GLASGOW AIRPORT

PROUD TO SERVE SCOTLAND

Glasgow Airport FASI-North Airspace Change Proposal

Stage 2A Engagement on Comprehensive List of Options

AGENDA

1. Introductions and project overview
2. Purpose of Stage 2A engagement
3. Our approach to developing the initial comprehensive list of options
4. Comprehensive List of Options
5. Our questions for you
6. Next steps

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1. Introductions and overview

1. INTRODUCTION AND OVERVIEW: RECAP

Glasgow Airport is developing an airspace change proposal (ACP) to upgrade the airport's arrival and departure routes. The ACP will cover a review of routes from the ground up to 7000ft and will also review the boundaries between controlled and uncontrolled airspace.

Every ACP sponsor must follow the regulatory process for changing the airspace design known as CAP1616 (Civil Aviation Publication no. 1616).

- CAP1616 sets out the process for developing airspace change options. This entails engaging with affected stakeholders, evaluating the impacts of options, consulting the public, regulatory approval and implementation.
- The CAA review our submission at each stage of the process to ensure the engagement and analysis is robust prior to moving to the next stage.

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1. CAP1616

Nov 2019 — Glasgow Airport submitted the Stage 1 Design Principles documents to the CAA and moved onto Stage 2 of the 7-stage CAP1616 process.

April 2020 — Due to COVID-19 the ACP was paused

Mar 2021 — Following the announcement in March 2021 from the Department for Transport and the CAA of short-term financial support for the next phase of the FASI project, Glasgow Airport have been able to progress this ACP.

In line with CAP1616 guidance, during Stage 2, Glasgow Airport will continue to seek involvement from the same stakeholders that were engaged as part of Step 1B.

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1. CAP1616 STAGE 2 DEVELOP & ASSESS

Our ACP is currently in Step 2A of the CAP1616 process – known as Options Development

Step 2A requires Glasgow Airport to first develop a comprehensive list options to the extent that a list is possible. This list of route options should address the Statement of Need and align with the Design Principles which were developed in Stage 1.

We are now engaging with stakeholders to ensure that they are satisfied that the route options are aligned with the design principles and that the airport has properly understood and accounted for stakeholder concerns, specifically related to the design options.

Glasgow Airport will then produce a design principle evaluation which will set out how our route options have responded to each of the design principles. This will be published on the CAA's Airspace Change Portal.

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2. Purpose of Stage 2A Engagement

2. PURPOSE OF THIS ENGAGEMENT

- The purpose of this session is to explore and test our approach to developing the options and answer questions relating to our approach.
- We will use your feedback to try and address any concerns raised. We are able to refine or develop more options, based on your feedback.
- The purpose of this engagement is **NOT** to seek feedback on individual route options by examining the detailed specific geographical position of the options.
- We do not yet have any detail on the potential impacts of each option, that will come later.
- At this stage we are engaging community groups, local authorities, airline, general aviation bodies, other airports and NATS.
- This is not a public consultation exercise, that comes later, on the preferred option(s).

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3. Our approach to developing the initial comprehensive list of options

3. OUR APPROACH

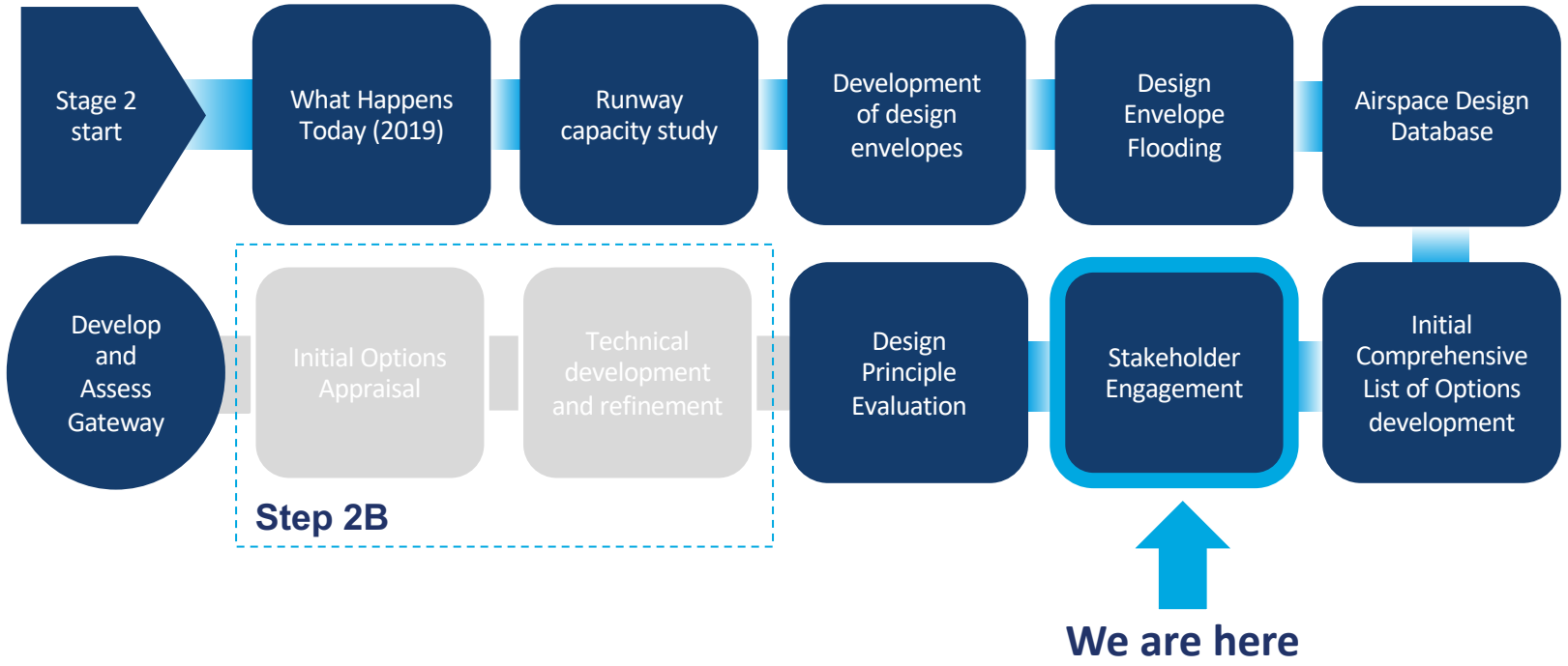
When developing Airspace Change options, Glasgow Airport must address the Statement of Need and align with the Design Principles which were developed in Stage 1 with stakeholders:

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

3. OUR APPROACH

In practice, developing a comprehensive list of options that address the statement of need and align with the design principles is a complex task, especially when faced with a 'blank sheet' approach. There are several stages of work that are required to take place in order to arrive at a comprehensive list of options. The following slides summarise the methods employed to develop as many options as practicable.

Overview of our approach:



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3. OUR APPROACH

What happens today

All Design Principles

The first step in developing our Comprehensive List of Options is to understand what happens today. When we restarted the project after COVID-19, we refreshed this analysis.

We took initial steps to understand the existing Airspace Environment and how we can change and improve it to meet the Design Principles. This included:

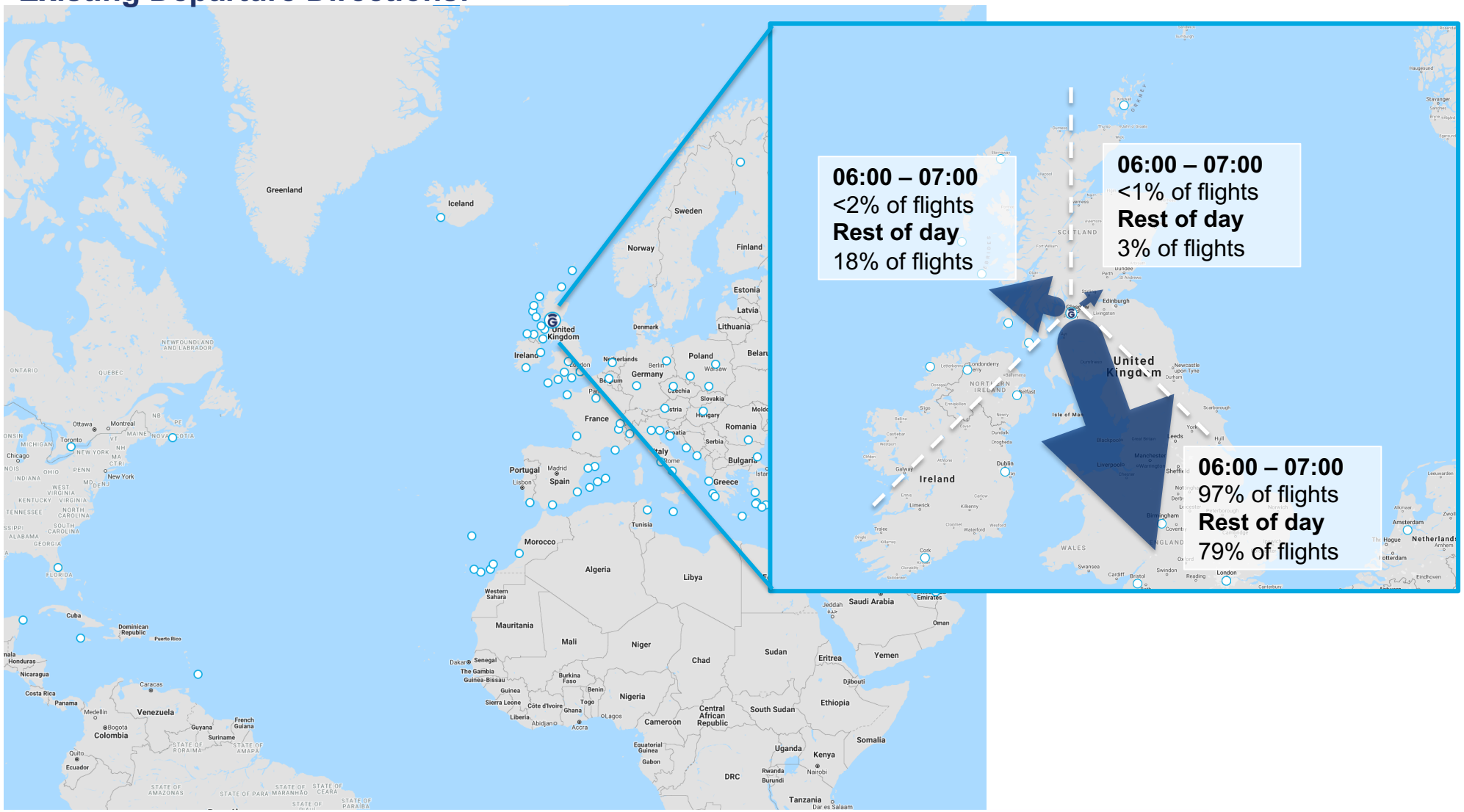
- Analysing flight track data to understand how aircraft currently operate at Glasgow Airport
- Engaging with General Aviation and Airlines around the Controlled Airspace structure
- Engaging with Airlines to understand their future fleet capabilities

The following information is based on 2019 data, as this is most representative of a recovered COVID-19 scenario.

3. OUR APPROACH

What happens today

Existing Departure Directions:



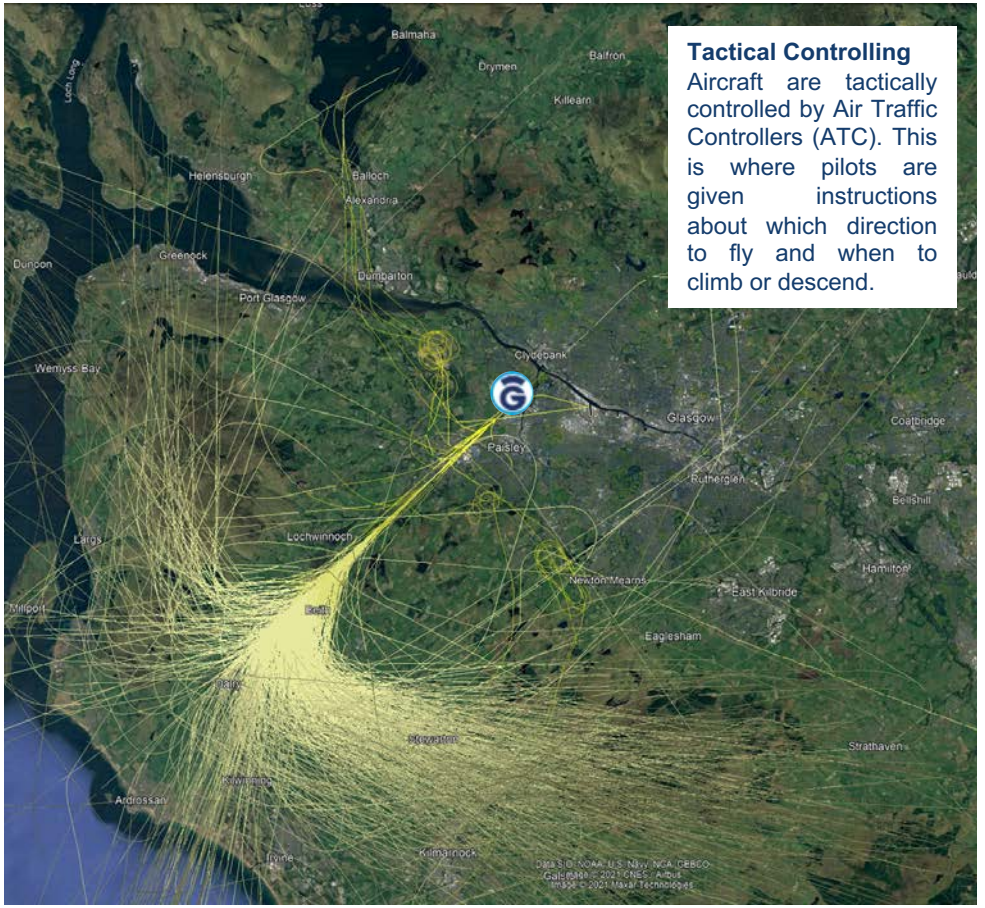
3. OUR APPROACH

Existing Routes: Runway 05

Aircraft land from the Johnstone/Linwood direction and take-off towards Clydebank and Bearsden (28% of the year in 2019)

Runway 05 Departures

Glasgow publish 9 departure routes (Route centerlines shown in red)



Tactical Controlling
Aircraft are tactically controlled by Air Traffic Controllers (ATC). This is where pilots are given instructions about which direction to fly and when to climb or descend.

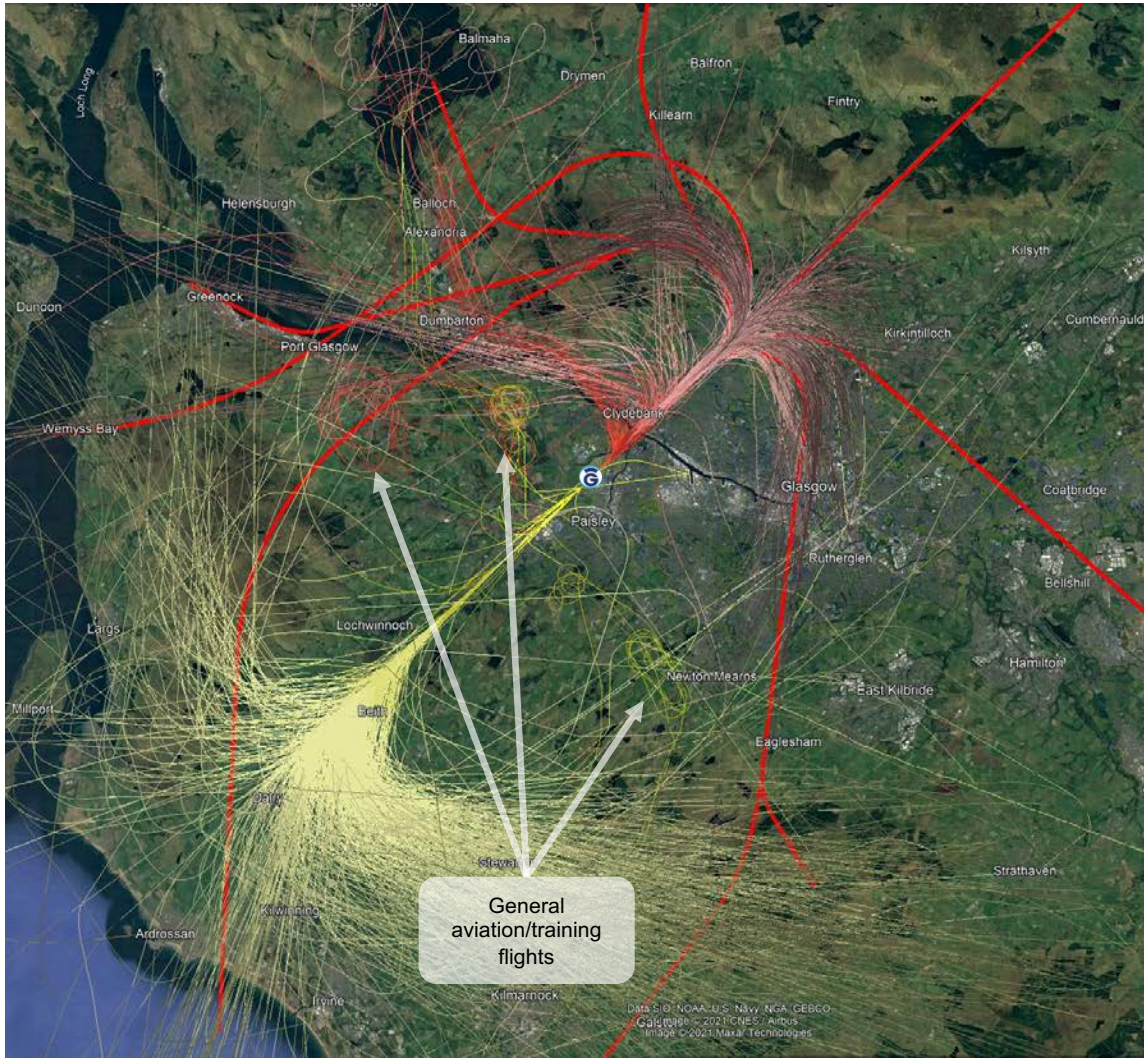
Runway 05 Arrivals (1 week of 2019 flight track data)

Arrivals are tactically controlled by ATC onto Final Approach. Aircraft join final approach at around 7 – 12 nm. There are no published routes.

3. OUR APPROACH

Runway 05: Actual flight tracks

(28% of the year in 2019)



In reality aircraft are frequently tactically controlled off the departure centerlines by Air Traffic Controllers (ATC). This is where ATC give pilots instructions about which direction to fly and when to climb or descend. This means that aircraft do not follow a set route.

This can be seen when we look at a week's flight track data captured during the summer of 2019.

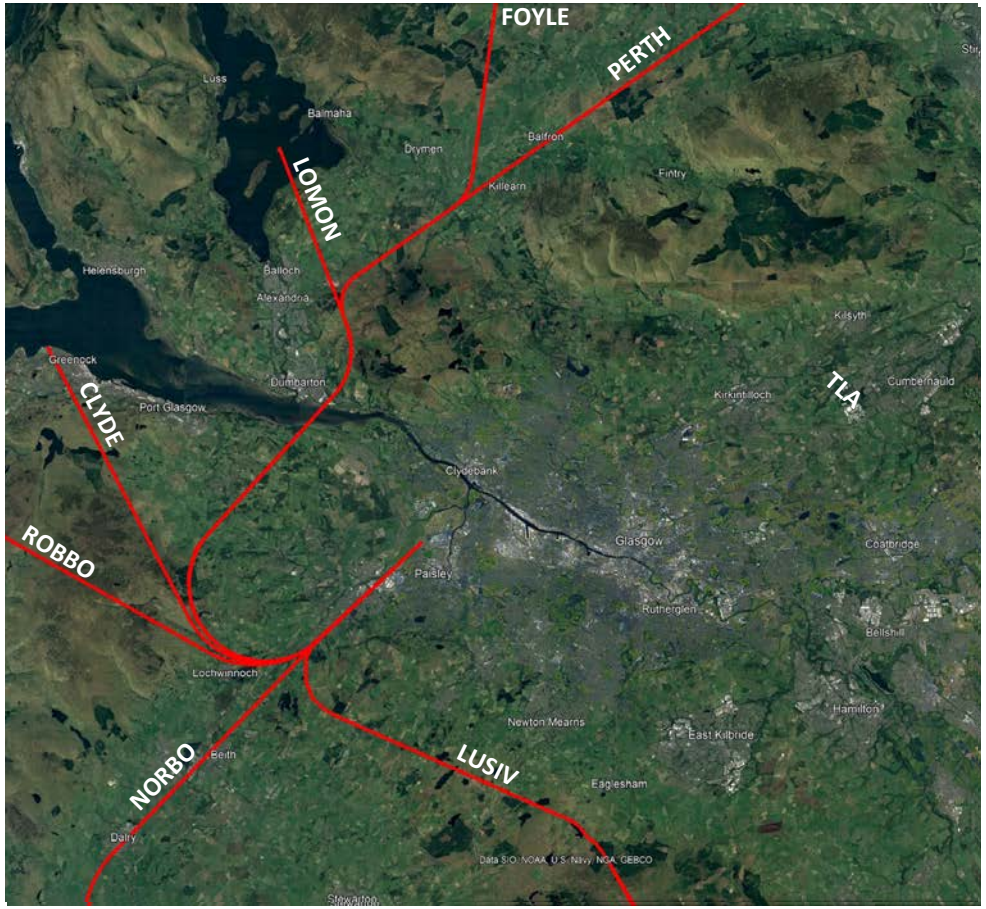
This data shows each flight up to 7000ft (within the scope of this ACP)

Altitude (ft)	Departures	Arrivals
0-1000		
1000-2000		
2000-3000		
3000-4000		
4000-5000		
5000-6000		
6000-7000		

3. OUR APPROACH

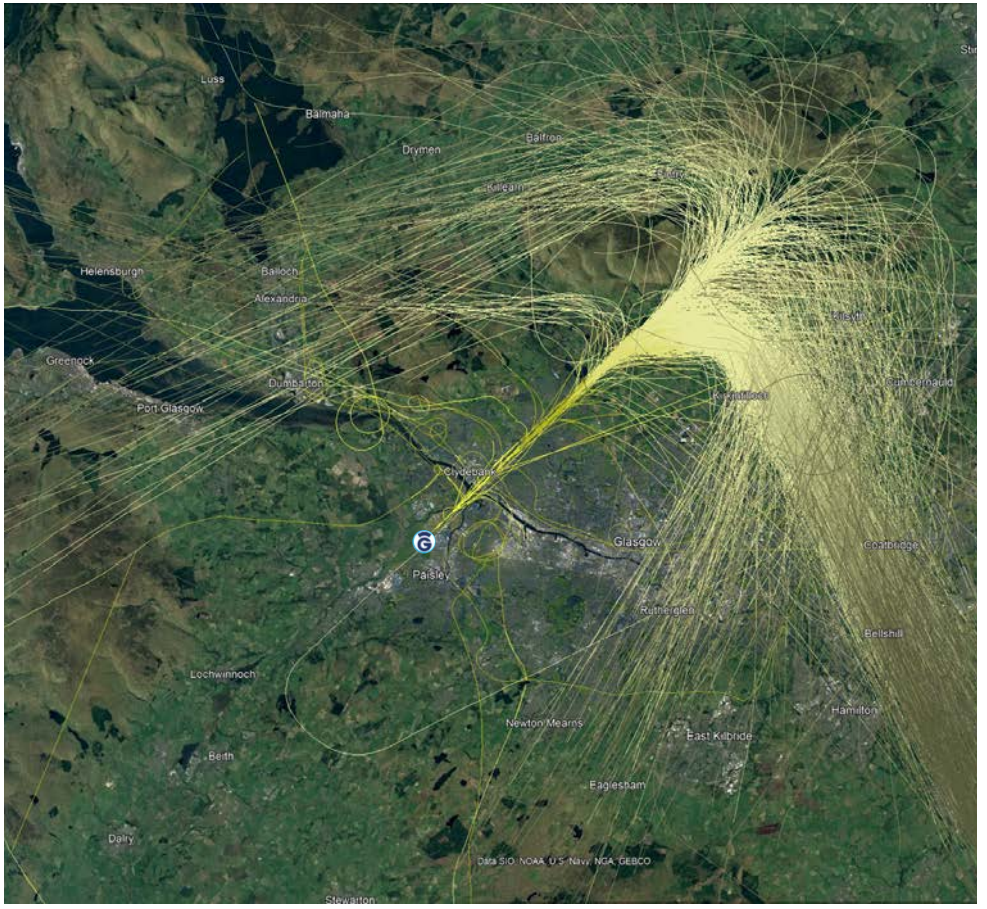
Existing Routes: Runway 23

Aircraft take off towards Linwood and Johnstone and land from the Bearsden and Clydebank direction (72% of the year in 2019)



Runway 23 Departures

Glasgow publish 7 departure routes (Route centerlines shown in red)



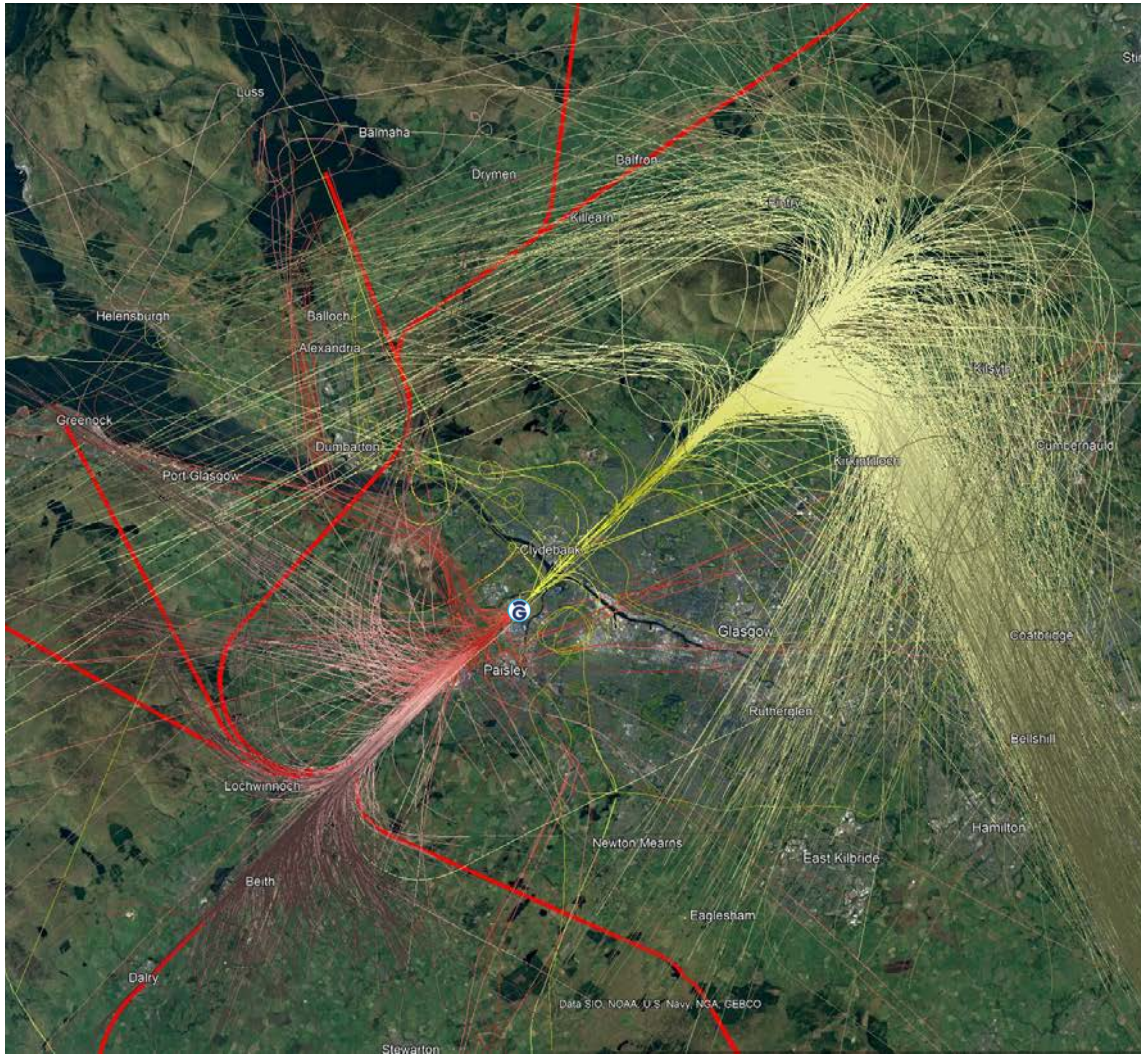
Runway 23 Arrivals

Arrivals are tactically controlled by ATC onto Final Approach. Aircraft join final approach at around 5 – 14 nm. There are no published routes.

3. OUR APPROACH

Runway 23: Actual flight tracks

(72% of the year in 2019)



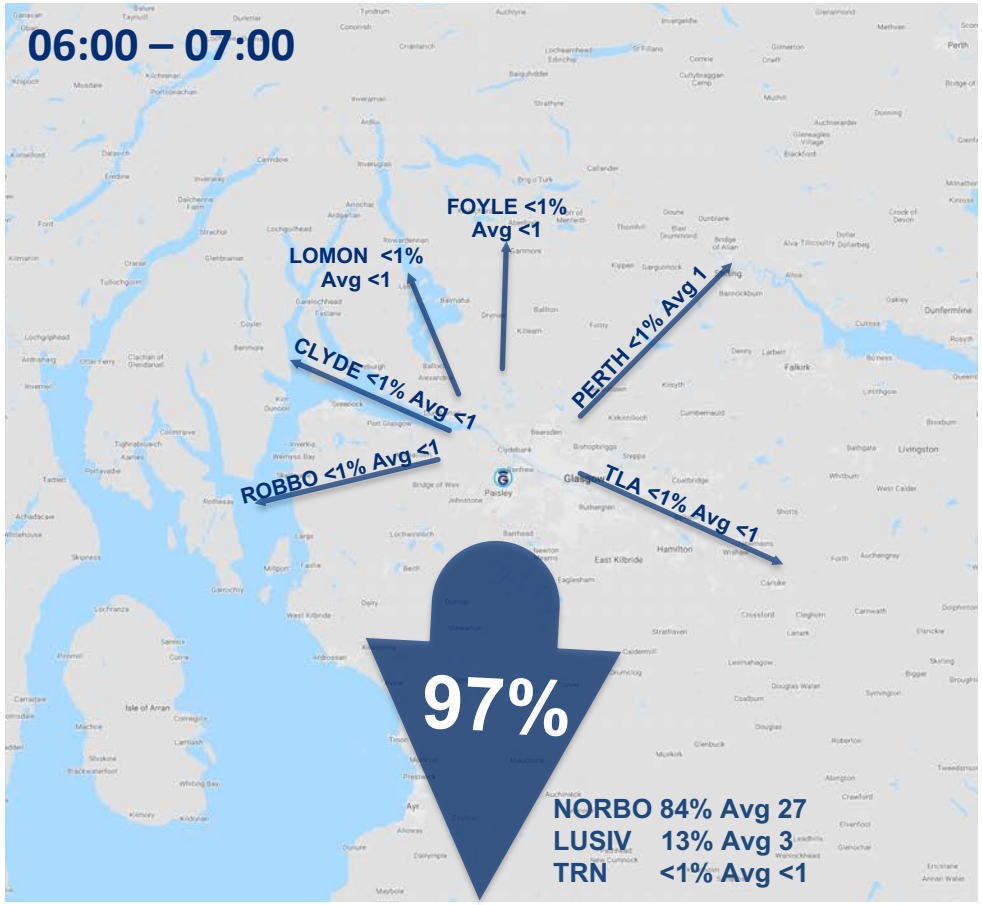
In reality aircraft are frequently tactically controlled off the departure centerlines by ATC. This can be seen when we look at a week's flight track data captured during the summer of 2019.

This data shows flights up to 7000ft (within the scope of this ACP)

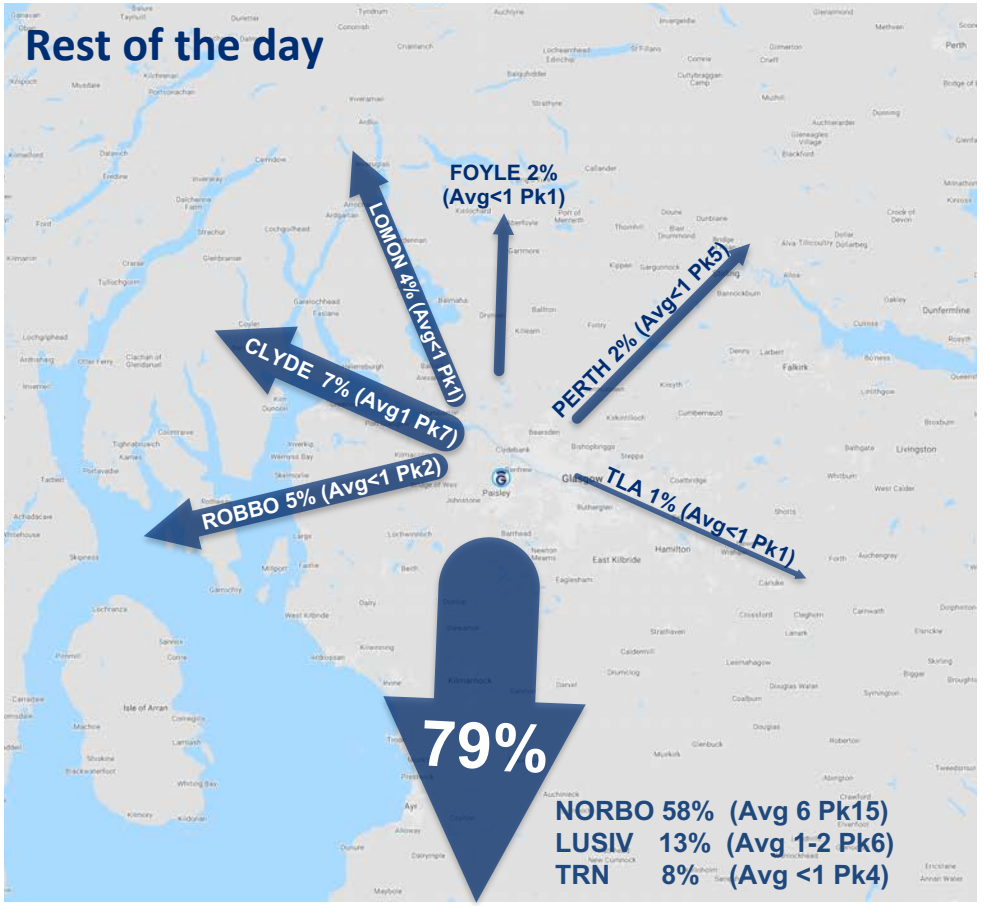
Altitude (ft)	Departures	Arrivals
0-1000		
1000-2000		
2000-3000		
3000-4000		
4000-5000		
5000-6000		
6000-7000		

3. OUR APPROACH

Existing Departure Usage/Directions



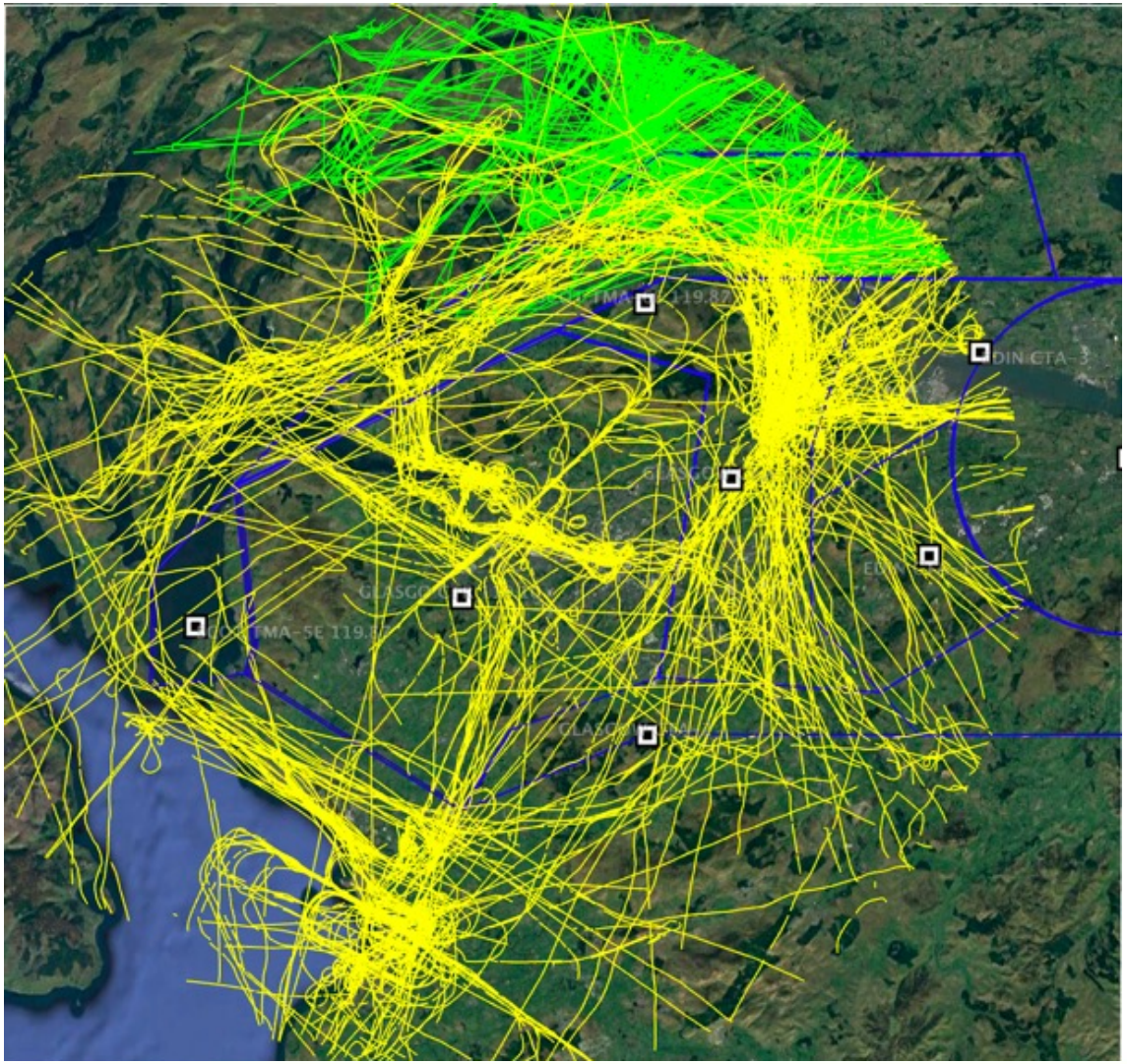
Avg = average number of hourly movements in 2019



A = average movements per hour P = Peak hour movements in 2019

3. OUR APPROACH

Controlled Airspace



General Aviation activity up to 6000ft

We also looked at the existing controlled airspace arrangements (blue) and how other airspace users (green and yellow) use the airspace surrounding Glasgow.

This was the starting point for engagement with the local General Aviation community around how the controlled airspace could be improved.

Technical Information for Aviation Stakeholders

The following image displays ADS-B and Mode S track data derived from 360Radar within 30nm of the Glasgow Airport ARP between 27th August and 10th September 2019 H24.

All commercial callsigns have been removed from the data.

There was no FLARM data recorded during that time period, so we have added data received from the BGA for the whole of 2019 within 30nm of the Glasgow Airport ARP. It includes only those flights that were posted to the BGA National Ladder site, which is entirely voluntary.

BGA data is in green

ADS-B and Mode S data is in yellow

Existing CAS boundaries are depicted in blue

Any questions?

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3. OUR APPROACH

Runway Capacity Study

Design Principles 2, 4, 12 & 15

In April 2020, we undertook a runway capacity study which we have used to inform the way we develop our initial Comprehensive List of Options. This ensures that we meet our Statement of Need, and Design Principles 2, 4, 12 and 15.

The Runway Capacity model was based on a pre-covid forecast schedule, grown from 2019 busy day traffic data.

The study concluded that in order to achieve capacity at Glasgow and minimise avoidable delays, a minimum of 2, ideally 3 departure routes would be required off each runway end.

3. OUR APPROACH

Development of design envelopes

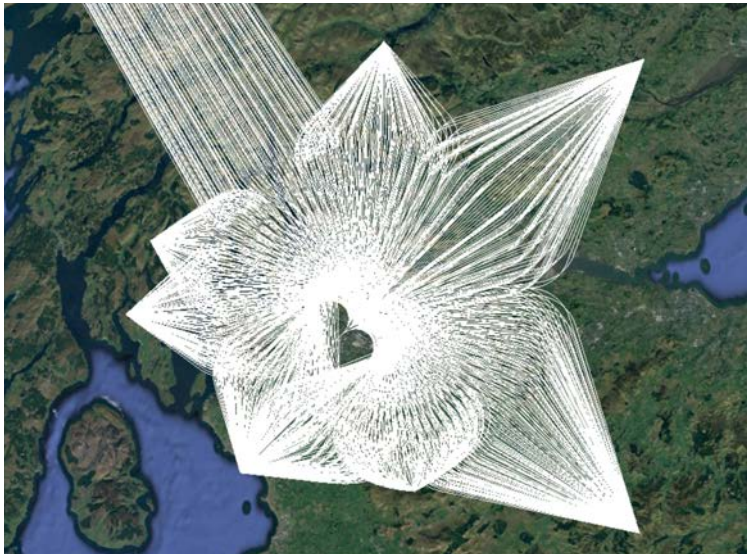
Design Principles 1 2 5 7 10 12 13 14 15

We next developed design envelopes. These are outlines of geographic areas within which flight paths could technically be positioned.

The Glasgow airspace change presents a blank sheet approach to airspace design and as such, we did not initially constrain ourselves with any existing airspace limitations.

The design envelopes were created by an Instrument Flight Procedure (IFP) designer so that we could ensure the areas considered met the rules used for designing arrival and departure routes.

Example Runway 05 Departure design envelope



Example Runway 05 Flooded with notional departure flight paths (See next slide)

3. OUR APPROACH

Design Envelope Flooding

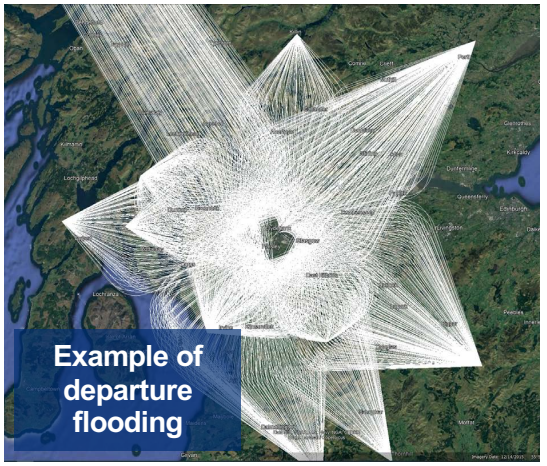
DP 1 5 7 8 12 13 14

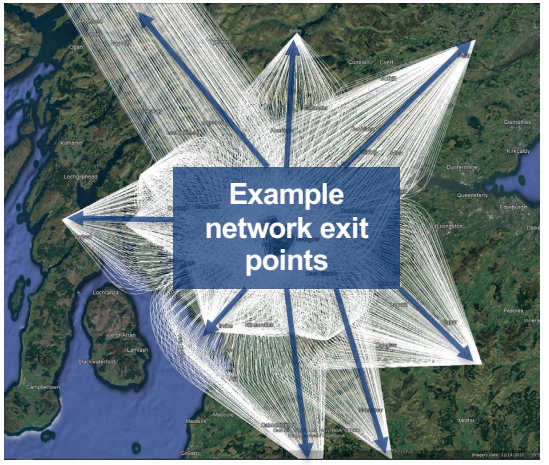
To ensure we investigate as many options as practicable within the envelopes, the design envelopes have been ‘flooded’ with hundreds of notional flight paths.

This allows insight into which areas of the design envelope may have the potential to best meet the design principles.

The notional flight paths are developed to join network entry/exit points (where aircraft enter/exit the airspace above 7000ft). These groupings allow us to create system options (groups of workable departure and arrival routes) later in this process.

Although notional flight paths are based on the basic principles of the rules Instrument Flight Procedure designers use when designing arrival and departure routes, **they are not considered final flight paths.** It is intended that they will be refined as we progress through the process to incorporate greater IFP detail. As we are undertaking this work, we will use map underlays and continue to process any developments through the database.





3. OUR APPROACH

Design Envelope Flooding

Design Principles 1 5 7 8 12 13 14

Arrivals

All notional flight paths assume a continuous descent from 7,000ft to meet DP13.

Arrivals were developed to turn onto the final approach at 8nm - 18nm (14.8km – 33.3km)

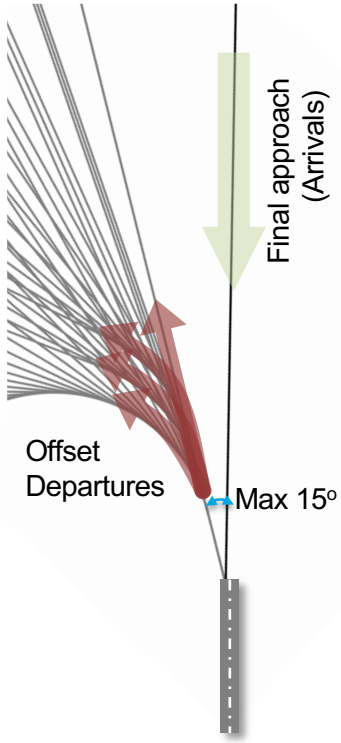
Departures

Departures were developed with initial turns at:

- 1.0 nautical miles (Around 1.9km)
- 1.5 nautical miles (Around 2.8km)
- 2 nautical miles (Around 3.7km)
- 3 nautical miles (Around 5.6km
- 4 nautical miles (Around 7.4km)
- 5 nautical miles (Around 9.26km)

All departures assume a continuous climb to 7,000ft to meet DP13.

There are also departures that have a track adjustment (a small turn) immediately after departure. These are called **offset departures**. They are used to look at options to avoid overflying communities close into the airport with arrivals and departures. An illustrative example is shown on the diagram opposite.



Illustrative example of offset departures

3. OUR APPROACH

All Arrival Notional Flight Paths:

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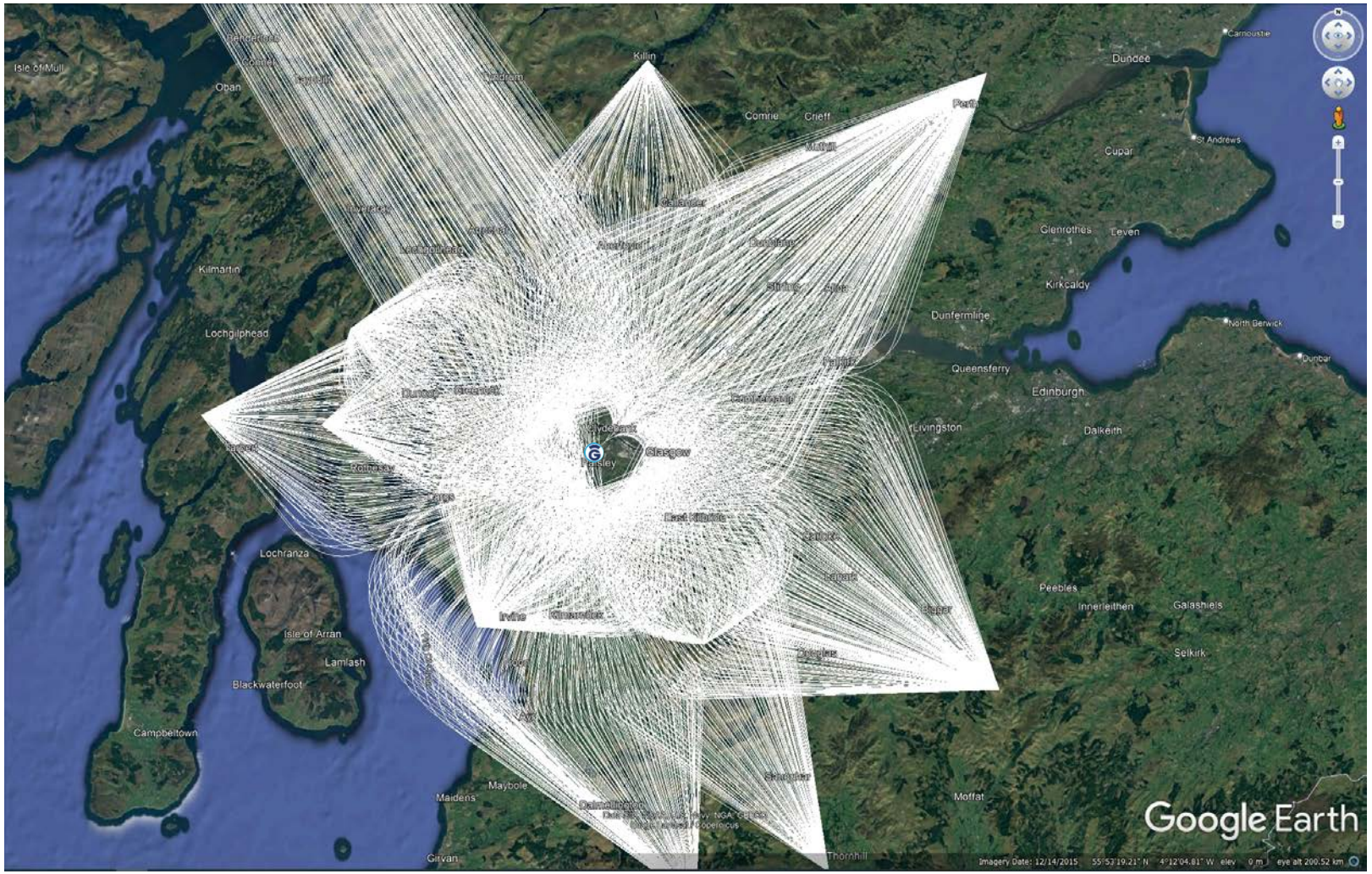
3. OUR APPROACH

All Departure Notional Flight Paths:



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3. OUR APPROACH

Airspace Design Database

Design Principles 1 3 5 7 8 12 13 14 15

An Airspace Design Database was created which allowed high performing notional flight paths to be identified. These are the flight paths which most align with our Design Principles.

The database includes a noise assessment of each path, based on single noise events such as L_{Amax} and overflight metrics. It also includes track mileage to enable high level comparison of potential fuel burn / CO_2 and information about whether an option would require additional new Controlled Airspace.

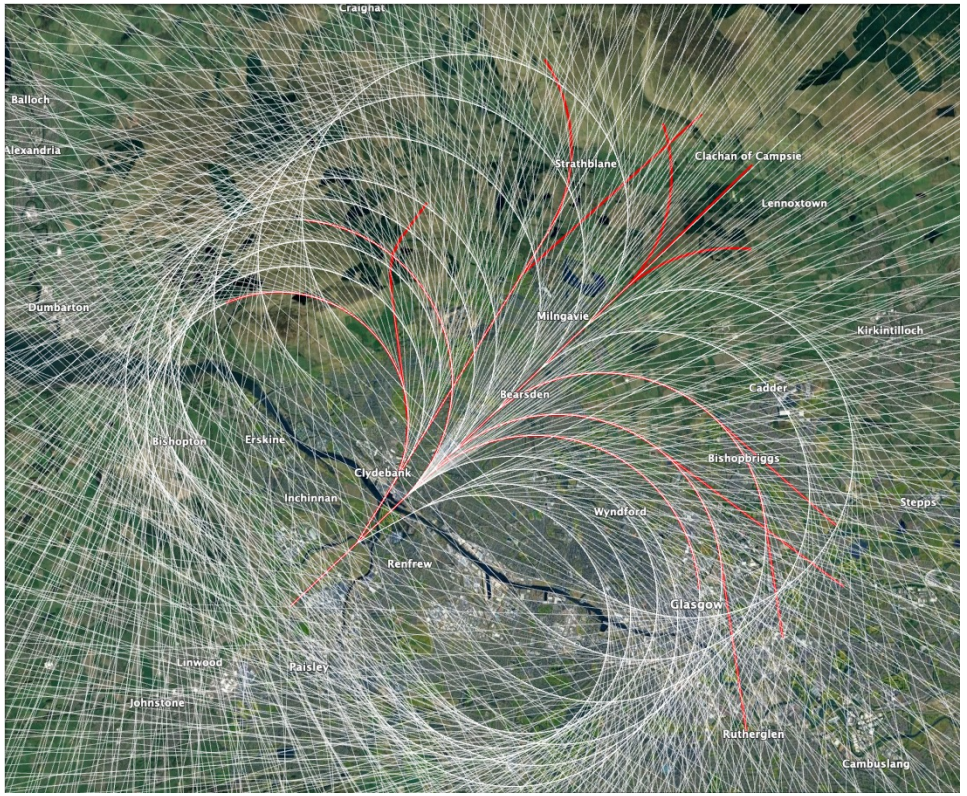
Our Noise Assessment Methodology

Our noise assessment methodology must comply with the requirements set out in CAP1616 and CAP2091 (the CAA's policy on minimum standards for noise modelling).

However, CAP1616 advocates a proportionate approach to assessment and the CAA recognises that it is not always proportionate to undertake detailed noise modelling to the requirements set out in CAP2091 when appraising the comprehensive list of options at Stage 2.

Therefore, in consultation with the CAA, we have developed a more proportionate approach for this stage of the assessment. This involves the use of a noise calculation tool with simplified assumptions such as standard flight profiles, allowing us to calculate noise indicators for thousands of flight path options.

For the Full Options Appraisal at Stage 3, and any subsequent noise assessment, we will undertake detailed noise modelling with airport specific assumptions in line with the standard of noise modelling set out in CAP2091.



3. OUR APPROACH

Comprehensive List of Options Development

All Design Principles

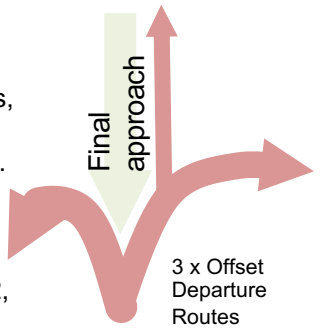
The Airspace Design Database has given us the high performing notional flight paths for each network exit/entry group however this only looks at the paths as individuals. In order to develop options that meet DP2, 4, and 6, we needed to consider how systems of arrivals and departures routes would work together, for example to create respite.

To achieve this, we developed concepts. The final stage in the process was to bring together the concepts and the best performing notional flight paths from the Airspace Design Database:

Concept

Concepts describe broad directions or splits of routes, that take into account expected traffic distribution.

These are informed by the runway capacity study and in order to try to meet DP 2, 4 & 6.



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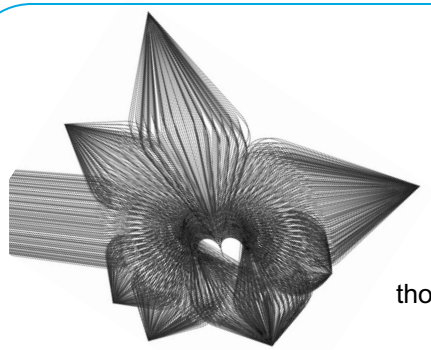

Airspace Design Database

Contains noise, environment and airspace data on thousands of notional flight paths.

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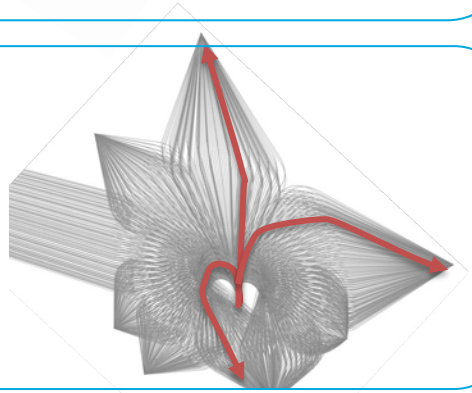
Airspace Option

The airspace option brings together the concept and the best performing notional flight paths alongside separation standards and other technical experience*, to build system options that form our initial comprehensive list of options.

*To create working systems is a complex task and therefore this is a collaborative group exercise between ATM experts, IFP designers, and ATC.



Illustrative example only

Any questions?

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Break

Back in 5 minutes

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4. Comprehensive List of Options

4. COMPREHENSIVE LIST OF OPTIONS

Stakeholder Engagement

The following section gives an overview of our comprehensive list of options. Owing to the number of options, as part of this workshop we will talk through a few examples to explain the information available to stakeholders at this stage. A link to this presentation will be circulated following the meeting to allow Stakeholder's time to review each option in detail.

It's important to note that at this stage we are not consulting on these options or seeking feedback on individual route options by examining the specific geographic positions.

The purpose of this session is to explore and test our approach to developing the options and answer questions relating to our approach. We are able to refine or develop more options based on your feedback.

The questions we are asking our Stakeholder are:

- **Are you satisfied that we have taken into account the Design Principles when developing our comprehensive list of route options?**
- **Are there any further considerations that relate to the Design Principles which we have not taken into account?**

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4. COMPREHENSIVE LIST OF OPTIONS

Stakeholder Engagement

The following slides show examples from our comprehensive list of options. These have been broken down into Runway 05 arrivals and departures, and Runway 23 arrivals and departures. Information about each option is shown across three images:

- The first image shows the expected usage of the route and an indication of whether it is shorter or longer than current day; this gives a high-level overview in terms of fuel burn and carbon emissions,
- The second image shows the route overlaid with population and noise sensitive site information, and
- The third image adds in an example of 1 week of 2019 aircraft tracks to show how the option compares to current day.

It is very important to note that detailed environmental analysis of these options takes place at a later stage of the process and therefore the information provided is *indicative* to help Stakeholders understand whether we have developed our Comprehensive List of options to meet the Design Principles and Statement of Need.

Key:

Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data	Arrival Options and aircraft track data
0 – 1000		
1000 – 2000		
2000 – 3000		
3000 – 4000		
4000 – 5000		
5000 – 6000		
6000 - 7000		

Population per km^2

5000

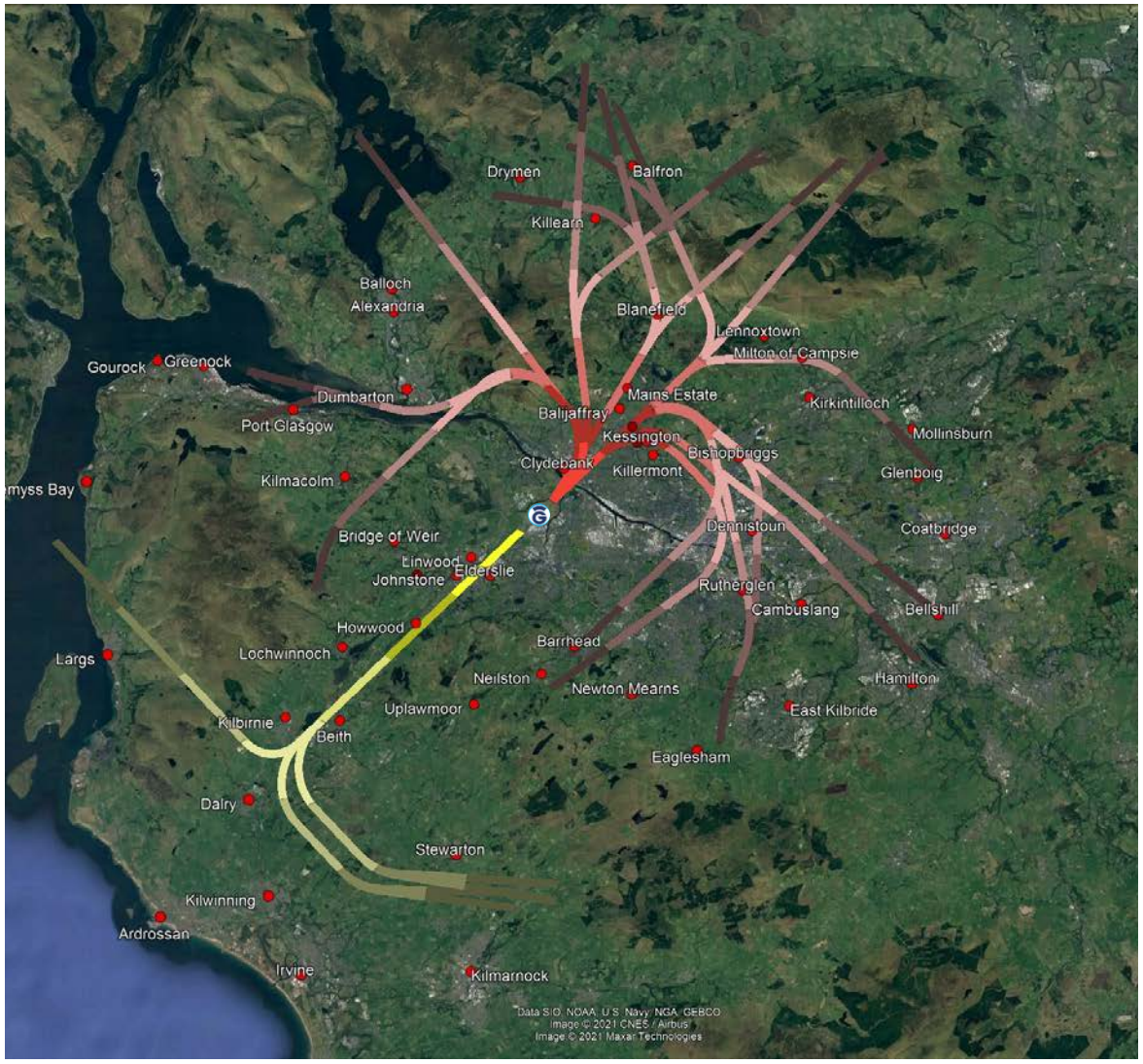
0

Noise Sensitive Areas

National Parks
SSSIs
Designated quiet areas
Gardens and designated landscapes
National Scenic Areas
Special areas of conservation
Special protection areas

4. COMPREHENSIVE LIST OF OPTIONS

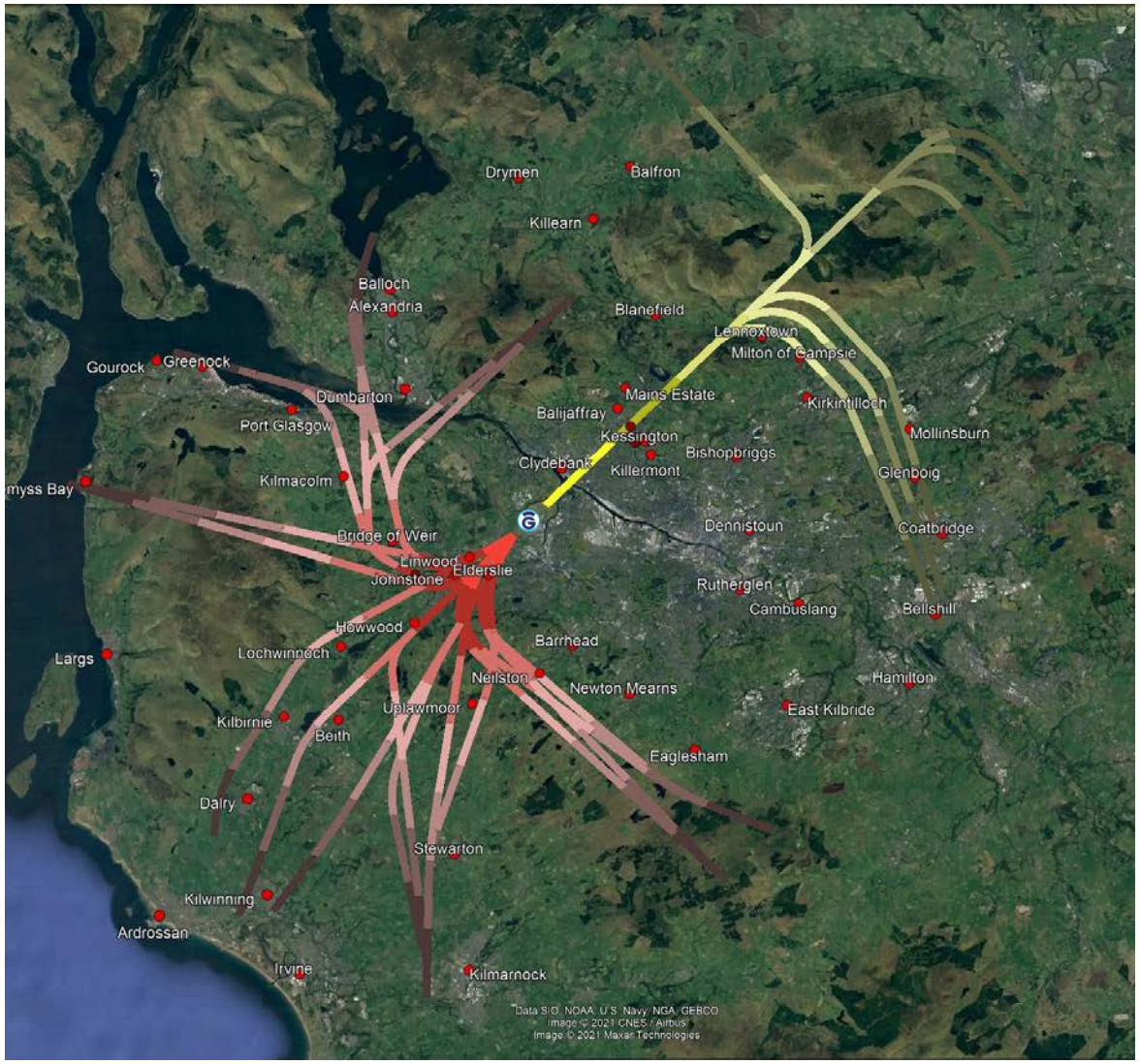
All Runway 05 Options:



Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data	Arrival Options and aircraft track data
0 – 1000		
1000 – 2000		
2000 – 3000		
3000 – 4000		
4000 – 5000		
5000 – 6000		
6000 - 7000		

4. COMPREHENSIVE LIST OF OPTIONS

All Runway 23 Options:



Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data	Arrival Options and aircraft track data
0 – 1000		
1000 – 2000		
2000 – 3000		
3000 – 4000		
4000 – 5000		
5000 – 6000		
6000 - 7000		

4. COMPREHENSIVE LIST OF OPTIONS

PBN Arrivals

Within the operational environment, there are different ways and means of ensuring aircraft are managed as efficiently as possible. Our options are based on Performance Based Navigation (PBN). PBN uses satellite based navigation technology to follow set routes.

On some occasions there may however be the requirement for aircraft to be tactically controlled by Air Traffic Controllers (ATC) where pilots are given instructions about which direction to fly and when to climb or descend. This means that aircraft do not follow a set route.

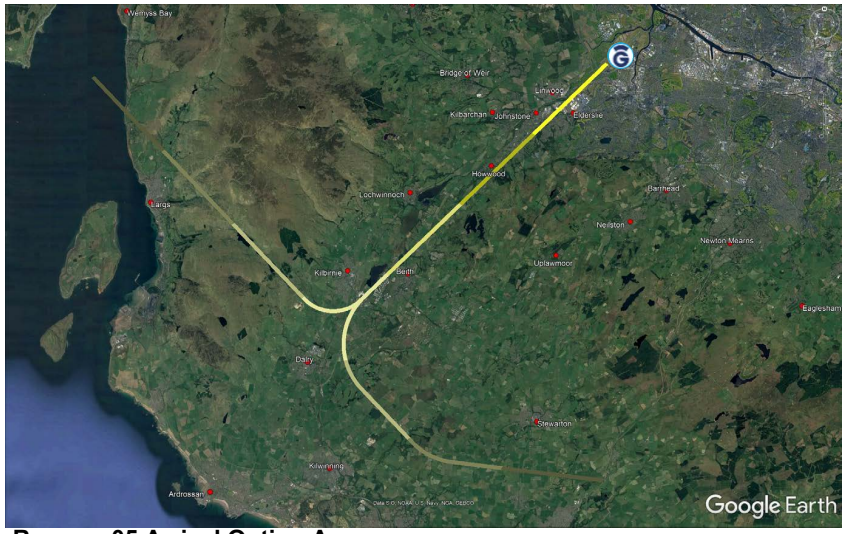
At this early stage in the development process, we are still considering all of the potential options for how aircraft could arrive at Glasgow Airport:

Full PBN Arrival	Partial PBN Arrival	Tactical ATC Controlling	PBN Arrival and ATC Mix
Aircraft would fly the full PBN route onto final approach. This would start above 7000ft all the way to the runway.	Aircraft would be instructed by ATC until told to join the latter part of the PBN route. The PBN route may start from typically 4,000-6,000ft to the final approach.	Aircraft would be provided with instructions by ATC from above 7,000ft until joining final approach, very similar to today. PBN arrival routes would not be available.	Some aircraft would fly the PBN transitions and others may be instructed by ATC depending on circumstances. For example, PBN transitions could be used at night or during periods of low frequency of arrival, and ATC instructions used during the busy periods.

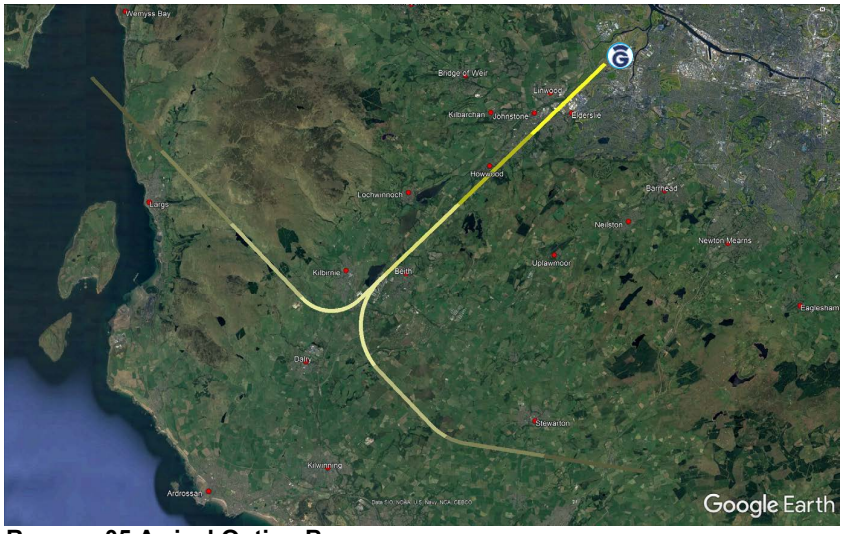
PBN arrival routes could potentially be alternated to provide respite for communities although this is not possible once an arrival has joined the final approach. The following slides show the PBN arrival routes currently under consideration:

4. COMPREHENSIVE LIST OF OPTIONS

All Runway 05 Arrival Options:

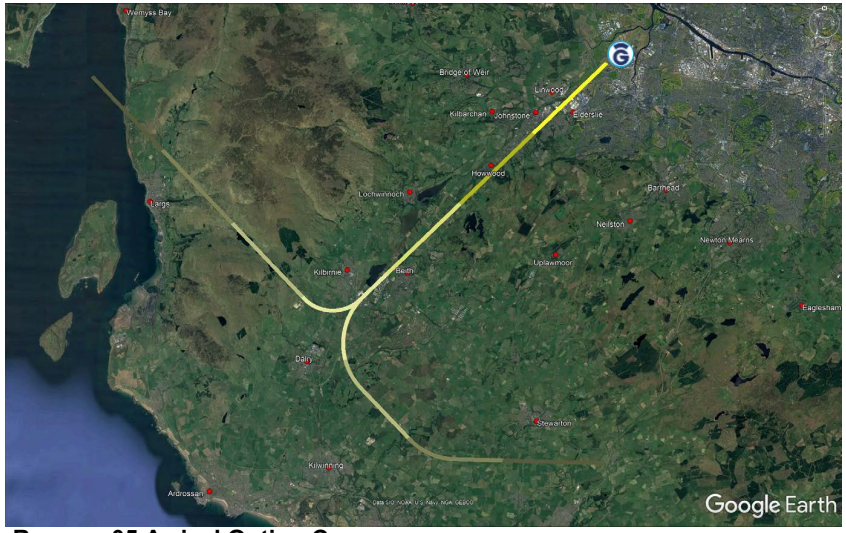


Runway 05 Arrival Option A

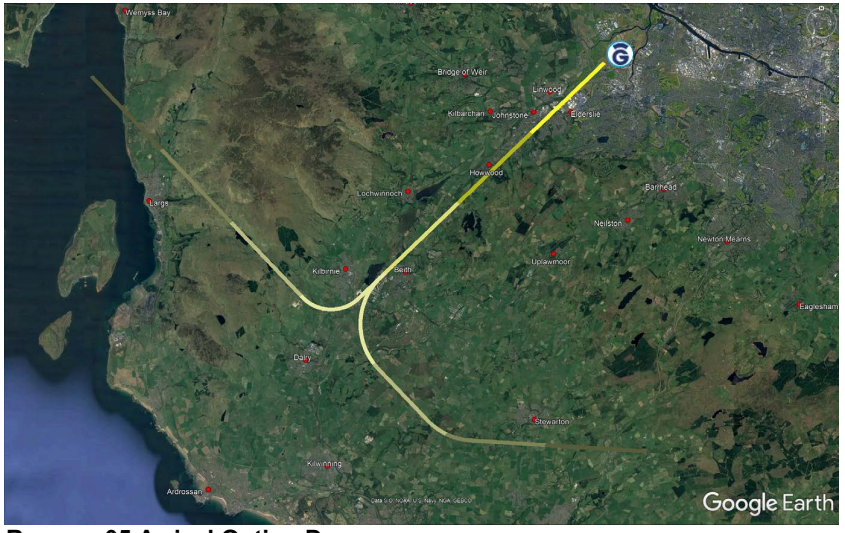


Runway 05 Arrival Option B

Indicative (Conservative) Altitude (ft)	Arrival Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	



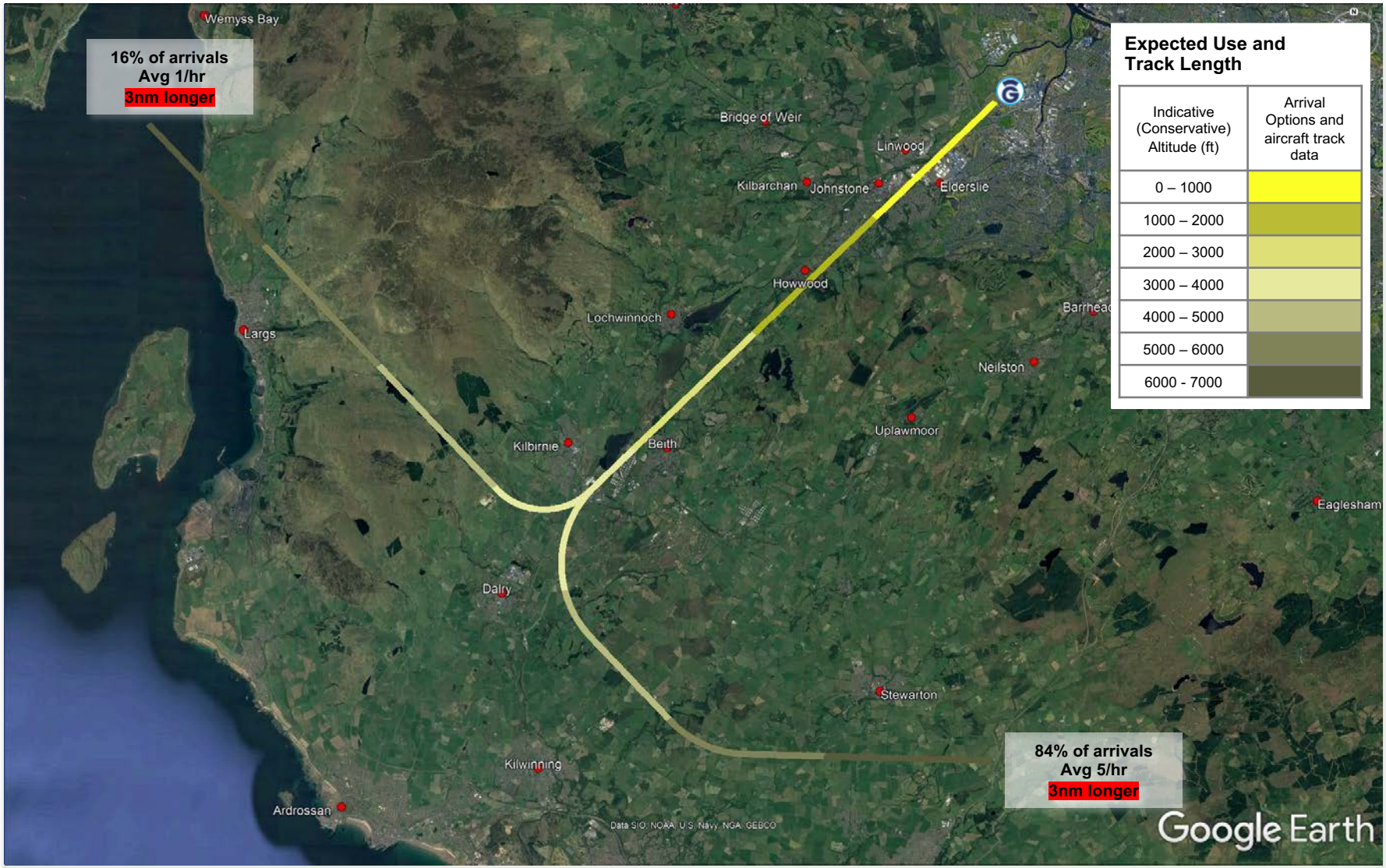
Runway 05 Arrival Option C



Runway 05 Arrival Option D

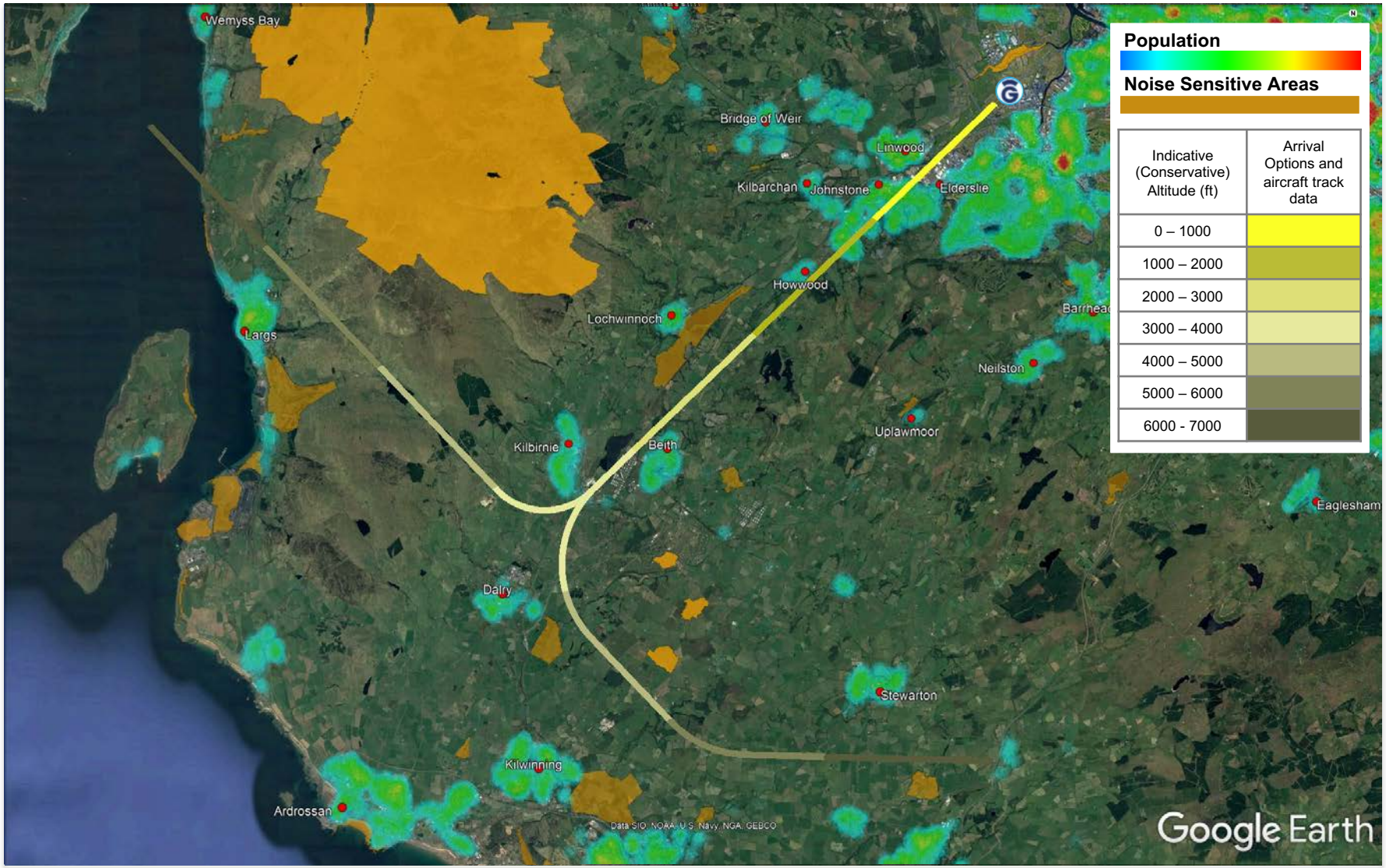
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 Arrival Option C



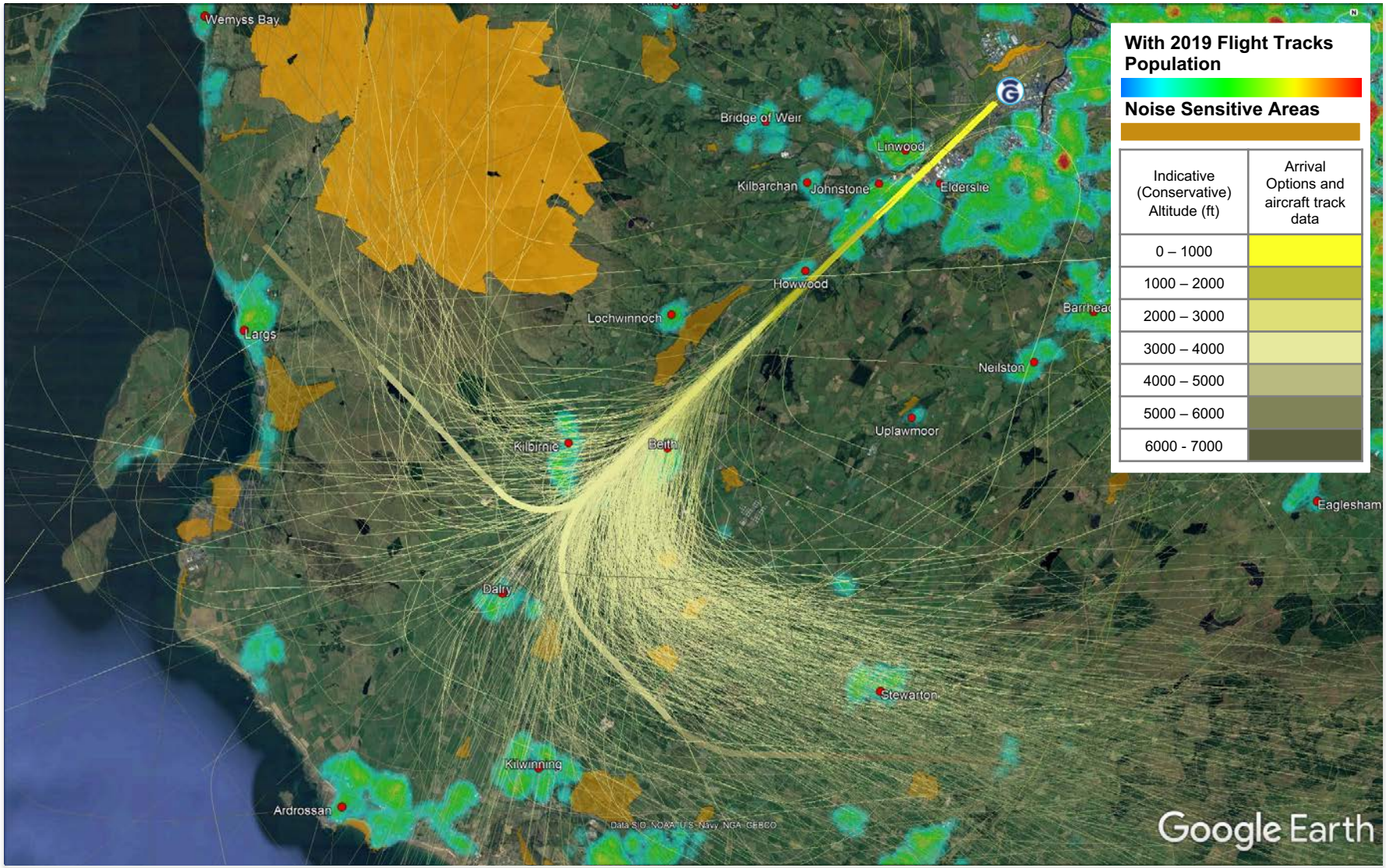
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 Arrival Option C



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 Arrival Option C



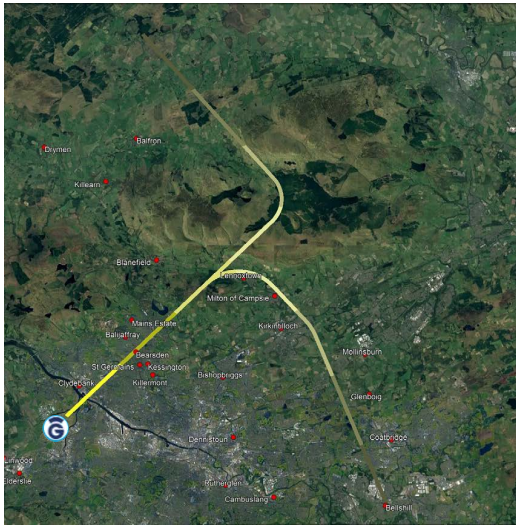
Indicative (Conservative) Altitude (ft)	Arrival Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

4. COMPREHENSIVE LIST OF OPTIONS

All Runway 23 Arrival Options:

Runway 23 Arrival Option A

Runway 23 Arrival Option B

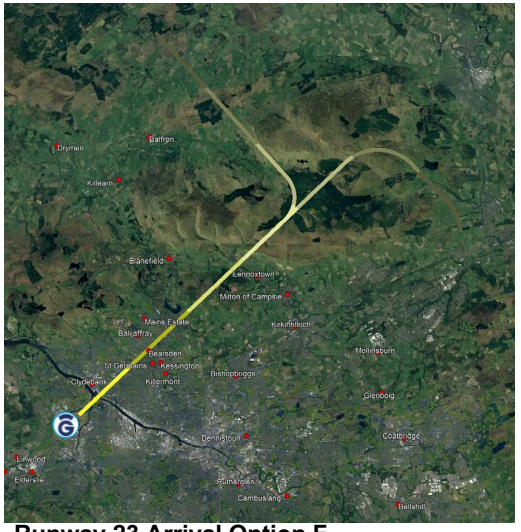


Runway 23 Arrival Option C

Indicative (Conservative) Altitude (ft)	Arrival Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

Runway 23 Arrival Option D

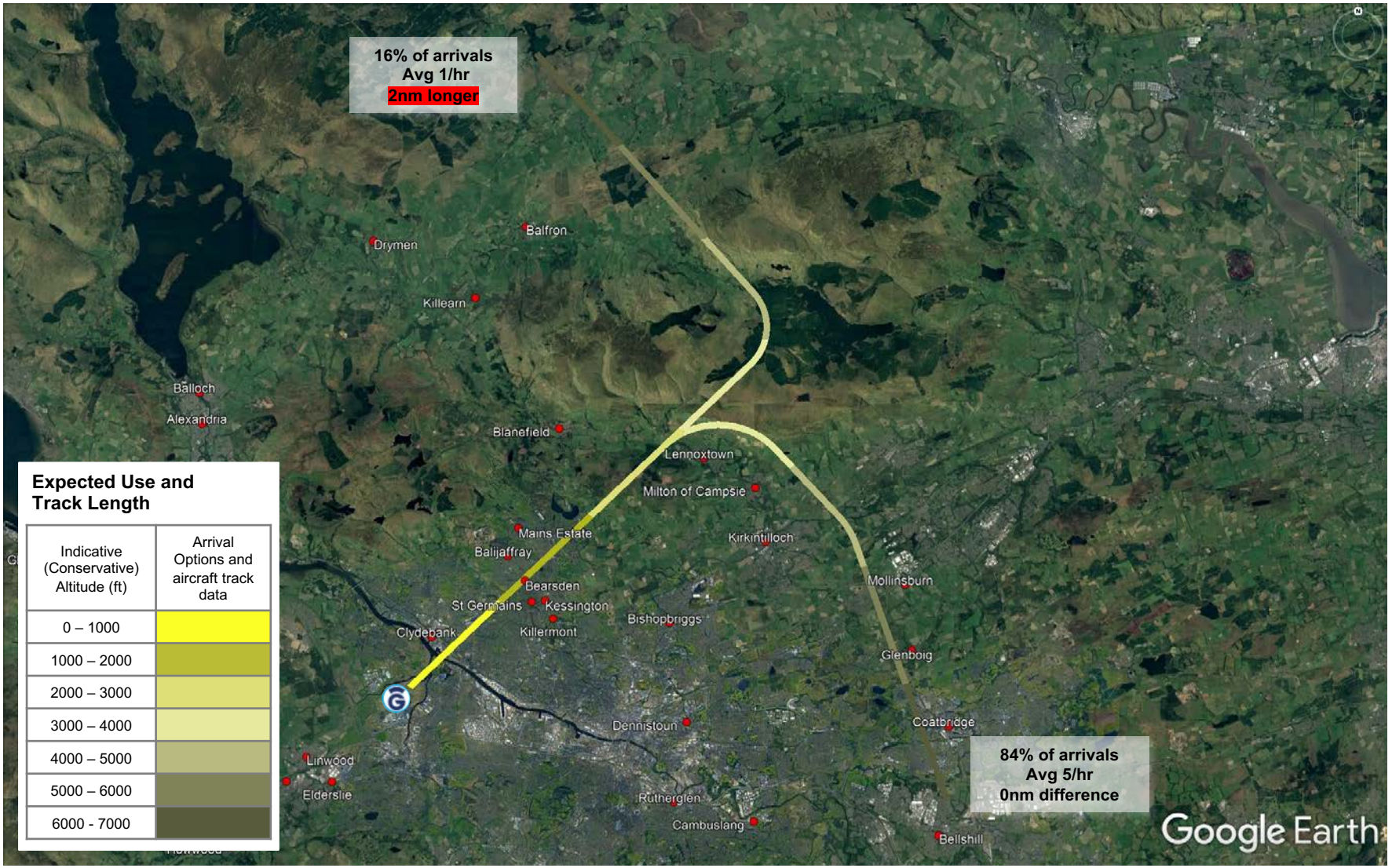
Runway 23 Arrival Option E



Runway 23 Arrival Option F

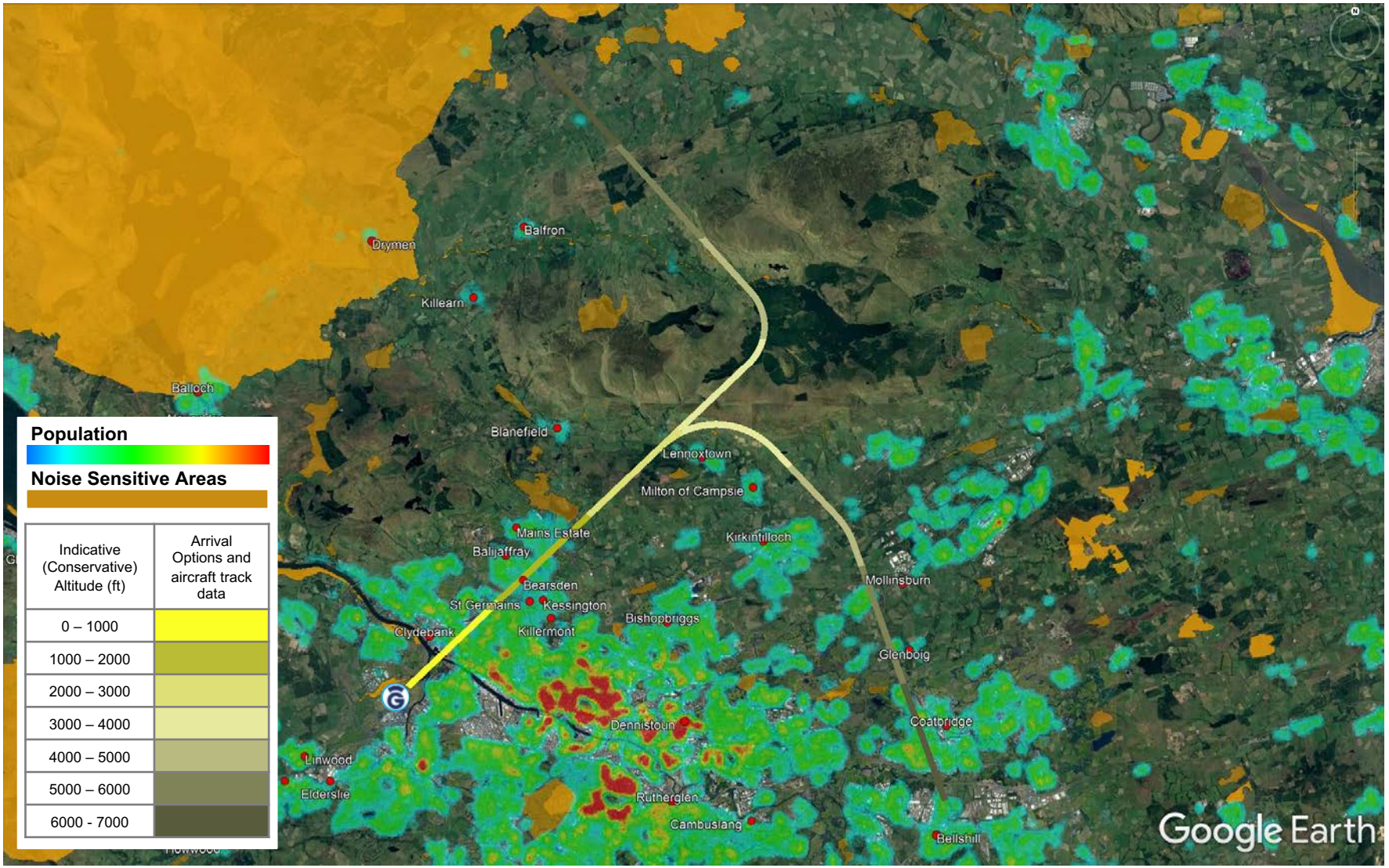
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 Arrival Option D



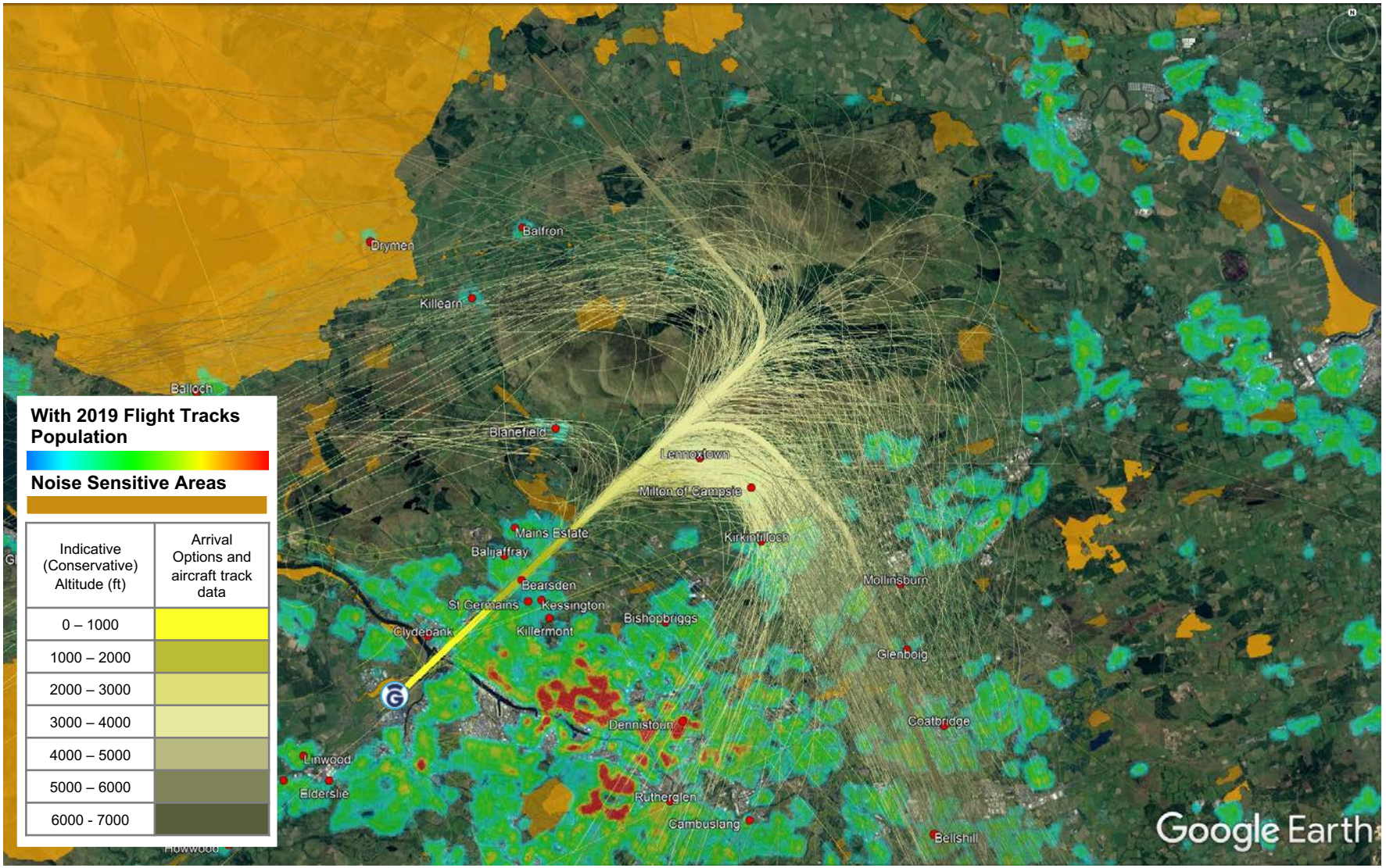
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 Arrival Option D



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 Arrival Option D



Any questions?

GLASGOW AIRPORT
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4. COMPREHENSIVE LIST OF OPTIONS

PBN Departures

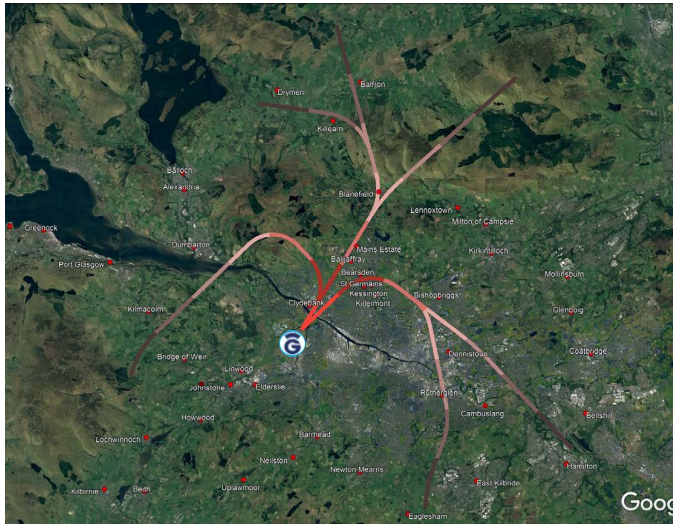
Our Departure Options are based on PBN flight paths where an aircraft would fly the full PBN flight path from take off to at least above 4,000ft through to 7000ft where they would join the upper airspace network.

PBN improves the accuracy of where aircraft fly and therefore this would result in traffic being more concentrated than today at the lower levels and potentially up to 7000ft. There may however still be some variations around the centerlines and there may be occasions where ATC have to tactically manage departures. We estimate that this will be less frequent than today, especially at lower altitudes.

The following slides show the PBN departure options currently under consideration:

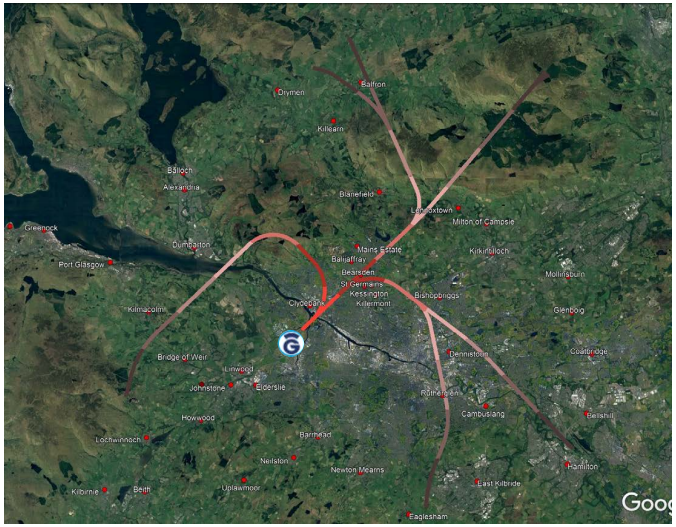
4. COMPREHENSIVE LIST OF OPTIONS

All Runway 05 Departure Options:



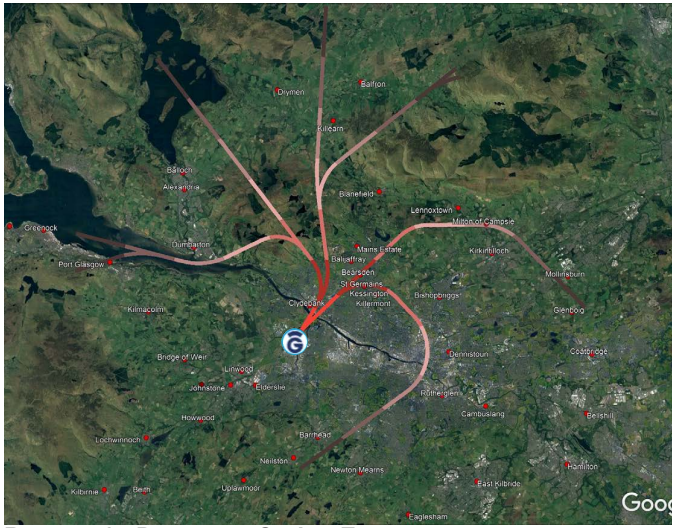
Runway 05 Departure Option A

Runway 05 Departure Option B



Runway 05 Departure Option C

Runway 05 Departure Option D



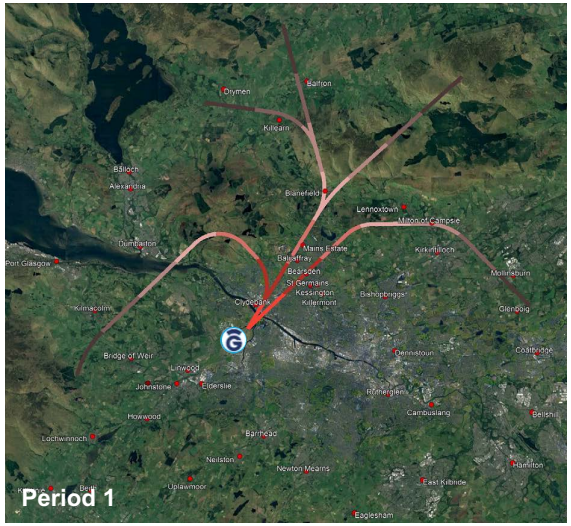
Runway 05 Departure Option E

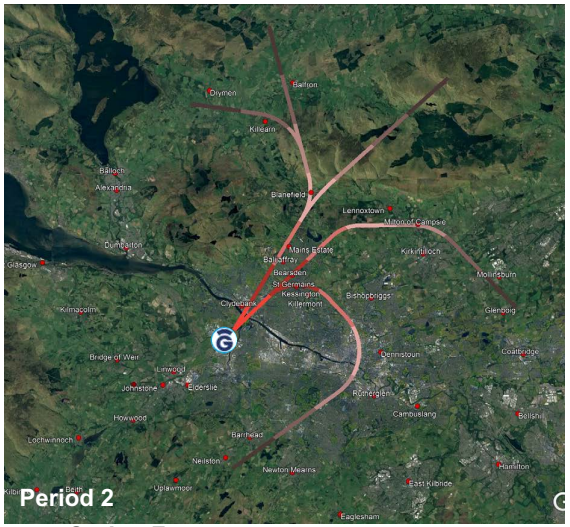
Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

Continued on next slide

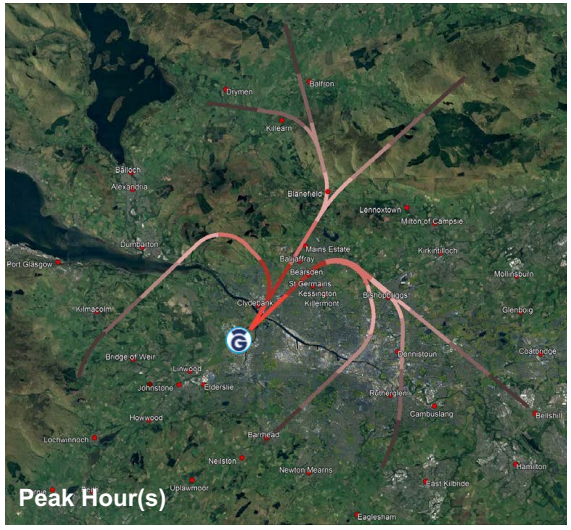
4. COMPREHENSIVE LIST OF OPTIONS

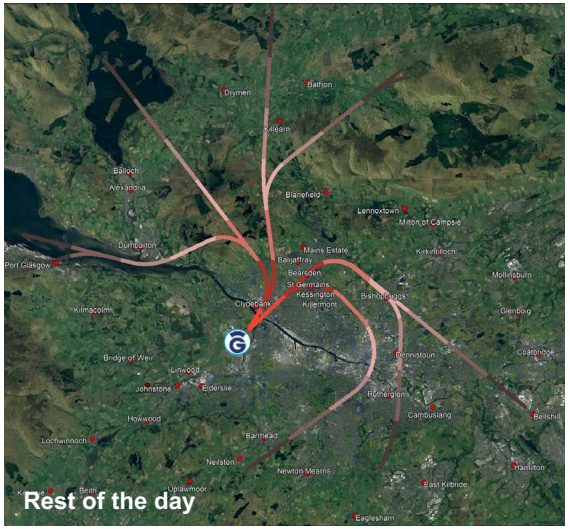
All Runway 05 Departure Options:





Runway 05 Departure Option F



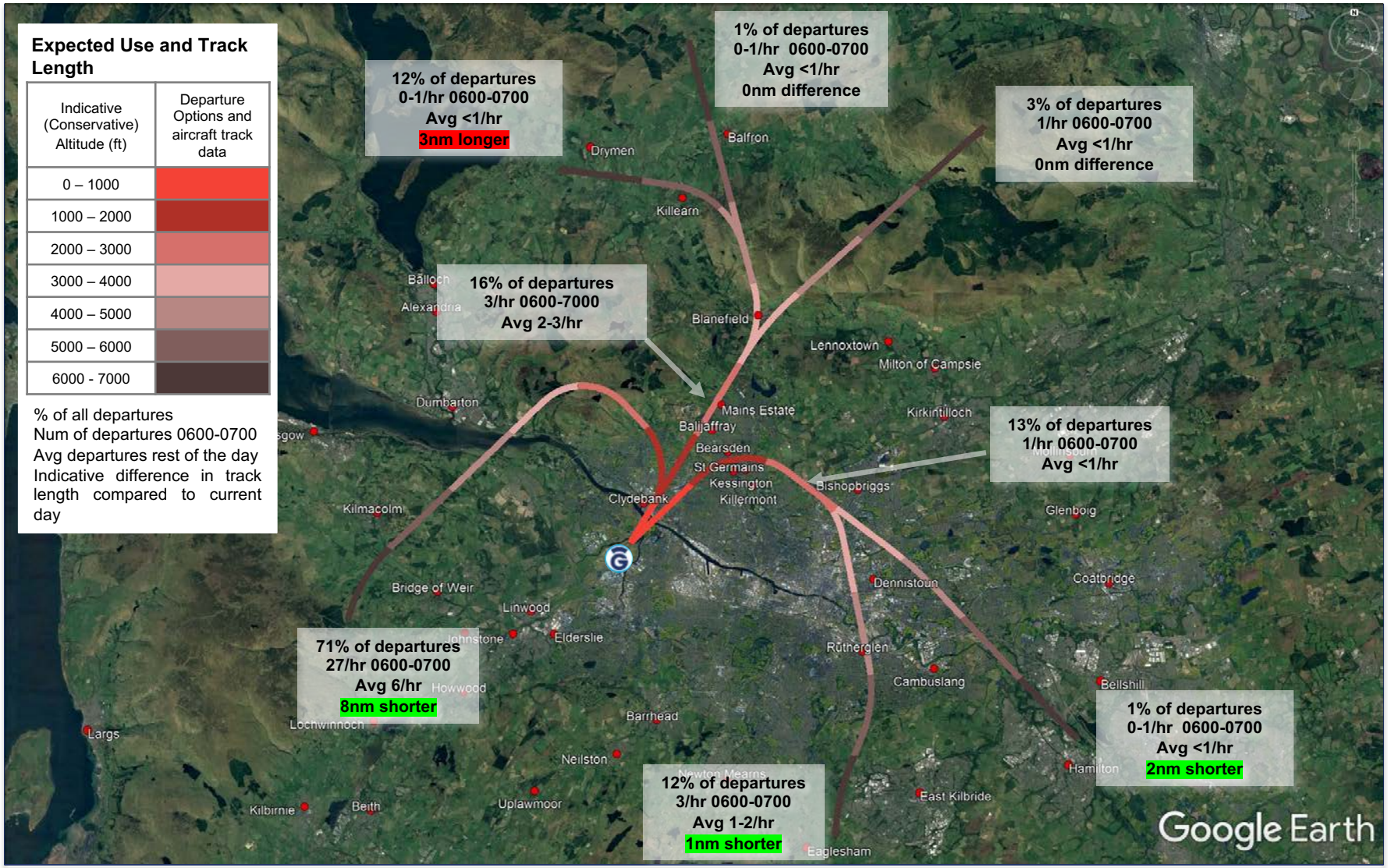


Runway 05 Departure Option G

Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

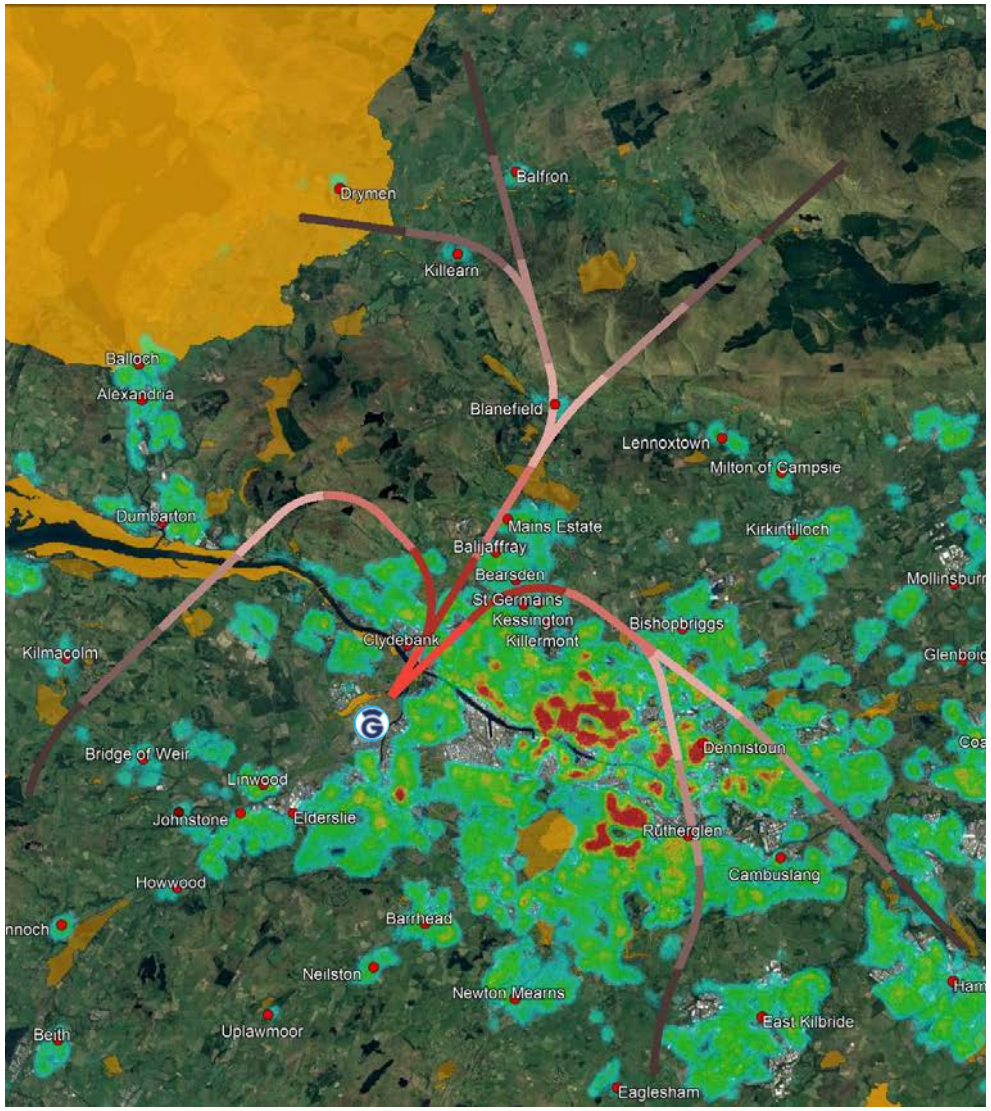
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

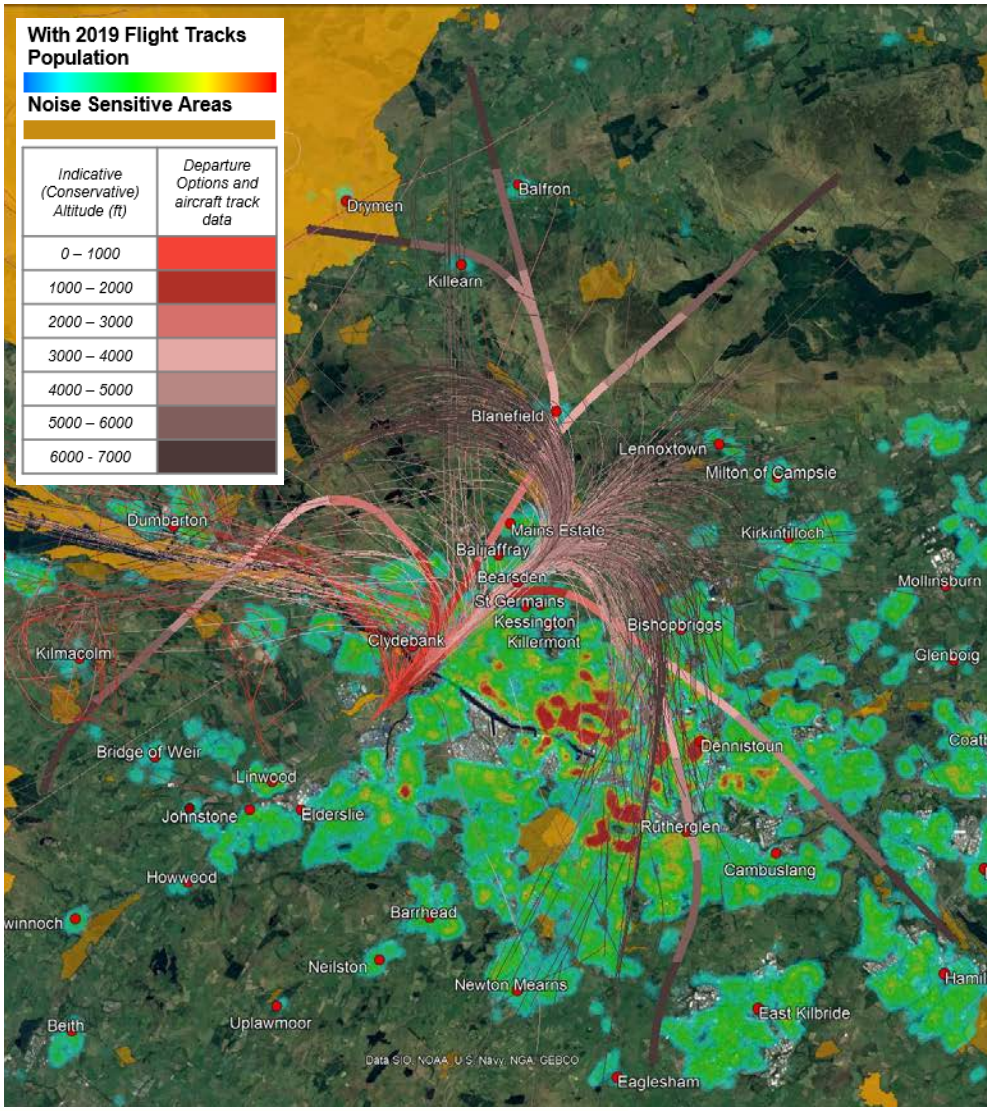
Runway 05 Departure Option A



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

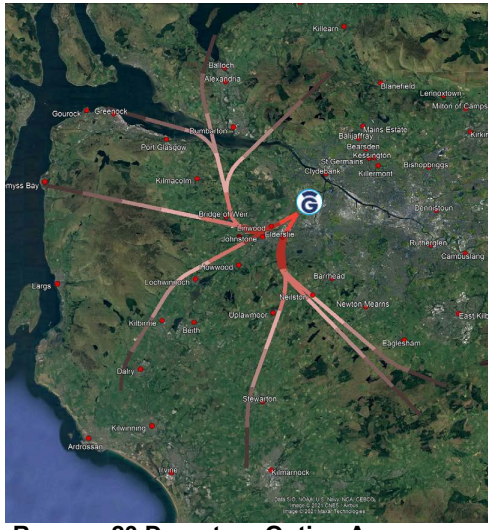
Runway 05 Departure Option A



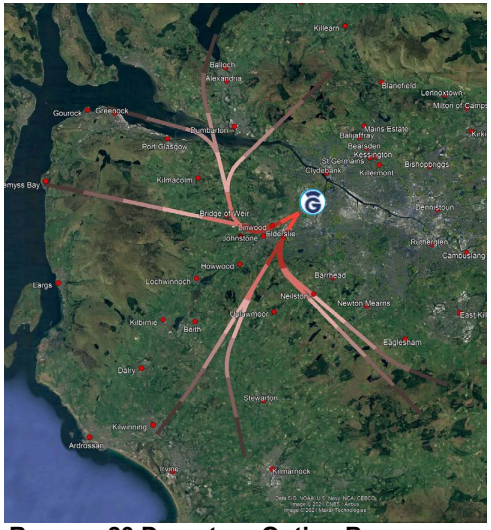


4. COMPREHENSIVE LIST OF OPTIONS

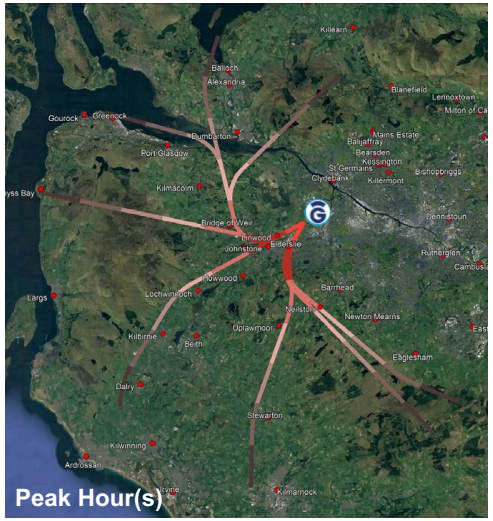
All Runway 23 Departure Options:

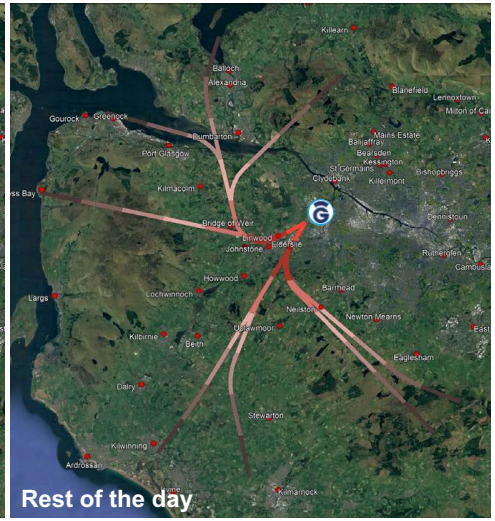


Runway 23 Departure Option A

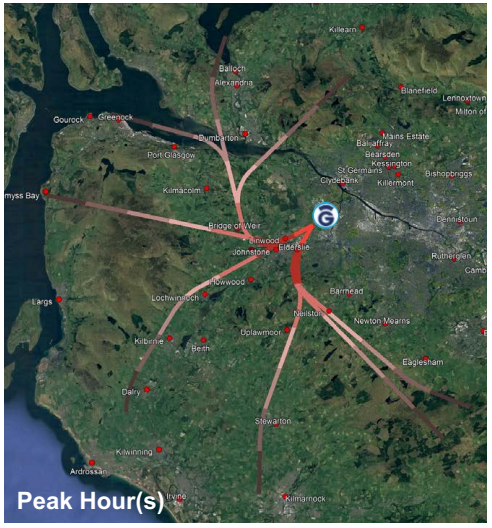


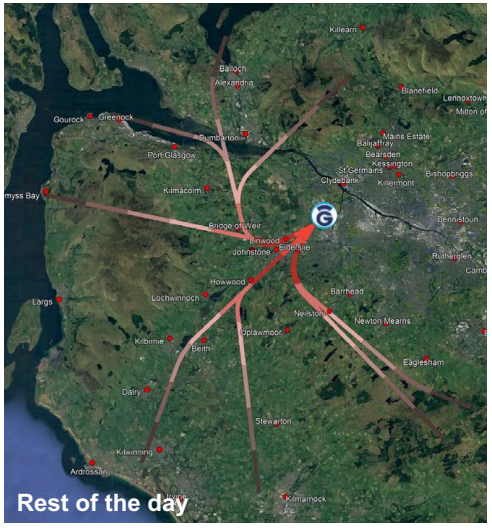
Runway 23 Departure Option B



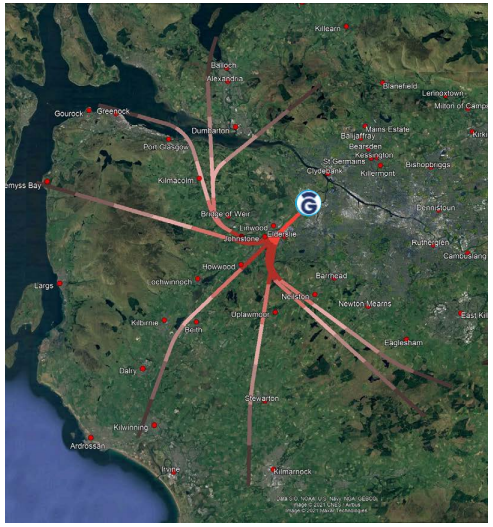


Runway 23 Departure Option C





Runway 23 Departure Option D

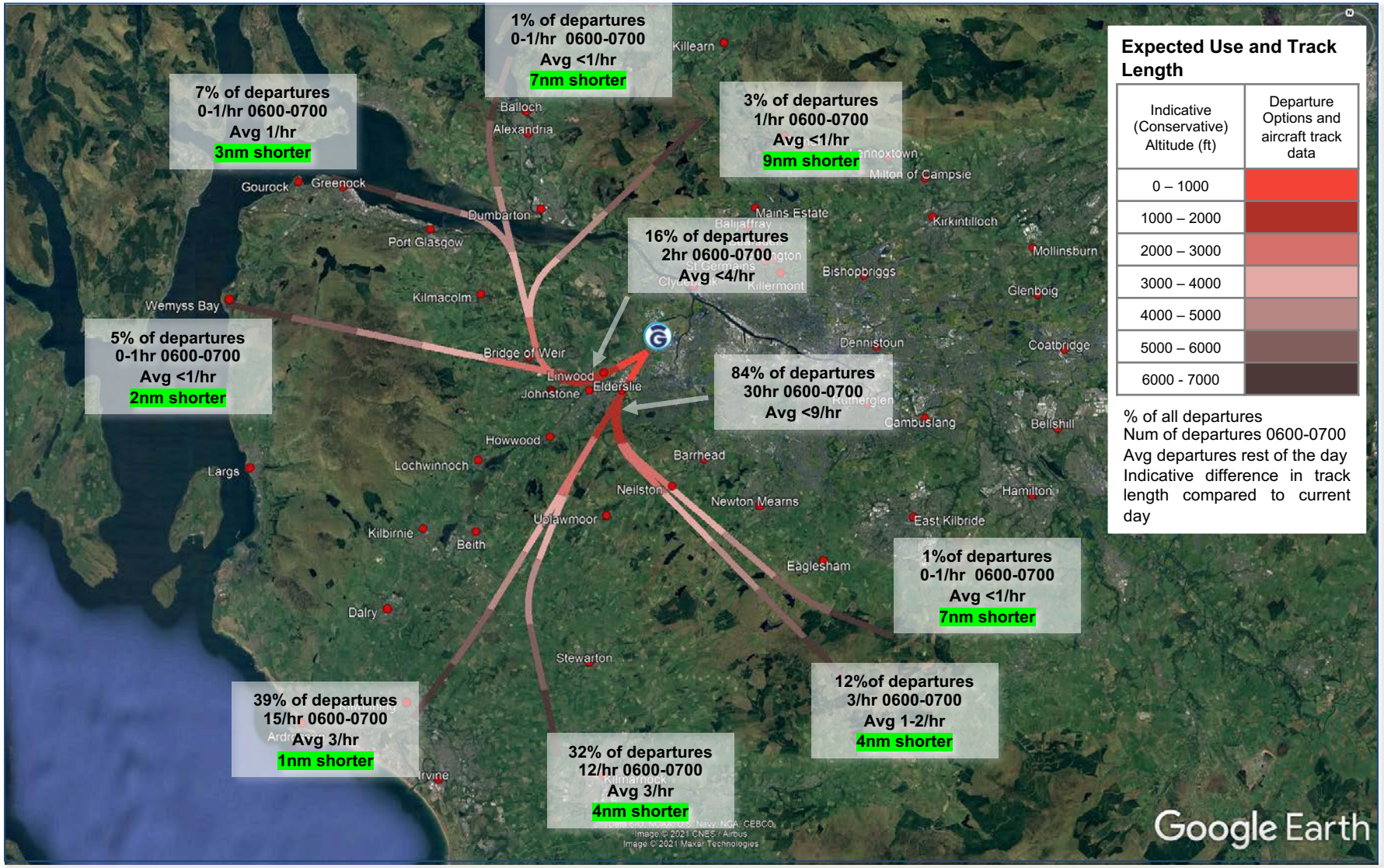


Runway 23 Departure Option E

Indicative (Conservative) Altitude (ft)	Departure Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

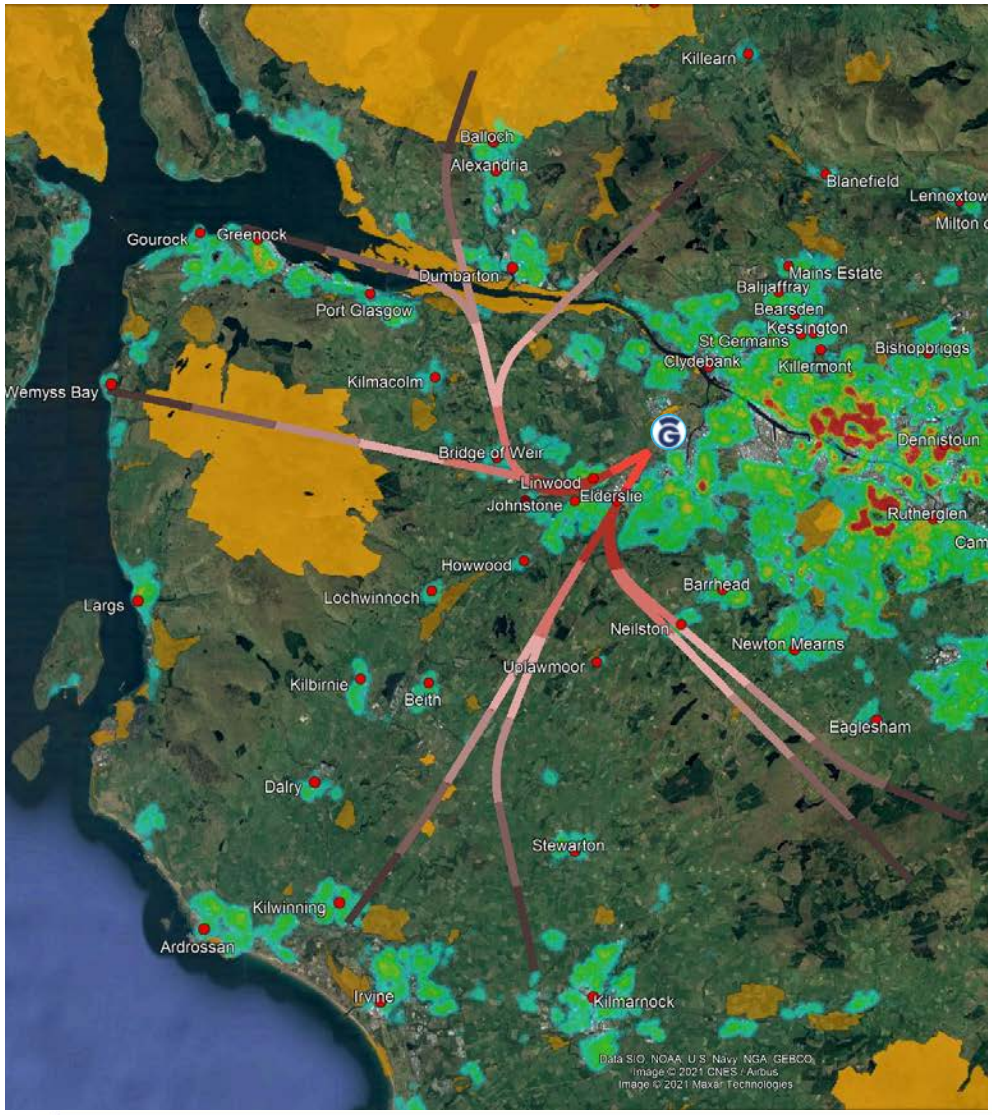
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

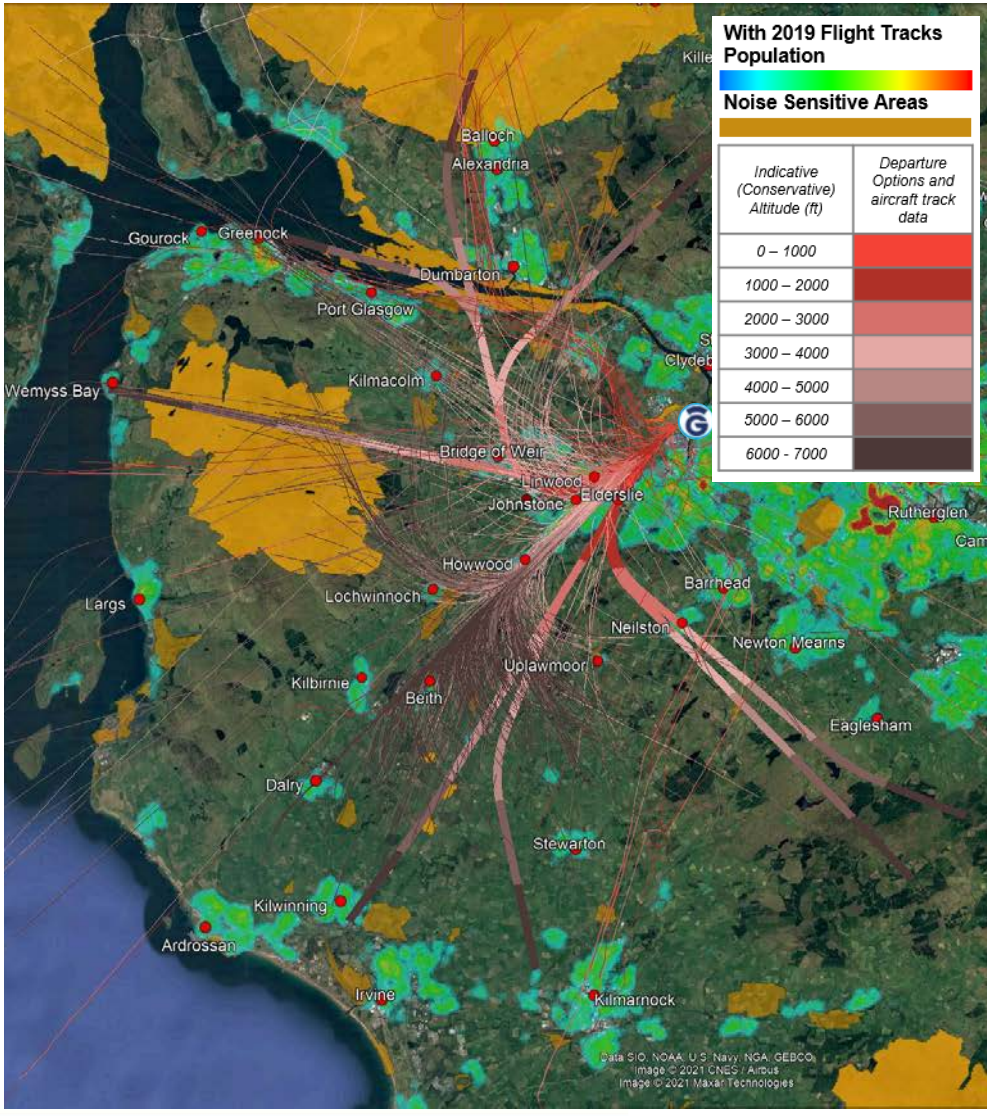
Runway 23 Departure Option B



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option B





Any questions?

GLASGOW AIRPORT
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4. COMPREHENSIVE LIST OF OPTIONS

Controlled Airspace

Our Comprehensive List of Options is formed of 10 arrival options and 12 departure system options. We have ensured that the departure and arrival options are compatible however we have kept them as separate options so that we do not limit the number of potential combinations at this stage.

To generate a bespoke controlled airspace (CAS) volume for every option given the many permutations is not practical, and we will therefore develop detailed CAS volumes for the full system options shortlisted at Stage 3.

For engagement purposes and to start the conversation we have created one CAS volume which we are calling ‘an initial illustrative CAS volume’. This volume:

- Covers all the options in accordance with the CAA’s Controlled Airspace Containment Policy
- provides airspace for a CDA from each direction,
- provides symmetry and simplicity where possible.
- doesn’t propose any particular classifications

This initial illustrative volume is not the proposed controlled airspace volume option for Glasgow’s ACP.

We’ve held a separate workshop to speak to General Aviation Stakeholders around the Controlled Airspace Arrangements and the presentation will be available as part of our feedback website.

If any stakeholders would like to learn more about the development of the CAS volume then please get in touch with the Glasgow Airspace team airspace@glasgowairport.com

5. Our questions for you

5. OUR QUESTIONS FOR YOU

- The purpose of this engagement is NOT to seek feedback on individual route options by examining the detailed specific geographical position of the options.
- The purpose of this session was to explore and test our approach to developing the options.
- The questions we are asking:
    - **Are you satisfied that we have taken into account the Design Principles when developing our comprehensive list of route options?**
    - **Are there any further considerations that relate to the Design Principles which we have not taken into account?**
- We will use your feedback to try and address any concerns raised. We are able to refine or develop more options, based on your feedback.
- Please submit your feedback on our feedback website using the link below by Monday 10th January 2022.

https://glasgowairport.consultationonline.co.uk/

- Please send any questions to **airspace@glasgowairport.com**, please note that feedback must be submitted via the link above.

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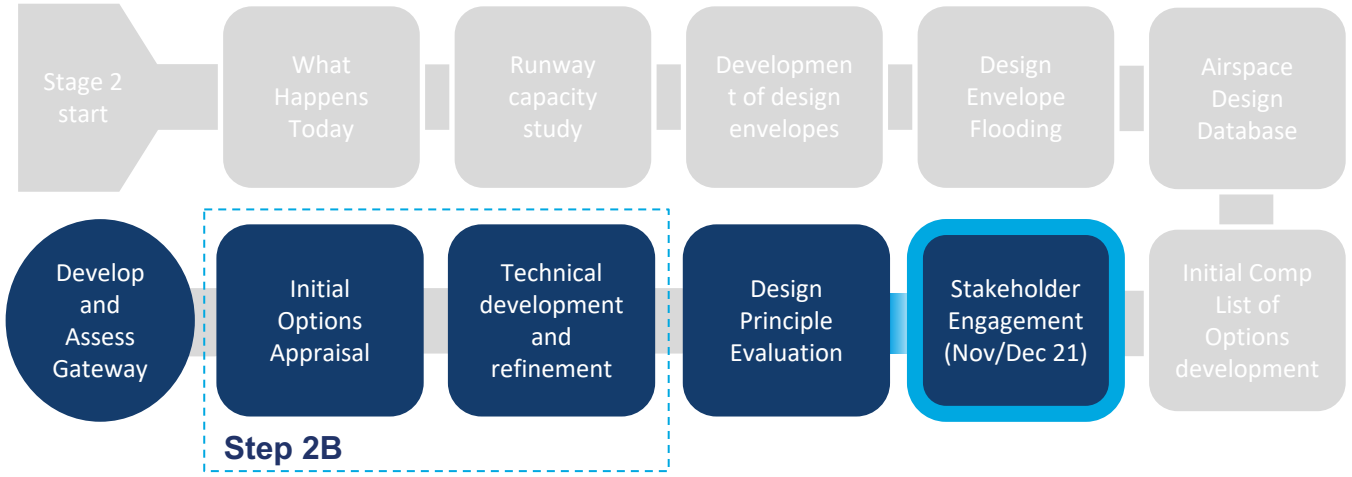
6. Next steps

6. NEXT STEPS

Design Principle Evaluation

- Following the close of the feedback period we will review all suggestions and refine or create new options as appropriate.
- Our full comprehensive list of options will then be taken forward to the Design Principle Evaluation. This is where we assess each option against each design principle to understand whether it has met, partially met, or not met that principle. This is a qualitative assessment although quantitative data from the airspace design database will be used to support the qualitative analysis undertaken where applicable.
- The outcome of the Design Principle Evaluation may be a shorter list of options taken forward to the Initial Options Appraisal at Step 2B.
- Our Design Principle Evaluation will be published on the CAA's Airspace Change Portal



Full Comprehensive List of Options (Detail)

Arrivals

4. COMPREHENSIVE LIST OF OPTIONS

PBN Arrivals

Within the operational environment, there are different ways and means of ensuring aircraft are managed as efficiently as possible. Our options are Performance Based Navigation (PBN) transitions. PBN uses satellite based navigation technology to follow set routes.

On some occasions there may however be the requirement for aircraft to be tactically controlled by Air Traffic Controllers (ATC) where pilots are given instructions about which direction to fly and when to climb or descend. This means that aircraft do not follow a set route.

At this early stage in the development process, we are still considering all of the potential options for how aircraft could arrive at Glasgow Airport:

Full PBN Arrival	Partial PBN Arrival	Tactical ATC Controlling	PBN Arrival and ATC Mix
Aircraft would fly the full PBN route from the holding stack and onto final approach. This would start above 7000ft all the way to the runway.	Aircraft would be instructed by ATC until told to join the latter part of the PBN route. The PBN route may start from typically 4,000-6,000ft to the final approach.	Aircraft would be provided with instructions by ATC from above 7,000ft until joining final approach, very similar to today. PBN arrival routes would not be available.	Some aircraft would fly the PBN transitions and others may be instructed by ATC depending on circumstances. For example, PBN transitions could be used at night or during periods of low frequency of arrival, and ATC instructions used during the busy periods.

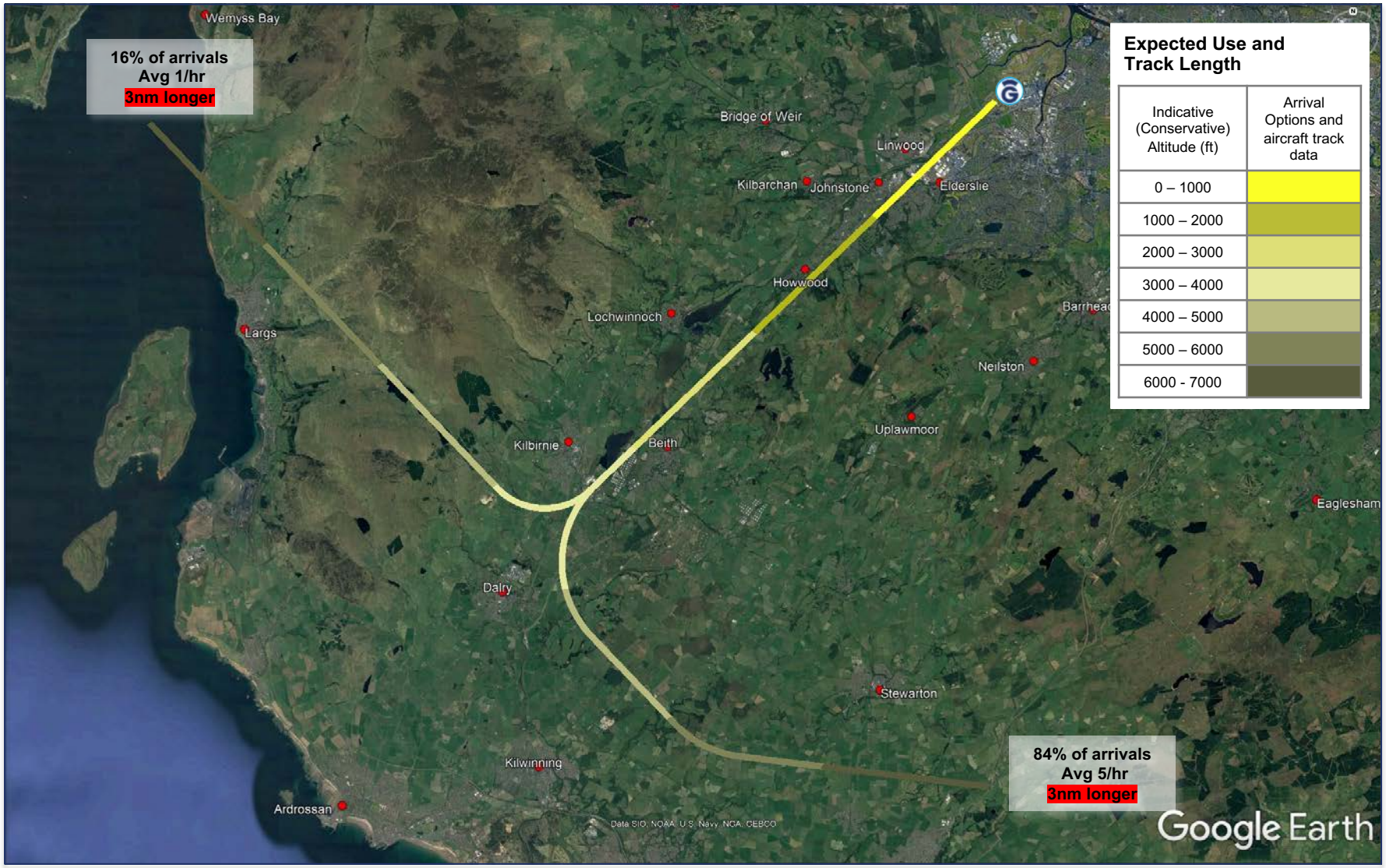
PBN arrival routes could potentially be alternated to provide respite for communities although this is not possible once an arrival has joined the final approach. The following slides show the PBN arrival routes currently under consideration:

Runway 05 PBN Arrival Option A

PBN arrivals from the north and south both joining final approach at approximately 11nm from the runway

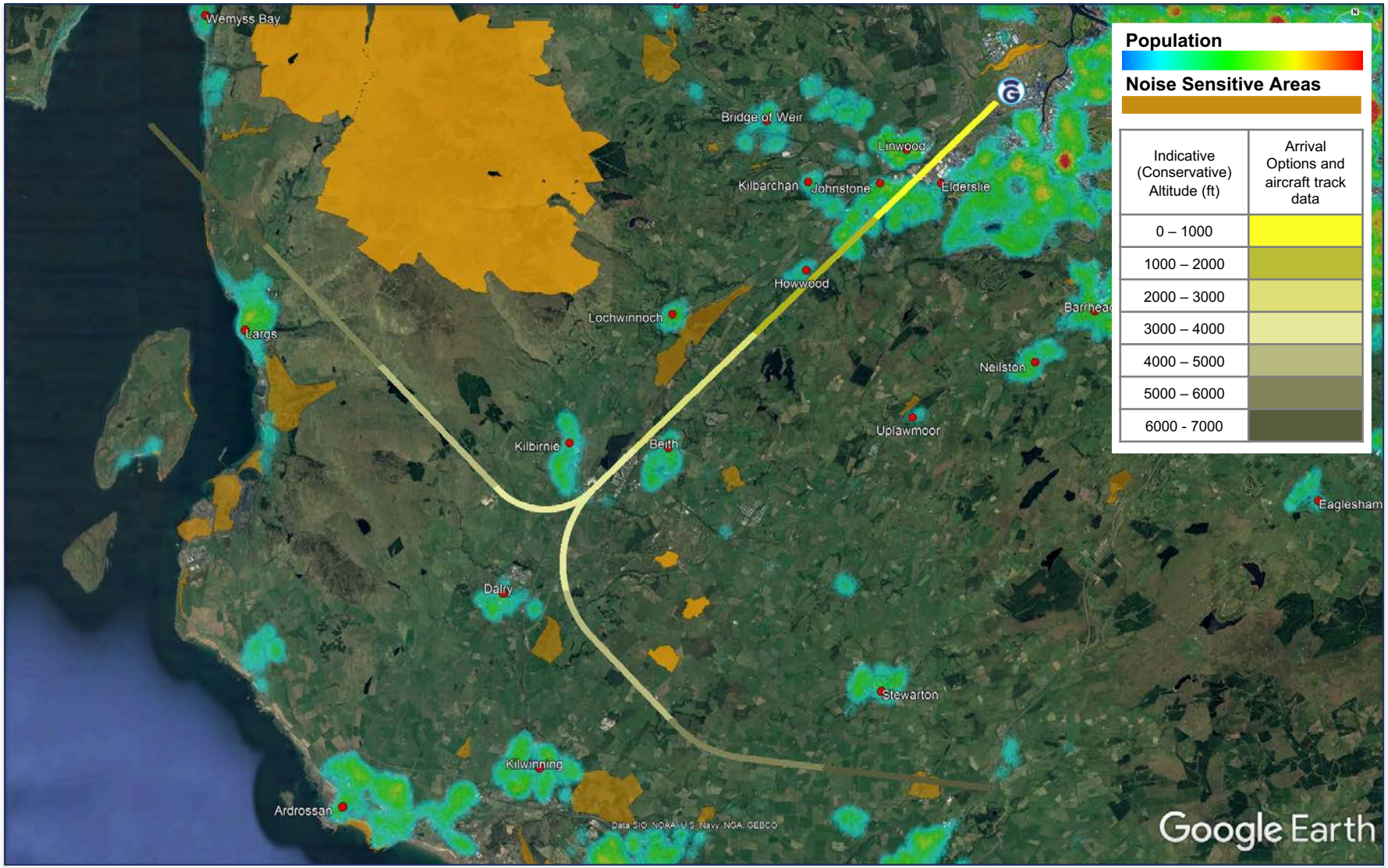
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option A



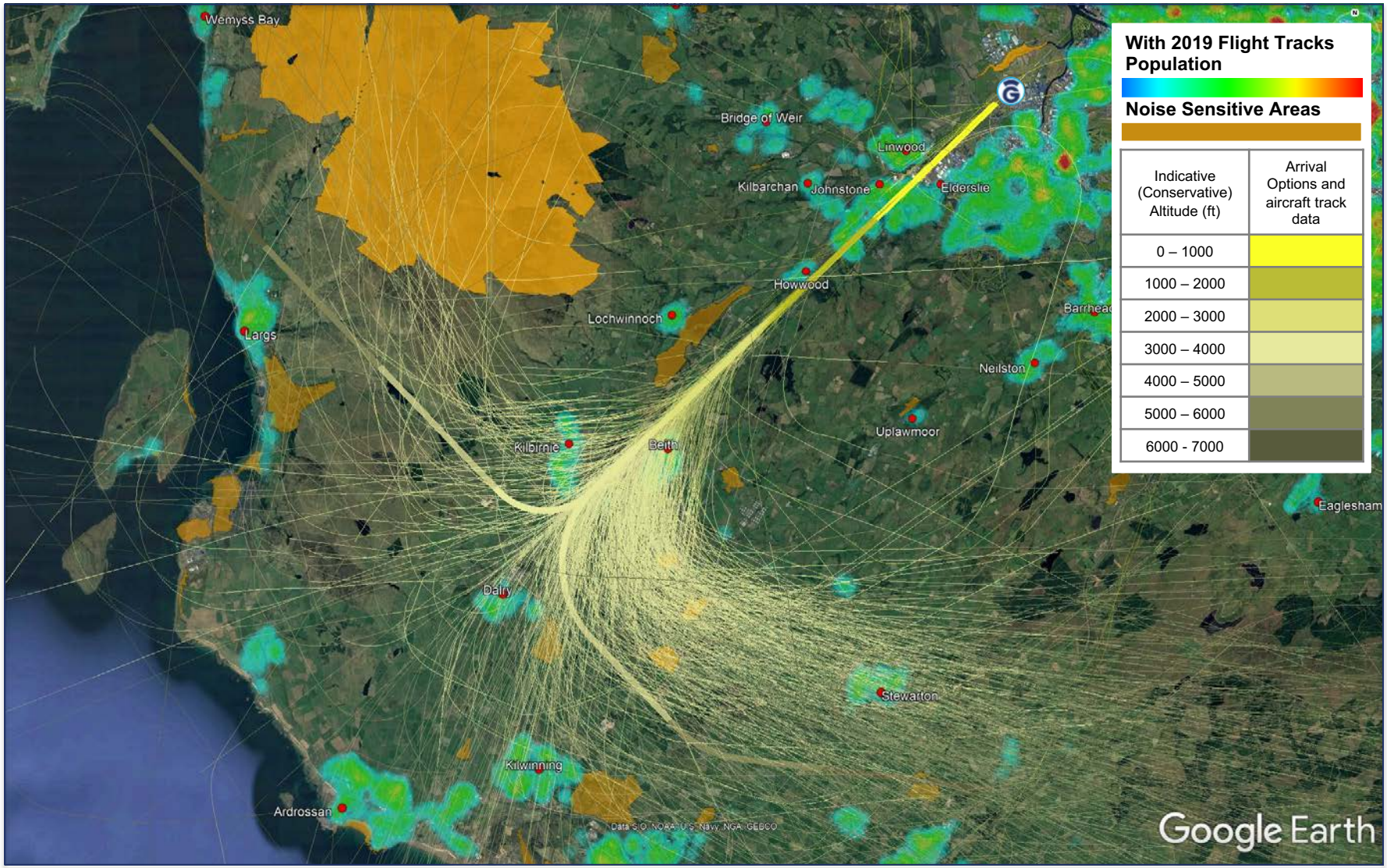
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option A



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option A

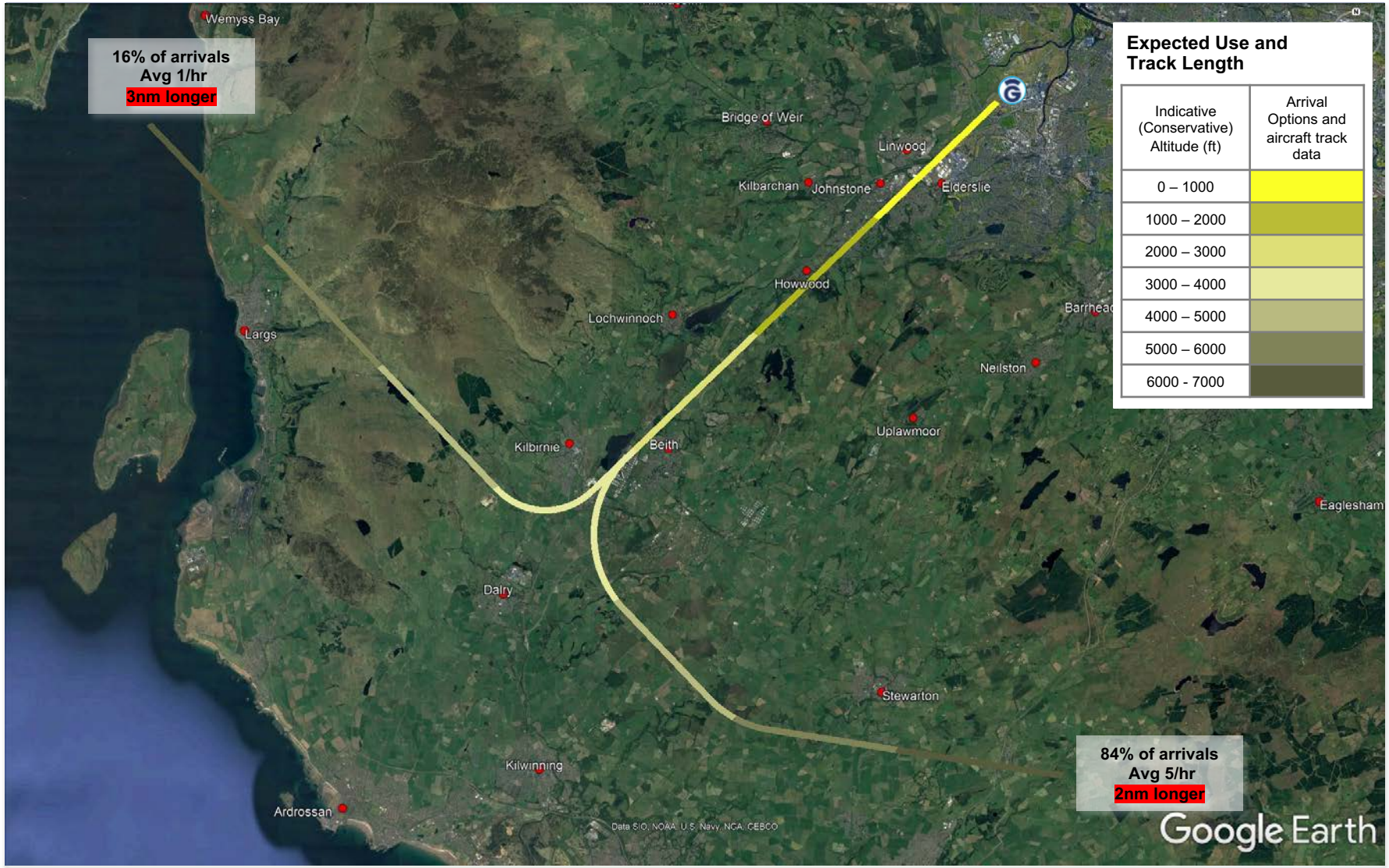


Runway 05 PBN Arrival Option B

PBN arrivals from the north joining final approach at approximately 11nm from the runway and from the south at approximately 10nm.

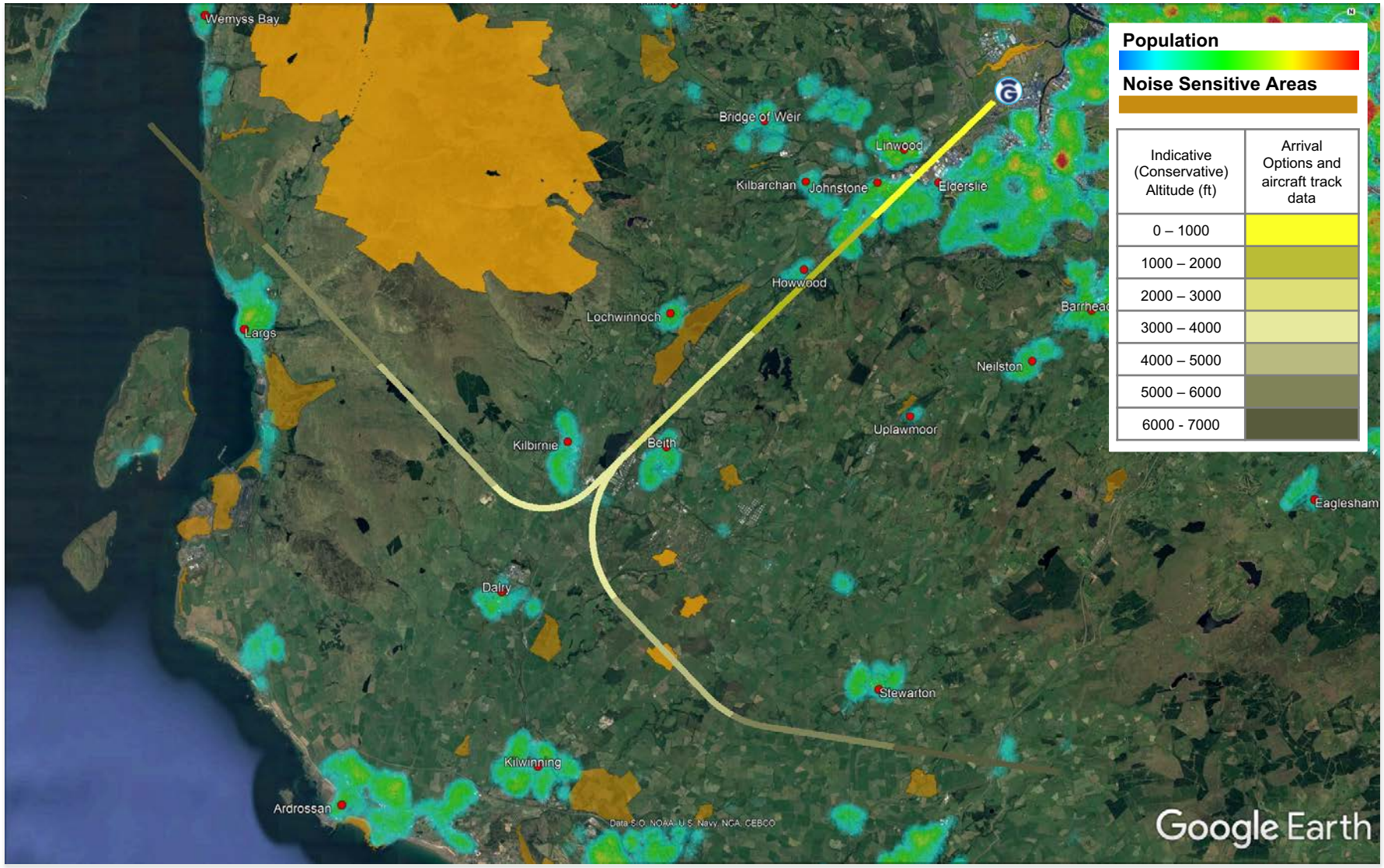
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option B



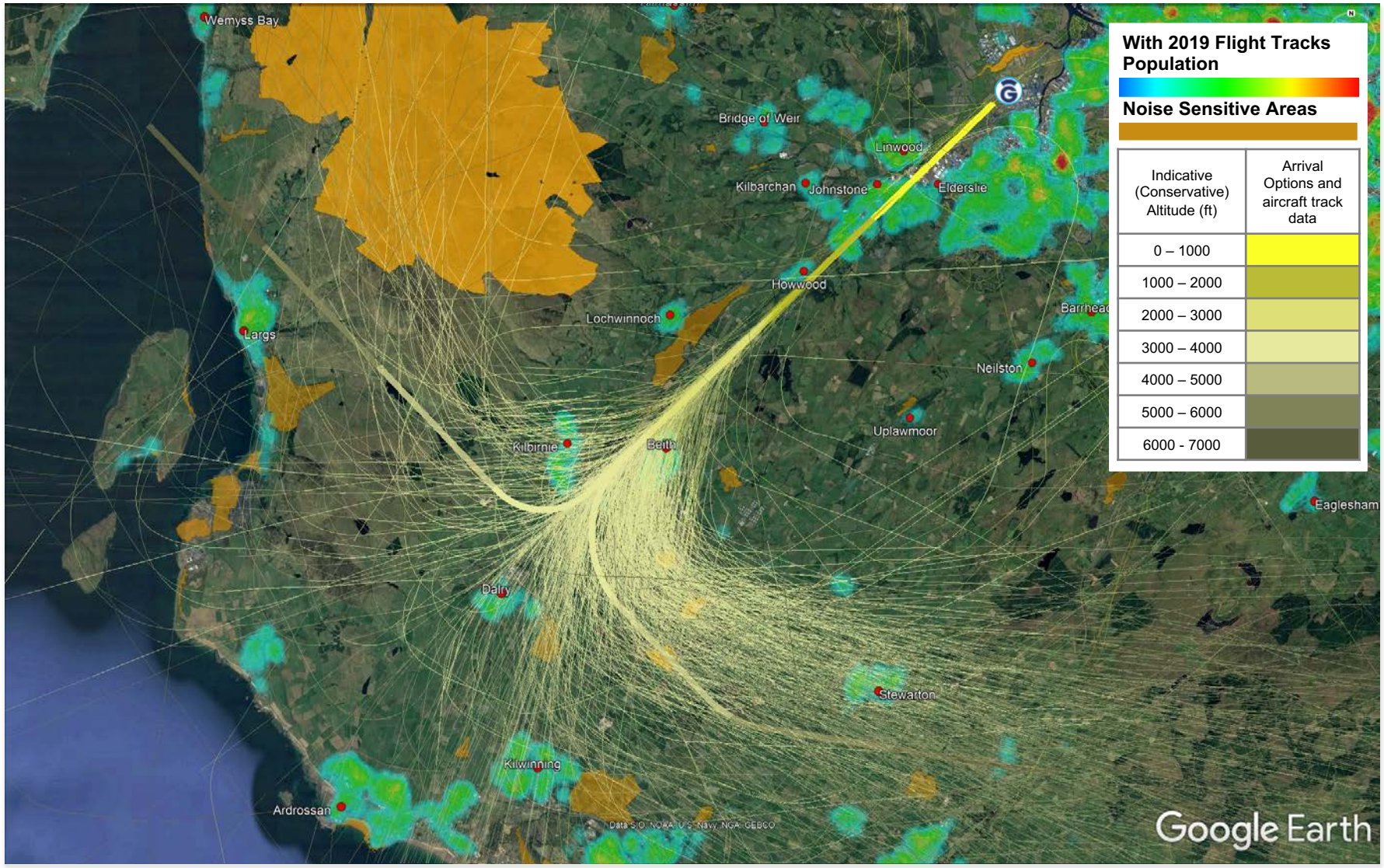
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option B



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option B

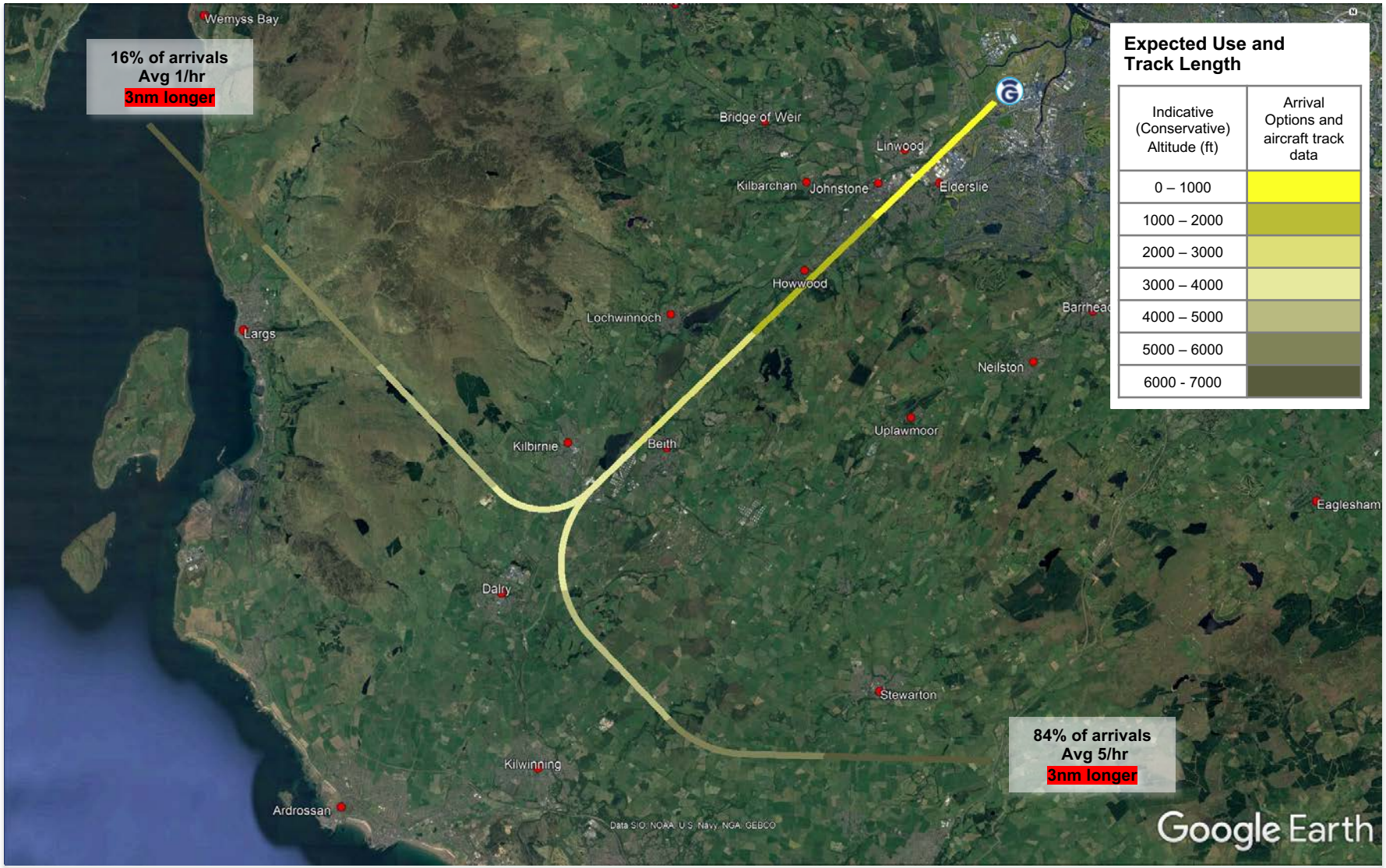


Runway 05 PBN Arrival Option C

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.

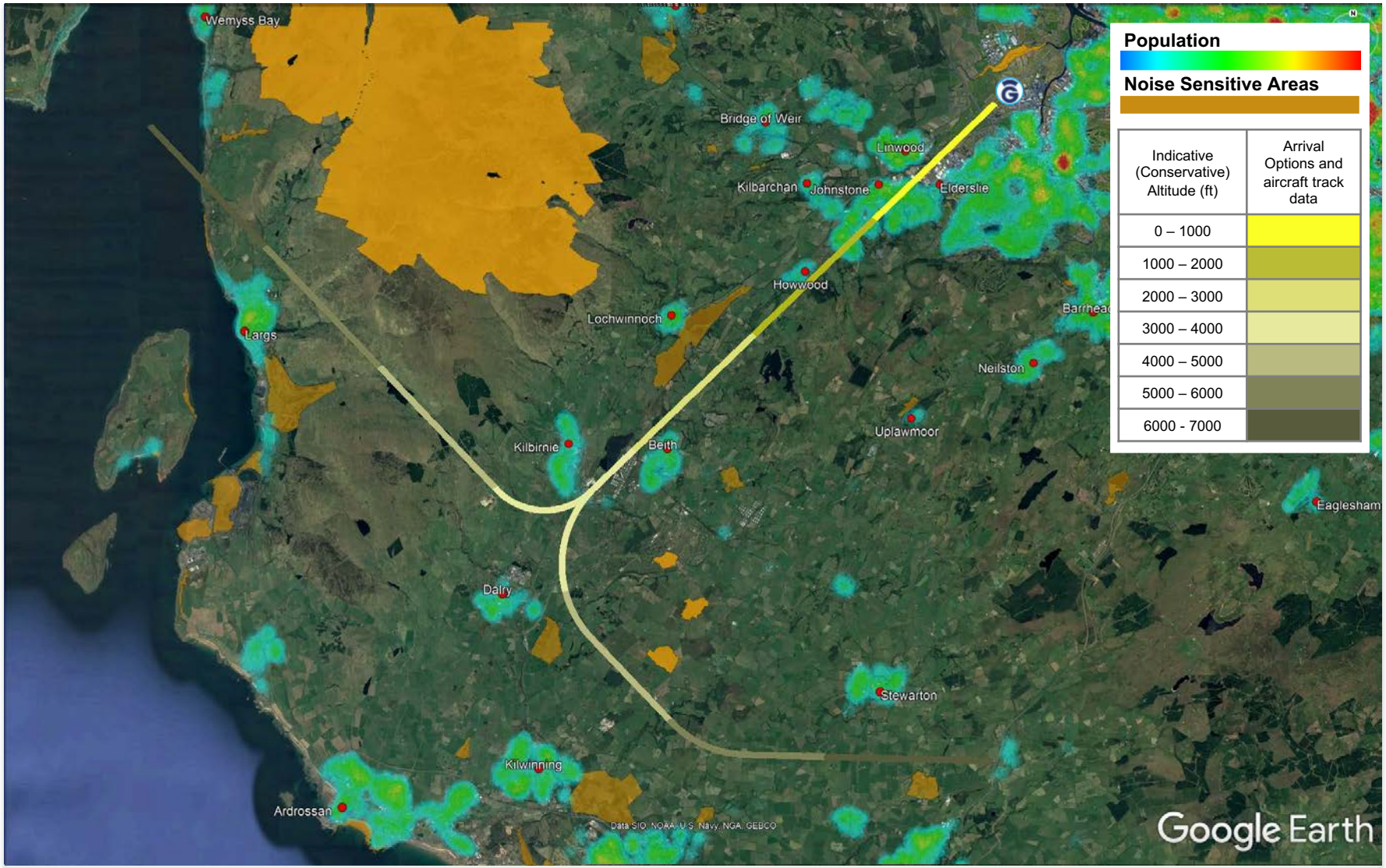
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option C



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

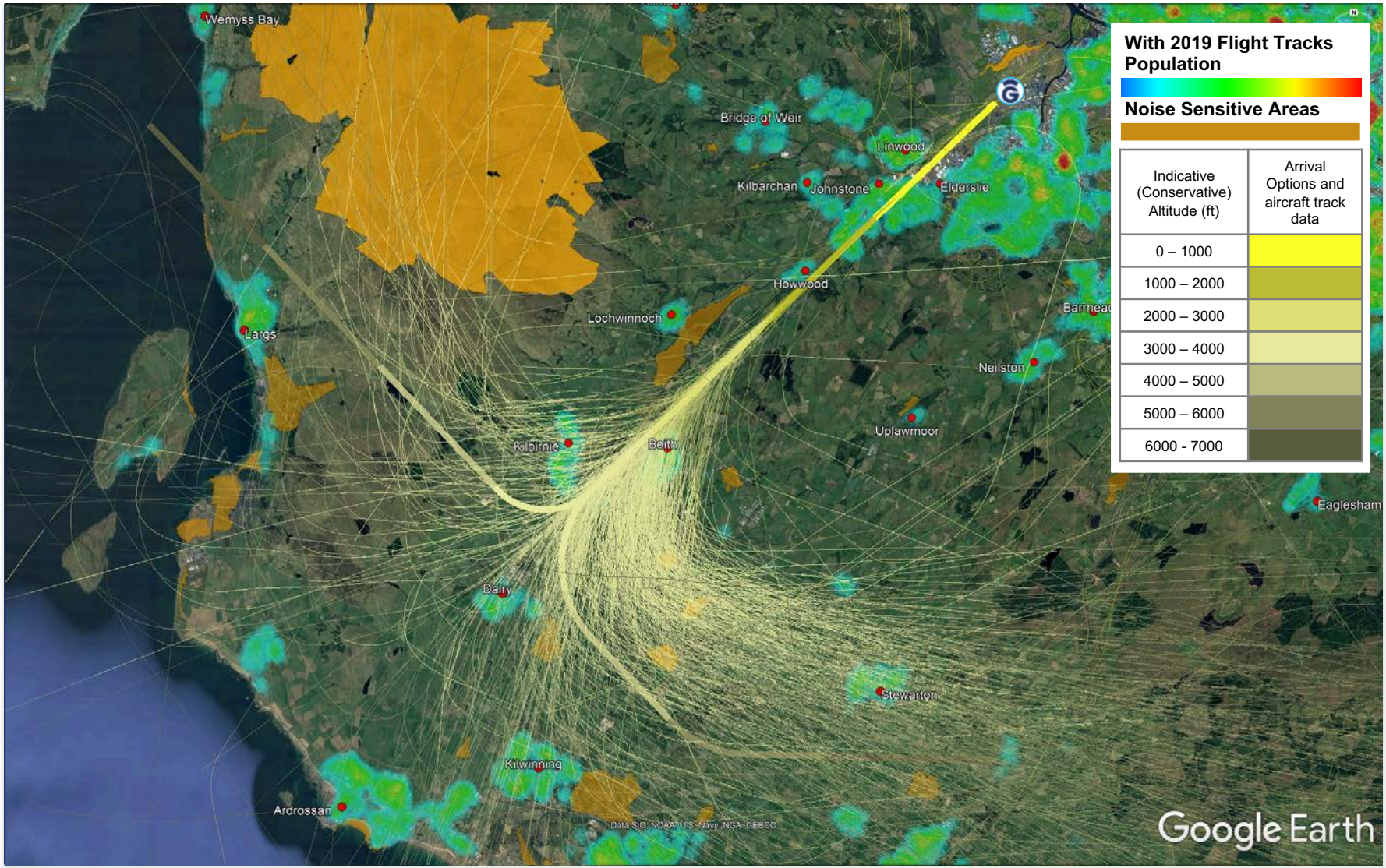
Runway 05 PBN Arrival Option C



Indicative (Conservative) Altitude (ft)	Arrival Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option C

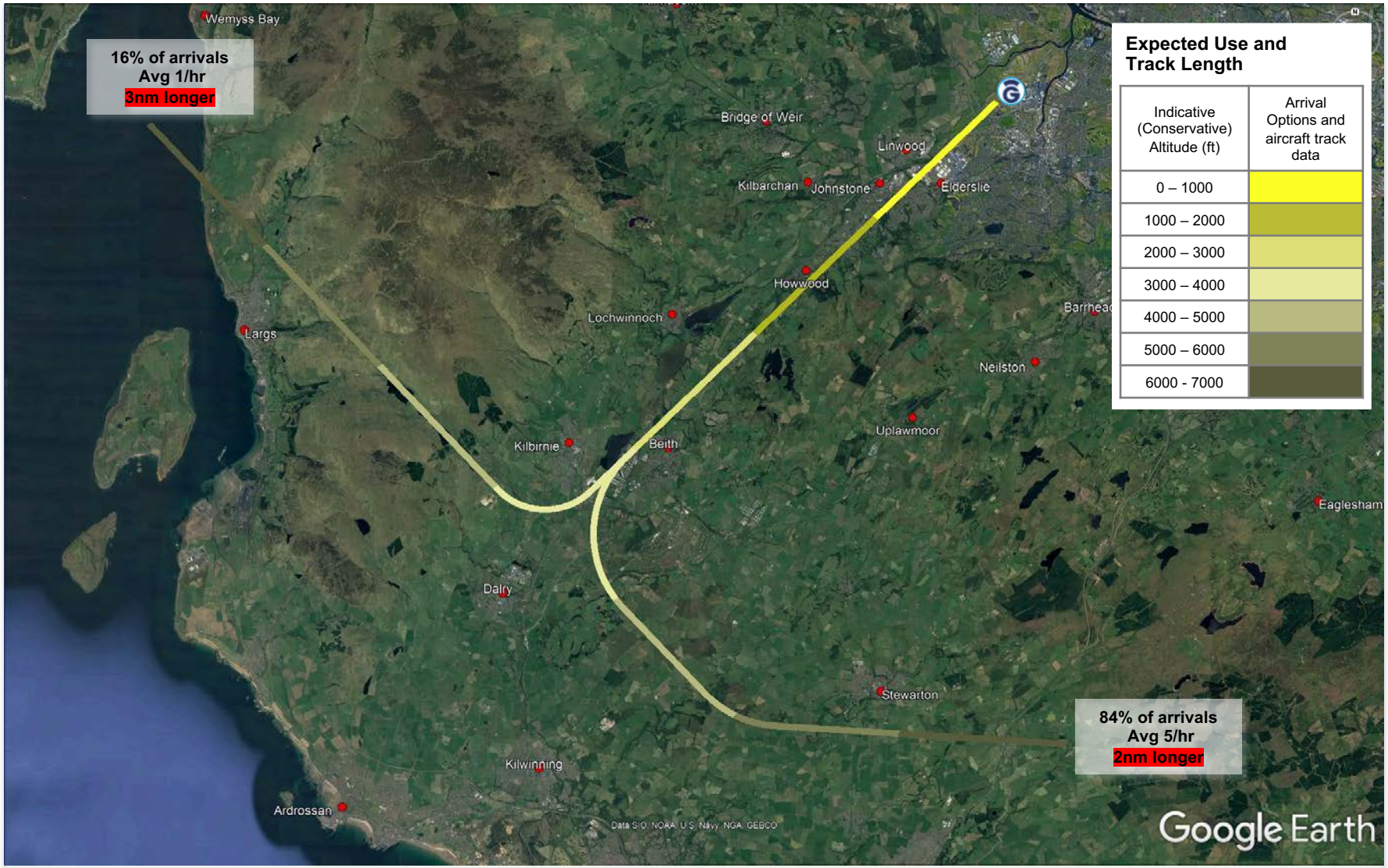


Runway 05 PBN Arrival Option D

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

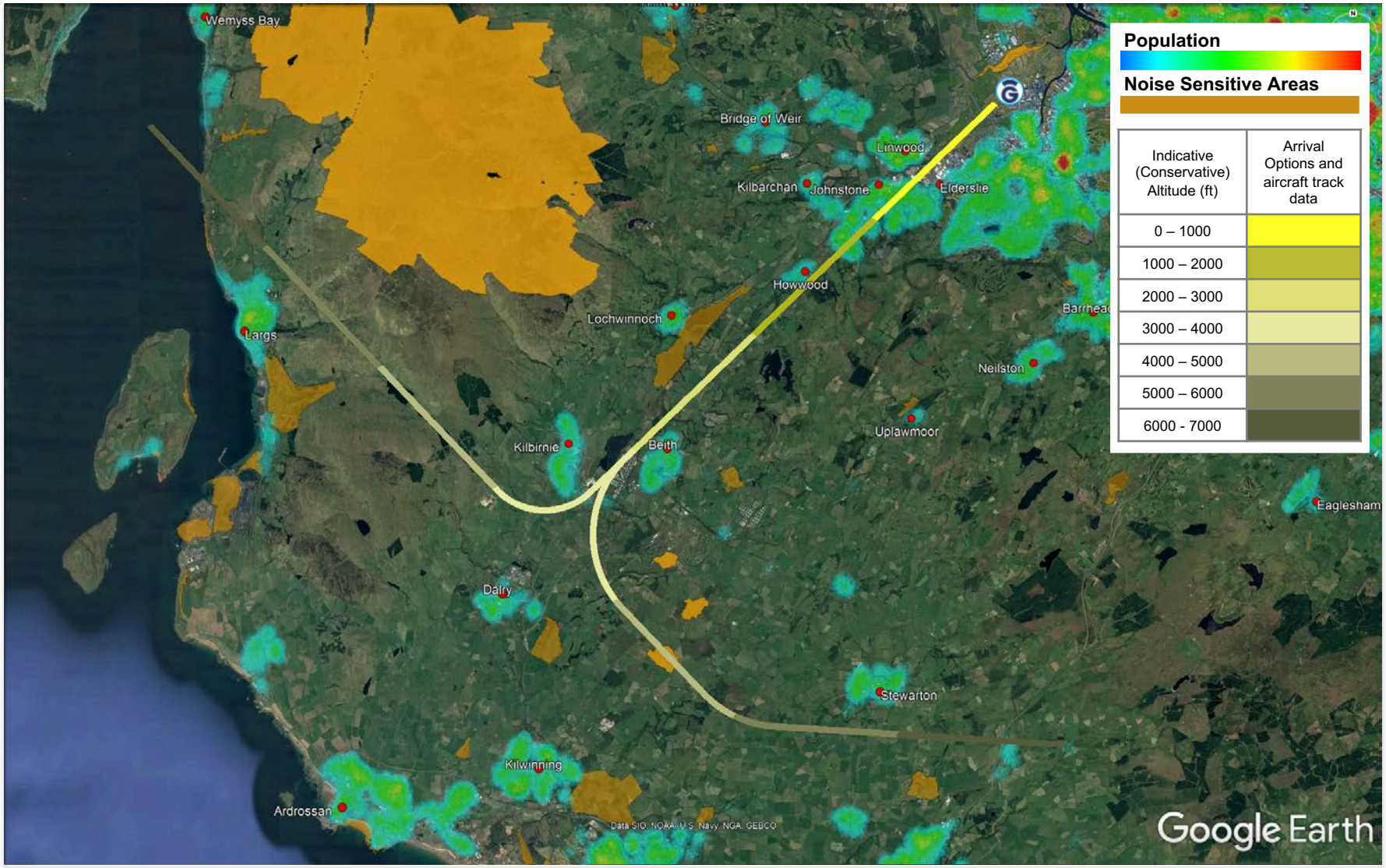
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option D



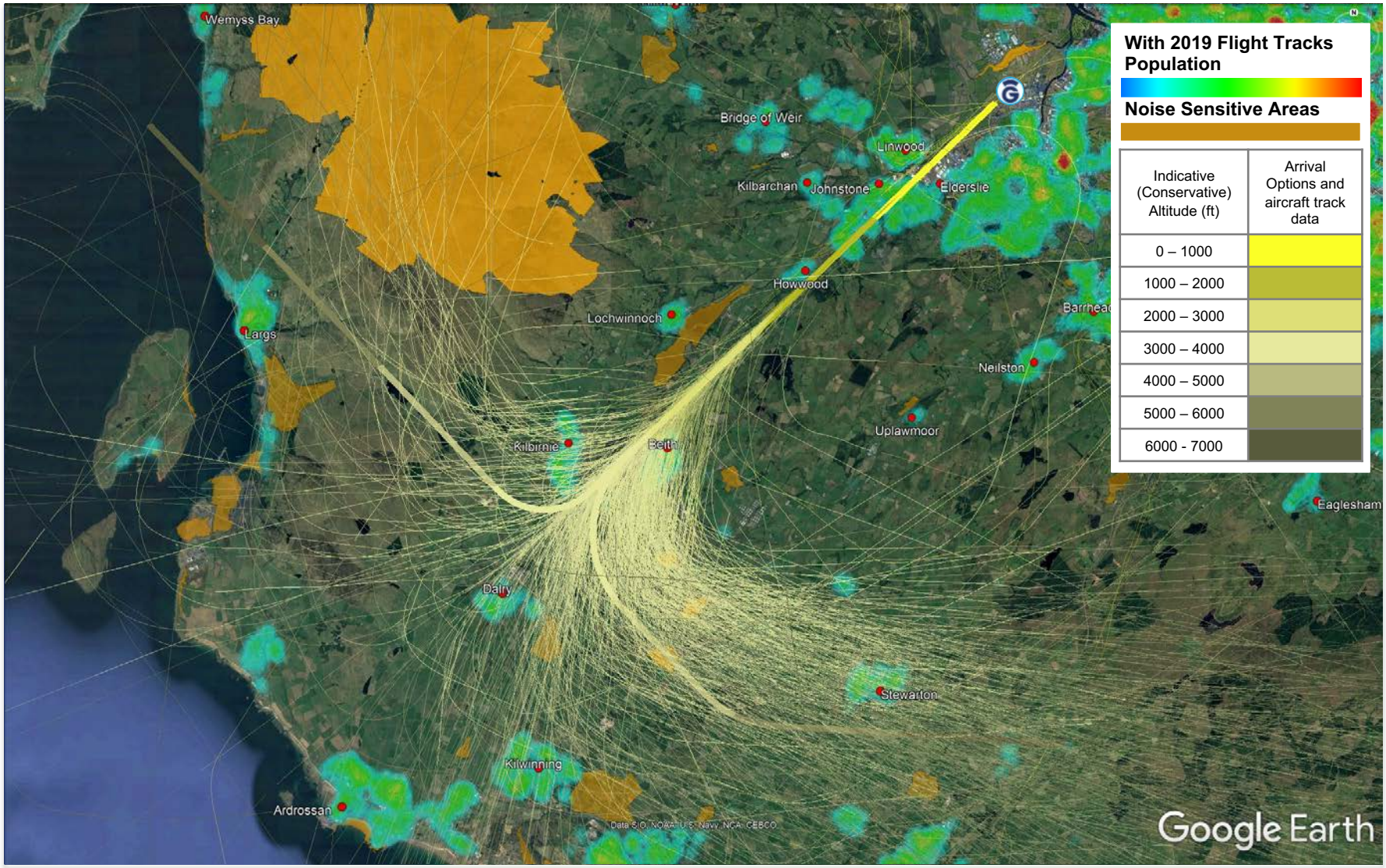
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option D



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 ARRIVALS

Runway 05 PBN Arrival Option D

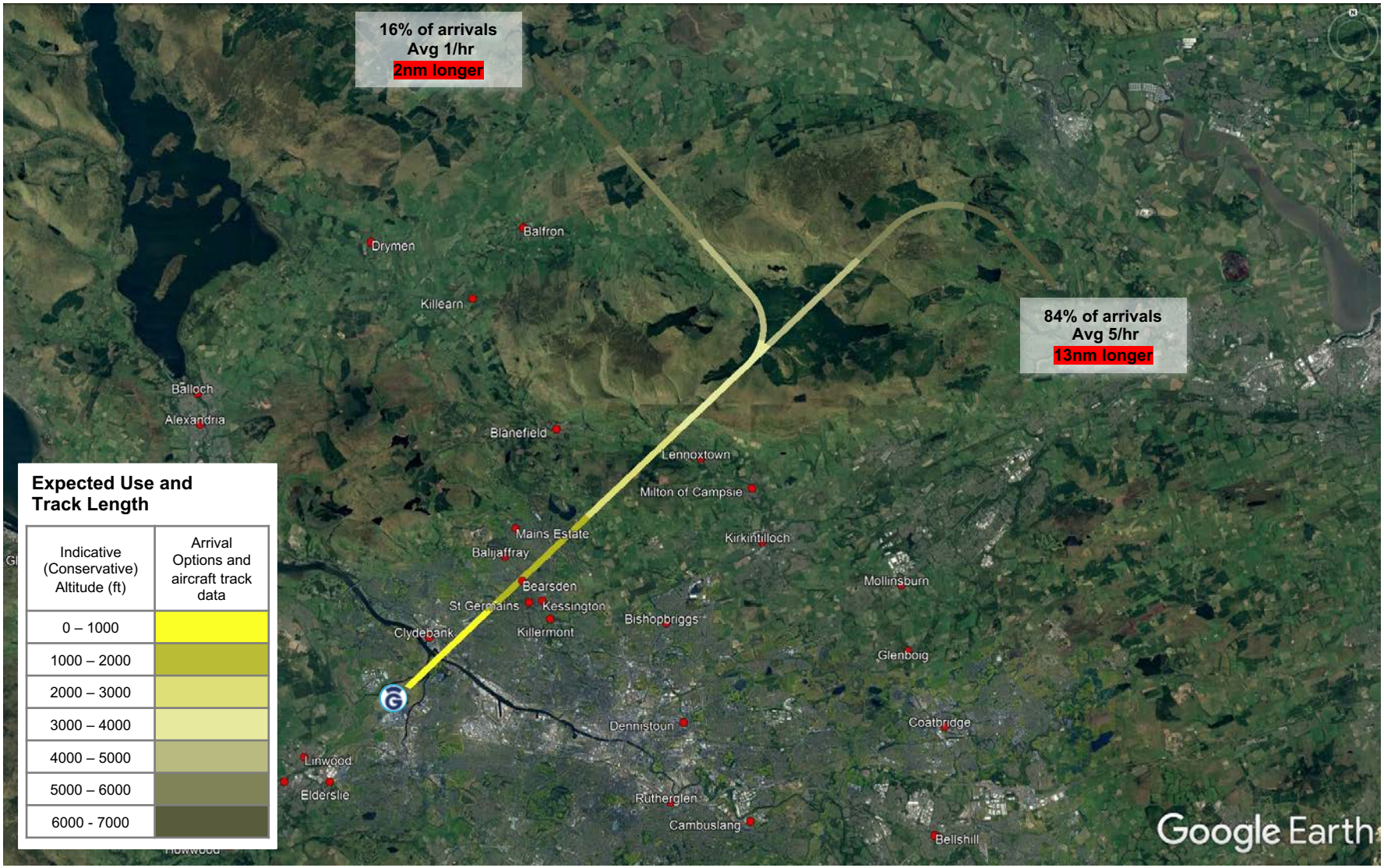


Runway 23 PBN Arrival Option A

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 17nm.

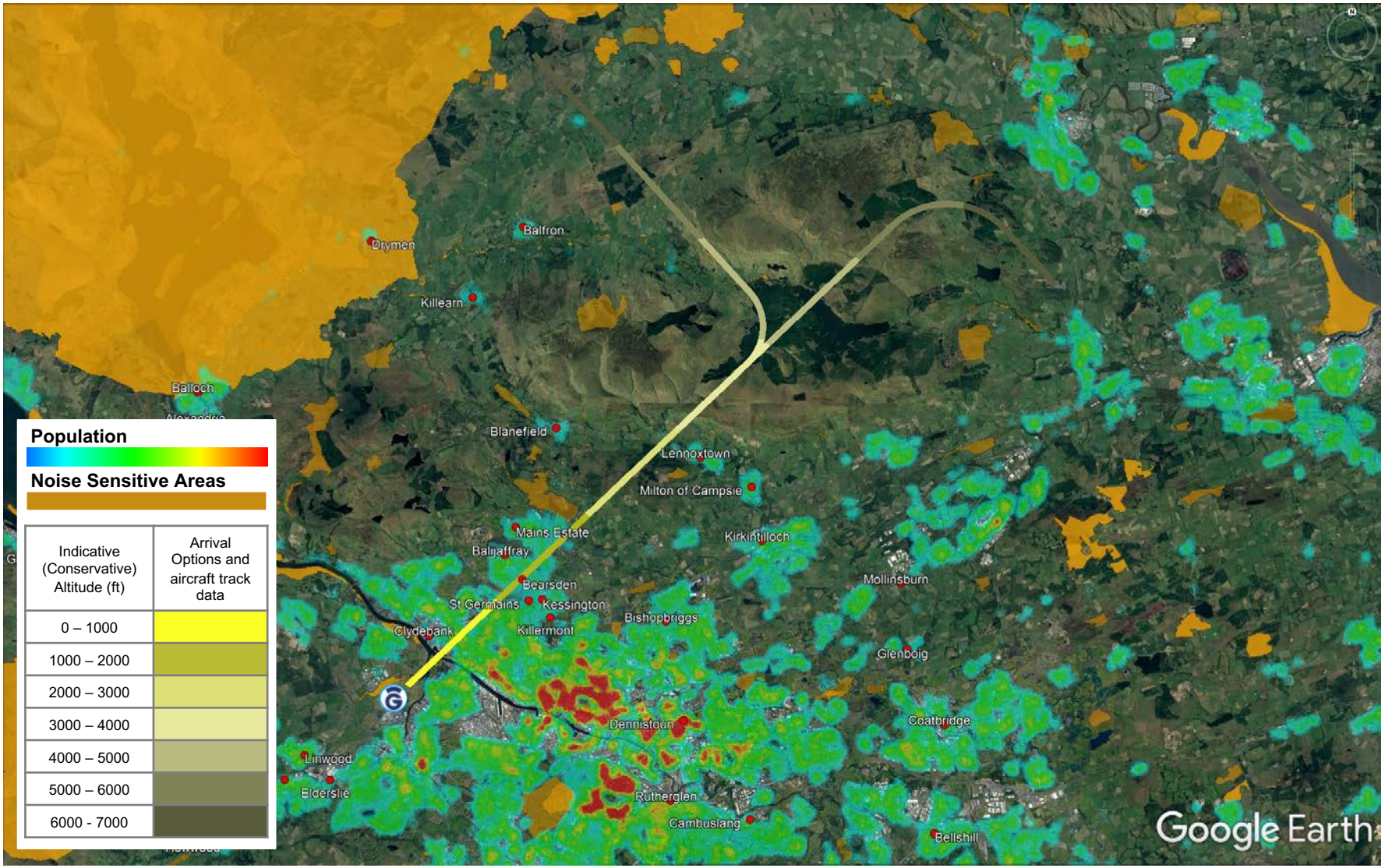
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option A



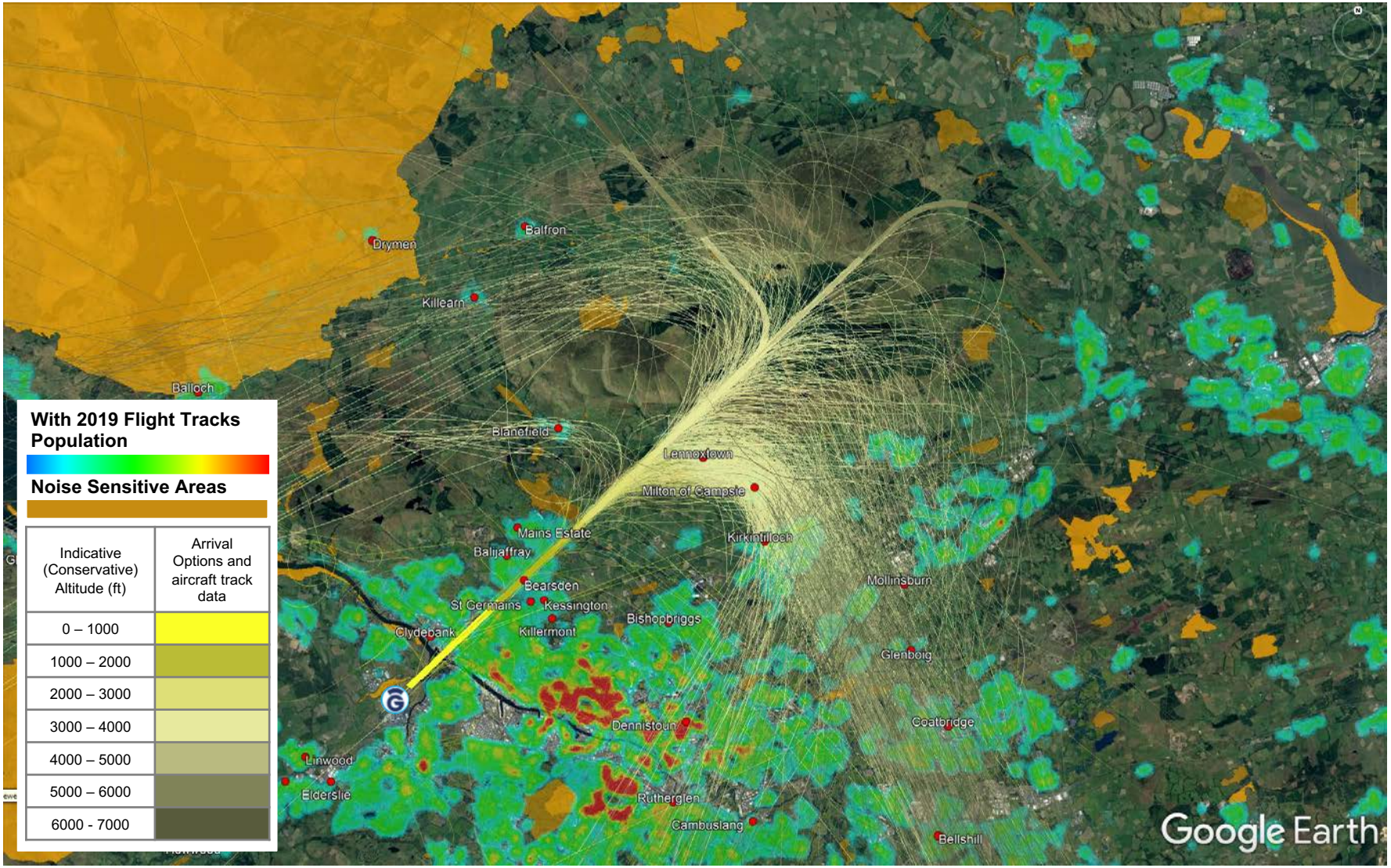
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option A



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option A

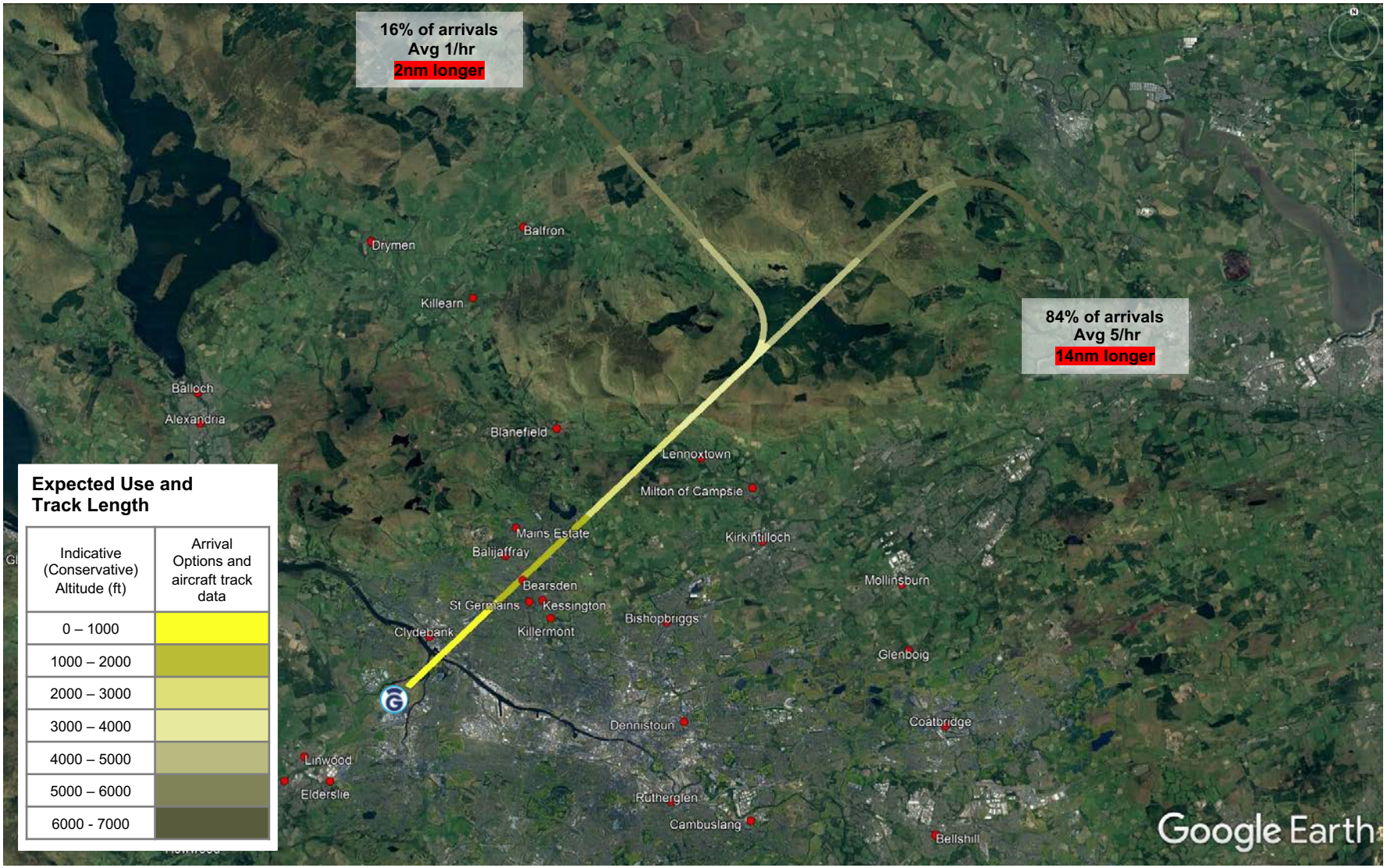


Runway 23 PBN Arrival Option B

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 18nm.

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option B

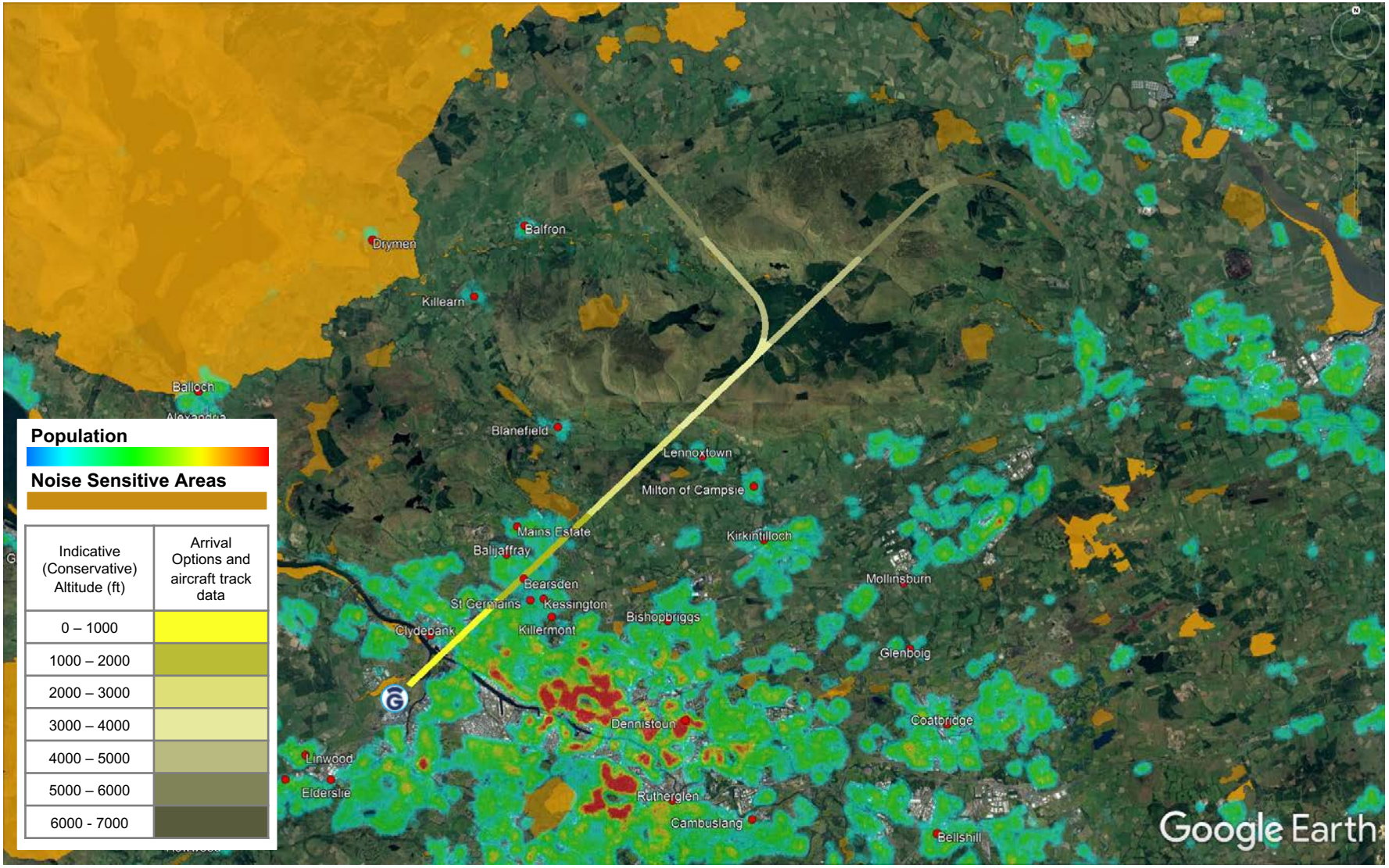


Expected Use and Track Length

Indicative (Conservative) Altitude (ft)	Arrival Options and aircraft track data
0 – 1000	
1000 – 2000	
2000 – 3000	
3000 – 4000	
4000 – 5000	
5000 – 6000	
6000 - 7000	

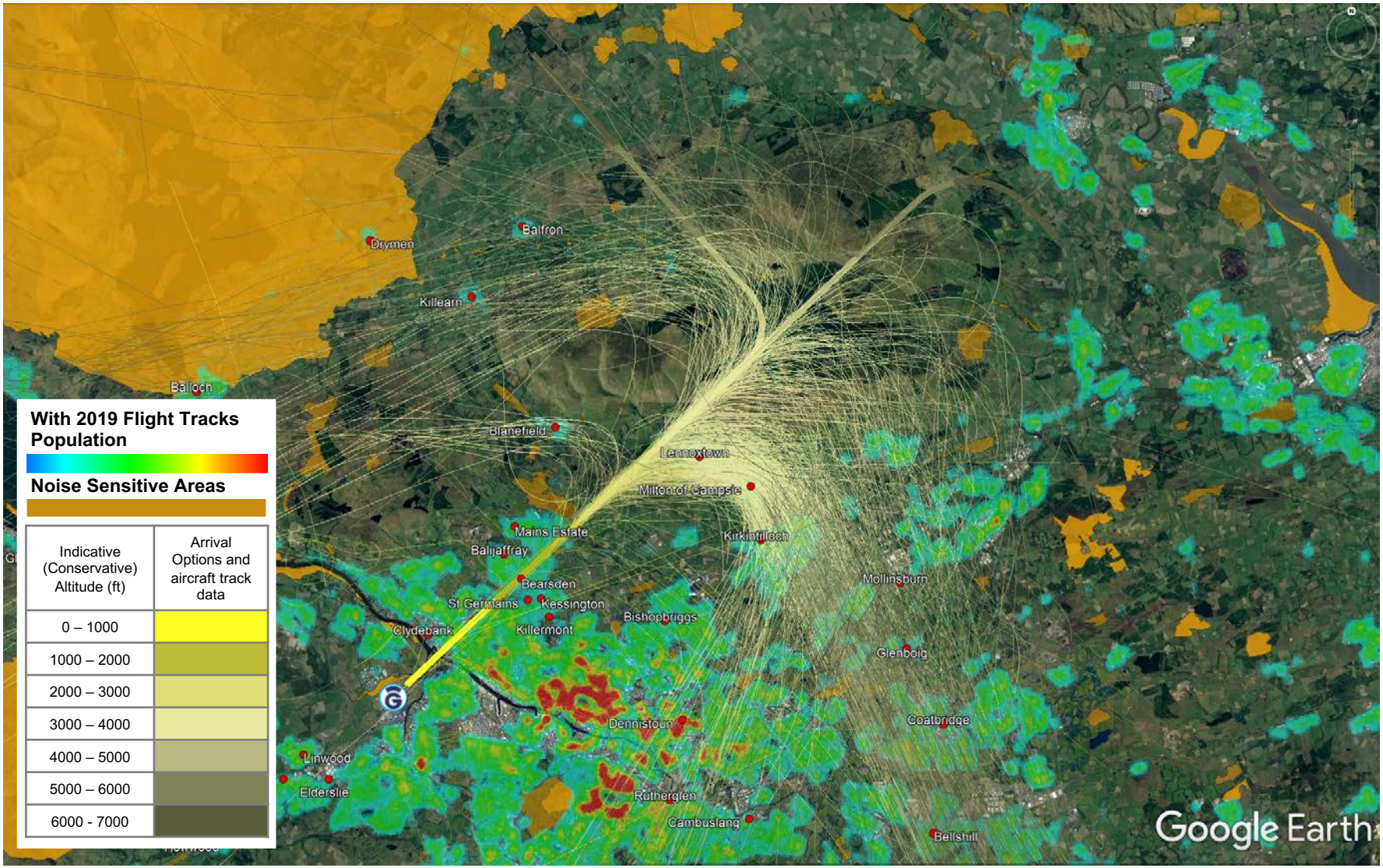
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option B



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option B

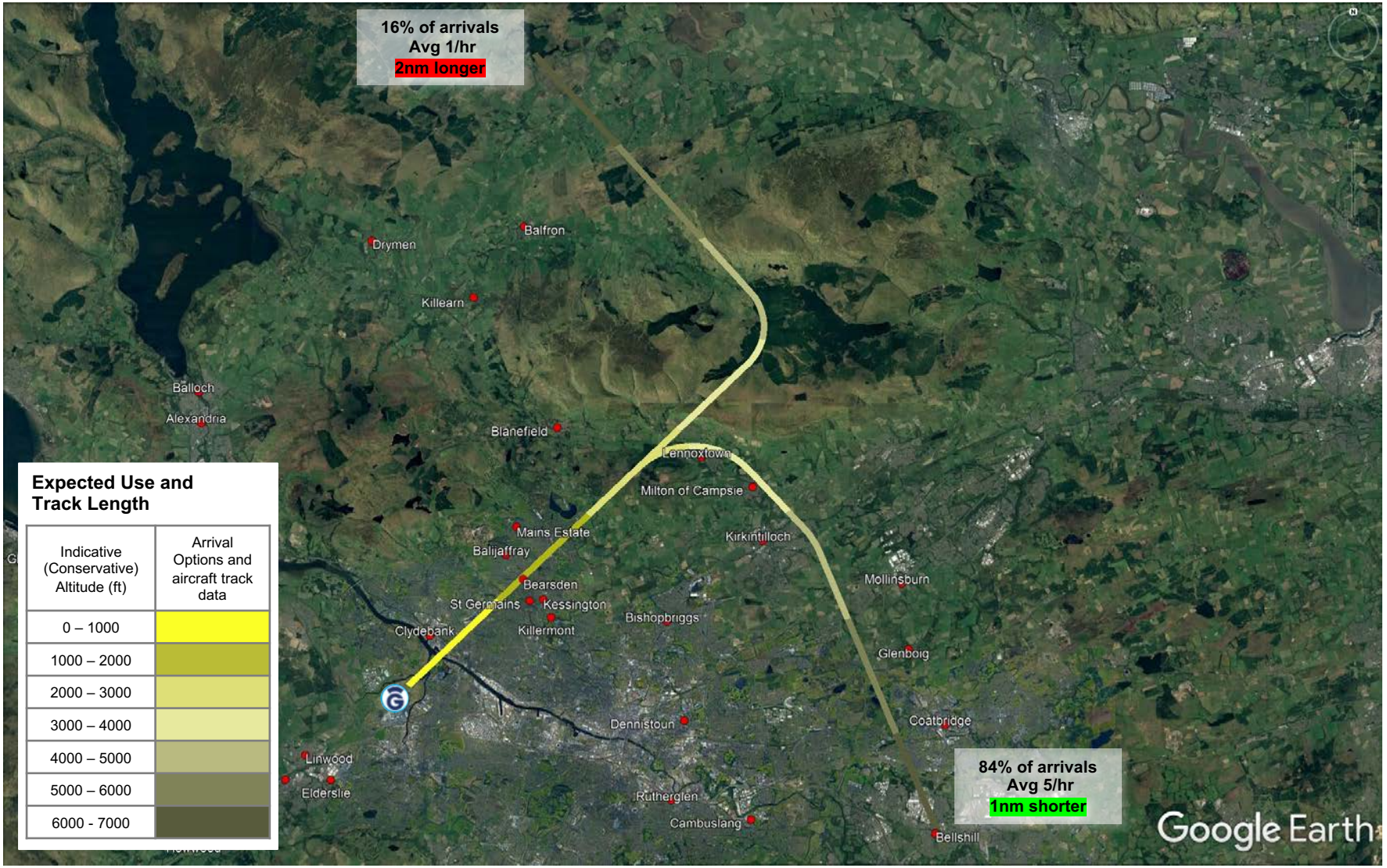


Runway 23 PBN Arrival Option C

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 8nm.

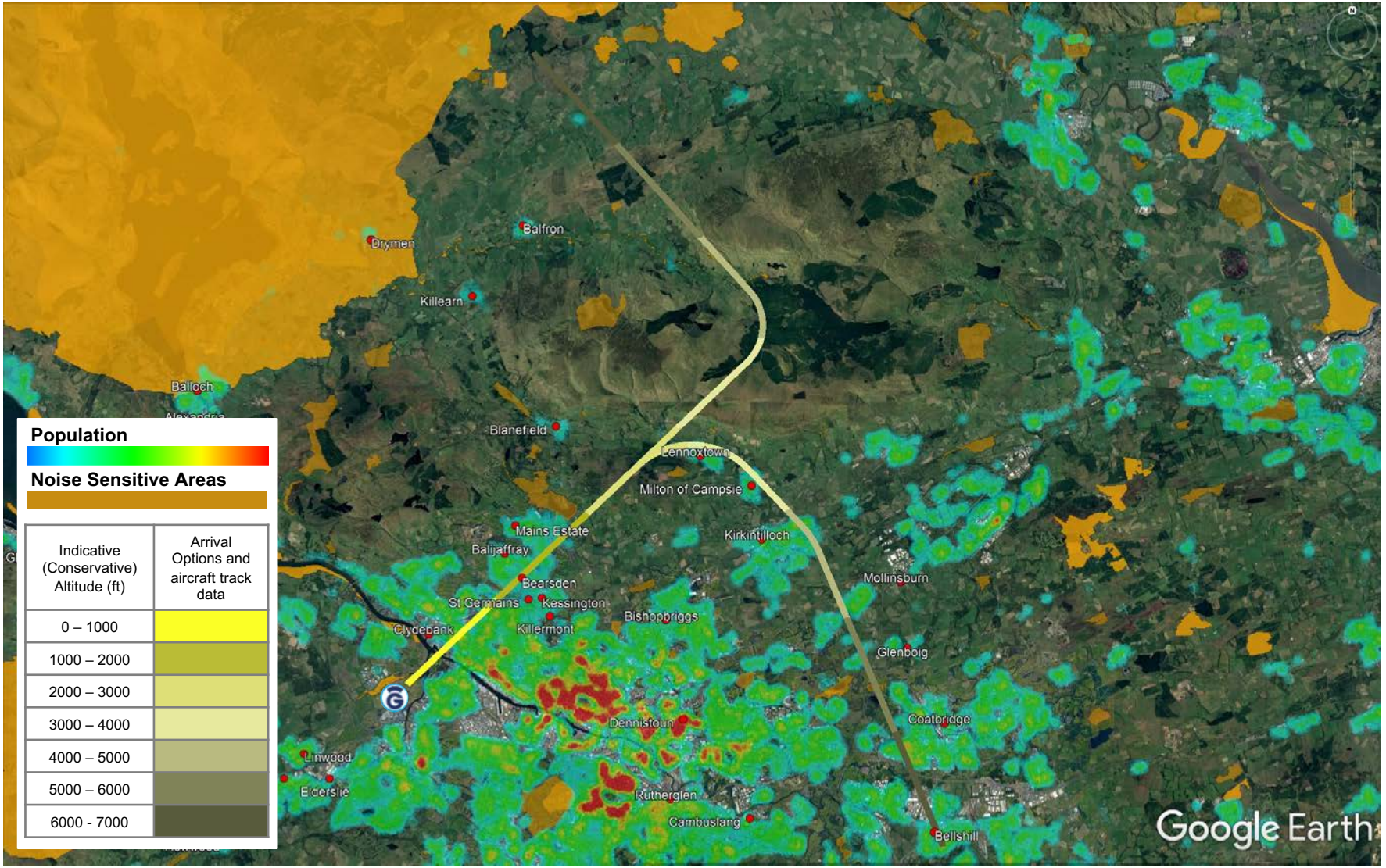
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option C



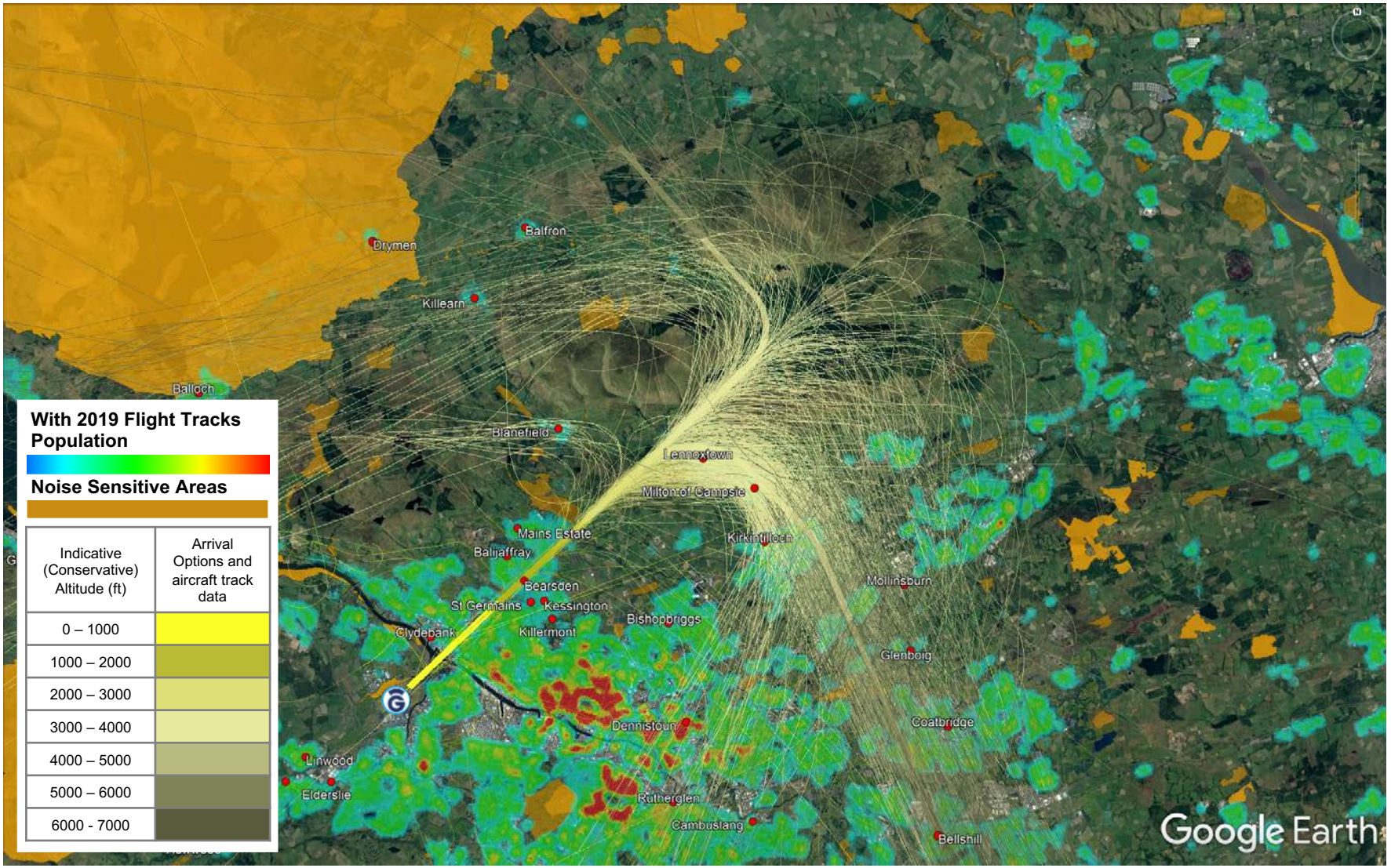
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option C



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option C

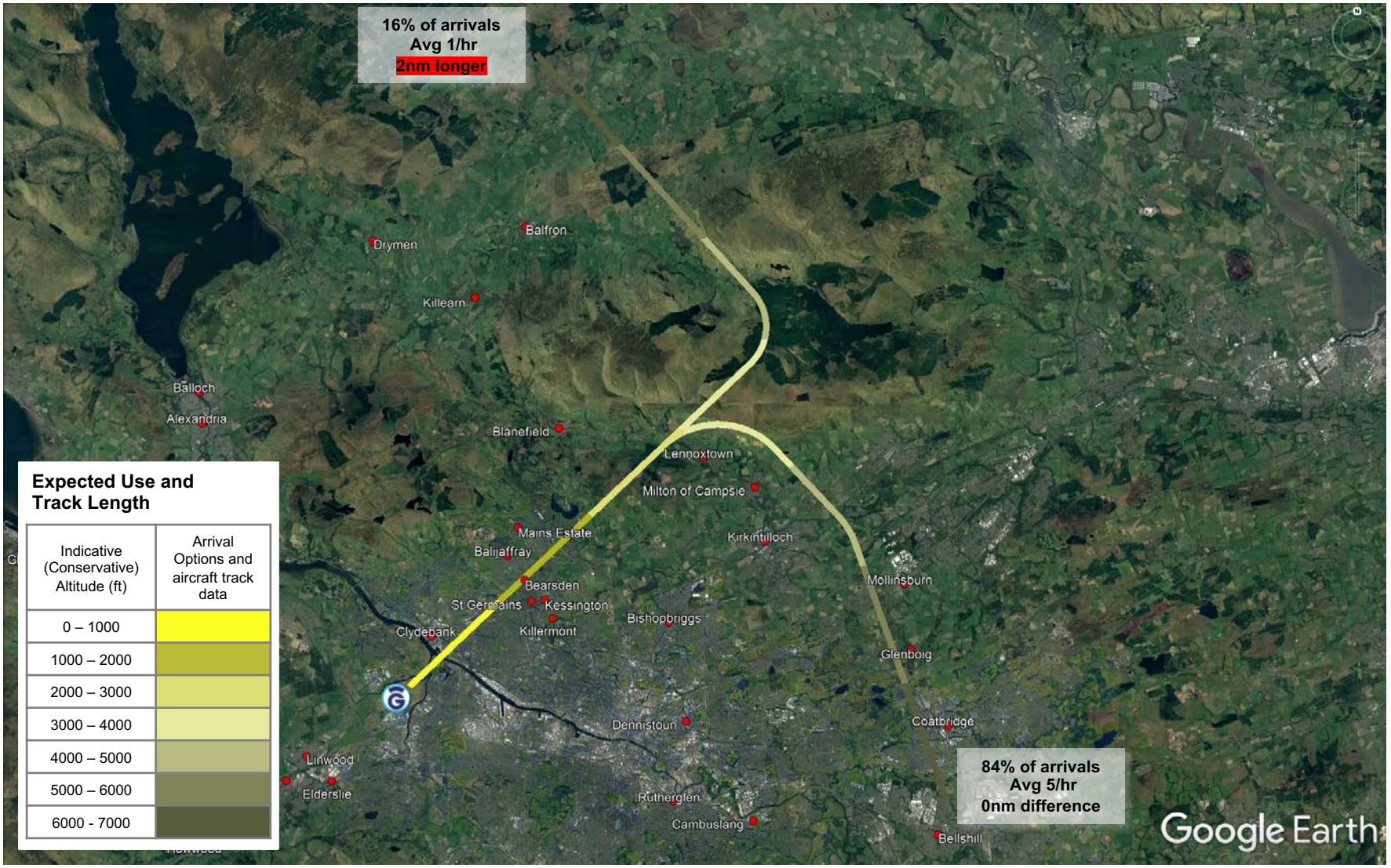


Runway 23 PBN Arrival Option D

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 9nm.

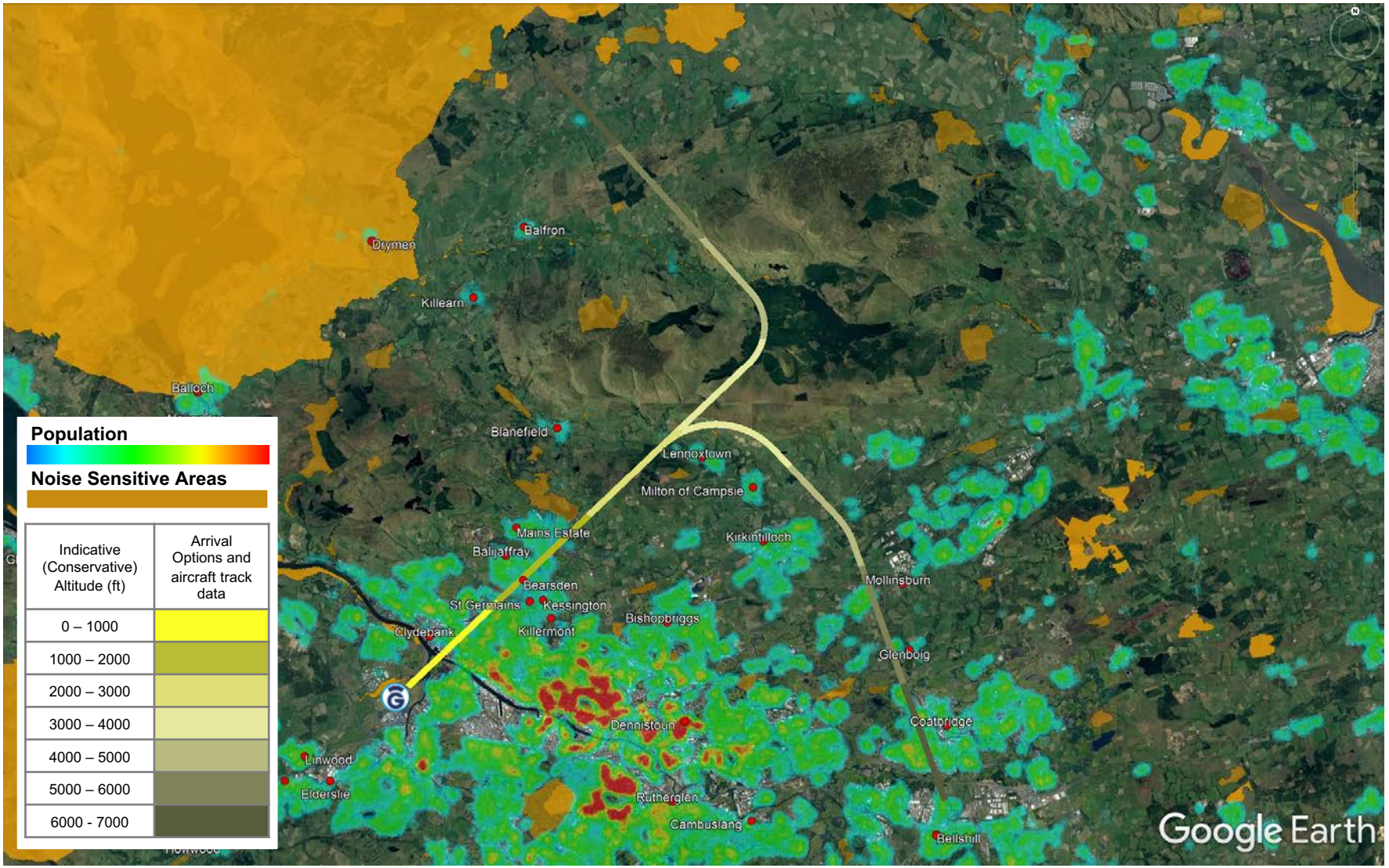
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option D



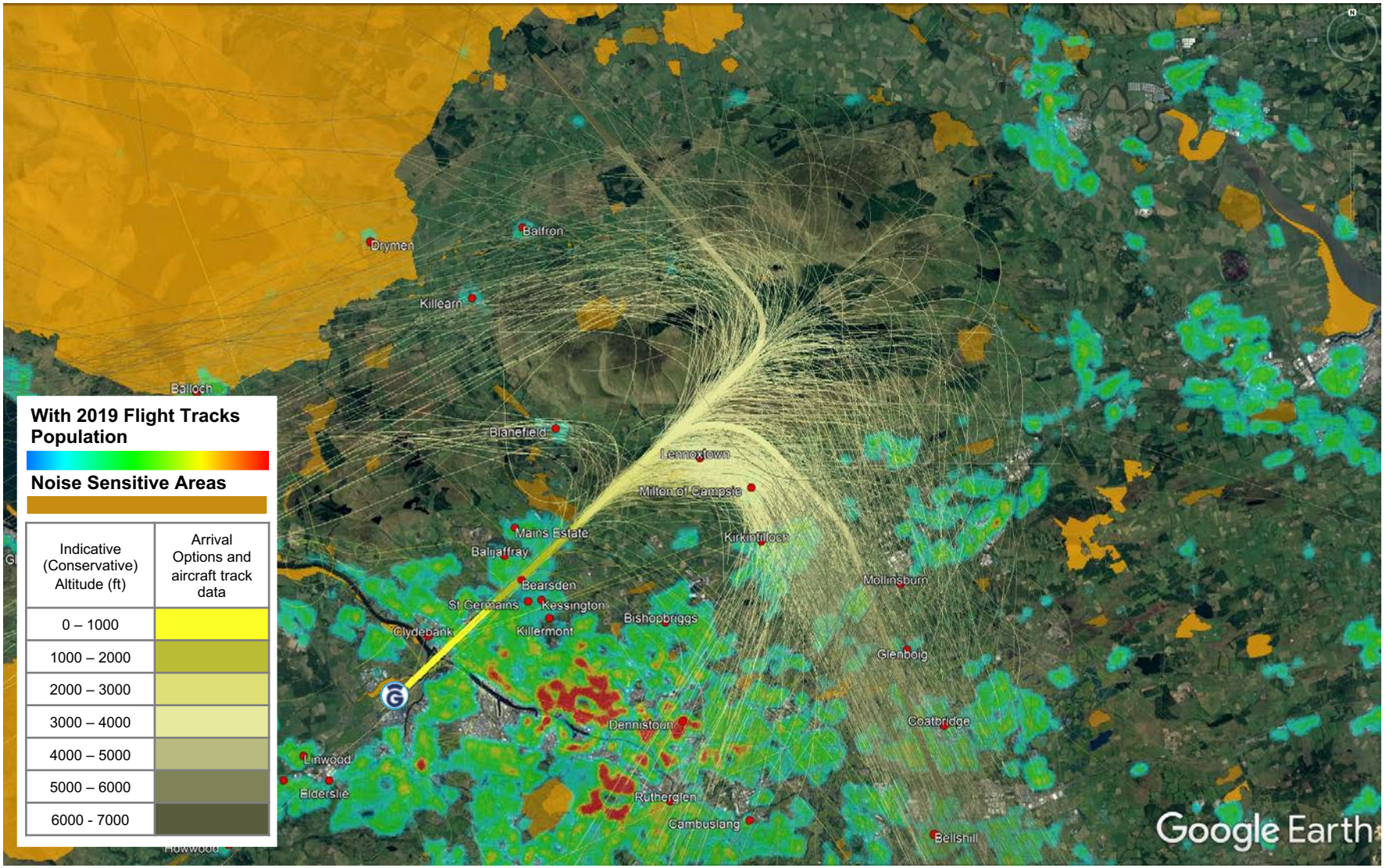
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option D



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option D

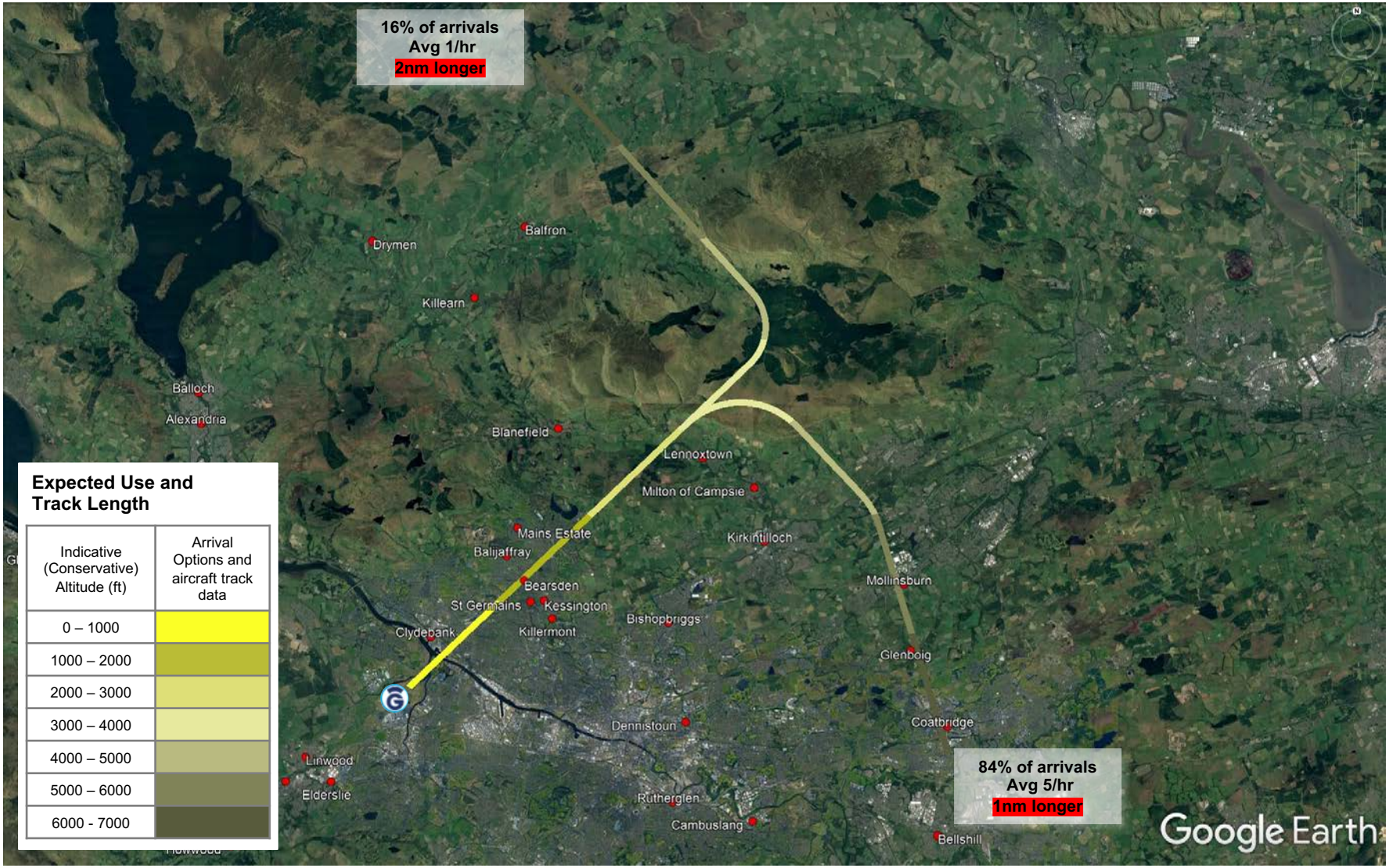


Runway 23 PBN Arrival Option E

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 10nm.

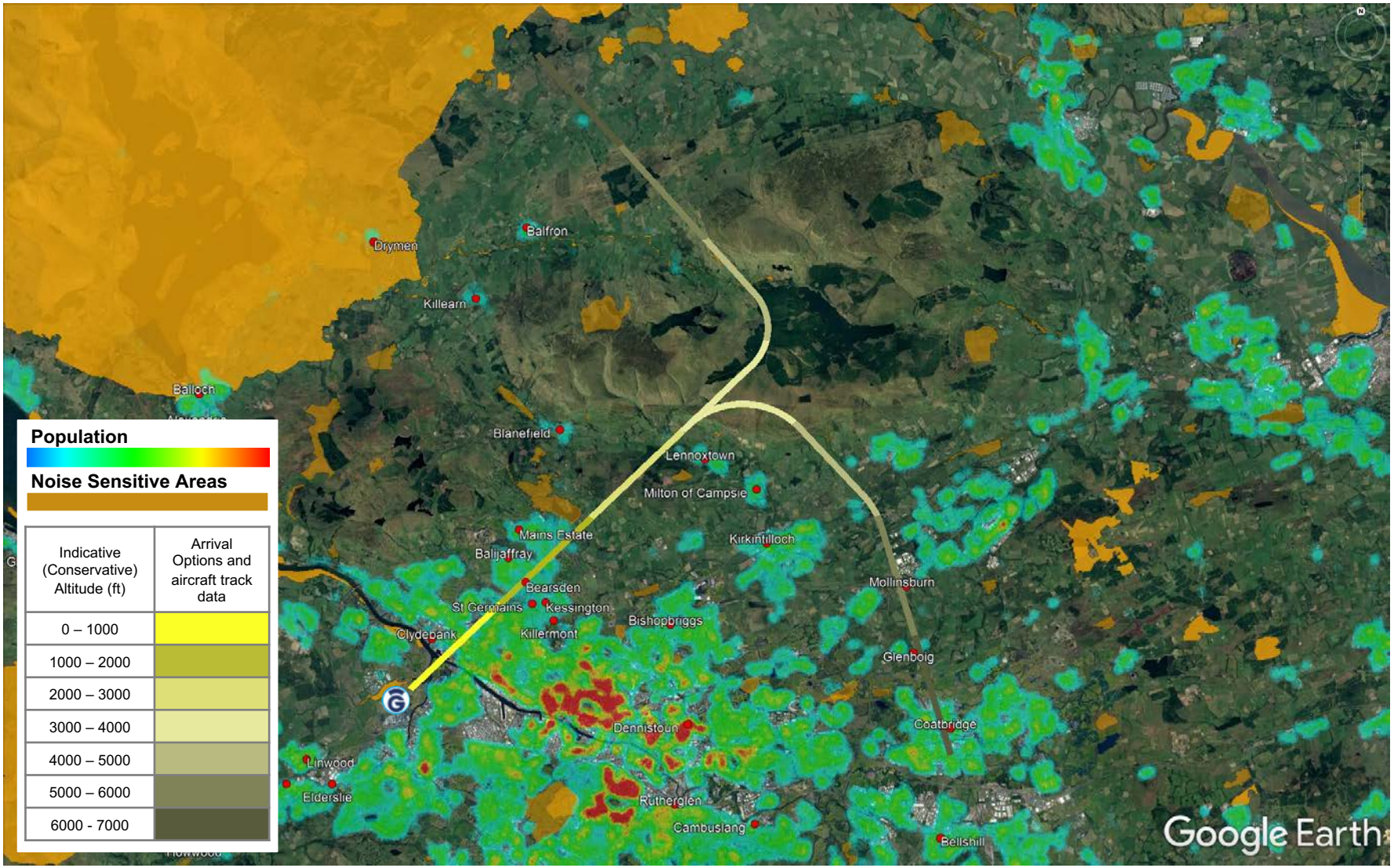
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option E



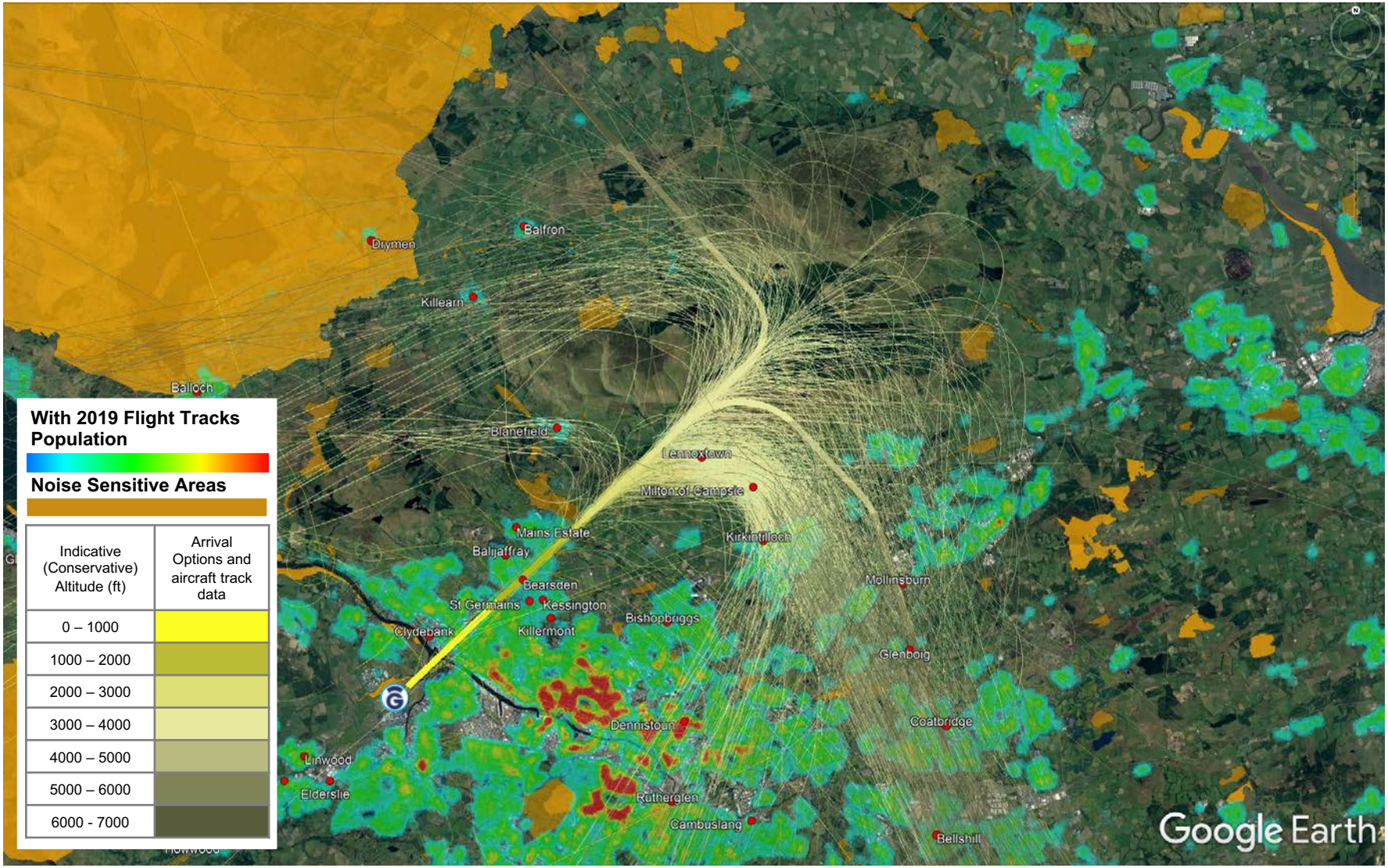
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option E



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option E

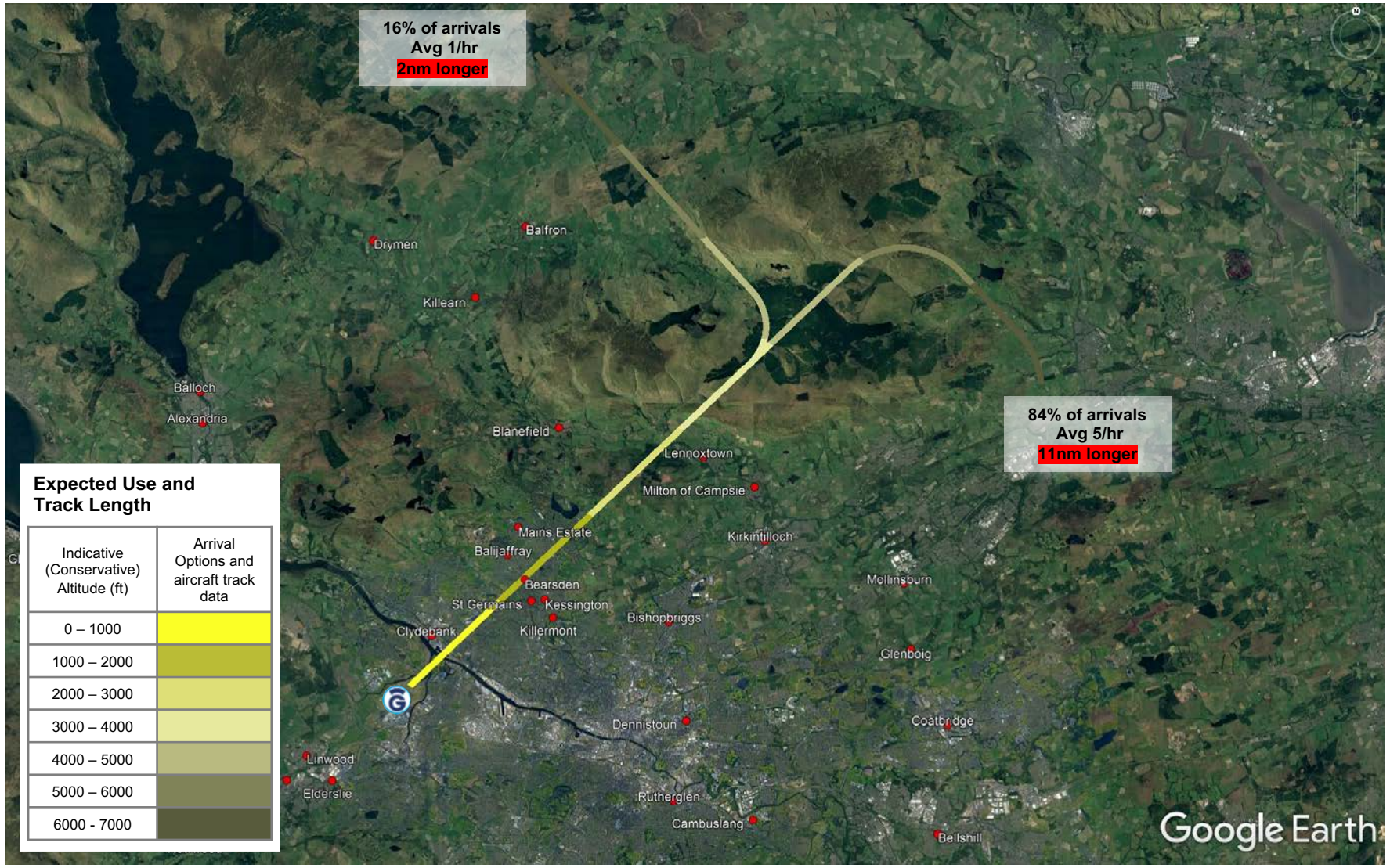


Runway 23 PBN Arrival Option F

PBN arrivals from the north joining final approach at approximately 12nm from the runway and from the south at approximately 15nm.

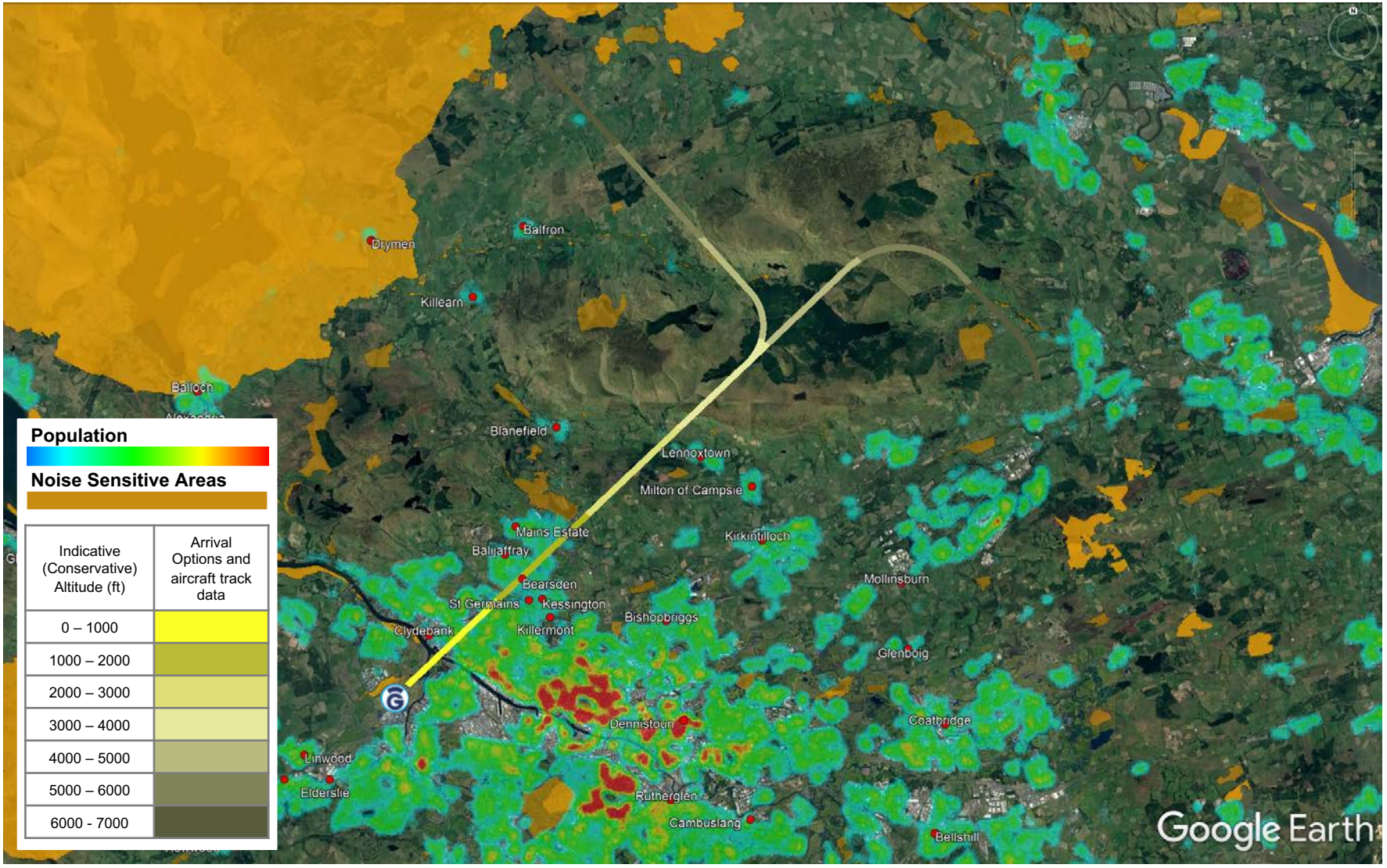
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option F



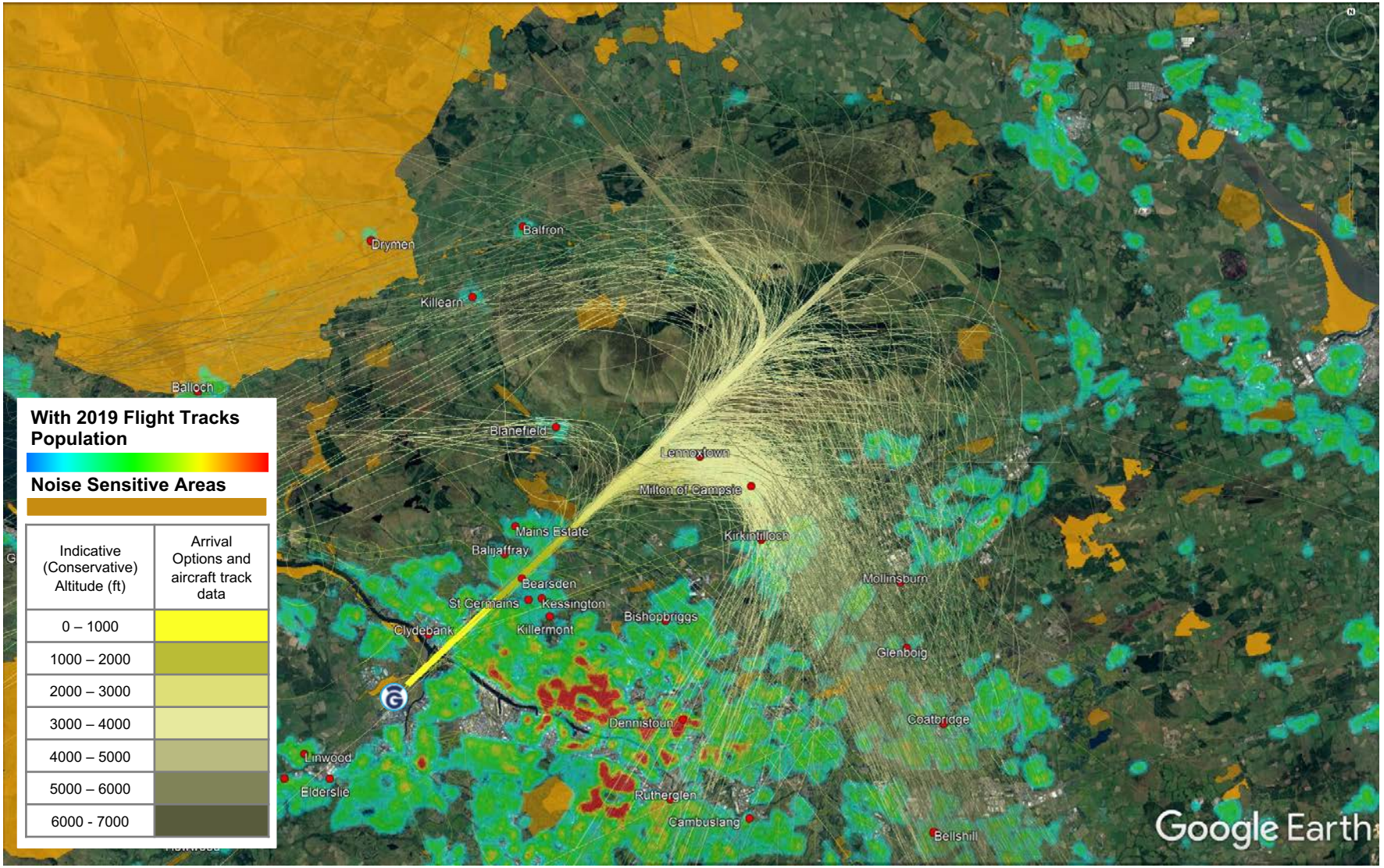
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option F



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 ARRIVALS

Runway 23 PBN Arrival Option F



Departures

4. COMPREHENSIVE LIST OF OPTIONS

PBN Departures

Our Departure Options are based on PBN transitions where an aircraft would fly the full PBN route from take off to above 7000ft where they would join the upper airspace network.

PBN improves the accuracy of where aircraft fly and therefore full PBN transitions would result in traffic being more concentrated than today. There may however still be some variations around the centerlines and there may be occasions where ATC have to tactically manage departures. We estimate that this will be less frequent than today, especially at lower altitudes.

The following slides show the PBN departure options currently under consideration:

Runway 05 Departure Option A

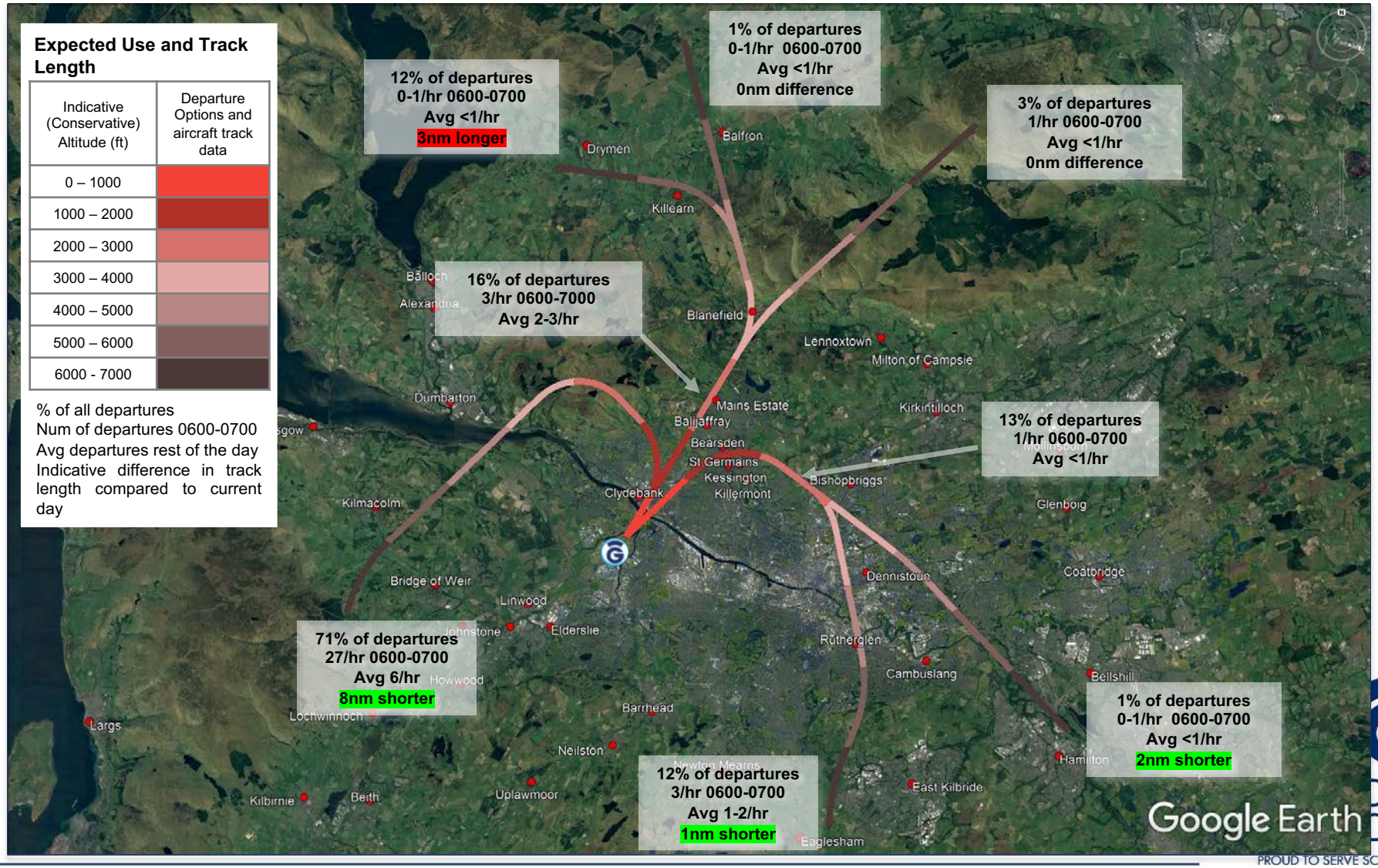
Offset left departures with turns at 1nm and 6nm from the runway.

Straight ahead departures with turns at 3nm from the runway.

NORBO is offset left with turn at 1nm

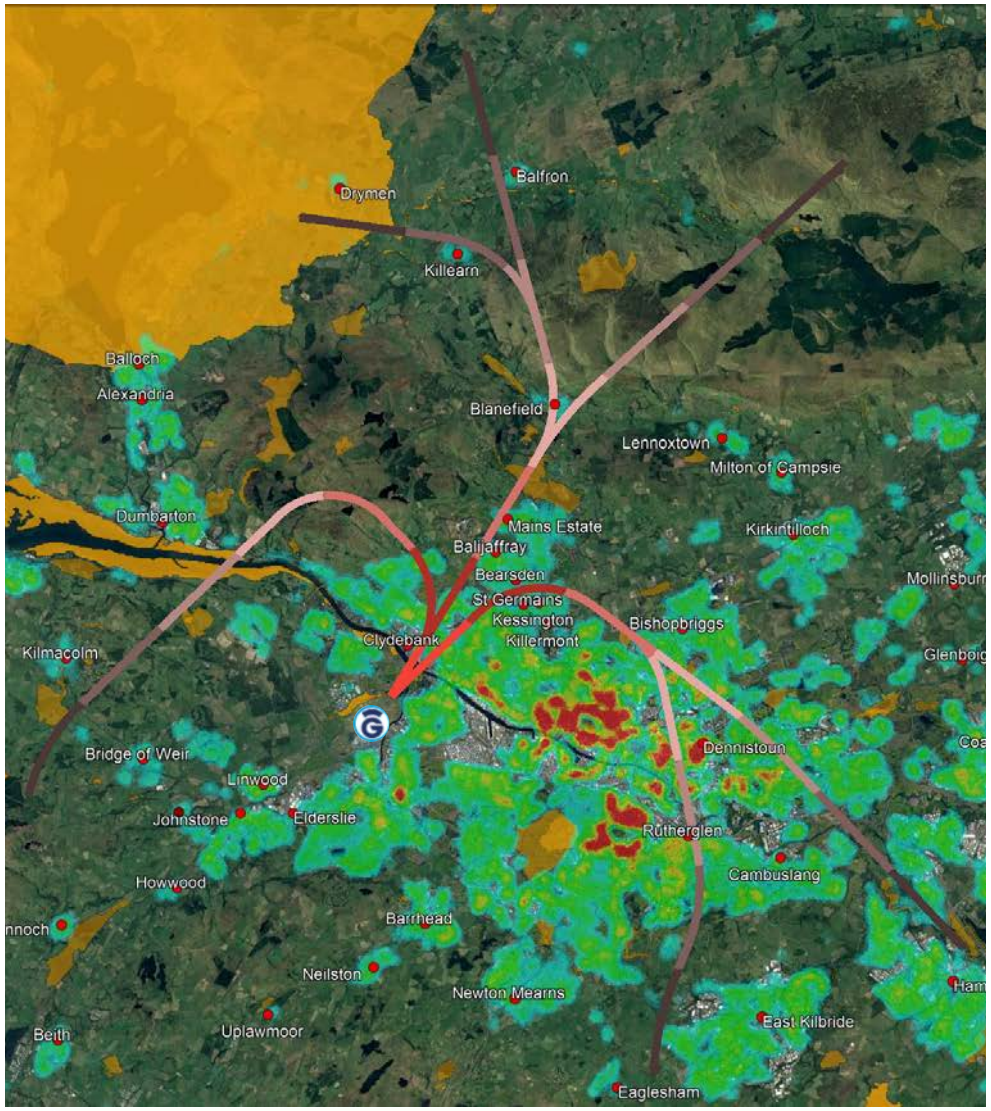
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

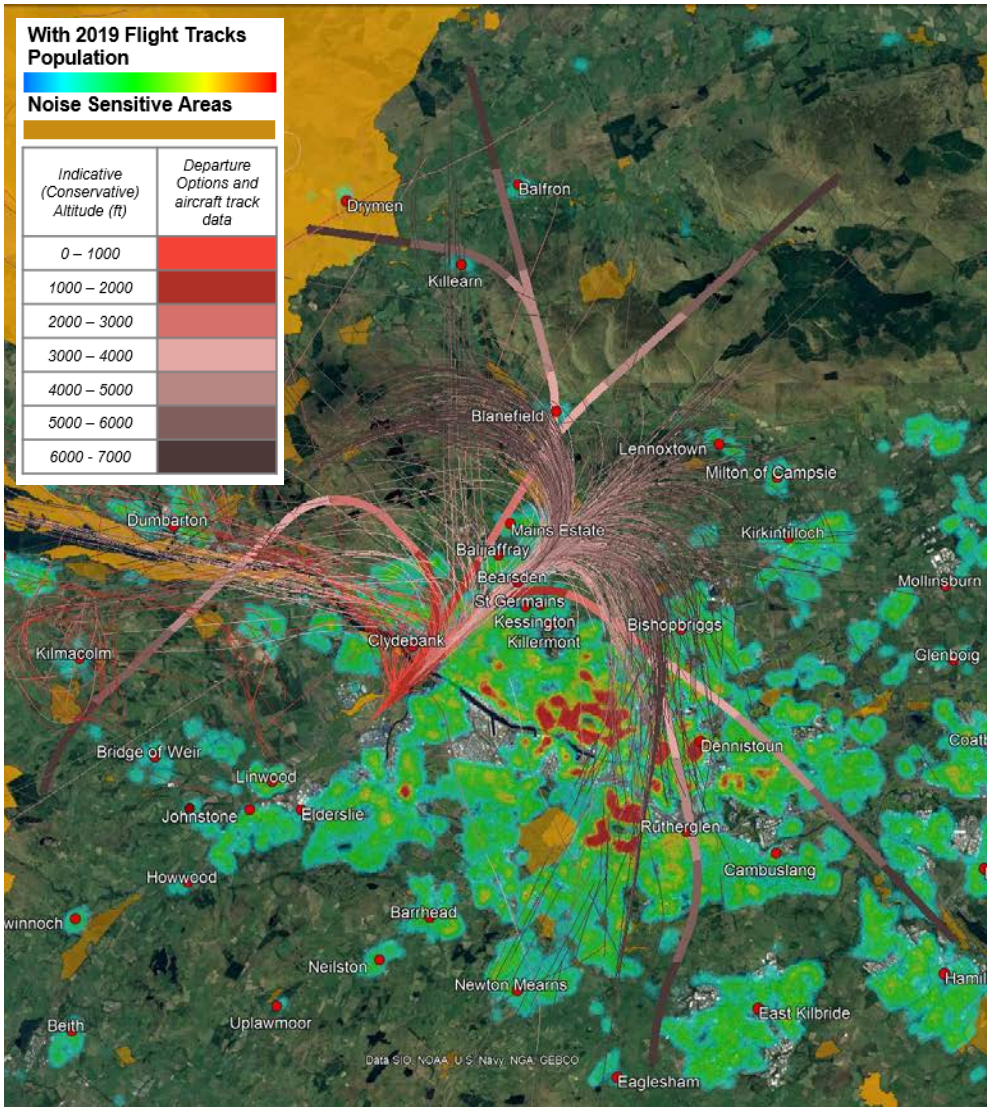
Runway 05 Departure Option A



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option A



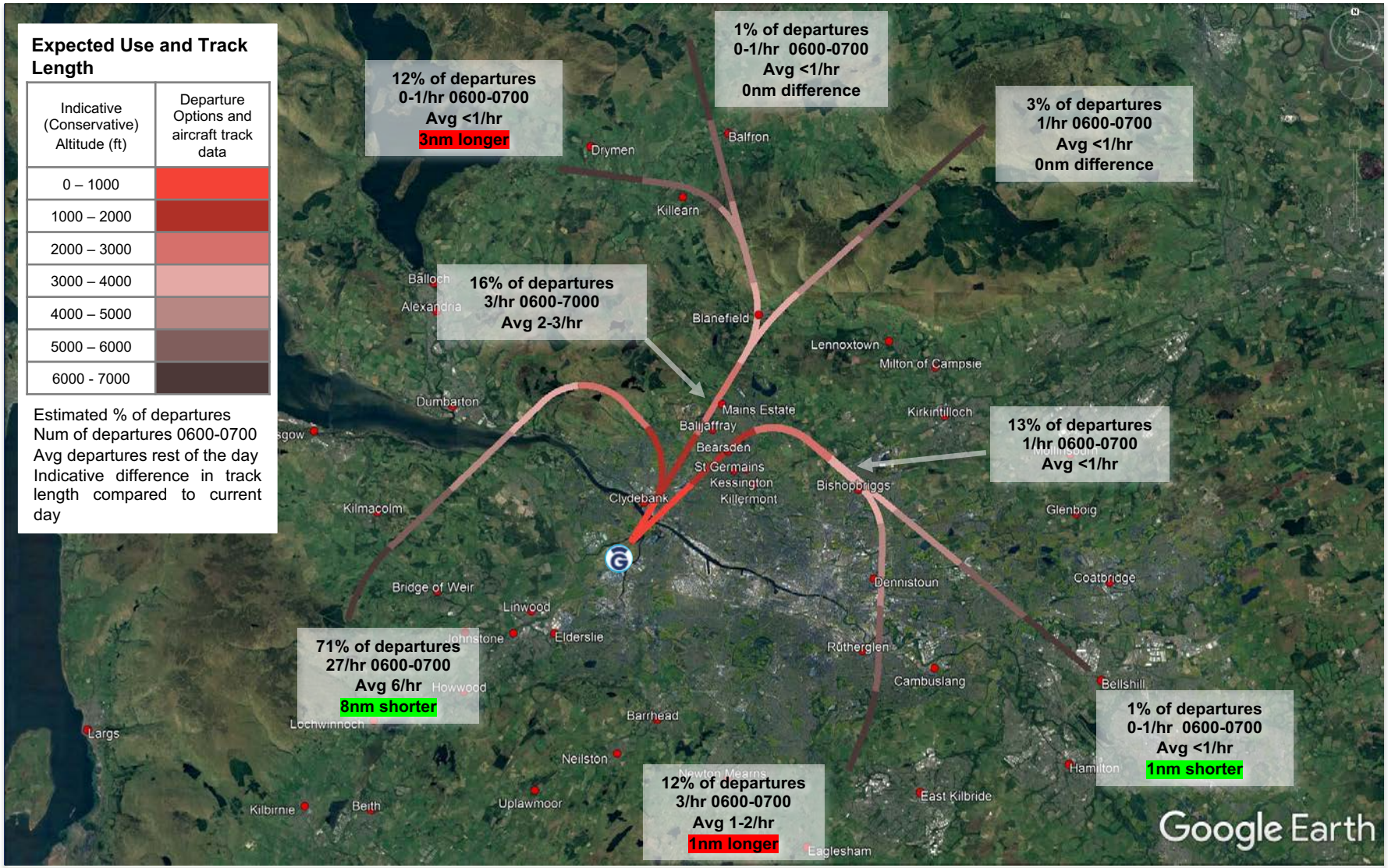


Runway 05 Departure Option B

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

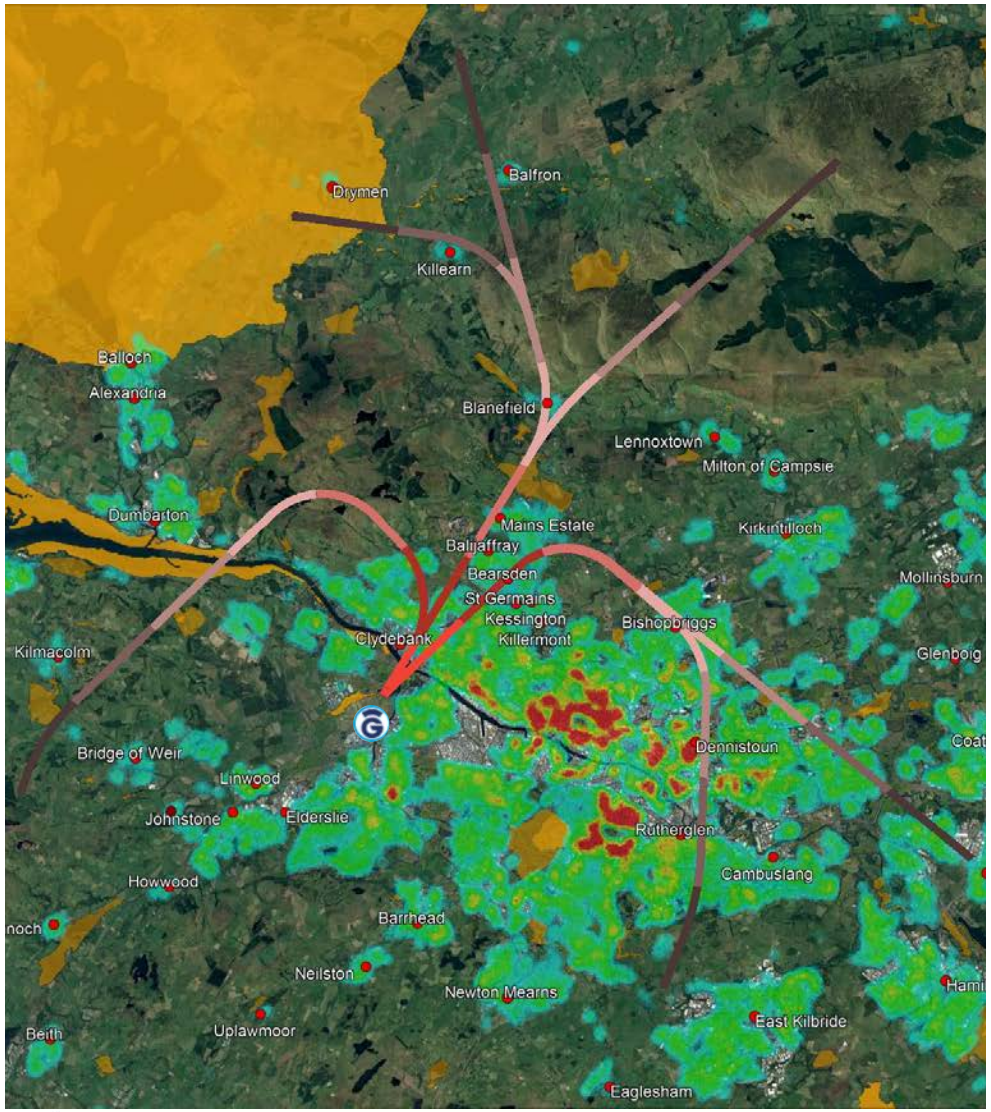
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

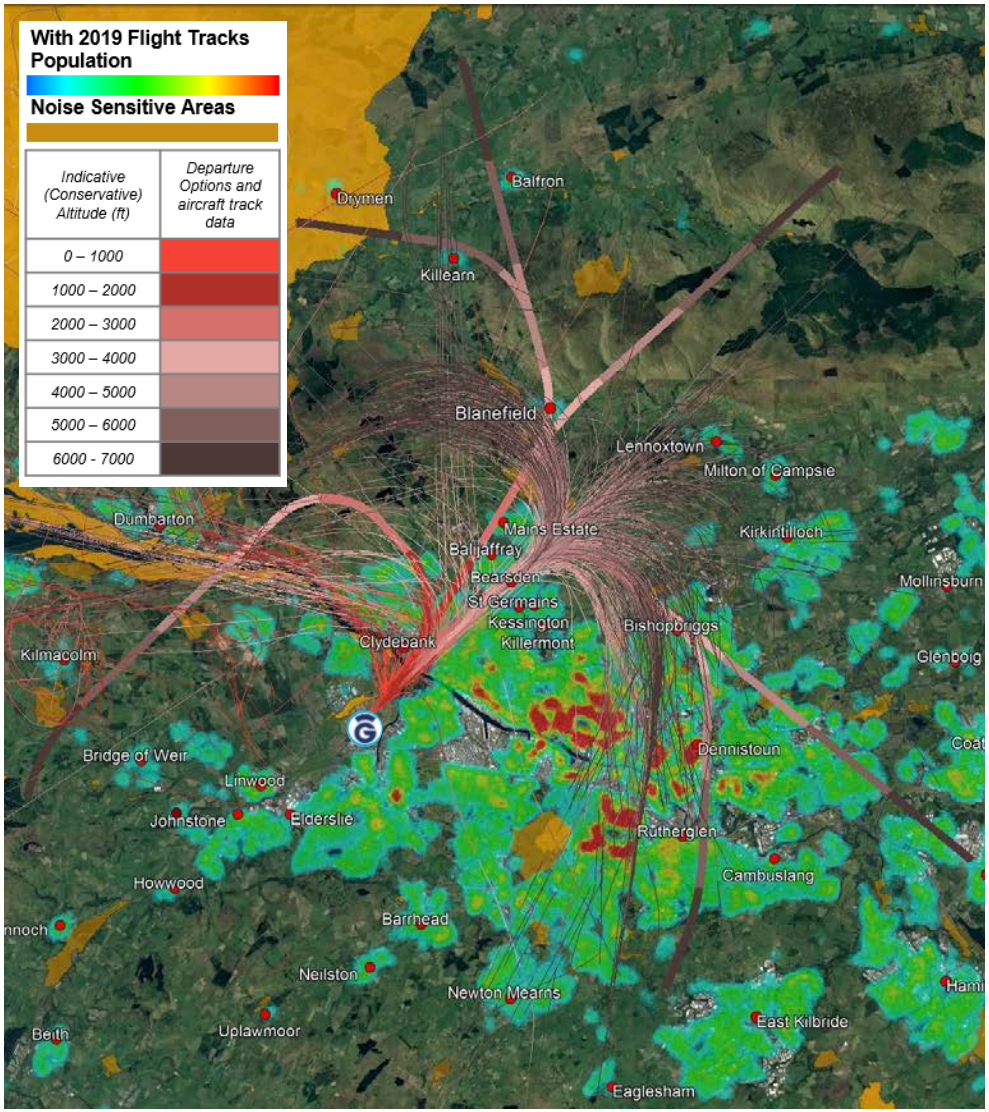
Runway 05 Departure Option B



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option B





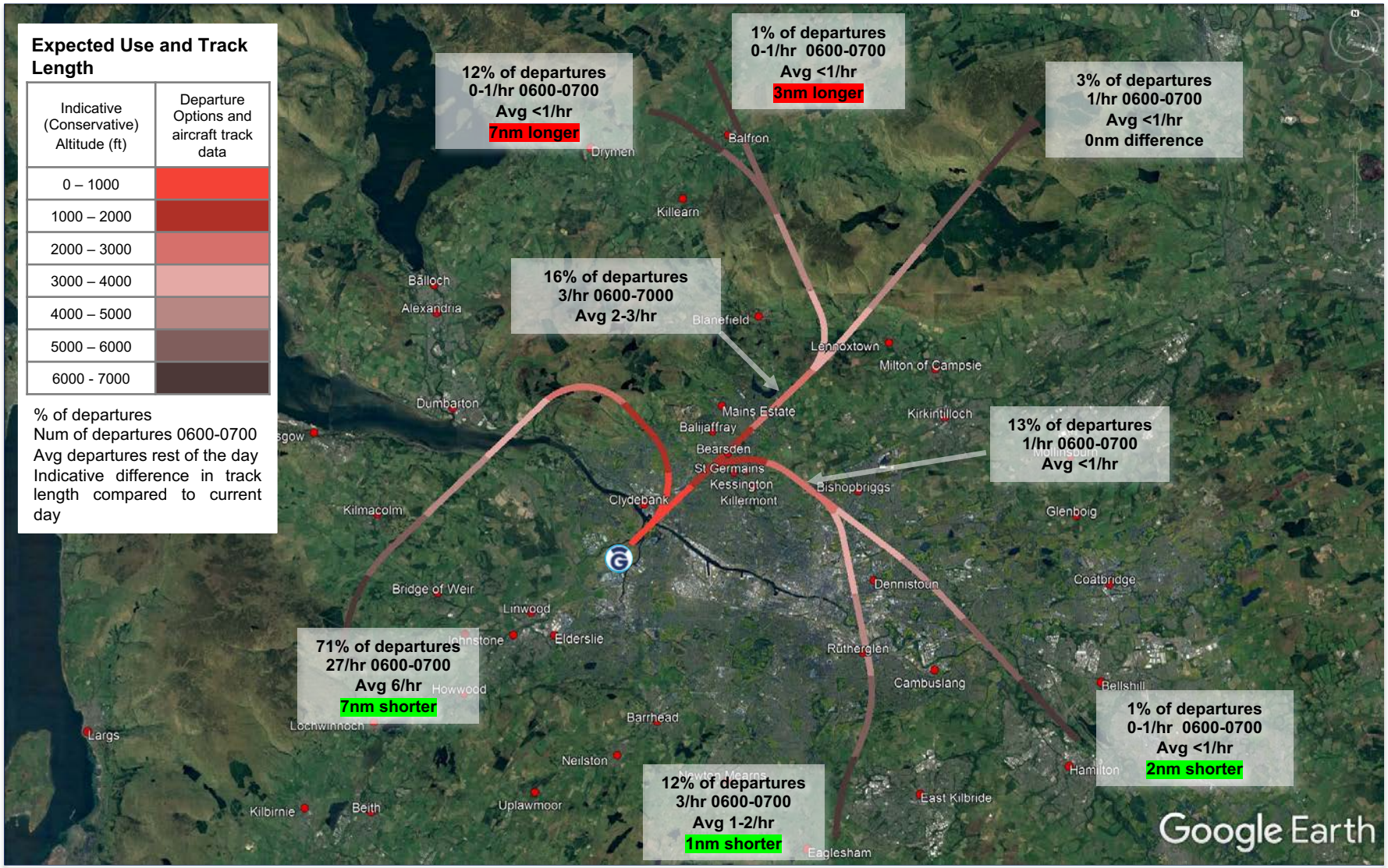
Runway 05 Departure Option C

Straight ahead departures only (no offsets) with turns at 1nm, 3nm and 6nm from the runway.

NORBO is offset left with turn at 1nm

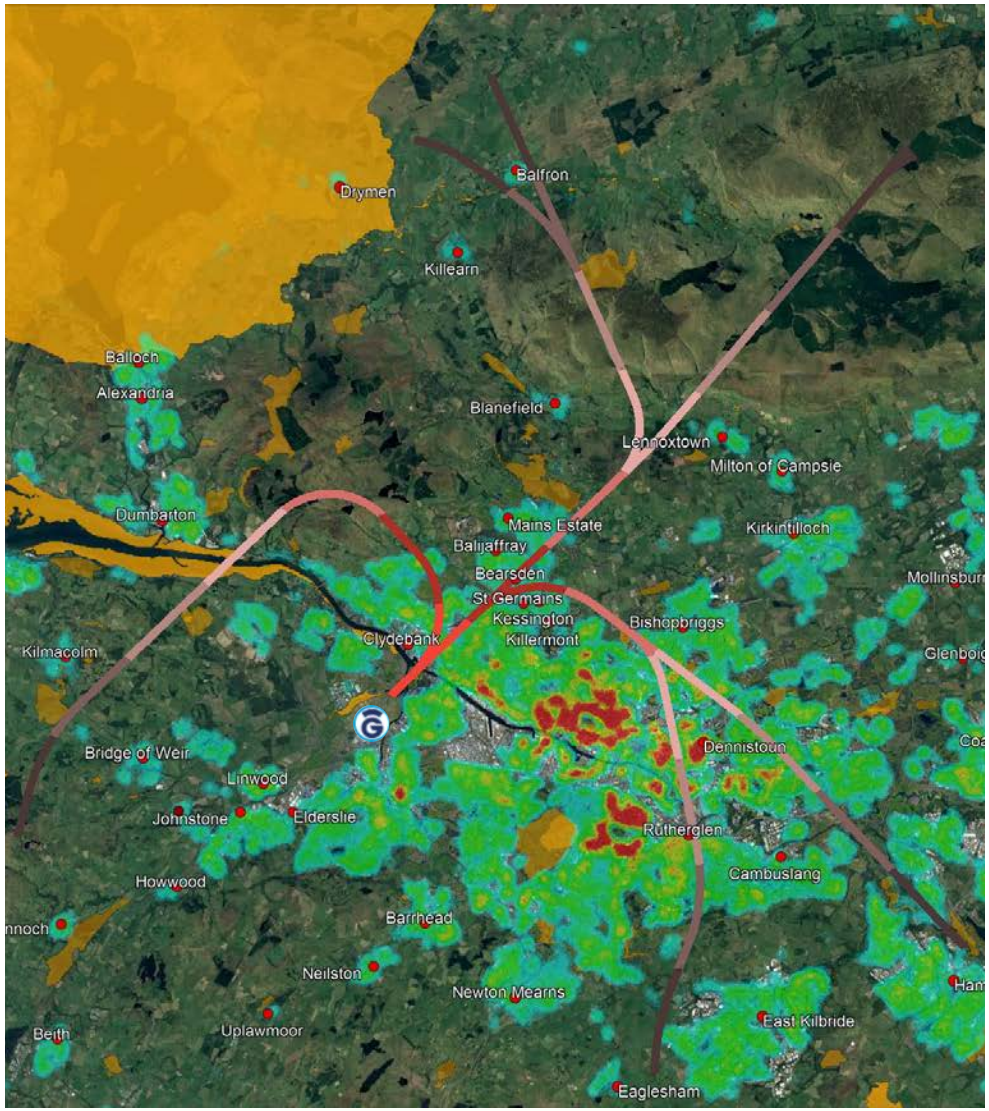
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

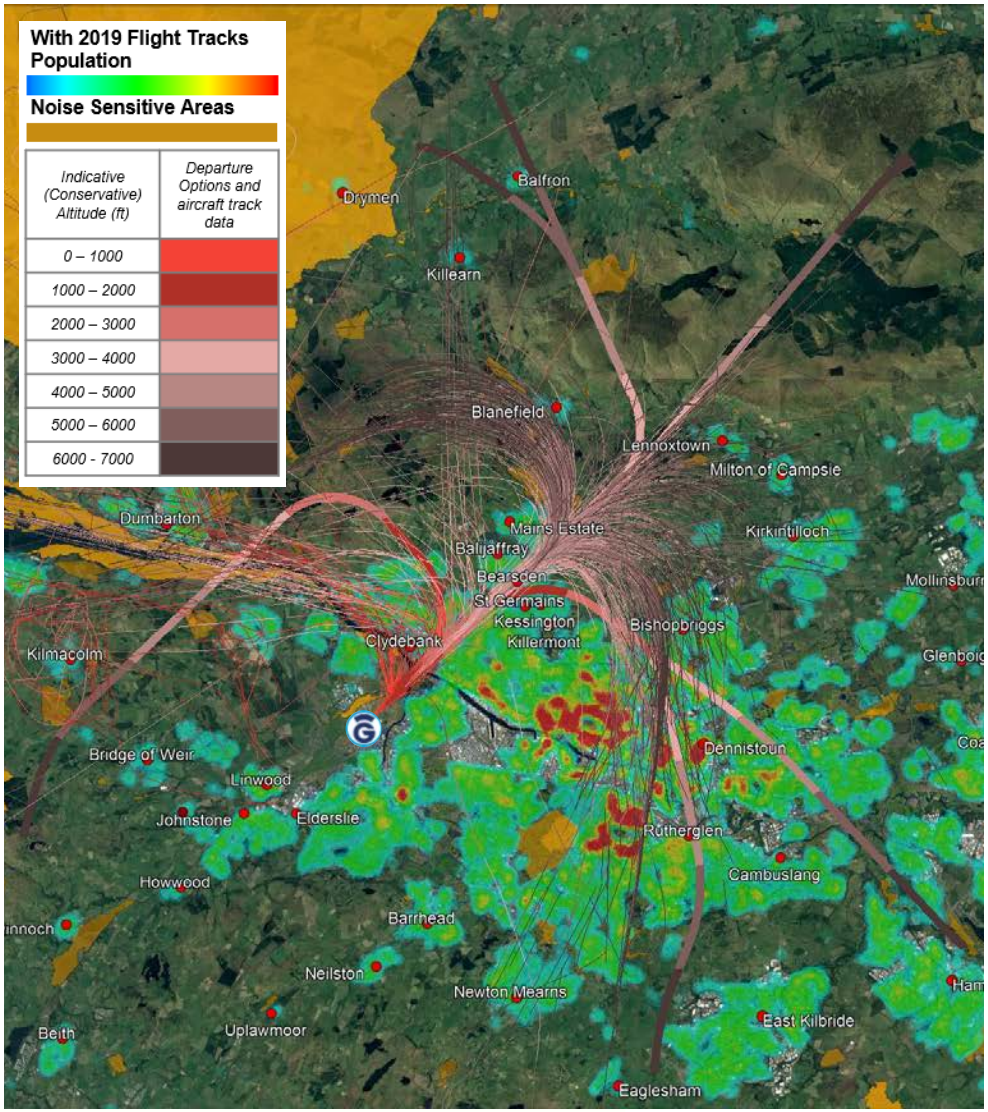
Runway 05 Departure Option C



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option C





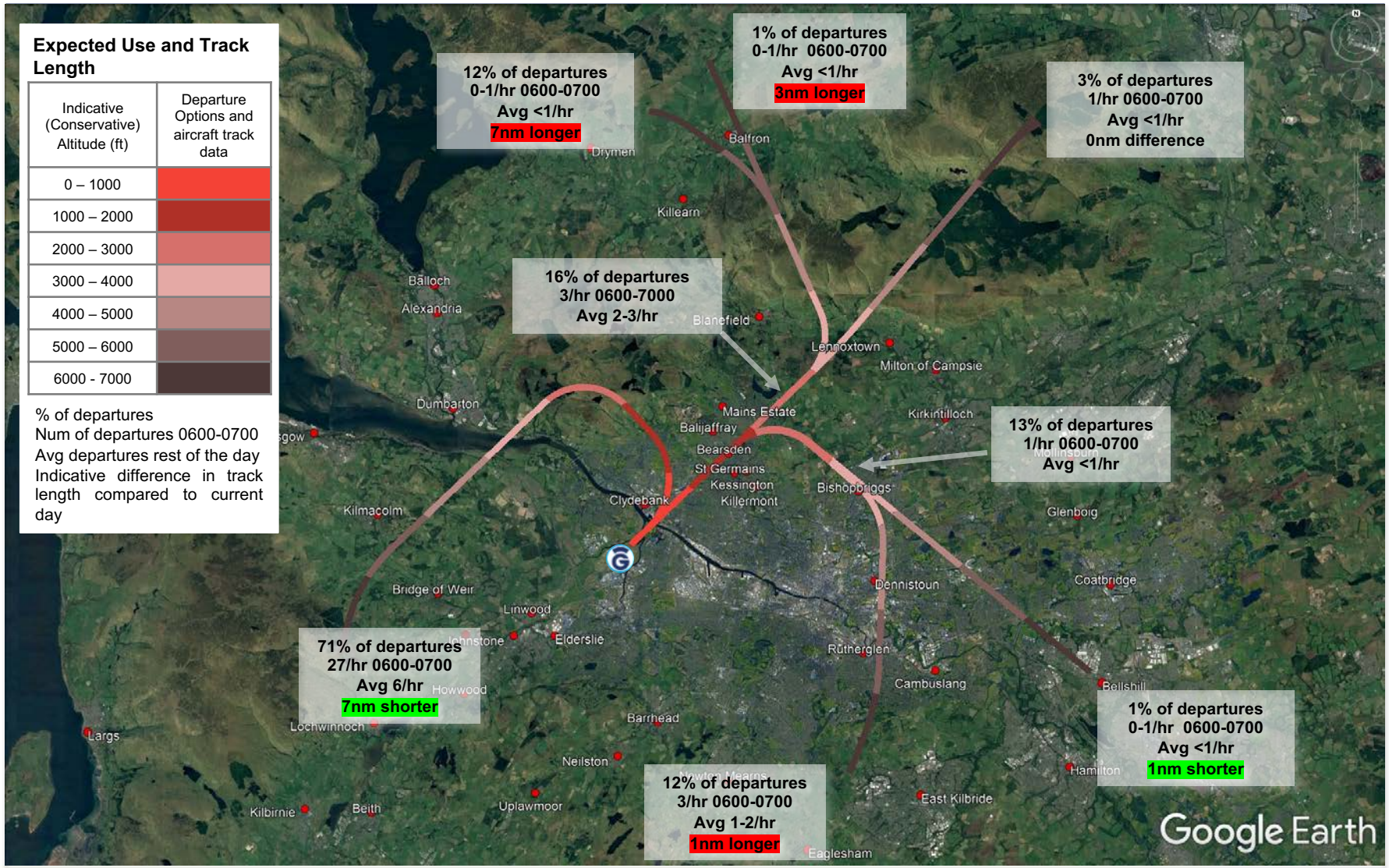
Runway 05 Departure Option D

Straight ahead departures only (no offsets) with turns at 1nm, 4nm and 6nm from the runway

NORBO is offset left with turn at 1nm

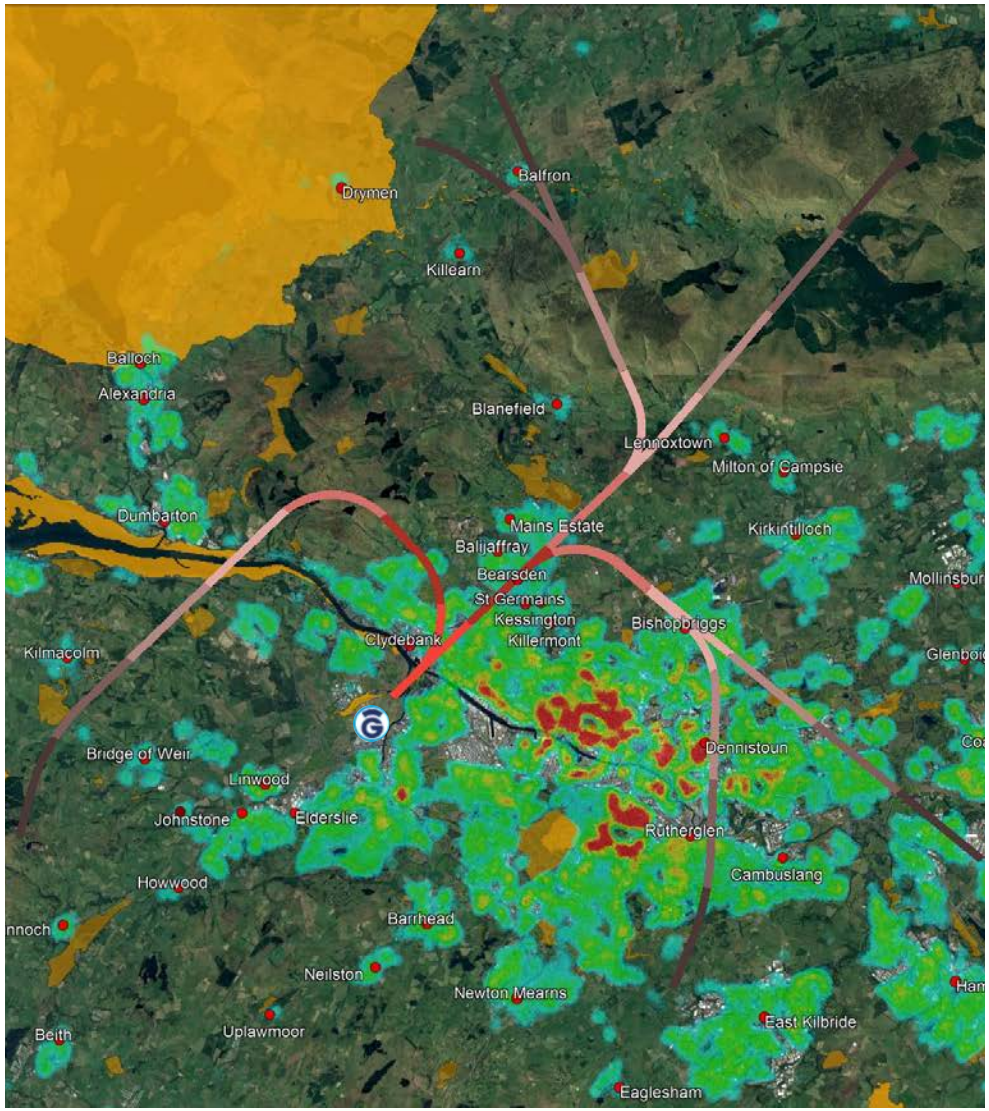
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

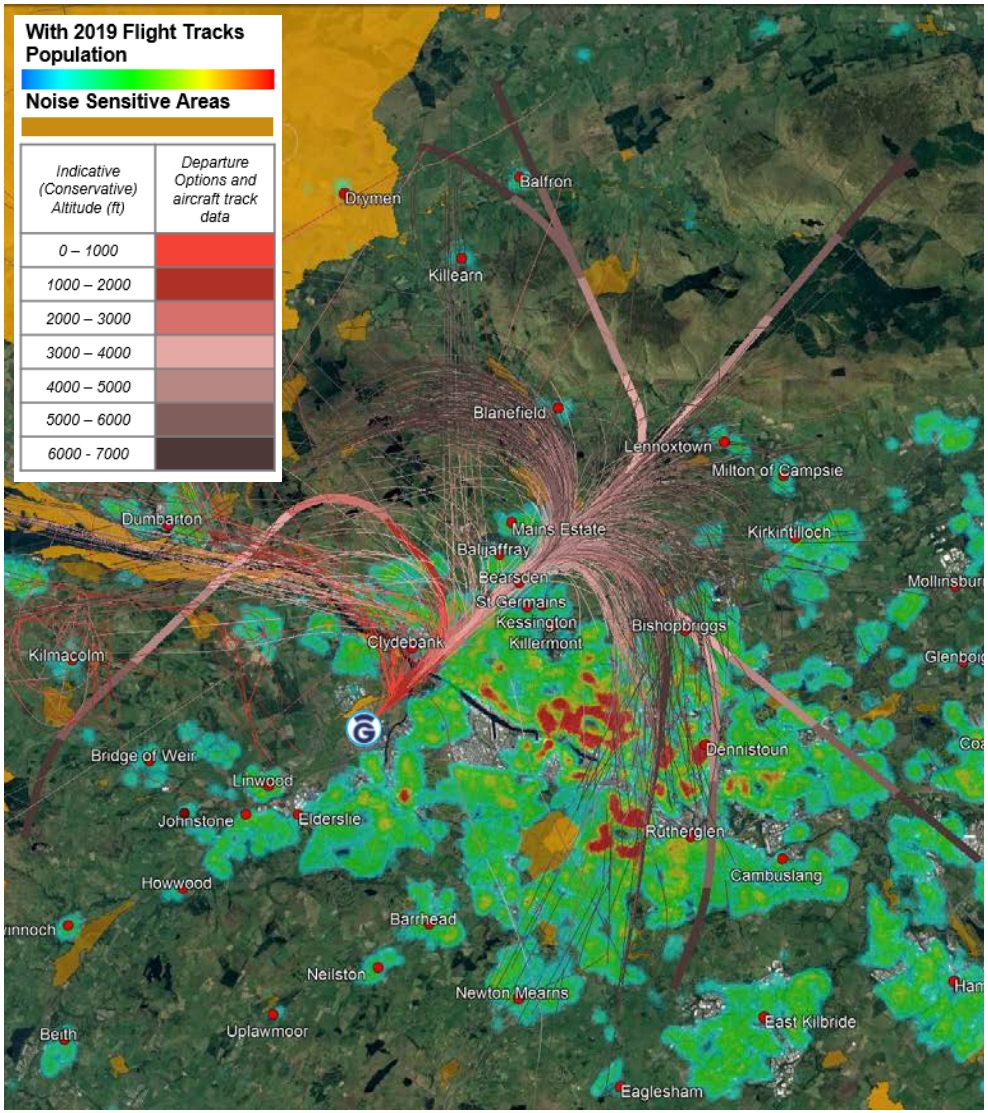
Runway 05 Departure Option D



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option D





Runway 05 Departure Option E

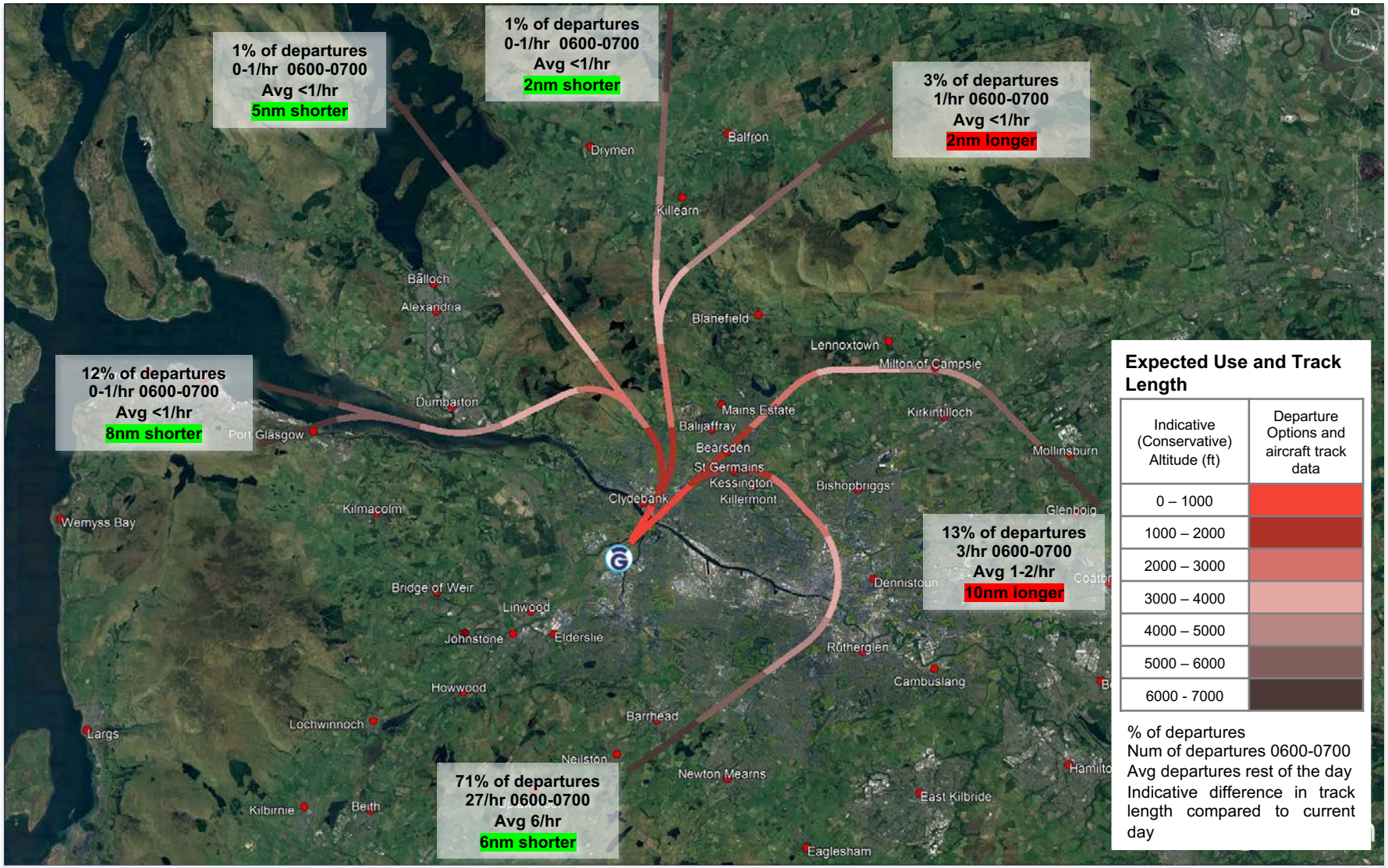
Offset left departures with turns at 1nm from the runway.

Straight ahead departures with turns at 2nm and 6.5nm from the runway.

NORBO is straight ahead to 2nm with a right turn.

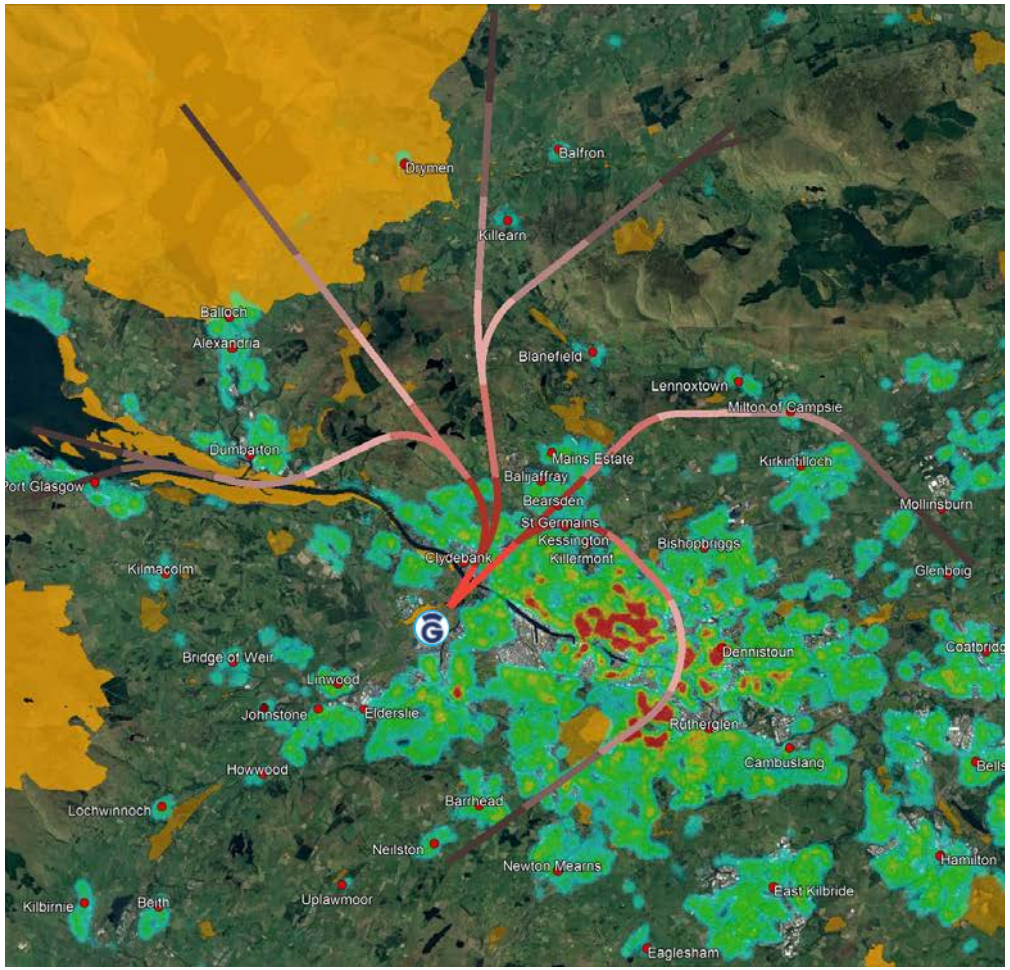
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

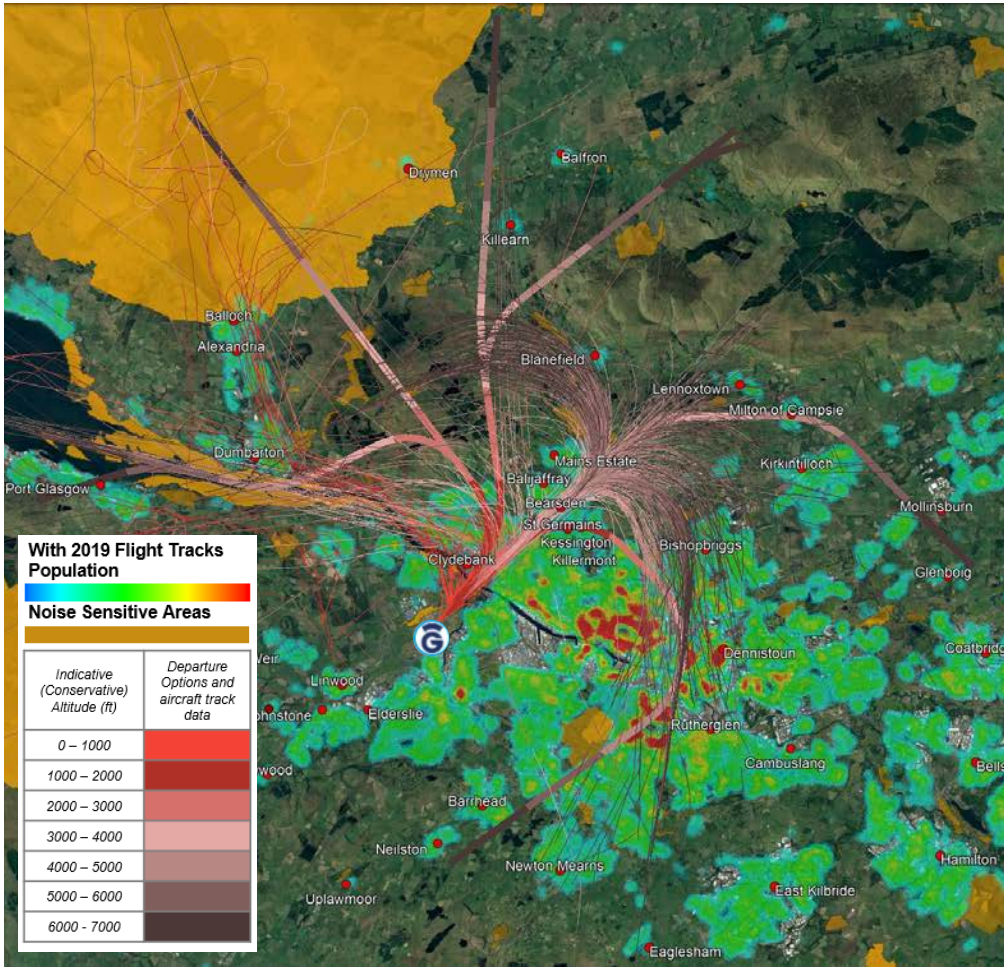
Runway 05 Departure Option E



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option E





Runway 05 Departure Option F (Split Left and Right)

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.

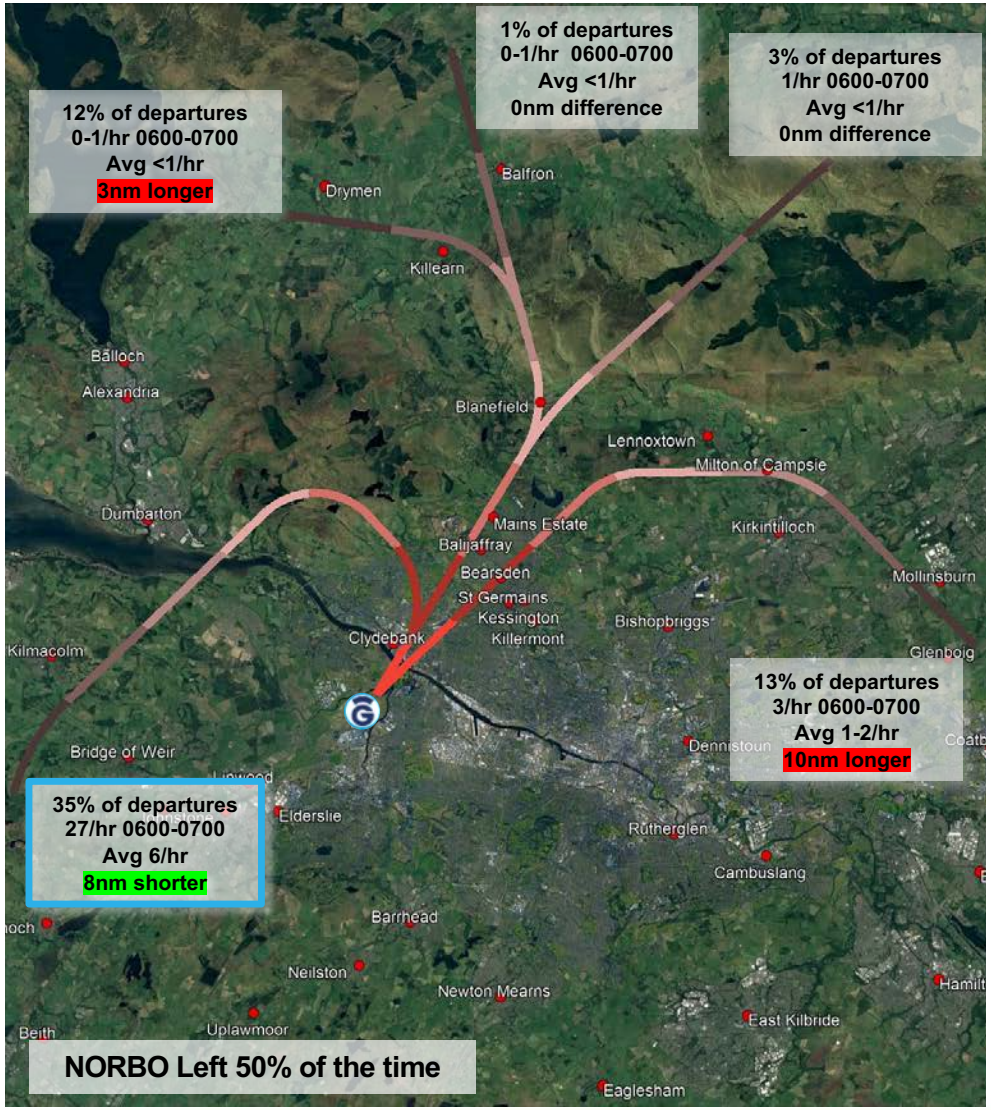
When turning left, the NORBO would offset left then turn further left at 1nm

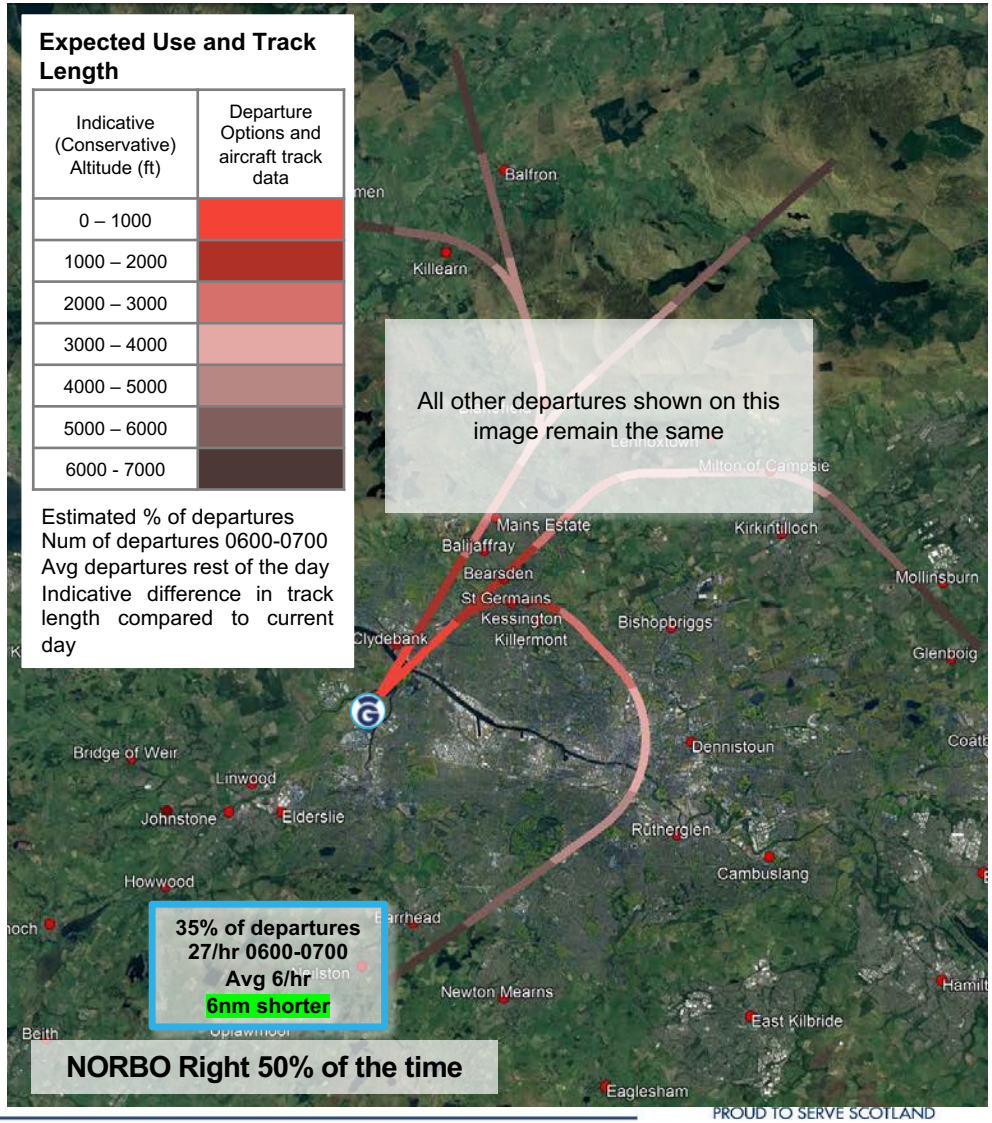
When turning right, the NORBO would go straight ahead to 2nm then a right turn

Assumes the NORBO route switches at a point each day/night to enable a 50/50 route utilisation.

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

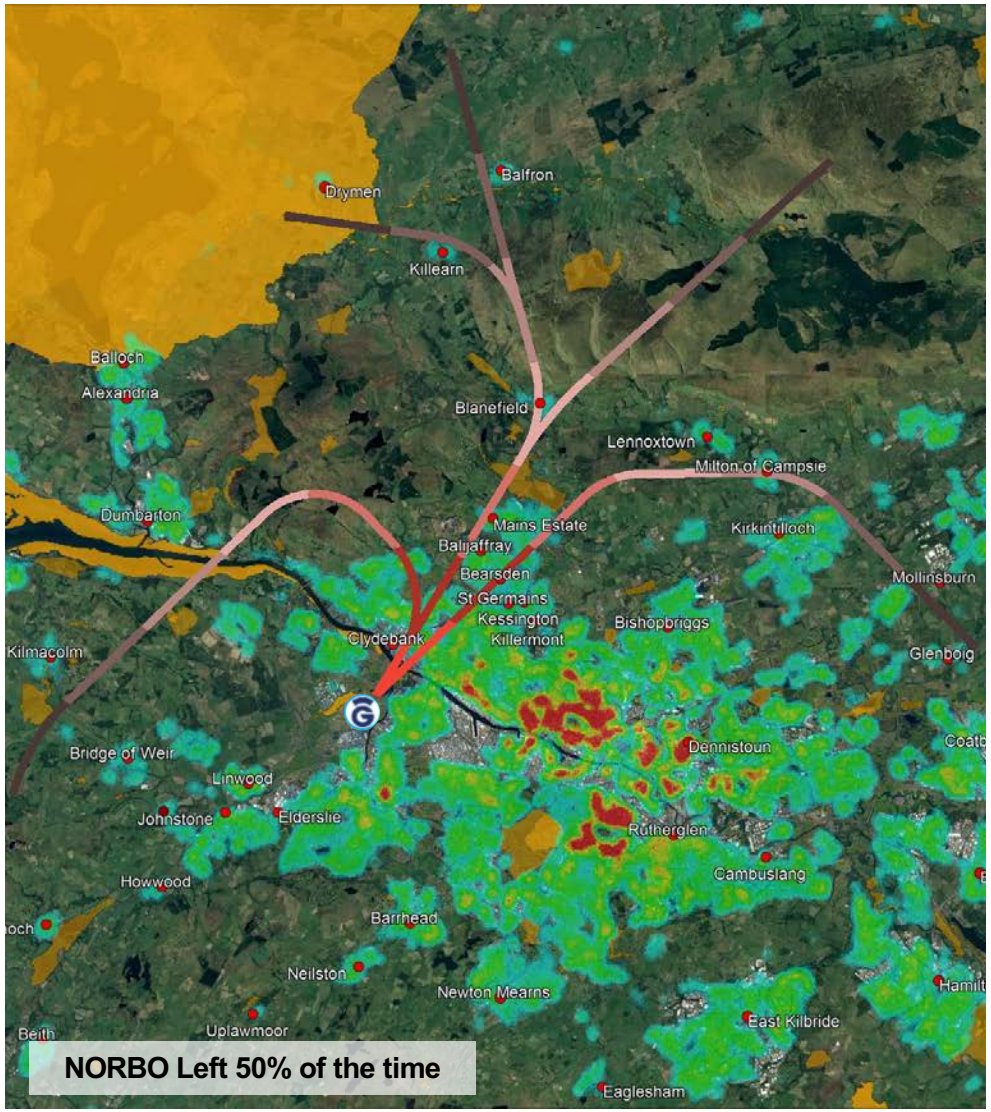
Runway 05 Departure Option F (Departures to the south split to go left or right)

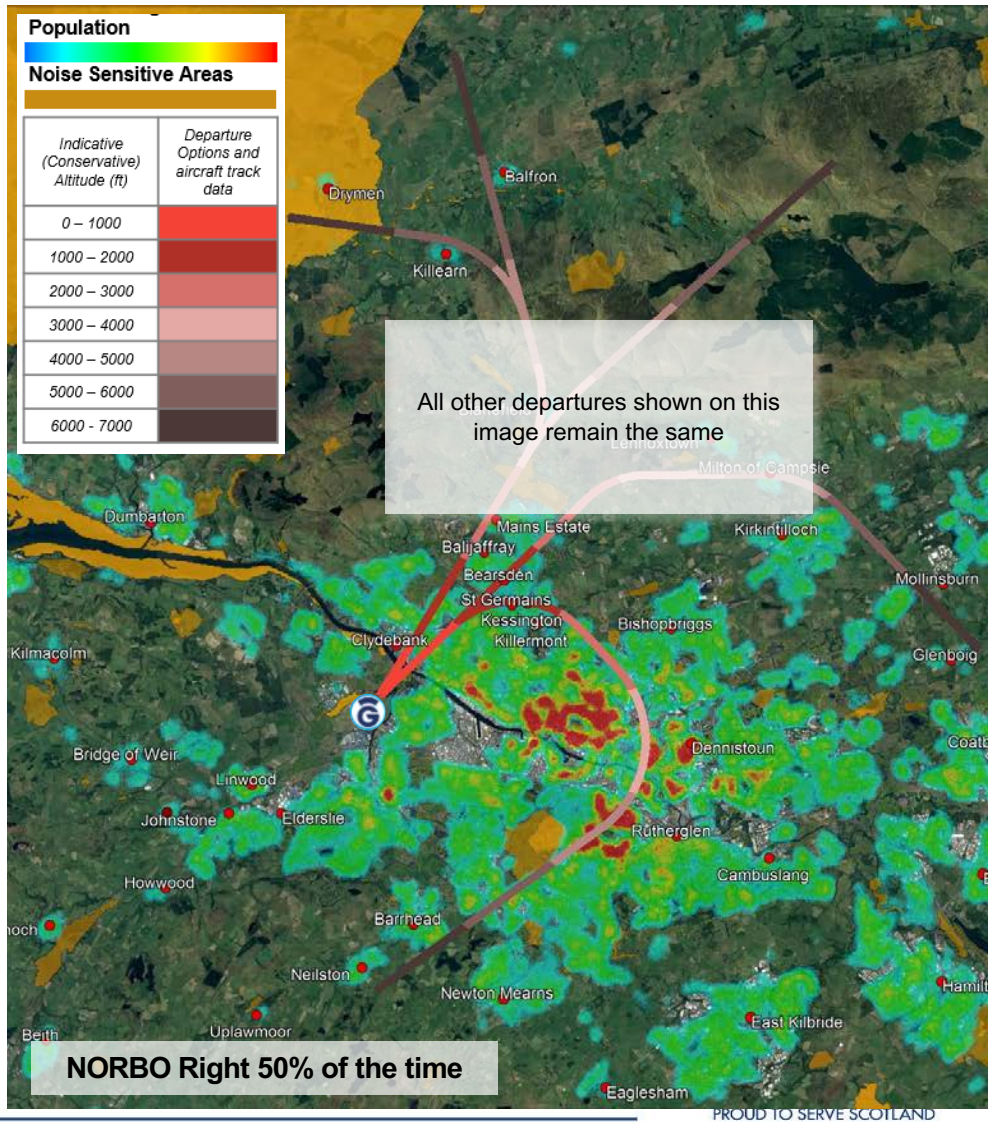




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

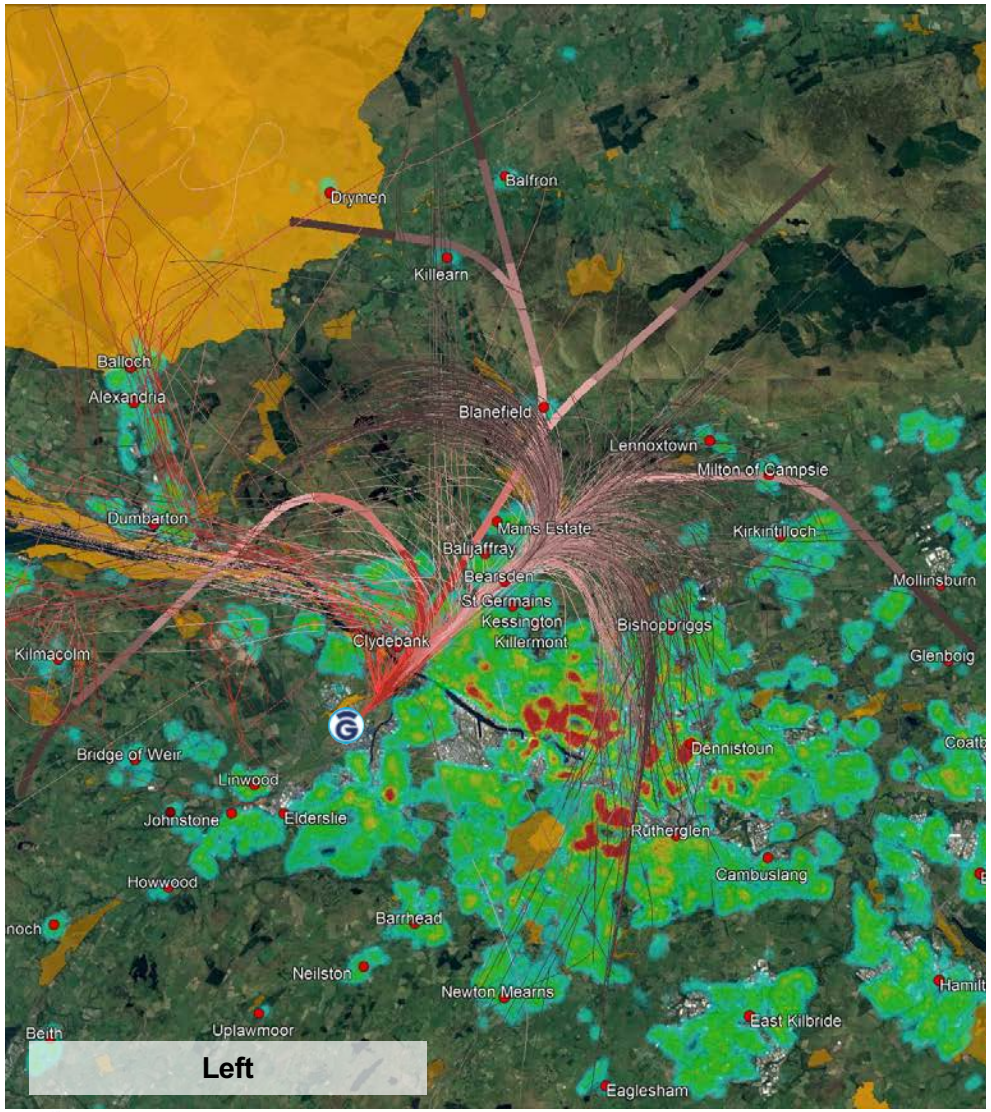
Runway 05 Departure Option F

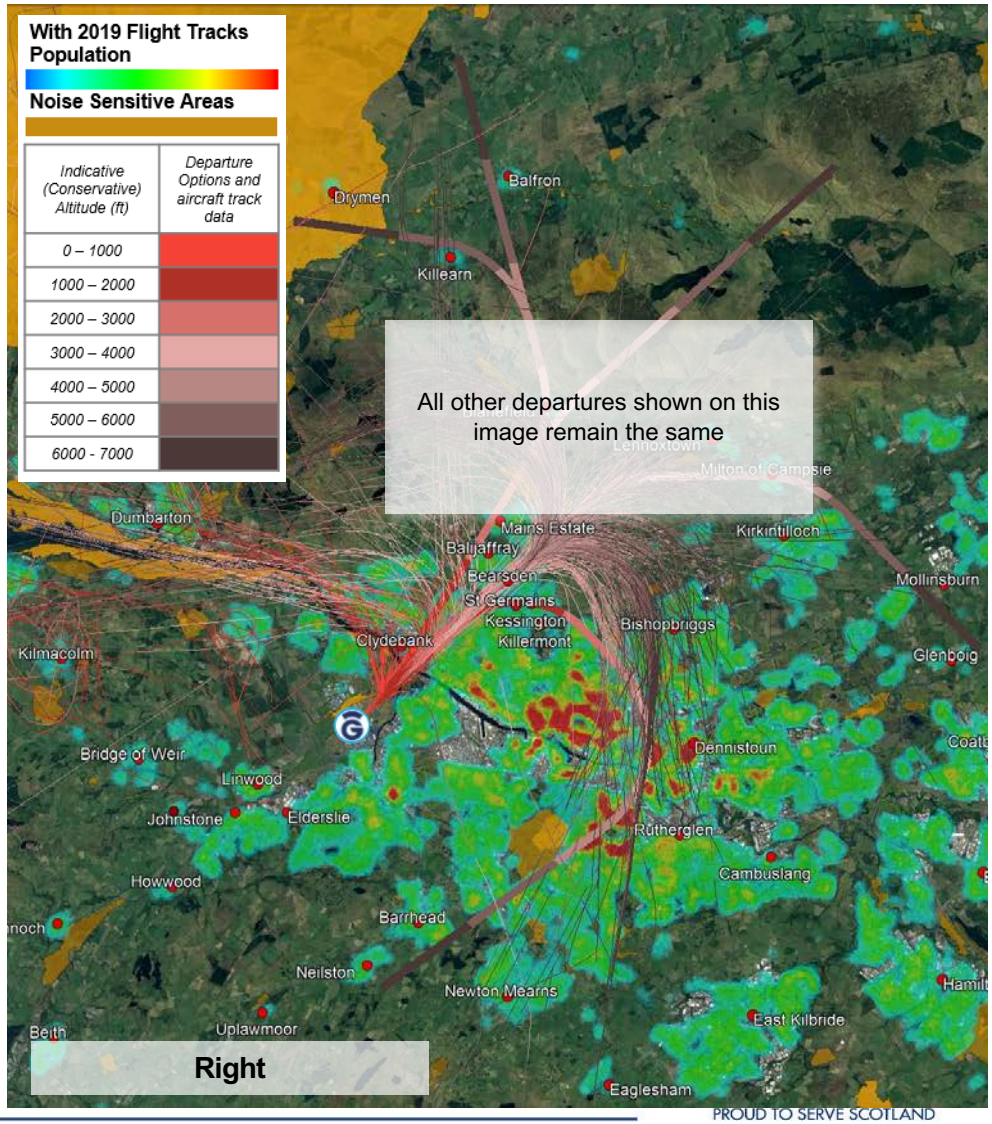




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES

Runway 05 Departure Option F:





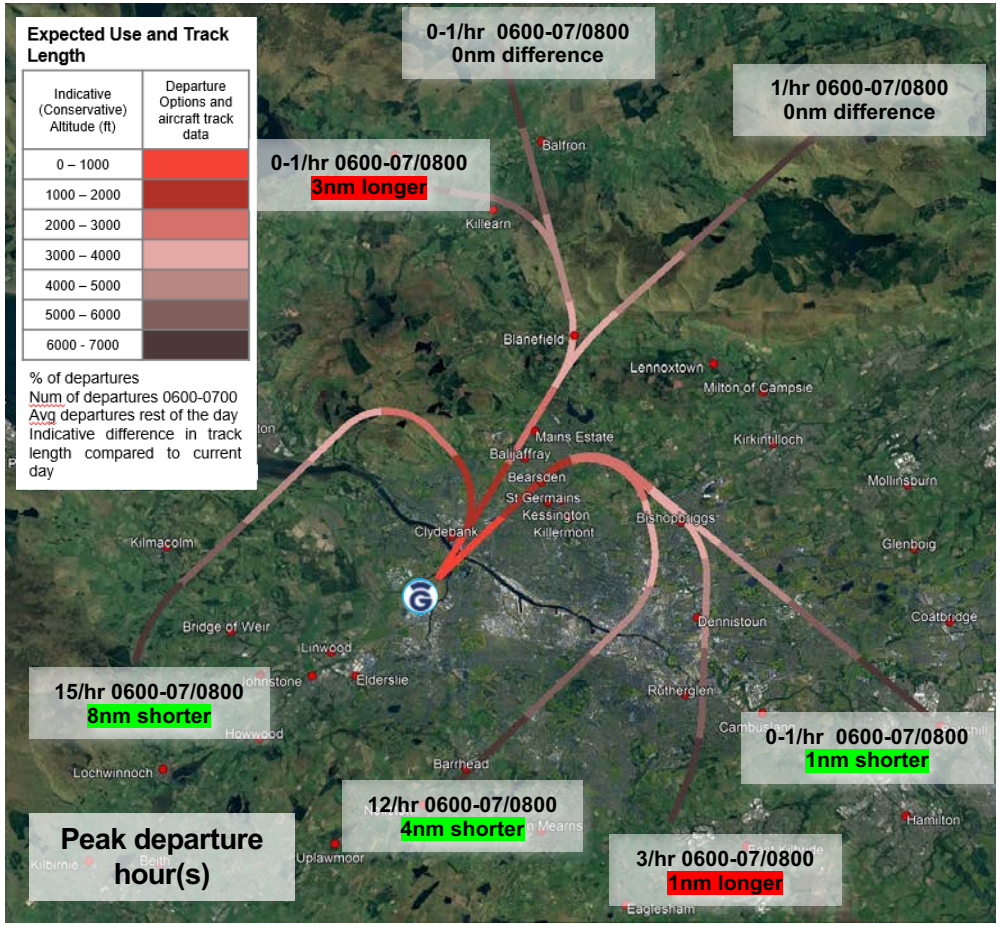
Runway 05 Departure Option G (Period 1 and Period 2)

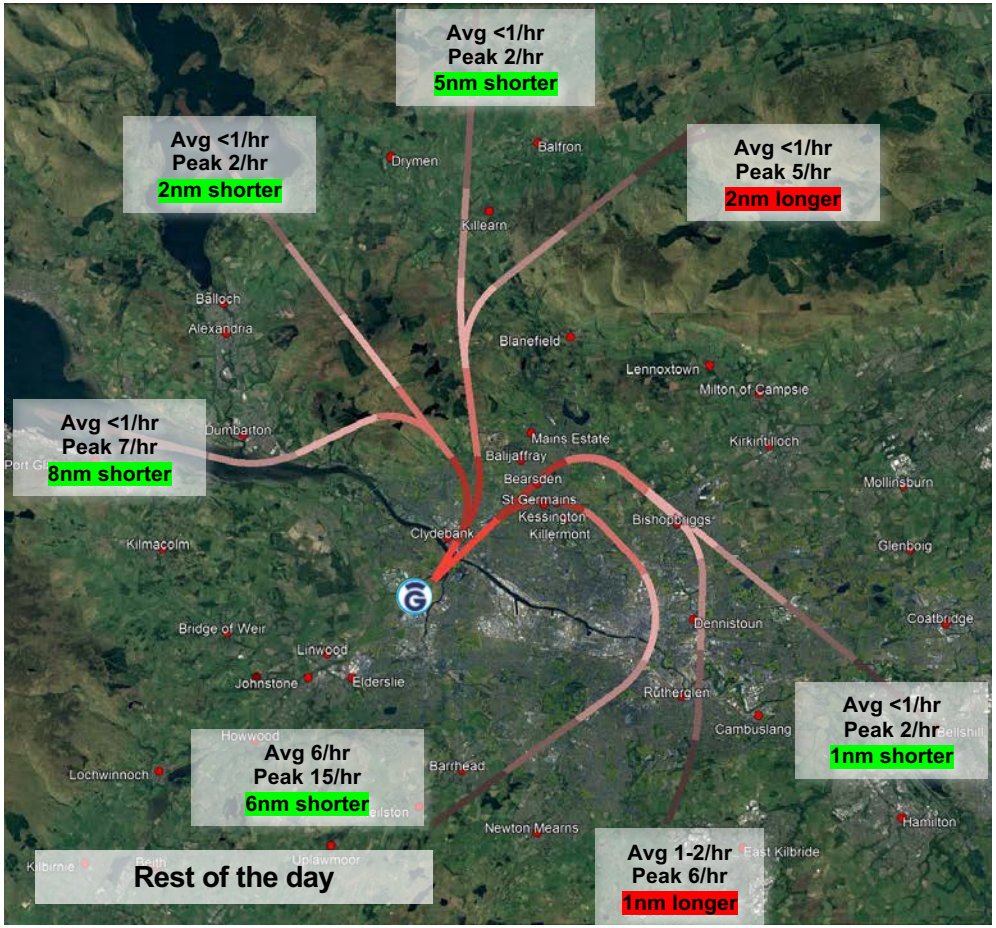
This option has two, quite different route configurations and assumes one configuration would be used for the peak departure period each morning. The configuration would then switch for the rest of the day.

In the morning, the NORBO traffic is shared between a left turn departure and a right turn departure with both routes available at the same time.

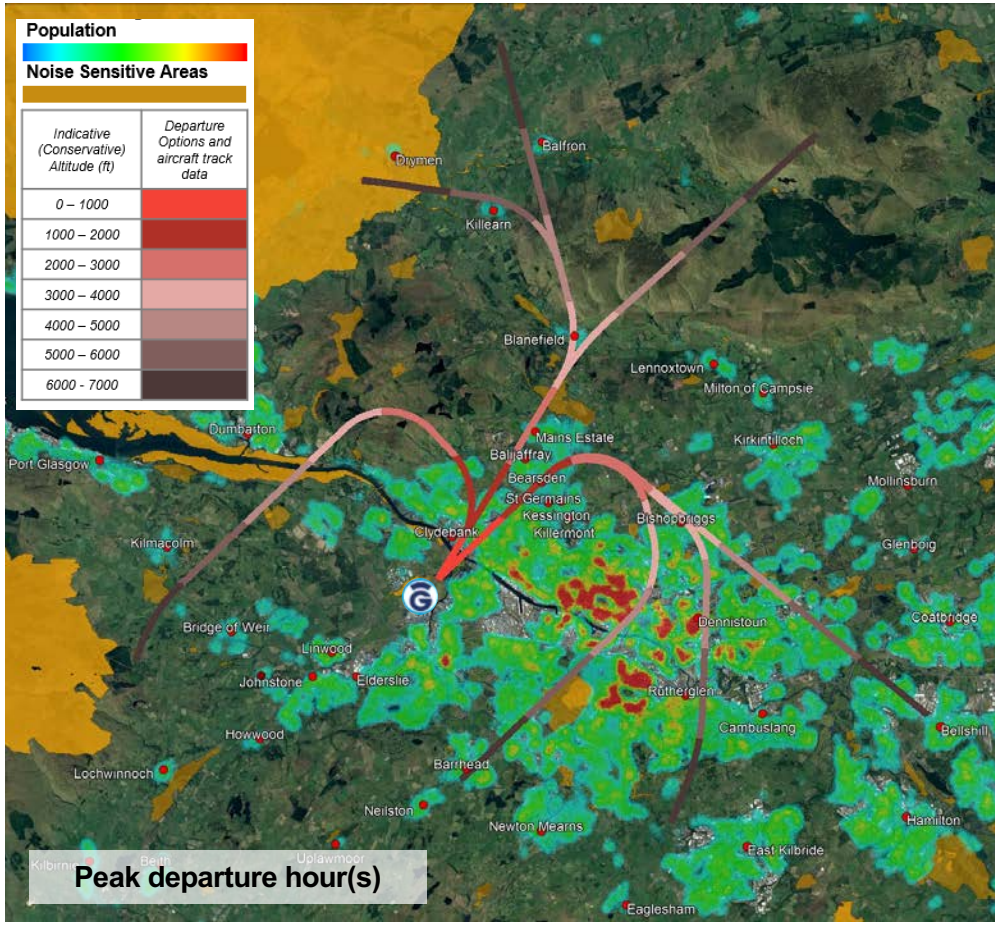
For the rest of the day, all the NORBO traffic would then use a single flight path turning right, but that path could be different to the one used for the morning.

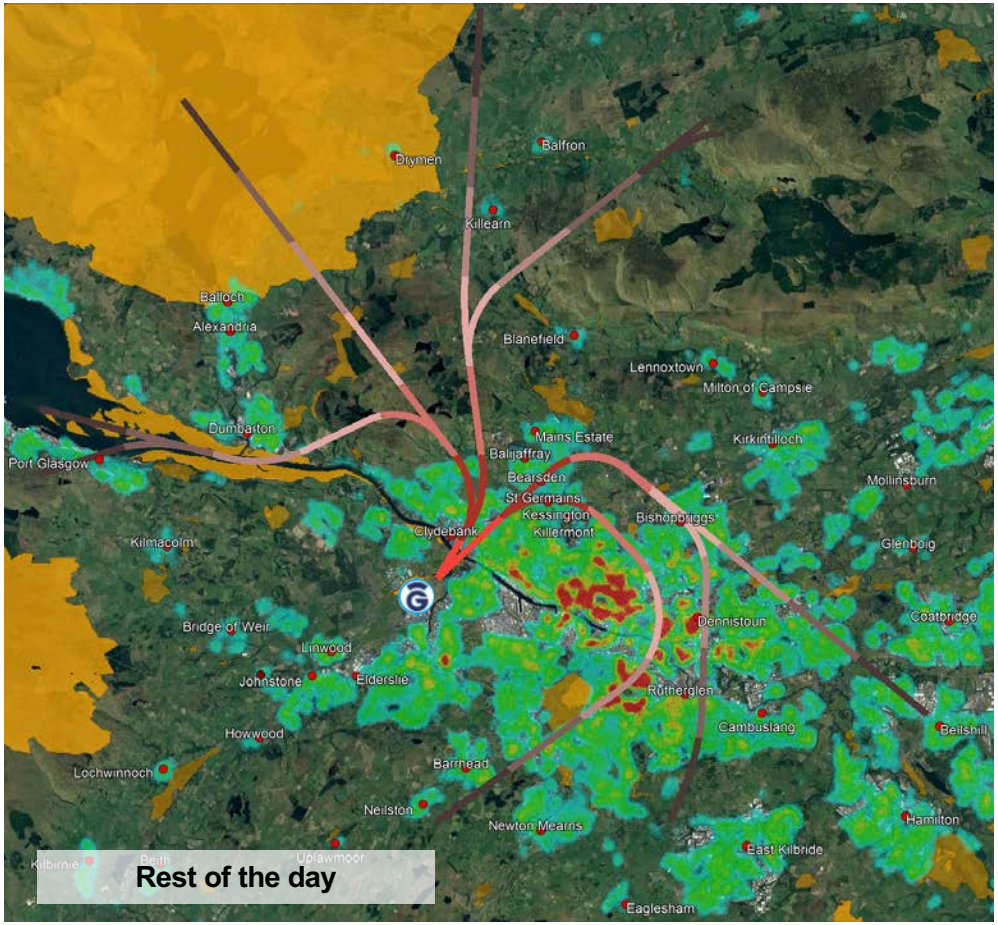
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES



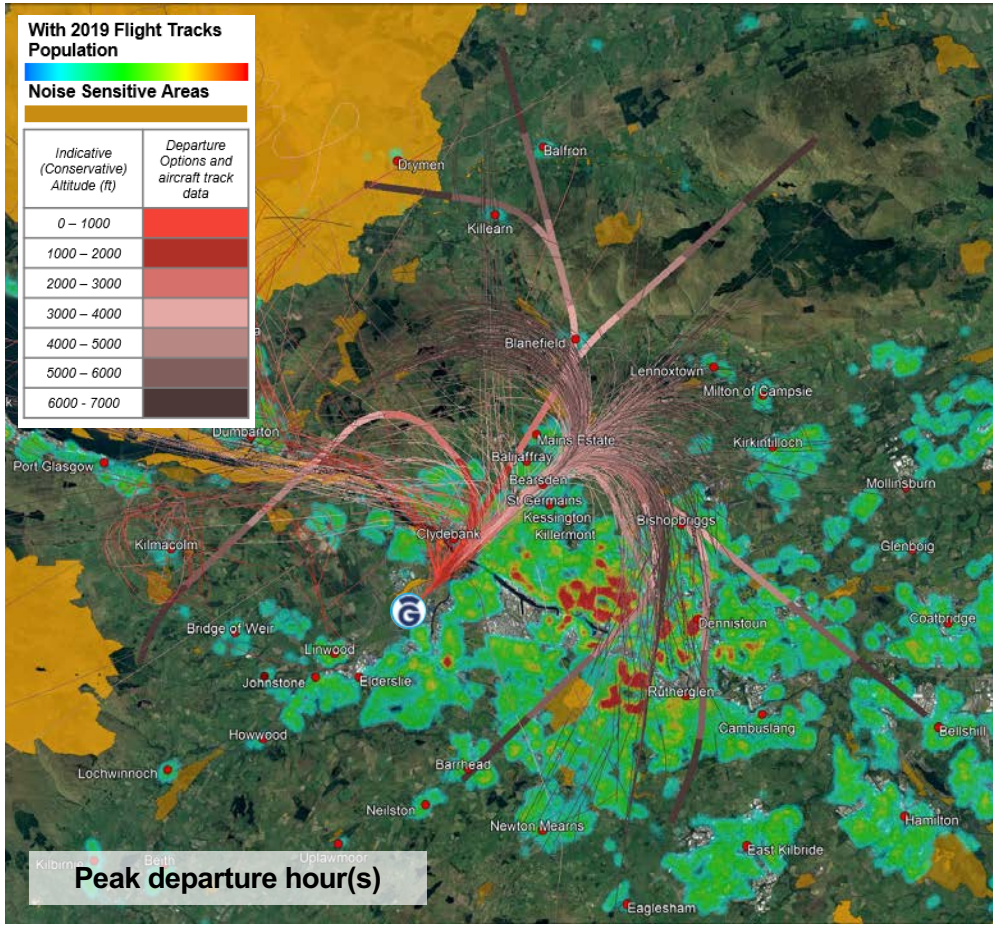


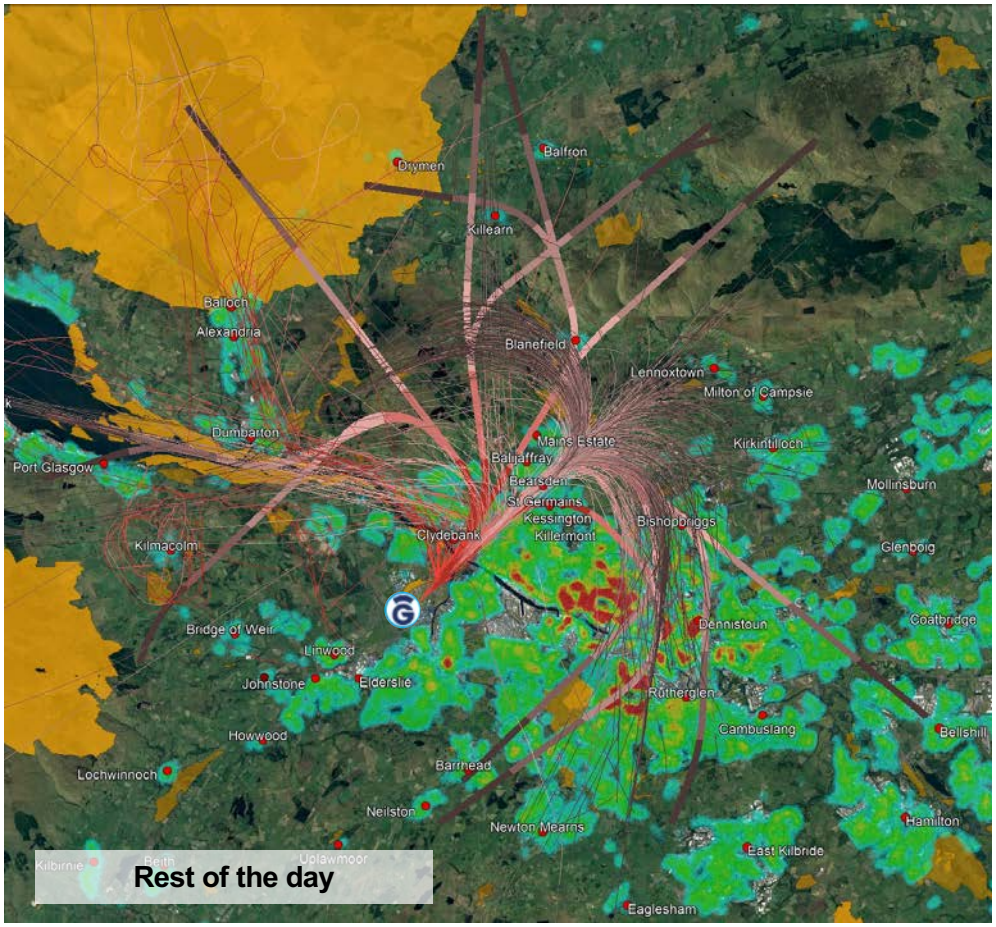
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES





4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 05 DEPARTURES





Runway 23 Departure Option A

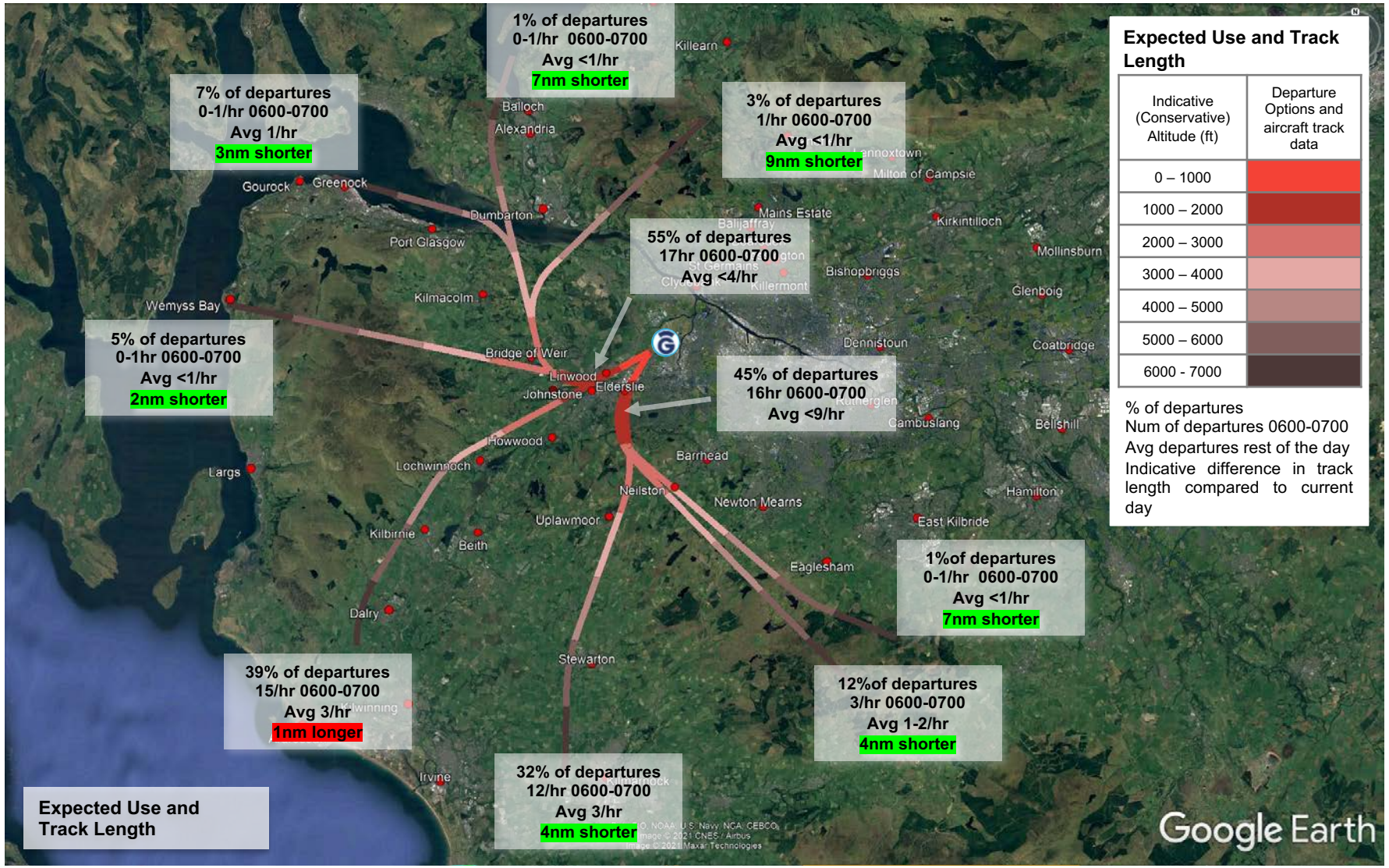
Offset right departures with turns at 2nm and 7nm from the runway.

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.

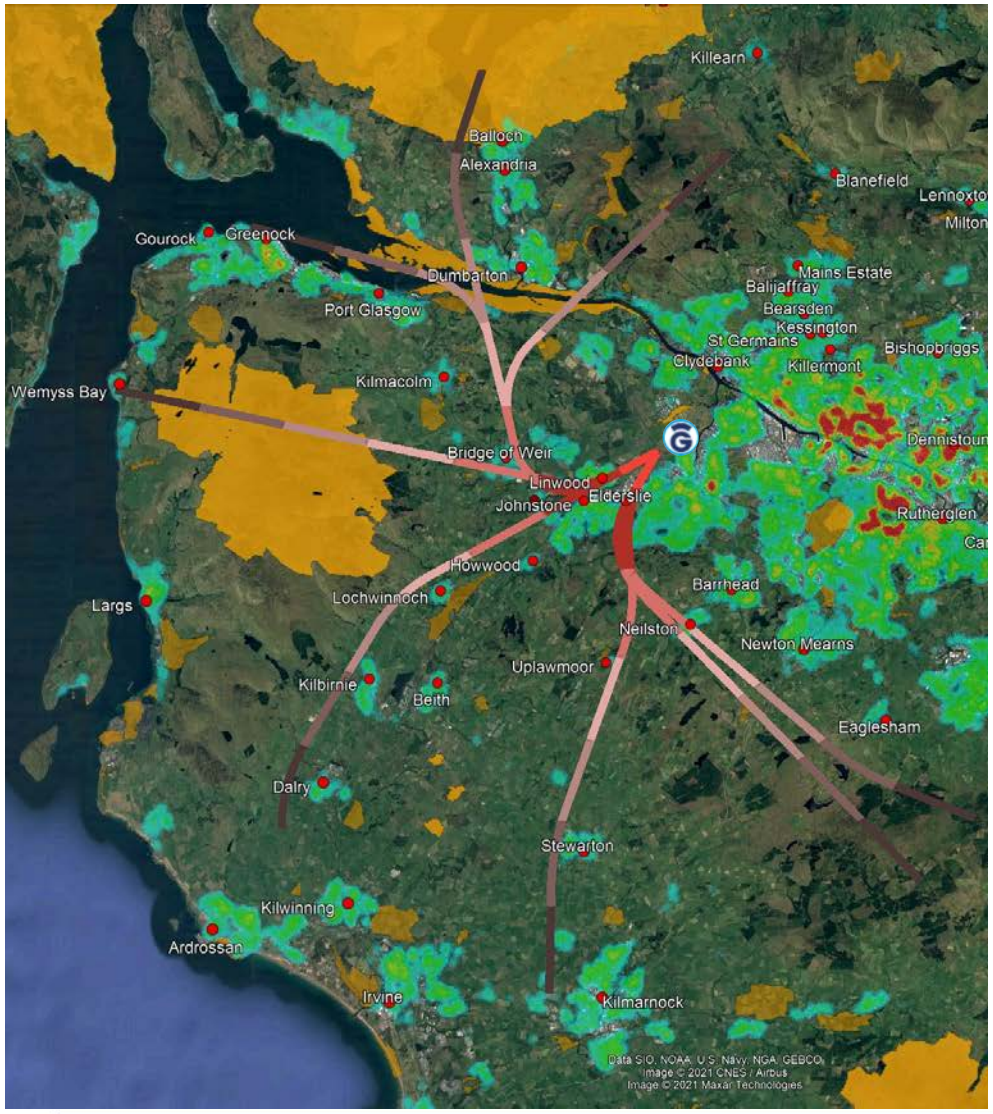
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

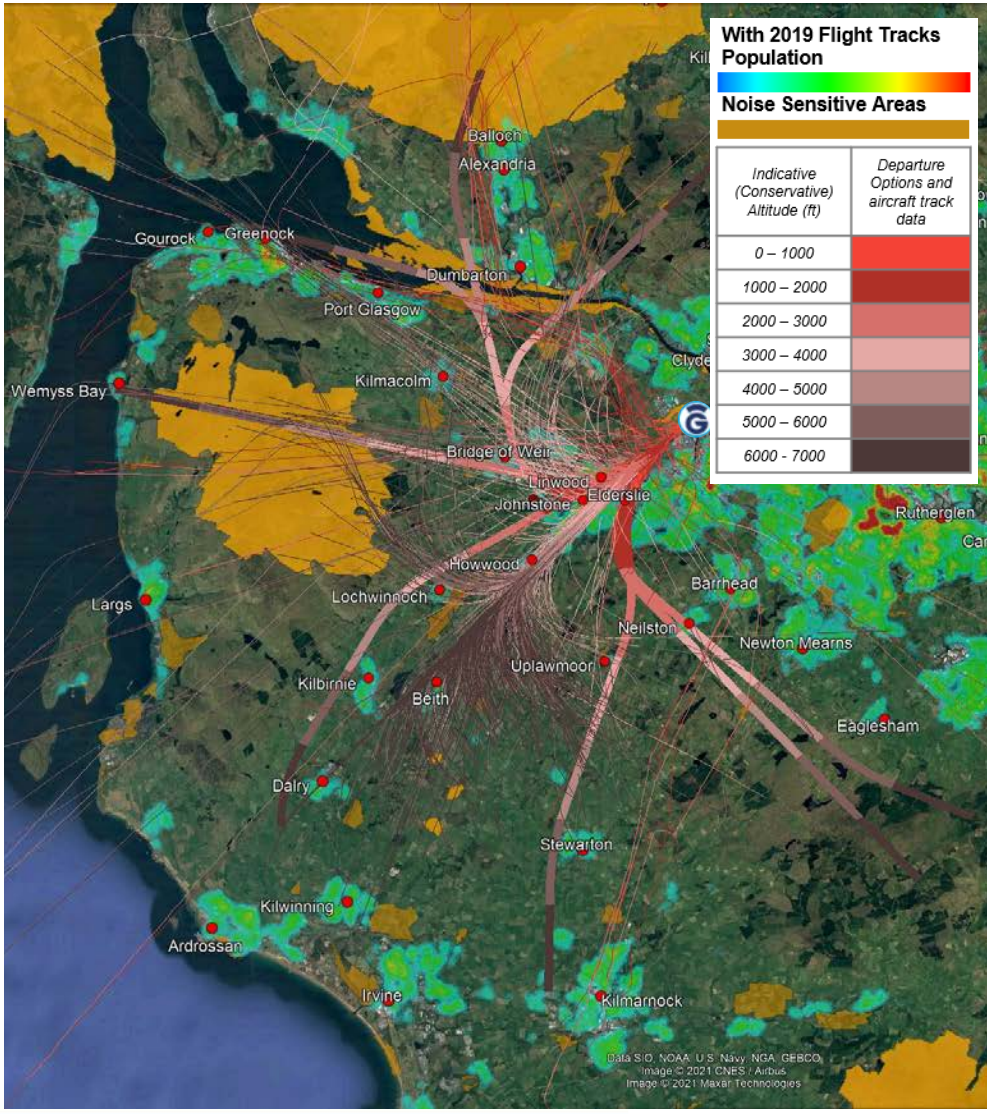
Runway 23 Departure Option A



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option A





Runway 23 Departure Option B

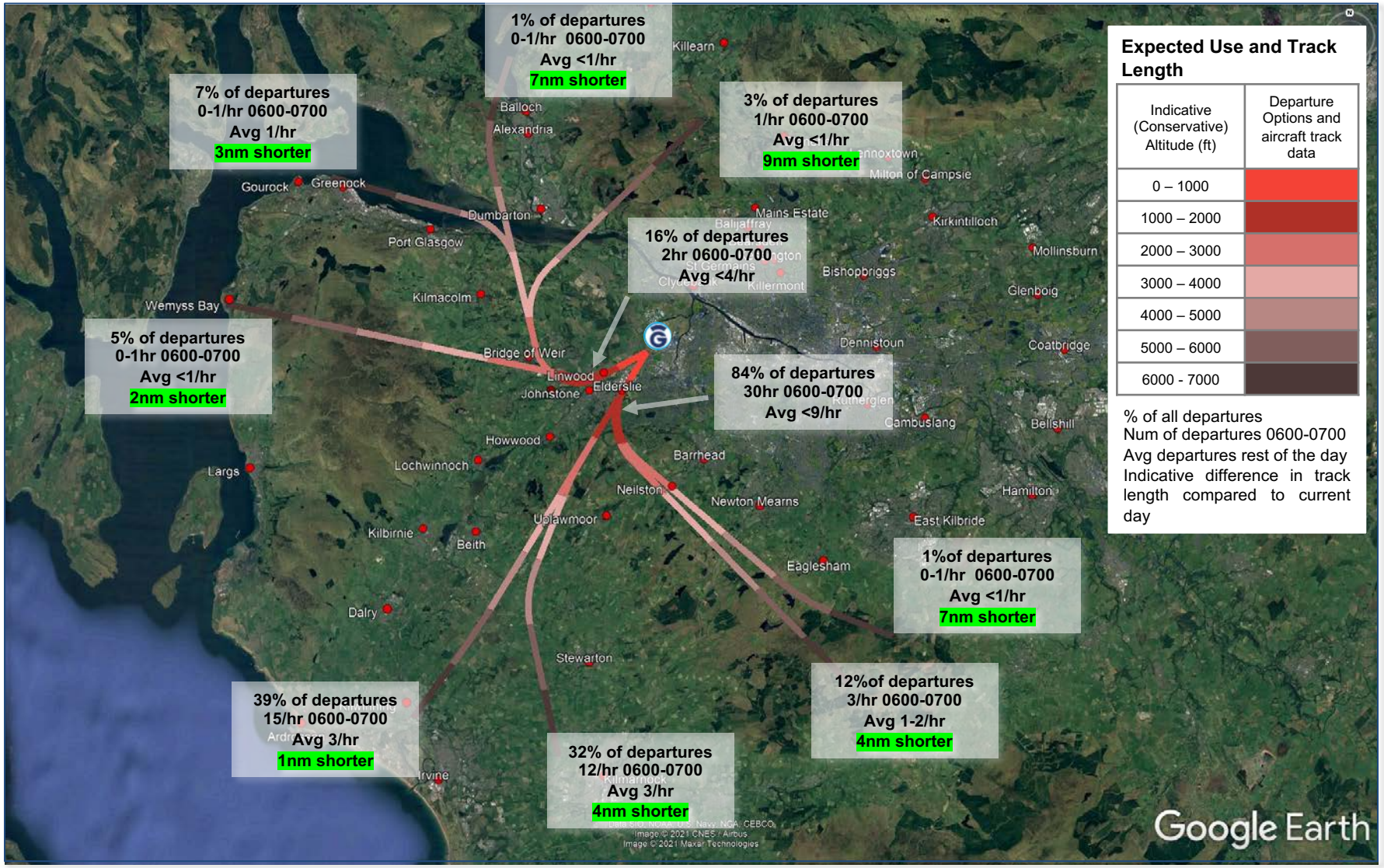
Offset right departures with turns at 2nm from the runway.

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.

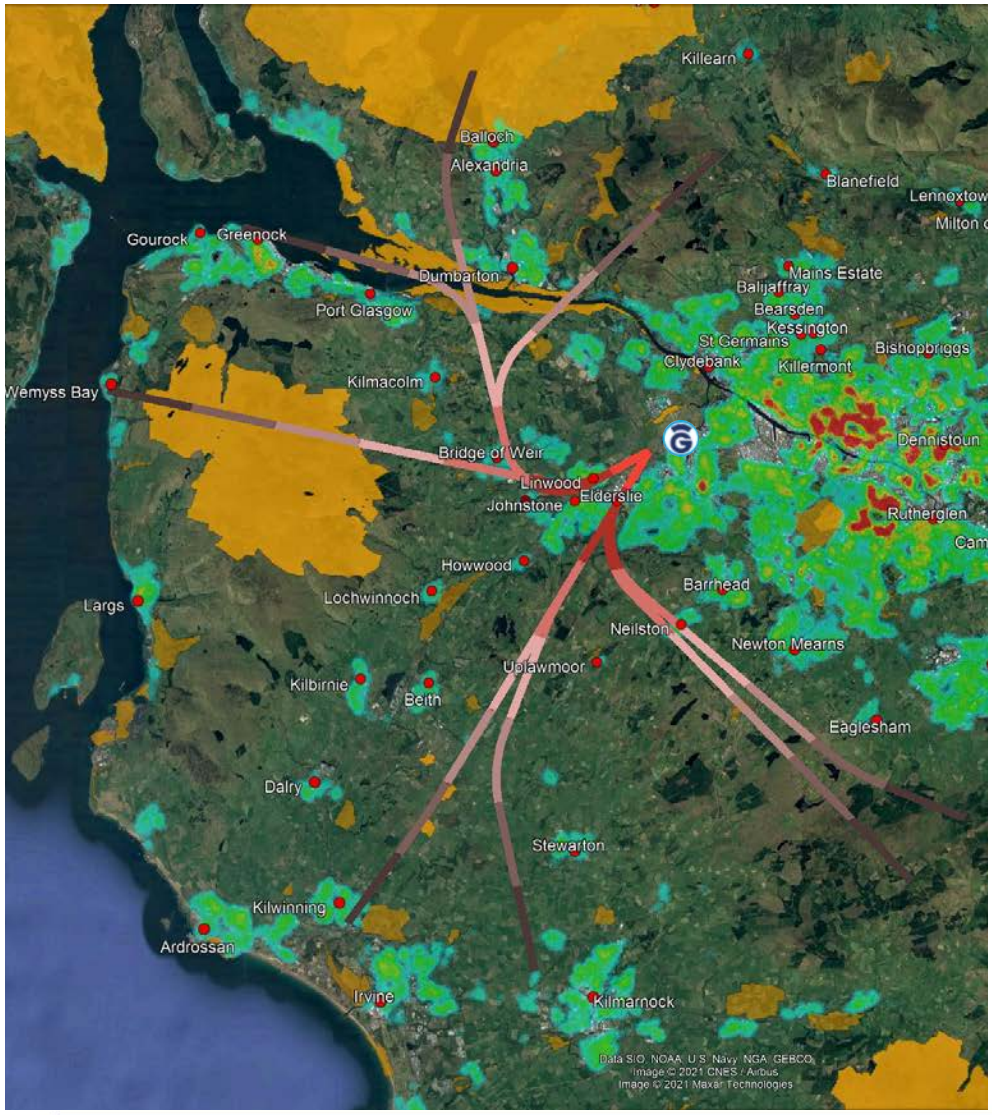
4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

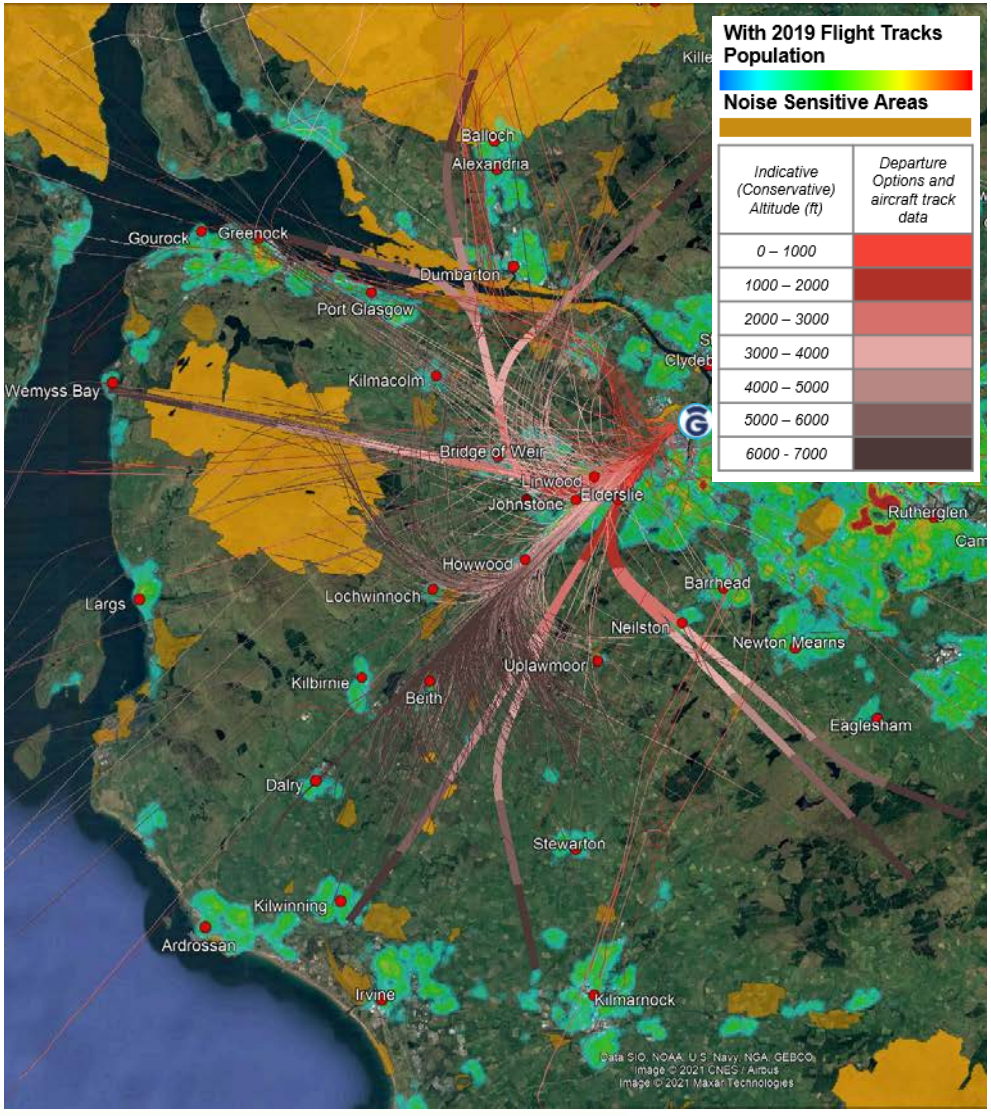
Runway 23 Departure Option B



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option B





Runway 23 Departure Option C

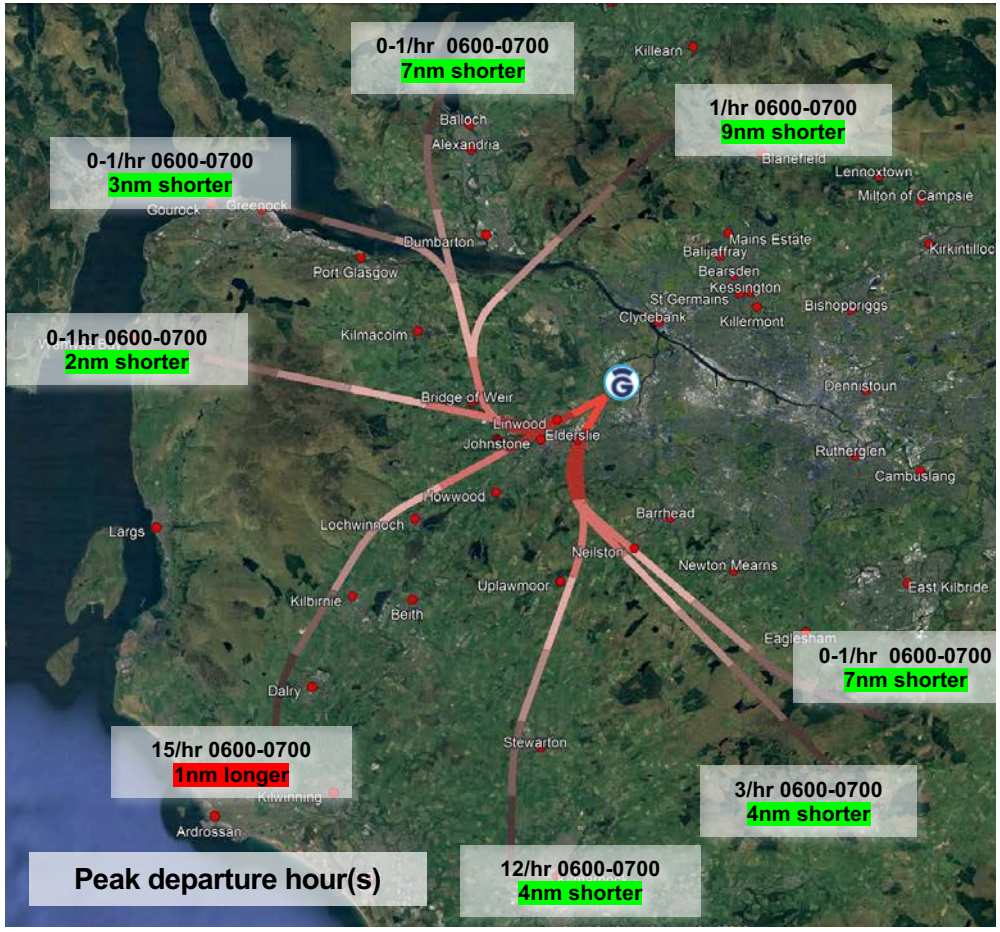
This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period each morning. The configuration would then switch for the rest of the day.

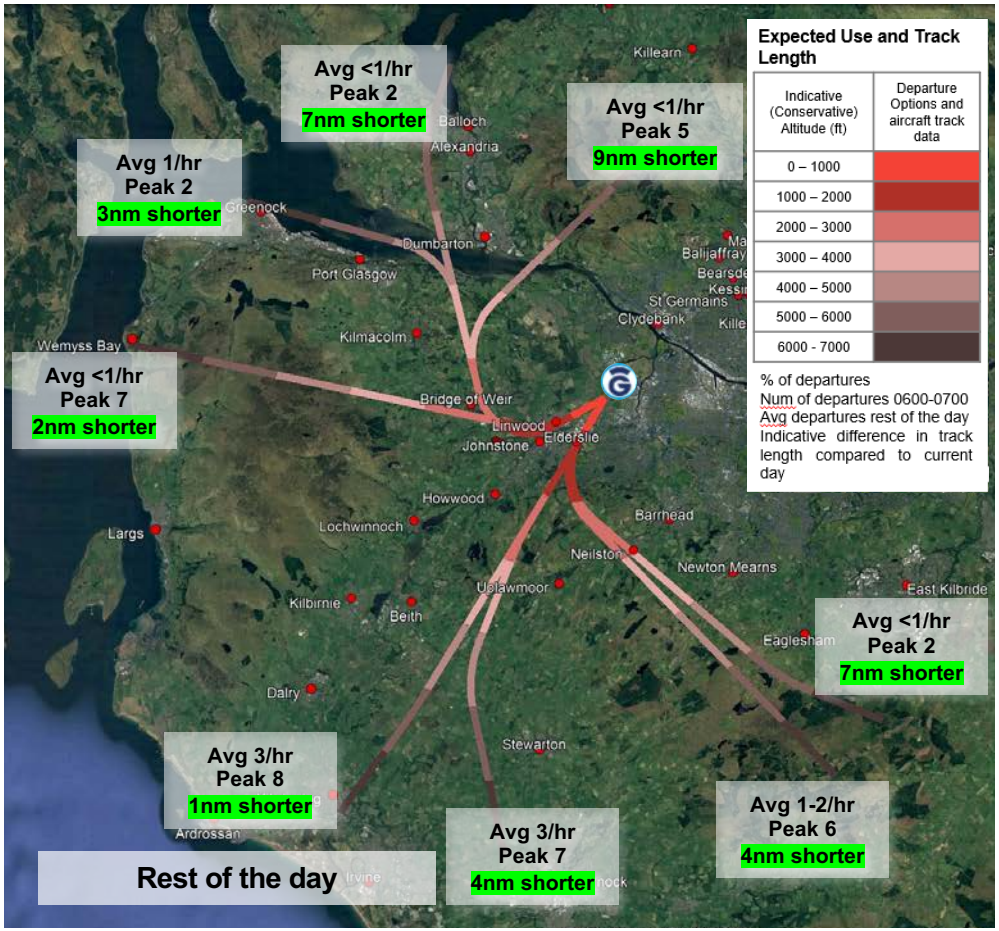
In the morning, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time.

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.

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

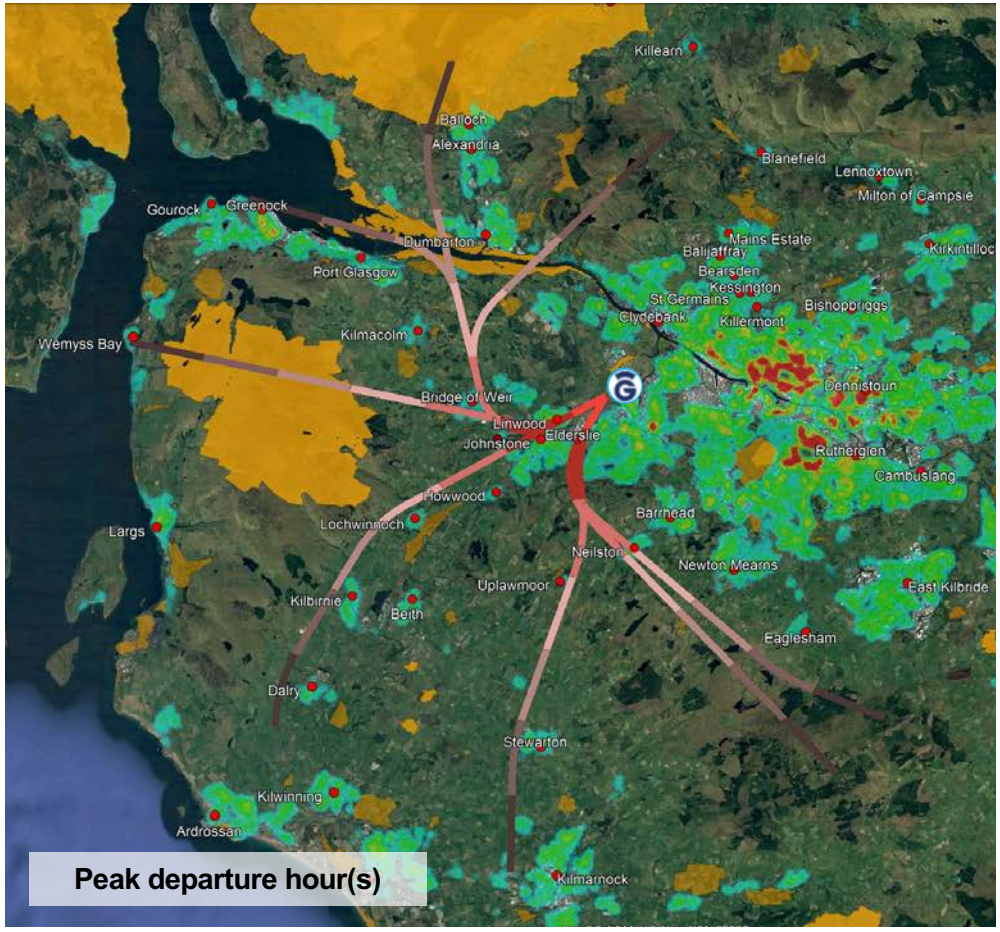
Runway 23 Departure Option C

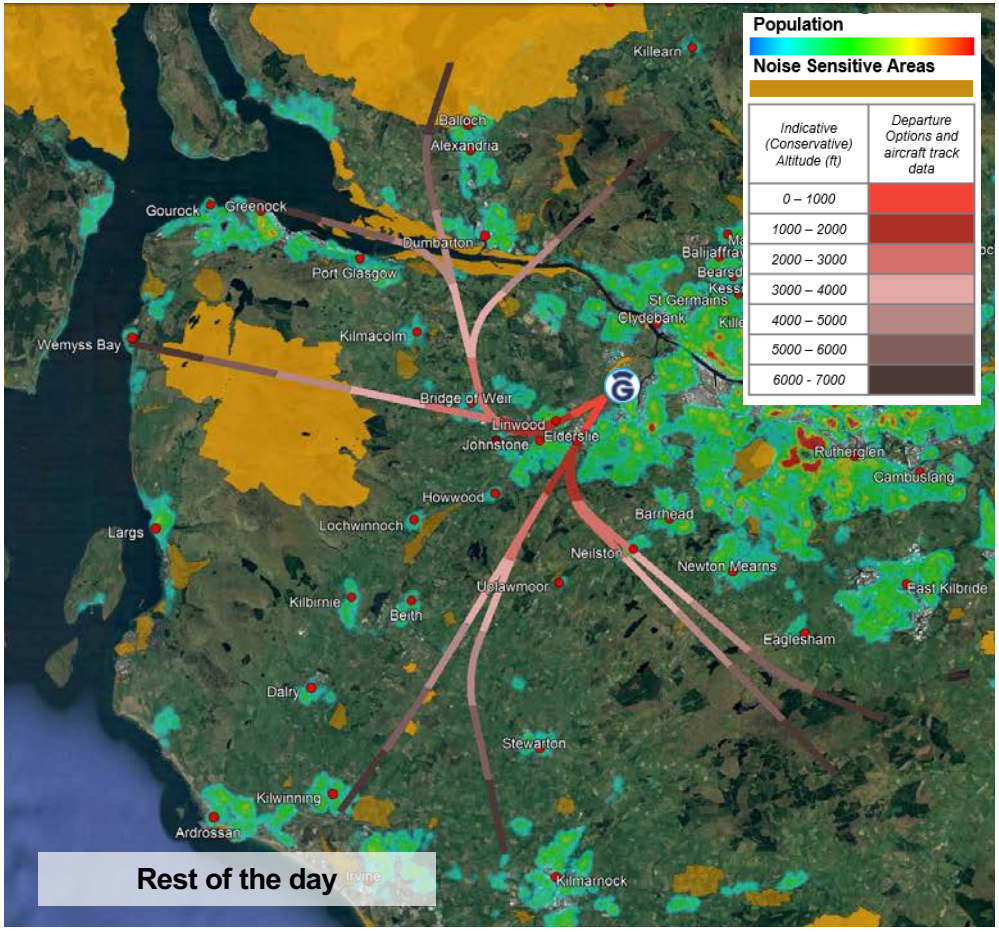




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

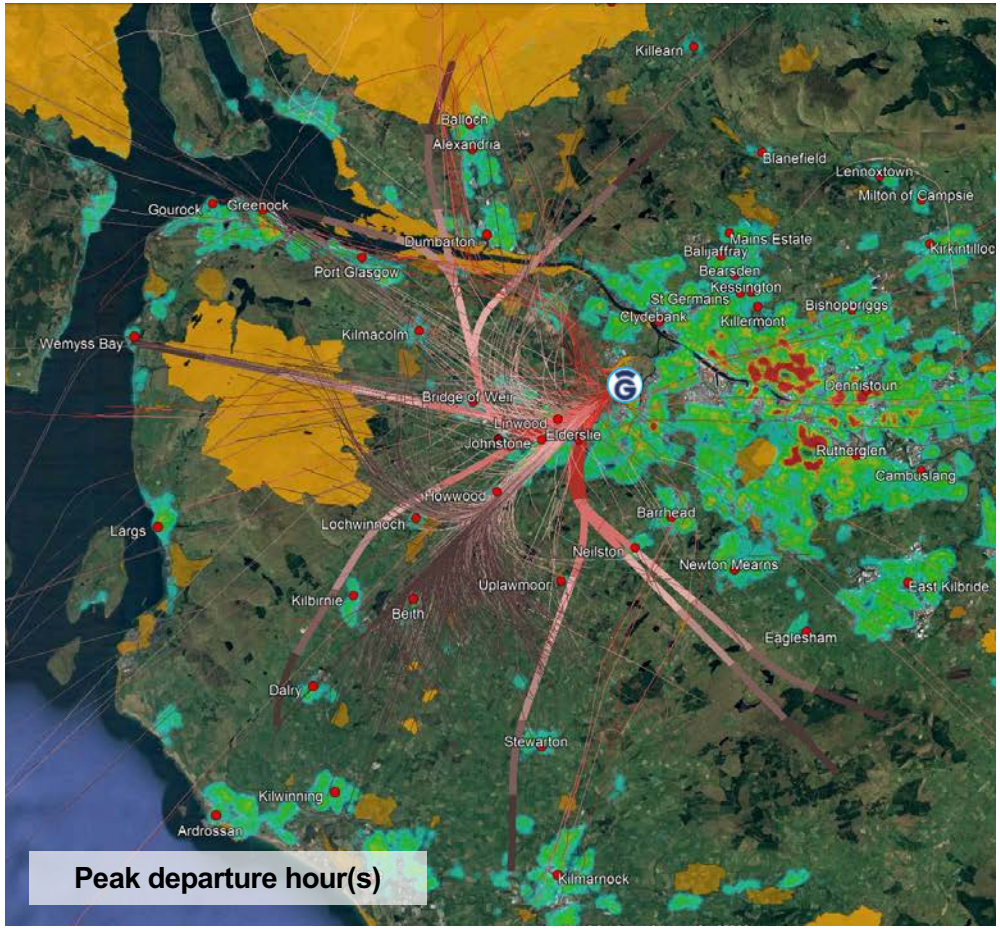
Runway 23 Departure Option C

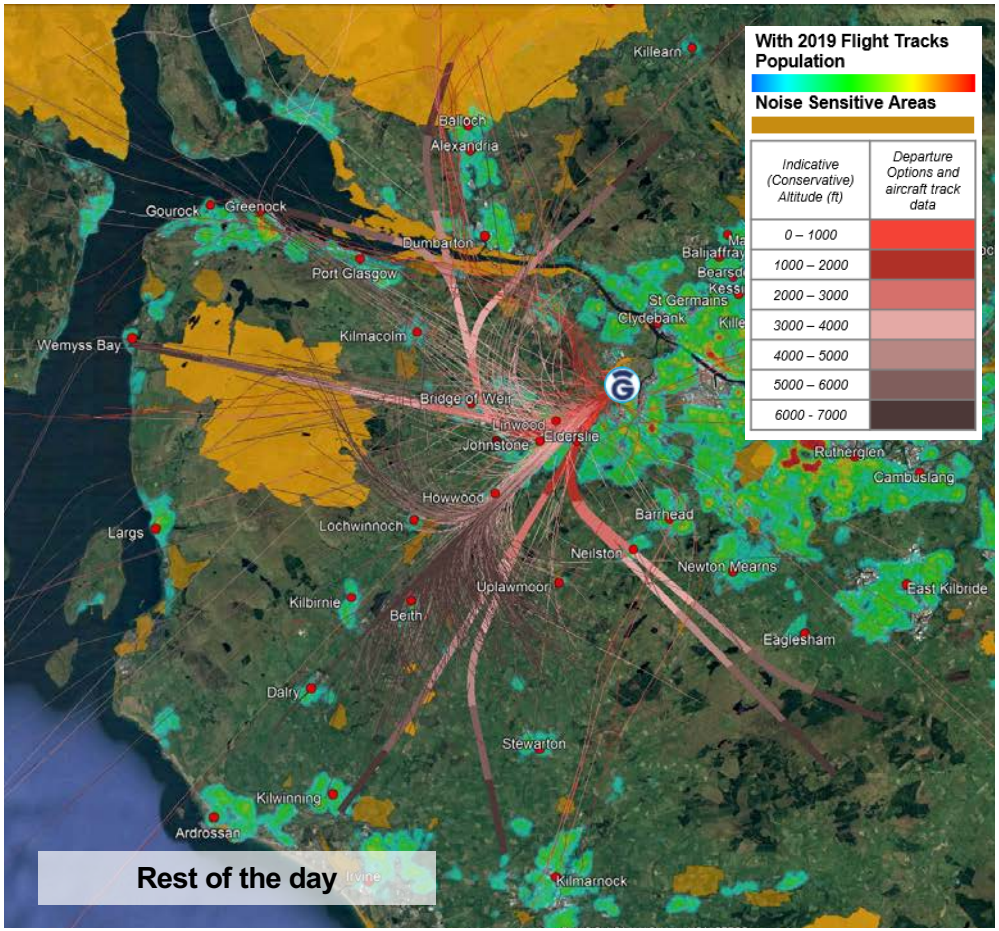




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option C





Runway 23 Departure Option D

This option has two, slightly different route configurations and assumes one configuration would be used for the peak departure period each morning. The configuration would then switch for the rest of the day.

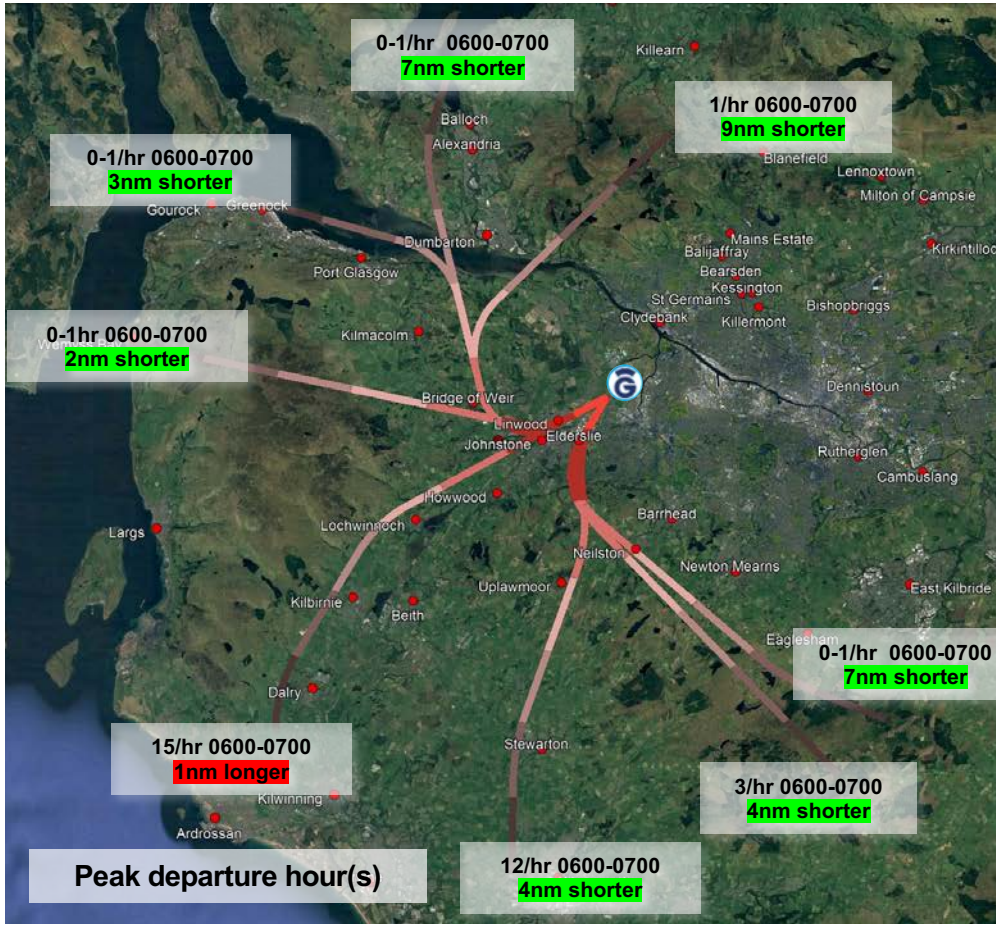
In the morning, the NORBO traffic is shared between an offset left turn departure and an offset right turn departure with both routes available at the same time.

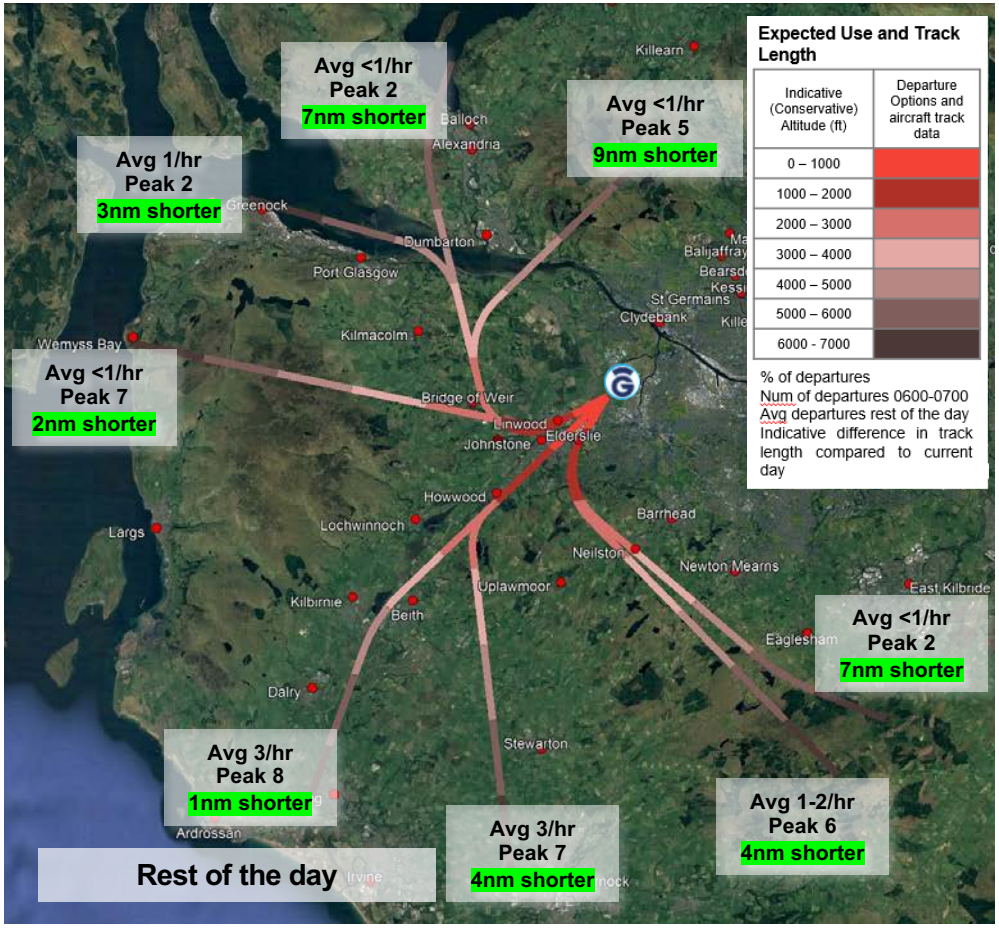
For the rest of the day, all the NORBO traffic would then use a different flight path which follows a straight line from the runway until splitting at 5nm, with the rest of the routes remaining the same.

This option is similar to Option C except that the daytime (non-peak) NORBO route is different.

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

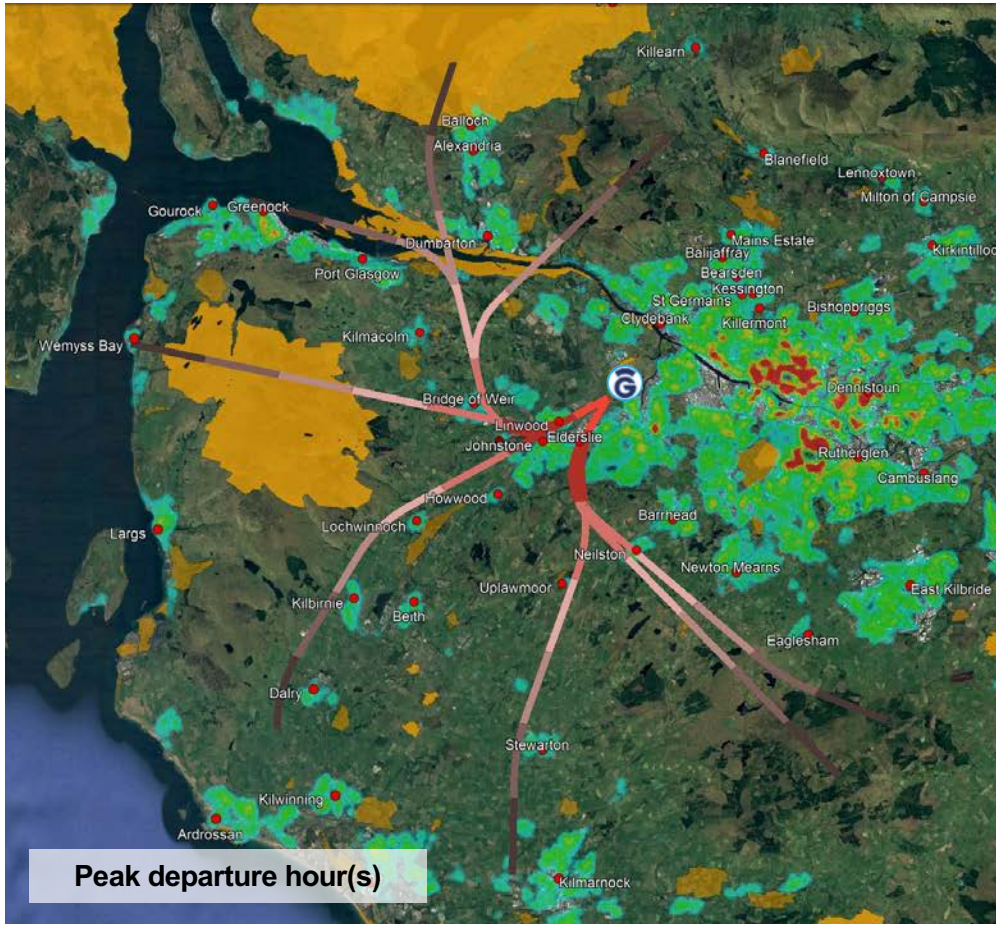
Runway 23 Departure Option D

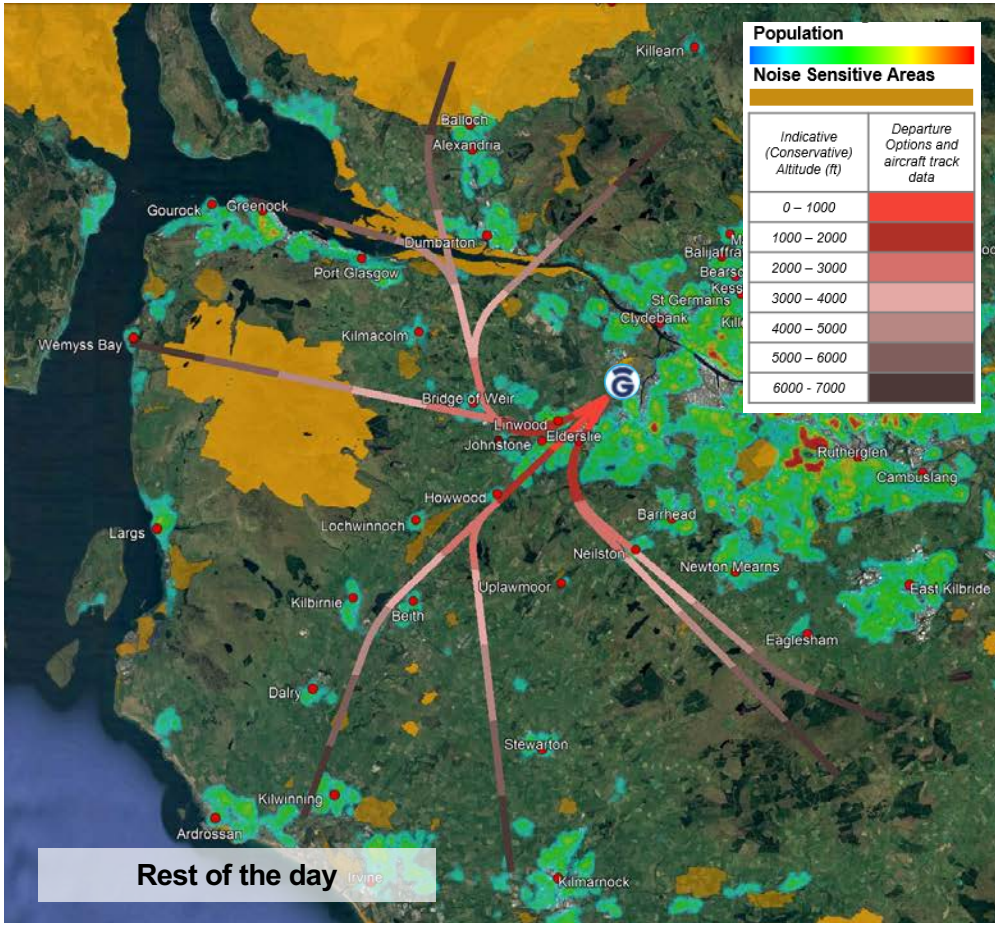




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

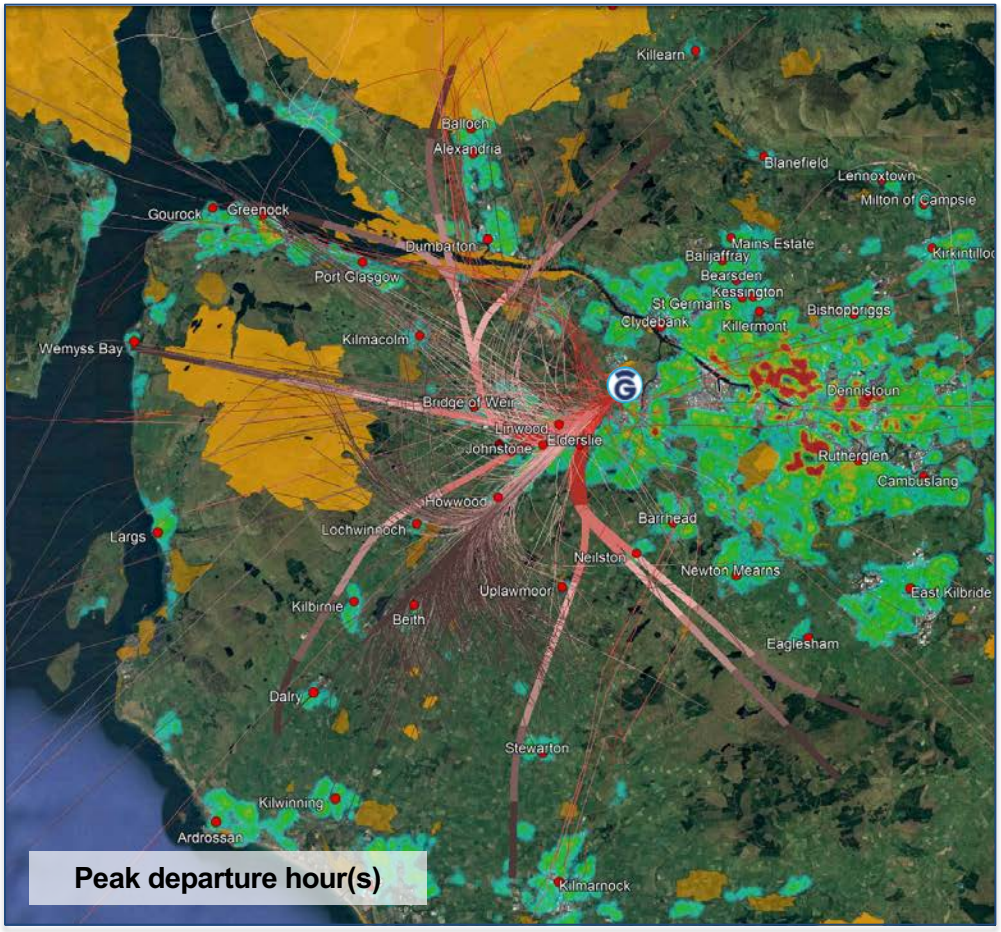
Runway 23 Departure Option D

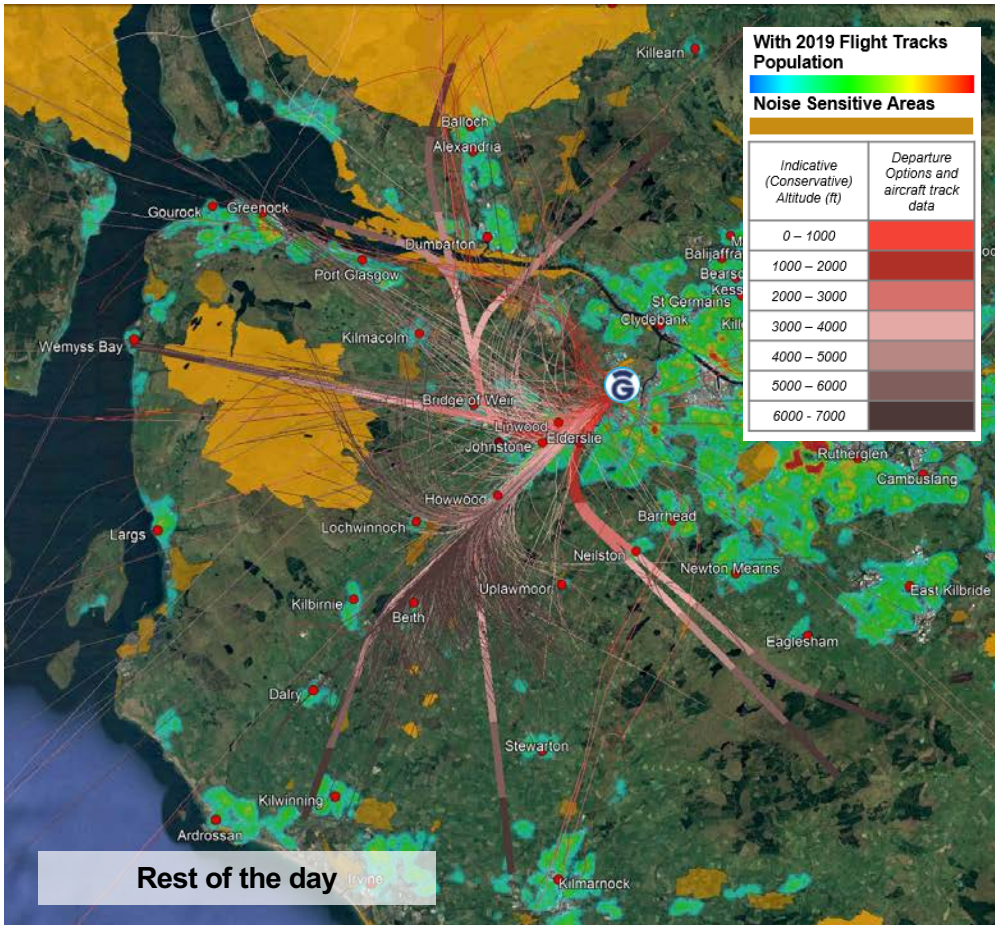




4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option D





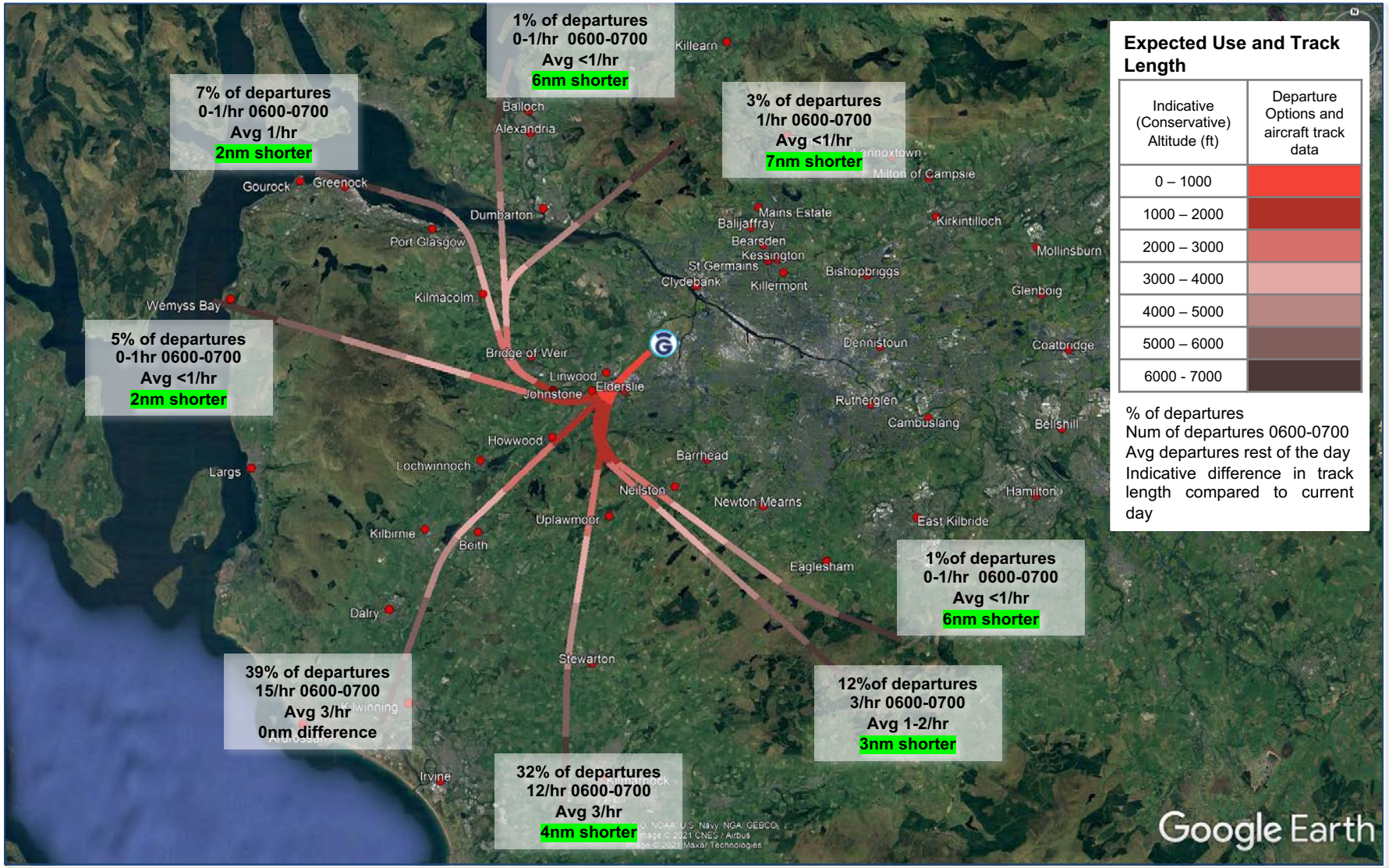
Runway 23 Departure Option E

Straight ahead departures only (no offsets) with turns at 1nm, 2nm and 9nm from the runway

NORBO is traffic is shared between a route that turns left at 2nm and one that doesn’t turn until 9nm from the runway.

4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option E



4. COMPREHENSIVE LIST OF OPTIONS: RUNWAY 23 DEPARTURES

Runway 23 Departure Option E