incu- ay is uncharte safely accom turn (or vice-v mitigated with ed) the wrong mental different s previously ic point which in tr	f Runway (DEI surances will by after the DER gradient is req affic with the e that aircraft wo tions in this op ated so far ha irring more CC red territory fo modated, ATC ersa) immedia hout introducin SIDs and the ht directions a lentified by NE urn would mea	R) to ensure the be required dur uired up to 140 exception perha- buld not usually tion. Namely th ve at least 6nr 2 and potentiall r the UK. Whils advised that a tely after depar g other issues* wrong time of con- fter departure ver- n similar SID n	e aircraft does" ing IFP ground Oft on the early aps of the Twir be expected to be expected to be early left turr m between the y more CAS. It it is expected in option where ture introduces . Such hazards day but also HF were SIDs with Ds going to the ames to match
AII	Interdepende ncies, conflicts and tradeoffs	There are no interdep however Easterly dep a slightly earlier turn to traffic routing further to This option is not exp structure which chang NERL's proposed du requirement for both these SIDs in Stage 3	bartures are to the West o the East m ected to be ges would n al southbou a LUSIV/TL/	sometimes requ on NORBO dep nay increase this possible within t ot fit with the ex nd track structu	ired to be 'stepped artures reduces this interaction, albeit the existing network kisting operation. H re in the upper ne	d up' undernea is interaction. above 7000ft. k as it could re laving a singl twork. In thei	ath Edinburgh' Conversely th equire a move e NORBO SIE r Stage 2A fe	s GOSAM depa e CLYDE/ROB of the LANAK would not ma edback NERL	artures. Having BO/LUSIV/TLA hold and a SID ike the most of questioned the

		The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
AII	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate CO ₂ reductions, provide some relief and respite from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown communities. This option could be expected to result in reductions in the volume of Glasgow's CAS.

³⁴ 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-S

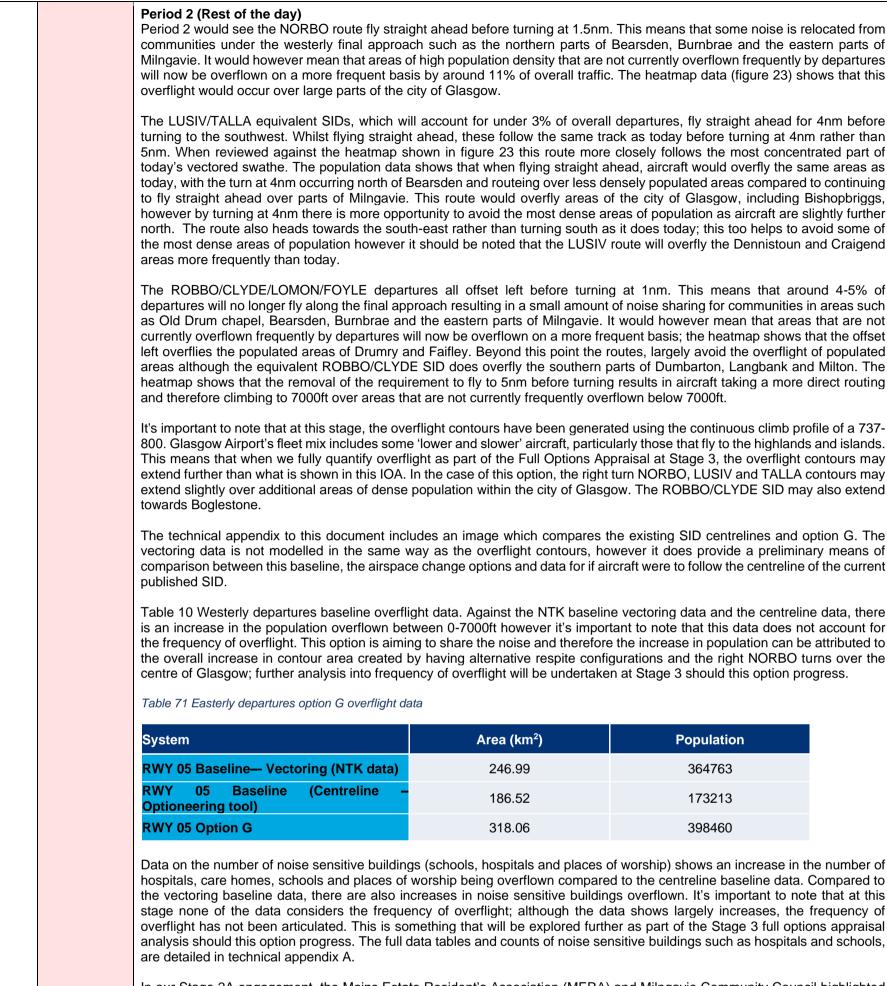
4.14. Runway 05 Easterly Departure Option G

Runway 05 Easterly Departures – Option G



noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight for other populated areas. The routes initially overfly Drumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. The equivalent CLYDE/ROBBO route, which turns to the east, also overflies Killearn at around 6000-7000ft. Figure 23 shows that the latter parts of these routes fly over areas not currently overflown today however these parts largely avoid dense areas of population.

Finally the LUSIV/TALLA equivalent SIDs, which will account for under 3% of overall departures, fly straight ahead for 5nm before turning to the southwest. Whilst flying straight ahead, these follow the same track as today before turning. When reviewed against the heatmap shown in figure 18 these routes more closely follow the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 5nm occurring over an area with lower population density as aircraft do today. Beyond the turn, aircraft would fly towards the south-east, rather than turning towards the south/south-west as they do today. This results in avoidance of some of the most densely populated parts of Glasgow city centre although it results in overflight already occurs in these areas today. The latter parts of the LUSIV/TALLA routes at higher altitudes overfly areas not currently overflown by Glasgow departures such as Dennistoun and Craigend.



In our Stage 2A engagement, the Mains Estate Resident's Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE/LOMON/ROBBO/CLYDE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB LaMax

Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option G against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 57 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to introducing alternative respite routes and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 72 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option G

	60dI	B LaMax	65dB LaMax			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option G	566.65	661368	194.89	229233		

LAeq

The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

		Most aircraft today fly si departures with some tu a very similar route to to expected that this option	rns earlier thar day in the area	today howev as within the s	er the lar cope of t	gest perce the L _{Aeq} co	entage of flig ontours. Wh	ghts (11% nen we co	6 using th onsider th	ne NORB nis, and tl	O right t	urn) follow
		Detailed consideration r exposures. Therefore th against new population	e ability to pr	ovide relief to	those co	ommunitie	es under fin	al approa	ach need	ls to be o	carefully	assessed
		The full L_{Aeq} contours wi	ll be quantified	as part of ou	r Stage 3	3 Full Opti	ons Apprais	al if this	option is	taken for	ward.	
		Noise Abatement Proc A change to the existing		be required to	accomm	odate the	offset depa	artures ar	nd turns.			
		Noise Mitigation The option offers a resp there is further sharing of increase in the overall po- are decreases in the fre requested by stakehold quantitative analysis as	of noise by spli opulation and r equency of ov ers and forme	tting the NOR toise sensitive erflight where d part of the	BO depa sites ov the freq design p	artures into erflown ho quency of principles.	o two routes owever the i overflight is	s. Our ove impacts c s current	erflight ar of noise a ly high. 1	nd L _{aMax} o re now sł This is so	data has nared an omething	shown an id so there g that was
	Air Quality	This option has a change in their totality, there will tracks are moving away decreases in the conce straight ahead departure flightpaths. However, it s local air quality.	be a change in from the stand ntrations belo e route (knowr	the location of lard 'straight a w these flight as 'offset de	of emissi head' de paths. W partures'	ons below eparture th /here late) there ma	/ 1,000ft whi nat aircraft fo ral tracks a ay be slight	ich could ollow belo re newly increase	affect loo ow 1,000 overflyir s in the o	cal air qua oft today t ng areas concentra	ality. Wh here ma to the s ations be	ere lateral y be slight side of the slow these
	Greenhouse gas impact	Our fuel burn assessme the baseline. We therefor further detail in the Stag	ore expect to s	ee a correspo	onding im	proveme	nt to greenh					
		This option sees the SID will be able to depart in is expected to reduce go seen particularly in futur	ntervals 1 min ound holding	utes apart (su which in turn v	bject to s vill reduc	safety cas	e and NERL	_ ability to	o accept	1 minute	separati	ions). This
	Capacity / resilience ³⁵	The ability for 2 NORBC demand during the off p			on woulc	l further h	elp to meet	demand	however	it does n	ot cater	for similar
		The introduction of PBI provides resilience. This Modernisation program VORs. Introduction of PI	equipment is ne. There is c	due to be dec urrently no lo	commissing term ³	ioned as j ³⁶ resiliend	part of a NE	ERL UK v gow's SII	vide prog Ds when	namme u NERL d	inder the ecommis	e Airspace ssions the
		Table 73 shows data on Glasgow's existing SID		of areas of tra	anquillity	based on	the NTK ve	ectoring b	aseline a	and if airc	craft wer	e to follow
		Table 73 Easterly departur	e – Tranquil are	as overflown O	ption G							
		System	NSA area	NSA cou		tional s count	National Parks area	DQA	count	DQA ar	ea	
	Tranquillity	RWY 05 Baseline Vectoring (NTK data	0	0		0	0		4	0.66		
		RWY 05 Baseline (Centreline Optioneering tool)	- 0	0		0	0	:	2	0.38		
Wider Society		Runway 05 Option G	2.91	1		1	14.3	4	5	2.28		
		The data shows that th appendix A contains a tranquil sites also show	map which she									
		Table 74 shows data on Glasgow's existing SID		of biodiverse a	areas up	to 7000ft	based on th	ne NTK h	eatmap a	and if airc	craft wer	e to follow
		Table 74 Biodiversity are	as overflown O _l	otion G								
		System	AC SAC rea count	SSSI count	SSSI area	SPA count	SPA area	National Park count	Nationa park area	NSA count	NSA area	
	Diodiversity	data)	0 0	24	10.46	11	6.37	0	0	0	0	
	Biodiversity	RWY 05 Baseline (Centreline – Optioneering tool)	0 0	10	3.31	0	0	0	0	0	0	
		RWY 05 Option G 0	.46 1	28	15.22	9	8.14	1 ation No	14.3	1	2.91	
		Below 2000ft no overflig and Sites of Special Sci							itional Pa	arks, Nati	onal Sce	enic Areas
		Lower slower aircraft, c Marise Burn and Mugdo majority of aircraft will cl	ck Wood SSS	s below 2000	ft. Given	the low o	verall % of a	aircraft ex	xpected t	to fly the	SIDs, an	nd the vast

 ³⁵ Summary colour corrected
 ³⁶ 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-S

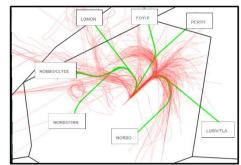
		We will Stage 3		e overflight	of biodiverse sites	s using the full (Glasgow fleet	mix, as part of	f our Full Optior	s Appraisal at
General Aviation	Access	offers po would n (togethe containe routes a We crea combine to reduc	otential to reduc ot quite be cont er with creation ed within CAS w are leaving CAS ated an "illustrati ed to help stakel ce the total volur	e the total v ained withir of the "illus hich is unli anyway, th ve CAS volu- nolder enga- ne of CAS.	anges to the exist volume of CAS. The ScTMA 7 in acco trative CAS volum kely to happen in erefore offering m ume" which was a igement on potent The total volume of an currently exists.	e Northbound S ordance with the reality because ore protection the single volume o ial impacts. We of the "illustrative	SIDs on this op CAA CAS contended COUST ACAS of COUST ACAS of COUST ACAS of CAS required have also use e" airspace vo	otion with the 7 ontainment poli SIDs terminat not exist in Airs otentially not p d to contain AL ed this volume	% climb gradier cy. However, th te at 7000ft and space Design te roportionate. L arrival and dep to understand if	at as illustrated is assessment are all wholly rms and these parture options there is scope
	Economic impact from increased effective capacity	air traffi	c compared with	the baseli	capacity detailed ir ne do nothing wes lay would not deliv	terly departure	baseline. How	vever the merg		
		mileage CLYDE day. The in track	 This option sh routes. There a e reduction in the miles is outweig 	nows reduc re small inc NORBO S hed by the	compared to bas tions in track mile creases to the PEF IDs means that wi decreases elsewh	eage for the TR RTH and LOMO nen considered nere.	N, NORBO S N routes. The against the ov	SUNUK, NORE	BO LAKEY, TLA	A, FOYLE and me as current
		Table 70	r Hack Length Oa			Lasteriy Departure	e option d			
		RWY 0	5		(Centreline)	0			G	0
General				nm	% Weighting	Score	nm P1	nm P2	Average	Score
Aviation / Commer cial			TRN NORBO SUBUK	50.00 112.00	0.81 5.75	40.50 644.00	49.20 97.30	49.70 103.15	49.45 100.23	40.05 576.29
airlines	Fuel burn		NORBO	112.00	7.03	787.36	96.50	96.00	96.25	676.64
	i dei buili									
		DEPS	LUSIV-DCS TLA	88.80 49.20	2.34 0.09	207.79 4.43	88.80 48.20	88.80 48.20	88.80 48.20	207.79 4.34
			PERTH	50.30	0.27	13.58	50.50	52.20	51.35	13.86
			FOYLE	19.10	0.18	3.44	18.50	17.60	18.05	3.25
				20.00	0.45	9.00	20.30	20.30	20.30	9.14
			CLYDE ROBBO	25.00 33.50	0.63 0.45	15.75 15.08	28.80 34.60	19.10 23.30	23.95 28.95	15.09 13.03
		Total	KOBBO	00.00	0.43	1740.92	04.00	20.00	20.33	1559.48
	Training	NATS N Full Opt	IERL ACP for th ions Appraisal a	e airspace at Stage 3 w	eage, and the asp above 7000ft), it is ve will investigate ntroduced worldw	anticipated that track mileage in	at this option w further detail.	vould see an in	nprovement in fu	el burn. In the
Commer cial airlines	Training costs	procedu training	res accordingly costs for airline	and underts.	ake training if req					
	Other costs		r airline costs a							
Airport / Air navigatio	Infrastructure costs	noise in resident assistar Therefo types sit within th adjustm Noise In	sulation schem tial properties wi nce to be offere re, Glasgow Air tuated within the 63dB L _{Aeq,16h} ents are propos sultation Schem	es for sens thin the 660 d towards bort are cur 63dB conto area as a ed in Glasg ne.	owner relocation s sitive buildings, su dB L _{Aeq,16h} contour the noise insulation rently developing a bur area. The L _{Aeq} is result of this option ow's ACP submission e ACP may require	ich as schools area. The UK (on of residentia a new Noise Ins modelling in Sta ns as a result o sion, there will b	and hospitals Government's al properties in ulation Policy ge 3 will deter of the track ac be an increase	s, within the 63 current aviation in the 63dB L_A for 2022, which mine if there are ljustments on d cost for Glas	3dB LAeq,16h con n policy now rec eq,16h noise con h will cover the v re any increases departure. If it c gow with regard	tour area and juires financial cour or above. varied property in households loes and track
n service provider	Operational	This airs	space change p	roposal is n	ot anticipated to ch n conventional gro	nange airport or	ANSP operati	ional costs. The	e implementatio	
	costs	in NERL	's operational o	osts as it e	nables VOR ration	alisation ³⁷ ;				
	Deployment costs	Glasgow when w interdep	w Airport. The so e are appraisin pendencies with	cale and na g our short Edinburgh	air traffic controller ture of this training list of options and . Owing to the re n part of this IOA.	g requires furthe	er exploration	as part of the \$ known about t	Stage 3 Full Opt he network abo	ions Appraisal ve 7000ft and
		departm turn bef	nent wanted a no ore the end of t	ot below 500 he runway.	ment on departure Oft flyover WP posi PANS OPS does eptable, especially	tioned at the De n't require this.	eclared End of Additional as	Runway (DER surances will b	to ensure the a be required duri	aircraft doesn't
				tigation eur	naeste a minimum	climb aradient (of 5.7% climb	aradient is rea	uired up to 1400)ft on the early
All	Safety	More de left turn	etailed IFP inves departures whi	ch is consid	ggests a minimum dered achievable f actical arrangeme	for the majority	of Glasgow tr			
AII	Safety	More de left turn Otter air There is NORBC	etailed IFP inves departures whi craft for which a a lack of globa against the la	ch is consid alternative ta I/UK PBN R ter turn RC	dered achievable	for the majority nts may be requ dance for some parture. The illu	of Glasgow tr uired. of the interac istrations crea	affic with the entry tions in this op ated so far ha	tion. Namely the ve at least 6nm	e early left turn between the

³⁷ 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-S

		that perhaps a much more subtle change to a SID structure can be safely accommodated, ATC advised that an option where a SID utilisation would change significantly from a left turn to a right turn (or vice-versa) immediately after departure introduces hazards to the operation which at this stage cannot considered to be mitigated without introducing other issues*. Such hazards are not just associated with aircraft inadvertently flying (or being issued) the wrong SIDs and the wrong time of day but also HF issues associated with ATC confusion. *As an example, mitigations identified for SIDs switching to fundamental different directions after departure were SIDs with completely different names. However flight planning and ATM issues previously identified by NERL requires SIDs going to the same places in the network are required to terminate at the same point which in turn would mean similar SID names to match the SID termination point.
AII	Interdepende ncies, conflicts and tradeoffs	There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Conversely the CLYDE/ROBBO traffic routing further to the East may increase this interaction, albeit above 7000ft. This option is not expected to be possible within the existing network as it could require a move of the LANAK hold and a SID structure which changes would not fit with the existing operation. In their Stage 2A feedback NERL questioned the requirement for both a LUSIV/TLA SID in the future. If this option is progressed, we will explore the ability to remove one of these SIDs in Stage 3. The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
AII	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace. The option would be expected to generate significant CO ₂ reductions, provide some respite from noise to those most frequently overflown by Glasgow arrivals and departures but a single NORBO departure route for the majority of the day does not meet future demand and therefore offer the most economic benefit. It would concentrate noise from the busiest departure route over the same, newly overflown and densely populated communities to the south of the airport for the majority of the day. This option could be expected to result in reductions in the volume of Glasgow's CAS.

4.15. Runway 05 Easterly Departure Option H

Runway 05 Easterly Departures – Option H



This option was generated as a result of Community and ATC feedback in our engagement. They proposed that ROBBO/CLYDE/LOMON SIDs could also turn left immediately, together with the left turn NORBO SID. Predictable respite is not a feature.

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

4	1/1	
Group	Impact	Qualitative Assessment
Group	Impact	Qualitative Assessment Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see the NORBO departures split between two routes. These would be operated throughout the day and therefore they would not be used in a respite configuration, however they would help to share the noise between communities. Unlike other options, the ROBBO/CLYDE/LOMON SIDS follow the same initial offset and turn as the left turn NORBO route. There is a mixtures of offset departures and departures that fly straight ahead, therefore there is limited relief for communities living under final approach however there are opportunities to share the noise. The NORBO route accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route is split into two. One NORBO SID offsets left and turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap in figure 24 shows that the offset left overflies the populated areas of Drumry and Failfley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. The other NORBO SID would fly straight ahead
Communiti es	Noise impact on health and quality of life	or populated areas with the exception of Million and western parts of bowling. The other NORBO SID would in ystraight aried a and turn at 5nm. This would largely replicate today's NORBO departures and therefore impact similar communities to current day. The only exception is at higher altitudes where the route turns further towards the south-west than the NORBO centreline does today. This results in overflight of some areas of Glasgow City centre which, according to the 2019 NTK heatmap, are not currently overflown on a frequent basis by departures. The sharing of the route between the two SIDs means that the frequency of overflight is reduced compared to some other options that use the same NORBO right turn route. Frequency of overflight will be explored in further detail as part of Stage 3.
		Figure 24 Easterly Option H Overflight and 2019 baseline NTK data The LUSIV/TALLA equivalent SIDs have been combined into one route, which will account for under 3% of overall departures, fly straight ahead for 4nm before turning to the southwest. Whilst flying straight ahead, the route follows the same track as today before turning at 4nm rather than 5nm. When reviewed against the heatmap shown in figure 24 this route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 4nm occurring north of Bearsden and

would overfly areas of the city of Glasgow including Bishopbriggs and Craigend however by turning at 4nm there is more opportunity to avoid the most dense areas of population in the very centre of Glasgow as aircraft are slightly further north.

routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route

The ROBBO/CLYDE/LOMON departures all offset left before turning at 1nm (The ROBBO/CLYDE has been combined into one route). This means that around 3% of these departures will no longer fly along the final approach resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap shows that the offset left overflies the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently frequently overflown below 7000ft.

The FOYLE/PERTH departures also offset to the left however these departures turn at 6nm. This again shares noise from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie however results in more frequent overflight of other populated areas. The route initially flies over Dumry and the western parts of Drumchapel before also routing over the western parts of Baljaffray and western Milngavie. At higher altitudes, the routes also overfly Blanefield and Strathblane. Figure 24 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a

737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight contours may extend further than what is shown in this IOA. In the case of this option, the NORBO right turn and LUSIV/TALLA contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The technical appendix to this document includes an image which compares the existing SID centrelines and option H. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 76 Easterly departures option H overflight data

System	Area (km²)	Population
RWY 05 Baseline Vectoring (NTK data)	246.99	364763
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213
RWY 05 Option H	234.43	248316

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

In our Stage 2A engagement, the Mains Estate Resident" Association (MERA) and Milngavie Community Council highlighted that the proposed PERTH/FOYLE route in this option would overfly the Douglas Music Academy as a noise sensitive building. If this option is carried forward we will investigate to see if overflight of this building can be avoided/mitigated or indeed if there are likely to be any adverse impacts due to aircraft overflight.

60dB and 65dB L_{aMax}

Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option H against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 77 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 77 60dB and 65dB L_{aMax} Data – Rwy05 Dep Option H

	60dI	B L _{aMax}	65dB L _{aMax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option H	433.3	442907	147.96	158079		

LAeq

The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located northeast of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces some offset departures with a turn at 1nm as well as straight ahead departures. Owing to the modal split, it is expected that this change will have minimal impact on the shape and size of the overall L_{Aeq} contours. When considering just the easterly departure component, the introduction of some traffic onto the offset departures may result in the contour shortening compared to current day which may benefit parts of Milngavie. The offset departures to the left may result in the component part of the contour extending further to the northwest to reflect the offset paths; this may result in parts of Drumry moving into a higher dB contour. Owing to the modal split, these changes are expected to be very minimal.

Detailed consideration needs to be given to the use of track adjustments on departure as this would re-distribute noise at higher exposures. Therefore the ability to provide relief to those communities under final approach needs to be carefully assessed against new population adversely affected by aircraft noise in the immediate climb out to the north and south of track.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

Noise Mitigations

The option does not offer an alternative respite configuration however it does aim to share the noise by relocating half of the NORBO departures and the ROBBO/CLYDE/LOMON/FOYLE/PERTH departures onto an offset track, rather than climbing straight ahead over the same areas as final approach as they do today. Splitting the NORBO departures into two on a permanent basis also shares the noise for those communities to the south of the centreline which will be overflown by the right turn NORBO route (although they are already overflown today). The L_{aMax} and overflight data has suggested that this configuration may increase the population overflown compared to the baseline centreline data, and therefore further detailed

		data analysis which o	consider	s frequency	of overflic	ht, will be	required a	t Stage 3	if this opti	on progre	esses.		
	Air Quality	This option has a ch emissions in their tota Where lateral tracks there may be slight d to the side of the s concentrations below the contribution of ro	ality, thei are mov lecrease straight a v these fl	e will be a c ing away fr s in the con head depa ightpaths. I	change in t com the sta centrations rture route However, i	the location andard 'str s below the e (known	n of emissi aight ahea ese flightp as 'offset	ons below ad' departu aths. Whe departure	1,000ft w ure that a re lateral es') there	/hich cou ircraft foll tracks are may be	ld affect low belov e newly o slight in	local air w 1,000f overflying icreases	quality t toda g area in the
	Greenhouse gas impact	Our fuel burn assess to the baseline. We th in further detail in the	herefore	expect to se	e a corres	ponding in	nprovemer	nt to green					
	Capacity / resilience	This option sees the aircraft will be able separations). This is benefits of this will be Having 2 NORBO ro The introduction of F provides resilience. T Modernisation progra VORs. Introduction programme.	to depar expected e seen part utes for t PBN SID This equip amme. T	t in interva d to reduce articularly ir he whole d s also remo oment is du here is curr	Is 1 minut ground ha future sca ay service oves Glasg e to be dea rently no la	tes apart olding whic enarios wir s future de gow's depe commissio ong term ³⁸	(subject to ch in turn v th increase emand to th endency or ned as part resilience	o safety ca vill reduce ed traffic le ne greates n conventi t of a NEF for Glasg	ase and N ground b evels. at extent. onal grou RL UK wid o"s SIDs	NERL ab ased em nd based e prograr when NE	ility to a issions a d navigat mme und ERL deco	ccept 1 ind delay ion aids ler the Ai pmmissio	minut ys. Th , whic irspac ons th
		Table 78 shows data follow Glasgow's exis Table 78 Easterly depa	sting SID	centrelines	s between	0-7000ft:	y based o	n the NTK	vectoring	g baselin	e and if	aircraft v	were t
		System		ISA count		ea Na	tional	National		count	DQA ar	еа	
	Tranquillity	RWY 05 Baseline Vectoring (NTK d	e	0	0	Park	o o o o o o o o o o o o o o o o o o o	Parks are 0	a	4	0.66		
		RWY 05 Baseline (Centreli Optioneering to		0	0		0	0	:	2	0.38		
		Runway 05 Optio		1	2.91		1	13.93		4	1.2		
		contour, with tranqui	l sites als	so shown.			_			_			
		Table 79 shows data follow Glasgow's exis <i>Table 79 Biodiversity</i>	l sites als a on the sting SID - areas ov	so shown. overflight o centrelines erflown Optio	f biodivers s. on H	se areas u	p to 7000f	t based o	n the NTk	(heatma National	p and if	aircraft v	
		Table 79 shows data follow Glasgow's exis <i>Table 79 Biodiversity</i> System RWY 05 Baseline Vectoring (NTK data)	l sites als a on the sting SID	overflight o centrelines	f biodivers s.		_		n the NTM	(heatma	p and if		
	Biodiversity	Table 79 shows data follow Glasgow's exis <i>Table 79 Biodiversity</i> System RWY 05 Baseline Vectoring (NTK	I sites als a on the sting SID - areas ov SAC area	so shown. overflight o centrelines erflown Option SAC count	f biodivers s. on H SSSI count	se areas u SSSI area	p to 7000f	t based or SPA area	National Park count	K heatma National park area	p and if NSA count	aircraft v NSA area	
	Biodiversity	Table 79 shows data follow Glasgow's exis Table 79 Biodiversity System RWY 05 Baseline Vectoring (NTK data) RWY 05 Baseline (Centreline - Optioneering tool) RWY 05 Option H	I sites als a on the sting SID - areas ov SAC area 0 0	overflight o centrelines erflown Option SAC count 0 0	f biodivers s. on H SSSI count 24 10 27	se areas u SSSI area 10.46 3.31 13.66	p to 7000f SPA count 11 0 9	t based or SPA area 6.37 0 8.14	National Park count 0 0	K heatma National park area 0 0 13.93	p and if NSA count 0 1	NSA area 0 2.91	were t
	Biodiversity	Table 79 shows data follow Glasgow's exis Table 79 Biodiversity System RWY 05 Baseline Vectoring (NTK data) RWY 05 Baseline (Centreline - Optioneering tool)	I sites als a on the sting SID - areas ov SAC area 0 0 0 0 cflight of S Scientific t, climbin gdock W aft will cli	so shown. overflight o centrelines erflown Option SAC count 0 0 0 0 Special Prote Interests is g at below food SSSIs mb above 2	f biodivers s. on H SSSI count 24 10 27 tection Are s expected a 6% climit below 200 000ft befo	se areas u SSSI area 10.46 3.31 13.66 as, Specia for the va b gradient Doft. Given re overflyin	p to 7000f SPA count 11 0 9 al Areas of ast majority on the CL the low o ng the sites	t based or SPA area 6.37 0 8.14 Conservat c of aircraf YDE/LOM verall % o s, it is expe	National Park count 0 0 1 tion, Natio t. ON/FOYL f aircraft e ected that	K heatma National park area 0 0 13.93 onal Parks E/PERT expected any impa	p and if NSA count 0 0 1 s, Nation H SIDs, to fly the acts will b	aircraft v NSA area 0 2.91 al Scenic may ove e SIDs, a be very m	c Area erfly thand th
General Aviation	Biodiversity	Table 79 shows data follow Glasgow's exist Table 79 Biodiversity System RWY 05 Baseline Vectoring (NTK data) RWY 05 Baseline (Centreline - Optioneering tool) RWY 05 Option H Below 2000ft no over and Sites of Special Lower slower aircraft Marise Burn and Mu vast majority of aircraft Marise Burn and Mu vast majority of aircraft Marise Burn and Mu vast majority of aircraft We will fully quantify at Stage 3. The design option m potential to reduce th would not quite be coo (together with creatic contained within CAS routes are leaving CA We created an "illust	I sites als a on the sting SID - areas ov SAC area 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	so shown. overflight o centrelines erflown Optic SAC count 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	f biodivers s. on H SSSI count 24 10 27 tection Are s expected a 6% climit below 200 000ft befo diverse sit s to the ex CAS. The N IA 7 in accor CAS volur happen in re offering ' which wa	se areas u SSSI area 10.46 3.31 13.66 as, Specia for the va b gradient Oft. Given re overflyin tes using t isting CAS Northbound ordance w me") assur reality bed more prote	p to 7000f SPA count 11 0 9 A Areas of ast majority on the CL ong the sites he full Gla boundari d SIDs on ith the CAA med the no cause 7000 ection thar e volume or	t based on SPA area 6.37 0 8.14 Conservat of aircraf YDE/LOM verall % o s, it is expense sgow fleet es to accord this option A CAS con orthbound Dft does no northbound Dft does no northbound Dft does no northbound	National Park count 0 0 1 tion, Natio t. ON/FOYL f aircraft e ected that aircraft e ected that mix, as p ommodate n with the tainment SIDs term of exist in p otentially uired to c	National park area 0 13.93 0 13.93 0 13.93 0 13.93 0 13.93 0 13.93 0 0 13.93 0 14.10 14.	p and if NSA count 0 0 1 s, Nationa H SIDs, to fly the acts will b acts will b r Full Op MON SIE b gradied b gradied	aircraft v NSA area 0 0 2.91 al Scenic may ove e SIDs, a be very m otions Ap otions Ap otions Ap otions Ap otions Ap otions Ap otions assess and are all erms and a	were the strate
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³⁸ 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-S

mileage. This option shows reductions in track mileage for the TRN, NORBO SUNUK, NORBO LAKEY, TLA, FOYLE, LOMON, CLYDE and ROBBO routes. There are increases to the LUSIV and PERTH routes. The reduction mainly in the NORBO SIDs but also in the other routes means that when considered against the overall % movements at Glasgow, any increase in track miles is outweighed by the decreases elsewhere.

Table 80 Track Length Calculations-- Fuel Burn RWY 05 Easterly Departure Option H

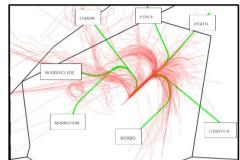
		RWY 05		Baseline	(Centreline)				
		RWY 05		nm	% Weighting	Score	nm	Score	
			TRN	50.00	0.81	40.50	49.20	39.85	
			NORBO SUBUK	112.00	5.75	644.00	103.60	595.70	
			NORBO LAKEY	112.00	7.03	787.36	96.50	678.40	
			LUSIV-DCS	88.80	2.34	207.79	96.50	225.81	
		DEPS	TLA	49.20	0.09	4.43	48.20	4.34	
			PERTH	50.30	0.27	13.58	50.50	13.64	
			FOYLE	19.10	0.18	3.44	18.50	3.33	
			LOMON	20.00	0.45	9.00	14.60	6.57	
			CLYDE	25.00	0.63	15.75	18.40	11.59	
			ROBBO	33.50	0.45	15.08	22.80	10.26	
		Total				1740.92		1589.48	
Commerc al airlines	Training costs Other costs	Flight pro procedui training o	ocedures are u	pdated or ir and underta s.	ake training if requir	e as part of an	AIRAC cycle.	As part of this cyc	le, airlines update tl o require any additic
	Other costs								B L _{Aeg,16h} contour a
Airport / Air navigatio n service	Infrastructure costs	above. T varied pi increase departur Glasgow	Therefore, Glas roperty types s s in household e. If it does and with regards f	gow Airpor ituated with Is within the d track adju unding their	t are currently devi in the 63dB contou e 63dB L _{Aeq,16h} area	eloping a new ir area. The L/ a as a result o sed in Glasgow Scheme.	Noise Insulat Aeq modelling in of this options a's ACP submi	on Policy for 202 n Stage 3 will dete as a result of the ssion, there will be	Aeq,16h noise contou 2, which will cover ermine if there are a e track adjustments e an increased cost
orovider	Operational costs	SIDs ren	noves Glasgow	's depende		al ground base	d navigation e		mplementation of P which contributes t
	Deployment costs	and Glas Appraisa	sgow Airport. T al when we are	he scale ar appraising	nd nature of this tra our shortlist of opt	ining requires	further explor	ation as part of th	ted at NATS Prestw e Stage 3 Full Optic out the network abo
			nd interdepend	choics with	Edinburgh.				
All	Safety	IFP depa doesn't t	on requires a 1 artment wanted urn before the	Frack Adjus a not belov end of the re	tment on departure v 500ft flyover WP p	. These are po positioned at th doesn't require	e Declared En e this. Addition	d of Runway (DEF al assurances will	a recent ACP, the C R) to ensure the airc be required during DER.
All	Safety	IFP depa doesn't t ground v More de early left	on requires a T artment wanted urn before the validation to ens tailed IFP inves turn departure	Frack Adjus a not below end of the ru sure the WF stigation su s which is c	tment on departure v 500ft flyover WP p unway. PANS OPS P is acceptable, esp ggests a minimum	. These are po positioned at th doesn't require pecially followin climb gradient ple for the majo	e Declared Er e this. Addition og another turn of 5.7% climb ority of Glasgov	d of Runway (DEF al assurances will shortly after the I gradient is requir	R) to ensure the airc be required during
AII	Safety	IFP depa doesn't t ground v More de early left Twin Ott There au 7000ft ho Having	on requires a T artment wanted urn before the validation to ensi- tailed IFP inves turn departure er aircraft for w re no interdepe owever Easterly a slightly east	Track Adjus a not below end of the ru sure the WF stigation su s which is c hich alterna endencies, o y departures rlier turn t	tment on departure v 500ft flyover WP p unway. PANS OPS P is acceptable, esp ggests a minimum onsidered achievat ative tactical arrang conflicts or trade o s are sometimes red	. These are po positioned at the doesn't require ecially following climb gradient ole for the major ements may be ffs with routes quired to be 'ste NORBO depa	e Declared En e this. Addition og another turn of 5.7% climb ority of Glasgov e required. to/from other epped up' under artures reduced	d of Runway (DEF al assurances will shortly after the I o gradient is requir w traffic with the ex airports with Eas erneath Edinburgh es this interactio	R) to ensure the airc be required during DER. red up to 1400ft on kception perhaps of terly departures be i's GOSAM departure on. Also keeping
AII AII	Safety Interdependenci es, conflicts and tradeoffs	IFP depa doesn't t ground v More de early left Twin Ott There ar 7000ft ho Having CLYDE/I This opti having 2 feedback	on requires a T artment wanted urn before the validation to ensi- tailed IFP inves turn departure er aircraft for w re no interdepe owever Easterly a slightly east ROBBO/LUSIV ion is not expe NORBO SIDs < NERL question	Track Adjus a not below end of the re- sure the WF stigation su s which is c thich alterna endencies, y departures lier turn t /TLA traffic cted to be maximises oned the re	tment on departure v 500ft flyover WP p unway. PANS OPS P is acceptable, esp ggests a minimum considered achievat ative tactical arrang conflicts or trade o s are sometimes rec o the West on more closely aligned possible within the s the benefits from 1	. These are po positioned at the doesn't require becially following climb gradient ole for the major ements may be ffs with routes quired to be 'ste NORBO depa ed to existing the existing networ NERL's propose a LUSIV/TLA	e Declared En e this. Addition of another turn of 5.7% climb ority of Glasgov e required. to/from other epped up' und artures reduce raffic patterns ork as it could sed dual south	d of Runway (DEF al assurances will shortly after the I o gradient is requir w traffic with the ex airports with Eas erneath Edinburgh es this interaction minimises this inter require a move on bound route struct	R) to ensure the airc be required during DER. red up to 1400ft on kception perhaps of terly departures be i's GOSAM departure on. Also keeping

		The cumulative effect on other airspace users as a result to CAS dimensions at Glasgow, Edinburgh and the ScTMA need to be co-ordinated and considered.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would support the modernisation of the airspace by accommodating future demand in an efficient manner. The option would be expected to generate significant CO ₂ reductions, provide some relief from noise to those most frequently overflown by Glasgow arrivals and departures and a dual NORBO track structure would mitigate the impacts on those newly overflown by reducing the frequency of overflight (compared to if under a single NORBO SID structure). This option could be expected to result in reductions in the volume of Glasgow's CAS.

³⁹ 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-S

4.16. Runway 05 Easterly Departure Option I

Runway 05 Easterly Departures – Option I



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

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
oroup	mpaor	Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		This option would see the NORBO departures split between two routes. These would be operated throughout the day and therefore they would not be used in a respite configuration, however they would help to share the noise between communities. Unlike other options, the ROBBO/CLYDE/LOMON SIDS follow the same initial turn as the left turn NORBO route. All departures fly straight ahead, therefore there is no relief for communities living under immediate final approach although the NORBO Left, ROBBO/CLYDE, LOMON and FOYLE do turn shortly after departure. The NORBO route accounts for around 13% of overall departure movements from Glasgow airport. In this option, the NORBO route is split into two. One NORBO SID turns at 1nm, which means that some noise is relocated from communities under the westerly final approach such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more
		frequent basis; the overflight contours and population data show that the left turn overflies the populated areas of Drumry and Faifley. Beyond this point the route, which would account for around 6.5% of overall departures, largely avoids the overflight of populated areas with the exception of Milton and western parts of Bowling. The other NORBO SID would fly straight ahead and turn at 5nm. This would largely replicate today's NORBO departures and therefore impact similar communities to current day. The only exception is at higher altitudes where the route turns further towards the south-west than the NORBO centreline does today. This results in overflight of some areas of Glasgow City centre which, according to the 2019 NTK heatmap shown in Figure 22, are not currently overflown on a frequent basis by departures. The sharing of the route between the two SIDs means that the frequency of overflight is reduced compared to some other options that use the same NORBO right turn route. Frequency of overflight will be explored in further detail as part of Stage 3.
		Contours (Black outline) with estimated % of overall departures 2019 baseline average summer day overflight swathe: 1
Communiti es	Noise impact on health and quality of life	20
		<i>Figure 25 Easterly Option I Overflight and 2019 baseline NTK data</i> The LUSIV/TALLA equivalent SIDs have been combined into one route, which will account for under 3% of overall departures, fly straight ahead for 4nm before turning to the southwest. Whilst flying straight ahead, the route follows the same track as today before turning at 4nm rather than 5nm. When reviewed against the heatmap shown in figure 25 this

would overfly areas of the city of Glasgow including Bishopbriggs and Craigend however by turning at 4nm there is more opportunity to avoid the most dense areas of population in the very centre of Glasgow as aircraft are slightly further north.

route more closely follows the most concentrated part of today's vectored swathe. The population data shows that when flying straight ahead, aircraft would overfly the same areas as today, with the turn at 4nm occurring north of Bearsden and routeing over less densely populated areas compared to continuing to fly straight ahead over parts of Milngavie. This route

The ROBBO/CLYDE/LOMON departures all turn at 1nm (The ROBBO/CLYDE has been combined into one route). This means that around 3% of these departures will no longer fly along the final approach up to 5nm resulting in a small amount of noise sharing for communities in areas such as Old Drum chapel, Bearsden, Burnbrae and the eastern parts of Milngavie. It would however mean that areas that are not currently overflown frequently by departures will now be overflown on a more frequent basis; the heatmap data shows that these departures turning left overfly the populated areas of Drumry and Faifley. Beyond this point the routes, largely avoid the overflight of populated areas although the equivalent ROBBO/CLYDE SID does overfly the southern parts of Dumbarton, Langbank and Milton. The heatmap shows that the removal of the requirement to fly to 5nm before turning results in aircraft taking a more direct routing and therefore climbing to 7000ft over areas that are not currently overflown below 7000ft.

The FOYLE/PERTH fly straight ahead and turn at 6nm. These routes therefore overfly the same areas as final approach and largely follow the same tracks as departures today, particularly from take off to 5nm. Beyond 6nm, at higher altitudes, the routes overfly Blanefield and Strathblane. Figure 25 shows that the latter parts of these routes fly over areas not currently overflown today however these largely avoid dense areas of population.

It's important to note that at this stage, the overflight contours have been generated using the continuous climb profile of a 737-800. Glasgow Airport's fleet mix includes some 'lower and slower' aircraft, particularly those that fly to the highlands and islands. This means that when we fully quantify overflight as part of the Full Options Appraisal at Stage 3, the overflight

contours may extend further than what is shown in this IOA. In the case of this option, the NORBO right turn and LUSIV/TALLA contour may extend slightly over additional areas of dense population within the city of Glasgow. The ROBBO/CLYDE SID may also extend towards Boglestone.

The technical appendix to this document includes an image which compares the existing SID centrelines and option H. The vectoring data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline, the airspace change options and data for if aircraft were to follow the centreline of the current published SID.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the existing SID centreline data, the area of the contour and the population overflown increases. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow; further analysis into frequency of overflight will be undertaken at Stage 3 should this option progress.

Table 81 Easterly departures option I overflight data

System	Area (km²)	Population		
RWY 05 Baseline Vectoring (NTK data)	246.99	364763		
RWY 05 Baseline (Centreline – Optioneering tool)	186.52	173213		
RWY 05 Option I	217.71	235019		

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows an increase in the number of hospitals, care homes, schools and places of worship being overflown compared to the centreline baseline data. Compared to the vectoring baseline data, there is a decrease in noise sensitive buildings overflown, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This is something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progress. The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in technical appendix A.

60dB and 65dB LaMax

Technical Appendix A includes 60dB and 65dB L_{aMax} contours which compare Option I against the centreline baseline. These 60dB and 65dB L_{Amax} contours are an indicator of the N60/N65 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data in table 82 shows an increase in the population within the 60dB L_{aMax} contour and 65dB L_{aMax} contour. This can be attributed to the overall increase in contour area created by splitting the NORBO route into two and the right NORBO turn over the centre of Glasgow and at Stage 3 we will explore potential benefits and impacts in terms of frequency of overflight. Also, the centreline baseline data is modelled on aircraft flying the SID centrelines rather than vectored as they are today and therefore we will explore this further at Stage 3.

Table 82 60dB and 65dB LaMax Data – Rwy05 Dep Option I

	60dE	3 L _{aMax}	65dB L _{aMax}			
System	Area (km²)	Population	Area (km²)	Population		
RWY05 Baseline (Centreline – Optioneering tool)	356.82	382113	114	120793		
RWY 05 Dep Option I	411.04	433493	132.97	147678		

LAeq

The easterly departures make up a component of the overall L_{Aeq} day time and night time contours. We have used the overall L_{Aeq} contours from 2017, as an indicative contour for 2025. Glasgow airport operates on easterlies 18% of the year and therefore the easterly departures will have a smaller influence on the overall parts of the L_{Aeq} contours that are located north-east of the airport.

Most aircraft today fly straight ahead for 5nm before turning; this option introduces straight ahead departures with some turns earlier than today however the largest percentage of flights follow a very similar route to today in the areas within the scope of the IAeq contours. When we consider this, and the modal split, it is expected that this option would have minimal impact on the shape and size of the overall L_{Aeq} contours.

The full LAeq contours will be quantified as part of our Stage 3 Full Options Appraisal if this option is taken forward.

Noise Abatement Procedures

A change to the existing NAPs would be required to accommodate the offset departures and turns.

		Noise Mitigation The option does not offer an alternative respite configuration however it does aim to share the noise by splitting the NORBO departures into two on a permanent basis. This shares the noise for those communities to the south of the centreline which will be overflown by the right turn NORBO route (although they are already overflown today). The L_{aMax} and overflight data has suggested that this configuration may increase the population overflown compared to the centreline data, and therefore further detailed data analysis which considers frequency of overflight, will be required at Stage 3 if this option progresses.
	Air Quality	This option has the potential to change to how a small number of aircraft will fly laterally below 1,000ft. Whilst there are likely to be no increase in emissions in their totality, there will be a change in the location of emissions below 1,000ft which could affect local air quality. Where lateral tracks are moving away from the standard 'straight ahead' departure that aircraft follow below 1,000ft today there may be slight decreases in the concentrations below these flightpaths. Where lateral tracks are newly overflying areas to the side of the straight ahead departure route (known as 'offset departures') there may be slight increases in the concentrations below these flightpaths. However, it should be noted that these changes are likely to be small compared to the contribution of road traffic to local air quality.
Wider Society	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated that Option I will have an overall improvement in fuel burn compared to the baseline. We therefore expect to see a corresponding improvement to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.

	Capacity / resilience	aircraft v separatio benefits Having 2 The intro provides Modernis VORs. I program Table 83 follow Gl <i>Table 83</i>	3 shows data o asgow's existi <i>Easterly departe</i> System 05 Baseline- ring (NTK dat	depart i seen par es for the N SIDs a s equipn me. The PBN S on the ov ng SID c ure – Trai	n interva o reduce ticularly in e whole d also remo nent is du re is curr Ds is ab verflight c entreline	Is 1 minut ground ho n future sca ay service: by servi	es apart (olding whice enarios with s future de ow's depe commission ng term ⁴⁰ ssential for tranquillity <i>Option I</i>	subject to th in turn w th increase emand to th endency on ned as par resilience f or the Glas / based or	safety cas vill reduce g ed traffic lev ne greatest convention t of a NERL for Glasgow sgow opera	e and N pround ba vels. extent. nal groun UK wide v's SIDs ation foll vectoring	IÈRL abii ased emi: and based program when NE lowing N	lity to ac ssions ar I navigation me unde RL decou IER''s VC	cept 1 m nd delays on aids, y er the Airs mmission DR withd ircraft we	hinute s. The which space hs the Irawal
		Optio Runw The data data. Te	RWY 05 ne (Centreline oneering tool) vay 05 Option a shows that the chnical apper e contour, with	nere is a ndix A co	ontains a	map which	s, National			ompared				
		Table 84 follow Gl <i>Table 84</i> Sy	shows data c asgow's existi Biodiversity a stem	on the ov ng SID c	erflight o entreline	f biodivers s.	e areas u SSSI area	o to 7000ft SPA count			heatmap National park area		NSA	ere to
	Biodiversity	Bas Vector d RV Bas (Cent Optio t RWY 0	VY 05 eline ring (NTK ata) VY 05 seline treline oneering ool) 5 Option I	0 0 0 light of \$	0 0 0 Special P	24 10 25 rotection A	10.46 3.31 12.99 Areas, Spe	11 0 9 ecial Areas	6.37 0 7.86	0 0 1 rvation, 1	0 0 12.7 National	0 0 1 Parks, N	0 0 1.62 ational S	Scenic
General Aviation	Access	Areas ar The desi potential would ne assessm are all w terms ar proportic We crea options of there is s	Below 2000ft no overflight of Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interests is expected which would offer some small benefits compared to the baseline. The design option may require changes to the existing CAS boundaries to accommodate the LOMON SID but still offers potential to reduce the total volume of CAS. The Northbound SIDs on this option with the 7% climb gradient as illustrated would not quite be contained within ScTMA 7 in accordance with the CAA CAS containment policy. However, this assessment (together with creation of the "illustrative CAS volume") assumed the northbound SIDs terminate at 7000ft and are all wholly contained within CAS which is unlikely to happen in reality because 7000ft does not exist in Airspace Design terms and these routes are leaving CAS anyway, therefore offering more protection than today is potentially not proportionate.											
General Aviation / Commerci al airlines	Economic impact from increased effective capacity	We expe on	CAS in the same lateral area is c.100nm ³ smaller than currently exists. The Glasgow CTR was c.47nm ³ smaller. We expect the increased effective capacity detailed in the section above will result in the greatest positive economic impact on commercial air traffic compared with the baseline do nothing westerly departure baseline.											
	Fuel burn	mileage. LOMON NORBO increase	nate that Option This option s , CLYDE and SIDs but also in track miles <i>Track Length C</i> . TRN NORBO–- SUBUK NORBO–- LAKEY LUSIV-DCS	hows re ROBBO in the ot is outwe	ductions routes. T her route ighed by s Fuel B ine (Cent % 0.8	in track m There are in as means th the decrea Burn RWY 04 treline) Weighting 31 75	ileage for ncreases f nat when c ases elsew 5 Easterly L	the TRN, to the LUS considered where. Departure O ore 50 .00 .36	NORBO S IV and FO against the	SUNUK, YLE rou	NORBO tes. The % move 7 43 40	LAKEY, reduction	TLA, PE n mainly	RTH, in the

⁴⁰ 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-S

		PERTH	50.30	0.27	13.58	50.20	13.55		
		FOYLE	19.10	0.18	3.44	20.30	3.65		
		LOMON	20.00	0.45	9.00	14.80	6.66		
		CLYDE	25.00	0.63	15.75	19.00	11.97		
		ROBBO	33.50	0.45	15.08	23.00	10.35		
		Total			1740.92		1591.93		
			o for the airs	pace above 70	000ft), it is anticipated	I that this o	ption would see a	east 6000ft (subject to n improvement in fuel	
Commerci al airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.							
	Other costs	No other airline costs	are foreseen	ı.					
Airport (Infrastructure costs	there are not expected. Unlike options that pro	d to be any c opose track a	hanges to infra djustments on	structure for the airpo	ort or the AN	ISP. o change the popul	however beyond this ations within the 63dB	
Airport / Air		LAeq,16h noise contour			0				
navigation service provider	Operational costs		w's depende	ncy on conven	tional ground based n	avigation e		nplementation of PBN which contributes to a	
provider	Deployment costs	and Glasgow Airport.	The scale ar	nd nature of th our shortlist o	is training requires fur	ther exploration	ation as part of the	ed at NATS Prestwick Stage 3 Full Options but the network above	
All	Safety	More detailed IFP investigation suggests a minimum climb gradient of 5.7% climb gradient is required up to 1400ft on the early left turn departures which is considered achievable for the majority of Glasgow traffic with the exception perhaps of the Twin Otter aircraft for which alternative tactical arrangements may be required.							
		The lack of a track adjustment on this option together with a permanent SID structure and SIDs that do not wrap around each other means this option will be more straightforward to assure within established rulesets.							
		There are no interdependencies, conflicts or trade offs with routes to/from other airports with Easterly departures below 7000ft however Easterly departures are sometimes required to be 'stepped up' underneath Edinburgh's GOSAM departures. Having a slightly earlier turn to the West on NORBO departures reduces this interaction. Also keeping the CLYDE/ROBBO/LUSIV/TLA traffic more closely aligned to existing traffic patterns minimises this interaction							
AII	Interdependenci es, conflicts and tradeoffs	having 2 NORBO SID	s maximises tioned the re	the benefits fi	om NERL's proposed both a LUSIV/TLA SI	l dual south	bound route struct	the LANAK hold and ure. In their Stage 2A is progressed, we will	
		The cumulative effect to be co-ordinated an			a result to CAS dime	nsions at Gl	lasgow, Edinburgh	and the ScTMA need	
		CAP1711 describes t	ne objective a	as:					
AII	AMS	Deliver quicker, quiet airspace. This option would sup option would be expe	er and clean port the mod cted to gene	er journeys and ernisation of th rate significant departures and	e airspace by accomr CO2 reductions, prov d a dual NORBO track	nodating fu ride some re	iture demand in an elief from noise to rould mitigate the ir	nd are affected by UK efficient manner. The those most frequently npacts on those newly re).	
		This option could be e	expected to re	esult in reduction	ons in the volume of G	Blasgow's C	AS.		

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⁴¹ 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-S

4.17. Runway 23 Westerly Arrivals Baseline

Runway 23 W	esterly Arrivals Bas	eline					
		The majority of aircraft are vectored to join final however they are allowed to join final approach as join final approach inside 6nm are likely performing For more information on our do nothing scenario,	s close as 2000ft/6nm when us g a visual approach.	sing the ILS. The tracks shown which			
		Portal.	please see our olage 2A docu	ment on the OAA's Anspace Onlange			
Group	Impact	Qualitative Assessment					
		Due to wind direction, westerly operations on run qualitative assessment has considered this modal					
		Aircraft arriving at Glasgow are tactically controlled (vectored) by ATC before joining final approach which is aligned with the extended runway centreline. Aircraft typically join final approach between 7nm and 13nm before landing although when undertaking an ILS approach they can be as close as 6nm. Aircraft may also undertake visual approaches closer than 6nm.					
		The NTK data shown in figure 26, demonstrates to that there are wide areas that are overflown betw Glasgow, Inverkip, Helensburgh, Cardross, Bogle Cumbernauld, Kilsyth, Airdrie, Wishaw, Carluke, eastern parts of the city centre of Glasgow. There before aircraft join the final approach which overflie Muirhead, eastern parts of Kirkintilloch, Milton of C	veen 1-10 times per day on av estone, Birdgend, Greenock, I Udston, Blantyre, East Kilbrid is some concentration which o s Larkhall, Motherwell, Belishill	verage including Weymess Bay, Fort Dumbarton, Bonhill, Balloch, Balfron, de, Newton Mearns, Clarkstone, and occurs from a south-easterly direction,			
			tan Pangadan na Inangy	and the second se			
				2019 baseline average summer day overflight swathe:			
Communities	Noise impact on health and quality of life	Figure 26 Runway 23 Departure Vectoring Swathe 2019 The technical appendix to this document includes		98			
		to note that this data is not modelled in the same we means of comparison between this baseline and the	vay as the overflight contours, I				
		The technical appendix also includes a baseline and not have any published PBN arrivals and therefor NTK data for 2019 and analysing the arrivals con- centreline has then been processed through the op Table 86 below includes data based on the NTK	the this centreline has been ger icentration which occurred acre- ptioneering tool in order to outp heat map as shown in figure	nerated by reviewing 92 day summer oss the vectored swathe. The output out the data tables and contours.			
		optioneering tool for if aircraft were to follow one control Table 86 Westerly arrivals baseline overflight data 0-700					
		System	Area (km²)	Population			
		RWY 23 Arrivals Baseline Vectoring	1659.74	1250066			
		(NTK data) RWY23 Arrivals Baseline (Centreline – optioneering tool)	184.13	139113			
		The data from these tables will be used to compar	e the westerly arrival options a	gainst the 'do nothing' baseline			
		In addition to population overflown, we also have hospitals and places of worship; the full data arour will provide a qualitative statement around this dat	data on the overflight of noise ad these is shown in technical a	e sensitive buildings such as schools,			
		60dB and 65dB L _{AMax} Technical Appendix A includes 60dB L _{AMax} contour and the options. Although we have shown a 65dl options as the scope of the contour is only on the f N60/N65 metrics which will be quantified at the Sta	B L _{AMax} contour in the appendizional approach. 60dB and 65dB	x, this does not change between the			

		Table 87 Westerly arrivals baselin	ne L _{AMax} data								
				60dB L	-AMax						
		System	Area ((km²)	Population						
		RWY23 Arrivals Baseline (Centreline – optioneering tool)	57.3	86	68289						
		The data from these tables will be used to compare the westerly arrivals options against the 'do nothing' baseline.									
		L _{Aeq} Westerly arrivals make up a co contours from 2017, as an indi									
		Noise Abatement Procedures As this baseline reflects current day, there would be no changes to NAPs as a result of this option.									
			Noise Mitigation The option doesn't see the use of multiple routes to share noise however routine vectoring does disperse the traffic. The option doesn't contain mechanisms for predictable respite.								
		Impacts to air quality are cons have a significant impact on lo			v around 1000ft	t (200m). Airci	aft flying abov	e this are unlik	ely to		
	Air Quality	Aircraft arriving at Glasgow fly This is when they are very clo lateral changes below 1000ft h	se to landin	ng. It's therefor	ore highly unlike	ely that any of	our arrival's o				
		Emissions of greenhouse gas linked to track length, we have assessment is therefore linked	initially lool	ked at the track	ck length for the	baseline wes	sterly arrivals.				
	Greenhouse gas impact	We will estimate the difference advantages/disadvantages of t than a typical flight today. As qualitatively describe anticipat technical appendix a.	the option. T CO2 emiss	his estimatio sions are link	n will consider we	vhether the air ence in aviati	craft tracks wil on fuel burnt,	l be longer or sh this will allow	horter us to		
	Capacity / resilience	disbenefits. Although vectoring to the vectoring practices may addition to this, no change to t	In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. Although vectoring of arrivals is expected to be able to meet the forecast demand, we anticipate changes to the vectoring practices may be required to facilitate the wider changes to CAS, the network and the departures. In addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme.								
		For some approaches, Glasge which are currently undergo decommissioned as part of a M approaches will remain availab event on an ILS outage.	oing a ratio NERL UK w	onalisation p ide programm	rogramme by ne under the Ai	NATS NERL rspace Moder	. This equip	ment is due t amme. Althoug	to be h ILS		
		of Outstanding Natural Beauty we've therefore included overf Tranquillity assessment. At this	CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Areas of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) and we've therefore included overflight data around these, National Parks and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP we will qualitatively assess whether the option differs from current day and whether this has the potential to impact tranquillity with regards to noise and AONB.								
Wider Society		Table 88 shows data on the ov The data from this table will be						e centreline bas	eline.		
	Tranquillity	Table 88 Westerly arrival baseline	e – Tranquillit	ty overflown 0-							
			SA count	NSA area	National Parks count	National Parks area	DQA count	DQA area			
		RWY 23 Arrival Baseline - Vectoring (NTK data)	1	17.51	5	79.21	8	2.29			
		RWY23 Arrival Baseline (Centreline – optioneering tool)	1	23.63	1	34.52	0	0			
	Biodiversity	general, airspace change pro ground-based infrastructure. A legislation." Though there is lin that disturbance effects associ 500m (~1,640ft). Consideratio Special Protection Areas, Spe Scientific Interest, particularly Aircraft arriving at Glasgow fly	optioneering tool) The effects of airspace change on ecology or biodiversity are expected to be minimal. CAA guidance states that "In general, airspace change proposals are unlikely to have an impact upon biodiversity because they do not involve ground-based infrastructure. As such they are unlikely to have a direct impact that would engage the Birds or Habitats legislation." Though there is limited research available on the effects of aircraft noise on wildlife, there is some evidence that disturbance effects associated with aircraft can occur during take-off and landing where aircraft are below around 500m (~1,640ft). Consideration will therefore be given to the effects on ecology and biodiversity where aircraft overfly Special Protection Areas, Special Areas of Conservation, National Parks, National Scenic Areas and Sites of Special Scientific Interest, particularly at altitudes below 2,000ft.								
General		centerline). It's highly unlikely however we will compare this This baseline scenario would r	that any of baseline ag	our arrival's o ainst each op	options will have	e any lateral c	hanges betwe	en 5nm and la	nding		
Aviation	Access	today. The options will be qual							P.000		

		Figure 27 Glasgow Airport Co	ontrol Zone and Control Area C	Chart (See eAIP for full details)	
		Airspace (CAS) volumes which generates the volu- limits with the volume clo Also, in this figure can b	b. In addition to this, the Scourses shown in Figure 27. posest to the airport going down on the airport gown on the airport going down on the airport going down on the a	and Glasgow Prestwick Airport each with their of ottish TMA airspace sits above and around the air The controlled airspace at Glasgow has varying lo wn to ground level. This is the Glasgow CTR shown ort approximately 15nm to the east of Glasgow air his is indicated with a yellow dot.	ports' airspace wer and upper n in red outline.
		CAS structures to support	rt Glasgow Airport's operation	nt by Glasgow and CAA's Airspace Classification F on are out of date and the CTR itself can likely be re the requirement for more airspace, this option offers	educed in size.
		to simplify the airspace be with GA stakeholders to t to the Edinburgh-Glasgo	oundaries or reduce the size ry to achieve. The most pror w Gap and the associated (of CAS which is something Glasgow has been spec ninent feature of Westerly arrivals in relation to CAS Gliding Corridor with a base of 3000ft. The ability to and the gliding community.	ifically working is with regards
	Economic impact from increased effective capacity	There will be no increas system).	e to effective capacity by d	oing nothing with Westerly arrivals (in isolation to	the rest of the
		As the compustion of avi	iation fuel is linked to track l	ength, we have initially looked at the track length f	or the baseline
General		westerly arrivals. When arriving at Glasgov is varied from flight to flig we have used the NTK v then used the track milea a weighting based on arri	w, aircraft are vectored by A ght. For the purposes of con vectoring baseline data and uge from this centreline as ar	ength, we have initially looked at the track length for TC before joining the final approach. This means the paring our westerly arrival options against the bas information from ATC to estimate an arrivals centre initial indication of 'do nothing' track length. We have verall total track mileage for the system. At the Stag in further detail.	nat track length eline scenario, eline; we have ve then applied
Aviation / Commercial		westerly arrivals. When arriving at Glasgov is varied from flight to flig we have used the NTK v then used the track milea a weighting based on arri appraisal track length and <i>Table 89 Westerly Arrival T</i>	w, aircraft are vectored by A ght. For the purposes of con vectoring baseline data and uge from this centreline as ar ival direction to provide an o d fuel burn will be modelled	TC before joining the final approach. This means the paring our westerly arrival options against the bas information from ATC to estimate an arrivals centre initial indication of 'do nothing' track length. We have verall total track mileage for the system. At the Stag	nat track length eline scenario, eline; we have ve then applied
Aviation /	Fuel burn	westerly arrivals. When arriving at Glasgov is varied from flight to flig we have used the NTK w then used the track milea a weighting based on arri appraisal track length and <i>Table 89 Westerly Arrival T</i>	w, aircraft are vectored by A ght. For the purposes of con vectoring baseline data and uge from this centreline as ar ival direction to provide an o d fuel burn will be modelled irack Mileage	TC before joining the final approach. This means the paring our westerly arrival options against the bas information from ATC to estimate an arrivals central indication of 'do nothing' track length. We have verall total track mileage for the system. At the Stage in further detail.	nat track length eline scenario, eline; we have ve then applied
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	, conflicts tradeoffs	and	between Westerly arrivals to Glasgow and Easterly arrivals to Edinburgh. Doing nothing will not reduce those dependencies however in all options, we expect some dependencies and airspace buffer arrangement will continue to be required based on the geography of the airports and runways.
			CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
AII	AMS		Whilst vectoring of arrivals is a perfectly reasonable options in a future operating environment, doing nothing with Westerly departures will not align with the AMS as it would constrain other options. Limiting our options to one which sees no change to vectoring practices could also reduce the ability to change CAS boundaries and improve CDA performance.

4.18. Runway 23 Arrival Option C

Runway 23 W	esterly Arrivals Opti	on C
		PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 8nm.
		For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 8nm, and would be used by around 69% of overall arrivals.
		Option Overflight Contours (Black outline) with estimated % of overall arrivals
		Figure 28 Westerly Arrivals Option C Overflight and 2019 baseline NTK data
Communitie s	Noise impact on health and quality of life	Route from the North This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 28 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today.
		Route from the South The route from the south would see aircraft start a continuous descent at 7000ft from around the Larkhall area. When reviewed against the NTK data in figure 28, the route then tracks north-west following the same areas where there is concentration in arrivals today. This occurs over the populated areas of Motherwell, Bellshill, Cuparhead, Gartcosh, and East Kirkintillock amongst others. Aircraft then turn to join the final approach at 8nm from the threshold, over Milton on Campsie and Lennoxtown. Reviewed against the NTK data shown in figure 28, this is area where concentration of arrivals traffic is also seen today. Aircraft then join the final approach and overfly the same areas as they do today.

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is a small decrease in the area of the contours and the number of population and noise sensitive sites overflown.

Note that a Centreline for the baseline does not actually exist in reality, we created one based on the areas most frequently overflown by RWY 23 arrivals in today's airspace arrangement. Compared to the other options, Option C overflies the highest number of population compared between 0-4000ft and 0-7000ft. *Table 90 Westerly arrivals option C overflight data*

System	Area (km²)	Population			
RWY 23 Baseline (Vectoring)	1659.74	1250066			
RWY23 Baseline (Centreline)	184.13	139113			
RWY23 Option C	180.49	129769			
	Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in number of schools, care homes, and places of worship overflown compared to the centreline baseline data. Hospit				

		remained the same. There is note that at this stage none of will result in a reduction in nu than today. This is something this option progress. The ful detailed in technical appendi	of the data o umber of bui g that will be I data tables	considers the ildings overflo e explored fur	frequency of over own, those that are ther as part of the	flight; althou e overflown Stage 3 full	ugh concentrat will likely be at options appra	ed PBN flight paths a higher frequency isal analysis should	
		50dB and 65dB L_{AMax} Technical Appendix A includes 60dB which compare Option C against the centreline baseline. These 60dB co are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as a In table 85 shows a decrease in the area and population within the 60dB L _{AMax} contour. The 65dB L _{AMax} contours r he same between the baseline and this option.							
		Table 91 60dB L _{AMax} Data - Rwy	/23 Arrival Op	otion C					
				60dB	L _{AMax}				
		System	Area	(km²)	Population				
		RWY23 Baseline (Centreline Optioneering tool)	- 57	7.86	68289				
		RWY 23 Dep Option C	55	5.49	63544				
		L _{Aeq} The north-east component of northerly arrival component of the shape/size of the L _{Aeq} co that this may influence the sh with the contour shape adjust	of option C jo ntour. The s nape of the o	oins the final a southerly arrivouter most 51	approach at 12nm /al component join dB contour althou	and therefo s at 8nm an gh we would	re we do not e nd therefore the d expect this to	expect this to impact ere is the possibility	
	Air Quality	This option has no change to changes to local air quality (p						e are no anticipated	
	Greenhouse gas impact	Our fuel burn assessment (s to the baseline. We therefore explored in further detail in the	re expect to	see a corre	sponding increase	e to greenho	ouse gas emi		
	Capacity /	explored in further detail in the Stage 3 Full Options Appraisal should this option progress. Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result less accurate final approach spacing meaning lower runway utilisation.							
	resilience	The introduction of PBN approaches will improve Glasgow'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.							
		Table 92 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline.							
		Table 92 Westerly arrival option C – Tranquil areas overflown 0-7000ft							
Wider Society		System NSA count NSA area National National DQA count DQA area						DQA area	
	Tranquillity	RWY 23 Baseline - Vectoring (NTK data) RWY 23	1	17.51	5	79.21	8	2.29	
		Baseline (Centreline – Optioneering tool)	1	23.63	1	34.52	0	0	
		Runway 23 Option C	0	0	1	26.29	0	0	
		The data shows that there is a reduction in NSAs, National Parks and DQAs overflown. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.							
	Biodiversity	The routes that form part of a typically associated with char before landing, this option is	nges below	1640ft, which	when flying a star	idard 3 degr			
General Aviation	Access	Use of a pure PBN solution expected to significantly redu							
	Economic impact from increased effective capacity	Use of PBN transitions alone less accurate final approach							
		We estimate that Option C, when compared to baseline nominal centrelines, will result in a small overall increase ir track mileage.						l overall increase in	
		Track Mileage				Track m	iles (Weigh	ted 69%	
General Aviation / Commercial airlines		Option	Trac	Track miles (nm)			3% (North)		
		Baseline (centreline) 58.2 2380.6 C 62.8 2513.2							
	Fuel burn	This increase in driven large compared to today in order t A. The southern route is alr arrivals.	o avoid nois	se sensitive si	ites. This can be s	een in the n	naps shown in	technical appendix	
		All arrival options have been airspace above 7000ft).	designed to	o continuousl	y descend from 70	000ft (subjec	ct to the NATS	NERL ACP for the	
		As part of Stage 3, should the review whether we can balar to understand the impacts of	nce noise ar	nd CO2 on th	e northern route.	Ne will also	quantify fuel b	ourn in further detail	

		CO ₂ and noise.
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴² .
provider	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further east.
All	Interdependencies , conflicts and tradeoffs	As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinbugh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects of a pure PBN arrival solution at Glasgow include increased delay, reduced economic benefit, increased CO ₂ emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

⁴² 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-S

4.19. Runway 23 Arrival Option D

Runway 23 We	esterly Arrivals Option	on D
		PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 9nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 9nm, and would be used by 69% of overall arrivals.
		Option Overflight Contours (Black outline with estimated % of overall arrivals
		Figure 29 Westerly Arrivals Option D Overflight and 2019 baseline NTK data
Communitie s	Noise impact on health and quality of life	Route from the North This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 29 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today. Route from the South The route from the south would see aircraft start a continuous descent at 7000ft from around the northern part of the Larkhall area. When reviewed against the NTK data in figure 29, the route then tracks north/north-west tracking slightly north-east of where the heat map shows the main concentration occurring today. This part of the route flies over the populated areas of Motherwell, Bellshill, Cuparhead, Coatbridge, Croftfoot, and east of Moodiesburn. Aircraft then turn to join final approach at around 9nm from the threshold. The NTK data in figure 29 shows that this happens north-east of today's arrival concentration however this avoids the densely populated area of Kirkintilloch and Milton on Campsie and largely routes over areas with relatively low population density. Aircraft then join the final approach and overfly the same areas as they do today.

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using

concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 93 Westerly arrivals option D overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	1659.74	1250066
RWY23 Baseline (Centreline)	184.13	139113
RWY23 Option D	178.24	118103

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, and places of worship overflown compared to the centreline baseline data. There is an increase in hospitals. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths

		will result in a reduction in nu than today. This is something this option progress. The full detailed in technical appendix	g that will be data tables	explored furth	her as part of th	e Stage 3 full	options appra	isal analysis should
		60dB and 65dB L _{AMax} Technical Appendix A include are an indicator of the N60 m in table 94 shows a decrease the same between the baseli	netrics which in the area a	will be quant	ified at the Stag	e 3 Full Optic	ons Appraisal.	The data, as shown
		Table 94 60dB L _{AMax} Data - Rwy	/23 Arrival Opt	tion D				
				60dB L	-AMax			
		System	Area	(km²)	Population			
		RWY23 Baseline (Centreline Optioneering tool)	- 57.	86	68289			
		RWY 23 Dep Option D	54.	55	54040			
		L _{Aeq} The north-east component of Option D sees a turn onto fi shape or size of the L _{Aeq} cont	nal approach					
	Air Quality	This option has no change to changes to local air quality (p						e are no anticipated
	Greenhouse gas impact	Our fuel burn assessment (so to the baseline. We therefor explored in further detail in th	e expect to	see a corres	ponding increa	se to greenh	ouse gas emis	
		Use of PBN transitions alone less accurate final approach					lding would inc	rease as a result of
	Capacity / resilience	The introduction of PBN appr part of a NERL UK wide pr precision approach and NDB	ogramme ur	nder the Airs	pace Modernisa	ation program		
		Table 95 shows data on the baseline:	overflight of	areas of tranc	quillity based or	the NTK veo	ctoring baseline	e and the centreline
		Table 95 Westerly arrival Option D – Tranquil areas overflown 0-7000ft						
Wider Society		System N	NSA count	NSA area	National Parks count	National Parks area	DQA count	DQA area
	Tranquillity	RWY 23 Baseline - Vectoring (NTK data)	1	17.51	5	79.21	8	2.29
	Tanquinty	RWY 23 Baseline (Centreline –	1	23.63	1	34.52	0	0
		Optioneering tool) Runway 23 Option D	0	0	0	0	0	0
		The data shows that there is a reduction in NSAs, National Parks and DQAs overflown; all are avoided. Technical appendix A contains a map which shows the overflight contour of this option alongside the baseline centreline contour, with tranquil sites also shown.						
	Biodiversity	The routes that form part of Arrival Option D join the final approach at 9nm and 12nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.						
General Aviation	Access	Use of a pure PBN solution expected to significantly redu						
	Economic impact from increased effective capacity	Use of PBN transitions alone less accurate final approach						
		We estimate that Option D, when compared to baseline nominal centrelines, will result in a small overall increase in track mileage.						
		Track Mileage				Treak	ilee (Meisch	
		Option	Trac	k miles (nm)		Track m (South), <i>*</i> 2019 mod	13% (North)	
General Aviation /		Baseline (centreline)	58.2 63.9			2380.6 2589.1		
Commercial airlines	Fuel burn	D63.92589.1This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a slightly longer path as it joins final approach at 9nm which further than most arrivals typically join today.						
		All arrival options have been airspace above 7000ft).	designed to	continuously	descend from ⁻	7000ft (subje	ct to the NATS	NERL ACP for the
		As part of Stage 3, should the will review whether we can be to understand the impacts of CO_2 and noise.	alance noise	and CO ₂ on the	ne northern rout	e. We will als	o quantify fuel l	burn in further detail
Commercial airlines	Training costs	Flight procedures are update their procedures accordingly						

		any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴³ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS
		alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further east.
All	Interdependencies , conflicts and tradeoffs	As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

⁴³ 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-S

4.20. Runway 23 Arrival Option E

Runway 23 Wes	terly Arrivals Option E	
L Ht		PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 10nm.
		For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Crown	Impost	
Group	Impact	Qualitative Assessment Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 12nm from the runway, and be used by around 13% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 10nm, and would be used by 69% of overall arrivals.
		Fyure 30 Westerly Arrivals Option E Overflight and 2019 baseline NTK data
Communities	Noise impact on health and quality of life	Route from the North This route would see aircraft continuously descending from 7000ft over areas of relatively low population. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map suggests these areas are not heavily populated and by relocating the arrival route to the north, populated areas such as Dryman and Balfron can be avoided. On the base-leg, (as aircraft turn to the south-east), the route continues to avoid overflight of populated areas with the exception of Buchlyvie before turning to join final approach. The NTK data shown in figure 30 suggests that this turn takes place in around the same areas as some concentration occurs today, although this could be more concentrated in future. Aircraft then join the final approach and overfly the same areas as they do today.
		Route from the South The route from the south would see aircraft start a continuous descent from 7000ft, from around south of Motherwell. When reviewed against the NTK data in figure 30, the route then tracks north/north-west flying north- east of where the heat map shows the main concentration of arrivals occurring today. This part of the route flies over the populated areas of Motherwell, Bellshill, New Stevenson, Coatbridge, Glenboig, and Croftfoot. Aircraft then turn to join final approach at around 10nm from the threshold. The NTK data in figure 30 shows that this happens north-east of today's arrival concentration however this avoids the densely populated area of Kirkintilloch, Milton on Campsie and Moodiesburn nd largely routes over areas with relatively low population density with the exception of the small areas of Twechar and southern parts of Queenzieburn. Aircraft then join the final approach and overfly the same areas as they do today.

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 96 Westerly arrivals option E overflight data

System	Area (km²)	Population
RWY 23 Baseline (Vectoring)	1659.74	1250066
RWY23 Baseline (Centreline)	184.13	139113
RWY23 Option E	175.89	115858
Data on the number of noise sensitive building	gs (schools, hospitals and places o	f worship) shows a decrease ir

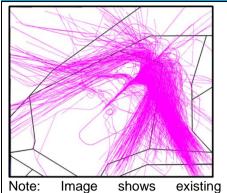
		the number of schools, can There is an increase in hos it's important to note that concentrated PBN flight par will likely be at a higher free 3 full options appraisal and buildings such as hospitals 60dB and 65dB L AMax Technical Appendix A incl	pitals. There is t at this stage ths will result i quency than to alysis should t and schools, udes 60dB w	s a significant e none of th n a reduction oday. This is s his option pro are detailed i hich compare	t decrease compar- ne data considers in number of build something that will ogress. The full da n technical append e Option E agains	ed to the ve the freque ings overflo be explored ta tables a lix A.	ectoring data in ency of overfli wn, those that d further as pain nd counts of n eline baseline.	all areas, but ght; although are overflown rt of the Stage oise sensitive These 60dB		
		contours are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appr data, as shown in table 97 shows a decrease in the area and population within the 60dB L _{AMax} contour. L _{AMax} contours remain the same between the baseline and this option.								
		Table 97 60dB L _{AMax} Data - R								
		Sustan		60dB						
		System RWY23		(km²)	Population					
		Baseline (Centreline Optioneering tool)	- 57	.86	68289					
		RWY 23 Dep Option E	53	.19	53821					
		L _{Aeq} The north-east component Arrival Option E sees a turr alter the shape or size of th	n onto final ap	proach at 9ni						
	Air Quality	This option has no change anticipated changes to loca								
	Greenhouse gas impact	Our fuel burn assessment compared to the baseline. This will be explored in furt	We therefore	expect to see	e a corresponding i	increase to	greenhouse g	as emissions.		
	Capacity / resilience	This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress. Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation.								
		The introduction of PBN approaches will improve Glasgow'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.								
		Table 98 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline:								
Midan Casiata	Tranquillity	Table 98 Westerly arrival Option E – Tranquil areas overflown 0-7000ft Sustam NSA areas National National								
Wider Society		System RWY 23 Baseline -	NSA count	NSA area	Parks count P	arks area	DQA count	DQA area		
		Vectoring (NTK data) RWY 23	1	17.51	5	79.21	8	2.29		
		Baseline (Centreline – Optioneering tool)	1	23.63	1	34.52	0	0		
		Runway 23 Option E	0	0	1	26.29	0	0		
		The data shows that there is a reduction in the overflight of National Parks and there is also reduction in NSAs and DQAs which are now avoided.								
	Biodiversity	The routes that form part of Arrival Option E join the final approach at 9nm and 12nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.								
General Aviation	Access	Use of a pure PBN solution expected to significantly re								
	Economic impact from increased effective capacity	Use of PBN transitions alo result of less accurate fina economic effect.	ne is likely to al approach s	reduce capa pacing mean	icity as airborne ar ing lower runway	nd ground I utilisation.	nolding would There would b	increase as a be a negative		
		We estimate that Option E, when compared to baseline nominal centrelines, will result in an overall increase in track mileage.								
		Track Mileage				Track m	iles (Weigh	ted 69%		
		Option		k miles (nm))	Track miles (Weighted 69% (South), 13% (North) based on 2019 modal split)				
General Aviation / Commercial airlines		Baseline (centreline) E	58.2 <mark>72.8</mark>			2380.6 3203.2				
	Fuel burn	This increase in driven by compared to today in orde appendix A. The southern most arrivals typically join t	er to avoid no route also tak	ise sensitive	sites. This can be	e seen in th	ne maps show	n in technical		
		All arrival options have bee the airspace above 7000ft)		continuously	descend from 700	00ft (subject	to the NATS N	NERL ACP for		
		As part of Stage 3, should t we will review whether we further detail to understand order to try to balance CO ₂	can balance r	noise and CC	D ₂ on the northern	route. We v	vill also quanti	fy fuel burn in		

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴⁴ .
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding. The use of a PBN arrival to RWY 23 may deliver safety enhancements through enabling a reduction in false GPWS alerts due to high ground under final approach/base-leg. This option would require a re-design of the ILS to move the FAF closer or move the PBN path slightly further
All	Interdependencies, conflicts and tradeoffs	east. As this PBN arrival remains clear of the existing Glasgow-Edinburgh buffer, so long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this PBN arrival option.
All	AMS	 CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

⁴⁴ 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-S

4.21. Runway 23 Arrival Vectors only

Runway 23 Westerly Arrivals Vectors only



vectoring swathe. Visualisation of option to be developed at Stage 3

once further information around

airspace above 7000ft is known

alongside more information about

departures and CAS arrangements.

Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Westerly arrivals on a single path. Communities can sometimes favour the 'spreading' of arrivals to mitigate against potential adverse effects of concentration as seen in Design Principle 6.

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

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

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

For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		In this vectoring option, aircraft arriving at Glasgow would continue to be tactically controlled (vectored) by ATC before joining final approach. Today aircraft typically join the runway 23 final approach between 7nm and 13nm before landing although when undertaking an ILS approach they can be as close as 6nm. This option would continue to see aircraft joining the final approach at these distances, although there is a small possibility that this could be influenced by changes to the airspace above 7000ft and departures – this will be explored in further detail at Stage 3 should this option progress.
		Unlike PBN routes, tactical controlling of aircraft typically leads to higher levels of dispersion of flights and therefore sharing of the noise. The NTK data shown in figure 31, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas that are overflown between 1-10 times per day on average including Weymess Bay, Fort Glasgow, Inverkip, Helensburgh, Cardross, Boglestone, Birdgend, Greenock, Dumbarton, Bonhill, Balloch, Balfron, Cumbernauld, Kilsyth, Airdrie, Wishaw, Carluke, Udston, Blantyre, East Kilbride, Newton Mearns, Clarkstone, and eastern parts of the city centre of Glasgow. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Larkhall, Motherwell, Belishill, Coatbridge, Gartcosh, Moddlesburn, Muirhead, eastern parts of Kirkintilloch, Milton of Campsie, and Lennoxtown.
Communities	Noise impact on health and quality of life	<figure></figure>
		Figure 31 Runway 23 Departure Vectoring Swathe 2019
		The vectoring swathe as seen in Figure 31 is influenced by how aircraft arrive from the airspace above 7000ft, how departures operate, and by the structure of the surrounding CAS. This option will therefore evolve as further details

are known about where aircraft will enter at 7000ft, where and how the departures might be operated, and the shape and size of the CAS volume.

For the purposes of this IOA, we will use the baseline data as the closest representative data for this option. The technical appendix includes NTK and centreline data for the baseline. It's important to note that the NTK data is not modelled in the same way as the other data, however it does provide a preliminary means of comparison between this baseline and the airspace change options.

Table 99 below includes data based on the NTK heat map as shown in figure 33 above:

Table 99 Westerly arrivals baseline overflight data 0-7000ft

System	Area (km²)	Population
RWY 23 Arrivals Baseline - Vectoring (NTK data)	1659.74	1250066

In addition to population overflown, we also have data on the overflight of noise sensitive buildings such as schools, hospitals and places of worship:

		System		Schools count	Hospitals c	ount Care	e homes count		s of worship
		RWY 23	Baseline		23		206	count	695
			luency of o	higher number of verflight will be lov at Stage 3.					
		and the options. the baseline, ho centreline data. to equivalent PB	ndix A inclue Similar to t wever this It also does N routes. V	des 60dB L _{AMax} cor he overflight data data does not curr not articulate the Ve will explore this long the extended	above, the po ently take into frequency of in further deta	pulation within o account the fo overflight which ail a Stage 3 sho	the 60dB LAMax ull vectored swa would be lower ould the option p	x contours athe, as it is for some a progress. T	is highest within s modelled from areas compared he 65dB LAMax
		Table 100 Wester	ly arrivals ba	seline L _{AMax} data					
					60dB LAMax				
		System		Area (km ²	²) F	opulation			
		RWY23 Arrivals Baseline (Ce Optioneering to	entreline	- 57.86		68289			
		option is expected option to alter the	ed to see ai le shape or	of the existing L _{Ae} rcraft continue to j size of the L _{Aeq} cc e fully quantified.	oin final appro	bach as they do	today and there	efore we do	o not expect this
	Air Quality			to how aircraft fly l (positive or negativ					e no anticipated
	Greenhouse gas impact	compared to the	e baseline.	see below) has an We therefore exp the Stage 3 Full O	ect neutral b	enefit/impact to	o greenhouse ga	as emissio	
	Capacity / resilience	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future subject to some potential changes to the vectoring patterns as a result of the changes to surrounding structures.							
		Vectoring only would not 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.							
Wider Society		Table 101 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the impacts to tranquillity.							
	Tranquillity	Table 101 Westerly vectors only – Tranquil areas overflown 0-7000ft							
		Systen	n I	NSA count NSA	area	al Parks Na ount	tional Parks area	QA count	DQA area
		RWY 23 Bas (Vectorin	ng)	1 17.	51	5	79.21	8	2.29
		RWY23 Baseline (Cer	-	1 23.	63	1	34.52	0	0
	Biodiversity	are typically ass	ociated with	ange where aircra n changes below 1 ion is not expected	640ft, which v	when flying a sta	andard 3 degree	approach	occur at around
General Aviation	Access			e to a reduction in opportunity to red				on can be o	contained within
	Economic impact from increased effective capacity	today's airspace	through ve	cted to cope with ectoring could be e ctoring patterns as	xpected to be	delivered throu	ugh vectoring in	the future	
General		vectoring swath	e to be sim	e centreline data fo nilar today howeve on the benefits and	r, should this	option progres			
Aviation / Commercial airlines	Fuelburg	Table 102 Wester	ly Arrival Tra	ck Mileage					
	Fuel burn	Track Mileage			T	rack miles	(Weighted		
		Option		Track miles (nn	ı) 6	9% (South), 1 ased on 2019 i	3% (North)		
		Baseline (centre	,	58.2	2	380.6			
Commercial airlines	Training costs		according	ed or introduced w y and undertake to s for airlines.					
	Other costs	No other airline				ATC aveter	anginooring are	andmonto "	
Airport / Air	Infrastructure costs	this there are no	t expected	se of the ACP may to be any changes	to infrastruct	ure for the airpo	ort or the ANSP.		
navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables							

		VOR rationalisation ⁴⁵ ;
	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	No safety concerns have been identified at this stage.
All	Interdependencies, conflicts and tradeoffs	As detailed in our Stage 2A documentation on the CAA airspace change portal there are currently interdependencies between Westerly arrivals to Glasgow and Easterly arrivals to Edinburgh. We expect some dependencies and airspace buffer arrangement will continue to be required based on the geography of the airports and runways. Any changes to vectoring practices would only be as a result to changes to surrounding airspace and route structures enabled by other options.
All	AMS	 CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. Vectoring of arrivals in the future would not deliver a PBN arrival solution, nor reduce the numbers of people overflown / affected by noise from Glasgow's arrivals. However it is unlikely to change the adverse effects which would be measured within the LOAEL which would not extend out to the final approach joining point. This option would meet future demand however it may not be the best future-proofed option should technological enhancements become available in the future to better rely on a pure PBN arrival solution for Glasgow.

⁴⁵ 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-S

4.22. Runway 23 Arrival Vectors and PBN hybrid

Runway 23 We	esterly Arrivals Vect	tors and PBN hybrid				
		Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. There are however the benefits of PBN for arrivals.				
		This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing.				
		The PBN arrival(s) would likely be the 'best performing' of Options C-E above which are then optimised in Stage 3 to balance CO ₂ , noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation.				
overflight conto Visualisation developed at s shortlist is kn further info vectoring arran	athe alongside the ours for Options A-D. of option to be Stage 3 once PBN nown and there is prmation around agements.	For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.				
Group	Impact	Qualitative Assessment				
		Due to wind direction, westerly operations on runway 23 occur approximately 82% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.				
		This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing.				
		The PBN arrival component could be any of the PBN options already assessed; the option taken forward will depend on the shortlisting as part of this IOA and the outcome of the Stage 3 Full Options Appraisal.				
		Below provide links to the four assessments for the PBN Options: Initial Options Appraisal – Runway 23 Arrival Option C Initial Options Appraisal – Runway 23 Arrival Option D Initial Options Appraisal – Runway 23 Arrival Option E				
		The PBN option assessments linked above have shown that there is the potential for PBN routes to reduce the numbrof people and noise sensitive sites overflown, however due to the concentration created by PBN routes, areas overflow would likely be at a higher frequency than today.				
		By combining with vectoring, some of this concentration from PBN routes could be mitigated, as some aircraft would continue to be tactically controlled and would therefore see the dispersion that occurs today. This dispersion has been described in the vectoring option linked below: <u>Initial Options Appraisal – Runway 23 Arrival Vectors only</u>				
		As described in the Vectoring assessment, the shape/size of the vectoring swathe will be dependent on a number of factors which are yet to be determined including the airspace above 7000ft, the departure options, and the CAS arrangements. We will explore this further at Stage 3.				
		For this IOA, we have included an image which shows all of the potential PBN options alongside the vectoring swathe. In Stage 3 we will refine this in further detail as described above and we will also quantify when we would expect to see the PBN and vectoring used.				
Communitie s	Noise impact on health and quality of life	PBN Options Overflight Contours (Black outline) with estimated % of overall arrivals				
		2019 baseline average summer day overflight swathe:				
		69%				



Figure 32 Runway 23 PBN (All potential options) and Vectoring. Note only one PBN option would be proposed alongside vectoring.

Overflight Data The individual sections of the PBN Options linked above provide more detailed information on the areas overflown and overflight data. Table 103 below shows the comparison between the baseline NTK vectoring data and the different options. Although the NTK vectoring data is not modelled in the same way as the centreline data, it does provide a preliminary means of comparison between the baseline and the airspace change options.

		System	Area	Population	Schools count	Hospitals count	Carehomes count	Places c worship count		
		RWY23_BASE (Vectoring NTK data)	1659.74	1250066	399	23	206	695		
		RWY23_BASE (Centreline)	184.13	139113	66	0	22	83		
		RWY23_C	180.49	129769	58	0	20	82		
		RWY23_D	178.24	118103	51	1	18	79		
		RWY23_E	175.89	115858	50	1	15	80		
		Overall, the data suggests that vectoring baseline however the articulated in the data tables a	ese options	s will result in so						
		This suggests that the combination of utilising PBN routes alongside vectoring may have some noise benefit would mitigate some of the impacts of concentration for those communities living under the PBN routes, routes would mean that when traffic allowed, a far lower number of people would be overflown compared t will be explored in further detail should this option progress to Stage 3.								
		60dB and 65dB L _{AMax} Technical Appendix A includes At this stage we do not have L data shows that the PBN arri although at this stage, this da Similar to the overflight assess mitigate the impacts of PBN w this will be explored further in S	AMax data fo vals routes ita does no sment abov ith some of	or the vectoring o result in a redu ot take into acco ve, by offering a l f the benefits of v	r overall N60 i iction in area unt the freque nybrid PBN/ve vectoring whic	metrics - we wi and population ency of overflig ctoring option, h may result in	Il quantify these a within the 60dE there would be of favourable LAMAN	at Stage 3. The 3 L _{AMax} contou likely increase opportunities to		
		L _{Aeq} The north-east component of th of the PBN Options and the V the LAeq contour and therefore	ectors only e this hybri	option have sug d option is also u	gested that th Inlikely to sign	ere will be no ificantly impact	impact to the sha t the shape or siz	ape and size o e.		
	Air Quality	This option has no change to changes to local air quality (po		•	•			no anticipated		
	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated this option will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.								
	Capacity /	Option is expected to enhance Glasgow's operational performance in the future. This is because ATC can use the PBN arrivals when traffic levels are low-medium and this will also facilitate the use of combined Tower and Approach services (Radar In Tower) offering additional resilience to ATC resource.								
Wider Society	resilience	The introduction of PBN approaches will improve Glasgow'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.								
wider society	Tranquillity	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that there are benefits to areas of tranquillity for all runway 23 PBN options. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offer neutral benefits/impacts to areas of tranquillity. Overall, at this stage, the IOA suggests there may therefore be some benefits to the overall hybrid option owing to the use of the PBN routes. We will explore this tranquillity assessment further in Stage 3 should this option progress.								
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. The PBN options also all join the final approach from at 10 or 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.								
General Aviation	Access	Option is likely to contribute to existing CAS whilst offering so					option can be co	ontained within		
General	Economic impact from increased This option would be expected to cope with future of airspace through vectoring could be expected to b			ected to be delive gow in the case o	demand. The peak hourly landing rate already experienced in today' be delivered through vectoring in the future and the feature of PBN i e case of technological enhancements that may allow for greater us s.					
Aviation / Commercial airlines	Fuel burn	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that the may be increases in track mileage and fuel burn as a result of the PBN options. For the purposes of this IOA we hassumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offer new benefits/impacts to fuel burn. Overall, at this stage, the IOA suggests there may therefore be some impacts to fuel b as a result of a hybrid option although these will be less than operating purely PBN arrivals alone.								
Commercial Training costs Flight procedures are updated or introduced worldwide as part of an their procedures accordingly and undertake training if required. The procedures accordingly according										
airlines	Other costs	No other airline costs are fores	seen.							
	Infrastructure	The initial deployment phase	of the ACP					owever beyon		
Airport / Air navigation service provider	Costs Operational costs	this there are not expected to be any changes to infrastructure for the airport or the ANSP. This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴⁶ ;								
	Deployment costs	This option is expected to re Prestwick and Glasgow Airpor								

⁴⁶ 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-S

		Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All Safety		Use of a PBN solution to RWY 23 may reduce the number of false GPWS alerts occasionally experienced by some arrivals.
		No other safety issues identified with this option.
All	Interdependencies , conflicts and tradeoffs	So long as future Edinburgh GOSAM departures can ensure CCO to be above MSL there should not be any dependences with Edinburgh below 7000ft. There would not be any dependencies with the network design with this option assuming LANAK stays where it is however that stack may require re-alignment to enable some RWY 05 departure options which could affect the upper portions of this hybrid-PBN arrival option.
All	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. This option is considered to best meet the requirements of the AMS for Westerly arrivals. It introduces a PBN arrival solution without being reliant on it which ensures that demand can be met but allowing improved CDA for arrivals using the PBN structure. The feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders. It would help to reduce the number of people overflown by Glasgow's arrivals without concentrating all arrivals permanently onto 2 routes.

4.23. Runway 05 Easterly Arrivals Baseline

Runway 05 Easterly Arrivals Baseline						
	The how join For Port					

The majority of aircraft are vectored to join final approach between approximately 8nm and 11nm from touchdown however they are allowed to join final approach as close as 2000ft/6nm when using the ILS. The tracks shown which join final approach inside 6nm are likely performing a visual approach.

For more information on our do nothing scenario, please see our Stage 2A document on the CAA's Airspace Change Portal.

Group	Impact	Qualitative Assessment				
		Due to wind direction, easterly operations on qualitative assessment has considered this mo				
		Aircraft arriving at Glasgow are tactically contr with the extended runway centreline. Aircraft ty landing although when undertaking an ILS app approaches closer than 6nm.	pically join the runway 05 final app	proach between 8nm and 11nm before		
		The NTK data shown in figure 33, demonstrate that there are wide areas to the south of the airp Darvel, Newmilns, Galston, Kilmarnock, Kilmau which occurs from a south-easterly direction, b and Beith:	port that are overflown between 1- irs, Dunlop, Kilwinning, Dalry, and	10 times per day on average including Kilbirnie. There is some concentration		
Communitie	Noise impact on health and quality			22		
S	of life	Figure 33 Runway 23 Departure Vectoring Swathe 2	2019			
		The technical appendix to this document includes a larger version of this map along with overflight data. It's important to note that this data is not modelled in the same way as the overflight contours, however it does provide a preliminary means of comparison between this baseline and the airspace change options.				
		The technical appendix also includes a baselin not have any published PBN arrivals and there NTK data for 2019 and analysing the arrivals centreline has then been processed through th	efore this centreline has been ge concentration which occurred ac	nerated by reviewing 92 day summer ross the vectored swathe. The output		
		Table 104 below includes data based on the I optioneering tool for if aircraft were to follow on	ne centreline arrival:	e 33 above, and data output from the		
		Table 104 Easterly arrivals baseline overflight data (0-7000ft			
		System	Area (km²)	Population		
		RWY 05 Arrivals Baseline - Vectoring (NTK data)	691.95	140596		
		RWY 05 Arrivals Baseline (Centreline – optioneering tool)	182.63	51256		
		The data from these tables will be used to compare the easterly arrival options against the 'do nothing' baseline.				
		In addition to population overflown, we also han han has had places of worship; the full data ar will provide a qualitative statement around this	ound these is shown in technical			
		60dB and 65dB L_{AMax} Technical Appendix A includes 60dB L _{AMax} contand the options. Although we have shown a 6 options as the scope of the contour is only on the N60/N65 metrics which will be quantified at the	65dB L _{AMax} contour in the append he final approach. 60dB and 65dE	ix, this does not change between the		

				60dB L	.AMax					
		System	Area	(km²)	Population					
		RWY 05 Arrivals Baseline (Centreline optioneering tool)		.96	34798					
		The data from these tables	will be used t	o compare the	e easterly arriva	ls options aga	ainst the 'do no	othing' baseline.		
		L _{Aeq} Easterly arrivals make up a component of the overall L _{Aeq} day time and night time contours. We have us contours from 2017, as an indicative contour for 2025 as it is expected that contours will be a similar sha								
		Impacts to air quality are contract have a significant impact or			v around 1000f	t (200m). Airci	raft flying abov	e this are unlike		
	Air Quality	Aircraft arriving at Glasgow This is when they are very lateral changes below 1000	close to landi	ng. It's therefo	ore highly unlike	ely that any of	our arrival's c			
		Emissions of greenhouse g linked to track length, we ha assessment is therefore line	ave initially loc	ked at the tra	ck length for the	e baseline wes	sterly arrivals.			
	Greenhouse gas impact	We will estimate the differ advantages/disadvantages than a typical flight today. qualitatively describe antic technical appendix a.	of the option. As CO ₂ emis	This estimatio sions are link	n will consider we deter we deter we deter we deter we determine the differ	whether the air ence in aviation	craft tracks wil ion fuel burnt,	l be longer or sh this will allow		
Cá	Capacity /	In future, increased forecast movements across the Scottish TMA are anticipated to result in capacity and resilience disbenefits. Although vectoring of arrivals is expected to be able to meet the forecast demand, we anticipate change to the vectoring practices may be required to facilitate the wider changes to CAS, the network and the departures. I addition to this, no change to the airspace around Glasgow may also inhibit the wider FASI programme of change and AMS benefits associated with the programme.								
	resilience	For some approaches, Gla which are currently unde decommissioned as part of approaches will remain ava event on an ILS outage.	rgoing a rati a NERL UK v	onalisation p	rogramme by ne under the Ai	NATS NERL rspace Moder	This equip	ment is due to amme. Although		
ider		CAP1616 outlines the consideration of impacts upon tranquillity is with specific reference to National Parks and Area of Outstanding Natural Beauty (AONB). In Scotland, the equivalent of AONB are National Scenic Areas (NSA) an we've therefore included overflight data around these, National Parks and designated quiet areas (DQA) as part of our Tranquillity assessment. At this stage of the ACP we will qualitatively assess whether the option differs from current date and whether this has the potential to impact tranquillity with regards to noise and AONB.								
ociety		Table 106 shows data on Glasgow's existing SID cent								
	Tranquillity	Table 106 Westerly arrival bas	seline – Tranqu	illity overflown (0-7000ft					
		System	NSA count	NSA area	National Parks count	National Parks area	DQA count	DQA area		
		RWY 05 Arrival Baseline - Vectoring (NTK data)	0	0	0	0	0	0		
		RWY05 Arrival Baseline (Centreline – optioneering tool)	0	0	0	0	0	0		
	Biodiversity	The effects of airspace char general, airspace change ground-based infrastructure legislation." Though there is that disturbance effects ass 500m (~1,640ft). Considera Special Protection Areas, S Scientific Interest, particula	proposals are e. As such the s limited resea sociated with a ation will there Special Areas	a unlikely to h y are unlikely rch available of aircraft can oc fore be given of Conservati	ave an impact to have a direc on the effects of cur during take to the effects o on, National Pa	upon biodive t impact that v aircraft noise -off and landir n ecology and	rsity because vould engage on wildlife, the ng where aircra d biodiversity v	they do not inv the Birds or Hat ere is some evid aft are below ar vhere aircraft ov		
		Aircraft arriving at Glasgow this typically occurs at arou overflight of Castle Semple	und 5nm (9-1	0km) from lar	ding. The NTK	vectoring ba	seline shows	some low frequ		

		this typically occurs at around 5nm (9-10km) from landing. The NTK vectoring baseline shows some low frequency overflight of Castle Semple and Barr Lochs SSSI below 2000ft (Located north of the extended runway centerline). It's highly unlikely that any of our arrival's options will have any lateral changes between 5nm and landing however we will compare this baseline against each option.
General Aviation	Access	 This baseline scenario would not offer any change from the existing Controlled Airspace (CAS) arrangements in place today. The options will be qualitatively compared against this existing scenario. 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 34. 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.

		Figure 34 Glasgow Airport Control Zone and Control Area Chart (See eAIP for full details)					
		It is apparent from previous continual GA engagement by Glasgow and CAA's Airspace Classification Review that the CAS structures to support Glasgow Airport's operation are out of date and the CTR itself can likely be reduced in size. Whilst the existing baseline scenario will not result in the requirement for more airspace, doing nothing with westerly arrivals would constrain departure options and therefore offers less opportunity to simplify the airspace boundaries or reduce the size of CAS which is something Glasgow has been specifically working with GA stakeholders to try to					
		achieve.					
	Economic impact from increased effective capacity	There will be no increase to effective capacity by doing nothing with Easterly arrivals (in isolation to the rest of the system) and doing nothing would constrain the ability to change easterly departures.					
		As the combustion of aviation fuel is linked to track length, we have initially looked at the track length for the baseline easterly arrivals.					
General		When arriving at Glasgow, aircraft are vectored by ATC before joining the final approach. This means that track length is varied from flight to flight. For the purposes of comparing our westerly arrival options against the baseline scenario, we have used the NTK vectoring baseline data and information from ATC to estimate an arrivals centreline; we have then used the track mileage from this centreline as an initial indication of 'do nothing' track length. We have then applied a weighting based on arrival direction to provide an overall total track mileage for the system. At the Stage 3 full options appraisal track length and fuel burn will be modelled in further detail.					
Aviation / Commercial		Table 107 Easterly Arrival Track Mileage					
airlines	Fuel burn	Track Mileage					
		Option Track miles (nm) Track miles (Weighted based on 2019 modal split)					
		Baseline (centreline)50428.4					
		Aircraft arriving at Glasgow are sometimes prevented from continuously descending due to the tactical coordination with other traffic in the airspace. We will qualitatively estimate the differences between this baseline and the option, to understand if there are any anticipated advantages/disadvantages of the option against current day. This estimation will consider whether the aircraft tracks will be longer or shorter than a typical flight today and will also consider the opportunity for continuous descent from 7000ft.					
Commercial	Training costs	As this option is already in operation, there are no training costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.					
airlines	Other costs	As this option is already in operation, there are no other costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.					
	Infrastructure costs	As this option is already in operation, there are no infrastructure costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.					
Airport / Air navigation service provider	Operational costs	As this option is already in operation, there are no operational costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline. For some approaches, Glasgow Airport is 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 considered an interim measure and failure to implement a long term solution may result in additional operational costs.					
	Deployment costs	As this option is already in operation, there are no deployment costs anticipated as there will be no change; later in this IOA we will estimate the difference between our options and this baseline.					
All	Safety	At current traffic levels, there are no safety concerns 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, on increased aircraft holding in order to maintain safety.					
All	Interdependencie s, conflicts and tradeoffs	This option would result in constraining some of Glasgow's own departure options as well as some of NERL's options should they consider a relocation of the LANAK holding stack.					
A11		CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.					
All	AMS	Whilst vectoring of arrivals is a perfectly reasonable options in a future operating environment, doing nothing with Easterly departures will not align with the AMS as it would constrain other options. Limiting our options to one which sees no change to vectoring practices could also reduce the ability to change CAS boundaries and improve CDA performance.					

4.24. Runway 05 Arrival Option A

Runway 05 Ea	sterly Arrivals Optic	on A
		PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would also join the final approach at around 11nm, and would be used by 15% of overall arrivals.
		Figure 35 Easterly Arrivals Option A Overflight and 2019 baseline NTK data
Communitie s	Noise impact on health and quality of life	 Route from the North This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today. Route from the South The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Forest. Aircraft would then route slightly west, largely avoiding Kilmarnock and Stewarton, before turning to the northwest, avoiding Dalry, and then joining the final approach at around 11nm. This largely avoids dense areas of population with the exception of the southern parts of Fenwick. The NTK heatmap in figure 35 shows that this route remains south of the existing areas of concentration however by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 11nm. This join occurs earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final approach. Beyond this point, aircraft overfly the same areas as the vertice.

areas as they do today.

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 108 Easterly arrivals option A overflight data

System	Area (km²)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option A	174.72	21006

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data.

		There is a significant decreation one of the data considers in number of buildings ov something that will be explored the full data tables and consider appendix A.	the frequer erflown, the ored further	ncy of overfligh ose that are o as part of the	it; although conce verflown will like Stage 3 full optior	entrated PBN y be at a h ns appraisal	l flight paths igher freque analysis sho	will result in a ncy than today uld this option	reduction y. This is progress.
		60dB and 65dB L_{AMax} Technical Appendix A incluare an indicator of the N60 in table 109 shows a deciremain the same between) metrics wh rease in the	ich will be qua e area and po	ntified at the Sta pulation within th	ge 3 Full Op	tions Apprai	sal. The data, a	as shown
		Table 109 60dB L _{AMax} Data –	Rwy05 Arriv	al Option A					
				60dI	B L _{AMax}				
		System	А	ea (km²)	Population	n			
		RWY05 Baseline (Centreline Optioneering tool)	-	56.96	34798				
		RWY 05 Dep Option A		52.74	27292				
		L _{Aeq} The south-west componer Option A sees turns onto f of the L _{Aeq} contours.							
	Air Quality	This option has no change changes to local air quality	y (positive o	r negative) as	a result of this air	space desig	n option.		
	Greenhouse gas impact	Our fuel burn assessment to the baseline. We there explored in further detail in	fore expect	to see a cor	responding incre	ase to gree	nhouse gas		
	Capacity /	Use of PBN transitions alo less accurate final approac	ch spacing r	meaning lower	runway utilisation	ı. _	-		
	resilience	The introduction of PBN approaches will improve Glasgow'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.							
		Table 110 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the ce baseline:							
\A /:-!		Table 110 Easterly arrival A – Tranquil areas overflown 0-7000ft							
Wider Society		System	NSA coun	t NSA area	National Parks count	National Parks area	DQA cou	nt DQA area	a
	Tranquillity	RWY 05 Baseline - Vectoring (NTK data) RWY 05	0	0	0	0	0	0	
		Baseline (Centreline – Optioneering tool)		0	0	0	0	0	
		The data shows that there	0 will be no	0 change in area	0 as of tranquillity o	0 overflown – a	0 all areas will	0 be avoided as	s they are
	Biodiversity	today. The routes that form part of Arrival Option A join the final approach at 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.							
General Aviation	Access	The design option may rec contained within ScTMA 5 the route closer to final ap PBN route in its existing po	uire change in accordar proach in lii	es to the existince with the CA	ng CAS boundari AA CAS containm	es. The arrivent	val routes as his could be	illustrated wou mitigated by po	ositioning
	Economic impact from increased effective capacity	Use of PBN transitions alo less accurate final approact							
		We estimate that Option A when compared to baseline nominal centrelines, will result in a small overall increase in track mileage.							
		Track Mileage				•			
		Option		Track miles (nm)		2019 mo		eighted 15% h) based or	
General Aviation /		Baseline (centreline) A	5 5	0 7.5		428.4 492.9			
Commercial airlines	Fuel burn	This increase in driven la compared to today in orde A. The southern route also approach at around 11nm	r to avoid n takes a lo	oise sensitive nger path to a	sites. This can be void some popula	e seen in the ited areas a	e maps shov	vn in technical	appendix
		All arrival options have be airspace above 7000ft).	en designe	d to continuou	sly descend from	7000ft (sub	ject to the N	ATS NERL AC	CP for the
		As part of Stage 3, should review whether we can ba to understand the impacts	lance noise	and CO2 on	he northern route	e. We will al	so quantify f	uel burn in furt	her detai

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴⁷ .
provider	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies , conflicts and tradeoffs	No interdependencies, conflicts and trade-offs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

⁴⁷ 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-S

4.25. Runway 05 Arrival Option B

Runway 05 Ea	sterly Arrivals Optio	on B	
		PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the approximately 10nm. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.	south at
Group	Impact	Qualitative Assessment	
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise of qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final appraround 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route the south, which would join the final approach at around 10nm, and would be used by 15% of overall arrivals.	roach at
		Option Over Contours (with estimation overall arrit	Black outline ated % of
			ine average ay overflight
		Figure 36 Easterly Arrivals Option B Overflight and 2019 baseline NTK data	
Communitie s	Noise impact on health and quality of life	Route from the North This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial paroute overflies areas not typically overflown by arrivals today. The population heat map shows these areas heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft wo turn and fly south-east; this part of the route again overflies new areas however these are not heavily popula the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach at 100 today.	are not uld then ted with hen join
		Route from the South The route from the south would see aircraft start a continuous descent from 7000ft starting from around W Forest. Aircraft would then route slightly west, overflying Fenwick and Waterside but largely avoiding Kilmarn Stewarton, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 100 NTK heatmap in figure 36 shows that this route remains south of most of the existing areas of concentration H by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around This join occurs slightly earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that ro Beith when joining final approach. Beyond this point, aircraft overfly the same areas as they do today.	ock and nm. The nowever d 10nm. craft are

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 111 Easterly arrivals option B overflight data

System	Area (km²)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option B	176.02	21242

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction

		in number of buildings overfl something that will be explore The full data tables and cour appendix A.	ed further as pai	rt of the Sta	age 3 full option	s appraisal an	alysis should t	his option progress.	
		60dB and 65dB L AMax Technical Appendix A include are an indicator of the N60 m in table 112 shows a decrea remain the same between the	etrics which wil use in the area	l be quanti and popul	fied at the Stag ation within the	ge 3 Full Optio	ns Appraisal.	The data, as shown	
		Table 112 60dB L _{AMax} Data - Rw	y23 Arrival Optio	n B					
				60dB L	AMax				
		System	Area (kr	n²)	Population				
		RWY05 Baseline (Centreline - Optioneering tool)	56.96		34798				
		RWY 05 Dep Option B	53.79		27446				
		L _{Aeq} The south-west component o Option A sees turns onto fina shape or size of the L _{Aeq} cont	al approach at						
	Air Quality	This option has no change to changes to local air quality (p						e are no anticipated	
	Greenhouse gas impact	Our fuel burn assessment (set to the baseline. We therefore explored in further detail in th	e expect to se	e a corres	ponding increa	ase to greenh	ouse gas emi		
	Capacity /	Use of PBN transitions alone less accurate final approach s	is likely to redu	ice capacit	y as airborne a	nd ground hol	-	crease as a result of	
	resilience	The introduction of PBN approaches will improve Glasgow'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.							
		Table 113 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline:							
Wider	Tranquillity	Table 113 Easterly arrival B – Tranquil areas overflown 0-7000ft							
Society			ISA count N	ISA area	National Parks count	National Parks area	DQA count	DQA area	
		RWY 05 Baseline - Vectoring (NTK data) RWY 05	0	0	0	0	0	0	
		Baseline (Centreline – Optioneering tool)	0	0	0	0	0	0	
		Runway 05 Option A	0	0	0	0	0	0	
		The data shows that there will be no change in areas of tranquillity overflown – all areas will be avoided as today.							
	Biodiversity	The routes that form part of Arrival Option B join the final approach at 11nm and 10nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.							
General Aviation	Access	The design option may requi quite be contained within ScT positioning the route slightly c people than the PBN route in	TMA 5 in accor loser to final ap	dance with proach in li	the CAA CAS	containment	policy. This co	ould be mitigated by	
	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.							
		We estimate that Option B w track mileage.	hen compared	to baseline	e nominal cent	relines, will re	sult in a smal	l overall increase in	
		Track Mileage				Track m	iles (Weigh	ted 15%	
		Option	Track n	niles (nm)		(South), : 2019 moda	3% (North) al split)	based on	
General Aviation /		Baseline (centreline) B	50 <mark>56.3</mark>			428.4 474.9			
Commercial airlines	Fuel burn	This increase in driven largely by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 10nm which is further than most arrivals typically join today.							
		All arrival options have been airspace above 7000ft).	designed to co	ntinuously	descend from	7000ft (subjed	ct to the NATS	S NERL ACP for the	
		As part of Stage 3, should the review whether we can balan to understand the impacts of the CO_2 and noise.	ice noise and C	CO2 on the	northern route	. We will also	quantify fuel b	ourn in further detail	
Commercial	Training costs	Flight procedures are updated	d or introduced	worldwide	as part of an A	IRAC cycle. A	s part of this c	ycle, airlines update	

airlines		their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴⁸ ;
provider	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies , conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.
All	AMS	CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

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-S

4.26. Runway 05 Arrival Option C

Runway 05 Ea	sterly Arrivals Optio	on C
		PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway. Slightly different track to Option A above 5000ft. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would also join the final approach at around 11nm, and would be used by 15% of overall arrivals. The southerly route option differs slightly from option A above 5000ft.
		Option Overflight Contours (Black outline) wretal arrivals 219 baseline average summer day overflight overflight
Communitie s	Noise impact on health and quality of life	Figure 37 Easterly Arrivals Option C Overflight and 2019 baseline NTK data Figure 37 Easterly Arrivals Option C Overflight and 2019 baseline NTK data Route from the North This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overfliges areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today. Route from the South The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Hill. Aircraft would then route west, avoiding Kilmarnock and Stewarton, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 11nm. This avoids dense areas of population with the exception of Ferwick. The NTK heatmap in figure 37 shows that this route remains south of the existing areas of concentration however by doing so, it avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 11nm. This join occurs earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach. Beyond this point, aircraft overfly the same areas as they do today. Overflight Data

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 114 Easterly arrivals option C overflight data

System	Area (km²)	Population
RWY 05 Baseline (Vectoring)	691.95	140596
RWY 05 Baseline (Centreline)	182.63	51256
RWY 05 Option C	174.44	21211

Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data. There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduction

		in number of buildings ove something that will be explo The full data tables and co	ored further as pa	art of the Sta	age 3 full option	s appraisal a	nalysis should	this option progress	
		appendix A. 60dB and 65dB L AMax Technical Appendix A inclu are an indicator of the N60 in table 115 shows a decre	ides 60dB which metrics which w ease in the area	compare (ill be quant a and popul	Option C agains ified at the Stag lation within the	t the centreli e 3 Full Opti	ne baseline. T ons Appraisal.	hese 60dB contour The data, as show	
		remain the same between t Table 115 60dB L _{AMax} Data – F		•					
			Rwy03 Amvai Opt	60dB L					
		System	Area (k		Population				
		RWY05 Baseline (Centreline Optioneering tool)	- 56.96		34798				
		RWY 05 Dep Option C	52.74	4	27292				
		LAeq The south-west component Option C sees turns onto fir of the LAeq contours.							
	Air Quality	This option has no change changes to local air quality						e are no anticipate	
	Greenhouse gas impact	Our fuel burn assessment (to the baseline. We therefore explored in further detail in	ore expect to se	ee a corres	ponding increa	se to greenł	nouse gas emi		
	Capacity /		explored in further detail in the Stage 3 Full Options Appraisal should this option progress. Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation.						
	resilience	The introduction of PBN approaches will improve Glasgow's resilience, as following the decommission of the VOF part of a NERL UK wide programme under the Airspace Modernisation programme, Glasgow will only have precision approach and NDB and visual non precision approaches available.							
		Table 116 shows data on th baseline:	ne overflight of a	reas of tran	quillity based or	n the NTK ve	ctoring baselin	e and the centrelir	
	Tranquillity	Table 116 Easterly arrival C – Tranquil areas overflown 0-7000ft							
Wider Society		System	NSA count	NSA area	National Parks count	National Parks area	DQA count	DQA area	
		RWY 05 Baseline - Vectoring (NTK data)	0	0	0	0	0	0	
		RWY 05 Baseline (Centreline – Optioneering tool)	0	0	0	0	0	0	
		Runway 05 Option C	0	0	0	0	0	0	
		The data shows that there will be no change in areas of tranquillity overflown – all areas will be avoided as they are today.							
	Biodiversity	The routes that form part of Arrival Option C join the final approach at 11nm. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.							
General Aviation	Access	The design option may request contained within ScTMA 5 in the route closer to final app PBN route in its existing pos	n accordance wi broach in line wit	th the CAA	CAS containme	ent policy. Th	is could be miti	gated by positionir	
	Economic impact from increased effective capacity	Use of PBN transitions alor less accurate final approact							
		We estimate that Option C when compared to baseline nominal centrelines, will result in a small overall increase in track mileage.							
		Track Mileage				Track n	niles (Weigh	nted 15%	
		Option	Track	miles (nm)			3% (North)		
General		Baseline (centreline) C	50 57.8			428.4 497.4			
Aviation / Commercial airlines	Fuel burn	C57.8497.4This increase in largely driven by the northern arrival route, which takes a less direct route to join final approach compared to today in order to avoid noise sensitive sites. This can be seen in the maps shown in technical appendix A. The southern route also takes a longer path to avoid some populated areas and noise sensitive sites; it joins final approach at around 11nm which is further than most arrivals typically join today. Compared to Option A, which also joins at 11nm, this route is slightly longer when considering connectivity with the network, due to the positioning of the 7000ft point.							
		All arrival options have bee airspace above 7000ft).	en designed to c	ontinuously	descend from	7000ft (subje	ect to the NATS	S NERL ACP for th	
		As part of Stage 3, should review whether we can bala to understand the impacts of CO ₂ and noise.	ance noise and	CO2 on the	northern route	. We will also	o quantify fuel	burn in further deta	

Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.
	Other costs	No other airline costs are foreseen.
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁴⁹ ;
provider	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.
All	Interdependencies , conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.
AII AMS		CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. However the negative effects include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of all arrivals into just 2 arrival routes to each runway.

⁴⁹ 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-S

4.27. Runway 05 Arrival Option D

Runway 05 Ea	sterly Arrivals Optic	on D
		PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm. Slightly different track to Option B above 5000ft For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
	t - me	
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year.
		This option would see two PBN arrival routes. The first would route from the north, which would join final approach at around 11nm from the runway, and be used by around 3% of overall arrivals at Glasgow. The second would route from the south, which would join the final approach at around 10nm, and would be used by 15% of overall arrivals.
		Option Overflight Contours (Black outline) with estimated % of overall arrivals
		2019 baseline average summer day overflight voathe: 1 1 2 2 2
		Figure 38 Easterly Arrivals Option D Overflight and 2019 baseline NTK data
Communitie s	Noise impact on health and quality of life	Route from the North This route would see aircraft continuously descending from 7000ft starting from around Levan. The initial part of the route overflies areas not typically overflown by arrivals today. The population heat map shows these areas are not heavily populated however there is some overflight at higher altitudes of Inverkip and Wemyss Bay. Aircraft would then turn and fly south-east; this part of the route again overflies new areas however these are not heavily populated with the exception of the north eastern part of Largs which is just captured by the overflight contour. Aircraft would then join the final approach at 11nm avoiding all but the very southern part of Kilbirinie. Aircraft would then fly the final approach over the same areas as they do today.
		Route from the South The route from the south would see aircraft start a continuous descent from 7000ft starting from around Whitelee Forest. Aircraft would then route west, overflying Fenwick and Waterside and the very southern parts of Stewaton, but avoiding Kilmarnock, before turning to the north-west, avoiding Dalry, and then joining the final approach at around 10nm. The NTK heatmap in figure 38 shows that the initial part of this route aligns with some existing concentration however then heads slightly further west than the concentration seen today. In doing so, the route avoids the densely populated area of Stewarton. Aircraft then join the final approach at around 10nm. This join occurs slightly earlier than the NTK data shows the majority of aircraft join today, but in doing so, aircraft are aligned on final approach when overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final

Overflight Data

The technical appendix to this document includes a baseline image which shows a PBN centreline created using concentration information from the NTK data. There is also data based on the NTK data which, although is not modelled in the same way as the centreline data, does provide a preliminary means of comparison between the baseline and the airspace change options.

overflying Beith, whereas at present, there is a concentration of aircraft that route over Beith when joining final

Table 10 Westerly departures baseline overflight data. Against the NTK baseline vectoring data, there is a decrease in population overflown between 0-7000ft however the option will result in some population being overflown more frequently, which is not articulated in the data tables at this stage of the process. When comparing against the baseline centreline data, there is also a decrease in the area of the contours and the number of population overflown.

Table 117 Easterly arrivals option D overflight data

System	Area (km²)	Population			
RWY 05 Baseline (Vectoring)	691.95	140596			
RWY 05 Baseline (Centreline)	182.63	51256			
RWY 05 Option B	176.01	21379			
Data on the number of noise sensitive buildings (schools, hospitals and places of worship) shows a decrease in the number of schools, care homes, hospitals and places of worship overflown compared to the centreline baseline data There is a significant decrease compared to the vectoring data in all areas, but it's important to note that at this stage					

approach. Beyond this point, aircraft overfly the same areas as they do today.

		none of the data considers the frequency of overflight; although concentrated PBN flight paths will result in a reduct in number of buildings overflown, those that are overflown will likely be at a higher frequency than today. This something that will be explored further as part of the Stage 3 full options appraisal analysis should this option progree The full data tables and counts of noise sensitive buildings such as hospitals and schools, are detailed in techn appendix A. 60dB and 65dB LAMAX Technical Appendix A includes 60dB which compare Option D against the centreline baseline. These 60dB conte are an indicator of the N60 metrics which will be quantified at the Stage 3 Full Options Appraisal. The data, as sho in table 118 shows a decrease in the area and population within the 60dB LAMAX contour. The 65dB LAMAX contour							
		Table 118 60dB L _{AMax} Data - Rw	able 118 60dB L _{AMax} Data - Rwy23 Arrival Option B						
				60dB L	AMax				
		System	Area	(km²)	Population				
		RWY05 Baseline (Centreline - Optioneering tool)	- 56	5.96	34798				
		RWY 05 Dep Option D	53	3.88	27446				
		L _{Aeq} The south-west component of Option D sees turns onto fin shape or size of the L _{Aeq} cont	al approach						
	Air Quality	This option has no change to changes to local air quality (p						e are no anticipat	
	Greenhouse gas impact	Our fuel burn assessment (se to the baseline. We therefor explored in further detail in th	e expect to	see a corres	ponding increase	e to greenh	ouse gas emi		
	Capacity /	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result of less accurate final approach spacing meaning lower runway utilisation.							
	resilience	The introduction of PBN approaches will improve Glasgow'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.							
		Table 119 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and centreline baseline.							
		Table 119 Easterly arrival D – Tranquil areas overflown 0-7000ft							
Wider Society	Tranquillity	System N	NSA count	NSA area	National Parks count	National Parks area	DQA count	DQA area	
		RWY 05 Baseline - Vectoring (NTK data)	0	0	0	0	0	0	
		RWY 05 Baseline (Centreline – Optioneering tool)	0	0	0	0	0	0	
		Runway 05 Option D 0							
		The data shows that there will be no change in areas of tranquillity overflown – all areas would be avoided as they are today.							
	Biodiversity	The routes that form part of Arrival Option D join the final approach at 11nm and 10nm. As impacts to biodiversity typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5 before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline							
General Aviation	Access	The design option may require be contained within Sc positioning the route slightly c people than the PBN route in	TMA 5 in ac closer to fina	cordance with I approach in li	the CAA CAS c	ontainment	policy. This co	uld be mitigated	
	Economic impact from increased effective capacity	Use of PBN transitions alone is likely to reduce capacity as airborne and ground holding would increase as a result o less accurate final approach spacing meaning lower runway utilisation. There would be a negative economic effect.							
		We estimate that Option D when compared to baseline nominal centrelines, will result in a small overall increase i track mileage.							
		Track Mileage				Track m	iles (Weigh	ted 15%	
		Option	Trad	ck miles (nm)			3% (North)		
General Aviation / Commercial airlines		Baseline (centreline) D	50 <mark>56.5</mark>	5		428.4 477.9			
	Fuel burn	This increase in largely drive compared to today in order to A. The southern route also ta approach at around 10nm wl joins at 10nm, this route is sli 7000ft point.	o avoid nois akes a longe hich is furth	e sensitive site or path to avoid er than most a	es. This can be s d some populate arrivals typically j	een in the n d areas and oin today. C	naps shown in I noise sensitiv Compared to O	technical appender e sites; it joins fin ption B, which al	
		All arrival options have been airspace above 7000ft).	designed to	o continuously	descend from 70	000ft (subjed	ct to the NATS	NERL ACP for t	
		As part of Stage 3, should th review whether we can balar to understand the impacts of	nce noise ar	nd CO2 on the	northern route.	We will also	quantify fuel b	ourn in further det	

		CO ₂ and noise.			
Commercial airlines	Training costs	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle, airlines update their procedures accordingly and undertake training if required. This westerly SID option is not anticipated to require any additional training costs for airlines.			
	Other costs	No other airline costs are foreseen.			
	Infrastructure costs	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP.			
Airport / Air navigation service provider	Operational costs	This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional ground based navigation equipment (VORs). This contributes to a reduction in NERL's operational costs as it enables VOR rationalisation ⁵⁰ ;			
F	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.			
All	Safety	There is nothing unsafe with PBN arrival transitions to final approach and it would be preferable from an airline perspective owing to lower pilot workload and improved CDA performance. However, industry currently lacks the ability to deliver accurate final approach spacing using PBN alone in an environment, such as Glasgow, with a varied fleet mix and variable runway spacing requirements. As a result it would lead to increased delays and increased workload for pilots and crews to manage routine stack holding.			
All	Interdependencies , conflicts and tradeoffs	No interdependencies, conflicts and tradeoffs have been identified with other sponsors' ACPs below 7000ft.			
All	AMS CAP1711 describes the objective as: This option would modernise the airspace by introducing PBN as required by the AMS. Howevrr the negative include increased delay, reduced economic benefit, increased CO2 emissions and increased concentration of arrivals into juyst 2 arrival routes to each runway.				

⁵⁰ 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-S

4.28. Runway 05 Arrival Vectors only

Runway 05 Ea	sterly Arrivals Vecto	ors only
Note: Image shows existing vectoring swathe. Visualisation of option to be developed at Stage 3 once further information around airspace above 7000ft is known alongside more information about departures and CAS arrangements.		 Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. The former, because it is difficult for ATC to deliver accurate final approach spacing to varying runway spacing requirements using PBN only and they can often require more Controlled Airspace than is required by vectoring. The latter because they can often result in longer final approach joining points than vectoring caters for and, in the case of Glasgow would see c.85% of all Easterly arrivals on a single path. Communities can sometimes favour the 'spreading' of arrivals through vectoring to mitigate against potential adverse effects of concentration. This option would see all arrivals continuing to be vectored with no PBN paths available for routine use. Any change to the departures, controlled airspace arrangements and ScTMA network design is likely to result in a change to vectoring practices therefore this option is currently different to a 'Do Nothing' option for arrivals. However, what that change is not possible to determine yet so there is not an illustration for this option. For the Design Principle Evaluation and Initial Options Appraisal we will assume similar impacts as the baseline however, for the Full Options Appraisal in Stage 3 we will need to determine what these changes would result in and analyse the impacts. It is more likely that the differences between this option and the baseline options will be at altitudes of c.5-7000ft with more negligible changes below c.5000ft. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. In this vectoring option, aircraft arriving at Glasgow would continue to be tactically controlled (vectored) by ATC before joining final approach. Today aircraft typically join the runway 05 final approach between 8mm and 11nm before landing although when undertaking an ILS approach they can be as close as 6mm. This option would continue to see aircraft joining the final approach at these distances, although there is a possibility that this could be influenced by changes to the airspace above 7000ft and departures – this will be explored in further detail at Stage 3 should this option progress. Unlike PBN routes, tactical controlling of aircraft typically leads to higher levels of dispersion of flights and therefore sharing of the noise. The NTK data shown in figure 33, demonstrates the large swathe of overflight created by today's vectoring. It shows that there are wide areas to the south of the airport , and some areas to the north, that are overflown between 1-10 times per day on average including Darvel, Newmilns, Galston, Kilmarnock, Kilmaurs, Dunlop, Kilwinning, Dalry, and Kilbirnie. There is some concentration which occurs from a south-easterly direction, before aircraft join the final approach which overflies Fenwick, Stewarton and Beith:
Communities	Noise impact on health and quality of life	Figure 39 Runway 23 Departure Vectoring Swathe 2019 The vectoring swathe as seen in Figure 39 is influenced by how aircraft arrive from the airspace above 7000ft, how departures operate, and by the structure of the surrounding CAS. This option will therefore evolve as further details are known about where aircraft will enter at 7000ft, where and how the departures might be operated, and the shape and size of the CAS volume.

For the purposes of this IOA, we will use the baseline data as the closest representative data for this option. The technical appendix includes NTK and centreline data for the baseline. It's important to note that the NTK data is not modelled in the same way as the other data, however it does provide a preliminary means of comparison between this baseline and the airspace change options.

Table 120 below includes data based on the NTK heat map as shown in figure 39 above:

Table 120 Easterly arrivals baseline overflight data 0-7000ft

System			Area (km²)		Population		
RWY 05 Arrivals data)	Baseline -	Vectoring (NTK	691.95			40596	
In addition to pop hospitals and place	ces of wors	hip:	ave data on the overflig	ht of noise	e sensitive buil	dings such as scho	
System	ę	Schools count	Hospitals count	Care hom	nes count	count	
RWY 05 (Vectoring)	Baseline	51	0	32		77	
			noise sensitive building er owing to the dispers				

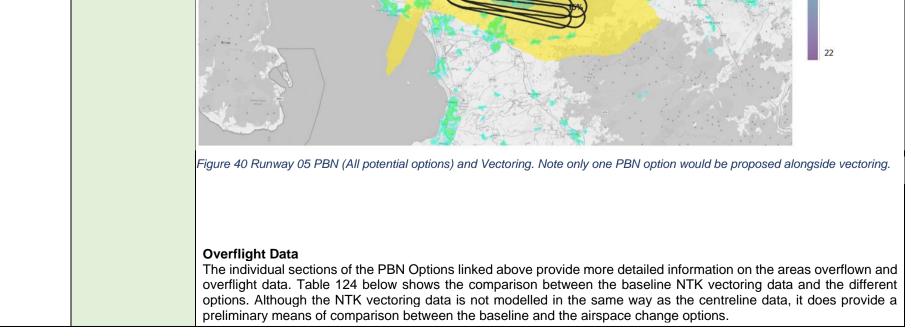
		will explore in further detail at Stage 3. 60dB and 65dB LAMax Technical Appendix A includes 60dB LAMax contours and data for the baseline, to aid comparison between the baseline							
		and the options. Similar to the overflight data above, the population within the 60dB LAMax contours is highes the baseline, however this data does not currently take into account the full vectored swathe, as it is modelle centreline data. It also does not articulate the frequency of overflight which would be lower for some areas cor to equivalent PBN routes. We will explore this in further detail a Stage 3 should the option progress. The 65dB contours extend partially along the extended runway centreline and are expected to remain the same betw options.							
		Table 121 Westerly arrivals bas	eline L _{AMax} data						
				-AMax					
		System	Area (k	m²)	Population				
		RWY 05 Arrivals Baseline (Centreline Optioneering tool)	- 56.96	6	34798				
		L _{Aeq} The south-west component option is expected to see airc We therefore do not expect t	craft continue to	o join final a	pproach as they	do today whi	ich typically o		
	Air Quality	This option has no change to changes to local air quality (p						e are no anticipated	
	Greenhouse gas impact	Our fuel burn assessment (se compared to the baseline. N explored in further detail in th	We therefore e	expect neuti	ral benefit/impac	t to greenho	ouse gas emis		
	Capacity /	This option would be expec today's airspace through vec potential changes to the vect	ctoring could be	e expected t	to be delivered th	rough vecto	ring in the fut		
	resilience	Vectoring only would not 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.							
Wider Society		Table 122 shows data on the overflight of areas of tranquillity based on the NTK vectoring baseline and the centreline baseline. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the impacts to tranquillity.							
-	Tranquillity	Table 122 Easterly arrival vectors only – Tranquil areas overflown 0-7000ft							
		System N	NSA count	NSA area		National Parks area	DQA count	DQA area	
		RWY 05 Baseline - Vectoring (NTK data)	0	0	0	0	0	0	
		Runway 05 Baseline Centreline	0	0	0	0	0	0	
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. As impacts to biodiversity are typically associated with changes below 1640ft, which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not expected to have an impact on biodiversity or present a change from the baseline.							
General Aviation	Access	This option can be contained within existing CAS whilst offering opportunity to reduce the total volume of CAS as a result of enabling changes the other surrounding route structures.							
	Economic impact from increased effective capacity	This option would be expec today's airspace through vec potential changes to the vect	ctoring could be	e expected t	to be delivered th	rough vecto	ring in the fut		
General		Table 123 provides baseline centreline data for easterly arrivals. For the purposes of this IOA we have assumed the vectoring swathe to be similar today however, should this option progress, at Stage 3 we will refine it further and undertake further analysis on the benefits and impacts to fuel burn.							
Aviation / Commercial airlines	Fuelburg	Table 123 Easterly Arrival Track	k Mileage						
	Fuel burn	Track Mileage			Track mile	s (Weight	ed		
		Option Baseline (centreline)	Track miles (1 50	nm)	69% (South) based on 201 428.4	, 13 [°] % (Nor	th)		
Commercial airlines	Training costs	Flight procedures are update their procedures accordingly any additional training costs	and undertake						
	Other costs	No other airline costs are for	eseen.						
	Infrastructure costs	The initial deployment phase this there are not expected to						ts however beyond	
Airport / Air navigation service provider	Operational costs	This airspace change propose PBN approaches provides ar is the potential for the existing ground based navigation equ VOR rationalisation ⁵¹ ;	n alternative ap g VOR approac	proach proc hes to be re	edure alongside	the current II luces Glasgo	LS approache ow's depende	s. This means there ncy on conventional	
PLOTINOI	Deployment costs	This option is expected to r Prestwick and Glasgow Airpo 3 Full Options Appraisal whe the network above 7000ft an	ort. The scale a	and nature o aising our s	of this training re- hortlist of options	quires furthe	r exploration a	as part of the Stage	

⁵¹ 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-S

All	Safety	ATC advised that with any option which sees a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05, a PBN waypoint to direct RWY 05 arrivals to would be preferable to help them ensure separation. This would not be available in a vectoring only option. No other safety concerns have been identified at this stage.
All	Interdependencies, conflicts and tradeoffs	To accommodate a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05 may also require a relocation of the LANAK hold in the network. This could slightly change the vectoring swathe to Runway 05 but most likely above 5/6000ft. There are not expected to be tradeoffs between arrivals below 7000ft and NERL or Edinburgh's options.
AII	AMS	CAP1711 describes the objective as: Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace. Vectoring of arrivals in the future would not deliver a PBN arrival solution, nor reduce the numbers of people overflown / affected by noise from Glasgow's arrivals. However it is unlikely to change the adverse effects which would be measured within the LOAEL which would not extend out to the final approach joining point. Conversely a PBN arrival to RWY 05 in the lowest areas of population would require additional CAS to ensure CAS containment therefore a vectoring solution may be preferable from a CAS perspective. This option would meet future demand however it may not be the best future-proofed option should technologoical enhancements become available in the future to better rely on a pure PBN arrival solution if desired by Glasgow and its stakeholders.

4.29. Runway 05 Arrival Vectors and PBN hybrid

Runway 05 Ea	sterly Arrivals Vector	ors and PBN hybrid
Note: Image shows existing vectoring swathe alongside the overflight contours for Options A-D. Visualisation of option to be developed at Stage 3 once PBN shortlist is known and there is further information around vectoring arrangements.		 Whilst PBN arrivals enable systemisation and enhanced CDA performance, they are not always operationally or environmentally optimal. There are however the benefits of PBN for arrivals. In addition, from an operational perspective for RWY 05, due to the interaction of NORBO departures with arrivals, ATC have advised than the option of PBN for arrivals would be extremely desirable. This is because it would provide a Waypoint for use which, when combined with an altitude restriction, could be used to guarantee separation against NORBO departures. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival(s) would likely be the 'best performing' of Options A-D above which are then optimised in Stage 3 to balance CO2, noise impacts and Controlled Airspace containment requirements. The frequency of usage of the PBN route(s) would need to be determined through stakeholder engagement and consultation. For more information, please see our Stage 2A document on the CAA's Airspace Change Portal.
Group	Impact	Qualitative Assessment
		Due to wind direction, easterly operations on runway 05 occur approximately 18% of the year. The noise data and qualitative assessment has considered this modal split with daily movements averaged across the year. This scenario would see the availability of PBN arrivals but with the ability for ATC to still vector arrivals when required to provide the required final approach sequence and spacing. The PBN arrival component could be any of the PBN options already assessed; the option taken forward will depend on the shortlisting as part of this IOA and the outcome of the Stage 3 Full Options Appraisal. Below provide links to the four assessments for the PBN Options: Initial Options Appraisal – Runway 05 Arrival Option A Initial Options Appraisal – Runway 05 Arrival Option B Initial Options Appraisal – Runway 05 Arrival Option C Initial Options Appraisal – Runway 05 Arrival Option D The PBN option assessments linked above have shown that there is the potential for PBN routes to reduce the number of people and noise sensitive sites overflown, however due to the concentration created by PBN routes, areas overflown would likely be at a higher frequency than today. By combining with vectoring, some of this concentration from PBN routes could be mitigated, as some aircraft would continue to be tactically controlled and would therefore see the dispersion that occurs today. This dispersion has been described in the vectoring assessment, the shape/size of the vectoring swathe will be dependent on a number of factors which are yet to be determined including the airspace above 7000ft, the departure options, and the CAS arrangements. We will refine this in further detail as described above and we will also quantify when we would expect to see the PBN and vectoring used.
Communitie s	Noise impact on health and quality of life	PBN Options Overflight Contours (Black 0% of overall arrivals 2019 baseline average summer day overflight swate: 1



		System	Area	Population	Schools	Hospitals	Carehomes	Places worship							
					count	count	count	count							
		RWY05_BASE (Vectoring NTK data)	691.95	140596	51	0	32	77							
		RWY05_BAS (Centreline)	182.63	51256	19	2	9	26							
		RWY05_A RWY05_B	174.72 176.02	21006 21242	7 6	0 0	5 5	10 10							
		RWY05_C	174.44	21211	7	0	5	10							
		RWY05_D	176.01	21379	6	0	6	10							
		Overall, the data suggests that the vectoring however these articulated in the data tables at	options will	result in some p											
		This suggests that the combina would mitigate some of the imp routes would mean that when t will be explored in further detail	pacts of cone raffic allowe	centration for tho d, a far lower nur	ose communition of people	es living under	the PBN routes,	and the PBN							
		60dB and 65dB L _{AMax} Technical Appendix A includes At this stage we do not have L data shows that the PBN arriva at this stage, this data does no overflight assessment above, impacts of PBN with some of further in Stage 3 when this op	AMax data for Ils routes res t take into ac by offering a the benefits	the vectoring or ult in a reduction ccount the freque hybrid PBN/vec of vectoring whi	overall N60 m in area and pe ency of overflig ctoring option, ch may result	etrics - we will opulation within opulation within ght which would there would be in favourale LA	quantify these at the 60dB L _{AMax} likely increase.	Stage 3. The ontour although Similar to the o mitigate the							
		L _{Aeq} The south-west component of of the PBN Options and the Ve the LAeq contour and therefore	ectors only c	ption have sugg	ested that the	re will be no im	pact to the shap	e and size o							
	Air Quality	This option has no change to l changes to local air quality (po						o anticipated							
	Greenhouse gas impact	Our fuel burn assessment (see below) has anticipated this option will have a small increase in fuel burn compared to the baseline. We therefore expect to see a corresponding increase to greenhouse gas emissions. This will be explored in further detail in the Stage 3 Full Options Appraisal should this option progress.													
	Capacity / Option is expected to enhance Glasgow's operational performance in the future. This is because ATC of arrivals when traffic levels are low-medium and this will also facilitate the use of combined Tower and Ap (Radar In Tower) offering additional resilience to ATC resource.														
Wider Society	resilience	The introduction of PBN approaches will improve Glasgow'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.													
	Tranquillity	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that all of the options will continue to avoid NSAs, DQAs and National Parks, as they do today. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this too avoids these areas. We therefore expect there to be no change to overflight of tranquil areas as a result of a hybrid PBN/vectoring scenario.													
	Biodiversity	This option is unlikely to change where aircraft join the final approach compared to today. The PBN options the final approach from at 10 or 11nm. As impacts to biodiversity are typically associated with changes be which when flying a standard 3 degree approach occur at around 5nm before landing, this option is not a have an impact on biodiversity or present a change from the baseline.													
General Aviation	Access	All of the existing PBN arrival options from the South may require changes to CAS boundaries to protect the PBN arrival in accordance with CAA's policy on CAS containment. This could be avoided by positioning a PBN arrival route for the East or in the middle of the existing swathe which would avoid any increase in additional CAS although it result in more people being overflown compared to any of the existing PBN options. Options B and D would release adjustment to CAS then Options A and C.						l route f <mark>urthe</mark> ough it woule							
General	Economic impact from increased effective capacity	This option would be expected to cope with future demand. The peak hourly landing rate already experienced in today's airspace through vectoring could be expected to be delivered through vectoring in the future and the feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders.													
General Aviation / Commercial airlines	Fuel burn	This option proposes a hybrid of PBN routes and vectoring. Our assessment of the PBN routes has shown that there may be increases in track mileage and fuel burn as a result of all of the PBN options. For the purposes of this IOA we have assumed the vectoring swathe to be similar today and therefore this component of a hybrid option would offe neutral benefits/impacts to fuel burn. Overall, at this stage, the IOA suggests there may therefore be some impacts to fuel burn as a result of a hybrid option although these will be less than operating purely PBN arrivals alone. There is scope to position a PBN arrival route in the middle of the existing swathe which would avoid any increase in CO2 emissions although it would result in more people being overflown compared to any of the existing PBN options.													
Commercial airlines	Flight procedures are updated or introduced worldwide as part of an AIRAC cycle. As part of this cycle														
-	Other costs	No other airline costs are fores	een.												
	Infrastructure costs							vever beyon							
Airport / Air navigation service provider	Operational costs	This airspace change proposa PBN approaches provides an a	l is not antic alternative ap VOR approa	ipated to change proach procedu	airport or AN re alongside tl	The initial deployment phase of the ACP may require some ATC system engineering amendments however beyond this there are not expected to be any changes to infrastructure for the airport or the ANSP. This airspace change proposal is not anticipated to change airport or ANSP operational costs. The implementation of PBN approaches provides an alternative approach procedure alongside the current ILS approaches. This means there is the potential for the existing VOR approaches to be removed which reduces Glasgow's dependency on conventional									

⁵² 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-S

	Deployment costs	This option is expected to require air traffic controller training for the controllers and assistants located at NATS Prestwick and Glasgow Airport. The scale and nature of this training requires further exploration as part of the Stage 3 Full Options Appraisal when we are appraising our shortlist of options and once further information is known about the network above 7000ft and interdependencies with Edinburgh.
AII	Safety	ATC advised that with any option which sees a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05, a PBN waypoint to direct RWY 05 arrivals to would be preferable to help them ensure separation. This would be available with this option. No other safety concerns have been identified at this stage.
		To accommodate a RWY 05 wrap around SID that needs to outclimb arrivals to RWY 05 may also require a relocation
All	Interdependencies , conflicts and tradeoffs	of the LANAK hold in the network. This could slightly change the position of the upper portion of the PBN arrival options to Runway 05 but most likely above 5/6000ft.
		There are not expected to be tradeoffs between arrivals below 7000ft and NERL or Edinburgh's options.
		CAP1711 describes the objective as:
		Deliver quicker, quieter and cleaner journeys and more capacity for the benefit of those who use and are affected by UK airspace.
All	AMS	This option is considered to best meet the requirements of the AMS for Easterly arrivals. It introduces a PBN arrival solution without being reliant on it which ensures that demand can be met but allowing improved CDA for arrivals using the PBN structure. The feature of PBN in the solution would best future-proof Glasgow in the case of technological enhancements that may allow for greater use of PBN, if desired by Glasgow and its stakeholders.
		It would help to reduce the number of people overflown by Glasgow's arrivals without concentrating all arrivals permanently onto 2 routes. However it could require additional CAS to contain the arrival routes in accordance with CAA policy.

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5. IOA Summary and Conclusion

The following sections provide an overview of the outcome of the IOA before explaining whether an option has been progressed into Stage 3 and the rationale around this. Within this document, we have identified that further qualitative assessment is required for some categories; details have been included, where applicable, in the full IOA tables and is also summarised in the 'preferred option' section below.

Discounting Methodology

Glasgow Airport Ltd

When discounting or progressing an option, each category within the IOA for each option has been reviewed in detail before being summarised as per the categories shown in table 125 below. The summary tables shown in the following sections for each runway mode provide an overview of this categorisation and show how the option has performed overall as part of the IOA when compared against the baseline 'do nothing' scenario.

Table 125 IOA Summary Table Key

IOA Summar	у Кеу
	Anticipated overall net impacts/costs; the option may have only impacts (negatives compared to the baseline) or may have a mix of benefits and impacts where the impacts outweigh the benefits
	Neutral; the option either offers neutral benefit, or may have a mix of benefits and impacts (some of which may require quantified assessment at Stage 3 should the option progress).
	Anticipated overall net benefits/costs; the option may have only benefits (positives compared to the baseline) or may have a mix of benefits and impacts where the benefits outweigh the impacts

We have used the detailed IOA assessment as well as the summary tables as the basis for determining whether to continue or discount an option. In some cases there may be multiple options that perform well against the baseline and in these cases we have also looked at the comparative performance of each option; details of this are included in the conclusion tables below. Alongside this, we have considered the Design Principles developed with stakeholders at Stage 1 as well as the requirement to meet the Airspace Modernisation Strategy (AMS). The threshold for discounting 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 to balance - many of which will not be quantified until the Full Options Appraisal at Stage 3. Therefore, alongside the summary tables shown in the sections below, we have included the rationale for discounting or progressing an option which explains these qualitative elements.

5.1. Runway 23 Westerly Departures

Group	Impact	Option A	Option B	Option C	Option D	Option E
Communities	Noise impact on health and quality of life					
	Air Quality					
	Greenhouse gas impact					
Wider Society	Capacity / resilience53					
······,	Tranquillity					
	Biodiversity					
General Aviation	Access					
General Aviation / Commercial	Economic impact from increased effective capacity					
airlines	Fuel burn					
Commercial	Training costs					
airlines	Other costs					
Airport / Air	Infrastructure costs					
navigation service	Operational costs					
provider	Deployment costs					
All	Safety					
All	Interdependencies, conflicts and trade-offs					
All	AMS					
Option progressed to	o Stage 3	\checkmark	X	X	Х	\checkmark

Today, all of Glasgow's SIDs turn at 5nm however in order to deliver CO2 reductions through reduced track mileage and delays, all of Glasgow design options

require SIDs to turn before 5nm which unavoidably means overflying new communities and more people overall. All the options were generated to explore the pros and cons of various configurations alongside their positive and negative effects. The options being taken forward into Stage 3 are those believed to best balance the range of competing environmental and operational requirements for Glasgow and its stakeholders.

⁵³ Option B, C and D capacity summary colour corrected

Option	option being	Rationale
	progressed	This option is progressed on the basis of it (along with Option E) best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route.
		It is not the most optimal in CO ₂ reductions owing to one of the NORBO tracks being slightly longer than today but it is still expected to offer significant CO ₂ reductions overall. It also does not overfly the fewest people compared to other options but that would have resulted in greater frequency of overflight for communities under a single NORBO route.
		It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3.
Runway 23 Departure Option A	Yes	It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO ₂ emissions and cater for future demand throughout the day. By having 2 NORBO SIDs, Glasgow's busiest departure route is split into two which helps mitigate the adverse noise effects of PBN concentration.
		As articulated within the appraisal, the track adjustments on departure followed by another immediate turn could be too technically challenging to achieve but this will be investigated in more detail in Stage 3. If they are a viable feature, the FOA will then help Glasgow to determine if the track adjustments increase or decrease population numbers within the 63db L _{Aeq, 16hr} contour.
		The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.
		This option is discontinued as it does not meet future demand and is the poorest performing option in terms of noise.
		It would concentrate Glasgow's busiest departure route (NORBO) over the same populations who would be newly overflown without any mitigation against the adverse noise impacts of PBN concentration. It would overfly the fewest people as well as performing well in reducing track miles compared to other options but in turn would lead to greater frequency of overflight for those communities under the new routes.
Runway 23 Departure Option B	No	In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO ₂ however this constraint on capacity could offset some of those gains in track mileage reductions.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. When compared to other runway 23 departure options, this option overall performs poorest in terms of noise (as seen in the summary table above).
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
		This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns, the options also does not meet future demand, and performs comparatively poorly in the noise assessments compared to some options.
		The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3.
Runway 23 Departure Option C	No	In addition, the IOA noise assessment outlined that this option would concentrate Glasgow's busiest departure route over the same populations for the majority of the day who would be newly overflown. We attempted to mitigate the overflying of new communities by introducing a SID switching feature but that would have resulted in the same communities (to the south of final approach) being overflown even more than without the SID switch, albeit to the benefits of other communities. Overall, the IOA concluded that there are a mix of benefits and impacts to noise with this option however when we compare these to the benefits and impacts of other options, other options comparatively perform better.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer benefits in terms of CO ₂ and CAS, there are a mix of impacts with noise, and it is not the most effective at meeting future demand.
		This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also does not meet future demand, and performs comparatively poorly in the noise assessments compared to some options.
		The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3.
Runway 23 Departure Option D	No	In addition, the IOA noise assessment outlined that, like with Option C, the single NORBO track would overfly the same communities all day without any mitigation against the adverse noise impacts of PBN concentration. With this option those communities are also under final approach and are therefore overflown the majority of the time. The result is this option overflies the most people below 4000ft compared to Options A-E.
		With regards to future demand, although this option offers improved capacity compared to the baseline, without splitting the NORBO route which accounts for the largest % of Glasgow departures, it does not as effectively meet future demand as other options.

		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer benefits in terms of CO ₂ and CAS, there are a mix of impacts with noise, and it is not the most effective at meeting future demand.
		This option is progressed on the basis of it best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading aircraft noise from Glasgow's busiest departure route across two routes. By having 2 NORBO SIDs, Glasgow's busiest departure route is split into two which helps mitigate the noise impacts of PBN concentration.
		It is the most optimal in CO ₂ reductions. The route positioning means it scored 2 nd best in terms of population overflown below 4000ft whilst still splitting NORBO departures across 2 different routes.
	ure Yes (preferred option)	It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3.
Runway 23 Departure Option E		It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO ₂ emissions and cater for future demand throughout the day. It also mitigates the adverse impacts of PBN concentration. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures.
		The data suggests that the lack of a track adjustment on departure would result in lower population numbers overflown below 4000ft compared to Option A but more granular analysis is required in the FOA.
		The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.2. Runway 05 Easterly Departures

Group	Impact	Option A	Option B	Option C	Option D	Option E	Option F	Option G	Option H	Option I
Communities	Noise impact on health and quality of life									
	Air Quality									
	Greenhouse gas impact									
Wider Society	Capacity / resilience54									
Wider Society	Tranquillity									
	Biodiversity									
General Aviation	Access									
General Aviation / Commercial	Economic impact from increased effective capacity									
airlines	Fuel burn									
Commercial	Training costs									
airlines	Other costs									
Airport / Air	Infrastructure costs									
navigation service	Operational costs									
provider	Deployment costs									
All	Safety									
AII	Interdependencies, conflicts and tradeoffs									
AMS	A qualitative (high-level) assessment of how the Design Options perform against the vision and parameters / strategic objectives of the AMS									
Option progres	sed to Stage 3	Х	Х	X	Х	Х	X	X	\checkmark	\checkmark

Today, all of Glasgow's SIDs turn at 5nm however in order to deliver CO₂ reductions through reduced track mileage and delays, all of Glasgow design options require SIDs to turn before 5nm which unavoidably means overflying new communities and more people overall. All the options were generated to explore the pros and cons of various configurations alongside their positive and negative effects. The options being taken forward into Stage 3 are those believed to best balance the range of competing environmental and operational requirements for Glasgow and its stakeholders.

⁵⁴ Option A-G capacity summary colour corrected

Option	ls the option being progressed	Rationale
		This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route without any mitigation against the noise impacts of PBN concentration. This route would also overfly over the same populations who would be newly overflown without any mitigation, albeit areas of relatively low population compared to under the other SIDs. The Southbound SIDs turn earlier than today, overflying new communities but without offering other benefits.
Runway 05 Departure Option	No	The option would have delivered significant CO ₂ savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North.
A		In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO2 however this constraint on capacity could offset some of those gains in track mileage reductions.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
		This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit over areas of relatively low population compared to under the other SIDs.
Runway 05 Departure Option	No	The option would have delivered significant CO ₂ savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North.
В		In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO2 however this constraint on capacity could offset some of those gains in track mileage reductions.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
		This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit areas of relatively low population compared to under the other SIDs. The Southbound SIDs turn earlier than today, overflying new communities but without offering other benefits.
Runway 05 Departure Option	No	The option would have delivered significant CO ₂ savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North.
С		In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO ₂ however this constraint on capacity could offset some of those gains in track mileage reductions.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
		This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, and has a mixed performance when considering the parameters of the AMS.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown without any mitigation against the impacts of PBN concentration, albeit over areas of relatively low population compared to under the other SIDs.
Runway 05 Departure Option D	No	The option would have delivered significant CO ₂ savings when making a direct comparison of expected track mileage but Options H and I are expected to be more optimal as this option would have penalised the 'low and slow' departures to the North.
		In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. The option performs well in terms of track mileage and CO ₂ however this constraint on capacity could offset some of those gains in track mileage reductions.

		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
		This option is discontinued as it does not meet future demand, performs negatively compared to the baseline when considering noise, performs comparatively poorly for CO2, and has a mixed performance when considering the parameters of the AMS.
		The IOA noise assessment showed that on balance there were overall negative noise impacts when compared to the baseline. It would concentrate Glasgow's busiest departure route over the same populations who would be newly overflown and this routes over highly populated areas. As all NORBO departures would use one route, there is no mitigation against the impacts of PBN concentration.
Runway 05 Departure Option	No	When compared to the baseline, the option offered better CO2 savings however compared to the other options it was the least optimal in track mileage reductions and subsequent CO2 savings.
E		In terms of future demand, the configuration of the option means that although it offers capacity improvements compared to the baseline, the use of a single route for the main departure SID, rather than splitting this traffic as occurs in some other options, could result in increased ground delay in the future. This constraint on capacity could offset some of those gains in track mileage reductions.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that whilst it does offer some benefits in terms of track miles and CAS, there are impacts in terms of noise and meeting future demand. Compared to other options, there was less potential with this option to meet the whole objectives / parameters of the AMS which is a major driver for this ACP.
	No	This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also does not meet future demand, and performs comparatively poorly in the noise and CO2 assessments compared to some options.
		The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3.
Runway 05 Departure Option F		In addition, the IOA noise assessment showed that this option would concentrate Glasgow's busiest departure route over areas of very high population for ½ of the day. This option performed similarly to Option E in terms of CO emissions from track mileage reductions. Whilst the SID switch is assessed as being not operationally viable for safety reasons articulated in the appraisal, it would have also increased CO ₂ performance compared to keeping the Period 1 SID as a permanent arrangement.
		With regards to future demand, although this option offers improved capacity compared to the baseline, without splitting the NORBO route which accounts for the largest % of Glasgow departures, it does not as effectively meet future demand as other options.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that there are a mix of benefits and impacts and it is not the most effective at meeting future demand.
		This option is discontinued as detailed appraisal as part of the IOA has identified significant safety concerns. The option also performs comparatively poorly in the noise and capacity assessments compared to some options.
	No	The IOA offered the opportunity to investigate safety concerns raised in the DPE in further detail and the IOA assessed the SID switching feature as being not operationally viable for safety reasons. This is the primary reason this option has not been progressed to Stage 3.
Runway 05 Departure Option G		In addition, the IOA noise assessment showed that this option would concentrate Glasgow's busiest departure route over extremely dense population for most of the day with high numbers of newly overflown people. It would have resulted in the highest numbers of population overflown 0-4000ft and 0-7000ft although would have delivered the greatest CO ₂ reductions based on track length.
-		With regards to future demand, although this option offers improved capacity compared to the baseline, and in the peak periods it splits the NORBO route which will meet future demand more effectively that Options A-F however for the remainder of the day the NORBO departures would operate on one route which has the potential to limit capacity in future.
		When considering this options' overall performance against the objective and parameters of the AMS, the IOA has concluded that there are a mix of benefits and impacts and other options meet the requirements of the AMS more effectively.
		This option is progressed on the basis of it best meeting the needs of the airport (along with option I), airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route.

Runway 05 Departure Option H

Yes

It performs very well in terms of CO₂ reductions. The route positioning means it scored similar to Options A-C in terms of overflight below 4000ft but without overflying new population to the south at low altitude but it still splits NORBO departures (Glasgow's busiest departure) across 2 different routes. By having 2 NORBO SIDs, this helps to mitigate the noise impacts of PBN concentration.

It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation (see assessments of Option F and G). However more subtle SID changes could be a potential feature and can be investigated in Stage 3.

As articulated within the appraisal, the track adjustments on departure followed by another immediate turn could be too technically challenging to achieve but this will be investigated in more detail in Stage 3. If they are a viable feature, the FOA will then help Glasgow to determine if the track adjustments increase or decrease population numbers within the 63db L_{Aeq, 16hr} contour.

It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO₂ emissions and caters for future demand throughout the day. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those

		communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.
Runway 05 Departure Option I	Yes (preferred option)	 This option is progressed on the basis of it best meeting the needs of the airport, airlines and the AMS whilst helping mitigate the negative effects of PBN concentration by relocating the majority of departure tracks away from final approach and spreading of aircraft noise from Glasgow's busiest departure route. It performs very well in terms of CO₂ reductions. The route positioning means it scored similar to Options D in terms of overflight below 4000ft but without overflying new population to the south at low altitude but it still splits NORBO departures across 2 different routes. It does not feature SID structures which switch to provide partly predictable respite (runway direction cannot be wholly predictable) but these are considered to introduce unacceptable hazards to the operation. However more subtle SID changes could be a potential feature and can be investigated in Stage 3. It does feature 2 NORBO SIDs available at all times which will reduce ground delay and associated CO₂ emissions and caters for future demand throughout the day. One of these NORBO SIDs would continue to fly down final approach but the option would result in a significant reduction in frequency of overflight for those under final approach (outside 1-2nm) compared to today. This NORBO route would also reduce the frequency of overflight for those communities to the north of final approach who may experience increased overflight (compared to today) from the northbound departures. The data suggests that the lack of a track adjustment on departure would result in lower population numbers overflown below 4000ft compared to Option H but more granular analysis is required in the FOA. The positioning of the PBN routes within this option are still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.

5.3. Runway 23 Westerly Arrivals

Group	Impact	Runway 23 Arrival Option C	Runway 23 Arrival Option D	Runway 23 Arrival Option E	Runway 23 Arrival Vectors only	Runway 23 Arrival Hybrid Vectors and PBN
Communities	Noise impact on health and quality of life					
	Air Quality					
	Greenhouse gas impact					
Wider Society	Capacity / resilience					
Wider Society	Tranquillity					
	Biodiversity					
General Aviation	Access					
General Aviation /	Economic impact from increased effective capacity					
Commercial airlines	Fuel burn					
	Training costs					
Commercial airlines	Other costs					
Airport / Air	Infrastructure costs					
navigation service	Operational costs					
provider	Deployment costs					
All	Safety					
All	Interdependencies, conflicts and tradeoffs					
AMS	A qualitative (high-level) assessment of how the Design Options perform against the vision and parameters / strategic objectives of the AMS					
Option progressed to Stage 3		Х	∕*	Х	\checkmark	\checkmark

*As articulated in our Stage 2A document, use of pure PBN for arrivals into Glasgow does not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. Therefore, this option was discounted in the DPE. However, the option of a mix of PBN and vectoring does come through very favourable. In this scenario, we would want to use the best performing PBN routes so we will take the PBN arrival options (other than the ones discounted above) into the Full Options Appraisal for further assessment to help inform the Hybrid vectors and PBN options.

Option	Is the option being progressed	Rationale
		Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others.
Runway 23 Arrival	No	It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the known Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.
Option C		Next, we looked at the IOA categories where the comparative performance of the options C, D and E varies; these were the noise and CO2/Fuel burn assessments.
		Although this option was the best performing PBN arrival option in terms of CO_2 , it was the poorest performer in terms of population numbers, overflying more than double the number of people at 4000ft and below compared to Option E and over two thirds more people than Option D. Given the small variations in track length and subsequent CO2 and Fuel burn impacts between Option C and Option D, we therefore determined that Option D's overall performance achieved a better balance between CO2 performance and noise and therefore we have chosen to discontinue Option C at this stage.
		Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others.
Runway 23 Arrival Option D	No (preferred for Hybrid Vectors and PBN option)	It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the know Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.
		Beyond the above categories, we've looked at the IOA categories where the comparative performance of the options varies; these were the noise and CO2/Fuel burn assessments.
		Option D overflies considerable fewer population numbers than Option C 0-4000ft and 0-7000ft with much better CO ₂ performance compared to Option E. We therefore concluded that it achieved a good compromise between these two elements and would be most appropriate to take forward to be optimised in Stage 3.
		Overall, when looking at the IOA summary tables, the three PBN options C, D and E perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each of options C, D and E, within the IOA categories to understand if any performed comparatively better than others.
Runway 23 Arrival	No	It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning) and consideration of safety elements including the know Campsie line ground proximity warning system (GPWS) issues. When considering these elements with the detail available at this stage, the options (C, D and E) are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.
Option E		Beyond the above categories, we've looked at the IOA categories where the comparative performance of the options varies; these were the noise and CO2/Fuel burn assessments.
		Although Option E was the best performing PBN arrival option in terms of noise, overflying more than half the numbers of people 4000ft and below than Option C, it was the poorest performer when considering fuel burn and CO2. Compared to Option D, Option D offers a relatively small increase in the number of people overflow compared to Option E however it also offers a more significant improvement in track mileage and subsequent fuel burn/CO2 emissions. We therefore determined that Option D's overall performance achieved a better balance between CO2 performance and noise and therefore we have chosen to discontinue Option E at this stage.
Runway 23 Arrival Vectors only	Yes	Vectoring is a proven and ever flexible method of efficiently managing arrivals. The IOA showed that it offered fewer benefits compared to the other options but also had fewer negative impacts. It is likely that changes to the network as well as to the rest of Glasgow's route structure will result in a change to vectoring practices and this option is carried forward to accommodate those changes.
Runway 23 Arrival Hybrid Vectors	Yes (preferred)	This is Glasgow's preferred option. In the IOA it offered the most benefits compared to the 'do nothing' baseline, as seen in the summary table above. The availability of PBN arrivals to RWY 23 may be able to address some of the GPWS issues, greatly reduce the numbers of people overflown by avoiding population centers, enhance CDA performance and reduce controller workload to support operation concepts such as Radar In The Tower. By also retaining vectoring, it enables ATC to deliver accurate and variable spacing, mitigates the increase in track miles that a Permanent PBN arrival may require and also ensure some track variation on the ground compared to pure PBN which helps to mitigate adverse effects from PBN concentration.

Vectors	res (preierred)	some track variation on the ground compared to pure PBN which helps to mitigate adverse effects from PBN concentration.	
and PBN		The positioning of the PBN route within this option is still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.	

5.4. Runway 05 Easterly Arrivals

Group	Impact	Runway 05 Arrival Option A		Runway 05 Arrival Option C		Runway 23 Arrival Vectors only	Runway 23 Arrival Hybrid Vectors and PBN	
Communities	Noise impact on health and quality of life							
	Air Quality							
	Greenhouse gas impact							
Wider Society	Capacity / resilience							
wider Society	Tranquillity ⁵⁵							
	Biodiversity							
General Aviation	Access							
General Aviation / Commercial	Economic impact from increased effective capacity							
airlines	Fuel burn							
Commercial	Training costs							
airlines	Other costs							
Airport / Air	Infrastructure costs							
navigation service	Operational costs							
provider	Deployment costs							
All	Safety							
All	Interdependencies, conflicts and trade-offs							
AMS	Performance against the vision and parameters / strategic objectives of the AMS							
Option progressed to Stage 3		Х	√*	Х	Х	\checkmark	\checkmark	

*As articulated in our Stage 2A document, use of pure PBN for arrivals into Glasgow does not perform well in the Design Principle Evaluation and is not a viable option for Glasgow going forwards. Therefore, this option was discounted in the DPE. However, the option of a mix of PBN and vectoring does come through very favourably. In this scenario, we would want to use the best performing PBN routes so we will take the PBN arrival options (other than the ones discounted above) into the Full Options Appraisal for further assessment to help inform the Hybrid vectors and PBN options.

Option	Is the option being progressed	Rationale
	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others.
Runway 05 Arrival Option A		It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.
		To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation.
		With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, there was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly, when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performing options.
		When considering track mileage, CO2 and fuel burn, there are only very small differences between the four options A-D. Of the four options, Option A is the second worst performing for track miles.
		Option A would require additional CAS and this is expected to be a greater volume than options B and D. Given the very small differences between Option A and Options B-D in the other areas outlined above, it is on basis of CAS that Option A is discontinued at this stage.
Runway 05 Arrival Option B	No (preferred for Hybrid Vectors and PBN option)	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if any performed comparatively better than others.
		It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN' option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.

⁵⁵ All options avoid overflight of tranquil areas which is the same as the vectoring and centreline baseline.

		To determine which options to take through, we've looked at the IOA categories where the comparative performanc of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/General Aviation.	
		With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, ther was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performin options.	
		When considering track mileage, CO2 and fuel burn, there are only very small differences between the four option A-D. Of the four options, Option B is the best performing.	
		Option B would require additional CAS unless moved slightly further East however this is expected to be less of move than would be required for Options A and C.	
		On balance, Option D and Option B are very similar however Option B performs slightly better in terms of population overflown, and CO2 and is expected to require a similar volume of CAS to Option B. We have therefore chosen to take forward Option B to Stage 3 of the process.	
	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly whe compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybrid scenario, we therefore looked at the performance of each option within the IOA categories to understand if an performed comparatively better than others.	
		It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBN option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.	
Runway 05 Arrival Option C		To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/Generative Aviation.	
		With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, the was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarly when looking at the 60dB LAmax data, there is less than 200 population between the best and worst performing options.	
		When considering track mileage, CO2 and fuel burn, there are only very small differences between the four option A-D. Of the four options, Option C is the worst performing for track miles.	
		Option C would require additional CAS and this is expected to be a greater volume than options B and D. Given the very small differences between Option C and Options A, and D in the other areas outlined above, it is obasis of CAS that Option A is discontinued at this stage.	
	No	Overall, when looking at the IOA summary tables, the four PBN options A, B, C and D perform similarly when compared against the baseline. When deciding which option(s) to take through to Stage 3 to use within the hybr scenario, we therefore looked at the performance of each option within the IOA categories to understand if an performed comparatively better than others.	
		It's important to note that the final positioning of the PBN element to accompany our 'Hybrid Vectors and PBI option depends on a variety of factors including the technical waypoint configuration of the route (particularly the Final Approach Fix (FAF) positioning). When considering this element with the detail available at this stage, the options are relatively similar, and we expect refinement of the design as part of the work undertaken at Stage 3.	
		To determine which options to take through, we've looked at the IOA categories where the comparative performance of options A-D varies; these were the noise, CO2/Fuel burn assessments and Controlled Airspace (CAS)/Generative Aviation.	
Runway 05 Arrival Option D		With regards to noise, Options A-D perform very similarly. When looking at the noise data between 0-7000ft, the was a difference of <400 people between Option A (best performing) and Option D (worst performing). Similarl when looking at the 60dB Lamax data, there is less than 200 population between the best and worst performing options.	
		When considering track mileage, CO2 and fuel burn, there are only very small differences between the four option A-D. Of the four options, Option D is the second best performing for track miles.	
		Option D would require additional CAS unless moved slightly further East however this is expected to be less of move than would be required for Options A and C.	
		On balance, Option D and Option B are very similar however Option B performs slightly better in terms of population overflown, and CO2 and is expected to require a similar volume of CAS to Option B. We have therefore chosen take forward Option B and discontinue Option D at this stage.	
Runway 05 Arrival Vectors only	Yes	Vectoring is a proven and ever flexible method of efficiently managing arrivals. The IOA showed that it offered fewer benefits compared to the other options but also had fewer negative impacts. It is likely that changes to the networ as well as to the rest of Glasgow's route structure will result in a change to vectoring practices and this option is carried forward to accommodate those changes.	
Runway 05 Arrival Hybrid Vectors and PBN	Yes	This is Glasgow's preferred option. In the IOA it offered the most benefits compared to the 'do nothing' baseline, a seen in the summary table above. The availability of PBN arrivals to RWY 05 may be able to reduce the number of people overflown by avoiding population centres, enhance CDA performance and reduce controller workload support operation concepts such as Radar In The Tower. However, all of options A-D could require additional CA to contain the routes in accordance with CAA policy. This CAS requirement will be investigated in Stage 3 to try ar avoid the need for any additional CAS through alternative mitigation. By also retaining vectoring, it enables ATC deliver accurate and variable spacing, mitigates the increase in track miles that a Permanent PBN arrival material require but also ensure some track variation on the ground compared to pure PBN which has some noise benefit	
		The availability of a PBN waypoint to ensure separation between RWY 05 arrivals and departures is current considered to be a requirement in the final solution. The positioning of the PBN route within this option is still subject to change throughout the airspace change process as options are matured in detail and refined in accordance with safety requirements, our design principles, our appraisals and stakeholder engagement and consultation.	

5.5. Preferred option and information to collect as part of the Full Options Appraisal

We have outlined which options we plan to take forward to Stage 3 as part of our <u>IOA Summary and conclusion section above</u>. As part of this, we have also indicated our preferred options however it's important to note that we will need to refine those options ahead of the Full Options Appraisal (FOA) to ensure they can integrate with the network, the PBN arrivals can connect to final approach in accordance with regulations and that the routes are all flyable. All refinements that lead to the final solution(s) taken to FOA and subsequent consultation will be documented as part of the design evolution.

Throughout this Initial Options Appraisal, we have highlighted where we plan to undertake further detailed appraisal as part of our Stage 3 Full Options Appraisal, in order to further assess the benefits and impacts of an option. This is particularly the case with the primary noise metric data, where at Stage 3 we will fully quantify the L_{Aeq} contours associated with each option to CAP2091 standards, allowing us to quantify the benefits and impacts. We have also identified other categories where further quantitative appraisal work is required.

We plan to collect the following data and undertake the additional assessments as part of our Full Options Appraisal assessment and following this assessment we will outline the options that we intend to take to Consultation:

- Quantify the baseline year (pre-implementation and 10 years post implementation, including 10 year traffic forecast)
- Quantitative L_{Aeq} contours, population counts and size (km²)
- WebTAG assessment
- Quantitative overflight contours that detail frequency of overflight including 100% easterlies and westerlies, and cumulative impacts from arrivals/departures and other airports
- Detailed track length comparison
- Detailed fuel burn and equivalent CO₂ emissions data
- Further information around interdependencies with the upper network and neighbouring airports
- ATC deployment / training costs
- Quantitative capacity information
- Quantified CAS requirements
- Further information following engagement with gliding areas around airspace availability

5.6. Impacted Audiences

At the 'Develop and assess' gateway, the IOA must set out impacted audiences, as this information will be a key feature in developing the consultation strategy required during Step 3A and at the 'Consult' gateway.

The following figures show our options on one map image, displayed using overflight contours and the vectoring NTK heatmap. We will use this mapping as a starting point to identify our impacted audiences and ensure that this is considered when developing our consultation strategy at Stage 3. We're aware that other factors also need to be taken into account when identifying the audience such as other noise metrics, changes to controlled airspace etc and we will ensure these are also factored in.

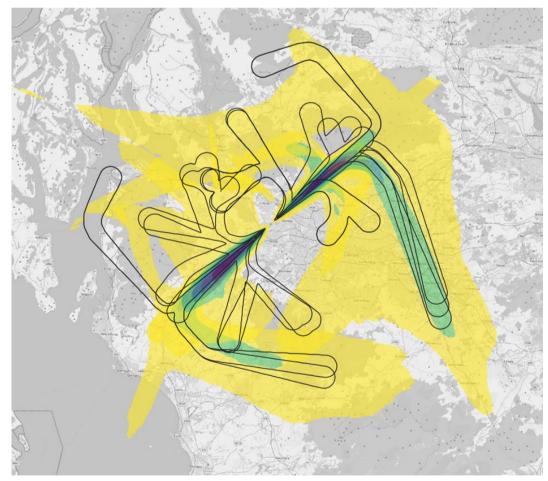


Figure 41 All Options for Stage 3 (Overflight Contours)

Glossary

Acronym	Term	Description		
ACOG	Airspace Change Organising Group	Established in 2019 at the request of the Department for Transport and Civil Aviation Authority to coordinate the delivery of key elements of the UK's Airspace Modernisation Strategy.		
ACP	Airspace Change Proposal	To carry out any permanent change to the published airspace, the Civil Aviation Authority (CAA) requires the change sponsor to carry out an airspace change proposal in accordance with <u>CAP1616</u> .		
ADS-B	Automatic Dependent Surveillan Broadcast	ceA means by which aircraft can automatically transmit and/or receive data such as identification, position, and additional data, as appropriate in a broadcast mode via a data link.		
AIP	Aeronautical Information Publication	A publication which contains details of regulations, procedures and other information pertinent to the operation of aircraft in the particular country to which it relates.		
AMS	Airspace Modernisation Strategy	UK Government has tasked the aviation industry to modernise airspace in the whole of the UK. The long-term strategy of the CAA and the UK Government is called the Airspace Modernisation Strategy (AMS). Its CAA document reference number is <u>CAP1711</u> .		
AMSL	Above Mean Sea Level			
ANSP	Air Navigation Service Provider	An organisation that provides the service of managing the aircraft in flight or on the manoeuvering area of an airport and which is the legitimate holder of that responsibility.		
AONB	Area of Outstanding Natural Beauty			
ATC	Air traffic control	The ground-based personnel and equipment concerned with controlling and monitoring air traffic within a particular area.		
ATZ	Aerodrome Traffic Zone	An airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.		
CAA	Civil Aviation Authority	The UK Regulator for aviation matters		
CAP1616	Civil Aviation Publication 1616	The airspace change process regulated by the CAA		
	Capacity	A term used to describe how many aircraft can be accommodated within an airspace area without compromising safety or generating excessive delay		
CAS	Controlled Airspace	Generic term for the airspace in which an air traffic control service is provided as standard; note that there are different sub classifications of airspace that define the particular air traffic services available in defined classes of controlled airspace.		
-	Centreline	The nominal track for a published route		
-	Concentration	Refers to a density of aircraft flight paths over a given location, this generally refers to high density where tracks are not spread out; this is the opposite of dispersal		
CCO	Continuous Climb Operations	An aircraft operating technique facilitated by the airspace and procedure design and assisted by appropriate ATC procedures, allowing the execution of a flight profile optimised to the performance of aircraft, leading to significant economy of fuel and environmental benefits in terms of noise and emissions reduction		
CDO	Continuous Descent Operations	An aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight to the extent permitted by the safe operation of the aircraft and compliance with published procedures and ATC instructions		
-	Conventional navigation	The historic navigation standard where aircraft fly with reference to ground-based radio navigation aids		
-	Conventional route	Routes defined to the conventional navigation standard, i.e. using ground based radio navigation beacons to determine their position.		
СТА	Control Area	Controlled airspace extending upwards from a specified limit above the earth. Control Areas are situated above the Aerodrome Traffic Zone (ATZ) and afford protection over a larger area to a specified upper limit.		
CTR	Control Zone	Controlled airspace extending upwards from the surface of the earth to a specified upper limit. Aerodrome Control Zones afford protection to aircraft within the immediate vicinity of aerodromes		
db	Decibels	A unit used to measure the intensity of a sound (or the power level) of an electrical signal by comparing it with a given level on a logarithmic scale.		
DER	Declared End of Runway			
-	Dispersal	Refers to the density of aircraft flight paths over a given location, this generally refers to lower density – tracks that are spread out; this is opposite of Concentration		

DPE	Design Principle Evaluation	A evaluation of each option against each design principle which forms part of Stage 2A of the CAP1616 process
-	Easterlies	When a runway is operating such that aircraft are taking off and landing in an easterly direction
-	Final Approach	The final part of an arrival flight path that is directly lined up with the runway
FL	Flight Level	The Altitude above sea-level in 100 feet units measured according to a standard atmosphere. A flight level is an indication of pressure, not of altitude. Only above the <u>transition level</u> (which depends on the local <u>QNH</u> but is typically 4000 feet above sea level) are flight levels used to indicate altitude; below the transition level feet are used.
FLARM	Flight Alarm	FLARM (an acronym based on 'flight alarm') is the proprietary name for an electronic device which is in use as a means of alerting pilots of small aircraft, particularly gliders, to potential collisions with other aircraft which are similarly equipped.
FUA	Flexible Use Airspace	Airspace which is not solely designated for a single purpose, but can be allocated flexibly according to need, or switched entirely on/off according to a schedule or agreed process.
-	Flight-path	The track flown by aircraft when following a route, or when being directed by air traffic control

ft	Feet	The standard measure for vertical distances used in air traffic control
FASI	Future Airspace Implementation	nUnder the Government's Airspace Modernisation Strategy (AMS, ref 15) airports in the UK are required to update their airspace and routes in a coordinated way.
GA	General Aviation	All civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire. The most common type of GA activity is recreational flying by private light aircraft and gliders, but it can range from paragliders and parachutists to microlights, balloons, and private corporate jet flights.
IFP	Instrument Flight Procedures	A published procedure used by aircraft flying in accordance with the instrument flight rules, which is designed to achieve and maintain an acceptable level of safety in operations and includes an instrument approach procedure, a standard instrument departure, a planned departure route and a standard instrument arrival.
ILS	Instrument Landing System	An ILS operates as a ground-based instrument approach system that provides precision lateral and vertical guidance to an aircraft approaching and landing on a runway, using a combination of radio signals to enable a safe landing even during poor weather.
IOA	Initial Options Appraisal	A qualitative appraisal of an option against a baseline 'do nothing' scenario, as required at Step 2B of CAP1616
L _{Aeq}		The most common international measure of noise, meaning, 'equivalent continuous sound level'. This is a measurement of sound energy over a period of time.
LAeq 16h		The A-weighted Leq measured over the 16 busiest daytime hours (0700-2300) is the normal time- period used to develop the Airport Noise Contours for day-time operations.
LAeq 8h		The A-weighted Leq measured over the 8 night-time hours (2300-0700) is the normal time-period used to develop the Airport Noise Contours for night-time operations.
-	Lower Airspace	Airspace in the general vicinity of the airport containing arrival and departure routes below 7,000ft. Airports have the primary accountability for the design of this airspace, as its design and operation is largely dictated by local noise requirements, airport capacity and efficiency
NAP	Noise Abatement Procedures	Noise abatement procedures are designed to minimise exposure of residential areas to aircraft noise, while ensuring safety of flight operations
NATS (ATC)		NATS ATC - the air navigation service provider at Glasgow Airport under commercial contract for the aerodrome control provision.
NATS NERL		NATS NERL - The UK's licenced air traffic service provider for the en route airspace (upper network) that connects airports with each other, and with the airspace of neighbouring states.
nm	Nautical Mile	Aviation measures distances in nautical miles. One nautical mile (nm) is 1,852 metres. One road mile ('statute mile') is 1,609 metres, making a nautical mile about 15% longer than a statute mile.
-	Network Airspace / Upper network	En route airspace above 7,000ft in which NATS has accountability for safe and efficient air traffic services for aircraft travelling between the UK airports and the airspace of neighbouring states.
NTK	Noise Track Keeping	A system that monitors and records radar data to monitor aircraft operations and report statistics focused around noise.
PANS OPS	Procedures for Air Navigation Service Aircraft Operations	esPANS-OPS is contained in an ICAO Document 8168 which sets out the design criteria and rules for instrument flight procedures which include approach and departure procedures.
PBN	Performance Based Navigation	Referred to as PBN; a generic term for modern standards for aircraft navigation capabilities including satellite navigation (as opposed to 'conventional' navigation standards)
PC	Prestwick Centre	Prestwick Centre handles air traffic across northern England, Scotland and out into North East Atlantic.
RMA	Radar Manoeuvring Area	An ATC operational area articulated as a volume of airspace by the ANSP. It facilitates the close-in radar vectoring by ATC that is required to take the aircraft safely from a holding stack and established onto final approach.
RNAV / RNAV 1	aRea NaVigation	This is a generic term for a particular specification of Performance Based Navigation. The suffix '1' denotes a requirement that aircraft can navigate to with 1nm of the centreline of the route 95% or more of the time. In practice the accuracy is much greater than this.
RNP-RF	Required Navigation Performance Radius to fix	-An advanced navigation specification under the PBN umbrella. The suffix '1' denotes a requirement that aircraft can navigate to with 1nm of the centreline 95% or more of the time, with additional self-monitoring criteria. In practice the accuracy is much greater than this. The RF means Radius to Fix, where airspace designers can set extremely specific curved paths to a greater accuracy than RNAV1.

RNP-AR	Required Navigation Performance Authorisation required	-An advanced navigation specification under the PBN umbrella. 'Authorisation required' refers to aircraft and operators complying with specific airworthiness and operational requirements. RNP-AR allow airspace designers to set extremely specific curved paths to a greater accuracy than RNAV1, these can be designed before and after the Final Approach Fix.
-	Separation	Aircraft under Air Traffic Control are kept apart by standard separation distances, as agreed by international safety standards. Participating aircraft are kept apart by at least 3nm or 5nm lateral separation (depending on the air traffic control operation), or 1,000ft vertical separation.
SID	Standard Instrument Departure	Usually abbreviated to SID; this is a route for departures to follow straight after take-off.
	Tactical Intervention	Air traffic control methods that involve controllers directing aircraft for specific reasons at that particular moment (see Vector)
TMA /	Terminal Manoeuvring Area (Terminal Airspace)	An aviation term to describe a designated area of controlled airspace surrounding a major airport or cluster of airports where there is a high volume of traffic. The airspace surrounding Glasgow &
ScTMA	, Scottish Terminal Manoeuvring Area	Edinburgh airports is described as the Scottish TMA (ScTMA). This is the airspace that contains all the arrival and departure routes for Glasgow & Edinburgh from the surface to 6000ft.

TMZ	Transponder Mandatory Zone	Airspace of defined dimensions where the carriage and operation of transponder equipment is mandatory.
VFR	Visual Flight Rules	Visual Flight Rules (VFR) are the rules that govern the operation of aircraft in <u>Visual Meteorological</u> <u>Conditions (VMC)</u> (conditions in which flight solely by visual reference is possible)
VMC	Visual Meteorological Conditions	Visual meteorological conditions (VMC) are the meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima
VSA	VFR Significant Area	A volume of airspace which has been identified as being particularly important to VFR operations. A VSA might take the form of a route, a zone, or an area chosen for its particular importance to GA users. These areas do not have any official status but are intended to highlight the importance of a particular area so that future airspace development plans can take account of the GA activity.
-	Vector / vectoring	An air traffic control method that involves directing aircraft off the established route structure or off their own navigation – ATC instruct the pilot to fly on a compass heading and at a specific altitude. In a busy tactical environment, these can change quickly. This is done for safety and for efficiency.
-	Westerly operation	When a runway is operating such that aircraft are taking off and landing in a westerly direction