Design Options Report

CAP1616 Stage 2 Develop and Assess

MAG Manchester Airport

Document Details

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1. Introduction

1.1. Purpose

The Manchester Airport (MAN) Future Airspace project has now reached Stage 2 – Develop and Assess of the CAP1616 process. Step 2A requires the change sponsor to develop a comprehensive list of options that address the Statement of Need (SoN) and align with the design principles developed during Stage 1 of the process.

This Design Options Report (DOR) describes how the comprehensive list of departure and arrivals design options has been derived, as required by Step 2A of CAP1616. The design options have been grouped within design envelopes that illustrate the lateral limits of where routes could be developed based upon design parameters of the aircraft and constraints within the airspace. These design options form the comprehensive list. As described both in section 6 for Departures and section 19 for Arrivals, they have been tested with stakeholders.

The DOR presents the comprehensive list of options to be progressed to the design principle evaluation, as reported in the separate Design Principle Evaluation (DPE).

This DOR forms part of the suite of documents submitted to the CAA at Gateway 2 of the CAP1616 process and is intended to be read alongside these documents.

The full suite of Stage 2 submission documents is:

- Stage 2 Summary Document, which draws together the key points from the Stage 2 submission and provides an overview of the Government's national programme of airspace change, the CAP1616 process and the progress to date of the MAN Future Airspace project. This information is not repeated in this report.
- Design Options Evolution (DOE), Appendix A to the Stage 2 Summary Document, shows the evolution of the design options through Steps 2A and 2B of the CAP1616 process. The resulting shortlist of design options will be considered in the Full Options Appraisal (FOA) at Stage 3.
- This report, the Design Options Report (DOR), which sets out the change sponsors approach to the design process and the output of that process in the form of design options for both departures and arrivals at the airport. It presents the design options identified and describes how those options were refined to provide a comprehensive list of design options to be progressed to the Design Principle Evaluation.
- Design Principle Evaluation (DPE), which assesses how the design options have responded to the design principles, which were established at Stage 1 of the CAP1616 process and identifies those that warrant further analysis at the next stage.
- Initial Options Appraisal (IOA), building on the results of the DPE, the IOA is the first iteration of three option appraisals, required as part of the CAP1616 process. The purpose of the IOA is to provide, at a minimum, a qualitative assessment of each design option providing stakeholders and the CAA with the relative differences between impacts, both positive and negative.
- The Stakeholder Engagement Report (SER), which explains how engagement has been used in the processes described in the other Stage 2 documents and records its outputs.

The full suite of reports, together with their supporting appendices, will be published on the CAA Airspace Change Portal www.airspacechange.caa.co.uk.

1.2. Document Overview

CAP1616 Step 2A requires the change sponsor to develop a comprehensive list of design options that address the SoN and that align with the design principles. This DOR is our response to that requirement and presents the process followed to arrive at a comprehensive list of design options for evaluation against the design principles as illustrated below:

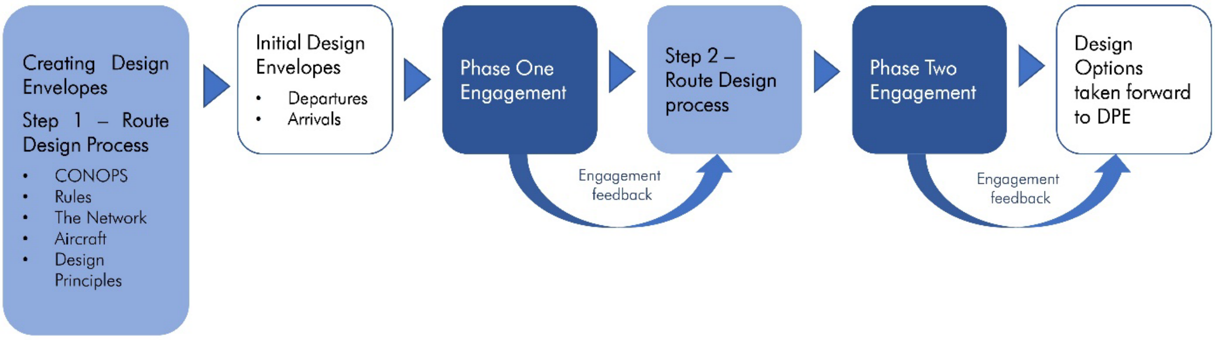


Figure 1: Design options process

This DOR first describes the background to the design work undertaken during Step 2A including the rationale that supports the design options. This includes:

- The list of design principles developed through the two-way engagement process with key stakeholders (section 2.3).
- Details of the current operations at MAN (section 2).
- An explanation of the interaction between the MAN Future Airspace project and the NATS en route (NERL) Airspace (section 3)
- Details of the future operational requirements at MAN, the core assumptions, the definition of 'do nothing' and 'do minimum' scenarios, and the controlled airspace requirements (section 4).

A description of the process used to develop the design options is provided (in section 5). This section also includes a description of the development of an initial design boundary, the application of design constraints and assumptions to create design envelopes and the subsequent development of design options within those design envelopes.

Finally, a description of how we have taken account of discussions with key aviation stakeholders, including NERL and Liverpool John Lennon Airport (LPL) in the development of the options is set out (section 5.10)

Sections 7 to 18 provide detail of the departure design options and sections 19 to 36 provide detail of the arrivals design options, taken together they form the comprehensive list of options. These sections describe each design envelope in turn, along with each design option within the relevant envelope, including the 'do minimum' option where this is located within the relevant envelope. A description of how each design envelope and the design options it contains were developed is provided, alongside a description of the characteristics of the design envelope and design options.

The design options presented in this DOR have been grouped into lettered and numbered options, based upon an initial qualitative assessment of the design options against the 'must have' design principles, as described in further detail in section 5.14 and summarised in the table below.

Classification	Criteria	Outcome
Unviable	Would not fully comply with the requirements of PANS-OPS 8168 or did not have an approved safety justification for the lack of non-compliance.	These options were not designed, due to a lack of compliance with the required standards. As a result, no such options were progressed to the DPE.
Viable but poor fit	Fail to meet the requirements of the three design principles with which all design options 'must' comply (Safety, Policy and Capacity).	These are identified as lettered options and were not progressed to a full evaluation in the DPE. However, a rationale and an initial evaluation against the three 'must have' design principles is included in both this DOR and the DPE.
Viable and good fit	Expected to meet the three design principles with which all design options 'must' comply (Safety, Policy and Capacity).	These are identified as numbered options and were progressed to a full evaluation in the DPE.

Table 1: Options Viability - Summary table

Both the numbered and the lettered options are incorporated within the comprehensive list of options. Only the numbered options are progressed to a full evaluation in the DPE, although an initial evaluation of the lettered options against the 'must have' design principles is included in the DPE. The unviable options referred to within this DOR were not progressed to the DPE, as they did not comply with the relevant standards, address the SoN or meet the three design principles with which all design options 'must' comply.

Within the relevant departure and arrival sections of this DOR, each 'viable and good fit' option is described and illustrated by a chart showing the path of the designed track over the ground. The rationale for including the option is also provided. A detailed assessment of the options against the design principles is not provided. These assessments are contained in the DPE.

Each section also contains a written description of the 'viable but poor fit' options. As design options fail to meet at least one of the 'must have' design principles, they have not been designed and are not described in the same level of detail as the 'viable and good fit' options.

For both departures and arrivals the design options are presented on an envelope-by-envelope basis with an analysis of all design options within each envelope. Runways 05L/05R are considered first followed by Runways 23L/23R.

The full design options evolution can be found within the Design Options Evolution (DOE), which is Appendix A to the Stage 2 Summary Document.

1.3. MAN Future Airspace project – Next Steps

1.3.1 We have undertaken a design process that is consistent with the requirements of CAP1616, to identify a comprehensive list of design options that are published in this DOR. In Step 2A, these design options have been evaluated against the design principles that were identified through stakeholder engagement in Stage 1. This work is reported separately in the DPE. Those that best align with the design principles were carried forward in the process to Step 2B.

1.3.2 Design options carried forward to Step 2B have been subject to an initial appraisal. The findings are set out in the IOA and the accompanying assessment tables.

1.3.3 The IOA is the first of three appraisals required under CAP1616 process. Subject to the approval of the CAA, the shortlisted options identified in the IOA will be considered in greater detail as part of Stage 3. This further assessment will increasingly make use of quantitative data and will explore local factors in greater detail than the level of assessment has allowed to date. The next stages in the appraisal will be guided by the requirements set out in CAP1616, including the metrics set out in Appendix B and Appendix E. In particular, further assessment will account for:

- Ten-year traffic forecasts (including all intermediate years)
- Safety
- Biodiversity
- Tranquillity

1.3.4 The short list of design options has benefited from extensive engagement with sstakeholders, including the general public. Amongst the stakeholders were other sponsors of airspace change including NATS as the en route airspace provider. Therefore, there is confidence that the proposals are flexible enough to provide compatibility with proposals emerging from other change sponsors, in so far as they are known at this time. As these separate but dependent airspace changes continue to mature it will be important to understand more fully how proposals from other airports, within the MTMA cluster, might interact with the Manchester Airport proposals. It will then be necessary to understand how, collectively, the developing design options are best integrated into the network at higher altitudes. Work with other change sponsors, including NATS, will continue so that our decisions are informed by the best available information and are consistent with the developing masterplan for the MTMA cluster. As part of this, MAN have already provided route information to NERL in order to populate their visualisation simulations to advance the latest proof of concept developments and will continue to work with NATS as operating networks are developed. If required, the work we have undertaken to date will be reviewed to reflect emerging information.

1.3.5 The next step in considering airspace change is for individual design options to be combined into operating networks. This will support ongoing engagement and, in turn, will allow for a more detailed evaluation against the design principles Noise N2, Capacity and Emissions. The assessment of operating networks will allow the frequency of aircraft operations to form part of the assessment and in this regard, we have noted the CAP1616 requirement to consider future air traffic forecasts for a period of ten years post implementation.

1.3.6 In addition, as the shortlisted design options are combined into operating networks, it is likely that some of the design options will respond less well to the design principles. For example, they may prove to be incompatible with other design options; may conflict with the proposals from other change sponsors; or may result in a higher cumulative impact. This may mean that certain design options will be discounted, because they are highly unlikely to perform as well as other options. As such, they would not be taken forward to the full options appraisal or public consultation at Stage 3. Consistent with the developing masterplan for the MTMA cluster, it is recognised that trade-offs may be identified by ACP sponsors during the development of the initial and full options appraisals (Steps 2B and 3A of the CAP1616 process) and in collaboration with ACOG when assessing the combined and net impacts of interdependent options.

1.3.7 The Design Principle Airspace states that the amount of Controlled Airspace (CAS) required should be minimised, to ensure the needs of other airspace users are considered. Because of the potential for routes to be refined or amended, as referred to earlier, it would be premature to define future CAS requirements at this stage. As such, CAS requirements for groups of design options will be identified during Stage 3. All stakeholders will be provided with an indication of the CAS requirements within the Step 3C consultation material, and the comments received will be considered as part of the consultation analysis activities in Step 3D. More details of this approach are provided in section 4.5 of this document.

1.3.8 Further refinement of design options, whereby certain design options are not to be appraised fully at Stage 3, will be fully explained in preparing for Stage 3. Affected stakeholders will be consulted and will have the opportunity to provide feedback prior to the full options appraisal.

1.3.9 The completion of the work required at Stage 2 'Develop and Assess' has developed and refined the design options available at Manchester Airport, as well as expanding the understanding of stakeholders' views on those options. While it is not a requirement of the CAP1616 process, all stakeholders that have participated in engagement activities to date, will be provided with the information submitted to the CAA at the conclusion of Stage 2, to ensure that they remain informed of the development of the Airspace Change Proposal at Manchester Airport ahead of the full public consultation at Stage 3.

2. Current Operations and Future Airspace Design Principles

2.1. Overview

In 2019, MAN submitted a SoN to the CAA, setting out why an airspace change was necessary. This step was completed in July 2019 when the CAA approved the SoN, agreeing that MAN should initiate an airspace change, with a provisional assessment of level 1 and an allocated reference ACP-2019-23. In accordance with para 108 of CAP1616, the CAA's confirmation of the level will follow once the change sponsor has completed its option development and options appraisal (Steps 2A and 2B respectively).

Further details of the SoN and the requirements it sets out are in section 5.2.

2.2. Current Operations

MAN has two runways running from a north-easterly direction to a south-westerly direction. Runways 23L and 23R are used in westerly operations, and the reciprocal Runways 05L and 05R in easterly operations. It has a mixed fleet of passenger aircraft serving destinations around the globe. MAN, also supports an air freight operation.

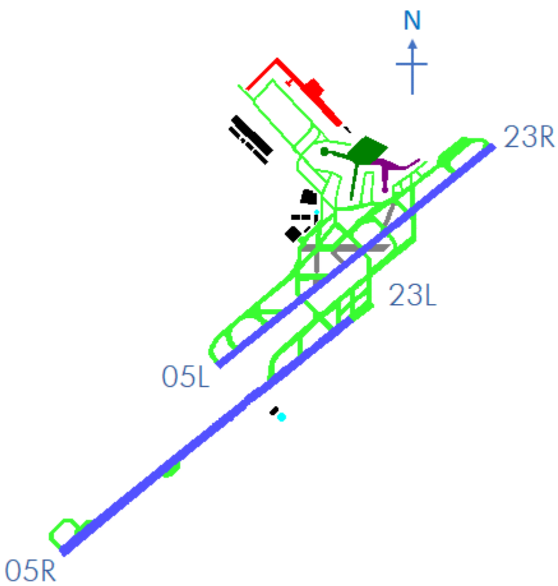


Figure 2: MAN Runway orientation

Aircraft arrivals/departures in 2020 and 2021 were distorted by the pandemic with a greatly reduced number of movements, no dual runway operations, and a distorted mix of short/long-haul operations/destinations. The calendar year and summer of 2019 represent the last experience of (pre-pandemic) normal operations and has therefore been used as the most appropriate set of assumptions to illustrate current operations.

The current operation at MAN can be summarised as follows:

- Runways 23R/05L are open 24 hours a day and both are certified for Instrument Landing Systems (ILS) arrivals to CATIIIB minima.
- Runway 23L has no ILS facility but has a Performance Based Navigation (PBN) Arrival to Lateral/Vertical Navigation (LNAV/VNAV) standard in operation. Runway 05R has an ILS but is only certified for CATI operations.
- The use of Runways 23L/05R is governed by a planning condition which allows their use between 06.00 to 22.00. They can only be used at night in cases of emergency or if there is planned maintenance which make Runways 23R/05L unavailable. In practice, the use of Runways 23L/05R is also driven by a mix of demand, weather, fire cover and Air Traffic Control (ATC) staffing.
- Westerly operations from Runways 23L/23R are predominant, and over the last 20 years the split between Runway 23 and Runway 05 operations has been approximately 80%/20%. When operating in dual runway mode there is a need for aircraft to cross an active runway. During easterly (Runway 05) operations this has limited impact. However, during westerly (Runway 23) operations, the location of the crossing points for departures results in an adverse impact on arrival spacing.
- All Instrument Flight Rules (IFR) departing traffic utilises Standard Instrument Departures (SIDs) but these are all based upon ground-based navaids, in particular the 'MCT' Doppler VHF Omni-directional Range (DVOR) facility. Departing aircraft are generally transferred to the en-route Prestwick ATC Centre between 2,500ft, and 5,000ft.
- Below 7,000ft, management of the airspace relies heavily on ATC tactical vectoring with very little systemisation employed. This effect of this can be seen in Figure 3 to Figure 6 that follow.

Further details of current operations and traffic flows can be found in section 8 of the Stage 2 Summary Document.

2.2.1. Departures

The diagrams below show the distribution of departing aircraft from Runways 23L/23R and 05L over a typical summer's day. Runway 05R movements are not shown as this runway is seldom used for departures – in 2019, Runway 05R was used for only 0.05% of all departures. However, the tracks taken by aircraft from this runway mimic those of Runway 05L.

This distribution is influenced by:

- The design of the Standard Instrument Departures (SIDs) including the location of ground based navigation aids, specifically the DVORs.
- The dimensions of the Preferred Noise Routes (PNRs) which encompass the SIDs.
- The rules and regulations regarding ATC vectoring. Once aircraft reach a certain altitude, which varies between 3,000ft and 5,000ft, ATC are permitted to turn the aircraft off the SID, either to create a more direct route, or to ensure separation from other air traffic.

For departures there are currently seven SIDs for Runways 23L and 23R and six for Runways 05L and 05R which are shown at Table 2: Departure directions and associated SIDs.

These link each runway direction to the NATS en route airspace network. Dual runway operations are used at peak times to meet demand, and in westerly operations, Runway 23L is used to depart aircraft and Runway 23R is used for arrivals. In easterly operations Runway 05R is used by landing aircraft and Runway 05L is used for departures.

Departure direction	Runways 23L/23R	Runways 05L/05R
North	POL	POL
East	SONEX	DESIG
South	LISTO SANBA	LISTO
West	EKLAD	ASMIM
South-west	KUXEM MONTY	ASMIM MONTY

Table 2: Departure directions and associated SIDs.

Departure noise is managed using PNRs and departing aircraft must remain within the PNR corridor until they have reached a minimum altitude which varies between 3,000ft and 5,000ft. Above this altitude, ATC vectoring is used to provide a route to connect to the NATS upper airspace network. The proximity of Liverpool Airport (LPL) results in a complex airspace environment in the area to the west of MAN, and ATC vectoring is also used to ensure a safe and efficient flow of traffic between these two airports. This vectoring results in the dispersed departure patterns shown in the figures below.

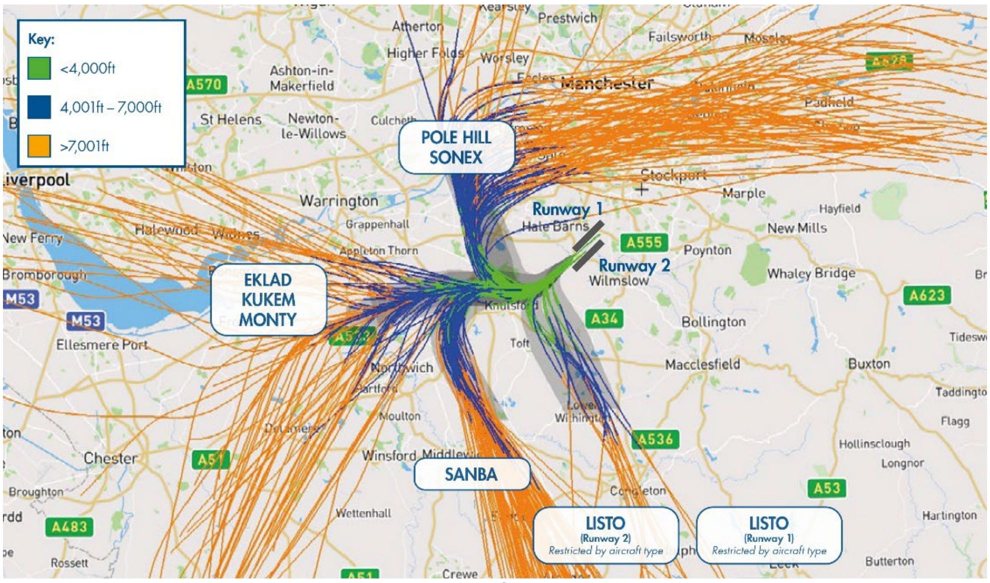


Figure 3: Typical summer's day departures from Runways 23L/23R in 2019.

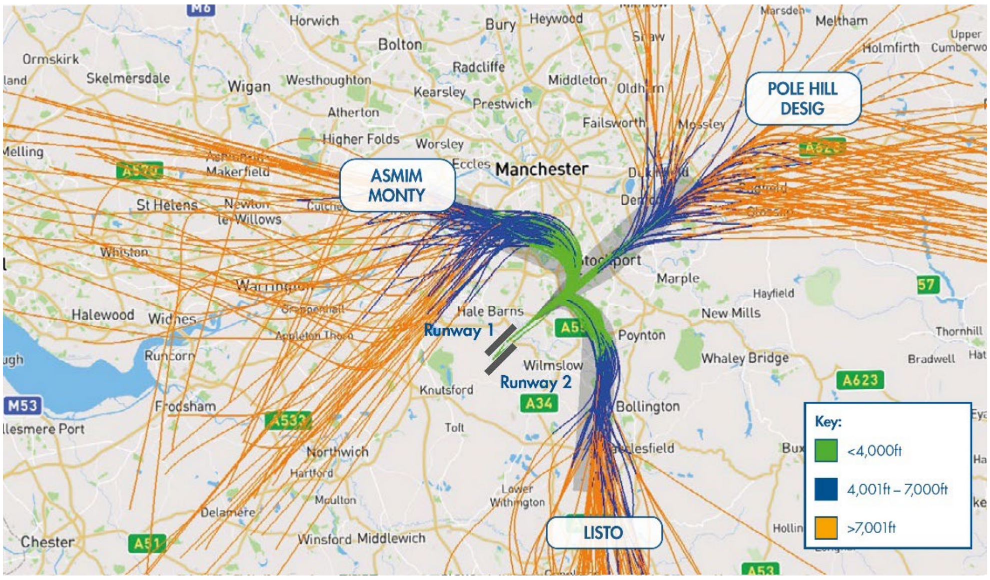


Figure 4: Typical summer's day departures from Runway 05L in 2019.

2.2.2. Arrivals

The diagrams below show the distribution of arriving aircraft over a typical summer's day. There are no fixed flightpaths for arriving aircraft below 7,000ft until they are established on 'final approach' at an altitude of at least 2,000ft or approximately six miles from the runway.

Arriving aircraft approach UK airspace from several fixed entry points before routing towards MAN airspace. ATC vector and sequence aircraft appropriately to ensure they remain safely separated from other air traffic and to maximise capacity. This involves controlling the speed, direction, and height of the aircraft prior to them being turned on to the Instrument Landing System (ILS). As with departures, this vectoring results in the dispersed departure patterns shown in the figures below.

During busy periods arriving aircraft may be held in one of three ‘holding stacks’ before being vectored for their final approach. The three holding stacks are DAYNE, MIRSI and ROSUN and are shown in the figures below. During dual runway operations Runway 23R is used for arrivals in westerly operations, and Runway 05R in easterly operations.

Wherever possible ATC will provide the aircraft with a Continuous Descent Approach (CDA) to manage noise and emissions. In 2019, 92% of arrivals were provided with a CDA once they were below 5,000ft, which is the current altitude from which CDAs are measured at MAN.

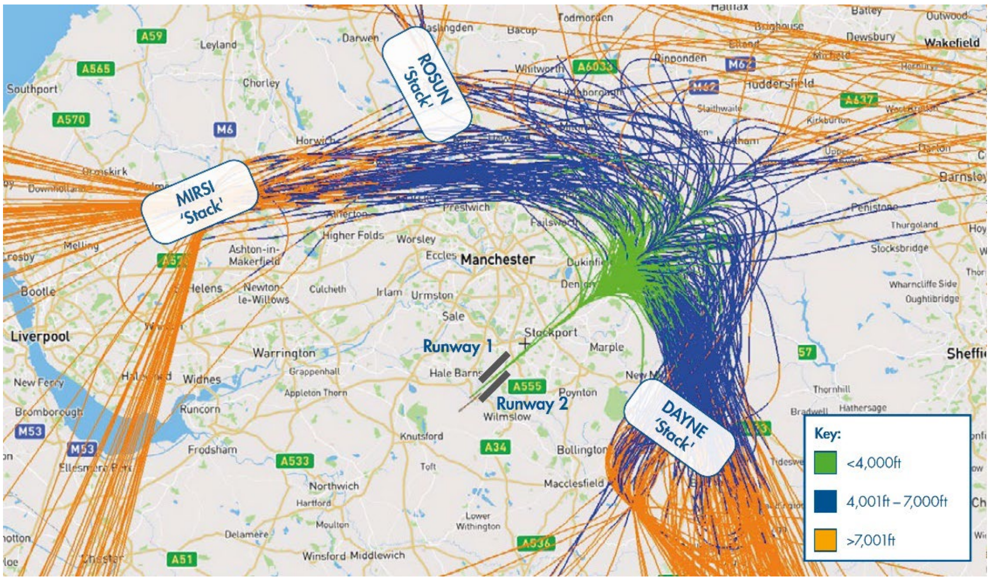


Figure 5: Typical summer’s day arrivals onto Runway 23R, in 2019.

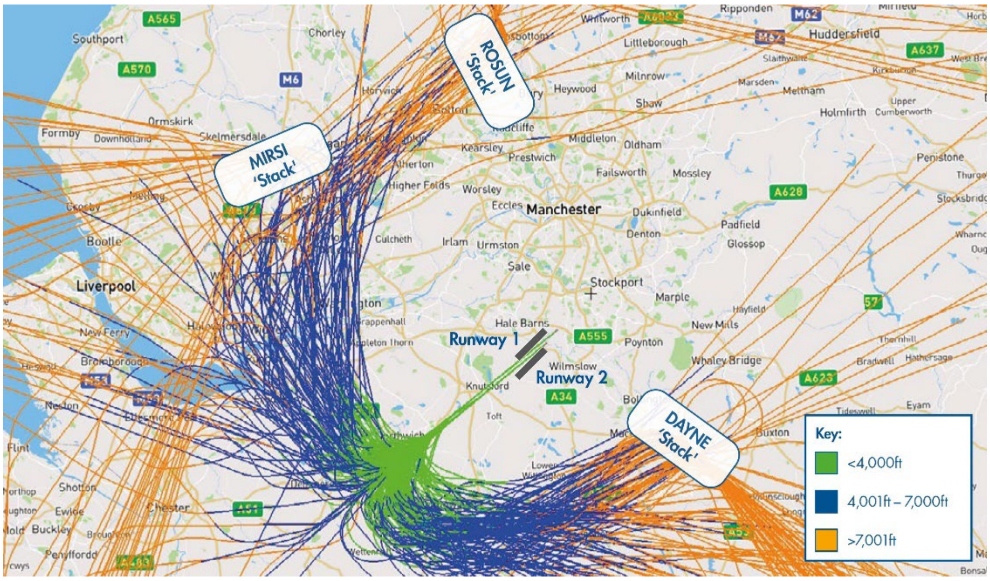


Figure 6: Typical summer’s day arrivals onto Runways 05R and 05L in 2019.

2.3. Design Principles

CAP1616 requires a list of design principles to be created. These were developed in Stage 1, Step 1B, and were informed by a two-way engagement with stakeholders. These design principles function as a framework which underpin how the design options were developed.

The agreed list of MAN design principles is shown below:

Reference	Design Principle
Safety	Our routes must be safe and must comply with industry standards and regulations.
Policy	Any airspace change must accord with the Civil Aviation Authority's Airspace Modernisation Strategy. Any airspace change must also allow connection to the wider UK en route network and be aligned with the Future Airspace Strategy Implementation for the north programme (FASI-N) and take into consideration the needs of other airports.
Capacity	Our future airspace must enable best use of the capacity of our existing runways, in line with Government policy.
Emissions	We will minimise and where possible, reduce emissions when we design routes. This may be achieved by selecting the most direct routes.
Noise N1	Our route designs should seek to minimise, and where possible, reduce the number of people affected by noise from our flights.
Noise N2	Where practical, noise effects should be shared. The use of dispersion and/or respite, especially at night, will be considered to achieve this.
Noise N3	Where practical, our route designs should avoid, or limit effects upon, noise sensitive areas. These may include cultural or historic assets, tranquil or rural areas, sites of care or education.
Airspace	Our route designs should minimise the impacts on other airspace users by limiting Controlled Airspace (CAS).
Technology	Our route designs should be based on the latest aircraft navigational technology widely available.

Table 3: Design principles.

3. Connection to the NATS En Route (Network) Airspace

3.1. Overview

Consistent with the Design Principle Policy, it is essential that the future MAN airspace design is developed in association with, and to align with, the UK en route airspace network and with the Future Airspace Strategy Implementation (FASI) programme.

FASI is the programme to redesign the entire airspace in the UK, including the airspace below 7,000ft surrounding airports used predominantly for departures and arrivals, and the en route national airspace structure above 7,000ft.

FASI is a complex airspace design programme and the CAA's Airspace Modernisation Strategy (AMS) requires coordination between the different sponsors of airspace change. These sponsors include airports such as MAN and LPL and the national ATC provider NERL, who is responsible for airspace change above 7,000ft including the upper airspace network.

The NERL ACP which relates to MAN Future Airspace is called Future Airspace Strategy Implementation – North (FASI-N MTMA), MAN and East Midlands (ACP-2019-77)

To inform the NERL airspace change process, MAN have agreed requirements with NERL which detail what MAN require the NERL airspace to deliver as part of the FASI-N programme.

In addition, bilateral meetings and workshops were held with NERL to explore the network solutions which could align with the design concepts being developed as part of MAN Future Airspace project. These led to a set of design assumptions being adopted by both parties. These assumptions are listed in section 3.2 below and a summary of the requirements for the NERL airspace can be found at Appendix B of this document. Further detail on the bilateral engagement with NERL is provided at section 5.12

In addition, this section explains

- The Design Assumptions agreed between MAN and NERL in relation to the design of the NERL upper airspace network (section 3.2)
- The requirements for the NATS en route airspace and what this must deliver (section 3.3)
- A summary of discussions with NERL on the network interfaces (section 3.4)
- Managing the process within the national airspace masterplan (section 3.5).

3.2. FASI-N NERL MTMA Design Assumptions

Different airport ACPs may develop and progress through the CAP1616 ACP process at differing rates. To inform the interdependent future airspace network design and the MAN design process, whilst adhering to the design principles of both MAN and NERL's ACP, a set of assumptions have been agreed between MAN and NERL and are detailed overleaf:

a) NATS Prestwick Centre will remain the controlling authority for the network airspace above MAN, and the main operational interface for arriving and departing traffic.

b) The routes from MAN will connect into an existing network of terminal airspace known as the Manchester Terminal Manoeuvring Area (MTMA). Some departure and arrival concepts within this may change as a result of the requirements of MAN and other airport sponsors, however, fundamental changes to the orientation of the airspace infrastructure are not anticipated. As a result, the main network flows, and general connection locations within the MTMA will remain.

c) There are constraints to this structure based upon the UK Traffic Orientation Structure (TOS) which is established to smooth traffic flows and decrease the safety risks associated with crossing traffic. The TOS dictates a direction of flow (via a one-way system in certain areas of airspace) and takes account of traffic demand, agreements with adjacent Flight Information Regions (FIRs), constraints on controlled airspace and the needs of the military.

d) Changes to the TOS are not planned within the scope of the NATS network change, and therefore MAN traffic will align with the current TOS structure including the one-way system established in certain areas. Further information on the impacts of these traffic flows and resulting constraints and considerations can be found in section 5.8.

e) In addition to the TOS, there are no fundamental changes planned to the position of the UK Coordination Points (COP) with adjacent FIRs. Whilst there may be additional COPs these will link into the existing route structure that supplies traffic to and from MAN.

f) Holds will continue to be a design feature for contingency/resilience although they may not necessarily be for routine use. There is no assumption on the number or type of these holds.

g) Whilst Flexible Use of Airspace (FUA) concepts will be explored, the military primacy in danger areas/restricted areas will remain unchanged.

h) NATS has commenced a project to introduce harmonisation of the Transition Altitude (TA) at 6000ft within the lateral limits of their MTMA change. The current altitude is 5,000ft. This change to the TA will be included by NATS as a design constraint within their submission and will bring the TA in line with most of UK Controlled Airspace (CAS). The design assumption for MAN's design process is that the harmonisation of the TA will not constrain the design options being considered by MAN or patterns of flights within the MTMA. MAN have indicated support for this project as it will enhance safety, ensuring all aircraft use the same TA within and beneath the CAS in and around the MTMA.

3.3. Future Requirements of NATS En Route Airspace.

MAN arrivals and departure routes are intrinsically linked with the airspace design of the surrounding en route airspace, which provides the air traffic service for the inbound and outbound traffic to and from MAN airspace above 7,000ft. As a result, a set of airspace requirements for NATS enroute airspace have been agreed, to ensure the designs of both parties are aligned as part of the FASI-N project.

The requirements for NATS enroute airspace are aligned with the design principles and have been agreed between MAN and the FASI-N NERL MTMA team. They set out what the future NATS network airspace must deliver in terms of outcomes and ensure the network creates a solution that allows MAN's future airspace to meet the design principles. They do not define options or solutions. A summary of these requirements is included at Appendix B of this document.

In addition, we are required to develop our future airspace in alignment with the national airspace masterplan. This document is being developed by ACOG and the process to manage and agree options within this national Masterplan is described in section 3.44.

3.4. Network Interface: Discussions with NERL

NERL are also undertaking a level 1 ACP which requires them to create a comprehensive list of design options and to engage with stakeholders including airport sponsors.

As part of this project, NERL ran a number of airspace development workshops with MAN. This was attended by subject matter experts (SMEs) from both NERL and MAN ensuring that the NERL design options were a product of co-ordination and agreement between both parties. Further detail is described in section 5.12.

NERL have also undertaken a project to remove the network airspace reliance on the ground based DVORs. This resulted in NERL redesigning all the Standard Terminal Arrival Routes (STARs) for MAN and the three arrival holds at MIRSI, ROSUN and DAYNE to the RNAV1 performance standard. These holds were previously dependant on the DVORs at Trent (TNT), Pole Hill (POL), Manchester (MCT) and Wallasey (WAL).

This project did not result in any change of position of these arrival holds and was implemented in March 2022 to be in line with AMS and the UK wide programme to reduce reliance on DVORs.

Because this project addressed routes and holds above 7,000ft it was the sole responsibility of NERL, although MAN and Manchester ATC were engaged in the process via regular briefings and bilateral meetings.

3.5. Managing the process within the national airspace Masterplan

The MAN Future Airspace project is currently more advanced than the NERL network ACP and although we have worked with NERL to develop our design options, their process has not fully developed a comprehensive list of design options. As a result, we do not have full visibility of the NERL design options in relation to:

- Design option connectivity for departures within the MTMA, which may change as a result of the design work within NERL and at other airports, in particular LPL.
- The type and number of arrival structures envisaged for MAN operations above 7,000ft, or the options for where such an arrival structure or structures could be positioned.

In order to address this, we have collaborated closely with colleagues in NERL to help us create a comprehensive list of departure and arrival design options that provide flexibility and have the ability to integrate with a new MTMA network.

Discussions with NERL took account of:

- the current network traffic flows
- the proposed routes to and from LPL
- the requirement to safely deconflict MAN departures and arrivals from each other.

We then tested our designs with NERL and other airport change sponsors including LPL and LBA during the stakeholder engagement process.

As the NERL designs progress, it is possible that some of our design options will either be misaligned or conflict with their designs (or those of other airports) and that some design options will need to be further refined or modified in response to the progress of this work. Alternatively, some options that have not been carried forward from either the DPE or IOA process may need to be restored as working options.

We will continue to engage in discussions across the MTMA and in partnership with NERL and other airports including LPL to respond to any such interactions in line with the developing national airspace masterplan.

Our proposed approach to address any such further information becoming available is described as part of the Next Steps in section 1.3.

4. Future Airspace – Operations

4.1. Overview

The MAN Future Airspace project has the potential to unlock a wide range of benefits for communities, passengers, airlines, the environment, and the regional economy. It is being progressed in line with UK Government policy which has highlighted the strategic need to upgrade the existing airspace network across the UK. This is supported by a UK wide strategy to modernise airspace, which for airports will require changes to the design of routes and operational ATC techniques used to manage flights below 7,000ft.

The MAN Future Airspace project is one part of this UK-wide programme and further details can be found in the Airport's SoN via the CAA Airspace Portal at airspacechange.caa.co.uk.

In order to align with this policy and the requirements of the Airspace Modernisation Strategy (AMS) the arrival and departure procedures serving MAN will need to be updated. This will enable the adoption of the latest technology, including satellite-based routes. Consistent with the SoN and the design principles, the Manchester Airport Future Airspace project will need to deliver an airspace design that enables MAN to continue to grow to make best use of its available runway capacity, while balancing the needs of communities and the environment in line with Government policy.

This section of the DOR describes the operational concepts incorporated into the design options presented in sections 6 to 36. These concepts outline how we expect the future airspace to operate, and form one of the foundations for the route option designs alongside the SoN, the design principles in section 2.3, information from the airline fleet equipage survey in section 5.6 and the rules contained within CAA and ICAO documentation.

These operational concepts were created with reference to this information and consolidated into the Concept of Operations (CONOPS) document described in section 4.2.

In addition, this section explains

- The purpose of the CONOPS (section 4.2)
- The operating concepts within the CONOPS that have informed the development of design options (section 4.3).
- The approach taken to defining the 'do nothing' and 'do minimum' scenarios for both arrivals and departures, which has informed the design and assessment of design options (section 4.4).
- How controlled airspace requirements have been considered at Stage 2 and will be considered further at Stage 3a (section 4.5).

4.2. Concept of Operations (CONOPS)

A CONOPS document has been developed. The purpose of the CONOPS document is to outline the operational concepts that will be used to realise the benefits from the MAN Future Airspace project, consistent with the agreed design principles. In addition, it describes the air traffic management techniques that will be used to manage the proposed system of routes.

The CONOPS does not contain any airspace designs or routes. Rather, it outlines the concepts to be considered and incorporated into those designs. Specifically, for the creation of the options contained within this DOR it provides the foundation for the development of the design envelopes and associated design options for both departures and arrivals within those envelopes. The design options presented in this DOR take account of this document.

4.3. CONOPS: Future operating concepts.

The CONOPS includes the following future operating concepts:

a) MAN will be responsible for the redesign of inbound and outbound routes and procedures from the runway up to and including 7,000ft. Above this altitude, the responsibility rests with NERL. This includes the responsibility for the airborne holds including those described in section 3.3.

b) The CAA AMS requires airports to design future airspace to Performance Based Navigation (PBN) standards. In addition, the Design Principle Technology requires the route designs to be based upon the latest aircraft technology widely available. Based on the results from an airline fleet survey, the designs shall meet the requirements of all PBN mandates and will use:

- RNAV1 as a minimum and where possible RNP1.
- RNP Approach (RNP APCH) as the design standard for arrivals.
- ILS as the primary means of precision approach using a 3°descent gradient.

c) The airspace change will be in accordance with the CAA AMS. Any change must allow connection to the wider UK en route network and be aligned with the FASI-N programme and take into consideration the needs of other airports.

d) Consistent with the 'must have' Design Principle Policy, all SIDs will be designed to provide continuous climb profiles from runway to an agreed joining point with en route airspace (assumed to be 7,000ft unless agreed otherwise with NATS). Adopting continuous climb profiles also aligns with the design principles Noise N1 and Emissions. The current system of PNRs is not a constraint to the design of routes. These will be reviewed and updated at a later stage in the process once the final routes have been agreed.

e) Similarly, all arrival transitions (intermediate approaches) will be designed to provide continuous descent profiles from an agreed exit point at 7,000ft from en route airspace to the joining point with the final approach.

f) In line with Government policy, the objective is to make 'best use' of existing runway capacity which may include changes to how some routes are used.

g) Consistent with the AMS and the Design Principle Technology the routes will be designed to accommodate the principle of systemisation (reduced ATC intervention). The result shall be PBN routes that are de-conflicted by design and in accordance with CAA CAP1385 Performance-based Navigation: Enhanced route spacing guidance. However, whist there should be a reduction in tactical intervention by ATC, some vectoring will be required to ensure safety and capacity are maintained.

h) The routes and the interactions with other airports, will be based upon 3nm radar separation within the MTMA in accordance with the minimum radar separation standards within CAP1378.

i) Consistent with the AMS, the route designs should minimise the impacts on other airspace users by limiting the need for additional Controlled Airspace (CAS).

4.4. 'Do nothing and 'Do minimum' Options.

The CAP1616 process requires the change sponsor to consider the 'do nothing' scenario and, as is the case at MAN, if 'do nothing' is not a feasible option, to consider the 'do minimum' option(s). The 'do nothing' scenario is used as the baseline for comparison in the options appraisals, including the IOA. The 'do minimum' options represent an 'informed view of the future', and describe the minimum changes required to address both the issues with the 'do nothing' scenario that mean that it is not a feasible option and to begin addressing the issues identified in the SoN. The 'do minimum' options, and are listed as design options in this DOR, so that they can be compared with other design options .

A description of and rationale for both the 'do nothing' scenario and the 'do minimum' options for both arrivals and departures is provided below.

4.4.1. 'Do nothing' Departures Scenario

The 'do nothing' scenario for departures would mean that, when the ground-based beacons (specifically DVORs) are taken out of service, there would be no published procedures for aircraft to fly.

These DVORs are expected to be phased out from late 2022, which is before the implementation of this airspace change. CAP1616 requires that the context is considered in defining the 'do nothing' scenario. MAN intends to follow the process under CAP1781 to allow the substitution of the current routes using PBN (specifically RNAV) on a temporary basis as commercial aircraft flying into MAN are already capable of flying these routes. This capability is evidenced by the results of the airline fleet equipage survey in section 5.6. Any aircraft unable to comply with these RNAV substitution routes will be provided with a bespoke clearance and radar vectors by ATC.

By following this process, the reliance on the DVOR network will have been removed before the MAN Future Airspace project is implemented. However, the process under CAP1781 only allows for these substitution routes to be used for a maximum of five years. Therefore, a long-term solution is required to avoid these substitutions being removed from publication. Without a long-term solution, ATC would be responsible for issuing individual instructions to aircraft prior to departure because the route would no longer be published.

The Design Principle Policy states that we must comply with the CAA AMS, and the 'do nothing' departures scenario would fail to do this, specifically in relation to initiative "7) Replication of existing arrival and departure routes with satellite navigation upgrades" and initiative "8) Deployment of new arrival and departure routes designed to satellite navigation standards".

In addition, this removal of standardised instructions to aircraft would:

- Not align with the Design Principle Technology for us to use the latest aircraft technology.
- Result in random track dispersal (due to ATC vectoring) which would not provide us with the opportunity to design routes that minimise noise. This track dispersal would not align to the Design Principle Noise N1 which requires us to minimise the number of people overflown (dispersal is likely to increase this number) or allow us to create routes that create noise relief or respite in alignment with Design Principle Noise N2.
- Significantly increase ATC workload which would lead to a reduced traffic flow. This would result in a failure to meet the Design Principle Capacity.
- Not provide a systemised operation in line with the Design Principle Policy.
- Not make best use of runway capacity in line with the Design Principle Capacity. This is because of the interaction between south and westbound routes from Runway 23R/23L.

Because the 'do nothing' departures scenario does not align with the 'must have' Design Principle Policy it is not a viable option and will not be carried forward as an option for assessment within the DPE. Indeed, the 'do nothing' scenario may very well represent a worsening in comparison with the current position.

However, applying the assumption to the 'do nothing' departures scenario that the substitution process permitted by CAP1781 continues beyond the five-year deadline provides the best representation of today's operation. Therefore, while the 'do nothing' departures scenario is not a feasible option, it is used a theoretical baseline within the DPE and IOA for comparative purposes only, to enable stakeholders to understand the impact/effect the 'do something' options would have.

4.4.2. 'Do Nothing' Arrivals Scenario

The 'do nothing' scenario for arrivals at MAN would be based upon:

- Use of the existing RNAV holds at DAYNE, MIRSI and ROSUN. These holds would remain in their existing location.
- ATC vectoring aircraft onto final approach from these holds.
- Final approach would be based upon ILS.

At MAN, arrivals are less dependent on navigation aids than departures under normal operations because aircraft are vectored by ATC from the three current holds, as described in section 5.4. NATS have already designed new RNAV1 holds above 7,000ft, and these are in the same position as the previous conventional holds at DAYNE, MIRSI and ROSUN. Further detail on this project is described in section 3.3.

Under the 'do nothing' arrivals scenario, on leaving these holds, aircraft would be vectored to final approach by ATC as they are today. Aircraft would then join the ILS for the final approach phase.

However, if the ILS is not operational, aircraft would require alternative (contingency) procedures to allow them to make an approach. At present this is achieved through procedures based on the MCT DVOR (UK AIP AD2. EGCC 8-1 – 8-13). Only Runway 23L has a procedure that is based upon PBN, but it is

- Only to LNAV standard.
- Not commonly used for arrivals due to the lack of ground infrastructure which limits capacity.

No PBN procedures exist for Runways 23R, 05L or 05R, which are the main arrival runways.

The Design Principle Policy states that we must comply with the CAA AMS, and the 'do nothing' arrivals scenario would fail to do this, in relation to:

- AMS Initiative 8): Deployment of new arrival and departure routes designed to satellite navigation standards.
- PBN IR: It is expected that European Union adopted legislation will be passed into U.K. law with the existing aims, objectives and timescales. Current CAA policy[1] and section 3 of the AMS reflects this and makes specific reference to legal, policy and other obligations with which UK airspace modernisation must comply. Specifically, the current policy refers to the PBN Implementing Rule (PBN-IR) (EU) 2018/1048 which requires certain aerodromes (including MAN) to deploy PBN approach procedures by 2030. The 'do nothing' scenario would not design and implement these approach procedures, and therefore would not comply with this AMS requirement.
- Provision of Continuous Descent Approaches (CDAs): Under the 'do nothing' scenario, the holds will remain in their current positions, and whilst it is possible to deliver a CDA to Runways 23 and 05 from DAYNE, it is only possible to deliver a consistent CDA to Runway 05 from MIRSI, and only to Runway 23 from ROSUN. This inability to deliver a consistent CDA to all runway ends does not align with the AMS policy requirement for improved environmental performance.

In addition, without PBN Approach procedures the 'do nothing' arrivals scenario would not align with:

- The 'must have' Design Principle Capacity. Under the 'do nothing' arrivals scenario, there would be only extremely limited contingency if the ILS failed, aside from the use of the LNAV procedure for Runway 23R. In such a scenario, Runway 23R, would only provide approximately 20-30% of normal capacity.
- The Design Principle Technology for airspace change to use the latest aircraft technology.

Because the 'do nothing' arrivals scenario does not provide procedures in accordance with the CAA AMS or the PBN-IR it does not align with the 'must have' Design Principle Policy and

[1] Details of the current CAA policy can be found at https://www.caa.co.uk/commercial-industry/airspace/airspace-modernisation/performance-based-navigation/policies-and-regulations-for-performance-based-navigation/

will not be carried forward as an option for evaluation within the DPE. Again, there may very well be deterioration in comparison with the current operations.

However, the 'do nothing' arrivals scenario provides the best representation of today's operation. Therefore, while it is not a feasible option, it is used a theoretical baseline within the DPE and IOA for comparative purposes only to enable stakeholders to understand the impact/effect the do something arrivals options would have on them.

4.4.3. 'Do Minimum' Departures Options

The 'do minimum' option for departures would involve replicating the current routes using satellite guidance to PBN standard. This would result in aircraft flying more accurately with more consistent track keeping, but in general the operation would be little changed from today.

The 'do minimum' option would represent the least technological change from current operations, and for departures this would involve replicating the current routes using satellite guidance to RNAV1 standard. RNAV1 has been chosen because it is the lowest PBN navigation specification useable by 100% of the airlines that responded to the fleet equipage survey as detailed in section 5.6, compared to 90% for RNP1. This makes this the realistic 'do minimum' specification and is in line with the CAA AMS initiative 7) "Replication of existing arrival and departure routes with satellite navigation upgrades."

However, if the 'do minimum' option were to be limited to a replication of the current routes, there would be a number of limitations. These would mean that the 'do minimum' option would not represent an 'informed view of the future' or describe the minimum changes required to address both the issues with the 'do nothing' scenario or the issues identified in the SoN.

- The Design Principle Capacity requires us to design airspace that enables the best use of the capacity of our existing runways, in line with Government policy. The current SID designs are not optimised for capacity, and one minute departure separations are not possible between certain combinations of routes, particularly on Runway 23L/23R. The 'do minimum' for departures would result in this sub-optimal SID structure being implemented for the future, resulting in this restriction on capacity being continued which is not aligned to this design principle.
- At present, during westerly operations, there are two departure routes that can take traffic to the south, they are the SANBA 1R/1Y and the LISTO 2R/2Y routes. The initial track of the SANBA route is also used by aircraft using four other routes, specifically the SONEX, EKLAD, MONTY and KUXEM. Having a common track for the first part of the flight means the separation between subsequent departures cannot be reduced to the minimum of one minute and runway flow is affected.
- Because it turns south earlier, the LISTO departure does not interact with other departure routes, and therefore aircraft using this route do not have an impact on runway flow. However, MAN limits the use of LISTO to aircraft of less than 35 tonnes. This long-standing restriction is a voluntary control, it is not required by any planning agreement or other similar condition. The voluntary restriction was always envisaged to apply in the short to medium term, as was communicated to the Consultative Committee's Technical

Advisory Group and reported in the Community Relations Annual Report (published) 2003.

- Continuing to apply the current restriction to the use of the LISTO, in the 'do minimum' would constrain runway flow and prevent the airport from making best use of its runway capacity, which is both a requirement of the SoN and the foundation behind the Design Principle Capacity.

To address these issues with the 'do minimum' option, such that the 'do minimum' meets the requirements of CAP1616 outlined above, the 'do minimum' option incorporates the removal or relaxation of the restriction that is currently applied to the use of LISTO.

While there are potential issues with the 'do minimum' option from the perspective of alignment with the Design Principles, as detailed in the DPE, this option replicates today's operation and the existing departure procedures to PBN standards. The 'do minimum' for departures is therefore a feasible option for further assessment in the DPE and IOA. Even if the 'do minimum' is not an option that would otherwise pass through DPE and IOA, we will retain the do minimum option as we consider it provides a useful (second) baseline against which stakeholders can see the likely impact of the minimum level of intervention required to address the SoN.

4.4.4. 'Do Minimum' Arrivals Options

The 'do minimum' for arrivals would incorporate the following:

- Use of the existing RNAV holds at DAYNE, MIRSI and ROSUN. Because these are the responsibility of NERL, it is assumed that these holds will remain in their existing location.
- ATC vectoring aircraft onto final approach from these holds.
- Final approach available via both RNP APCH and ILS.

As stated in section 4.4.2 above, arrivals are less dependent on navigation aids than departures under normal operations because aircraft are vectored by ATC from the three current holds, as described in section 5.4. As described in section 3.3, NATS have already designed new RNAV holds above 7,000ft, and these are in the same position as the previous conventional holds at DAYNE, MIRSI and ROSUN.

Therefore, for MAN, there are two elements to be considered within the arrivals 'do minimum' scenario.

- The transition from the RNAV hold to the final approach fix (Initial Approach Procedures).
- The final approach fix to the runway (Final Approach Procedures).

Transition: There are currently no conventional approach procedures (or transitions) designed for MAN that take aircraft from the airborne hold to the final approach fix (FAF). There are therefore no procedures that can be created as a PBN replication as a 'do minimum' option in this respect.

Neither the CAA AMS nor the PBN-IR require the design of PBN transitions. Therefore, these are not required in order to be compliant with the Design Principle Policy. Furthermore, whilst CAA have an expectation that airspace change sponsors consider the transitions as a PBN procedure, it is not a requirement to implement them. Therefore, under the arrivals 'do minimum' scenario, aircraft would continue to be vectored from the hold to the final approach as they are today.

Whilst this is a viable technical solution (as it mimics today's operation) it does not align with the Design Principle Policy that requires MAN to optimise environmental performance in line with the AMS. In particular (and as stated in section 4.4.2 above) CDAs are not possible to all runway directions from the current holds at DAYNE, MIRSI and ROSUN, from 7,000ft.

In summary there are therefore no replicated transition do minimum design options that have been designed for arrivals in sections 24 to 36 because:

- There are no existing intermediate approach procedures to replicate. All aircraft are vectored by ATC from the arrival holds at DAYNE, MIRSI and ROSUN which results in broad swathes of aircraft tracks as shown in section 2.2.2.
- The existing Initial Approach Fixes (IAFs), that define the northern holds (MIRSI and ROSUN), are outside of the viable good fit design area and would not permit a CDA to both runway directions.
- Therefore, for the transition element of the arrivals 'do minimum' scenario, aircraft would continue to be vectored from the hold to the final approach as they are today.

Final Approach: CAA policy and the AMS which are driven by the PBN-IR (EU) 2018/1048 requires aerodromes to deploy PBN approach procedures by 2030. Specifically, part-AUR.PBN.2005 requires airports to implement RNP APCH procedures. This relates to the final approach to the runway and is therefore a 'do minimum' requirement.

The 'do minimum' option for this element will therefore be to design Final Approach Procedures using satellite guidance to LNAV, LNAV/VNAV standard. This has been chosen because it is the ICAO recommended standard for the final approach phase and is a navigation specification useable by 100% of the airlines that responded to the fleet equipage survey.

This option closely aligns to today's operation and replicates existing arrivals approach procedures to RNAV standard. Therefore the 'do minimum' for the final approach element for arrivals is a viable option to design.

These final approaches have been designed and are detailed at section 21, 22 and 23 for Runways 05L and 05R and sections 30 and 31 for Runways 23L and 23R.

In summary, the 'do minimum' scenario for arrivals would be:

- Retained use of the current holds of DAYNE, MIRSI and ROSUN
- ATC vectoring aircraft onto final approach from these holds.
- PBN compliant final approach designs created to both LNAV and LNAV/VNAV standard. .

4.5. Controlled Airspace (CAS) Requirements

The system of airspace classification determines the flight rules that apply and the procedures that must be followed. The classification that is assigned depends upon the types of air traffic involved, the density and complexity of air traffic and the need to maintain a high level of safety. In the vicinity of MAN, there is a mix of airspace including Classes A, D and G.

At MAN, the Design Principle Airspace states that 'our route designs should minimise the impacts on other airspace users by limiting controlled airspace.' This design principle therefore seeks to ensure that the needs of other airspace users are considered, including the needs of commercial air transport, general aviation, and the military.

During Stage 2, we have applied the design principles to create a comprehensive list of departure and arrival design options, with the comprehensive nature of the list of design options providing the flexibility to respond to the Design Principle Airspace.

This approach recognises that the MAN Future Airspace project needs to take account of other change sponsors' airspace change programmes within the MTMA as part of the Airspace Masterplan. Considering this, section 3.44 of the DOR references the possibility that the design options identified during Stage 2 may need to be further refined or amended in response to the options of other change sponsors, the solutions to resolve interactions, or the need to manage cumulative impact. For this reason, it would be premature to define future CAS needs at this stage rigidly.

Therefore, the approach taken to the consideration of CAS at MAN is as follows:

a) At Stage 2, we have designed all options within the boundaries of the current CAS to align with the Design Principle Airspace. This is reflected in the assessment for each option within the DPE.

b) In Stage 3 individual design options will be combined into operating networks that cover both arrivals and departures, and the need to integrate them within the wider airspace network. This will support more detailed analysis and evaluation and will allow the CAS requirements for groups of options to be considered. Within this work we will seek to identify:

   - The CAS requirements for the groups of options.
   - Whether changes to CAS dimensions have the potential to deliver safety, environmental or access benefits to stakeholders.

c) This Stage 3 work will be conducted in cooperation with the CAA Airspace Classification team. MAN have already met with this team as part of their data gathering exercise for the Manchester Low Level Route[2] (LLR) and will continue to work with them to inform our work in Stage 3.

d) Any benefits would be likely to accrue across a wide range of aviation stakeholders including ATC and airspace users including airlines, the military, and the general aviation community. Depending on the updated AMS and how airspace classes develop, this may also include drone operators.

[2] The Manchester Low Level Route (LLR) is Class D airspace within which the UK CAA have exempted aircraft from requiring an ATC clearance to fly within the route, providing they fly in accordance with certain specified conditions. It is used by general aviation and helicopters to transit the airspace between Manchester and Liverpool and to route to City Airport (Manchester Barton).

In line with CAP1616, all stakeholders (aviation and non-aviation) will be provided with an indication of the CAS requirements for each set of design options within our Step 3C Consultation material. This will provide an opportunity to review and comment on the analysis undertaken. Comments received will be taken into account and considered as part of the consultation analysis activities in Step 3D.

5. Options Development Rationale

5.1. Introduction

This section describes the supporting rationale that was used to create the MAN comprehensive list of options including:

- Identifying the issues to be addressed in the SoN (5.2).
- The consideration of the design principles (5.3).
- Identifying the nature of the current operations at MAN (5.4).
- A summary of the 3-step process that was applied to develop the design envelopes and design options (5.5).
- A summary of the results from the airline fleet equipage survey and how this has influenced the design criteria (5.6).
- Design Step 1: Creating the design boundary for departures and arrivals (5.7).
- Design Step 2: Details of the constraints and considerations within the boundary we created and how these influenced the design options (5.8).
- Design Step 3: The foundations behind both the design envelopes and the design options based on the information from Steps 1 and 2 and the airline fleet survey (5.9).
- The role of bilateral meetings with other airport stakeholders and NERL in influencing the design options (5.10, 5.11, 5.12 and 5.13).
- How the design options have been classified through the use of a Viability filter (5.14).

Further information on the detailed process used to develop the departure envelopes and options can be found in section 6 and for arrivals in section 19.

5.2. Statement of Need (SoN)

In 2019, MAN submitted a SoN to the CAA, setting out why an airspace change was necessary. This step was completed in July 2019 when the CAA approved the SoN, agreeing that MAN should initiate an airspace change, with a provisional classification of level 1 and an allocated reference of ACP-2019-23.

Step 2A of CAP1616 requires change sponsors to identify a comprehensive list of design options that address the SoN and align with the design principles. To ensure that the design options proposed in the DOR addressed the SoN, the following key requirements from the SoN were considered:

- Removal of the reliance on ground-based DVOR navigational aids by making greater use of satellite based technology.
- Modernisation of airspace arrangements for aircraft operating to and from the airport at altitudes of 7,000ft and below.
- Making best use of new navigational technologies, so that the operational efficiency and environmental benefits that modern aircraft offer can be fully realised;
- Enabling MAN to continue to grow to make best use of its available runway capacity, while balancing the needs of communities and the environment; and
- Integration with other airports and the wider changes to the airspace system being pursued through the national airspace modernisation programme and in particular the FASI-N programme detailed in section 3.
- Alignment to the policies described in the CAA AMS.

The process followed, including the consideration of the design principles during the classification of the design options, reflects these requirements and has ensured the design options are aligned to the SoN.

5.3. Design Principles

During CAP1616 Stage 1, Step 1B, a list of design principles was developed during engagement with stakeholders which are detailed at section 2.3. These design principles function as a framework which underpins how the design options were developed and are used to evaluate those design options.

There are three design principles which the design options 'must' align with.

- Safety: Our routes must be safe and must comply with industry standards and regulations.
- Policy: Any airspace change must accord with the Civil Aviation Authority's Airspace Modernisation Strategy. Any airspace change must also allow connection to the wider UK en route network and be aligned with the Future Airspace Strategy Implementation for the North programme and take into consideration the needs of other airports. FASI.
- Capacity: Our future airspace must enable best use of the capacity of our existing runways, in line with Government policy.

As described in section 5.14, design options that did not align with one or more of these were classified as "viable but poor fit".

Whilst the design principles are detailed, this DOR does not provide a detailed assessment of the design options against these design principles. Instead, these assessments are contained in the DPE.

5.4. Current Operations

MAN has two runways running from a north-easterly direction to a south-westerly direction as shown in Figure 2.

For departures there are currently seven Standard Instrument Departure (SIDs) for Runways 23L and 23R and six for Runways 05L and 05R. These link each runway direction to the NATS en route airspace network at the SID termination altitude of 5,000ft. Departing aircraft follow the SIDs until they have reached a minimum altitude which varies between 3,000ft and 4,000ft. Above this, ATC vectoring is routinely used to provide a route to connect to the NATS upper airspace network which results in a dispersed overflight distribution.

Arriving aircraft approach UK airspace from several entry points before routing towards one of the three holds at DAYNE, MIRSI and ROSUN. ATC vectoring is then used to establish aircraft on final approach to the runway, which again results in a dispersed overflight distribution.

A more detailed description of current operations is provided in section 2.2.

5.5. Design Envelopes and Comprehensive List – Process

In order to respond to the SoN and to create a balanced set of design options, our development process considered five foundation elements, which were applied in a logical sequence to create the design options. These were a blend of regulatory requirements with which we must comply, information from airlines, information relating to the future operations at MAN and the design principles.

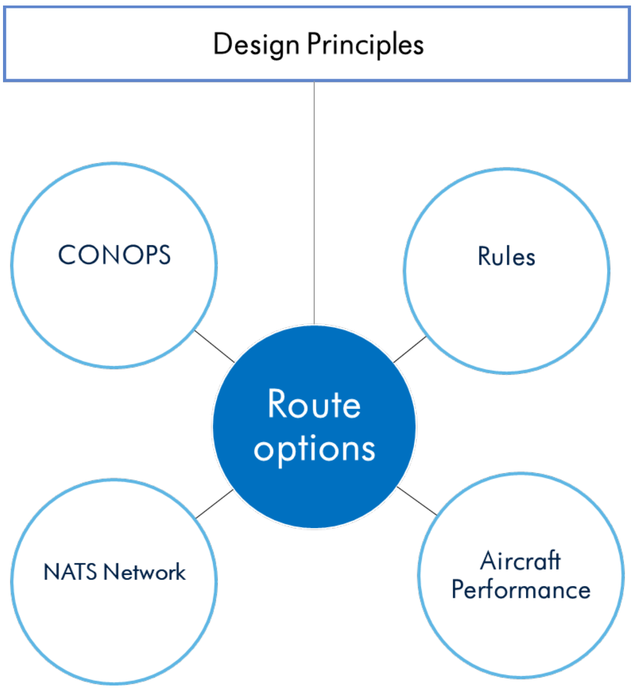


Figure 7: Design development foundations.

A sequence was followed to provide a logical development path using these foundations.

- Step 1 - Information on aircraft performance from the airline fleet equipage survey described at section 5.6, together with ICAO and CAA rules was used to understand where aircraft could fly and to create a basic boundary for departures.
- Step 2 - The upper airspace and operations around MAN were reviewed to identify constraints and considerations.
- Step 3 - We applied the design principles and supporting CONOPS document (as described at section 4.3) to develop a set of design envelopes which terminate at 7,000ft. These design envelopes formed the basis from which to create the comprehensive list of design options that are contained within this DOR.

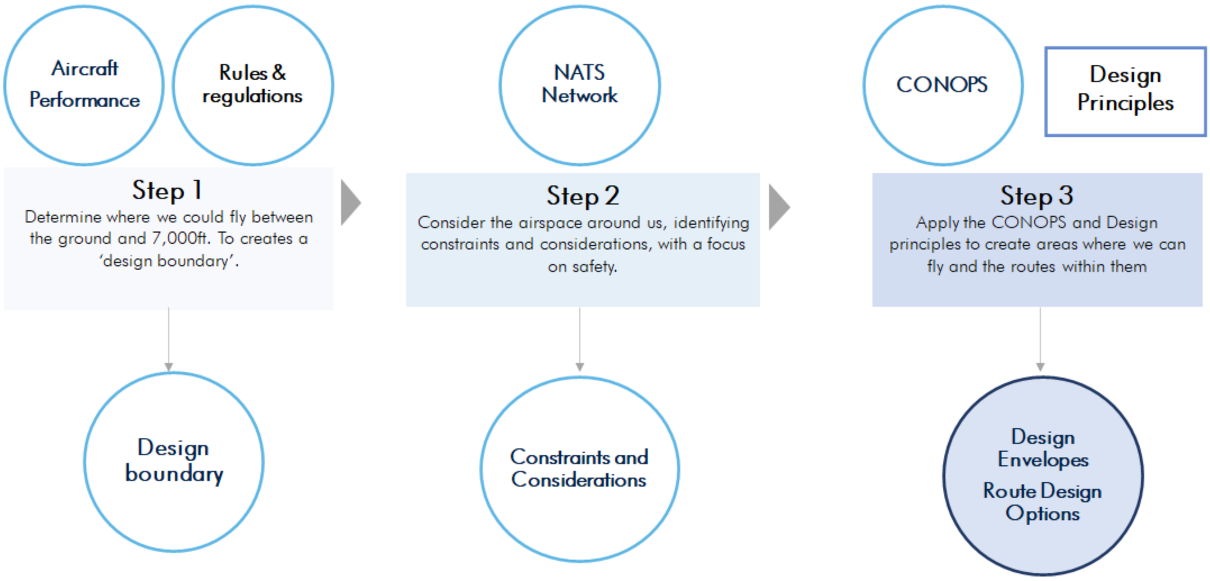


Figure 8: Design envelope development process.

5.6. Airline Fleet Equipage Survey

The Design Principle Policy states that airspace change must accord with the CAA AMS (which requires the use of PBN), and that we should make use of the latest aircraft technology widely available. To give effect to these principles, and prior to the commencement of design activities, we conducted a fleet equipage survey to find out what technology the airlines and their aircraft have and how they could fly.

The aim of this was to understand the capabilities of the aircraft regularly flown into and out of MAN to fly PBN routes, and also to understand the performance that could be achieved in the future. This information was important in informing the design work because it helped create design options that matched the operators' capabilities and responded to the design principles.

This fleet survey was conducted prior to the pandemic in 2020 and reflects the airline mix and percentage of mix at that time. Since that time, a number of older aircraft have been retired from service. The Design Principle Technology requires that the change sponsor's design options should be based on the latest aircraft navigational technology widely available. Feedback received in engagement made clear that stakeholders were keen to see new technology, particularly technology that improved environmental performance, adopted.

However, in some cases, such as the use of GBAS approaches, the fleet survey indicated that the level of equipage was low, and any designs created to these standards would not be aligned to the Design Principle Technology.

Therefore, to ensure the latest understanding of the technology widely available, as there is progression through the MAN Future Airspace project, the Airline Fleet Equipage will be repeated during Stage 3. This survey will inform understanding and allow the practicalities of adopting emerging technological solutions, including emerging options, to be evaluated as they emerge.

ATM Ranking	Airline	Percentage of Movements
1	Ryanair	19.6%
2	easyJet	16.4%
3	Jet2.com	10.1%
4	TUI	8.2%
5	British Airways	4.8%
9	SAS	2.4%
11	Virgin Atlantic	1.8%
13	Emirates	1.4%
15	Brussels Airlines	1.3%
16	Qatar Airways	1.2%
21	Swiss International	0.9%
	Total % of ATM's covered	68%

Figure 9: Responses to the airline fleet equipage survey by airline.

The survey was sent to the top 25 airlines operating to and from MAN which represented 97.4% of the total air transport movements. The original response percentage was 74% but this included airlines who are no longer in operation from MAN, and this has resulted in the reduction in the percentage to 68%.

Of those questioned, 6 airlines did not respond to the survey.

The questions focussed on operations and capabilities in both 2023 and 2028. These dates were chosen because at the time of the survey, the MAN Future Airspace project was programmed to be implemented in approximately 2023. The questions therefore focussed on this operational date, and the expected equipage five years after that date.

The results showed:

- **PBN departure capabilities**: By 2023, all aircraft would be capable of operating to at least RNAV1 (GNSS) capability as a minimum. This removes the need for reference to the ground based DVOR navigation aids that are being withdrawn from service. In addition, 97% of aircraft would be capable of RNP1 operations but only 84% of those would have the ability to perform these with radius fixed (RF) turns. However, this percentage rose to 95% by 2028. Further details of these standards and their application in the design of design options at MAN is detailed in section 6.6.
- **PBN arrivals capabilities**: By 2023, 100% of aircraft would be capable of flying an approach with both lateral and vertical guidance (LNAV/VNAV) and all aircraft will be

capable of flying arrival routes to RNP APCH standard. In addition, 70% would be capable of flying approaches to the Ground Based Augmentation System (GBAS) standard by 2028. However, the implementation of GBAS is not a regulatory requirement and is not planned for implementation at MAN.

- Climb gradients: All airlines that responded could achieve a minimum climb gradient of 6% under 2023 operations. This assumed a scenario of a fully laden aircraft, at an air temperature of +25c. The aim was to provide a scenario where climb performance may be reduced as a result of the combination of high load factor and high temperature which has the effect of reducing lift. In addition, 10 of the 11 airlines would be capable of a 7% climb gradient under the same conditions.

The data on both the PBN capability and climb performance was subsequently used in the creation of both the design envelopes and the design options. The PBN capability was applied to the design options themselves in the creation of the options to both RNAV and RNP1 criteria. The climb data informed the minimum gradient to be applied in the creation of the design envelopes, with design options designed to a default of 6%.

5.7. Step 1 - Design Boundary

The first step was to create the viable design area for departures. This initially applied the information from the aircraft fleet equipage survey, which confirmed that all aircraft operating out of MAN could climb at a gradient of at least 6% to 7,000ft.

This created a theoretical omni directional (circular) line assuming a constant climb (in line with the Design Principles Policy and Technology. We then applied the ICAO and CAA rules on procedure design, including those on the position or radius of the first turn, which created a more realistic design area.

This is shown in Figure 10 below. The outer blue line is the initial line created to 7,000ft, and the blue and yellow areas show the runway specific areas when the ICAO and CAA rules for departure design have been applied. The red hatched area in the centre describes the area within which the rules do not allow departure routes to be designed.

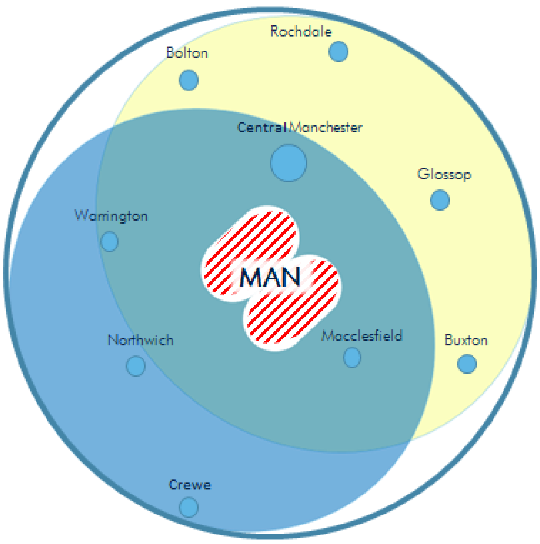


Figure 10: Departure designs boundary

A similar process was then undertaken to create the arrivals boundary. The Design Principle Policy requires alignment to the AMS, which includes the requirement for airspace change to improve environmental performance, specifically noise and emissions. Therefore, in creating this boundary, both the Design Principle Policy and those on noise and emissions guided the process for where the start of the omni directional boundary should be. The underlying rationale was that the quietest (Design Principle Noise N1) and most fuel-efficient method (Design Principle Emissions) of arriving was through a CDA.

CAA and ICAO guidance provides for a range of acceptable gradients for a CDA, but in this first phase a gradient of 5.24% or 3° was used as this is aligns with recommendations within both CAA and ICAO documentation. As with departures, this was constructed as a circular omni directional arrivals boundary, based upon applying this 3° descent gradient from the start of our design responsibility at 7,000ft to the runway. This is shown in Figure 11 below where the outer edge of the blue circle shows the theoretical furthest point away that a CDA could be possible.

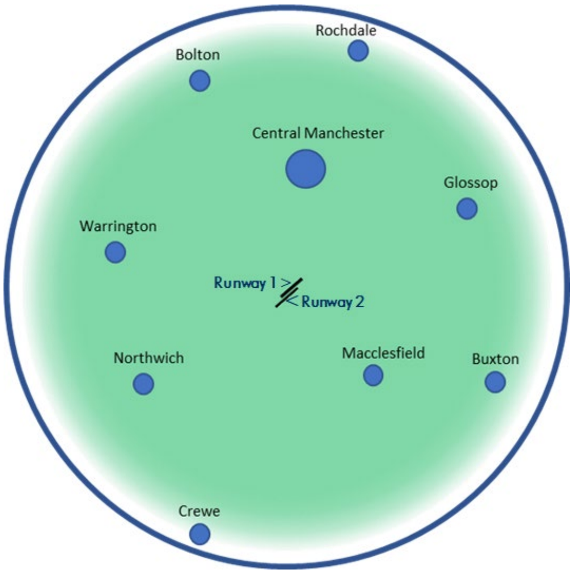


Figure 11: Arrivals design boundary

These boundaries were used to understand the broad area within which we would expect aircraft to be at 7,000ft and to assist in the identification of design constraints. They were also used to inform the process to develop the departure design envelopes in Step 3.

5.8. Step 2 - Constraints and Considerations

Within the design boundaries we identified a number of local factors that impact where design options could be placed. Some of these related to local airspace, whilst others related to adjacent airports or the en route airspace network.

These were separated into either constraints or considerations, and the comprehensive list of design options all took account of these factors. The constraints and considerations were developed by analysing the airspace and current operations in the MTMA and are defined as follows:

- **Constraints** were defined as aspects that have a direct impact on designs, or limit where we can place our design options.
- **Considerations** were defined as aspects that do not limit our designs but which we need to take account of in creating design options.

An initial set of constraints and considerations were developed and shared within the first phase of engagement. Feedback from stakeholders, and bilateral meetings with both NATS and adjacent airports resulted in changes to these as part of the ongoing process of iterative design creation under Stage 2 of CAP1616. Further details on how these have been considered in the design envelopes and design options is at sections 5.10 to 5.13.

Whilst our engagement contained no proposals to change the dimensions of controlled airspace (CAS), as detailed in section 4.5, in line with CAP1616, all stakeholders (aviation and non-aviation) will be provided with an indication of the CAS requirements for each set of design options within our Step 3C Consultation material.

The diagram and details in Figure 12 below represent the most up to date version of these constraints at the time of compiling this DOR. This shows the departures design boundary as the outer blue line, and then the identified constraints and considerations that are within or adjacent to that.

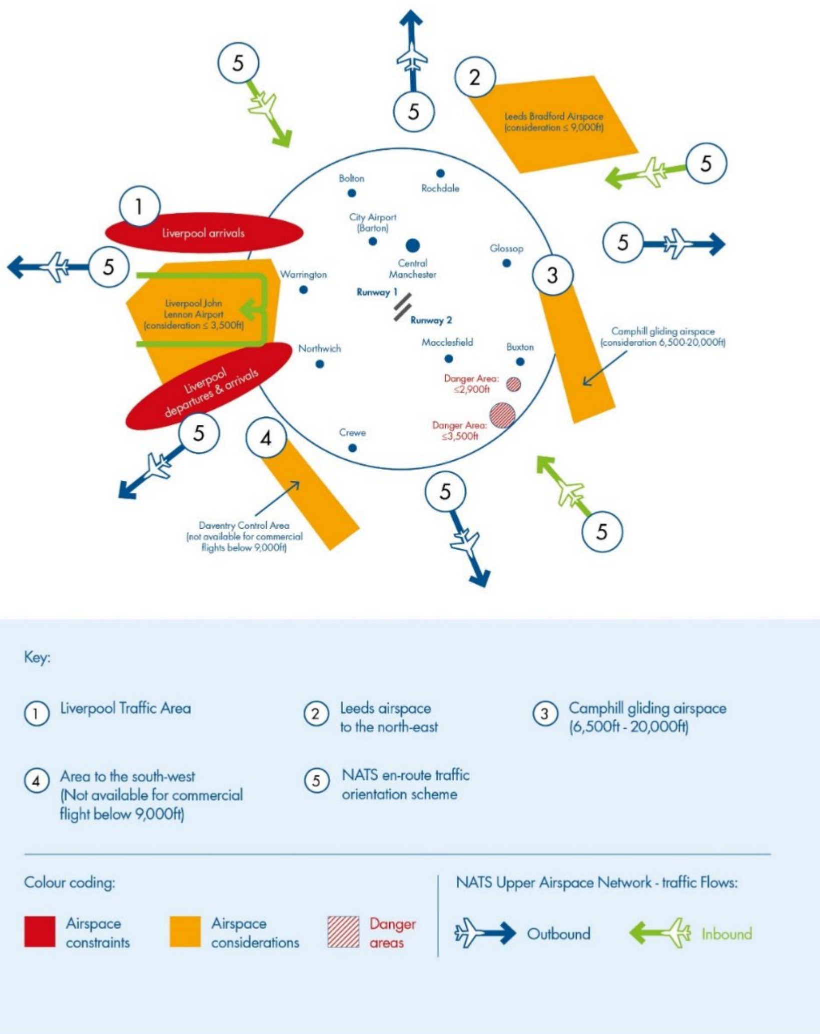


Figure 12: Design Constraints and Considerations

5.8.1. Liverpool John Lennon Airport (LPL) (Constraint and Consideration)

LPL is located 20 nautical miles (nm) west of MAN. It is surrounded by controlled airspace which extends from the surface up to 2,500ft. Additionally, NATS Manchester and NERL Prestwick have delegated portions of airspace above LPL to LPL ATC. The delegation of airspace is necessary to enable the safe and efficient handling of arriving aircraft into LPL. The proximity of the airspace and LPL departure and arrival routes creates a potential interaction to the southwest, west and north-west of MAN. In particular the proposed new arrival routes for LPL to the north-west may create a constraint to MAN future operations.

5.8.2. Leeds Bradford Airport (Constraint)

The Leeds Bradford (LBA) Control Area (CTA) extends to FL85. It is unlikely that MAN arrivals will be able to operate through this area as this may result in interactions with LBA traffic. This has therefore been classed as a constraint in planning design options.

5.8.3. Camphill Gliding Area (Consideration)

The Camphill Gliding Area is a block of airspace to the east of MAN. The use of this airspace is shared between NATS Prestwick and the GA Gliding community. Gliding activity requires prior permission from NATS and can only take place during the hours of daylight. When gliding occurs, the airspace cannot be used by commercial air traffic. The vertical extent of the airspace varies from FL65 to FL195.

5.8.4. Airspace to the South-west - Daventry Control Area (Consideration)

This area is currently uncontrolled airspace from the surface to FL90. Flights by commercial aircraft are generally not permitted in uncontrolled airspace and there is no connectivity to the NATS network in this area. It would not be possible to design arrival options that use this area of airspace. There is also a parachute area at Tilstock which is regularly activated at weekends up to FL100 or occasionally FL110. NERL is treating this airspace area as a constraint in the network airspace ACP and will consider the use of controlled airspace or procedures which overfly this area. However, this will remain a consideration for MAN when planning design options.

5.8.5. NATS Network Traffic Flows (Consideration):

The Design Principle Policy states that our future airspace must allow connection to the wider en route network. The arrows within the diagram at Figure 12 show this network traffic for MAN traffic. Flying against these flows would not be consistent with the Design Principle Policy and MAN designs therefore route traffic in such a way that these connections can be safely and efficiently created.

5.8.6. Other considerations

In addition to the above, City Airport (Manchester Barton) is one of our stakeholders and we need to ensure their needs and access requirements are captured and considered via bilateral engagement. Their airspace extends from the surface to 2,000ft but the distance from MAN means this airspace will not impact our design options. Access arrangement to the airport via the LLR is also a consideration. As detailed above and in section 4.5, City Airport (Manchester Barton) will be provided with an indication of the CAS requirements for each set of design options within our Step 3C Consultation material and will have an opportunity to review and comment on the analysis undertaken.

Lastly there are two military danger areas within our design area to the south-east. D304 extends from ground up to 2,900ft and D314 extends from ground up to 3,500ft. Our analysis of aircraft performance concluded that neither of the danger areas would impact our departures or arrivals because of the low altitude they extend to. However, these are noted on the map for completeness and were communicated to stakeholders during the engagement process.

5.9. Step 3 - Design Envelopes and Design Options.

5.9.1. Design Envelopes

Having considered all the factors in Steps 1 and 2, a set of design envelopes were developed to serve as the foundation for creating design options.

These design envelopes are defined as a 'swathe' or wide area of airspace that exists between the runway and 7,000ft and have a number of characteristics:

- The design envelopes are created bearing in mind the design principles, especially the three "must have" principles - safety, policy, capacity. However, the comprehensive assessment of the design options against the design principles is performed in the DPE.
- The design envelopes should support the creation of routes that adhere to PBN standards. This is in accordance with the Government's AMS and the design principles Policy and Technology.

Departures: The initial Departure design envelopes are shown in Figure 13 below. These were shared with stakeholders in the first phase of engagement and were updated following feedback. The updated versions and the changes made following the first phase of engagement can be seen in sections 6.4.1 and 6.4.2.

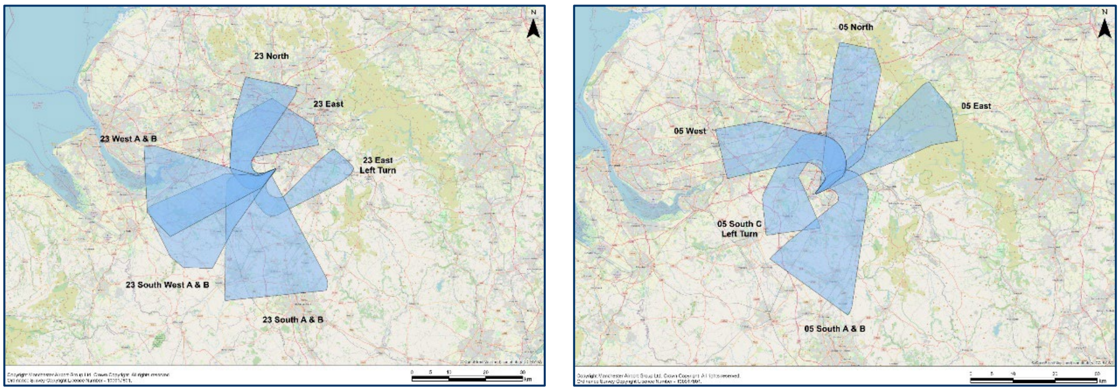


Figure 13: Initial departure design envelopes.

For departures the envelopes are based on a 6% continuous climb gradient to 7,000ft.

These departure envelopes are based around current routes where they exist. New envelopes were created if there may be a benefit aligned to one or more of the design principles including noise or emissions. These envelopes are at least 8km wide (4.5nm) at 7,000ft. This is to provide a wide area to design options which respond to the design principles and are sufficiently flexible to respond to stakeholder engagement feedback. Further information on the departure envelopes can be found in section 6.

Arrivals: The Arrival design envelopes were created by applying ICAO PANS-OPS and CAA guidance for a 3° CDA from 7,000ft, and assuming a minimum 2,000ft FAF for both runway directions. This FAF was chosen to create the largest possible design envelope area and therefore a comprehensive range of options.

This process created an arc for each runway where a CDA would be achievable, and where these arcs overlap, a CDA would be possible to all four runways. This overlapping area is defined as the arrival's design envelope and is shown in

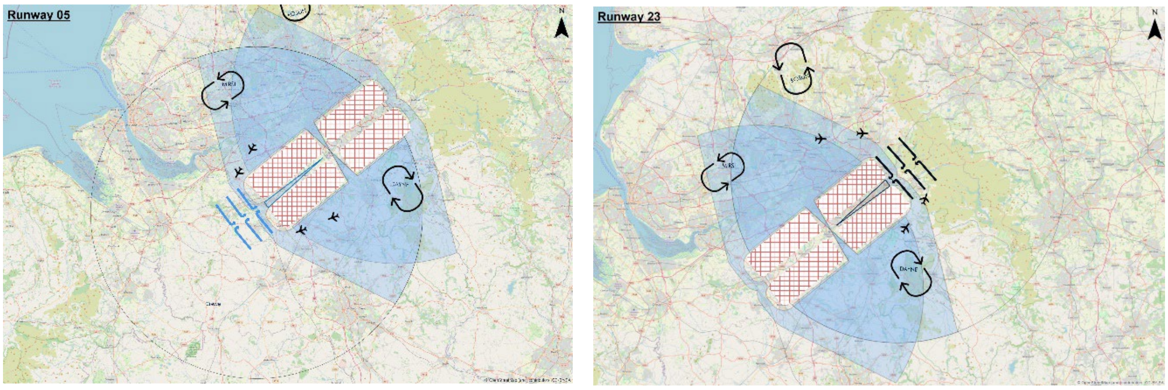


Figure 14 below. This also shows the position of the current holds (MIRSI and ROSUN to the north and DAYNE to the south) and demonstrates that, for the northern holds of MIRSI and ROSUN, their position is either at the limits of, or outside of the design envelope.

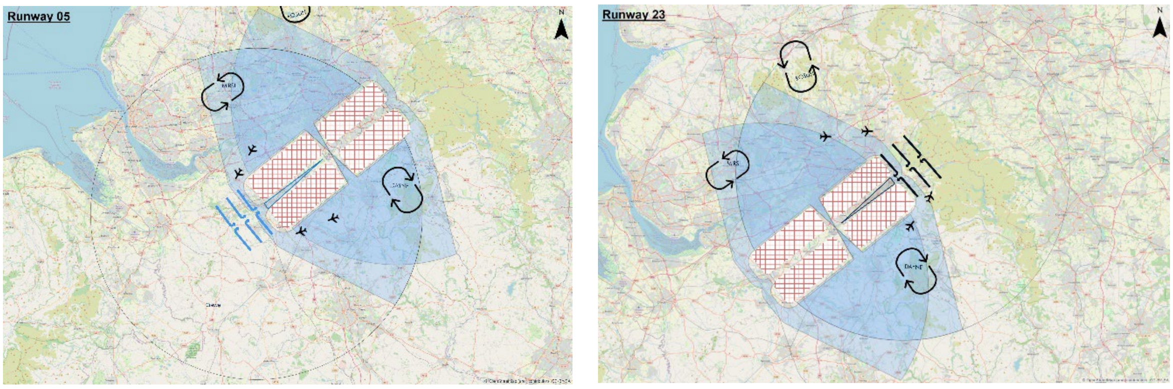


Figure 14: Arrivals design envelopes

These were shared with stakeholders in the first phase of engagement and provided the area within which arrival design options are created. Further information on the arrivals envelopes can be found in section 20.6.

5.9.2. Design Options

Following the first phase of stakeholder engagement, changes were made to the design envelopes to take account of stakeholder feedback as detailed in the Stakeholder Engagement Report (SER) and in section 6.4 of the DOR. Design options were then created within each design envelope.

- For **departures**, the starting point for the design of the design options was a PBN replication of the existing SID (if there was an existing SID within the design envelope) to represent a 'do minimum' baseline. Having established the 'do minimum' option for the design envelopes containing existing routes, further design options were developed within the design envelope that complied with the design principles. The aim of any new routes was to achieve a clear and objective benefit that aligned with one or more the design principles. Examples include creating a more direct route to reduce emissions, reducing the number of people overflown or avoiding noise sensitive areas. All SID design options terminate at 7,000ft.

Where a design envelope did not contain an existing route, a new set of design options were developed using the same principles.

An example of the departures material presented to stakeholders is shown at Figure 15 below.

Departures options example – Runway 05L/R East

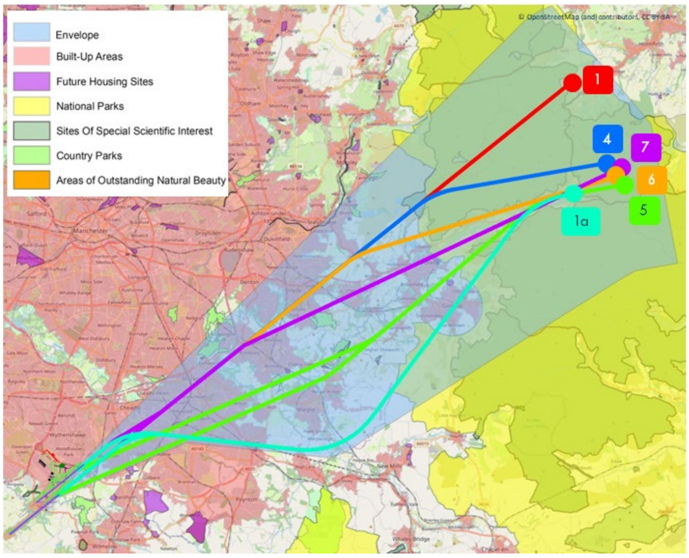


Figure 15: Example departures envelope containing design options.

- The **arrivals** design envelope was created by applying the 'must-have' Design Principle Policy and the requirement to provide a CDA. This resulted in an area contained within the overlapping area between two arcs and design options were then created, commencing at an Initial Approach Fix (IAF) of 7,000ft. As with departures, design options were developed based on one or more of the design principles. Arrivals design options were designed to join the final approach at a Final Approach Fix (FAF) which varies according to the runway, but commences at either 2,000ft, 2,500ft, 3,000ft or 3,500ft.

An example of the arrivals material presented to stakeholders is shown at Figure 16 below.

Arrivals options example – Runway 23R South

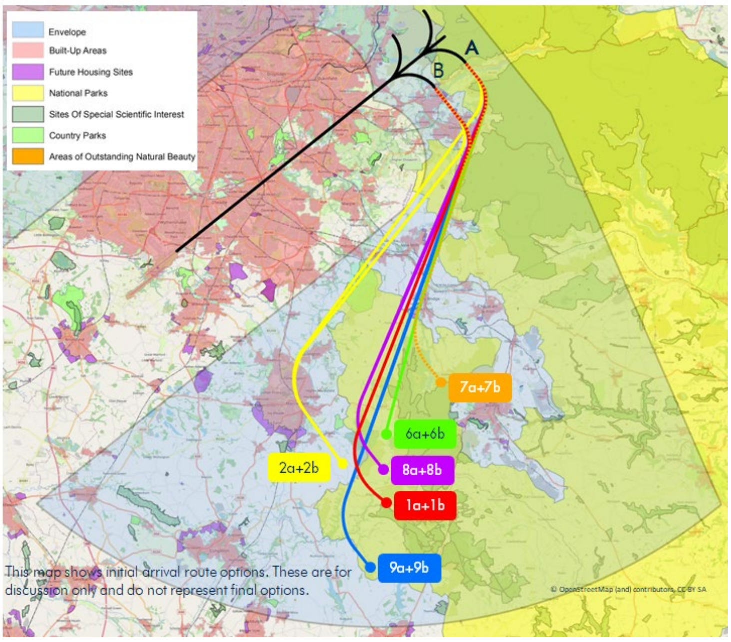


Figure 16: Example arrivals envelope containing design options.

Any option unable provide for CDAs for both runway ends was not fully aligned to the Design Principle Policy and could only be classed as viable but poor fit, with reference to the route classification exercise detailed in section 5.14 below. Further detail on this aspect is provided at section19.3

For both departures and arrivals, each design option, and the link to the relevant design principles, was communicated via phase two of the stakeholder engagement process, with further changes being made to the design options to take account of the feedback received (as detailed within section 6 of the SER).

As part of the engagement process, Airspace Change Organisation Group (ACOG) facilitated a collaborative design review in June 2022 with technical SMEs including representatives from ATC at MAN, LPL and NERL. This workshop assessed the potential route interactions between the options at MAN and those for LPL (which at the time of writing is paused at Step 4A of the CAP1616 process). The meeting identified several design interactions and considerations, and this was treated in the same way as other stakeholder feedback received as part of the formal MAN engagement process. The detailed feedback on the interactions discussed at this meeting resulted in viable options being created for both departures and arrivals. Following assessment in the DPE and IOA, these options will be progressed to Step 3a in order to assess the routes within bilateral discussions with LPL and as part of cumulative impact work at Stage 3. In tandem, further discussions will be held with LPL. Further details on this work are contained in section 5.11.

5.10. Bilateral Meetings: Feedback on Design Options

CAP1616 recognises the need for all parties involved in airspace changes to undertake stakeholder engagement as a vital element of the airspace change process. Within the MAN Future Airspace project, this engagement has been via a variety of means, details of which are included in the SER (particularly sections 2.1, 6.2 and 6.4) and in the associated Appendix 2 - Chronology of Engagement.

As part of the design development process, we used a series of bilateral meetings with airports within and around the MTMA (including other change sponsors) to communicate progress on the project, and to obtain feedback on the design concepts and design options being created. Feedback has then been accounted for within the design process and changes incorporated where required.

5.11. Bilateral Meetings: Liverpool John Lennon Airport (LPL)

LPL is the closest major airport to MAN and resolving any interaction between routes is a key outcome from this airspace change in line with the aims of the AMS.

Bilateral meetings have been held with LPL throughout the process of developing the design envelopes and the design options. LPL were also involved in the HAZID exercise undertaken as part of the safety process and provided formal feedback within the MAN Stage 2 engagement process. This feedback has been used to inform the development of both the design envelopes and the routes within them.

Throughout this phase of design options development for MAN, LPL have been paused at Stage 4 of the ACP process. They have consulted on their design options, but not entered the process for a CAA decision in Stage 5 and implementation in Stage 6. As a result, discussions with LPL have been based on their consulted routes, but with an acknowledgement that these are not approved. As stated in section 4.3h) feedback and discussions with LPL have assumed 3nm radar separation within the MTMA.

In addition to the bilateral meetings and the stakeholder engagement process, the Airspace Change Organisation Group (ACOG) facilitated a collaborative design review in June 2022 with technical experts from MAN, LPL and NERL. This workshop assessed the route interactions between the options at MAN and those for LPL and identified several design interactions and considerations. These were assessed for potential operational solutions which were agreed by those present via the formal notes of the meeting, and which resulted in additional or modified viable options being created for MAN departures and arrivals which are included in this DOR. The basis of these changes was to deliver an operationally feasible solution that:

- aligns with the AMS
- meets safety and PBN design standards
- maintains route availability and capacity for each sponsor.

The position of LPL to the west of MAN focussed discussions on:

- Departure design envelopes and design options from MAN Runway 23L/23R to the west, south-west and south.
- Arrivals to MAN Runway 05L/05R from the north.

No interactions or concerns were identified by LPL in relation to MAN departure routes from Runways 23L/23R to the north, south or the east or on any departure routes from Runways 05L/05R. In addition, no interactions were identified with MAN arrivals to Runways 23L/23R or to Runways 05L/05R from the south.

5.11.1. Interaction 1: LPL arrivals vs. MAN 23L/23R west departures:

MAN 23L/R West departures is a new envelope aligned to current operational practice where MAN flights are turned right direct to WAL after passing 4,000ft. However, an interaction was identified between MAN departures and both the LPL controlled airspace and the LPL base leg arrivals from the north. These route to a final approach fix (FAF) at 7nm. Possible solutions identified were:

- Shorten the LPL final approach by moving the FAF further west.
- Modify MAN options through changes to the vertical profile to avoid LPL controlled airspace. This resulted in the creation of options 7 to 12 within the MAN 23 West Design Envelope.

5.11.2. Interaction 2: LPL arrivals vs. MAN 23L/23R south-west departures:

Whilst MAN departures within MAN 23L/23R South-west Design Envelope were assessed as being separated from LPL airspace, an interaction was identified between south-west departures and the LPL base leg turn from the south (VEGUN arrival route). Possible solutions identified were:

- Remove the LPL left-hand VEGUN LH arrival and use a right-hand VEGUN for all arrivals.
- Remove the LPL left-hand VEGUN LH arrival and use a redesigned right-hand VEGUN for all arrivals.
- Redesign the LPL left-hand VEGUN LH arrival to reduce the base leg, combined with a MAN design of additional options to provide separation. This resulted in the design of options 8 to 10 within the MAN 23 South-west Design Envelope.

5.11.3. Interaction 3: LPL departures vs. MAN 05L/05R arrivals

Three interaction scenarios were identified in relation to MAN 05L/05R arrivals.

The first is the infrequent, but possible scenario when MAN is landing on Runway 05 and LPL is landing on Runway 27. This has potential to create a conflict between the two arrivals routes in an area between Warrington and Northwich. Possible solutions identified were:

- LPL prohibit the use of the VEGUN LH arrival in this runway configuration.
- The creation of more controlled airspace to enable a lateral solution. However, this did not align with the MAN Design Principle Airspace.

It was agreed between MAN and LPL that the safest option to resolve this interaction would be for LPL to prohibit the use of the VEGUN LH arrival when in this configuration, which aligns to current operational practice.

The second interaction was between LPL Runway 09 Left Turn departures and MAN Runway 05 arrivals. The LPL Runway 09 Left Turn out option routes initially to the east which may result in it not being laterally separated from MAN 05 arrivals. Possible solutions identified were:

- LPL SIDs have a vertical constraint applied to them to ensure safe separation.
- MAN arrivals have a level segment applied within the approach transition.

This scenario did not lead to any additional or modified options being created in the workshop, but these will be addressed as part of the next steps described at section 5.11.4.

The final interaction scenario was between LPL Runway 09 right turn departures and MAN Runway 05 arrivals. The LPL Runway 09 Left Turn out option routes initially to the east before turning right to route south. When applying the CAA CAP1385 PBN separation criteria these routes may not be separated by the required distance. Possible solutions identified were:

- Reduce the length of the MAN final approach by moving the position of the final approach fix further east. This resulted in the design of options 7c, 12 and 13 within the MAN Runways 05L/05R North Design Envelope being designed to a 2,000ft FAF. However, it was noted that MAN require the flexibility to vector to variable points on final approach to meet the design principles Capacity and Noise N2 to provide noise relief. Previous engagement feedback identified variable joining points as one way to achieve this and the requirement for all traffic to join at this altitude would compromise this.
- Create a tighter turn radius on the LPL departure to match what is currently flown.
- Undertake more detailed work to confirm the applicable PBN separation criteria to resolve the interaction.

This scenario did not lead to any additional or modified options being created in the workshop, but these will be addressed as part of the next steps described at section 5.11.4.

5.11.4. LPL Next Steps

Following the feedback from engagement and the ACOG collaborative workshop, a further meeting was held by ACOG. The aim of this was to agree a framework plan for collaboration and engagement between MAN and LPL to resolve the interaction issues identified. The working assumption within this meeting was that the LPL ACP would be un-paused, and their ACP would return to an earlier stage in the process. This would allow them to work collaboratively to create an efficient and holistic system within the MTMA, that takes account of the cumulative impacts of the possible solutions to the identified interactions.

The expected outcome is a programme of workshops to resolve route interactions between MAN and LPL, which would involve the airports and NERL. It was agreed that this activity would take place towards the latter part of 2022. Therefore, and because of these upcoming discussions we have not discounted any 'viable and good fit options' that might be needed to resolve the identified interactions and we will continue to consider interactions with LPL at Stage 3.

5.12. Bilateral Meetings: NERL

Bilateral meetings and workshops were held with NERL to explore the network solutions which could align with the design concepts being developed as part of MAN Future Airspace project.

As part of NATS Project L6268 – TMA Definition, NERL ran a number of airspace development workshops with MAN. This was attended by SMEs from both NERL and MAN ensuring that the design options were a product of co-ordination and agreement between both parties. The aim has been to inform the NERL development of their 'long list' of possible options in order to build their Stage 2 ACP submission.

The output from these sessions has been captured in the MAN Airspace Design Workshop Record (ADWR). This is a NERL document which details the design assumptions used by both parties long list of potential network concepts which the group considered and discussed. The ADWR document tells the story of how concepts, options and designs have developed and is the formal NERL record of the output from the meetings and will be used to support the NERL Stage 2 ACP submission.

The NERL network design options were considered as high-level concepts. Concepts which were not considered viable due to existing airspace constraints, or that did not address the statement of need or align to the NERL and MAN design principles were rejected and no further work undertaken. The reason for rejection was recorded by NERL.

Concepts which were considered as viable were recorded, along with their associated rationale. These concepts will be developed into more mature network solutions by NERL throughout Stage 2 of their own ACP CAP1616 process.

Initial work with MAN considered previous NATS 'proof of concept' work on arrivals patterns and holds above 7,000ft. Some of this was undertaken prior to the commencement of the current NERL level 1 ACP and covered:

- The creation of two-point merge structures to the north and south of MAN.
- A combination of conventional type holds (to PBN standards) and point merge.
- The use of conventional type holds to PBN standard only.
- A single multi-merge option that switches according to runway direction.

In summary, the NERL engagement provided,

- An agreed set of assumptions for both NERL and MAN (including the Traffic Orientation System, Constraints and Considerations and FIR Coordination points).
- A long list of Network Design Concepts, some considered viable and others unviable.
- Multiple options to provide traffic delay absorption for the MTMA which included both Point Merge and regular 'racetrack' holding facilities.
- A record of the discussions and a foundation to continue to develop options which were considered to deliver benefits to both the MAN Future Airspace project and the NERL ACP.

MAN will continue to work collaboratively with NERL through subsequent stage of the network ACP to create a network design that facilitates the MAN design principles. As part of this, MAN have provided route information to NERL in order to populate their visualisation simulations to advance the latest proof of concept developments. Further work based on the results of this and future simulations is expected in Step 3a of the MAN Future Airspace project.

5.13. Bilateral Meetings: Other airport stakeholders

- Leeds Bradford Airport (LBA): Arrivals to LBA from the south have the potential to interact with MAN departures to the east, but any interactions would be in NERL airspace above 7,000ft. It was agreed that no changes to MAN design options were required but any discussion with NERL in Step 3a on network joining points should take account of this.
- Doncaster Sheffield Airport (DSA): The possible interaction between MAN departures to the east and UPTON departures from DSA were discussed, but any interactions would be in NERL airspace above 7,000ft. It was agreed that no changes to MAN design options were required. This work was undertaken prior to recent announcements regarding the closure of DSA.
- City Airport (Manchester Barton): The possible interaction between MAN traffic and City Airport traffic was discussed. It was confirmed that all MAN departure and arrival options will be in the range of 2,500ft-4,000ft in the vicinity of City Airport. It was agreed that no interactions existed and no changes to MAN design options were required.

Discussions also covered the potential for MAN to require additional airspace. It was confirmed that no changes were presently envisaged as part of MAN Future Airspace project, and that changes that have the potential to improve access arrangements for City airport would be investigated as part of Step 3A detailed design work, as detailed in section 4.5.

Barton will also be involved in any discussions with CAA regarding future CAS requirements and the use of the Manchester Low Level Route (LLR) as detailed at section 4.5c).

- Hawarden Airport: Radar control for Hawarden operations is performed by Liverpool due to the proximity of their operations, and respective airspace. All of the proposed MAN design options would be well above Hawarden traffic which would be below 3,500ft near Liverpool/Chester.

One potential issue was identified: there may be limited space to separate MAN Runway 05 arrivals (easterly operations) to a 3,000ft FAF and Hawarden arrivals if they are operating on Runway 22 (westerly operations). This feedback resulted in Runway 05 design options being designed with a range of FAFs, from 3,000ft to 2,000ft.

- Warton Airport: It was agreed that no interactions were present, and the proposed options would not impact Warton operations. The ability for Warton to access controlled airspace was identified as important and MAN confirmed that there is no intention to change the shape or dimensions of the current airspace architecture to the north of MAN. It was agreed that changes to controlled airspace dimensions would be investigated as part of Step 3A detailed design work, as detailed 4.5.

5.14. Design Option Classification – The Viability Filter

In line with CAP1616 the change sponsor created a comprehensive list of design options. This was done by using the design principles and feedback from engagement to guide the placing of the design options within the design envelopes. This created a balanced set of options because each design option addresses at least one of the design principles. The rationale for the creation of each option is described in the design options description in sections 7 to 18 for departures and sections 24 to 36 for arrivals.

However, because of the width of the design envelope and the need to create a comprehensive list of options, the result was that not all of the design options initially created were feasible options or would align with the 'must have' design principles.

Our design process adopted an approach that identified a long list of options and then refined this list of options to focus on the viable options to be progressed to the full DPE. To achieve this, a qualitative viability filter was applied to the long list of design options. This resulted in design options being classified in one of three categories according to their compliance with safety requirements and alignment with the 'must-have' design principles. These 'must-have' design principles are Safety, Policy, and Capacity, as identified at Stage 1 of the CAP1616 process. The categories assigned to the design options were:

- Unviable;
- Viable but poor fit; or
- Viable and good fit.

The flow diagram below shows the process used to differentiate between each category.

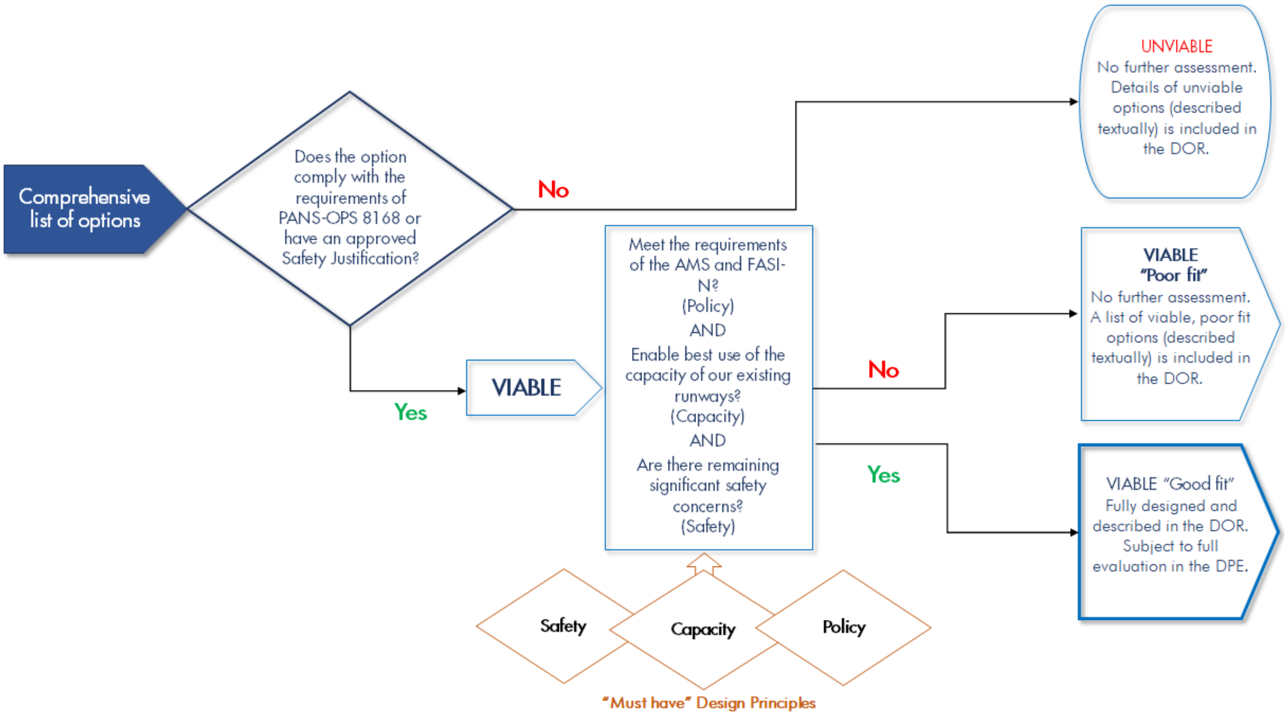


Figure 17: Flow diagram of viability analysis

5.14.1. Unviable

'Unviable' design options were defined as options that:

a) Would not fully comply with the requirements of PANS-OPS 8168 or;

b) Would not have an approved safety justification for the non-compliance with the PANS-OPS criteria.

At MAN a number of SIDs have the first turn after departure that is within PANS-OPS criteria for the first turn and at a point that is less than the 1nm recommended within UK CAA CAP778. These SIDs are supported by a CAA approved unit safety case and have been demonstrated to be safe since their introduction. On this basis, any option that replicated these routes or which had a first turn at an identical position were not classified as being 'unviable'.

'Unviable' design options include those that may be non-compliant with PANS-OPS in relation to:

- Minimum Stabilization Distance (MSD).
- Position of the first turn in relation to departure end of runway (DER) within PANS-OPS.
- Turn radius based on speed, altitude and climb gradient.
- Procedure Design Gradient (PDG).

The categories and nature of the design options identified as 'unviable' are summarised for each design envelope within a table at the end of each section. However, due to the volume of non-compliant options, these were not designed or subjected to further analysis. This approach is consistent with both the Design Principle Safety, and the guidance given in CAP1616 paragraph 127, which acknowledges that the scope for multiple options may be limited where, for example, options do not align with relevant international standards (in our case, PANS-OPS 8168).

The basis for options being Unviable is described but these were not progressed to the DPE or IOA.

5.14.2. Viable but Poor fit

'Viable and poor fit' options are those that would not meet the requirements of the design principles Safety, Policy or Capacity. These options are described in this DOR and the DPE but were not subjected to a full evaluation in the DPE or progressed to the IOA, as they do not address the SoN or align with the design principles. The assessment undertaken was based on qualitative operational judgement and took place within the design process by the relevant SMEs.

It should be noted that this basic assessment does not replicate or replace the Design Principles Evaluation (DPE) process which evaluates each viable and good fit option against the full range of design principles. This exercise applied a basic qualitative operational judgement to the options and covered aspects such as:

- Clear and unsafe conflicts with other routes at MAN.
- Clear and unsafe conflicts with routes at adjacent airports, or with other areas of airspace.

- Environmental performance and routes that were fuel inefficient because of the highly indirect nature of their track which would not be aligned to the design principle Policy.
- Options which routed through areas where we had identified constraints or where there was an obvious interaction with other routes. This includes options that route in directions that conflict with the network traffic flows identified in section 5.8.

The criteria used at this stage are described below:

- Safety: The application of this design principle identified the potential for inbuilt operational hazards or where significant safety concerns were present. This included where the relevant option has the potential to create a hazardous interaction between the route and other aircraft either at MAN or at adjacent airports. Alternatively:

  ✓ The route may have extended into uncontrolled or Class G airspace. Routing commercial aircraft within this class of airspace, which is also used by general aviation, is not considered to be safe, and all departure and arrival design options must remain wholly inside controlled airspace in accordance with CAP778 and the CAA Controlled Airspace Containment Policy Statement.

  ✓ It may not comply with UK CAA airspace containment requirements with respect to the minimum distance between aircraft operating in Class D airspace (the airspace surrounding MAN) and Class G airspace.

  In the absence of a full safety analysis at this stage of the CAP1616 process, where such an interaction has been identified, a qualitative assessment was made to ascertain whether the relevant design option was classified as viable and good fit or viable but poor fit. This assessment is detailed within the rationale for each Viable but Poor fit option.

- Policy: The Air Navigation Guidance 2018 and the CAA AMS (CAP1711) set out initiatives that airspace modernisation must deliver. These can be summarised as:

  a) Safety: Maintaining and enhancing high aviation safety standards.

  b) Efficiency: The most efficient use of airspace and the expeditious flow of traffic including greater runway throughput.

  c) Integration: Facilitating the greatest possible access to all users.

  d) Environmental performance: including shorter or more fuel-efficient flightpaths and allowing for noise impacts to be better managed. This includes the use of CDAs and CCOs. Within the MAN Future Airspace project, the CDA gradient required for an option to be classified as Viable and Good fit is between 3.5° and 1.5°. This is within PANS-OPS CDO recommended range and also encompasses the optimal descent gradient identified within CAA Low Noise Arrival Metric (CAP2302). Options that have a gradient outside of this range are classified as Viable but Poor fit.

  e) Defence and security: ensuring designs take account of the interests of national security.

  f) International alignment with ICAO and the EU.

- Capacity: The application of this 'must have' design principle identified design options which may create interactions with airborne holds, arrival routes or departure routes. Whilst not unsafe, these may require ATC intervention and result in a reduction in capacity. This assessment is detailed within the rationale for each viable but poor fit option.

Where a design option is judged to be misaligned with one or more of these objectives, a qualitative operational assessment was made to ascertain whether the relevant design option was classified as viable but poor fit.

This output for assessment is detailed within the rationale for each viable but poor fit option and describes the non-compliance and assigns a colour status of the option against the 'must have' design principles.

Red	The option was judged to be misaligned to the design principle.
Amber	There is a high probability of misalignment to the design principle. Further analysis would be needed to confirm this, but SME judgement determined that the likelihood of misalignment was sufficiently high to justify an Amber categorisation.
Green	No misalignment was identified.

Table 4: Viable Poor Fit options: colour categories.

Any option that was categorised for any of Safety, Policy or Capacity as being either red or amber was deemed to be viable poor fit.

5.14.3. Viable and Good fit

Design options that were classified as 'viable and good fit' were defined as routes that would be expected to meet the three 'must have' design principles Safety, Policy and Capacity with which all design options must comply. These are included as numbered options in this DOR and were progressed for full evaluation within the DPE.

6. Departure Designs – Introduction

6.1. Overview

Sections 7 to 18 of the DOR provide a technical overview of the departures design envelopes and a breakdown of the design options within them. In line with CAP1616 guidance, the departure design options start at the runway and end at 7,000ft.

This section of the DOR contains details of:

- A summary of the Departure Design Envelopes (6.2)
- The development process to create the Departure Designs. (6.3)
- The Design Envelope changes in Stage 2 (6.4)
- The creation of Departure design options (6.5)
- PBN design criteria (6.6)
- Climb gradients (6.7)
- A summary description of the departure options (6.8)

6.2. Departure Design Envelopes Summary

The MAN design envelopes start at the runway and expand until they are 8,000m or approximately 4.5nm wide when they reach 7,000ft. This approach provided lateral flexibility to create design options that respond to different elements of the design principles and to respond to stakeholder feedback through the engagement process. To enable us to create the widest range of options, the design envelopes are defined by the end point of the routes created within them, rather than by defining a fixed end point for all design options. Again, this gave us the ability to create different lateral and vertical tracks for the design options.

The dimensions of the design envelopes are based upon the rationale and diagrams within CAA CAP1498 'Definition of Overflight' document. This states that a 1,888m lateral displacement at 7,000ft would be expected to result in a 3dB reduction in noise which is the minimum difference that can ordinarily be perceived on the ground. By expanding the width of the end of the envelope from 1,888m to a 4,000m lateral displacement either side of centreline this will equate to a total end width of 8,000m or 4.32nm and a broader range over which to reduce the impact of noise.

For design purposes, the total end width was rounded up to 4.5nm to provide a wide area within which to create design options.

6.3. Departure Design – Development Process

The departure design process comprised a sequence of steps commencing with the creation of our initial design envelopes – broad areas where it would be possible to design options. The process to create the initial design envelopes is detailed in section 5.7 and 5.9.

For departures, this exercise included the consideration of:

- The PANS-OPS criteria, with regards to the initial turn after departure. This ruled out certain areas within the initial boundaries where we could not put forward design options.
- The constraints and considerations which may impact departures as detailed in section 5.8. These included operations from adjacent airports, such as LPL and LBA, and the NATS upper airspace network traffic flows.

Having established the above constraints and considerations, a set of initial design envelopes were produced, taking into account:

- Rules: CAA and ICAO PANS-OPS rules relating to Instrument Flight Procedure (IFP) design, including turn altitudes and radius and stabilisation requirements.
- Aircraft performance: The fleet equipage survey gave us detail on the navigation standards that airlines can fly and the climb performance they can achieve.
- Network: Traffic flows within the MTMA and potential 7,000ft connection points for MAN traffic (both arrivals and departures).
- Design principles: The design principles as detailed in section 2 and the SoN that supports these.
- CONOPS: The MAN CONOPS to support the change, specifying how the new airspace should work.

As detailed in section 6.2 the design envelopes start at the runway and expand in a linear fashion until they are 8,000m or approx. 4.5nm wide when they reach 7,000ft. This approach provided lateral flexibility to create design options that responded to different elements of the design principles, including noise, track length or interaction with traffic from other airports.

In the phase one engagement, stakeholders were presented with an initial set of six design envelopes for Runways 23L/23R and five design envelopes for Runways 05L/05R. These were based around the current route network with additional envelopes to add flexibility, and stakeholders were asked to comment on both the concept and the position of these design envelopes. We then considered this feedback and applied the design principles to refine the design envelopes and create a comprehensive list of design options within them.

6.4. Design Envelope Changes – Stage 2

For some design envelopes, the process of considering the design options and the stakeholder feedback had the effect of changing the dimensions or position of the design envelopes from the initial designs shown to stakeholders during the phase one engagement, with the updated designs then being presented during the phase two engagement. In the case of Runways 05L and 05R one envelope was added (Runway 05 south-west) to ensure access to the NATS route network in that direction.

The maps below show the design envelopes shared with stakeholders. These include the amendments that were made to the design envelopes between the phase one and phase two engagement, including where envelopes were extended, new envelopes added (in blue) and where areas were removed (red).

6.4.1. Runways 23L and 23R changes

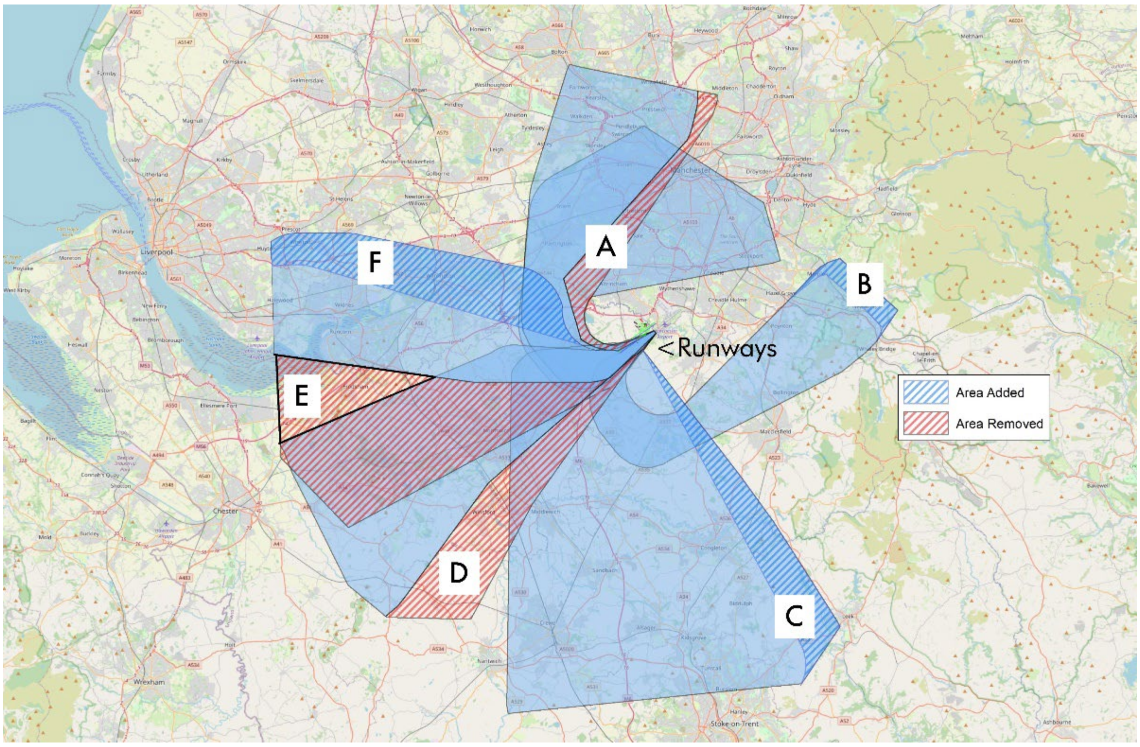


Figure 18: Runway 23 Design Envelopes

- In Design Envelope 23 North an area (A) was removed along the right-hand edge of the envelope in order for the envelope to conform to PANS-OPS 8168 turn criteria. The updated envelope matched to the radius of the earliest turn possible to align with both design principles Safety and Policy.
- In Design Envelope 23 East Left Turn (B) a small extension was made at the end of the design envelope at 7,000ft. This took account of a route that was designed to be as short as possible in line with the Design Principle Emissions.
- In Design Envelope 23 South (C) an area was added to allow the design of design options that avoid Congleton in line with the Design Principle Noise N1.
- In Design Envelope 23 South-west (D) the size of the envelope was reduced to avoid potential interaction between design options in this envelope and those in the 23 South envelope in line with the design principles Safety and Capacity.
- The initial design envelopes included existing routes for Runways 23L/23R South-west that were duplicated as part of the Runway 23R/23L West envelope. In line with the design principles Safety and Capacity, and to make the use of the envelopes clearer the west

and south-west envelopes were separated to create two distinct envelopes. As detailed at section 6.2 each design envelope is approximately 4.5nm wide, and this process of creating two separate areas resulted in an area between these two envelopes (E). Figure 18 shows this as the small triangular area marked with a thick black line between Runways 23R/23L South-west and Runway 23R/23L West envelopes. In line with the Design Constraints and Considerations detailed at section 5.8 this area was not deemed to be a viable area to create design options because of the potential interaction with both the CAS and flights to and from LPL and this was therefore removed from the westerly envelopes. This change resulted in a clear distinction between the two new envelopes and created separation between the design options for traffic heading either south-west or west, and this removal was offset by the creation of the area (F) detailed below.

- In Design Envelope 23 West (F) an area was to the north of the envelope in recognition of bilateral meetings with NATS and Liverpool airport (LPL) which highlighted potential interaction with LPL traffic. This aligns with the design principles Safety, Policy and Capacity.

6.4.2. Runways 05L and 05R changes

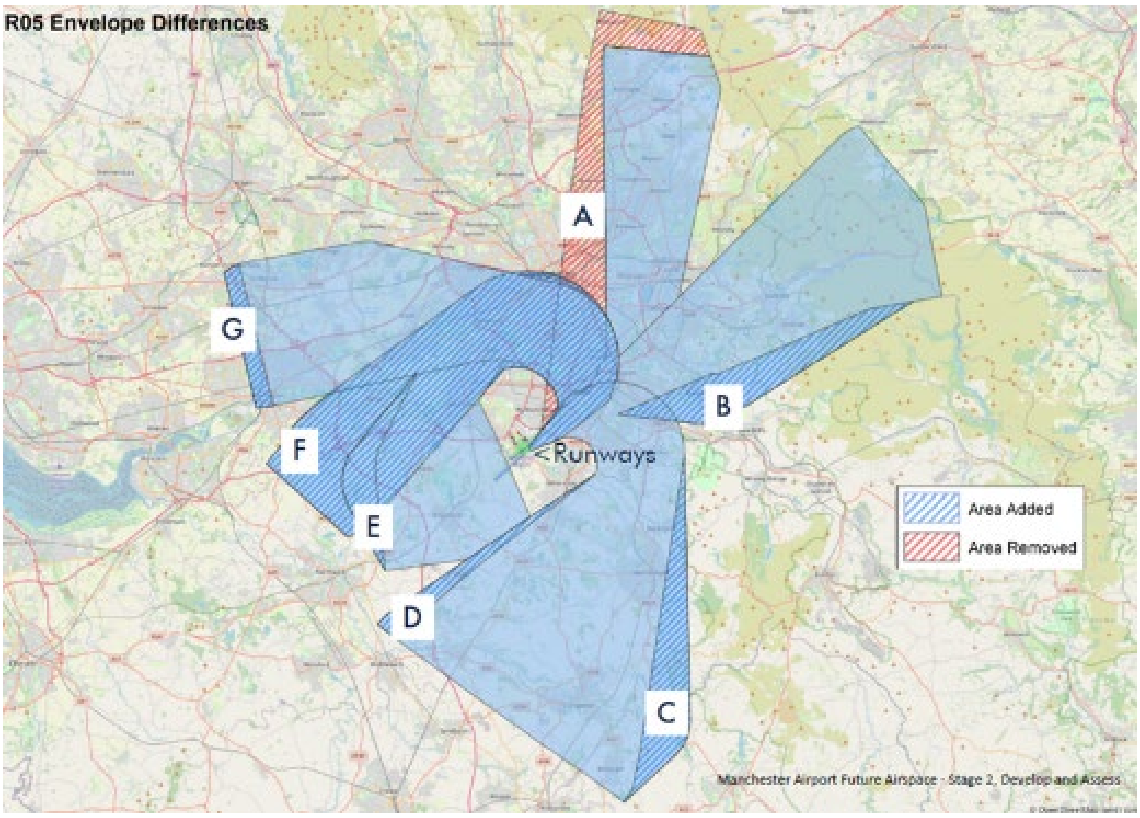


Figure 19: Runway 05 Design Envelopes

- In Design Envelope 05 North (A) the initial design envelope accommodated an early left turn. When reviewed, the position may have impacted the design principles Safety and Capacity by creating conflict with other routes. Therefore, an area was removed to the west and northern edge of the envelope in line with the design principles Safety and Policy.

- In Design Envelope 05 East (B) an area was added to accommodate a route that is aligned to the Design Principle Capacity and helps to align all design options in this envelope with the NATS network traffic flow.
- In Design Envelope 05 South (C) an area was added to accommodate routes that avoided direct overflight of Macclesfield in line with the Design Principle Noise N1.
- (D) indicates an area that was added to Design Envelope 05 South to allow routes that reduce the interaction with inbound aircraft to Runway 05L and Runway 05R to align with the design principles Safety and Capacity.
- On Design Envelope 05 South Left Turn (E) the westerly edge was extended to provide more room for options that may reduce noise. These options route slightly further west to avoid communities before turning south.
- Envelope F was the new design envelope which was created in line with the design principles on Safety and Emissions. On safety it seeks to reduce or remove potential conflictions with LPL traffic to the north. On emissions it enables the creation of a shorter route to the south-west. At present, traffic routing to the south-west needs to route via the west envelope initially before turning south-west later. Routes within this envelope make that turn earlier and therefore reduce track miles, fuel burn and emissions.
- In Design Envelope 05 West (G) the envelope was slightly extended to accommodate the shortest possible route to the west. This reduces fuel burn in line with the Design Principle Emissions.

These updated envelopes were used as the foundation for creating the comprehensive list of departure routes options that are contained in this DOR.

6.5. Creating Departure Design Options

As detailed above, the foundation for the design options are the updated design envelopes which were produced following stakeholder engagement.

For departures, the starting point for the design of the design options was a PBN replication of the existing SID (if there was an existing SID within the design envelope) to represent a 'do minimum' baseline.

Having established the 'do minimum' option, further design options were developed within the design envelope that responded to the design principles. Examples include creating options that:

- Provide a more direct routing to the joining point with the network airspace to reduce fuel burn (Emissions), or
- Route to reduce the number of people overflown (Noise N1), or
- Reduce delays on the ground for following aircraft on different routes by creating 1 minute departure separations. (Capacity).

Because some design envelopes are new, there will not be an existing SID upon which to build a 'do minimum' replication. In these envelopes the design options were designed using the same concept, with each of the options being created to align with one or more of the design principles.

Each design option has been built and described in the DOR as a matching 'pair' that covers both runways in that particular direction. For example option 2 for westerly operations covers the routes from both 23L and 23R. This has been done to provide a common termination point at 7,000ft for each pair of routes which meets the CAP778 requirement for the safe integration of departure routes with the upper airspace network. It has also been done to provide a clear and understandable set of options for stakeholders to review and comment upon.

However, because of the slightly different track taken by each option, the assessment of the routes within the DPE and the IOA has been conducted using the individual routes for each runway. This will allow a more accurate evaluation of the routes to be undertaken.

6.6. PBN Design Criteria

In line with the results of the airline fleet equipage survey detailed in section 5.6, both the replication design options, and the new design options have been designed to two design standards.

- RNAV1.
- RNP1 with Radius to Fix turns (RNP1+RF).

Both design standards have an accuracy requirement of within 1nm and are fundamentally similar. However, an aircraft flying an RNP1 route is required to have monitoring and alerting equipment on the aircraft, whereas RNAV does not. Additionally, RNP1 offers the capability of Radius to Fix (RF) legs, whereas RNAV does not. Their difference is not noticeable in level flight but in a turn, some difference may be apparent, especially where RF legs are used.

- RNAV1: This has the lower aircraft equipment requirement and is therefore more suitable for older aircraft to fly the routes accurately. The use of RNAV1 aligns with the requirement to upgrade to PBN, and the alternatives design principle but it is not the most modern system available. When aircraft fly RNAV routes, they sometimes refer to ground-based systems to assure their position using Distance Measuring Equipment (DME). This means that, whilst the aircraft will fly within the accuracy criteria required within the ICAO standard, some dispersion can occur within a turn, depending on how far away these ground-based systems are. The fleet survey confirmed that all aircraft operating into MAN were capable of flying routes designed to this standard.
- RNP1+RF: This requires on board monitoring and alerting system and aligns with the Design Principle Technology. As the name suggests, this procedure offers the RF path terminator, which implies a constant radius of turn, and makes no reference to any ground-based system. All navigation is conducted via satellite reference with aircraft flying to a specific point at the end of the turn for RF legs. This type of procedure is highly accurate and results in less dispersion, but the enhanced equipment requirements mean that not all aircraft are currently able to fly it (especially the RF legs).

6.7. Design Envelopes – Climb Gradient Summary

As detailed in section 5.6 the airline fleet equipage survey asked airlines to supply information on both their PBN capabilities and their climb performance.

The question asked was: "Assuming ISA +10 conditions (25°c) could the worst performing aircraft that operates from MAN fly a departure PDG of 6%, 7% or 10%? to 7,000ft". The survey indicated that by 2028 all aircraft would be capable of climbing at 6%, and 85% could meet a gradient of 7%.

Based on this information, the design envelopes were designed to accommodate a minimum climb gradient of 6%. This ensures we make available a route structure for all aircraft operating to and from the airport.

Whilst the choice of 6% was informed by the fleet equipage survey, bilateral discussions with NERL have confirmed that that their concept does not seek to place vertical restrictions to aircraft climbing more quickly than this 6% minimum. Aircraft will therefore be permitted to use their preferred climb rate unless specific conflicts exist that require altitude restrictions to be applied.

In addition, the Airspace Change Organisation Group (ACOG) facilitated a collaborative design review in June 2022 with input from MAN, LPL and NERL. This workshop assessed interactions between options at MAN and those for LPL which at the time of writing is paused at Step 4A of the CAP1616 process. This meeting resulted in modified options being created for departures to the west of MAN which are aligned to the Design Principle Safety and the need to safely separate MAN options from LPL controlled airspace. Some of these are initially greater than the minimum 6%, but once clear of the LPL airspace return to a lower climb gradient. In combination with creating these options, work will be undertaken with airlines to investigate their flyability, and a proposed solution will be developed as part of bilateral discussions within Step 3A.

6.8. Departures Options Description

The following sections 7 to 18 detail the departure design envelopes and the design options created within them.

Each section has an introduction to the envelope and the basis for its inclusion which is followed by a map to show the position of the envelope in relation to the airport.

An options summary table is then provided which shows the comprehensive options for each design envelope. This includes options from the numbered list (viable and good fit), the lettered list (viable and poor fit) and any unviable options we have considered but discounted.

There is then a detailed description of each design option. In those design envelopes where a route currently exists, the first described design options relate to the replication of the current conventional routes to PBN standards, to provide the 'do minimum' options. Additional options are then provided for alternative routes. As described at section 6.5, routes are designed with the same termination point to act as a matching pair. However, the description covers the track taken by the individual route for each runway and highlights where the routes combine.

For each design option this description also covers what has been designed, and the rationale for designing the route (the 'why'). In addition, an explanation of which design principles the route seeks to align with is provided.

The graphic below provides an example of the table used to explain the information contained within it.

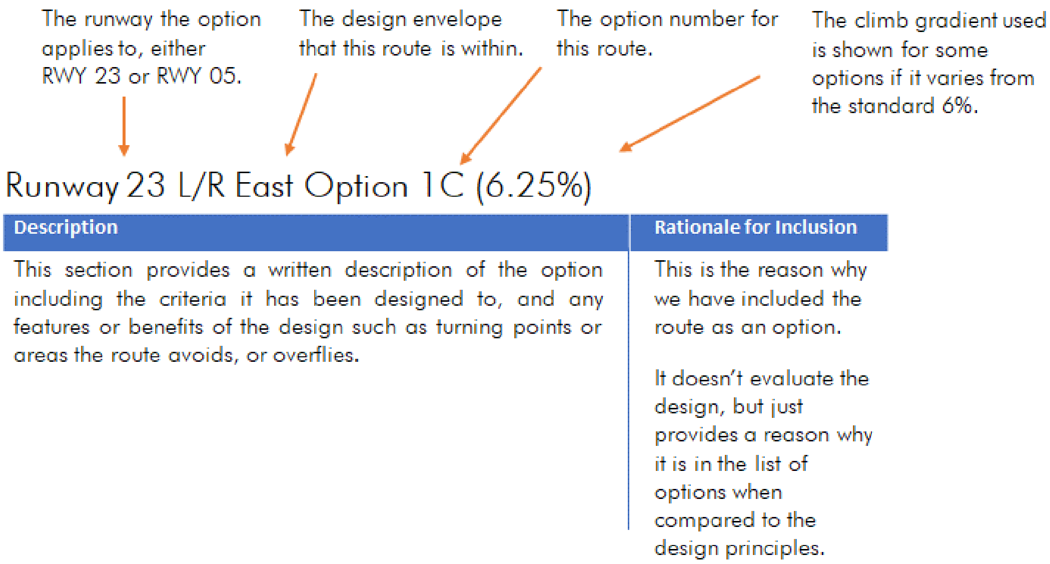


Figure 20: Example departure design option table

Each design option is also accompanied by a map and an explanation of the ICAO PANS-OPS design criteria used.

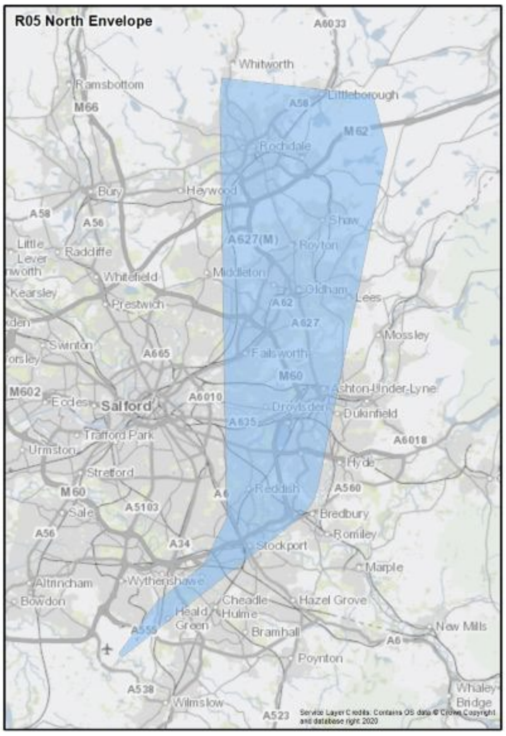
7. SID Runways 05L/05R – North

7.1. Introduction to 05L/05R North Design Envelope

This envelope has been created for traffic routing to the north from Runway 05L and Runway 05R. The envelope is based around the existing POL 4S/1Z SID and after departure, design options within this envelope turn left and route north towards POL, terminating at 7,000ft.

This letterbox is 4.5nm wide (2.25nm either side of the nominal track) and a minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

7.2. Design Envelope Location Map



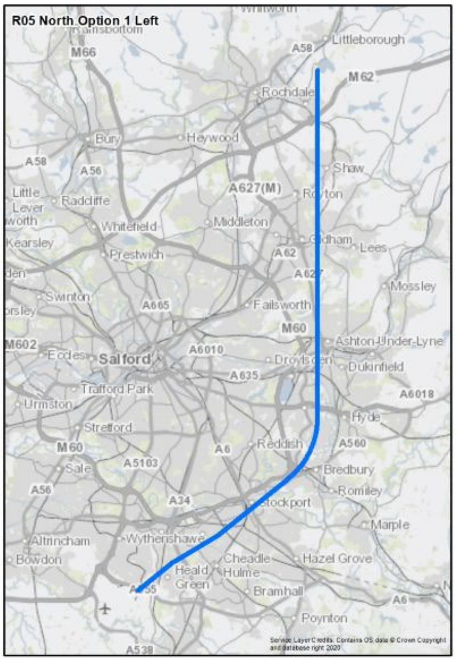
7.3. 05L/05R North Options Summary Table

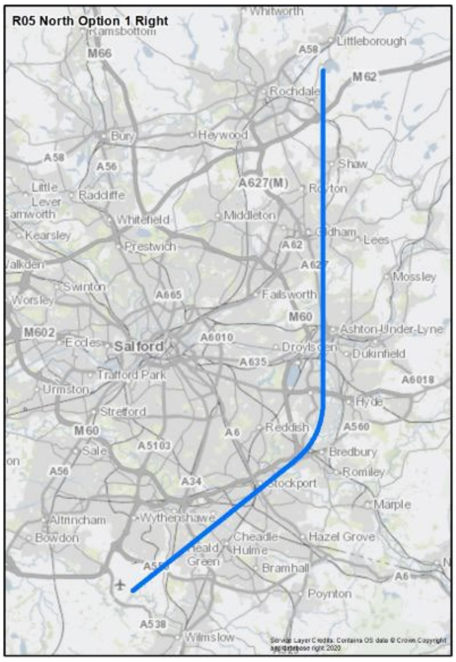
Viable and Good Fit		Viable but Poor Fit		Unviable	
05 North 1	'Do minimum' This option is included to provide a RNAV1 replication of the existing conventional POL 4S/1Z SID to 7,000ft. -250 Knots-Indicated Air Speed (KIAS)	A2	Earliest PANS-OPS compliant left turn.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the departure end of runway (DER), but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • Minimum Stabilisation Distance (MSD). • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
05 North 3	This is an RNAV1 option that has an earlier turn to the north to avoid direct overflight of communities east of Stockport. -250 KIAS	B5	Straight ahead then gradual left turn north.		

05 North 4	This is an RNAV1 option that has a turn mid-way between options 1 and 3. It has been created in line with the Design Principle Noise N1 by following the course of the M60 motorway. -250 KIAS	C6	Left wraparound.		
		C7	Right wraparound.		

7.4. Runways 05L/05R North Option 1

Description	Rationale for inclusion
Option 1 is an RNAV1 replication of the current departure to POL and uses fly-by waypoints to create a replication of the existing conventional POL 4S/1Z departure. As a replicated route it follows a similar track over the ground as the current published departure. The routes combine shortly after departure and fly straight ahead overflying Stockport where they commence a left turn to the north. This takes the routes west of Ashton-under-Lyne and close to Oldham and they terminate at 7,000ft to the east of Rochdale. The design speed will permit a large number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. Due to the track-to-fix coding and simplicity of the route, dispersion is likely to be low even with maximum speeds.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1**: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.





7.5. Runways 05L/05R North Option 3

Description

This is an **RNAV1** option that provides an earlier turn to the north than option 1 to avoid direct overflight of Stockport. This turn point is approximately half the distance when compared to option 1 and has been created to ensure safe separation from west and south-west options from Runway 05.

The option has a direct routing to the north following the initial turn, which due to the track-to-fix coding and a fly-by waypoint, would result in repeatable ground tracks and a low level of dispersal.

The design speed will permit a large number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The route has been designed using fly-by waypoints.

- **05L**: After departure this route flies straight ahead and commences a left turn just to the west of Stockport, at which point it combines with the option for 05R. The routes continue north, flying to the west of Audenshaw reservoir, Ashton-under-Lyne and Oldham and terminate at 7,000ft just to the east of Rochdale.
- **05R**: After departure this route flies straight ahead and commences a left turn north just to the west of Stockport, at which point it combines with the option for 05L. The routes continue north, flying to the west of Audenshaw reservoir, Ashton-under-Lyne and Oldham and terminate at 7,000ft just to the east of Rochdale.

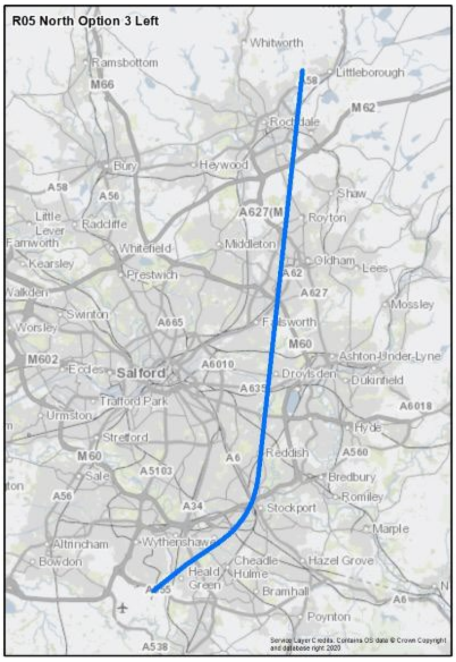
There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply.

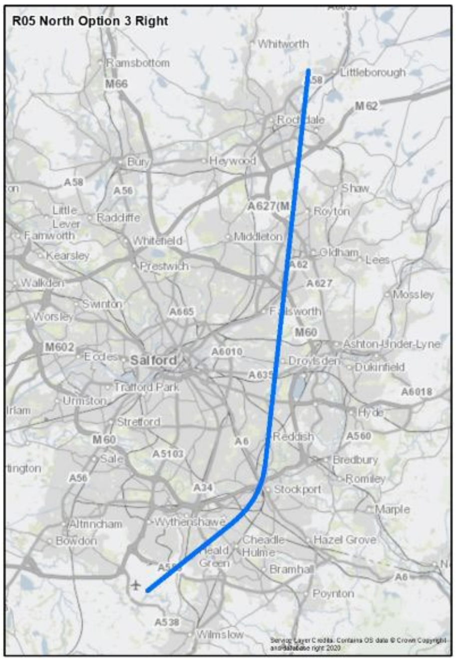
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The earlier turn is intended to reduce the impact of noise for communities on the extended centreline that are also impacted by Runway 23 arrivals.
The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Capacity: Has the potential to aid departure utilisation and separation when operated in association with westbound and eastbound departure options.





7.6. Runways 05L/05R North Option 4

Description

This is an **RNAV1** option that has a turn mid-way between options 1 and 3. It has been created in line with the Design Principle Noise N1 by following the course of the M60 motorway which already generates a level of ambient noise.

This option has a direct routing to the north following the initial turn, which due to the track-to-fix coding and a fly-by waypoint, would result in repeatable ground tracks and a low level of dispersal.

The design speed will permit a large number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The route has been designed using fly-by waypoints.

- **05L**: After departure this route combines with the option for 05R and flies straight ahead and commences a left turn just to the east of Stockport. It continues north, broadly following the route of the M60 motorway which takes it over Audenshaw reservoir and west of Ashton-under-Lyne. It passes overhead Oldham and terminates at 7,000ft just to the east of Rochdale.
- **05R**: After departure this route combines with the option for 05L and flies straight ahead overflying Heald Green and commences a left turn just to the east of Stockport. It continues north, broadly following the route of the M60 motorway which takes it over Audenshaw reservoir and west of Ashton-under-Lyne. It passes overhead Oldham and terminates at 7,000ft just to the east of Rochdale

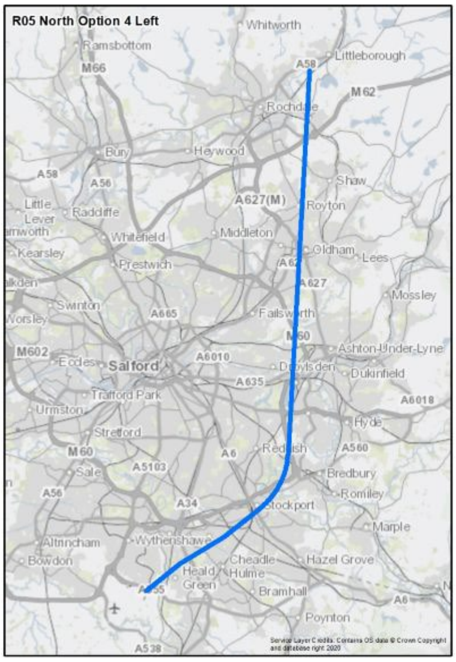
There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. Due to the track-to-fix coding however, and simplicity of the route, dispersion is likely to be low even with maximum speeds.

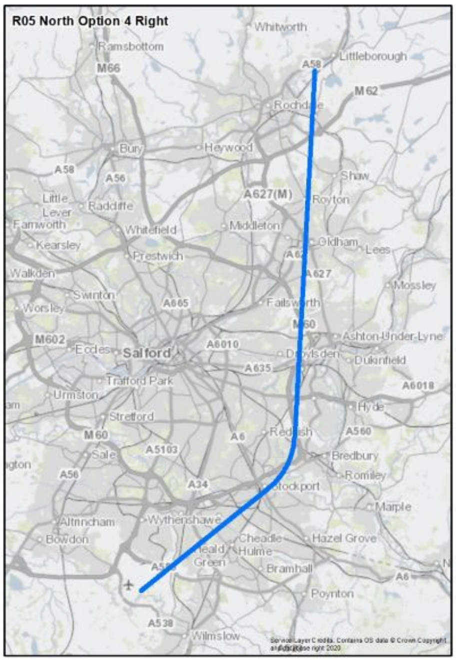
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The option seeks to reduce the impact of noise to communities by routing along the course of the M60 motorway.

The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.





7.7. Runways 05L/05R North Viable but Poor Fit Options

<table>
<tr><th>Option</th><th>Safety</th><th>Policy</th><th>Capacity</th></tr>
<tr><td>A2 Early left turn</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">Originally designed as option 2, this was considered to provide an early turn and a more direct route to POL. The route was designed as an RNAV 1 route using fly-over waypoints.

Safety: This option was expected to interact with the Runway 05 westbound design options.

Capacity: This option would interact with departures to the west and south-west and would limit the ability to achieving capacity through one minute departure splits and not enabling best use of runway capacity.</td></tr>
<tr><td>B5 Straight ahead then gradual left turn north</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">After departure from Runways 05L/05R, aircraft would continue straight ahead to beyond Stockport before gradually turning left towards the north, towards the SID aiming point.

Policy: This design option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

Capacity: This option would take the same track as some departure options in the 05L/05R East Design Envelope which would limit the ability to achieve 1 min departure splits and enable best use of runway capacity.</td></tr>
<tr><td>C6 Left Wraparound</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">After departure from Runways 05L/05R, aircraft would make a left-hand turn, fly around the airport, through the overhead and then begin heading north towards the SID aiming point.

Safety: This option is expected to interact with the Runway 05R Missed Approach Procedure (MAP).

Policy: This option involves greater track mileage than is necessary by taking traffic south and east before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

Capacity: This option interacts with arrivals from the north and south along with the 05 South Departure Envelope, which would limit the ability to enable best use of runway capacity.</td></tr>
<tr><td>C7 Right Wraparound</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">After departure from Runways 05L/05R, aircraft would make a right-hand turn, fly around the airport, through the overhead and then begin heading north towards the SID aiming point.

Safety: This option is expected to conflict with the Runway 05R MAP.

Policy: This option involves greater track mileage than is necessary by taking traffic south and west before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

Capacity: This option would interact with arrivals from the north and south along with the 05 South Departure Envelope along with arrivals, which would limit the ability to enable best use of runway capacity.</td></tr>
</table>

8. SID Runways 05L/05R – East

8.1. Introduction to 05L/05R East Design Envelope

This envelope has been created for traffic routing to the east from Runway 05L and Runway 05R. The envelope is based around the existing DESIG 1S/1Z SID and includes design options in addition to the replicated track.

The design options within this envelope are based around current operations where aircraft routing to the east via a DESIG departure are vectored off the SID by ATC once they are above 4,000ft. This takes them on a more direct track to either join the network to reduce fuel burn, or to resolve interactions with other traffic.

It also ensures safe separation from opposite direction arriving traffic to both MAN and LPL from the east on route L975.

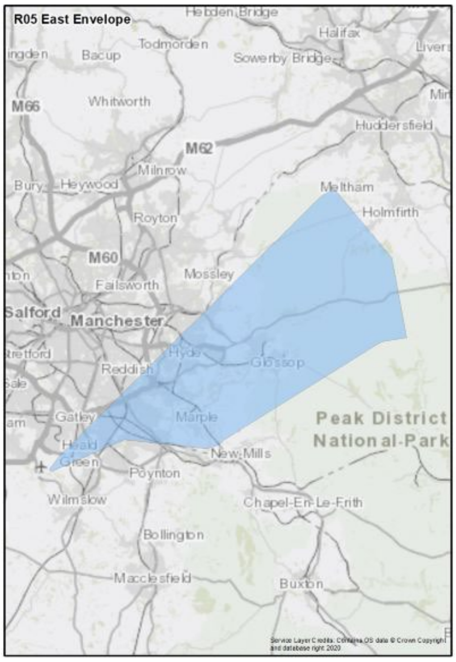
For these reasons, the envelope and associated options have been designed to be south of the replicated DESIG SID to be in line with the following design principles:

- Policy: CAP1711 Airspace Modernisation Strategy states that pinch-points and unnecessary interactions are designed out of the future airspace route network.
- Capacity: Any interactions will require ATC intervention to resolve. This will limit the capacity that can be achieved by the routes being designed.

The envelope and options also take account of the constraints created by the base of controlled airspace to the east of MAN, and the consideration of the Camphill gliding site within that area. Whilst tactical routings through this area may still be possible, the design of systemized routes which have limited ATC intervention, would not align with the Design Principle Safety due to possible interaction with gliders or commercial aircraft routing outside of controlled airspace. Further information on these constraints is detailed in section 5.8.

All options terminate at 7,000ft at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

8.2. Design Envelope Location Map



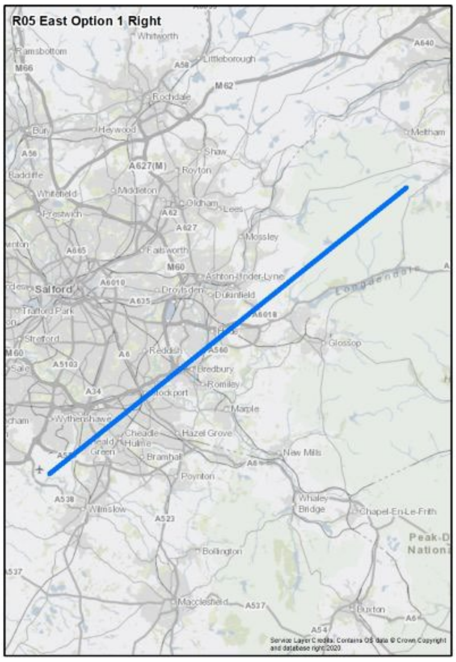
8.3. Runways 05L/05R East Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1	'Do minimum' This option is included to provide a **RNAV1 replication** of the existing conventional DESIG 1S/1Z SID. -250 KIAS	A2	Track divergence 15° to the south then continue north-east.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient These options have not been designed and are not described further within this comprehensive list of design options.
4	This is an **RNAV1** option to provide an initial route identical to the existing DESIG SID, but with an earlier turn towards the network joining point to the east. -250 KIAS	B3	Route directly to the east.		

5	This is an **RNAV1** option which provides an initial 15° track adjustment from the runway heading before correcting back to the runway heading and then turning east to connect with the network. -250 KIAS	C9	Track divergence 15° to the north then route direct north-east.		
6	This is an **RNAV1** option to provide an initial route identical to the existing DESIG SID, but with an earlier turn towards the network joining point to the east. This has a similar profile to option 4 but the right turn takes place approximately 2.5NM earlier. -250 KIAS	D10	Left-hand wraparound		
7	This is an **RNAV1** option that seeks to provide the shortest route to the network joining point. It has a similar profile to options 4 and 6 except aircraft make a right turn just north of Stockport. -250 KIAS	E11	Right-hand wraparound		
8	This is an **RNAV1** option that has been created to provide track divergence from northbound departures to enable a 1-minute departure separation in line with the Design Principle Capacity. -210 KIAS	F12	Left turn towards north then right-hand turn back to east.		

8.4. Runways 05L/05R East Option 1

Description	Rationale for inclusion
Option 1 is an **RNAV1** replication of the current DESIG 1S/1Z SID and uses fly-over waypoints. As a replicated route it follows a similar track over the ground as the current published route. After departure this takes it straight ahead on a runway heading in a straight line to 7,000ft. This takes it overhead Stockport and Hyde, and to the north of Glossop and it terminates south-west of Holmfirth. There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. This design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. Due to the track-to-fix coding and simplicity of the route, dispersion is likely to be low even with maximum speeds.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1**: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.



8.5. Runways 05L/05R East Option 4

Description

This is an **RNAV1** option to provide an initial route identical to the existing DESIG SID, but with an earlier turn towards the network joining point to the east. This has been done to align with current operational practice and routes it to the southern edge of route L975 in line with the NATS network traffic flow.

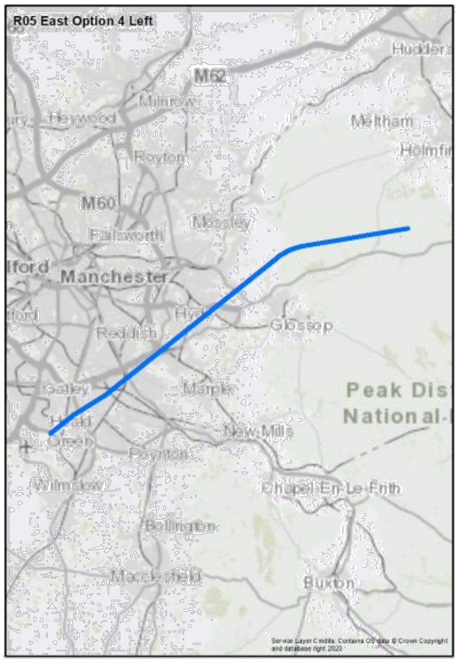
The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

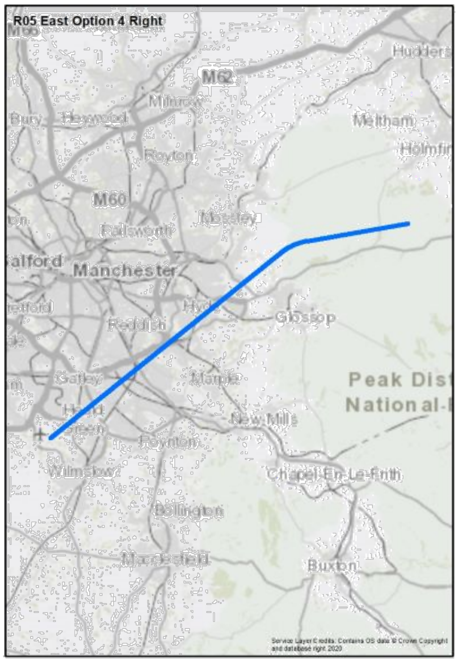
The route has been designed using fly-by waypoints.

05L: After departure this route combines with the option for 05R and flies straight ahead overflying Stockport and the southern edge of Hyde. It routes to the north-west of Glossop at which point it makes a right turn to route north of Glossop and terminates at 7,000ft just to the north and east of the Woodhead reservoir.

05R: After departure this route combines with the option for 05L and flies straight ahead overflying Stockport and the southern edge of Hyde. It routes to the north-west of Glossop at which point it makes a right turn to route north of Glossop and terminates at 7,000ft just to the north and east of the Woodhead reservoir.

There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: Avoids interactions with inbound traffic from the east by connecting to the wider en route network to the south of route L975.

Capacity: Avoids the need for ATC intervention to resolve conflicts with inbound traffic from the east (on L975) which would reduce the capacity on this route.

Noise N1: The route has potential to reduce noise impact to Glossop and Hadfield by placing the turn to connect to L975 to the north of both towns.

The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Emissions: There is a reduction in track miles to join the network compared to the 'do minimum' option as it routes to the east at an earlier position. This makes it a more fuel-efficient route.

8.6. Runways 05L/05R East Option 5

Description

This is an RNAV1 option which provides an initial 15° track adjustment from the runway heading before correcting back to the runway heading (parallel to the existing SID) before turning east north-east of Glossop and Hadfield. This track adjustment is intended to reduce the impact of noise for communities on the extended runway centreline that are also impacted by Runway 23 arrivals.

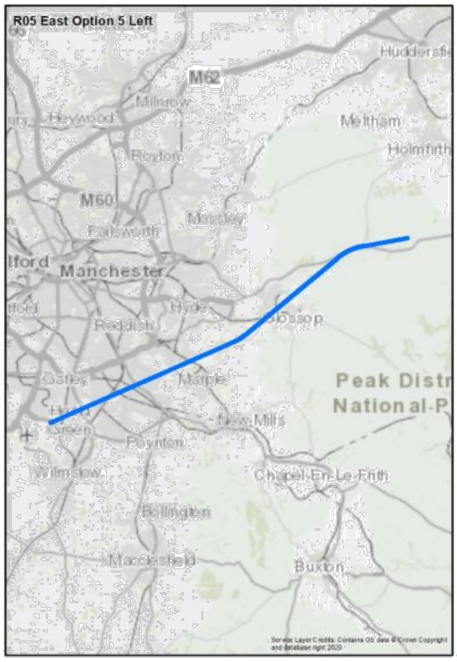
This 15° initial track adjustment from the extended centreline is to a width of 2.25nm parallel to the centreline. It extends to 9nm from the DER on Runway 05L and 8.5nm for Runway 05R.

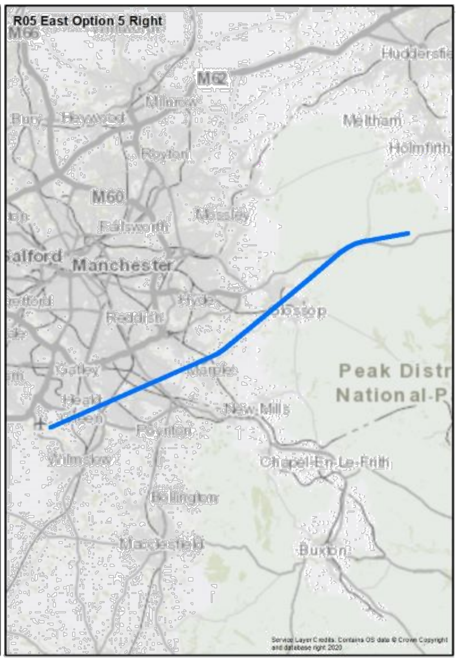
The design speed will permit a large number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise, and the option has been designed using track to fix coding.

05L: After passing the DER this route has a 15° track adjustment to the right which routes it south of Stockport. This track continues until just to the south-west of Glossop where it combines with the option for 05R returns to a runway heading. After overflying Glossop it makes a right turn to the east and terminates at 7,000ft just east of the Woodhead reservoir.

05R: After passing the DER this route has a 15° track adjustment to the right which routes it south of Stockport. This track continues until just to the south-west of Glossop where it combines with the option for 05L and returns to a runway heading. After overflying Glossop it makes a right turn to the east and terminates at 7,000ft just east of the Woodhead reservoir.

There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. Due to the track-to-fix coding and simplicity of the route, dispersion is likely to be low even with maximum speeds.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: Avoids interactions with inbound traffic from the east by connecting to the wider en route network to the south of route L975.

Capacity: Avoids the need for ATC intervention to resolve conflicts with inbound traffic from the east (on L975) which would reduce the capacity on this route.

Noise N1: Reduces the impact of noise for communities on the extended runway centreline including Stockport.

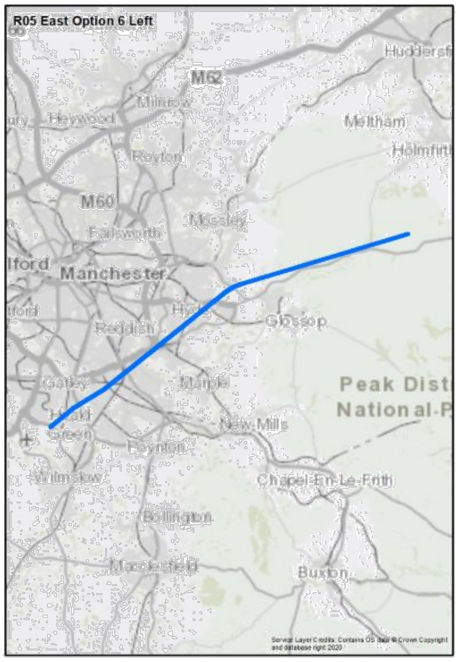
The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

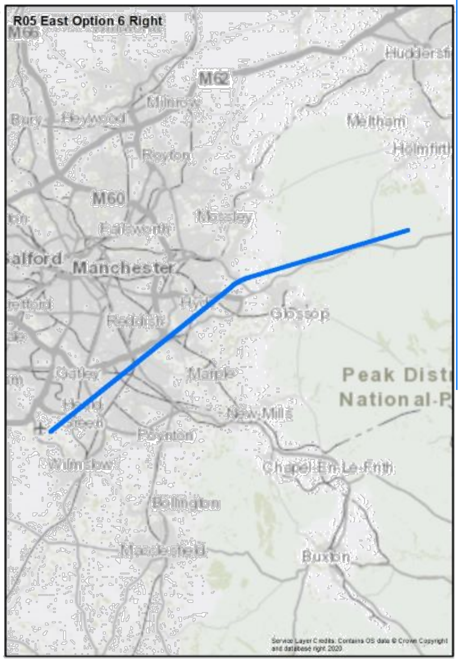
Noise N2: May be used in conjunction with other options to provide noise relief to communities on the extended runway centreline.

Emissions: There is a reduction in track miles to join the network compared to the 'do minimum' option as it routes to the east at an earlier position. This makes it a more fuel-efficient route.

8.7. Runways 05L/05R East Option 6

Description	Rationale for inclusion
This is an **RNAV1** option to provide an initial route identical to the existing DESIG SID, but with an earlier turn towards the network joining point to the east. This has been done to align with current operational practice and routes it to the southern edge of route L975 in line with the NATS network traffic flow. This option has a similar profile to option 4 but the right turn takes place approximately 2.5nm earlier. The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The route has been designed using fly-by waypoints. **05L**: After departure, this route combines with the option for 05R and flies straight ahead overflying Stockport and the southern edge of Hyde. It routes to the west of Glossop at which point it makes a right turn to the east to the north of Glossop and terminates at 7,000ft overhead the Woodhead reservoir. **05R**: After departure, this route combines with the option for 05L and flies straight ahead overflying Stockport and the southern edge of Hyde. It routes to the west of Glossop at which point it makes a right turn to the east to the north of Glossop and terminates at 7,000ft overhead the Woodhead reservoir. There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Policy**: Avoids interactions with inbound traffic from the east by connecting to the wider en route network to the south of route L975. **Capacity:** Avoids the need for ATC intervention to resolve conflicts with inbound traffic from the east (on L975) which would reduce the capacity on this route. **Emissions**: There is a reduction in track miles to join the network compared to the 'do minimum' option as it routes to the east at an earlier position. This makes it a more fuel-efficient route. **Noise N1**: The route has been designed to avoid the overflight of Glossop and Hadfield. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.





8.8. Runways 05L/05R East Option 7

Description

This is an **RNAV1** option that seeks to provide the shortest (most fuel efficient) route to the network joining point by using the earliest turn to the east, taking account of the constraints created by the base of controlled airspace.

It has a similar profile to options 4 and 6 except aircraft make the first right turn just north of Stockport to route to the network joining point. The position of this first turn is dictated by the dimensions of the controlled airspace to the east of Glossop which do not permit a turn and a direct route from an earlier point.

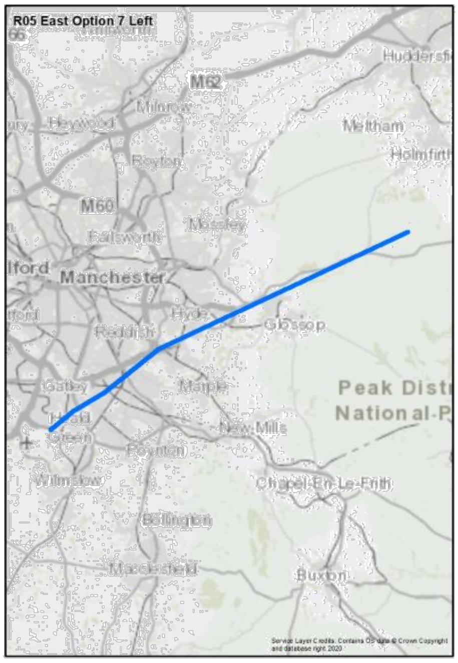
The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

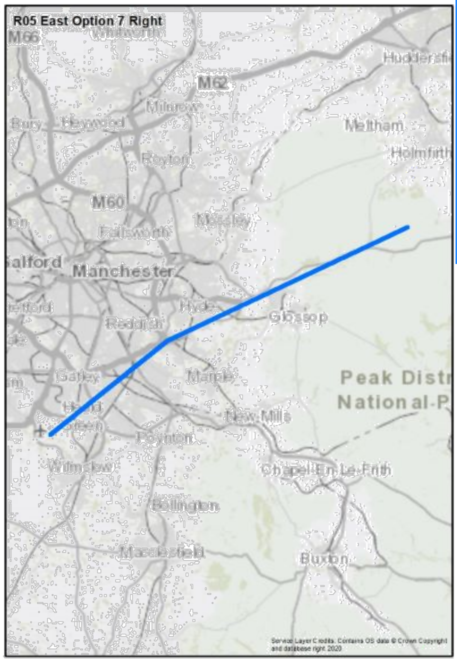
The route has been designed using fly-by waypoints.

05L: After departure, this route combines with the option for 05R and flies straight ahead overflying Stockport. Upon reaching Bredbury the route turns right to route south of Hyde and routes direct to the east to terminates at 7,000ft to the east of the Woodhead reservoir.

05R: After departure, this route combines with the option for 05L and flies straight ahead overflying Stockport. Upon reaching Bredbury the route turns right to route south of Hyde and routes direct to the east to terminates at 7,000ft to the east of the Woodhead reservoir.

There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: Avoids interactions with inbound traffic from the east by connecting to the wider en route network to the south of route L975.

Capacity: Avoids the need for ATC intervention to resolve conflicts with inbound traffic from the east (on L975) which would reduce the capacity on this route.

Emissions: This is the shortest route to join the network compared to the 'do minimum' option. This makes it a more fuel-efficient route.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

8.9. Runways 05L/05R East Option 8

Description

This is an **RNAV1** option created to provide a 45° track divergence from northbound departures and enable a one-minute departure separation to align with the Design Principle Capacity. This one-minute separation between north and eastbound departures is not possible on other options within this design envelope all of which will all require two minutes separation.

In line with CAP493 Manual of Air Traffic Services Pt1, the minimum departure separation can be reduced to one minute provided that the aircraft fly on tracks diverging by 45° or more immediately after take-off.

This right turn also has a benefit in reducing the impact of noise for communities on the extended runway centreline that are impacted by Runway 23 arrivals and Runway 05 north departures. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

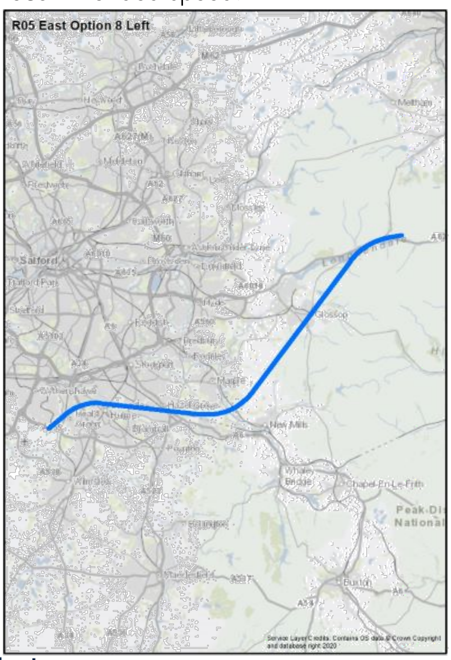
This option has a right turn no earlier than 1nm from DER, which is in accordance with CAP778.

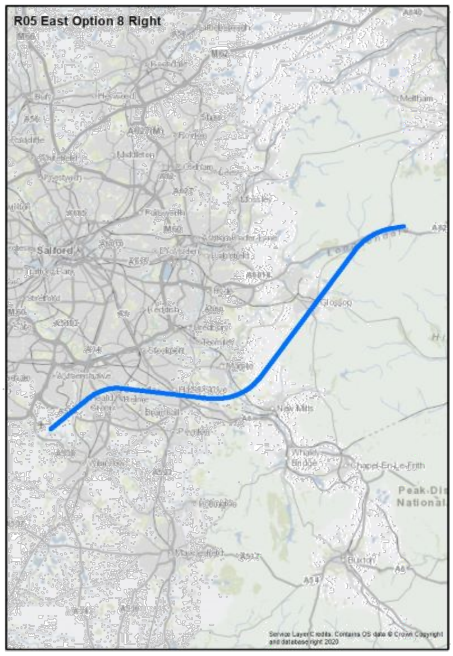
The route has been designed as an RNAV1 route using fly-over and fly-by waypoints.

05L: After departure, this route makes a 45° turn to the right at 1nm from the DER and combines with the option for 05R. This routes it overhead Hazel Grove after which it makes a second turn to the left to route in a north-easterly direction. It overflies Glossop before making a final right turn to the east and terminates at 7,000ft to the Woodhead reservoir.

05R After departure this route makes a 45° turn to the right at approximately 2.1nm from the DER and combines with the option for 05L. This routes it overhead Hazel Grove after which it makes a second turn to the left to route in a north-easterly direction. It overflies Glossop before making a final right turn to the east and terminates at 7,000ft to the Woodhead reservoir.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Capacity: The 45° track divergence enables one minute departure separation when operated in conjunction with other routes to the north.

This option avoids the need for ATC intervention to resolve conflicts with inbound traffic from the east (on L975).

Policy: Avoids interactions with inbound traffic from the east by connecting to the wider en route network to the south of route L975.

Noise N1: Reduces the impact of noise for communities on the extended runway centreline including Stockport.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

Noise N2: May be used in conjunction with other options to provide noise relief to communities on the extended runway centreline.

8.10. Runways 05L/05R East Viable but Poor Fit Options

Option	Safety	Policy	Capacity
A2 Track divergence 15° to the south then continue north-east.	S	P	C
Originally **option 2** this uses initial track adjustment of 15° right of the departure track, then routing directly north-east to terminate close to the current DESIG SID. Safety: Inbound aircraft to both MAN and LPL are routed westbound in the area towards the end of this option. This option would route traffic in conflict with this traffic flow. Because of this conflict, this option was replaced with option 5 which turns traffic south at the end of the SID.			
B3 Route directly to the east	S	P	C
Originally **option 3**, this was considered to formalise tracks that are representative of current operations, where ATC provide a bearing to the east following take off and reaching the correct altitude permitted for vectors. Safety: This option would not be compliant with airspace containment requirements for slower climbing aircraft and has the possibility to interact with Camphill gliding operations. Policy: May require additional controlled airspace, which is not aligned to the aims of the AMS.			
C9 Track divergence 15° to the north then route direct north-east.	S	P	C
An alternative version of this option was considered whereby the route diverges 15° to the north. Safety: Inbound aircraft to both MAN and LPL are routed westbound in the area towards the end of this option. This option would route traffic in conflict with this traffic flow.			
D10 Left-hand Wraparound	S	P	C
After departure from Runways 05L/05R, aircraft would make a left-hand turn, fly around the airport then begin heading north-east towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic north and west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would interact with arrivals from the north and the 05 South Departure Envelope, which would limit the ability to enable best use of runway capacity.			
E11 Right-hand Wraparound	S	P	C
After departure from Runways 05L/05R, aircraft would make a right-hand turn, fly around the airport then begin heading north-east towards the SID aiming point. Safety: This option is expected to conflict with the Runway 05R MAP. Policy: This option involves greater track mileage than is necessary by taking traffic south and west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would interact with arrivals from the south along with the 05 South Departure Envelope, which would limit the ability to enable best use of runway capacity.			

F12: Left turn towards north then right-hand turn back to east	S	P	C
After departure from Runways 05L/05R, aircraft would make a left turn to head north before turning right to the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic a north before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would interact with departures in the 05 North Design Envelope which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity.			

9. SID Runways 05L/05R – South Right Turn

9.1. Introduction to 05L/05R South Right Turn Design Envelope

These options have been created for traffic routing to the south from Runway 05L and Runway 05R. Southbound operations make up a high percentage of the total MAN traffic which results in the design of two envelopes:

- A right turn envelope based on current departures (this envelope).
- A new left turn envelope that routes to the north which is described in section 10. This has been created to align with the Design Principle Capacity and to potentially provide noise respite in line with Design Principle Noise N2.

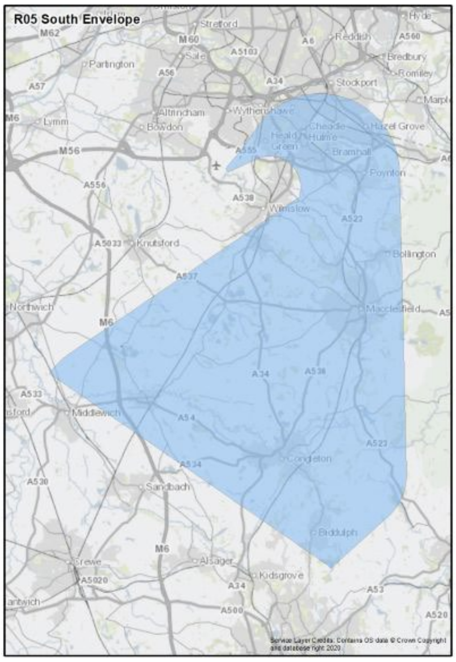
This right turn envelope covers options 1-6 which;

- Replicate the existing LISTO 2S/2Z SID
- Provide options which align to current operational practice by ATC where aircraft are taken off the LISTO SID above 4,000ft and vectored on a track that allows them to gain height and be safely and efficiently separated from MAN arriving aircraft.

Further information on these operational considerations is detailed in section 5.8.

All options terminate at 7,000ft at a letterbox that is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000 ft is achieved.

9.2. Design Envelope Location Map



9.3. Runways 05L/05R South Right Turn Options Summary Table

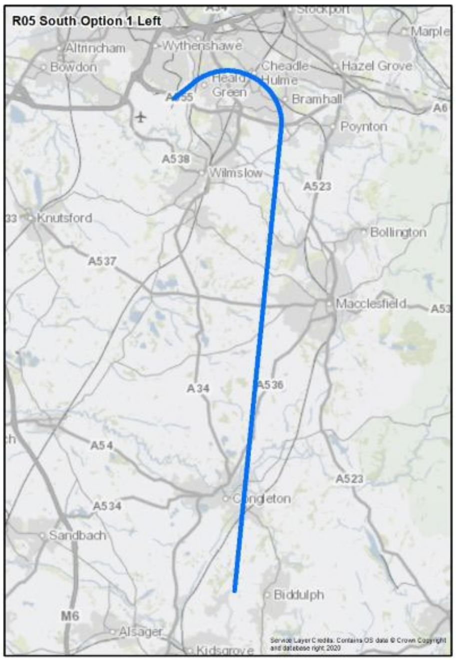
Viable and Good Fit		Viable but Poor Fit		Unviable	
1	'Do minimum' This option is included to provide a **RNAV1 replication** of the existing conventional LISTO 2S/2Z SID. **This option has a turn point less than 1nm to replicate the existing MCT D1.2 marker.* 185 KIAS	A11	Extended straight ahead then right towards south.	U1	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These design options have not been designed and are not described further within this comprehensive list of design options.
2A	This is an **RNP1** option with RF coding that makes a turn at the recommended PANS-OPS distance from the end of the runway. This results in a wider turn and a track to the eastern edge of the envelope. 220 KIAS	B12	Extended straight ahead then left towards south.		

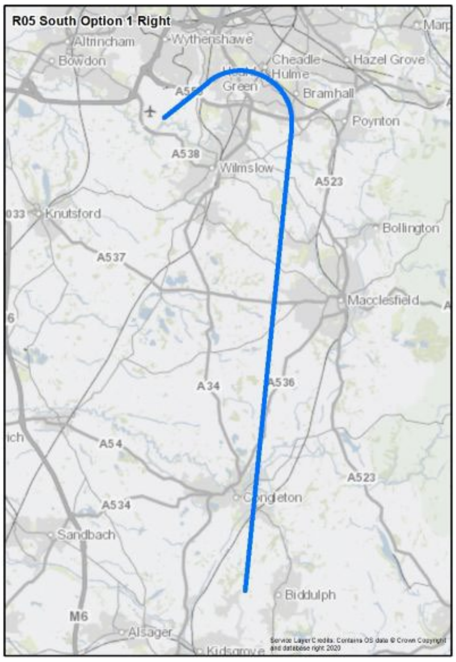
2B	This is an **RNP1** option with RF coding that has the same first turn as option 2A but then routes south-west then south to avoid both Macclesfield and Congleton. **220 KIAS**	C13	Extended straight ahead then extended left towards south.		
3	This is an **RNP1** option with RF coding to provide a tight right turn then routing south-west to align with current operational practice. This route forms the far-west side of the envelope. **190 KIAS**				
4	This is included as an **RNP 1** route using RF coding version of the current LISTO 2S/2Z SID. The use of RF coding results in a route slightly east of the 'do minimum' option which uses RNAV1. **190 KIAS**				
5	This option is included to provide a **RNAV1** route that is similar to that of the existing conventional LISTO 2S/2Z SID but with the first turn slightly later to align to PANS-OPS and CAP778 recommendations. **200 KIAS**				
6A	This is an **RNP1** option with RF coding to provide a tight right turn to initially route south-west before turning south. This aligns with current operational practice and is similar to option 3 initially but turns south earlier. **210 KIAS**				

6B	This is an RNP1 option with RF coding to provide a tight right turn to initially route south-west before turning south. It is similar to option 6 but has the second left turn to the south at an earlier point to follow the course of the A34 south. 210 KIAS				

9.4. Runways 05L/05R South Right Turn Option 1

Description	Rationale for inclusion
Option 1 is included to provide an **RNAV1 replication** of the existing conventional LISTO 2S/2Z SID. As a replicated route it follows a similar track over the ground as the current route to connect to the NATS network. The fly-over waypoints for the right turn to the south are positioned at the position of the existing markers. For Runway 05L this is at the MCT D1.2 point which less than 1nm from DER but as this replicates the turn of the current procedure it aligns to the Design Principle Safety. After departure the routes turn right to pass overhead Cheadle Hulme at which point they combine. They then pass just to the west of Woodford and Macclesfield and overfly Congleton and terminate at 7,000ft just west of Biddulph. An element of dispersion will be present in the right turn to the south due to the fly-over coding and the variables that affect this. This is seen currently with the conventional procedure. A speed restriction of 185 KIAS is used for the first turn.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N2**: The flyover turn will result in an element of dispersion, which is consistent with Design Principle Noise N2.





9.5. Runways 05L/05R South Right Turn Option 2A

Description

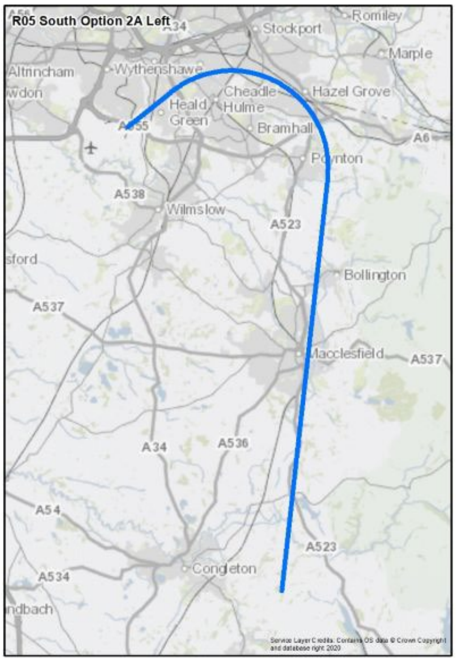
This is an **RNP1** option with RF coding that makes a turn at the recommended PANS-OPS distance from the end of the runway. This results in a wider turn and a track to the eastern edge of the envelope.

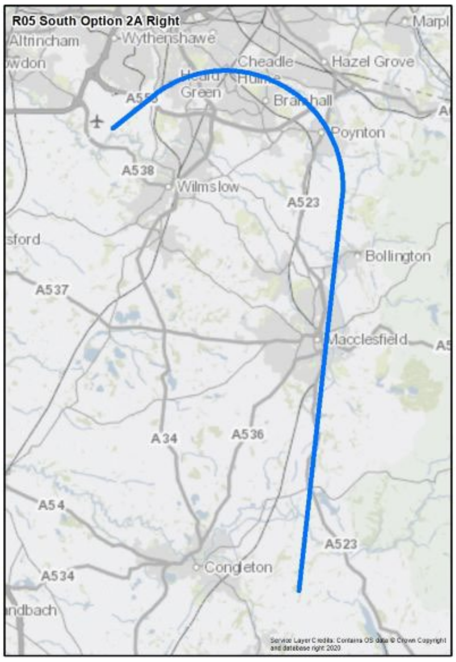
The wider track allows a greater speed in the turn which permits aircraft to be in a clean configuration (without the use of flaps). This has potential benefits in terms of noise. The wider arc may also aid vertical separation from MAN arriving traffic from the south by allowing aircraft to climb higher before any potential interaction.

05L: After departure, this route turns right shortly after Heald Green in a wide turn that routes it just east of Poynton where it combines with the route for 05R. The routes continue south passing overhead Macclesfield and terminate at 7,000ft to the east of Congleton.

05R: After departure, this route turns right in a track that is inside the route for 05L and that passes overhead Cheadle Hulme and Poynton where it combines with the route for 05L. The routes continue south passing overhead Macclesfield and terminate at 7,000ft to the east of Congleton.

A speed restriction of 220 KIAS is applied to the first turn.





Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

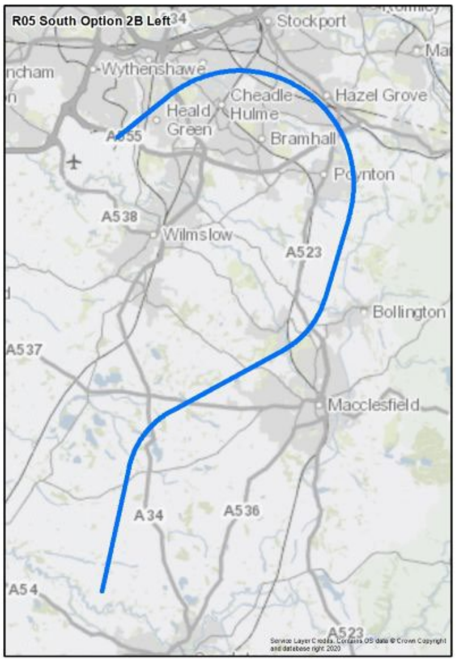
Policy: Avoids interactions with inbound traffic from the south by climbing aircraft in a wider arc.

Noise N1: The route has potential to reduce noise impact by avoiding overflight of Congleton.

The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

9.6. Runways 05L/05R South Right Turn Option 2B

Description	Rationale for inclusion
This is an **RNP1** option with RF coding that has the same first turn as option 2A but then routes south-west then south to avoid both Macclesfield and Congleton in line with the Design Principle Noise N1. As with option 2A, the wider track allows a greater speed in the turn which permits aircraft to be in a clean configuration (without the use of flaps). This has potential benefits in terms of noise. The wider arc may also aid vertical separation from MAN arriving traffic from the south by re-creating common ATC operational practice to separate departures and arrivals above 4,000ft. The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **05L**: After departure, this route turns right shortly after Heald Green in a wide turn that routes it just east of Poynton where it combines with the route for 05R. The routes continue south passing overhead Macclesfield and terminate at 7,000ft to the east of Congleton. **05R** After departure this route turns right in a track that is inside the route for 05L and that passes overhead Cheadle Hulme and Poynton where it combines with the route for 05R. The routes continue south passing overhead Macclesfield and terminate at 7,000ft to the east of Congleton. A speed restriction of 220 KIAS is applied to the first turn.	**Technology**: Procedure uses latest technology (RNP+RF). **Policy:** Avoids interactions with inbound traffic from the south by climbing aircraft in a wider arc. **Noise N1:** The route has potential to reduce noise impact by avoiding both Macclesfield and Congleton. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.



9.7. Runways 05L/05R South Right Turn Option 3

Description

This is an **RNP1** option with RF coding to provide a tight right turn then routing south-west to align with current operational practice.

The track following the right turn is often used by ATC to resolve interactions between flights on the LISTO departure and MAN arrivals from the south. This option therefore re-creates common operational practice above 4,000ft.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for 05R is located at a point roughly perpendicular to 05L, to create a similar ground track in the turn and subsequent leg.

05L: After departure this route turns right shortly after Heald Green in a tight radius turn that routes it inside of Poynton. This turn is continued onto a south-west heading to take it south of Wilmslow and Alderley Edge. It makes a left turn to head south to the north of Holmes Chapel and terminates at 7,000ft east of Middlewich.

05R After departure this route turns right shortly after Heald Green in a tight radius turn that routes it inside of Poynton. This turn is continued onto a south west heading to take it south of Wilmslow and Alderley Edge. It makes a left turn to head south to the north of Holmes Chapel and terminates at 7,000ft east of Middlewich.

A speed restriction of 190 KIAS is applied to the first turn which allows the smallest radius. Although PANS-OPS compliant it should be tested for flyability as part of the procedure validation process within Stage 4 of CAP1616.

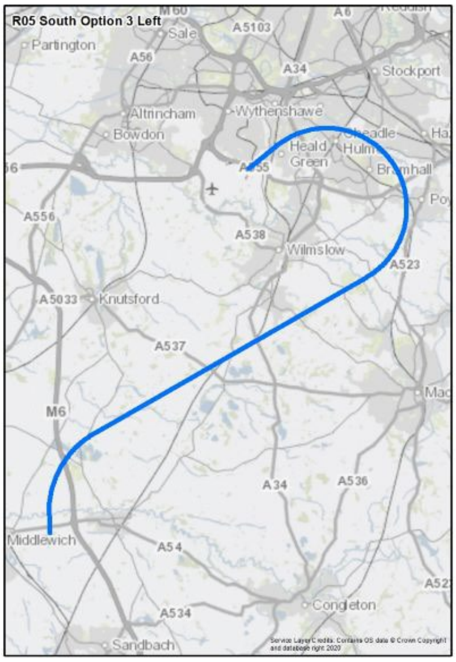
Rationale for inclusion

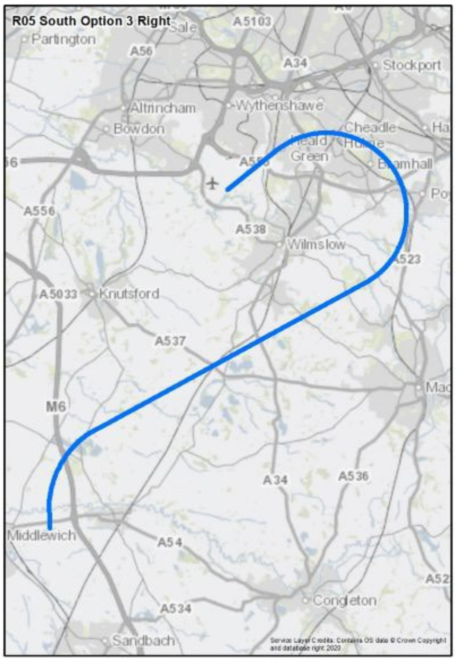
Technology: Procedure uses latest technology (RNP +RF).

Policy: Avoids interactions with inbound traffic from the south by climbing aircraft to the south-west.

Capacity: Formalises a route used by ATC today to resolve conflicts with inbound traffic from the south which reduces delays and maintains capacity.

Noise N1: The route has potential to reduce noise impact by avoiding Poynton, Macclesfield, and Wilmslow.





9.8. Runways 05L/05R South Right Turn Option 4

Description

This is included as an **RNP 1** route using RF coding that is similar to the current LISTO 2S/2Z SID. The use of RF coding results in a slightly wider first turn and a route slightly east of the 'do minimum' option which uses RNAV1.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg.

05L: After departure, the route turns right to pass just north of Cheadle Hulme and combines with the option for 05R just west of Poynton. They then pass just to the west of Macclesfield and just east of Congleton and terminate at 7,000ft just north of Biddulph.

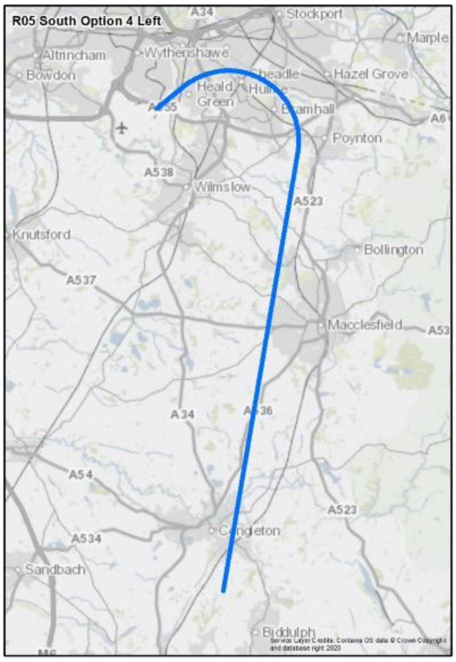
05R After departure the route turns right to pass just north of Cheadle Hulme and combines with the option for 05L just west of Poynton. They then pass just to the west of Macclesfield and just east of Congleton and terminate at 7,000ft just north of Biddulph.

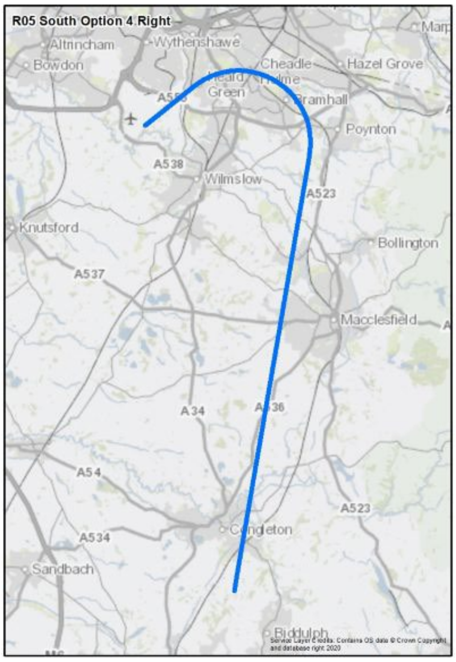
A speed restriction of 190 KIAS is applied to the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Noise N1: The route has potential to reduce noise impact by avoiding Poynton and Macclesfield.





9.9. Runways 05L/05R South Right Turn Option 5

Description

This option is included to provide a **RNAV1** route that is similar to that of the existing conventional LISTO 2S/2Z SID but with the first turn slightly later. This turn has been designed to be no earlier than 1nm from DER for Runway 05L and at the DME1.2 marker for Runway 05R, in line with CAA and PANS-OPS first turn recommendations. This results in a track that is almost identical to option 4 but using different technology.

The route uses fly-by waypoints.

05L: After departure, the route turns right to pass just north of Cheadle Hulme and combines with the option for 05R just west of Poynton. They then pass just to the west of Macclesfield and just east of Congleton and terminate at 7,000ft just north of Biddulph.

05R After departure the route turns right to pass just north of Cheadle Hulme and combines with the option for 05L just west of Poynton. They then pass just to the west of Macclesfield and just east of Congleton and terminate at 7,000ft just north of Biddulph.

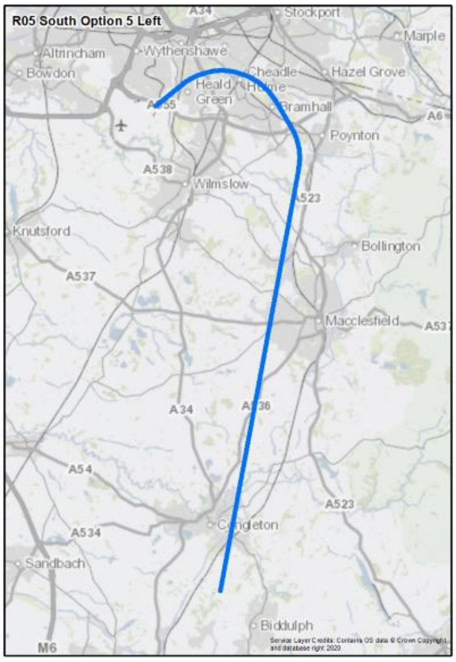
A speed restriction of 200 KIAS for the first turn and 210 KIAS for the second turn is used to keep segment lengths and track miles to a minimum.

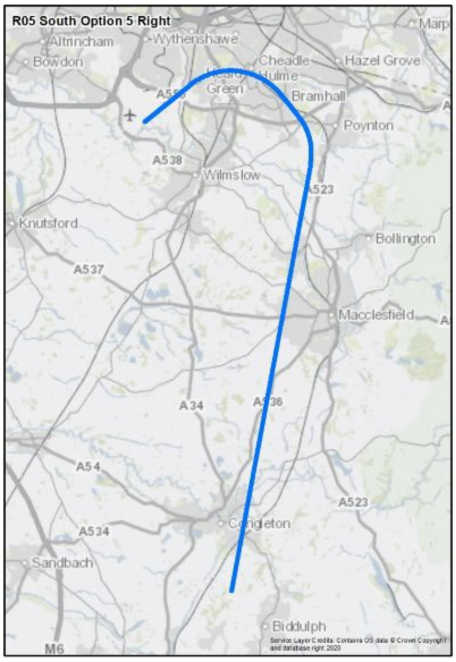
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: Fully aligns to PANS-OPS and CAP778 requirements in relation to the position of the first turn.

Noise N1: The route has potential to reduce noise impact by avoiding Poynton and Macclesfield.





9.10. Runways 05L/05R South Right Turn Option 6A

Description

This is an **RNP1** option with RF coding to provide a tight right turn to route south-west to align with current operational practice. It is similar to option 3 initially but uses a higher speed in the initial turn which allow aircraft to climb more quickly, and it then turns south earlier.

This design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The track following the right turn is often used by ATC to resolve interactions between flights on the LISTO departure and MAN arrivals from the south. This option therefore re-creates common operational practice above 4,000ft.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg.

05L: After departure, this route turns right shortly after Heald Green to route overhead Poynton. This turn is continued onto a south-west heading to take it south of Wilmslow and Alderley Edge and west of Macclesfield. It makes a left turn to head south at Chelford and terminates at 7,000ft east of Holmes Chapel.

05R: After departure, this route turns right shortly after Heald Green to route overhead Poynton. This turn is continued onto a south-west heading to take it south of Wilmslow and Alderley Edge and west of Macclesfield. It makes a left turn to head south at Chelford and terminates at 7,000ft east of Holmes Chapel.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

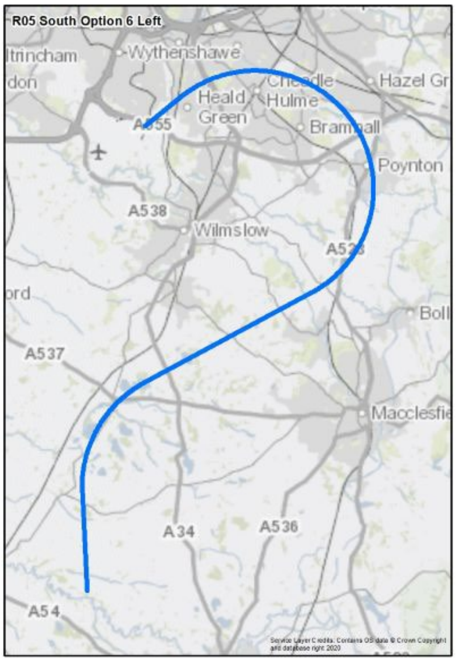
Rationale for inclusion

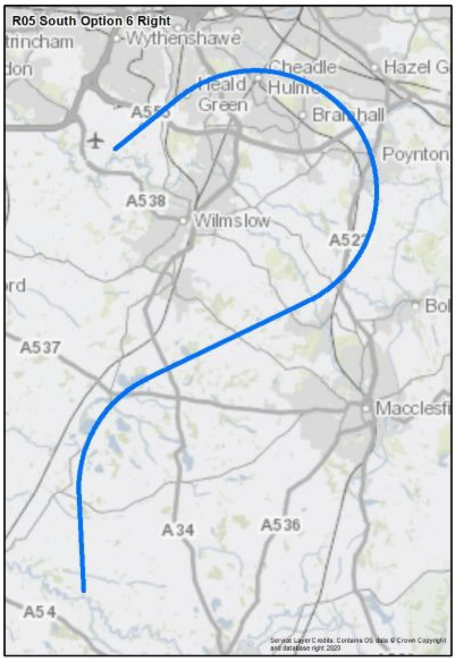
Technology: Procedure uses latest technology (RNP+RF).

Policy: Avoids interactions with inbound traffic from the south by climbing aircraft to the south-west.

Capacity: Formalises a route used by ATC today to resolve conflicts with inbound traffic from the south which reduces delays and maintains capacity.

Noise N1: The route has potential to reduce noise impact by avoiding Poynton, Macclesfield, and Wilmslow.





9.11. Runways 05L/05R South Right Turn Option 6B

Description

This is an **RNP1** option with RF coding to provide a tight right turn to route south-west to align with current operational practice. It is identical to option 6 in the speed and initial right turn but has a left turn to the south earlier to follow the course of the A34 which has a level of ambient noise.

This design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The track following the right turn is often used by ATC to resolve interactions between flights on the LISTO departure and MAN arrivals from the south. This option therefore re-creates common operational practice above 4,000ft.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg.

05L: After departure, this route turns right shortly after Heald Green to route overhead Poynton. This turn is continued onto a south-west heading to take it south of Wilmslow and Alderley Edge and west of Macclesfield. It makes a left turn to head south between Chelford and Macclesfield, roughly following the A34 road to terminate at 7,000ft just north of Congleton.

05R: After departure, this route turns right shortly after Heald Green to route overhead Poynton. This turn is continued onto a south-west heading to take it south of Wilmslow and Alderley Edge and west of Macclesfield. It makes a left turn to head south between Chelford and Macclesfield, roughly following the A34 road to terminate at 7,000ft just north of Congleton.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

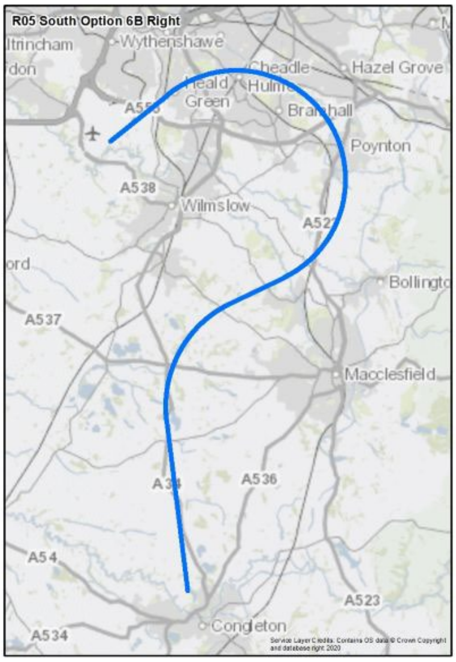
Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Policy: Avoids interactions with inbound traffic from the south by climbing aircraft to the south-west.

Capacity: Formalises a route used by ATC today to resolve conflicts with inbound traffic from the south which reduces delays and maintains capacity.

Noise N1: The route has potential to reduce noise impact by avoiding Macclesfield and Wilmslow. The route also follows the A34 to try and mitigate the noise impact.



9.12. Runways 05L/05R South Right Turn Viable Poor Fit Options

Note: Because the options development process for 05 South Right Turn and 05 Left Turn took place simultaneously, the viable but poor fit options are identical and apply equally to both envelopes.

Option	Safety	Policy	Capacity
A11 Extended straight ahead then right towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead to Stockport before making a 180-degree right-hand turn, south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it south, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would take the same track as departures in the east which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity.			
B12 Extended straight ahead then left towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead to Stockport before making a 180-degree left-hand turn, south-west, and then another left-hand turn to the south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north along with departures in the 05 East Design Envelope, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			
C13 Extended straight ahead then extended left towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead beyond Stockport before making a gradual 180-degree left-hand turn, heading south-west, and then another left-hand turn to the south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north along with departures in the 05 East Design Envelope, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			

10. SID Runways 05L/05R – South Left Turn

10.1. Introduction to 05L/05R South Left Turn Design Envelope

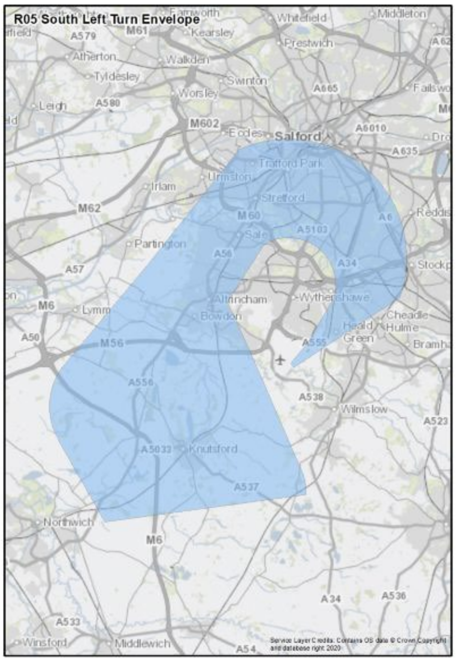
These design options have been created for traffic routing to the south from Runway 05L and Runway 05R. Southbound operations make up a high percentage of the total MAN traffic which results in the design of two envelopes:

- A right turn envelope based on current departures (described in section 9).
- A new left turn envelope that routes to the north and more over the city of Manchester, and which is described in this section. This has been created to align with the Design Principle Capacity and to potentially provide noise respite in line with Design Principle Noise N2.

This left turn envelope covers options 7-10 which are all new design options. There is no 'do minimum' option. It has been created to provide options to create additional capacity and to provide options for noise respite in line with Design Principle Noise N2 when operated in conjunction with the 05 South Right Turn Design Envelope.

All options terminate at 7,000ft at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

10.2. Design Envelope Location Map



10.3. 05L/05R South Left Turn Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
7A	**Left Turn**: This is an **RNP1** option with RF coding that turns left after departure to route north of Sale and then head south-west before heading south. This option forms the west and northern edge of the envelope. 220 KIAS	A11	Extended straight ahead then right towards south.	U1	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to the DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
7B	**Left Turn**: This is an **RNP1** option with RF coding that turns left after departure to route north of Sale. It is initially the same as option 7A, except the track routes further south-west before making the left turn south. 220 KIAS	B12	Extended straight ahead then left towards south.		

8	**Left Turn**: This is an **RNP1** option with RF coding that turns left after departure with the tightest radius possible to reduce track miles. **190 KIAS**	C13	Extended straight ahead then extended left towards south.		
9	**Left Turn:** This is an **RNP1** option with RF coding that turns left after departure with the tightest radius possible to reduce track miles. It is similar to option 8 but terminates slightly further west. **190 KIAS**				
10	**Left Turn**: This is an **RNP1** option with RF coding that turns left after departure. It routes mid-way between the other options in this envelope. **210 KIAS**				

10.4. Runways 05L/05R South Left Turn Option 7A

Description

This is an **RNP1** option with RF coding that turns left after departure to route north of Sale and then head south-west before heading south.

The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

Although this option creates more track miles to route to the south, because of the large number of southbound departures it has potential to aid departure flow and achieving one minute splits for southbound SIDs to align to the Design Principle Capacity.

05L: After departure this route turns left shortly after Heald Green to route overhead Cheadle. This turn is continued in a wide arc to the north of Chorlton and Sale and overhead Stretford where it combines with the option for 05R. It then heads south-west for a short straight segment and passes north of Altrincham where it makes a left turn to head south and terminates at 7,000ft west of Tatton Park.

05R: After departure this route turns left shortly after Heald Green to route overhead Cheadle. This turn is continued in a wide arc to the north of Chorlton and Sale and overhead Stretford where it combines with the option for 05L. It then heads south-west for a short straight segment and passes north of Altrincham where it makes a left turn to head south and terminates at 7,000ft west of Tatton Park.

A speed restriction of 220 KIAS has been applied to the first turn which allows most aircraft to fly in a clean configuration.

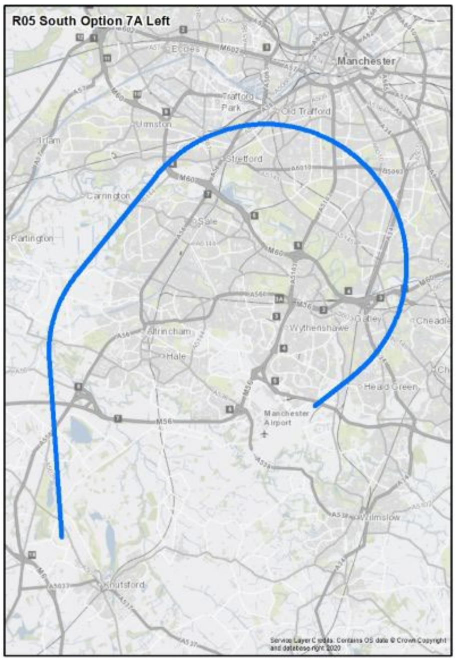
Rationale for inclusion

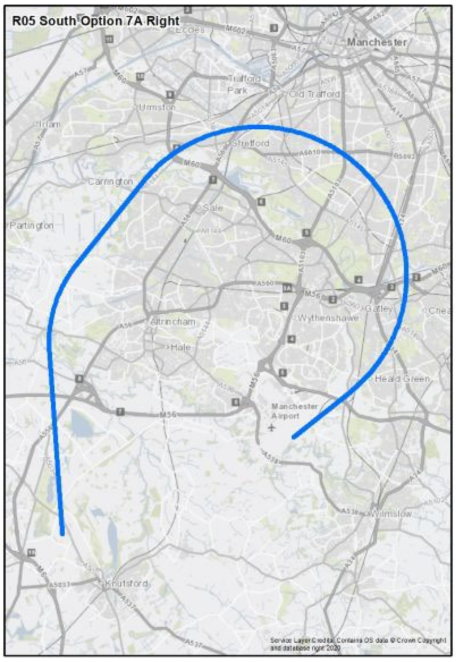
Technology: Procedure uses latest technology (RNP+RF).

Capacity: Has the potential to aid departure utilisation and reduce delays when operated in association with other departure options.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

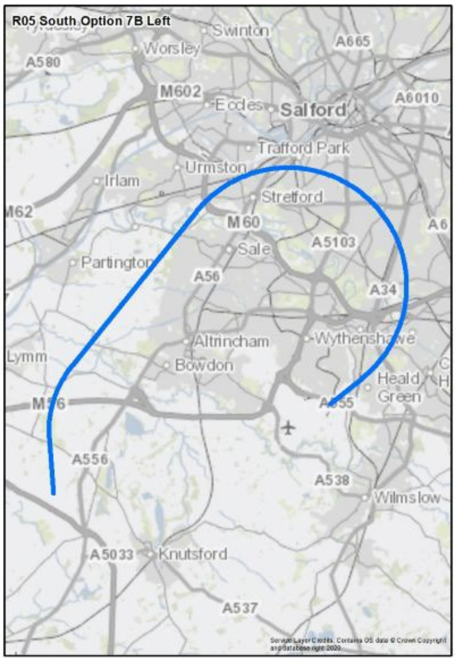
Noise N2: May provide an opportunity for noise respite from right turn southbound departures.

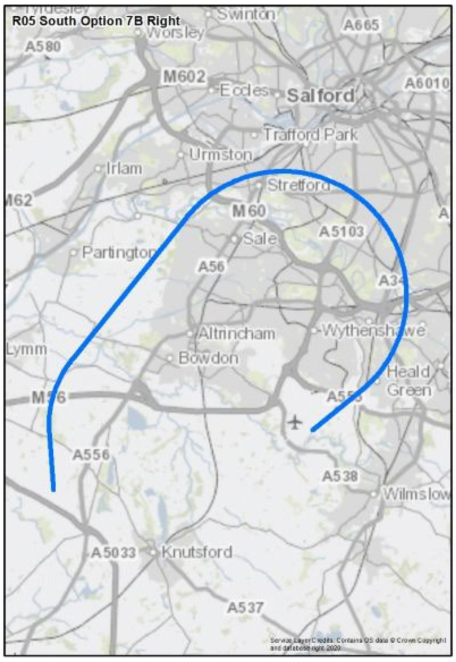




10.5. Runways 05L/05R South Left Turn Option 7B

Description	Rationale for inclusion
This is an **RNP1** option with RF coding that turns left after departure to route north of Sale. It is initially the same as option 7A, except the track routes further south-west before making the left turn south. The design speed will permit many aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. Although this option creates more track miles to route to the south, because of the large number of southbound departures it has potential to aid departure flow and achieving 1-minute splits for southbound SIDs to align to the Design Principle Capacity. **05L:** After departure this route turns left shortly after Heald Green to route overhead Cheadle. This turn is continued in a wide arc to the north of Chorlton and Sale and overhead Stretford where it combines with the option for 05R. It then heads south-west for a straight segment and passes north of Altrincham and makes a left turn to head south between Boden and the Lymm Interchange on the M6. It terminates at 7,000ft close to Over Tabley. **05R:** After departure this route turns left shortly after Heald Green to route overhead Cheadle. This turn is continued in a wide arc to the north of Chorlton and Sale and overhead Stretford where it combines with the option for 05L. It then heads south-west for a straight segment and passes north of Altrincham and makes a left turn to head south between Boden and the Lymm Interchange on the M6. It terminates at 7,000ft close to Over Tabley. A speed restriction of 220 KIAS has been applied to the first turn which allows most aircraft to fly in a clean configuration.	**Technology:** Procedure uses latest technology (RNP+RF). **Capacity:** Has the potential to aid departure utilisation and reduce delays when operated in association with other departure options. **Noise N1:** The track has been designed to avoid large towns in the latter part of the route including Sale, Altrincham, and Knutsford. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact. **Noise N2:** May provide an opportunity for noise respite from right turn southbound departures.





10.6. Runways 05L/05R South Left Turn Option 8

Description

This is an **RNP1** option with RF coding that turns left after departure with the tightest radius possible to reduce track miles. This requires a speed restriction to allow the smaller turn radius.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778 recommendation. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg.

Although this option creates more track miles to route to the south, it is the shortest of the left turn options. In addition, because of the large number of southbound departures it has potential to aid departure flow and achieving 1-minute splits for southbound SIDs to align to the Design Principle Capacity.

05L: After departure this route turns left shortly after Heald Green to route overhead Cheadle, West Didsbury and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns slightly south-east and combines with the route for 05R to pass east of Knutsford and terminate at 7,000ft.

05R: After departure this route turns left shortly after Heald Green to route overhead Cheadle, West Didsbury and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns slightly south-east and combines with the route for 05L to pass east of Knutsford and terminates at 7,000ft.

A speed restriction of 190 KIAS has been applied to the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assessed for flyability as part of the procedure validation process within Stage 4 of CAP1616.

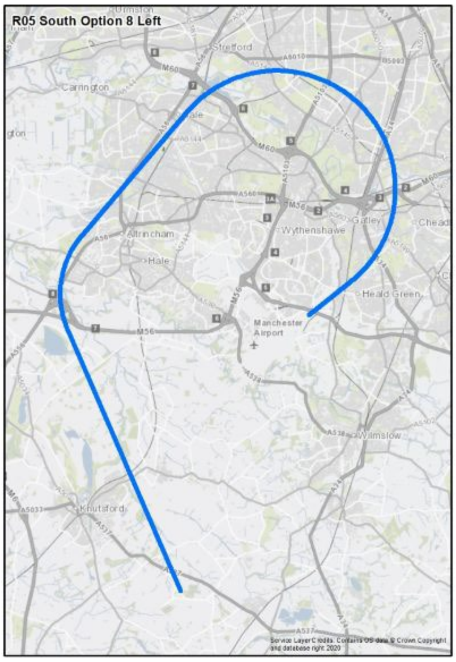
Rationale for inclusion

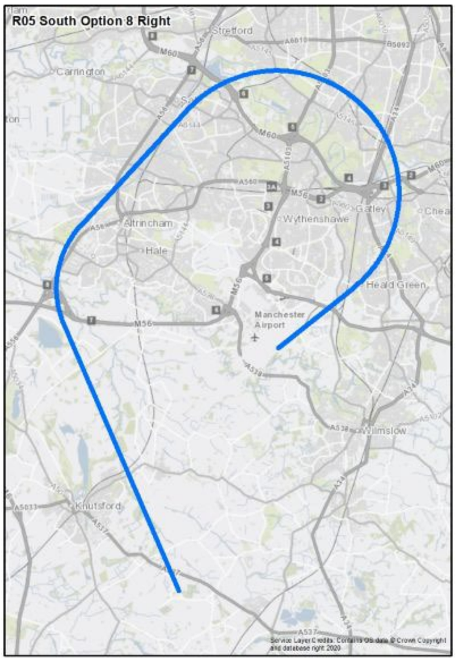
Technology: Procedure uses latest technology (RNP+RF).

Capacity: The tight turn has a greater potential to aid departure utilisation and separation from other departure options to the north and east.

Emissions: There is a small reduction in track miles to join the network compared to the other left turn options. This makes it a more fuel-efficient route.

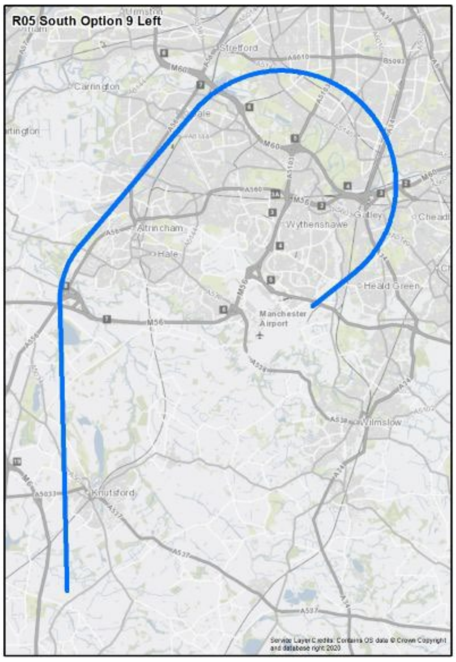
Noise N2: May provide an opportunity for noise respite from right turn southbound departures.

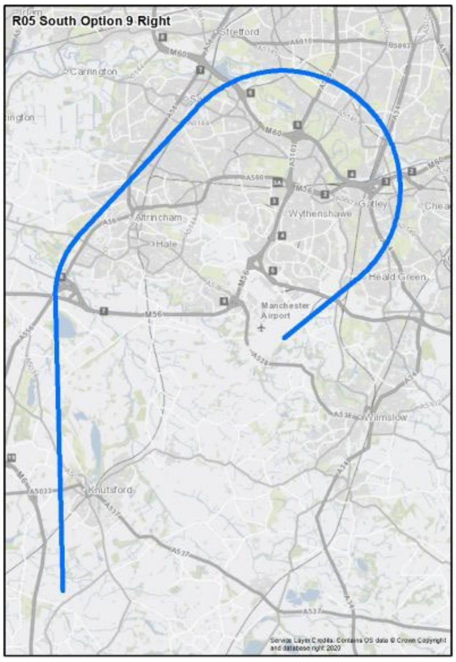




10.7. Runways 05L/05R South Left Turn Option 9

Description	Rationale for inclusion
This is an **RNP1** option with RF coding that turns left after departure with the tightest radius possible to reduce track miles. It is similar to option 8 but terminates slightly further west. In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg. Although this option creates more track miles to route to the south, it is only slightly more track miles than option 8 which is shortest. Because of the large number of southbound departures it has potential to aid departure flow and achieving one minute splits for southbound SIDs. **05L:** After departure this route turns left shortly after Heald Green to route overhead Cheadle, West Didsbury and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns south and combines with the route for 05R to pass west of Knutsford and terminates at 7,000ft. **05R**: After departure this route turns left shortly after Heald Green to route overhead Cheadle, West Didsbury and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns south and combines with the route for 05L to pass west of Knutsford and terminates at 7,000ft. A speed restriction of 190 KIAS applied to the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology**: Procedure uses latest technology (RNP+RF). **Capacity**: The tight turn has a greater potential to aid departure utilisation and separation from other southbound departures when compared to other options. **Noise N1**: It has been created to lessen noise impact by routing further west to follow the track of the M6 south. **Noise N2**: May provide an opportunity for noise respite from right turn southbound departures. **Emissions**: There is a small reduction in track miles to join the network compared to the other left turn options. This makes it a more fuel-efficient route.





10.8. Runways 05L/05R South Left Turn Option 10

Description

This is an **RNP1** option with RF coding that turns left after departure. It routes mid-way between the other options in this envelope.

Although this option creates more track miles to route to the south, because of the large number of southbound departures it has potential to aid departure flow and achieving one minute splits for southbound SIDs.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

In the case of 05L, the turn point is at a minimum distance of 1nm from the DER, in accordance with PANS-OPS and CAP778. The turn point for Runway 05R is located at a point roughly perpendicular to Runway 05L, to create a similar ground track in the turn and subsequent leg.

05L: After departure this route turns left shortly after Heald Green to route overhead Cheadle, Chorlton and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns south and combines with the route for 05R to pass west of Knutsford and terminates at 7,000ft.

05R: After departure this route turns left shortly after Heald Green to route overhead Cheadle, Chorlton and Sale. It then heads south-west for a straight segment and passes just north of Altrincham where it turns south and combines with the route for 05L to pass west of Knutsford and terminates at 7,000ft.

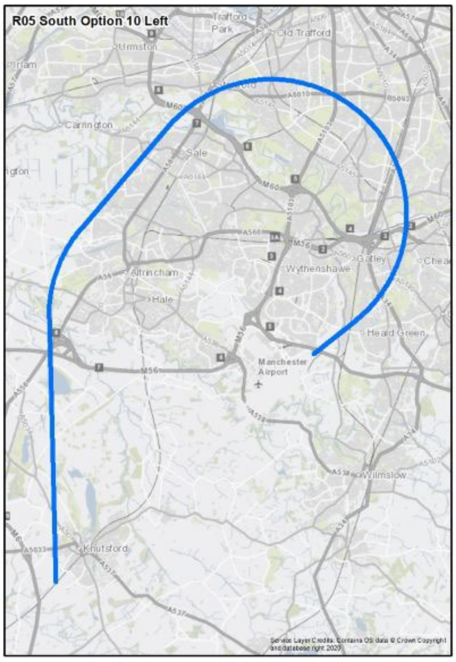
A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

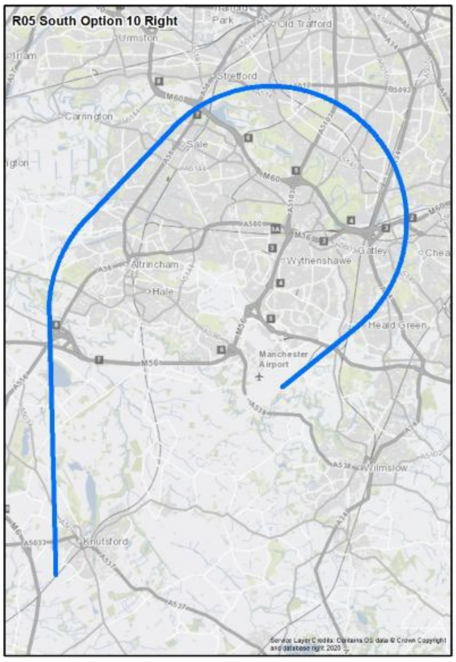
Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Capacity: Has the potential to aid departure utilisation and reduce delays when operated in association with other departure options.

Noise N2: May provide an opportunity for noise respite from right turn southbound departures.





10.9. Runways 05L/05R South Left Turn Viable Poor Fit Options

Note: Because the options development process for 05 South Right Turn and Left Turn took place simultaneously, the viable but poor fit options are identical and apply equally to both envelopes.

Option	Safety	Policy	Capacity
A11 Extended straight ahead then right towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead to Stockport before making a 180-degree right-hand turn, south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it south, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would take the same track as departures in the east which could limit the ability to enable best use of runway capacity and limit the ability to achieve one minute departure splits.			
B12 Extended straight ahead then left towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead to Stockport before making a 180-degree left-hand turn, south-west, and then another left-hand turn to the south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north along with departures in the 05 East Design Envelope, which could limit the ability to enable best use of runway capacity and limit the ability to achieve one minute departure splits.			
C13 Extended straight ahead then extended left towards south	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead beyond Stockport before making a gradual 180-degree left-hand turn, heading south-west, and then another left-hand turn to the south-west, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north along with departures in the 05 East Design Envelope, which could limit the ability to which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			

11.SID Runways 05L/05R – West

11.1. Introduction to 05L/05R West Design Envelope

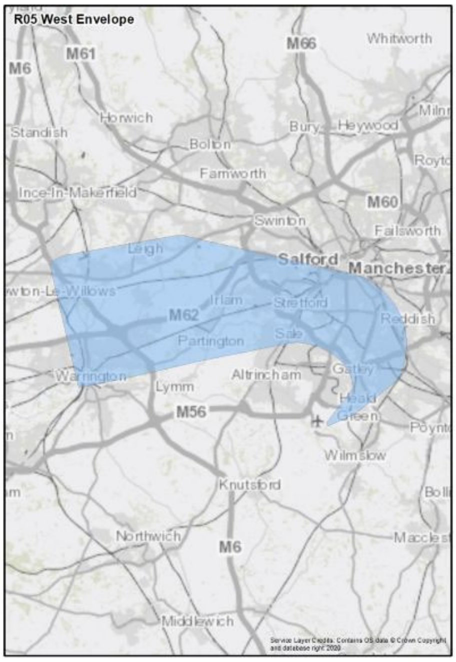
This envelope is based on the ASMIM 1S/1Z SID which currently serves two purposes, one is for traffic to the west and the other is the south-west. However, future options within this envelope have only been designed to service traffic in a westerly direction. Options for the south-west are contained within a new envelope in that direction.

Traffic using this envelope to the west is headed towards the network joining point in the vicinity of Wallasey (WAL).

The design options seek to align with current operational practice and bilateral discussions with LVP. This assessed the route interactions between the options at MAN and those for LVP but found no significant issues with this envelope and the options within it.

All options terminate at 7,000ft, at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

11.2. Design Envelope Location Map



11.3. 05L/05R West Options Summary Table

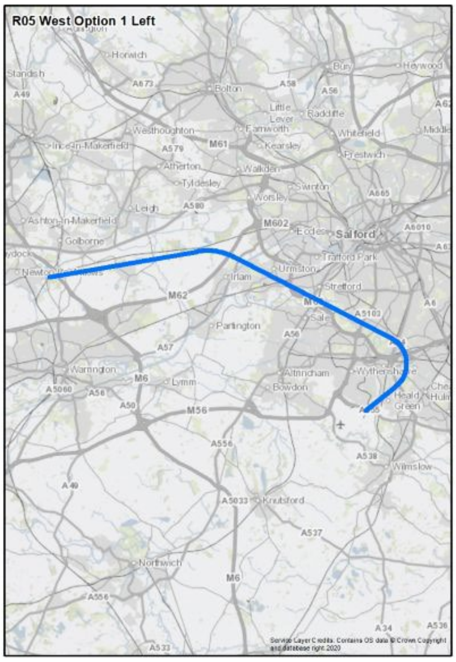
Viable and Good Fit		Viable but Poor Fit		Unviable	
1	'Do minimum' This option is included to provide a RNAV1 replication of the existing conventional ASMIM 1S 1Z SID. 185 KIAS	A2	Later wider initial turn	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to the DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
3	This is an RNAV1 option included to provide a shorter and more fuel-efficient route to the west. It has a wider track in the turn but avoids routing as far to the north. 210 KIAS	B8	Extended straight ahead then left turn towards west.		

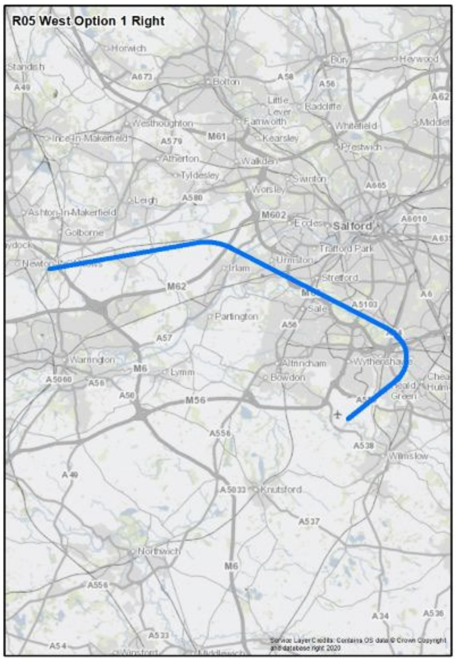
4A	This is an RNP1 option that uses RF coding to provide a single initial turn starting at the position of the current turn to create a fuel-efficient route to the west. 190 KIAS	C9	Right-hand wraparound		
4B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest position possible to create a fuel-efficient route to the west. 190 KIAS				
5A	This is an RNP1 option that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route to the west. It is similar to option 4A but is designed with a higher speed. 210 KIAS				
5B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest position possible to create a fuel-efficient route to the west. It is similar to option 4B but is designed with a higher speed. 210 KIAS				

6A	This is an RNP1 option that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route to the west. It is similar to options 4A and 5A but is designed with a higher speed intended to allow aircraft to use the route in a more aerodynamic configuration. 220 KIAS				
6B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest position possible to create a fuel-efficient route to the west. It is similar to options 4B and 5B but with a higher speed intended to allow aircraft to use the route in a more aerodynamic configuration. 220 KIAS				
7	This is an RNP1 option that uses RF coding, and which provides an initial track adjustment to the left (north) at the DER before a single turn to create a fuel-efficient route to the west. This is intended to provide noise relief for the Cheadle area. 190 KIAS				

11.4. Runways 05L/05R West Option 1

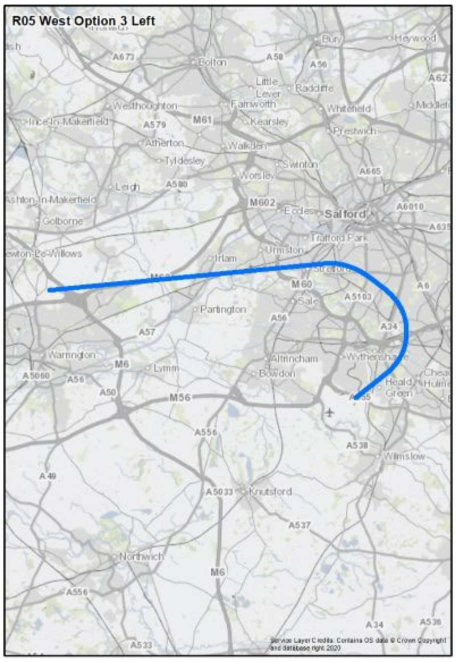
Description	Rationale for inclusion
This option is included to provide a **RNAV1** replication of the existing conventional ASMIM 1S/1Z SID. It uses a fly-over waypoint with Course-to-Fix (CF) path terminator coding and an element of dispersion would be apparent in the turn due to this coding As a replicated route it follows a similar track over the ground as the current route. After departure this involves a right turn to pass overhead Cheadle at which point the routes combine. They then pass just to the west of Didsbury and overfly Stretford and Urmston. The routes make a left turn just north of Irlam and route west to terminate at 7,000ft to the north of Warrington at Earlestown. A speed restriction of 185 KIAS is used for the first turn to replicate the existing 298° course to XOBRO, although this can be increased if it proves flyability issues. A higher speed would result in greater track dispersal in the first turn. This flyability will be conducted as part of the procedure validation process within Stage 4 of CAP1616.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft.

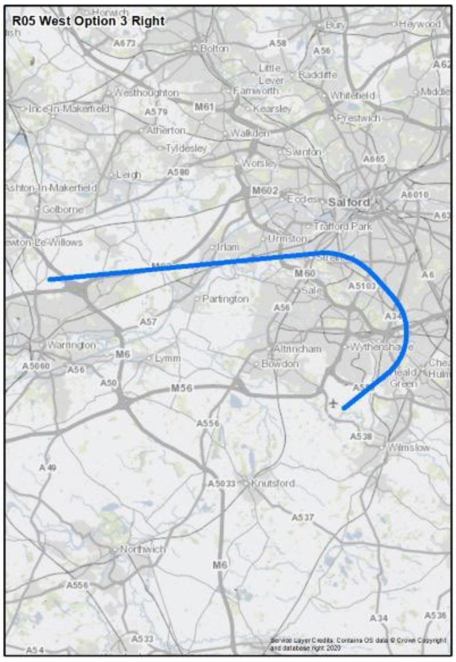




11.5. Runways 05L/05R West Option 3

Description	Rationale for inclusion
This is an **RNAV1** option included to provide a shorter and more fuel-efficient route to the west and the network joining point at Wallasey. It has a wider track in the turn but avoids routing as far to the north. This design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The option maximises fuel efficiency by removing the leg between the first turn to XOBRO and replacing it with a direct route to the west. The procedure uses fly-by waypoints, and the climb gradient has been set at 6%. **05L:** After departure this route turns left shortly after Cheadle (at approximately MCT D2), and heads north in a track that takes it just west of Didsbury and Chorlton where the routes combine. At this point a left turn to the west is made to route overhead Urmston and Lower Irlam and terminates at 7,000ft north of Warrington. **05R**: After departure this route turns left shortly after Cheadle, (at approximately MCT D2) and heads north, in a track that takes it just west of Didsbury and Chorlton where the routes combine. At this point a left turn to the west is made to route overhead Urmston and Lower Irlam and terminates at 7,000ft north of Warrington. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Emissions**: There is a reduction in track miles to join the network compared to the current SID as it routes to the west at an earlier position. This makes it a more fuel-efficient route.





11.6. Runways 05L/05R West Option 4A

Description

This is an **RNP1** that uses RF coding to provide a single initial turn starting at the position of the current turn to create a fuel-efficient route to the network joining point to the west. Because of the turn position used, the routes are separate for their duration and do not combine until the 7,000ft which creates a small element of dispersal.

05L: After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Withington. The left turn is completed heading in a westerly direction to the south of Chorlton and it continues west to route just north of Sale and terminates at 7,000ft north of Warrington where the two routes combine.

05R: After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Withington. The left turn is completed heading in a westerly direction to the south of Chorlton and it continues west to route just north of Sale and terminates at 7,000ft north of Warrington where the two routes combine.

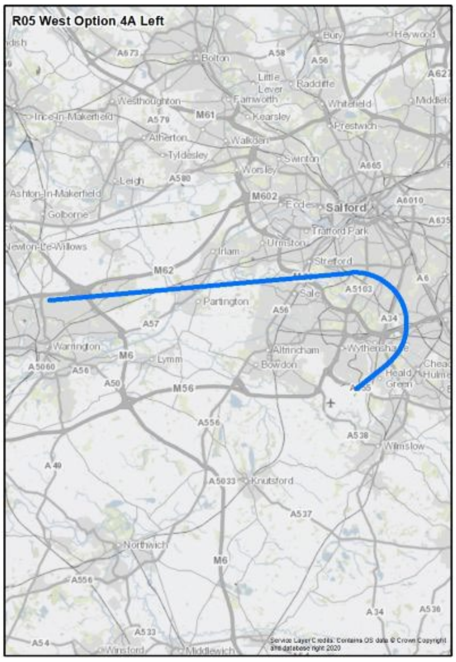
A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

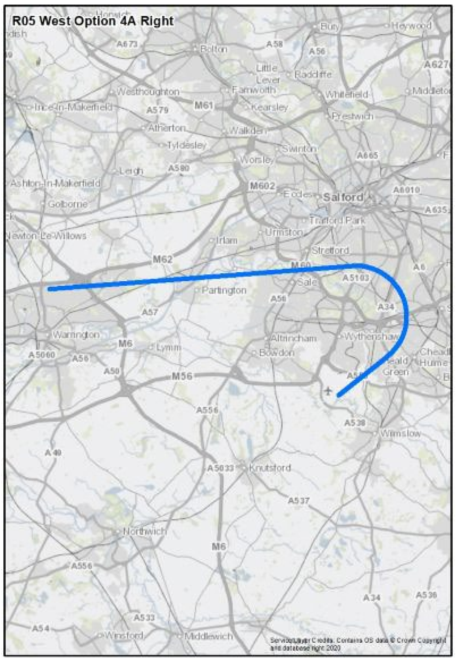
Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: There is a reduction in track miles to join the network compared to the current SID as it routes to the west at an earlier position. This makes it a more fuel-efficient route.

Noise N2: Minor dispersal is created by the use of a common turn point.





11.7. Runways 05L/05R West Option 4B

Description

This is an **RNP1** that uses RF coding to provide a single initial turn to create a fuel-efficient route to the network joining point to the west. It differs from option 4A in that the turn is at the earliest PANS-OPS compliant position from 05L to create the shortest route possible at this design speed.

Because of the turn positions used, the routes are separate for their duration and do not combine until the 7,000ft which creates a small element of dispersal.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle and West Didsbury before completing the left turn heading in a westerly direction to the south of Chorlton. It continues west to route just north of Sale and terminates at 7,000ft north of Warrington where the two routes combine.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This is a single left turn that takes it overhead Cheadle and West Didsbury before completing the left turn heading in a westerly direction to the south of Chorlton. It continues west to route just north of Sale and terminates at 7,000ft north of Warrington where the two routes combine.

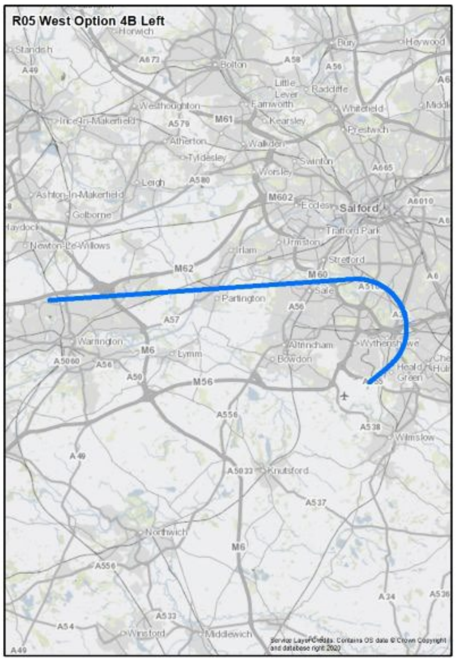
A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

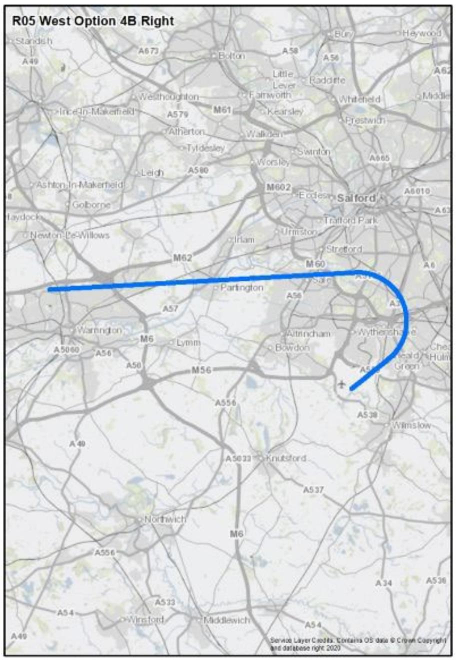
Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: There is a reduction in track miles to join the network compared to the current SID and option 4A as it routes to the west at an earlier position. This makes it a more fuel-efficient route.

Noise N2: Minor dispersal is created using a common turn point.





11.8. Runways 05L/05R West Option 5A

Description

This is an **RNP1** that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route to the network joining point to the west.

It is similar to option 4A but is designed with a higher speed of 210kts. The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. This design speed may also permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route makes a single left turn just after Cheadle which takes it east of Burnage and overhead Fallowfield. The left turn is completed heading in a westerly direction close to Old Trafford and it continues west to route via Urmston and terminates at 7,000ft north of Warrington close to the junction between the M62 and the M6 where the two routes combine.

05R: After departure this route makes a single left turn just after Cheadle which takes it east of Burnage and overhead Fallowfield. The left turn is completed heading in a westerly direction close to Old Trafford and it continues west to route via Urmston and terminates at 7,000ft north of Warrington close to the junction between the M62 and the M6 where the two routes combine.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

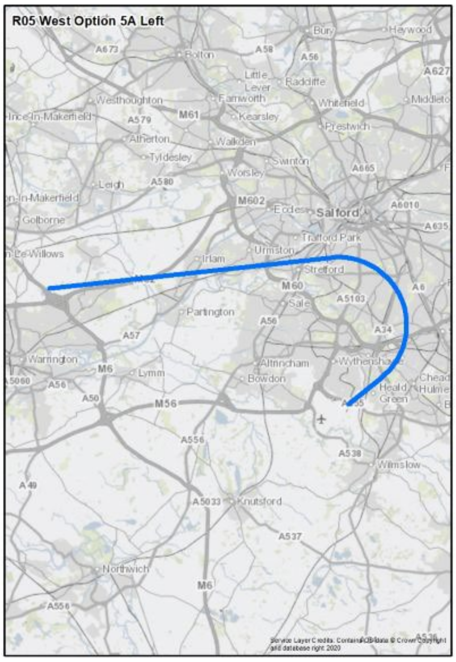
Rationale for inclusion

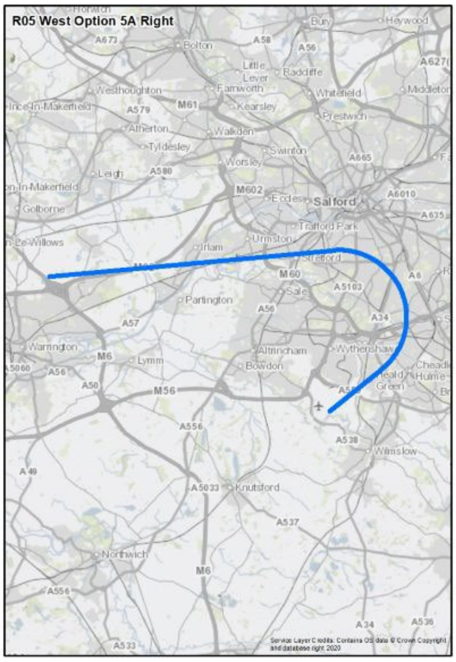
Technology: Procedure uses latest technology (RNP+RF).

Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Emissions: There is a reduction in track miles to join the network compared to the current SID as it routes to the west at an earlier position. This makes it a more fuel-efficient route.

Noise N1: The wider arc of this option routes further north potentially reducing the noise impact for Warrington compared to option 4A and 4B.





11.9. Runways 05L/05R West Option 5B

Description

This is an **RNP1** that uses RF coding to provide a single initial turn to create a fuel-efficient route to the network joining point to the west. It differs from option 5A in that the turn is at the earliest PANS-OPS compliant position from Runway 05L to create a shorter route for this design speed.

It is similar to option 4B but is designed with a higher speed of 210kts. The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. The design speed may also permit some aircraft to be in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle and Withington before completing the left turn heading in a westerly direction to the north of Chorlton. It continues west to route to be south of Stretford and Urmston and terminates at 7,000ft north of Warrington just beyond the junction between the M62 and the M6 where the two routes combine.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This single left turn takes it overhead Cheadle and Withington before completing the left turn heading in a westerly direction to the north of Chorlton. It continues west to route to be south of Stretford and Urmston and terminates at 7,000ft north of Warrington just beyond the junction between the M62 and the M6 where the two routes combine.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

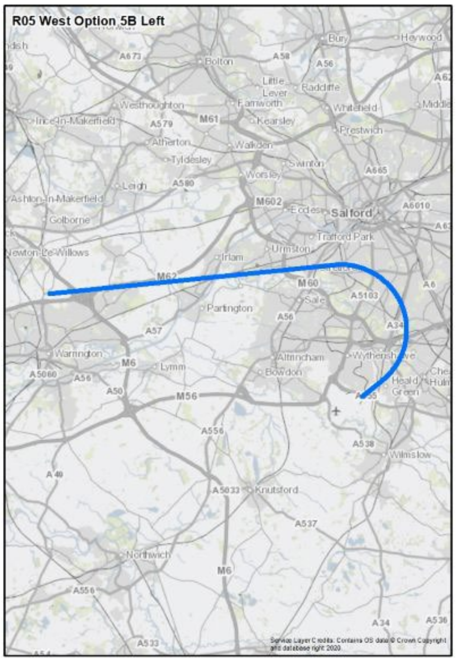
Rationale for inclusion

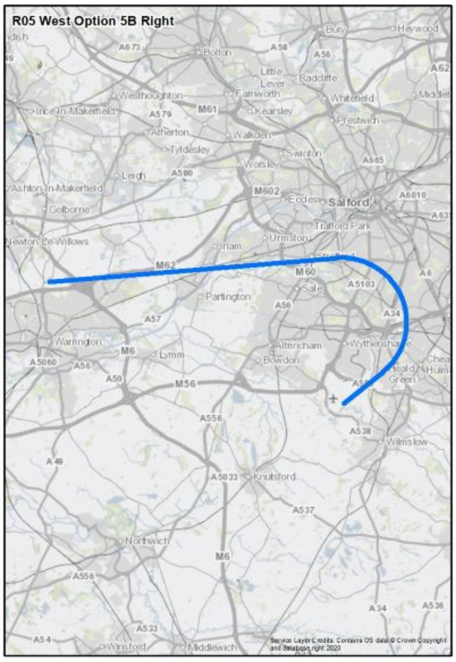
Technology: Procedure uses latest technology (RNP+RF).

Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Emissions: There is a reduction in track miles to join the network compared to the current ASMIM SID and option 5A as it routes to the west at an earlier position. This makes it a more fuel-efficient route.

Noise N1: The wider arc of this option routes further north potentially reducing the noise impact for Warrington compared to option 4A and 4B.





11.10. Runways 05L/05R West Option 6A

Description

This is an **RNP1** that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route to the network joining point to the west. It is similar to option 5A but is designed with a higher speed of 220kts speed intended to allow aircraft to use the route in a more aerodynamic configuration.

The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. It will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route makes a single left turn just after Cheadle which takes it east of Burnage and overhead Fallowfield. The left turn is completed heading in a westerly direction overhead Old Trafford where the routes combine and continue west to route north of Stretford, Urmston and Irlam. It terminates at 7,000ft north of Warrington to the east of Earlestown.

05R: After departure this route makes a single left turn just after Cheadle which takes it east of Burnage and overhead Rusholme. The left turn is completed heading in a westerly direction overhead Old Trafford where the routes combine and continue west to route north of Stretford, Urmston and Irlam. It terminates at 7,000ft north of Warrington to the east of Earlestown.

A speed restriction of 220 KIAS is used for the first turn which allows most aircraft to fly in a clean configuration.

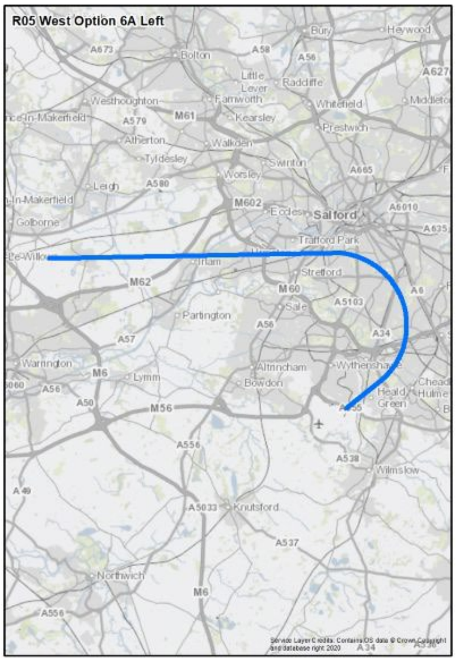
Rationale for inclusion

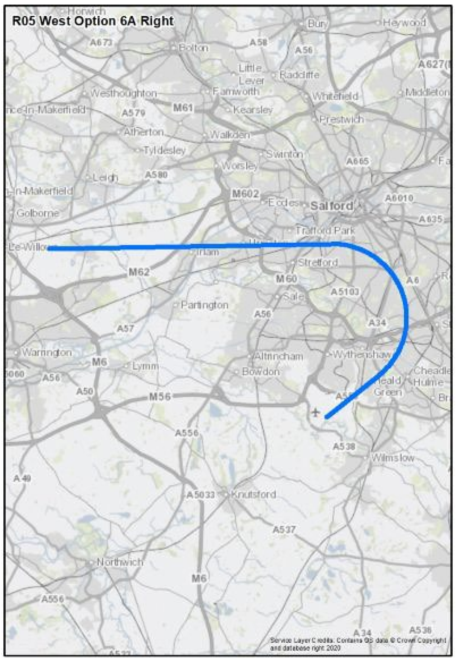
Technology: Procedure uses latest technology (RNP+RF).

Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

By turning on a wider arc this option routes further north and so it has the potential to reduce noise impact for Warrington.





11.11. Runways 05L/05R West Option 6B

Description

This is an **RNP1** that uses RF coding to provide a single initial turn to create a fuel-efficient route to the network joining point to the west. It differs from option 6A in that the turn is at the earliest PANS-OPS compliant position from Runway 05L to create a shorter route for this design speed.

It is similar to option 5B but is designed with a higher speed of 220kts. The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. The greater speed will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle and Burnage before completing the left turn heading in a westerly between Chorlton and Old Trafford. It continues west to route overhead Stretford and Urmston and terminates at 7,000ft north of Warrington just beyond the junction between the M62 and the M6.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This single left turn takes it overhead Cheadle and Burnage before completing the left turn heading in a westerly between Chorlton and Old Trafford. It continues west to route overhead Stretford and Urmston and terminates at 7,000ft north of Warrington just beyond the junction between the M62 and the M6.

A speed restriction of 220 KIAS is used for the first turn which allows most aircraft to fly in a clean configuration.

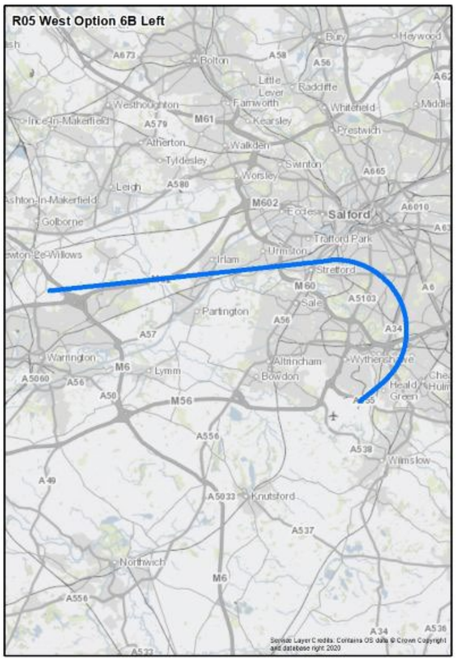
Rationale for inclusion

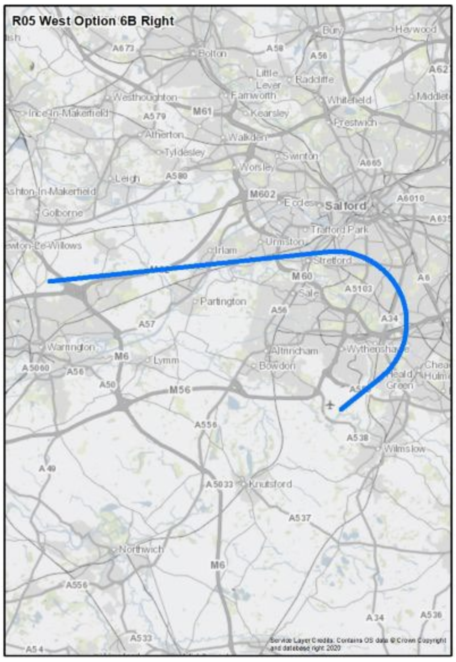
Technology: Procedure uses latest technology (RNP+RF).

Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Emissions: There is a reduction in track miles to join the network compared to the current SID and option 6A as it routes to the west at an earlier position. This makes it a more fuel-efficient route.





11.12. Runways 05L/05R West Option 7

Description

This is an RNP1 option that uses RF coding to provide a similar route to that of option 4B, but it uses an initial 15° track adjustment to the left from the DER for Runway 05L, and a 5° adjustment for Runway 05R. This is to provide noise relief for the Cheadle area, which lies underneath the approach path for Runways 23L/23R arrivals. After this track adjustment it has a single initial turn at the earliest PANS-OPS compliant position to create a fuel-efficient route to the network joining point to the west.

05L: After passing the DER aircraft make a 15° track adjustment to the left (north) and then turn left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it to the west side of Cheadle and then overhead West Didsbury before completing the left turn heading in a westerly direction to the south of Chorlton where the two routes combine. It continues west to route just north of Sale and terminates at 7,000ft north-west of Warrington.

05R: After passing the DER aircraft make a 5° track adjustment to the left (north) and then turn left at a point that is abeam the turn point for 05L. This is a single left turn that takes it to the west side of Cheadle and then overhead Didsbury before completing the left turn heading in a westerly direction to the south of Chorlton where the two routes combine. It continues west to route just north of Sale and terminates at 7,000ft north-west of Warrington.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: There is a reduction in track miles to join the network compared to the current SID.

Noise N1: The track adjustment to the left after departure is intended to reduce the impact of noise on communities in the Cheadle area that are also impacted by arrivals to Runways 23L/23R.

Noise N2: This may be used as a noise respite route in combination with option 4A/4B.

11.13. Runways 05L/05R West Viable but Poor Fit Options

Option	Safety	Policy	Capacity
A2 Later wider initial turn	S	P	C
Originally designed as **option 2** this was created to provide a later and wider initial turn using RF coding, forming the east side of the envelope, then routing to XOBRO and thereafter replicating the existing procedure. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.			
B8 Extended straight ahead then gradual left turn towards west	S	P	C
After departure from Runways 05L/05R, aircraft would fly straight ahead to Stockport before making a left-hand turn, heading west towards the SID aiming point. Safety: This option may interact with 05 departures to the north. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it west, leading to increased fuel burn and emissions_which is not aligned to the aims of the AMS. Capacity: This option would take the same track as departures on the east options which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity. In addition, this option is expected to interact with departures in the north design envelopes.			
C9 Right-hand wraparound	S	P	C
After departure from Runways 05L/05R, aircraft would make a right-hand turn, in the vicinity of Hazel Grove before making a right-hand turn, passing to the south of the airport and then turning west, towards the SID aiming point. Safety: This option is expected to conflict with the Runway 05R MAP. Capacity: This option interacts with departures in the 05 South Design Envelope and arrivals from the south which would limit the ability to enable best use of runway capacity.			

12. SID Runways 05L/05R – South-west

12.1. Introduction to 05L/05R South-west Design Envelope

This is a new design envelope that has been created in line with the design principles Policy and Emissions.

In relation to Design Principle Policy, the AMS requires future airspace to secure the most efficient use of airspace and the expeditious flow of traffic. This envelope seeks to provide a new and more efficient route to the south-west that has high levels of demand. This has potential to reduce delays at MAN but also reduce pressure on the upper airspace network which currently must split flights heading south-west from those to the west.

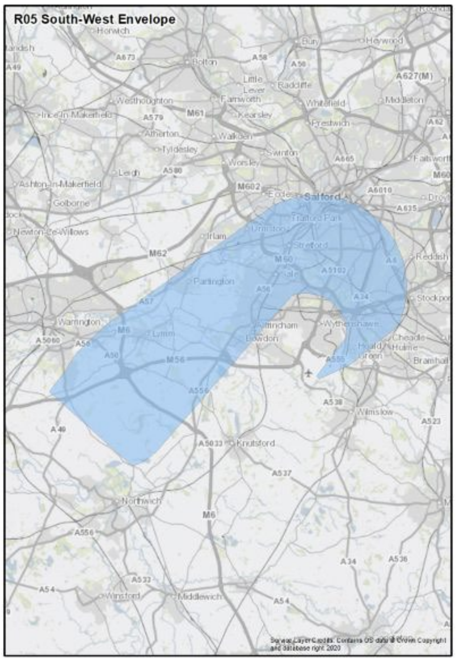
In relation to Design Principle Emissions, it enables the creation of a shorter route for flights to the south-west when compared to the current ASMIM 1S/1Z SID. At present, traffic routing to the south-west will initially flight plan via the west envelope before being tactically turned south-west by ATC later. However, aircraft on this route are often vectored off the SID once they are above 3,000ft to take them on a more direct track to the south-west to reduce fuel burn. This envelope seeks to systemize this operational practice by creating design options that reduce fuel burn and reduce the wide impact of noise created by ATC vectoring.

The design options seek to align with current operational practice and bilateral discussions with LVP. This assessed the route interactions between the options at MAN and LVP but found no significant issues with this envelope and the options within it.

All options terminate at 7,000ft, at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000 ft is achieved.

Because this is a new envelope, there is no 'do minimum' option.

12.2. Design Envelope Location Map



12.3. Runways 05L/05R South-west Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1	This is an RNAV1 option that provides two left turns and then a track to join the NATS network to the south-west. The initial track is similar to the ASMIM 1S/1Z SID. 210 KIAS	A6	Extended climb out left turn.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
2A	This is an RNP1 option that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route. The design speed results in a tight radius turn to create the shortest track length to join the NATS network to the south-west. 190 KIAS	B7	Extended climb out, right turn.		

2B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest PANS-OPS compliant position to create a fuel-efficient route. The design speed results in a tight radius turn to create the shortest track length to join the NATS network. 190 KIAS	C8	Right-hand wraparound.		
3A	This is an RNP1 that uses RF coding to provide a single initial turn based on the position of the current turn to create a fuel-efficient route to the south-west. It is similar to option 2A but is designed with a higher speed. 210 KIAS				
3B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest PANS-OPS compliant position possible to route to the south-west. It is similar to option 2B but is designed with a higher speed. 210 KIAS				
4A	This is an RNP1 option that uses RF coding to provide a single initial turn based on the position of the current turn to create a route to the south-west. It is similar to option 2A and 3A but is designed with a higher speed intended to allow aircraft to use the route in a more aerodynamic configuration. 220 KIAS				

4B	This is an RNP1 option that uses RF coding to provide a single initial turn at the earliest PANS-OPS compliant position to create a route to the south-west. It is similar to options 2B and 3B but is designed with a higher speed intended to allow aircraft to use the route in a more aerodynamic configuration. 220 KIAS				
5	This is an RNAV1 option that provides two turns to the left to route south-west similar option 1 but uses an initial 15° track adjustment to the left (north) from the DER for Runway 05L, and a 5° adjustment for Runway 05R. This is intended to provide noise relief for the Cheadle area. 210 KIAS				

12.4. Runways 05L/05R South-west Option 1

Description

This is an **RNAV1** option that provides two left turns and then a track to join the NATS network to the south-west. The initial course is similar to the current ASMIM 1S/1Z SID, but it turns off this to the north of MAN.

It has an initial turn at 1nm DER (05L) followed by a 117° left turn to head south-west. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The procedure uses fly-by waypoints.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This takes it overhead Cheadle and West Didsbury where it combines with the option for 05R. There is then a short straight segment before a second turn is made over Stretford and it heads in a south-westerly direction over sparsely populated areas to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This takes it overhead Cheadle and West Didsbury where it combines with the option for 05L. There is then a short straight segment before a second turn is made over Stretford and it heads in a south westerly direction over sparsely populated areas to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6.

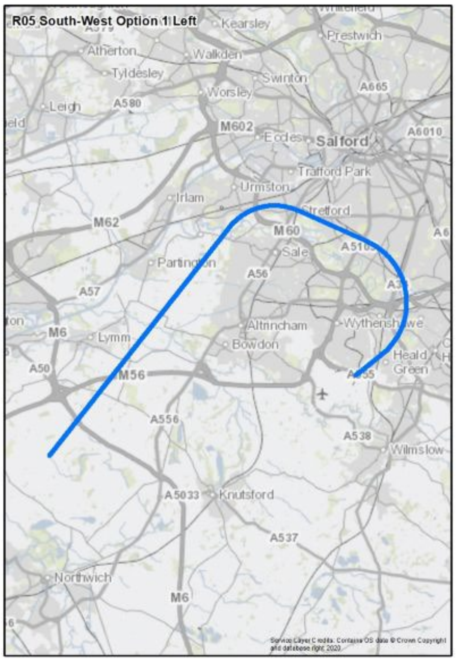
A speed restriction of 210 KIAS is used for the first turn and second turn, which is the CAP778 recommended speed.

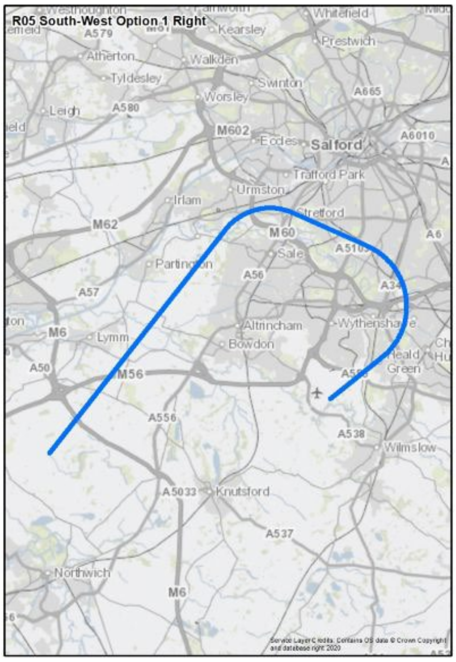
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: The track aims to replicate the existing initial track used on the ASMIM 1S/1Z SID.

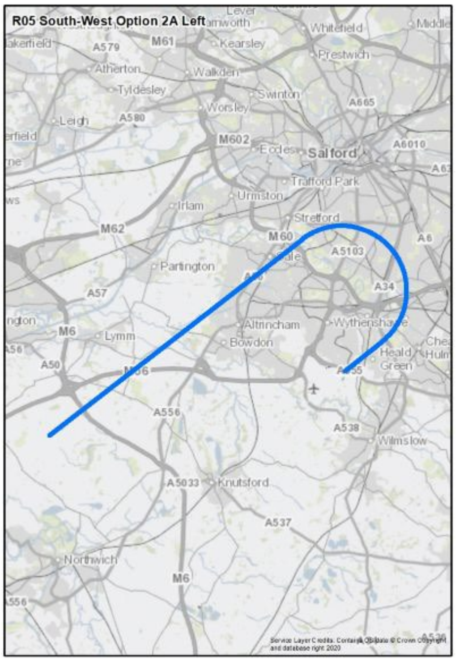
Noise N1: The track aims to avoid the areas of Sale, Urmston, Irlam, Partington and Warrington.

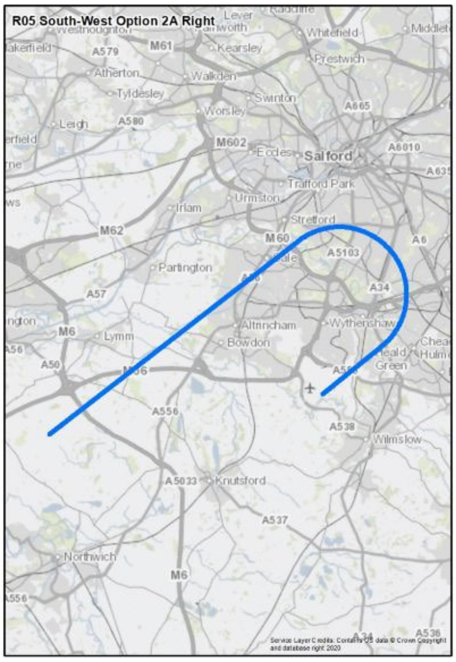




12.5. Runways 05L/05R South-west Option 2A

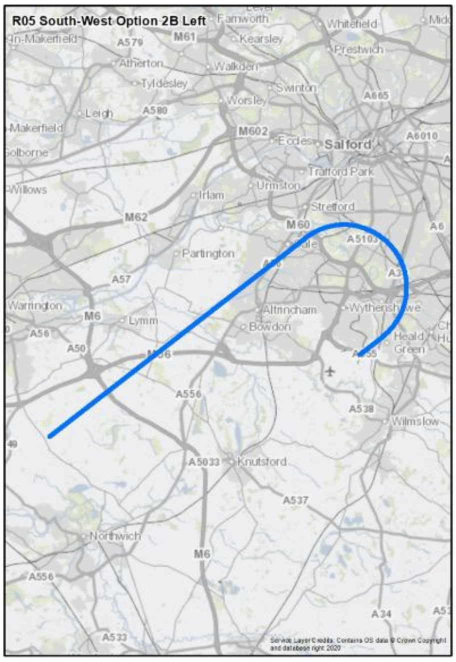
Description	Rationale for inclusion
This is an **RNP1** option that uses RF coding to provide a single left turn starting at the position of the current turn to create a fuel-efficient route. The design speed results in a tight radius turn to create a short track length to join the NATS network to the south-west. **05L:** After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Withington where it combines with the option for 05R. The left turn is completed heading in a south-westerly direction in the vicinity of Chorlton and it continues in this direction to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6. **05R**: After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Withington where it combines with the option for 05L. The left turn is completed heading in a south-westerly direction in the vicinity of Sale and it continues in this direction to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology:** Procedure uses latest technology (RNP+RF). **Emissions:** There is a reduction in track miles to join the network compared to the current routes used. This makes it a more fuel-efficient route. **Noise N1:** Remains north of the built-up areas in the vicinity of Altrincham.

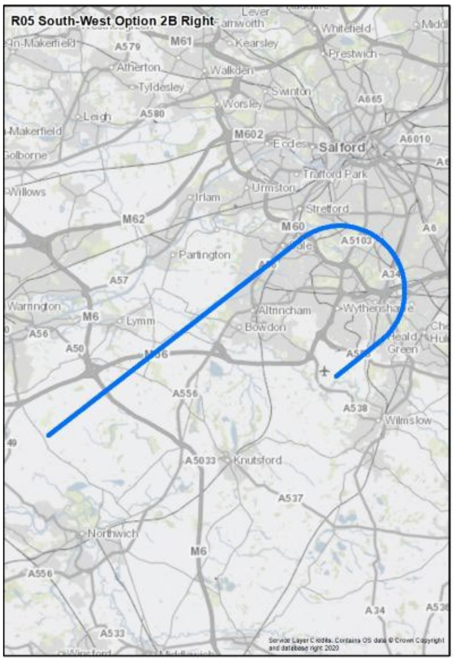




12.6. Runways 05L/05R South-west Option 2B

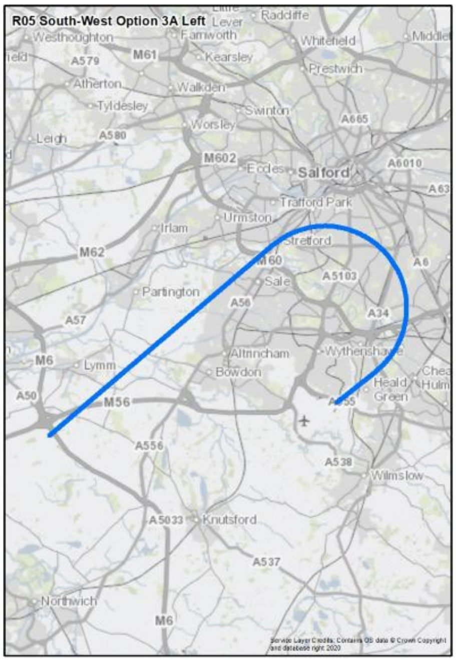
Description	Rationale for inclusion
This is an **RNP1** that uses RF coding to provide a single initial turn to create a fuel-efficient route to the network joining point to the west. It differs from option 2A in that the turn is at the earliest PANS-OPS compliant position from Runway 05L to create the shortest route possible at this design speed. **05L:** After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle and West Didsbury before completing the left turn heading in a south-westerly direction to the south of Sale where it combines with the option for 05R. It continues south-west to route just north of Altrincham and terminates at 7,000ft south of Warrington. **05R**: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This is a single left turn that takes it overhead Cheadle and West Didsbury before completing the left turn heading in a south-westerly direction to the south of Sale where it combines with the option for 05L. It continues south-west to route just north of Altrincham and terminates at 7,000ft south of Warrington. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology:** Procedure uses latest technology (RNP+RF). **Emissions:** This is the shortest and therefore the most fuel-efficient route for this envelope. **Noise N1**: Remains north of the built-up areas in the vicinity of Altrincham.

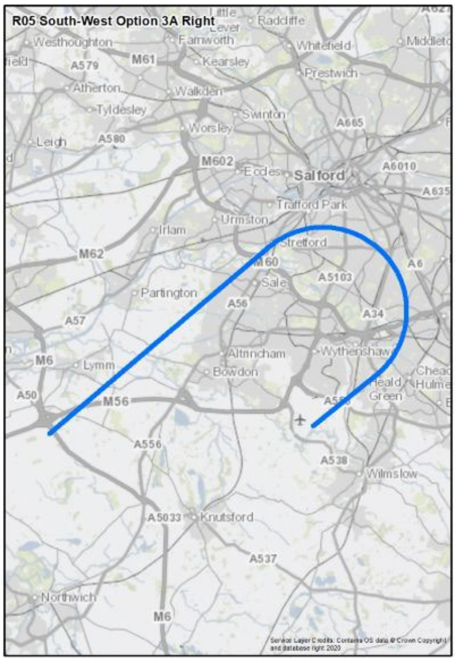




12.7. Runways 05L/05R South-west Option 3A

Description	Rationale for inclusion
This is an **RNP1** that uses RF coding to provide a single initial turn starting at the position of the current turn to create a fuel-efficient route to the south-west. It is similar to option 2A but is designed with a higher design speed of 210kts. The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. The design speed may also permit some aircraft to be in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **05L:** After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Fallowfield where it combines with the option for 05R. The left turn is completed heading in a south-westerly direction between Chorlton and Stretford and it continues in this direction to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6. **05R**: After departure this route makes a single left turn just after Cheadle which takes it overhead Burnage and Fallowfield where it combines with the option for 05L. The left turn is completed heading in a south-westerly direction between Chorlton and Stretford and it continues in this direction to terminate at 7,000ft south of the Lymm interchange between the M56 and the M6. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: Procedure uses latest technology (RNP+RF). **Policy:** Avoids interactions with inbound traffic from the north by climbing aircraft in a wider arc. **Emissions:** There is a reduction in track miles to join the network compared to the current routes used. This makes it a more fuel-efficient route. **Noise N1**: By turning on a wider arc this option routes further north and so it has the potential to reduce noise for Sale compared to option 2A/B.





12.8. Runways 05L/05R South-west Option 3B

Description

This is an **RNP1** option that uses RF coding to provide a single initial turn to create a fuel-efficient route to the network joining point to the west. It differs from option 3A in that the turn is at the earliest PANS-OPS compliant position from 05L to create a shorter route for this design speed.

It is similar to option 2B but is designed with a higher speed of 210kts. The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. It may also permit some aircraft to be in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle and Withington before completing the left turn heading in a south-westerly direction to the south of Stretford where it combines with the option for 05R. It continues south-west to route to avoid Altrincham and terminates at 7,000ft west of the Lymm interchange between the M56 and the M6.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This is a single left turn that takes it overhead Cheadle and Withington before completing the left turn heading in a south-westerly direction to the south of Stretford where it combines with the option for 05L. It continues south-west to route to avoid Altrincham and terminates at 7,000ft west of the Lymm interchange between the M56 and the M6.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

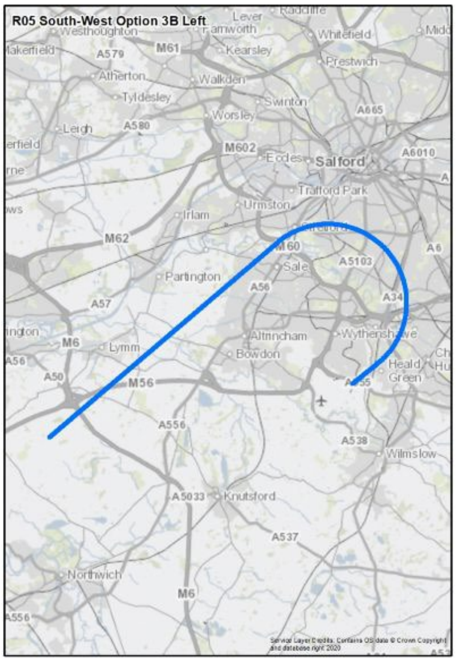
Rationale for inclusion

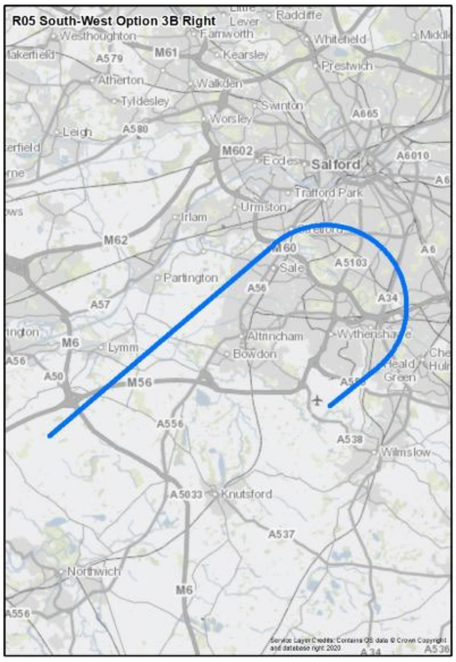
Technology: Procedure uses latest technology (RNP+RF).

Policy: Avoids interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Emissions: There is a reduction in track miles to join the network compared to the current routes used. This makes it a more fuel-efficient route.

Noise N1: By turning on a wider arc this option routes further north and so it has the potential to reduce noise for Sale compared to option 2A/B.





12.9. Runways 05L/05R South-west Option 4A

Description

This is an **RNP1** option that uses RF coding to provide a single initial turn based on the position of the current turn to create a route to the south-west. It is similar to option 2A and 3A but is designed with a higher speed of 220kts intended to allow aircraft to use the route in a more aerodynamic configuration.

The greater speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. It will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route makes a single left turn just after Cheadle which takes it overhead Rusholme and Old Trafford where it combines with the option for 05R. The left turn is completed heading in a south-westerly direction at Stretford and it continues in this direction to terminate at 7,000ft east of the Lymm interchange between the M56 and the M6.

05R: After departure this route makes a single left turn just after Cheadle which takes it overhead Rusholme and Old Trafford where it combines with the option for 05L. The left turn is completed heading in a south-westerly direction at Stretford and it continues in this direction to terminate at 7,000ft east of the Lymm interchange between the M56 and the M6.

A speed restriction of 220 KIAS is used for the first turn which allows most aircraft to fly in a clean configuration.

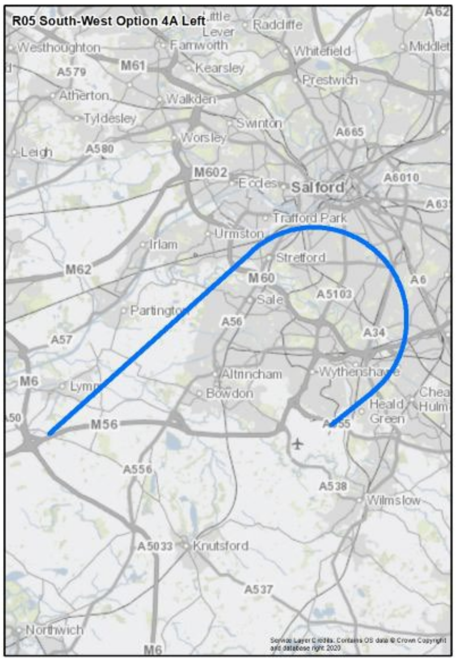
Rationale for inclusion

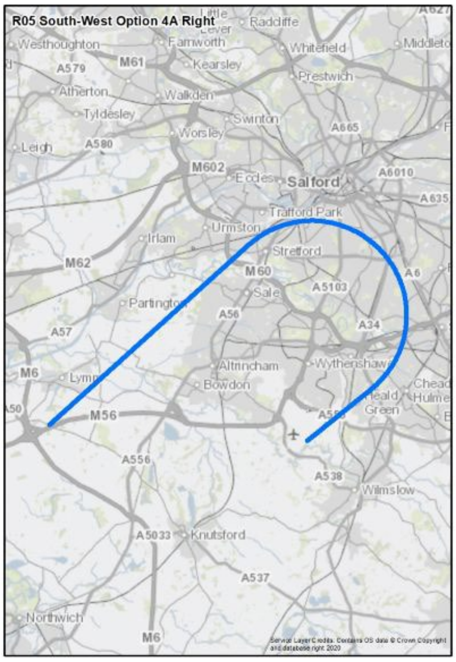
Technology: Procedure uses latest technology (RNP+RF).

Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

By turning on a wider arc this option routes further north and results in a route over more sparsely populated areas beyond Stretford.





12.10. Runways 05L/05R South-west Option 4B

Description

This is an **RNP1** option that uses RF coding to provide a single initial turn at the earliest PANS-OPS compliant position to create a route to the south-west. It differs from option 4A in that the turn is at the earliest PANS-OPS compliant position from Runway 05L to create a shorter route for this design speed.

It is similar to options 2B and 3B but is designed with a higher speed of 220kts. The design speed results in a wider track, which may aid vertical separation from MAN arriving traffic from the north. It will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

05L: After departure this route turns left at the earliest PANS-OPS compliant position (1nm from DER). This is a single left turn that takes it overhead Cheadle, Burnage and Fallowfield before completing the left turn heading in a south-westerly direction at Stretford where it combines with the option for 05R. It continues in this direction to terminate at 7,000ft west of the Lymm interchange between the M56 and the M6.

05R: After departure this route turns left at a point that is perpendicular with the turn point for the 05L option. This single left turn takes it overhead Cheadle, Burnage and Fallowfield before completing the left turn heading in a south-westerly direction at Stretford where it combines with the option for 05L. It continues in this direction to terminate at 7,000ft west of the Lymm interchange between the M56 and the M6.

A speed restriction of 220 KIAS is used for the first turn which allows most aircraft to fly in a clean configuration.

Rationale for inclusion

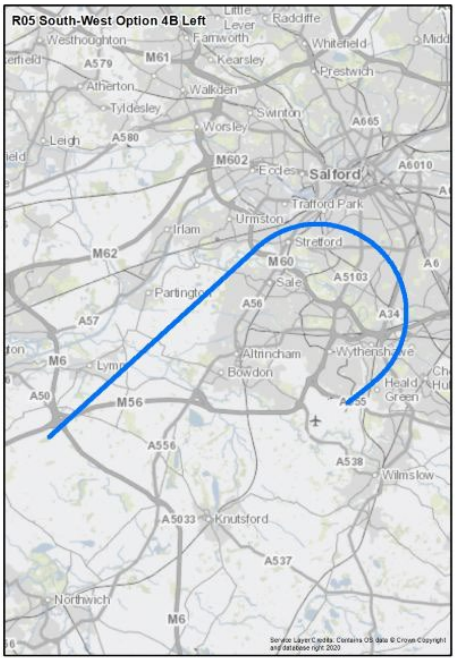
Technology: Procedure uses latest technology (RNP+RF).

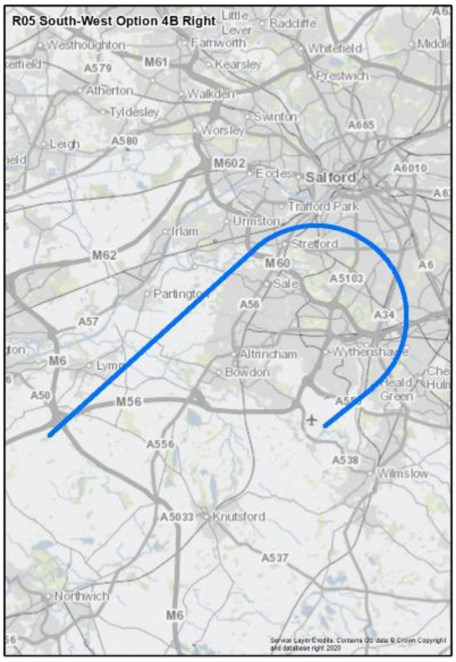
Policy: Seeks to avoid interactions with inbound traffic from the north by climbing aircraft in a wider arc.

This option has potential to reduce interactions with traffic to and from LPL.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Emissions: There is a reduction in track miles to join the network compared to option 4A as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route.





12.11. Runways 05L/05R South-west Option 5

Description

This is an **RNAV1** option that provides two turns to the left to route south-west similar option 1 but uses an initial 15° track adjustment to the left from the DER for Runway 05L, and a 5° adjustment for Runway 05R. This is to provide noise relief for the Cheadle area, which lies underneath the approach path for Runways 23L/23R arrivals.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The procedure uses fly-by waypoints.

05L: After passing the DER aircraft make a 15° track adjustment to the left (north) followed by a left turn that routes aircraft to the west of Cheadle. There is then a short straight segment where the routes combine before a second turn is made over Stretford and it heads in a south-westerly direction over sparsely populated areas to terminate at 7,000ft to the south-west of the junction between the M56 and M6.

05R: After passing the DER aircraft make a 5° track adjustment to the left (north) followed by a left turn that routes aircraft to the west of Cheadle. There is then a short straight segment where the routes combine before a second turn is made over Stretford and it heads in a south-westerly direction over sparsely populated areas to terminate at 7,000ft to the south-west of the junction between the M56 and M6.

A speed restriction of 210 KIAS is used for the first turn which is the CAP778 recommended speed.

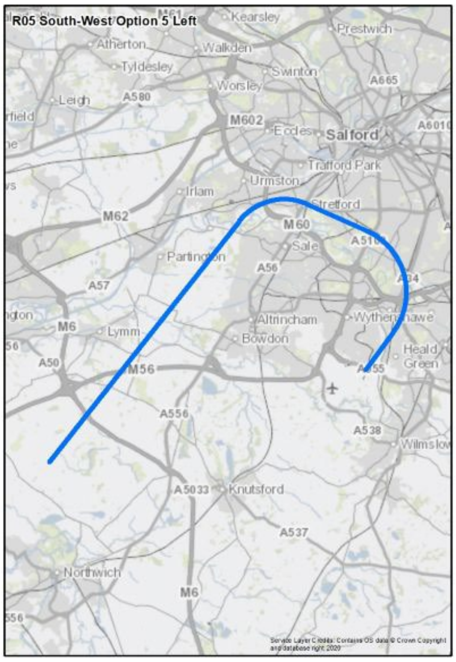
Rationale for inclusion

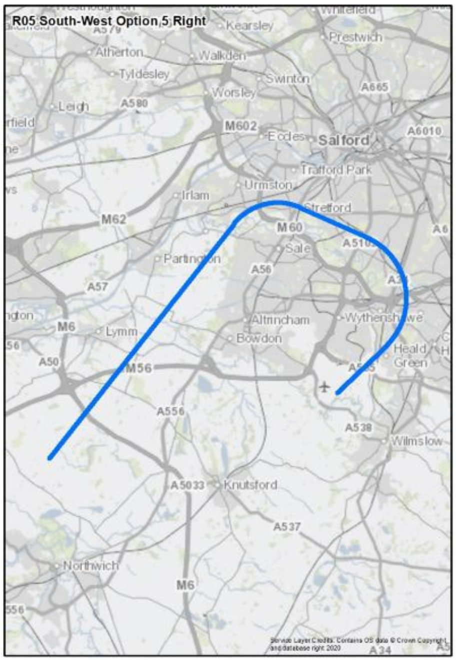
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Policy: The track aims to replicate existing vectoring routes to the south-west.

Noise N1: The track adjustment to the left after departure is intended to reduce the impact of noise to communities in the Cheadle area that are also impacted by arrivals to Runways 23L/23R.

In addition, the track aims to avoid the areas of Sale, Urmston, Irlam, Partington and Warrington.





12.12. Runways 05L/05R South-west Viable but Poor Fit Options

Option	Safety	Policy	Capacity
A6 Extended climb out then left turn	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead beyond Stockport before making a 180-degree left turn, south-west, towards the SID aiming point. Safety: This option may interact with Runway 05 departures to the north. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it south-west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would take the same track as departures in the east which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity. In addition, this option is expected to interact with departures in the north envelopes.			
B7 Extended climb out, right turn	S	P	C
After departure from Runways 05L/05R, aircraft would continue straight ahead beyond Stockport before making a 180-degree right-hand turn to the south-west. Safety: This option may interact with Runway 05 departures to the south and east. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would take the same track as departures in the east which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity. In addition, this option is expected to interact with departures in the south envelope.			
C8 Right-hand wraparound	S	P	C
After departure from Runways 05L/05R, aircraft would make a right-hand turn, fly around the airport then begin heading south-west towards the SID aiming point. Safety: This option is expected to conflict with the Runway 05R MAP. Capacity: This option interacts with departures in the 05 South Design Envelope and arrivals from the south which would limit the ability to enable best use of runway capacity.			

13. SID Runways 23L/23R – North

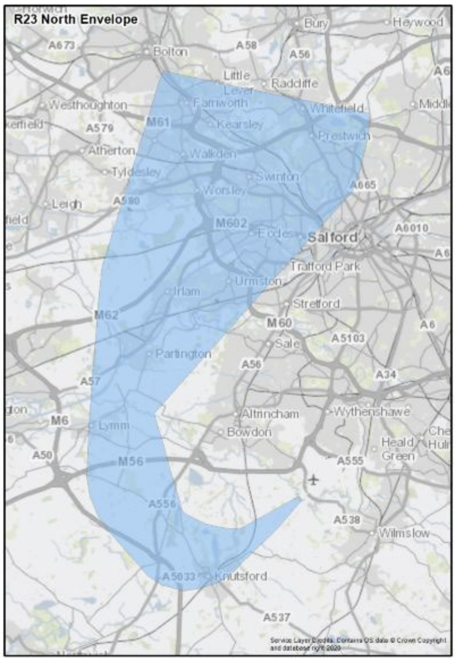
13.1. Introduction to 23L/23R North Design Envelope

This envelope has been created for traffic routing to the north from Runways 23L/23R. The envelope is based around the existing POL 5R/1Y SID and after departure, design options within this envelope turn right and route north towards POL, terminating at 7,000ft.

Options within this envelope have been created to take account of current operational practice, whereby ATC tactically vector traffic above 4,000ft in order to provide a more direct route and fuel saving to POL. It also takes account of the Runway 23 MAP which instructs aircraft to climb straight ahead until passing 750ft and to then turn right onto track 357° and climb to 3,500ft. All of the design options have been assessed against this to ensure they are separated in line with the Design Principle Safety.

This letterbox is 4.5nm wide (2.25nm either side of the nominal track) and a minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

13.2. Design Envelope Location Map



13.3. Runways 23L/23R North Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
23 North 1A	'Do minimum' This option provides an RNAV1 replication of the existing conventional POL 5R/1Y SID to 7,000ft. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	A5	Tight right turn 190kts	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient These options have not been designed and are not described further within this comprehensive list of design options.

23 North 1B	This option provides a similar initial RNAV1 route to the existing conventional SID. However, it makes a second right turn earlier, to provide a more direct and fuel efficient route. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	B8	Tight right turn 210kts.		
23 North 2B	This is an RNP1 option with RF coding that is similar to option 1B but tracks slightly further west before heading north-east to provide a more direct and fuel-efficient route. 210 KIAS	C9	Left-hand extended wraparound.		
23 North 3	This is an RNP1 option with RF coding using fly-by waypoints. It has a tighter turn radius than option 2B after the initial right turn aircraft head north and make a second right turn than the current SID to provide a more direct route. 210 kts	D10	Tight right-hand turn, east then north.		
23 North 4A	This is an RNP1 option with RF coding included to replicate the existing conventional POL SID but using an RF turn. This results in a slightly wider initial turn than the conventional route and the RNAV1 replication options. 190 KIAS	E11	Extended straight ahead then right turn to north.		

23 North 4B	This is an RNP1 option with RF coding to replicate the existing conventional SID but using an RF turn. It is similar to option 4A, but it has a second right turn earlier to head north-east to create a more direct and fuel-efficient route. 190 KIAS	F12	Sharp right-hand turn before heading north.		
23 North 6A	This is an RNP1 option with RF coding option that provides a single turn to head north-east to provide a direct and fuel-efficient routing. 220 KIAS				
23 North 6B	This is an RNP1 option with RF coding that is similar to option 2B but using a higher speed which results in a track slightly further west before heading north-east to provide a more direct and fuel-efficient route. 220 KIAS				
23 North 7	This is an RNP1 option with RF coding that provides a track adjustment to the north at the DER to reduce noise impact on Knutsford. It is similar to option 4B with an RF turn following this track adjustment and aircraft then head north and north-east to create a direct and fuel-efficient route. 210 kts				

13.4. Runways 23L/23R North Option 1A

Description

Option 1A is an RNAV 1 replication of the current departure to POL and uses fly-over waypoints with CF path terminator coding to create an approximate replication of the existing conventional POL 5R 1Y SID. An element of dispersion would be apparent in the turns due to the fly-over waypoint and CF coding.

The fly-over waypoints are positioned at the existing markers.

- For Runway 23R this first turn is at MCT D3.
- For Runway 23L, this is at D3.2 which is less than 1nm from DER but replicates the current procedure.

As a replicated route it follows a similar track over the ground as the current published route. This takes both routes to the north of Knutsford at which point the tracks of the SIDs converge. The route heads north until turning right to the north-west of Irlam to head in a north-east direction and terminates at 7,000ft just east of Farnworth.

A speed restriction of 200 KIAS is used for the first turn.

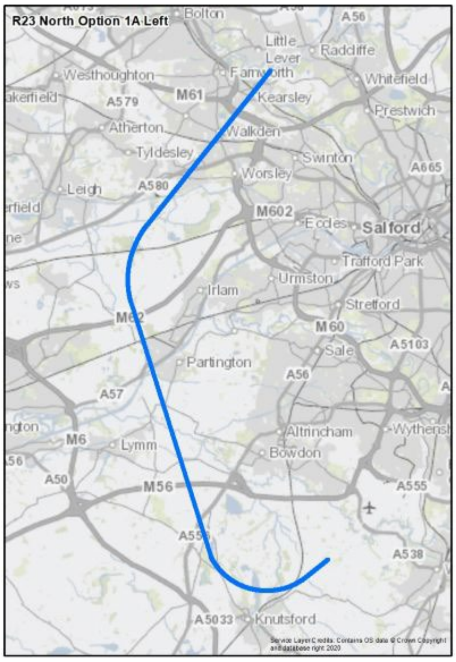
Rationale for inclusion

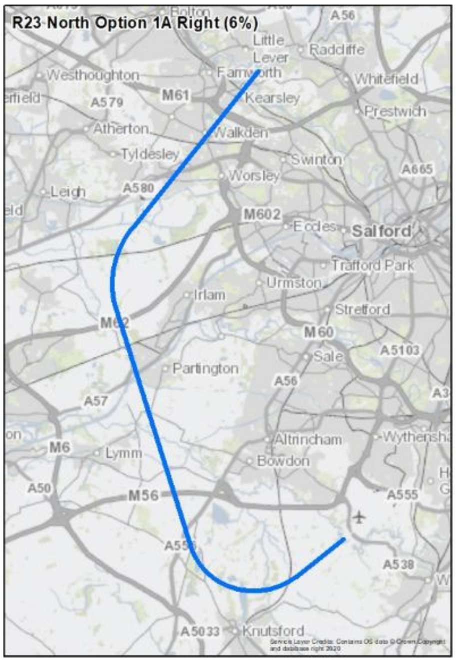
Aligns to a 'do minimum' option.

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N2: The turn would have an element of dispersion, which is consistent with Design Principle N2.

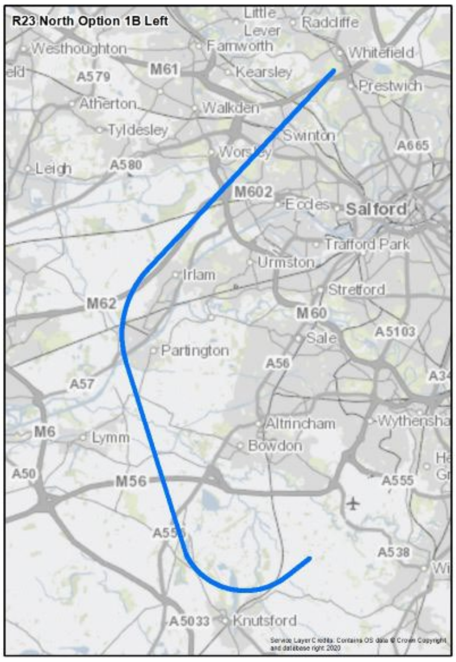
Noise N1: Avoids the centre of Knutsford and routes via sparsely populated areas north of Irlam.

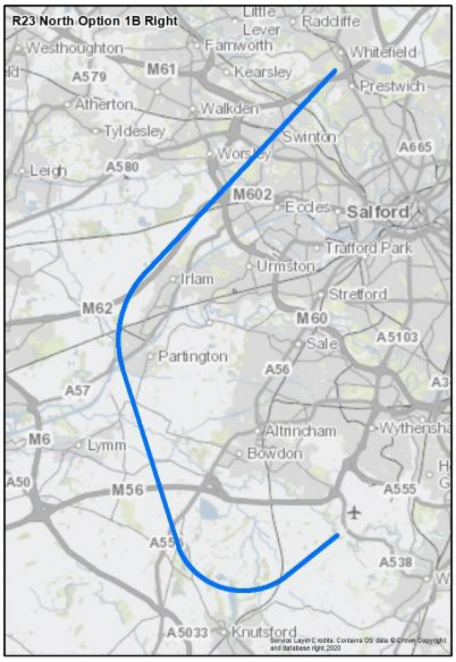




13.5. Runways 23L/23R North Option 1B

Description	Rationale for inclusion
Option 1B is an **RNAV1** option, similar to option 1A, using fly-over waypoints with CF path terminator coding. However, aircraft make a second right turn earlier to provide a more direct and fuel-efficient route. The fly-over waypoints are positioned at the existing markers: • For Runway 23R this first turn is at MCT D3. • For Runway 23L, this is at D3.2 which is less than 1nm from DER, but this replicates the turn of the current procedure and therefore aligns to the Design Principle Safety. **23L**: This route commences the RF turn to the north of Knutsford. This turn continues until Mere where it combines with the option for 23R and continues north until west of Partington at which point the route heads north-east following the line of the M62 initially and terminates at 7,000ft north of Prestwich. **23R**: This route commences the RF turn to the north of Knutsford. This turn continues until Mere where it combines with the option for 23L and continues north until west of Partington at which point the route heads north-east following the line of the M62 initially and terminates at 7,000ft north of Prestwich. An element of dispersion would be apparent in the turn due to the fly-over waypoint and CF coding. To create replication with the existing procedure, a speed restriction of 200 KIAS is used for the first turn.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1**: Using the existing turn points results in the routes avoiding the centre of Knutsford. Has potential to reduce noise impacts by following the M62 which has higher ambient noise. It also routes close to sparsely populated areas north of Irlam. **Noise N2**: The turns will have an element of dispersion, which is consistent with Design Principle Noise N2. **Emissions:** Provides a more direct routing and reduced fuel burn when compared to the replicated route.





13.6. Runways 23L/23R North Option 2B

Description

This is an **RNP1** option with RF coding that is similar to option 1B but the use of RF coding results in a track slightly further west initially before heading north-east initially following the course of the M62 to provide a more direct and fuel-efficient route.

The option has been created to use the more modern technology and maximise fuel efficiency by making a second right turn earlier to head on a north-east trajectory where it terminates south of the existing POL SID.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: This route commences the RF turn to the north of Knutsford. This turn continues via Over Tabley and routes north to the east of Lymm until west of Partington at which point the route heads north-east. It initially follows the route of the M62 and terminates at 7,000ft north of Prestwich.

23R: This route commences the RF turn to the north of Knutsford. This turn continues via Over Tabley and routes north to the east of Lymm until west of Partington at which point the route heads north-east. It initially follows the route of the M62 and terminates at 7,000ft north of Prestwich.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

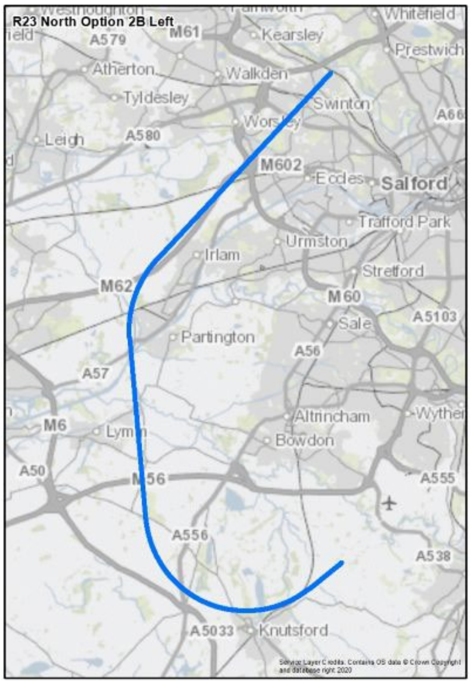
Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.

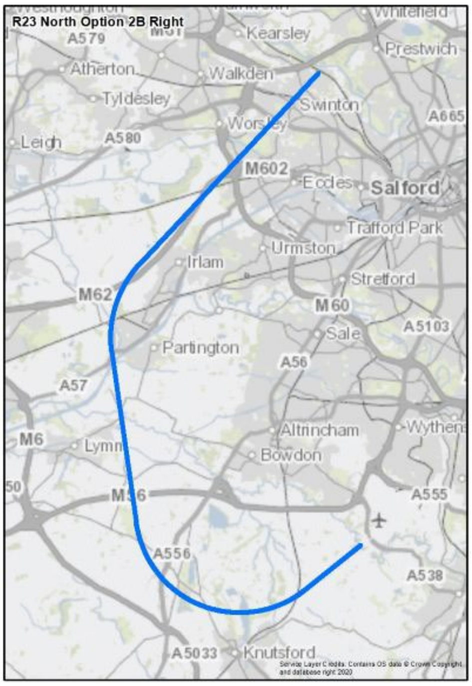
Noise N1: Avoids the centre of Knutsford.

Has potential to reduce noise impacts by following the M62 which has higher ambient noise.

It also routes close to sparsely populated areas north of Irlam.

Noise N2: The turns do not converge until Cadishead which creates an element of dispersion.





13.7. Runways 23L/23R North Option 3

Description

This provides an **RNP1** option with RF coding using fly-by waypoints.

It has been created using fly-by waypoints with a tighter radius first turn than option 2B to reduce noise impact for Knutsford. It also aims to improve fuel efficiency by making a second right turn earlier than the current POL SID.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: This route commences the RF turn to the north of Knutsford. The radius of this turn takes it further north of Knutsford than option 2B to route between High Legh and Bucklow Hill. The route heads north and combine near Broomedge and continue until just west of Partington. At this point the route turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft west of Prestwich.

23R: This route commences the RF turn earlier than 23L, to route further to the north of Knutsford. This routes it between High Legh and Bucklow Hill and it converges with the option for 23L in the vicinity of Broomedge. The route heads north until just west of Partington. At this point the route turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft west of Prestwich.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

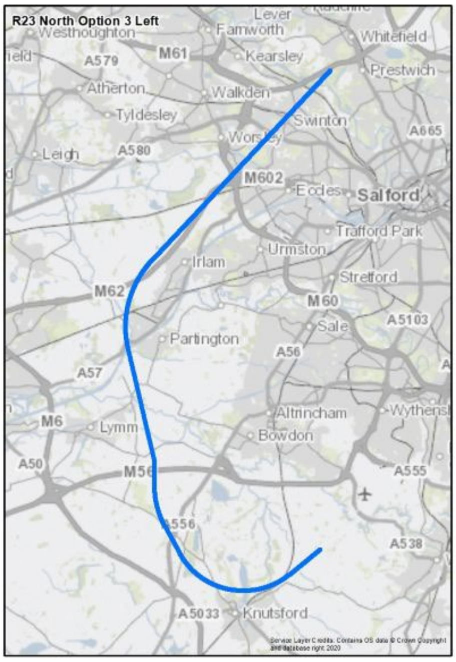
Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.

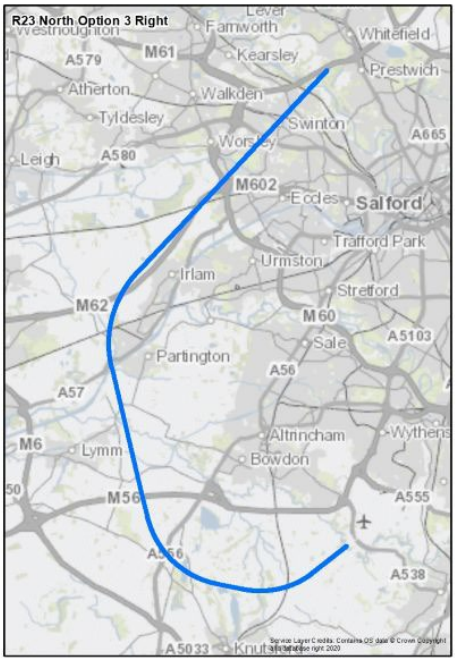
Noise N1: Has potential to reduce noise impact to Knutsford through the use of a tighter radius turn.

Has potential to reduce noise impacts by following the M62 which has higher ambient noise.

It also routes close to sparsely populated areas north of Irlam.

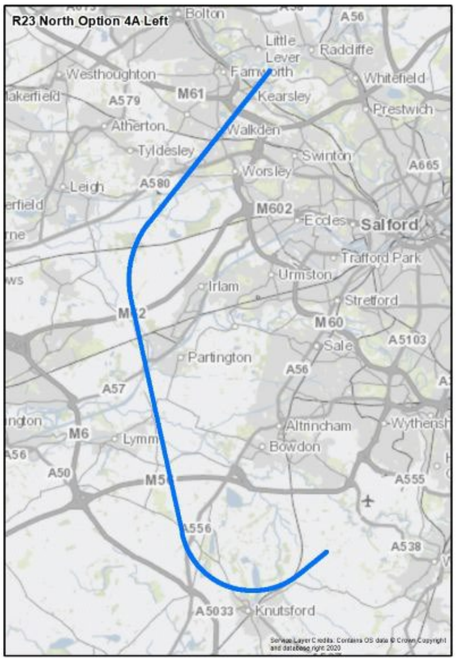
The design may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

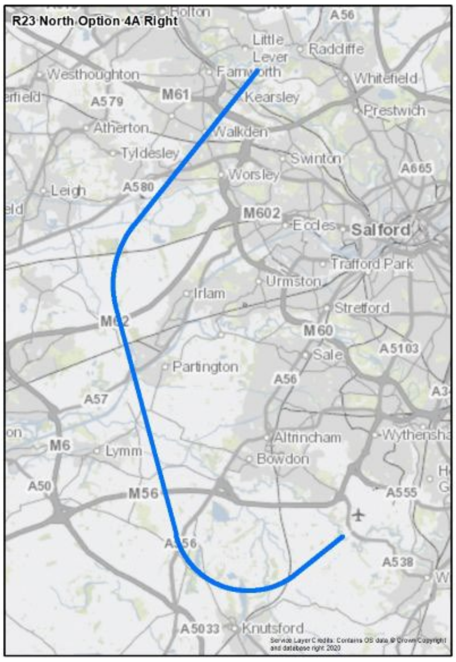




13.8. Runways 23L/23R North Option 4A

Description	Rationale for inclusion
This is an **RNP1** option with RF coding included to replicate the existing conventional POL SID but using an RF turn. This results in a slightly wider initial turn than the conventional route and the RNAV1 replication options. It has been created with the slightly tighter radius first turn similar to option 3 to reduce noise impact for Knutsford but does not have the second turn at the earlier point of that option because it replicates the current SID. The design aims to have aircraft make the first right turn no closer than 1nm from DER after which both routes head in a northerly direction and converge just north of Cadishead. **23L**: This route commences the RF turn to the north of Knutsford. The radius of this turn takes it further north of Knutsford than option 2B to route between High Legh and Bucklow Hill. The route heads north until turning right via a fly-by turn at XUMAT (north of Cadishead) to head in a north-east direction and terminates just east of Farnworth. **23R**: This route commences the RF turn earlier than 23L, to route further to the north of Knutsford. This routes it between High Legh and Bucklow Hill and it converges with the option for 23L in the vicinity of Cadishead. At this point the route turns right to head in a north-east direction and terminates just east of Farnworth. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it may need to be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Replication:** Provides an RNP+RF replication of the existing POL SID. **Technology**: Procedure uses latest technology (RNP+RF). **Noise N1**: Has potential to reduce noise impact to Knutsford through the use of a tighter radius turn. **Noise N2**: The turns do not converge until Cadishead which creates an element of dispersion.





13.9. Runways 23L/23R North Option 4B

Description

This is an **RNP1** option with RF coding included to replicate the existing conventional POL SID but using an RF turn. It has the same slightly tighter turn radius as option 4A to reduce noise impact for Knutsford but makes a second right turn earlier to head north-east to provide a more direct and fuel-efficient route.

The design aims to have aircraft make the first right turn no closer than 1nm from DER.

23L: This route commences the RF turn to the north of Knutsford. The radius of this turn takes it further north of Knutsford than option 2B to route between High Legh and Bucklow Hill. The route heads north until just west of Partington where it combines with the option for 23R. At this point the route turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft west of Prestwich.

23R: This route commences the RF turn earlier than 23L, prior to Parkgate Industrial Area to route further to the north of Knutsford. This routes between High Legh and Bucklow Hill and it converges with the option for 23L in the vicinity of Partington. At this point the route turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft west of Prestwich.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

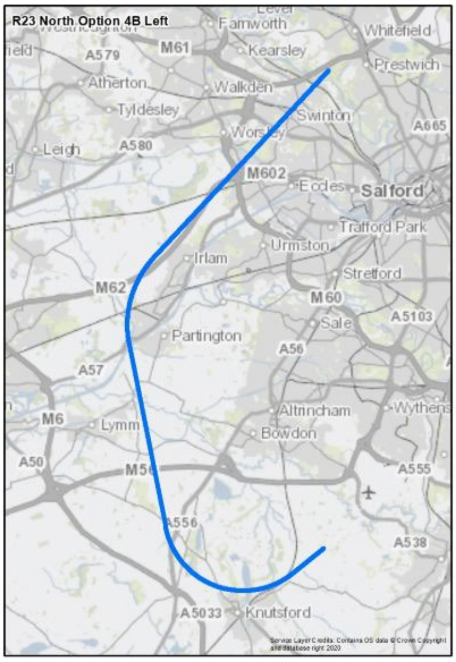
Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.

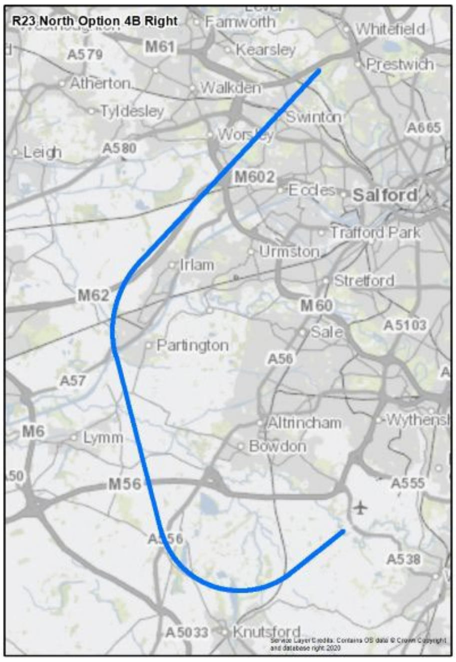
Noise N1: Has potential to reduce noise impact to Knutsford through the use of a tighter radius turn.

Has potential to reduce noise impacts by following the M62 which has higher ambient noise.

It also routes close to sparsely populated areas north of Irlam.

Noise N2: The turns do not converge until Cadishead which creates an element of dispersion.





13.10. Runways 23L/23R North Option 6A

Description

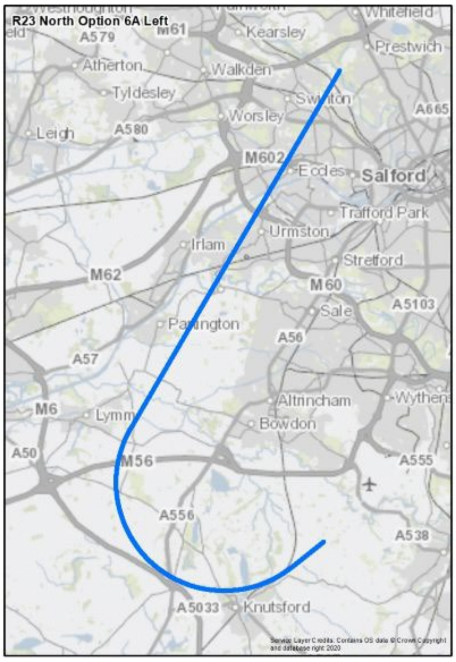
This is an **RNP1** option with RF coding that maximises fuel efficiency by removing the northbound leg between the first and second turns and replacing it with a single turn to the north-east. This provides the most direct route to POL.

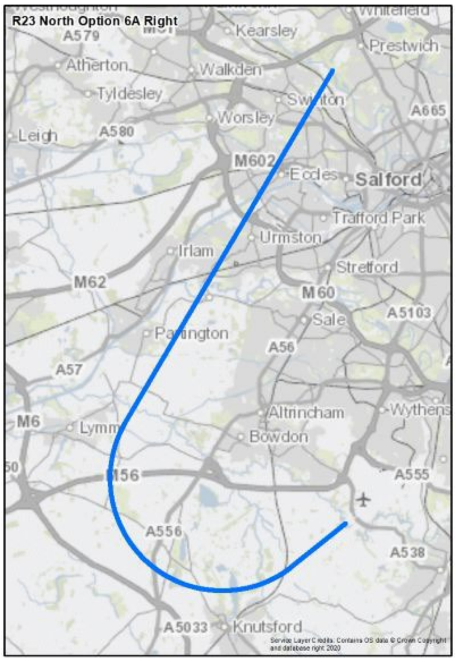
The design aims to have aircraft make the first right turn no closer than 1nm from DER, and the speed applied to this option results in this option forming the westerly edge of the envelope in the initial turn along with option 6B. This speed will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: This route commences the single RF turn to the north of Knutsford. The turn continues north via Over Tabley before heading in a north easterly direction in the vicinity of Broomedge. The route then continues to the west of the Sale and Urmston before terminating at 7,000ft in the vicinity of Eccles.

23R: This route commences the single RF turn earlier than 23L, prior to route further to the north of Knutsford. The turn continues to route east of Over Tabley before converging with the option for 23L in the vicinity of Broomedge. The route then continues to the west of the Sale and Urmston before terminating at 7,000ft in the vicinity of Eccles.

A speed restriction of 220 KIAS is used for the first turn.





Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: Provides the most direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

13.11. Runways 23L/23R North Option 6B

Description

This is an **RNP1** option with RF coding that is similar to option 2B but the use of a higher speed results in a track slightly further west before making the second turn to the north.

The design aims to have aircraft make the first right turn no closer than 1nm from DER, and the speed applied to this option results in this option forming the westerly edge of the envelope in the initial turn along with option 6A. This speed will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: This route commences the RF turn to the north of Knutsford. The radius of this turn takes it on the same track as option 6a via Over Tabley and east of Lymm, until west of Partington. At this point it combines with the option for 23R and heads north-east. They initially follow the route of the M62 and terminate at 7,000ft north of Prestwich.

23R: This route commences the RF turn earlier than 23L, to route further to the north of Knutsford. The radius of this turn takes it on the same track as option 6a via Over Tabley and east of Lymm, until west of Partington. At this point it combines with the option for 23L and heads north-east. They initially follow the route of the M62 and terminate at 7,000ft north of Prestwich.

A speed restriction of 220 KIAS is used for the first turn which allows most aircraft to fly in a clean configuration; however, this results in a wider turn radius than the replicated route.

Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

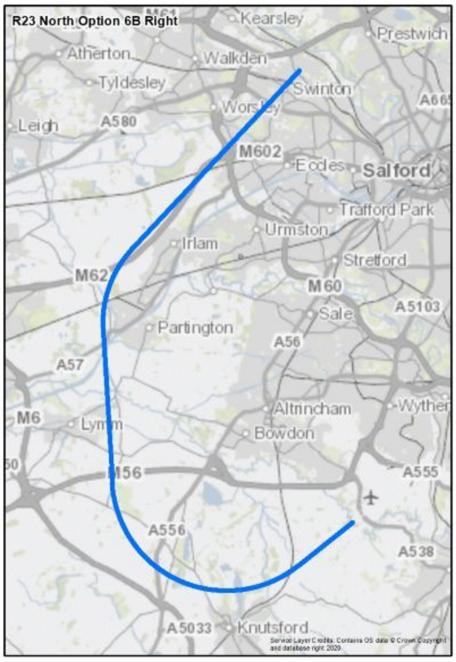
Emissions: More direct routing and reduced track miles when compared to replicated route.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Has potential to reduce noise impacts by following the M62 which has higher ambient noise.

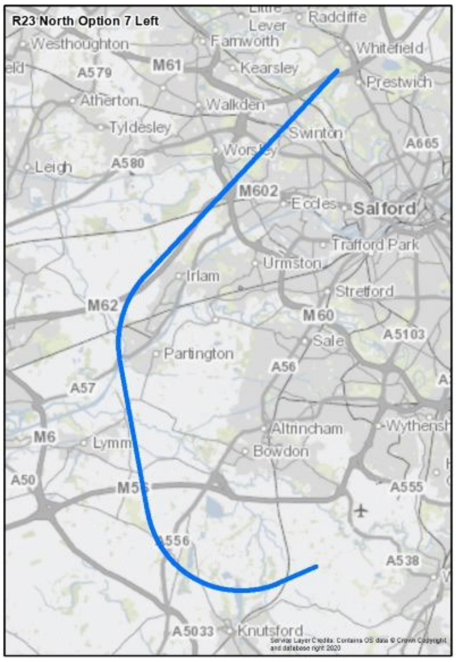
It also routes close to sparsely populated areas north of Irlam.

Noise N2: The turns do not converge until Cadishead which creates an element of dispersion.



13.12. Runways 23L/23R North Option 7

Description	Rationale for inclusion
This is an **RNP1** option that uses RF coding and an initial 15° track adjustment to the right from the DER for Runway 23L and a 5° adjustment for Runway 23R. This track adjustment is aimed to reduce noise impact on Knutsford. Thereafter this option has a similar route to that of option 4B. An RNP+RF turn follows the initial track adjustment, and this commences at 1nm from DER for Runway 23L. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L**: After passing DER this route has a 15° track adjustment to the north which continues until 1nm from DER. An RNP+RF turn is then commenced to the north of Knutsford. This is continued until heading north in the vicinity of High Legh at which point the route heads north until just west of Partington. It then turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft north of Prestwich. **23R**: After passing DER this route has a 5° track adjustment to the north. An RNP+RF turn is then commenced to the north of Knutsford. This is continued until the vicinity of High Legh where the route converges with the option for 23L. After this point the route heads north until just west of Cadishead where it turns right to follow the course of the M62 in a north-easterly direction and terminates at 7,000ft north of Prestwich. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: Provides a more direct routing and reduced fuel burn when compared to the replicated route. **Noise N1**: Uses the maximum track adjustment allowable under PANS-OPS to reduce the noise impact to Knutsford. Has potential to reduce noise impacts by following the M62 which has higher ambient noise. It also routes close to sparsely populated areas north of Irlam. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.



13.13. Runways 23L/23R North Viable but Poor Fit options.

Option	Safety	Policy	Capacity
A5 Tight right-hand turn 190kts	S	P	C
Originally **option 5**, this was initially included to provide a more direct route to POL following an initial tight turn at 190kts. Safety: This has been classed as a poor fit against the Design Principle Safety, as it is potentially conflicts with the MAP for Runway 23R. This option may result in both procedures routing to the north of the airfield in a similar location.			
B8 Tight right-hand turn 210kts	S	P	C
Originally **option 2A** this was initially included to provide a more direct route to POL following the initial turn using RF coding at 210kts. It is similar to viable poor fit option A5. Safety: This has been classed as a poor fit against the Design Principle Safety, as it is potentially conflicts with the MAP for Runway 23R. This option may result in both procedures routing to the north of the airfield in a similar location.			
C9 Left-hand Extended Wraparound	S	P	C
After departure from Runways 23L/23R, aircraft would make a left-hand turn, fly around the airport and then begin heading north towards the SID aiming point. Safety: This option would interact with the 23 South and 23 East Design Envelopes and the arrivals from the south requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic south before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would interact with the 23 South and 23 East Left Turn Design Envelopes as well as arrivals from the south which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity.			
D10 Tight right-hand turn, east then north	S	P	C
After departure from Runways 23L/23R, aircraft would make a tight right-hand turn, fly parallel to the airport then begin heading north towards the SID aiming point. Safety: This option is expected to conflict with the Runway 23R MAP. Policy: This option involves greater track mileage than is necessary by taking traffic east before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.			

E11 Extended straight ahead then right turn to north	S	P	C
After departure from Runways 23L/23R, aircraft would continue straight ahead to the vicinity of Knutsford before gradually turning right towards the north, towards the SID aiming point. Safety: From a safety perspective, this option may interact with LVP airspace which would require tactical intervention to resolve interactions. Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it north, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.			

F12 Sharp right-hand turn before heading north	S	P	C
After departure from Runways 23L/23R, aircraft would make a sharp right-hand turn before heading north, towards the SID aiming point. Safety: This option is expected would conflict with the Runway 23R MAP.			

14. SID Runways 23L/23R – East Right Turn

14.1. Introduction to 23L/23R East Right Turn Design Envelope

These options have been created for traffic routing to the east from Runways 23L/23R. Two envelopes have been created:

- A **right turn** envelope based on current departures (this envelope).
- A new **left turn** envelope that routes to the south which is described in section 15. This has been created to align with the Design Principle Capacity and to potentially provide noise respite in line with the Design Principle Noise N2.

This right turn envelope covers options 1-5 which:

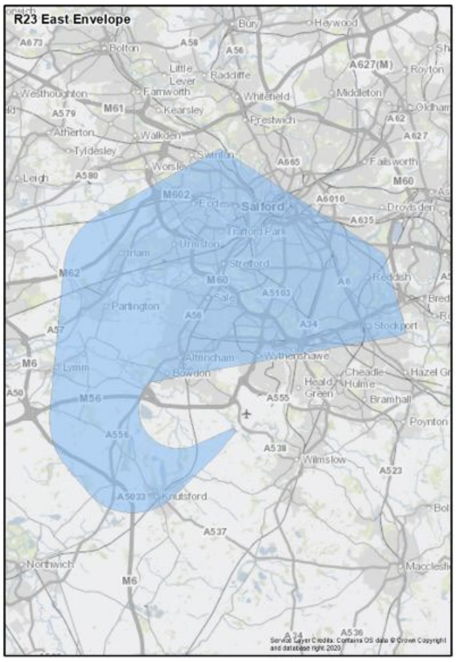
a) Replicate the existing SONEX 1R/1Y SID.

b) Provides options which align to current operational practice by ATC where aircraft are taken off the SONEX SID above 4,000ft to provide a more direct and fuel-efficient track or to separate them safely and efficiently from MAN arriving aircraft from the north. This also ensures safe separation from opposite direction arriving traffic to both MAN and LPL from the east on route L975 which routes to the north of this design envelope.

Further information on these considerations is detailed in section 5.8.

All options terminate at 7,000ft at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

14.2. Design Envelope Location Map



14.3. Runways 23L/23R East Right Turn Options Summary Table

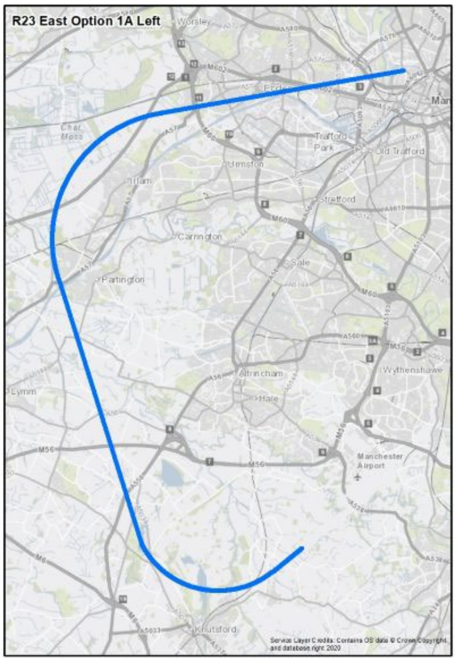
Viable and Good Fit		Viable but Poor Fit		Unviable	
23 East 1A	'Do minimum' This option provides a RNAV1 replication of the existing conventional SONEX 1R 1Y SID to 7,000ft. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	A3	Extended straight ahead, left turn to north-east.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.

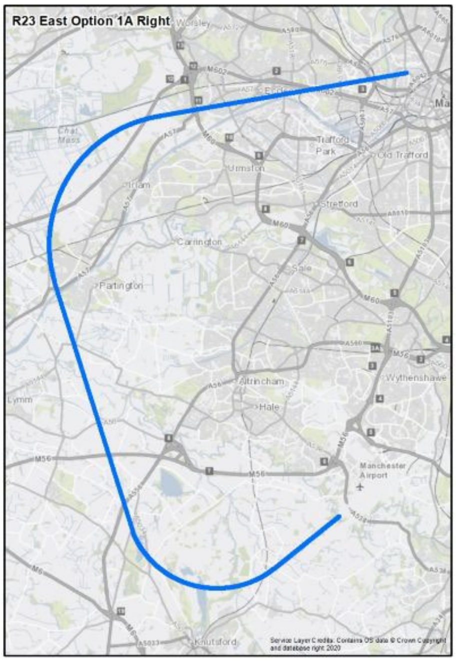
23 East 1B	This option provides a similar initial RNAV1 route to the existing conventional SID. However aircraft will make the second right turn to head east at an earlier point. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	B7	Extended straight ahead then right turn to north-east.		
23 East 1C	This option provides a similar initial RNAV1 route to the existing conventional SID. However aircraft will make the second right turn at an earlier point in an area of low population density. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	C9	Further extended straight ahead then left turn to north-east.		
23 East 2	This is an RNP1 option using RF coding that provides a more route to the east using a single right turn. 190 KIAS	D10	Further extended straight ahead then right turn to north-east.		

23 East 4A	This is an RNP1 option using RF coding that provides a direct route to the east using a single right turn. It is similar to option 2A but with an increased speed in the turn which results in a slightly wider track to the west and north. 210 KIAS				
23 East 4B	This is an RNP1 option using RF coding that provides a direct route to the east using a single right turn (similar to option 4A) but with a track adjustment immediately after departure to increase the lateral separation from Knutsford for noise purposes. 210 KIAS				
23 East 5	This is an RNP1 option using RF coding that provides a direct route to the east using a single right turn. It is similar to option 4A but the increased speed in the turn results in this option forming the westerly edge of the envelope in the initial turn. 220 KIAS				

14.4. Runways 23L/23R East Option 1A

Description	Rationale for inclusion
Option 1A is an **RNAV 1** replication of the current SONEX 1R/1Y SID and uses a fly-over waypoint with CF path terminator coding. The fly-over waypoints are positioned at the existing markers. **23R** this first turn is at MCT D3. **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. As a replicated route it follows a similar track over the ground as the current published route. The first turn commences to the north and east of Knutsford which takes both routes north of Knutsford at which point the tracks of the SIDs converge close to Mere. The routes head north until turning right to the north of Irlam, and then heads in an easterly direction south of Eccles and terminates at 7,000ft just east of Salford. An element of dispersion would be apparent in the turns due to the fly-over waypoint and CF coding. A speed restriction of 200 KIAS is used for the first turn to create replication of the current route.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N2**: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.





14.5. Runways 23L/23R East Option 1B

Description

This is an **RNAV1** option similar to the existing conventional SID. However, aircraft will make the second right turn to head east at an earlier point to create a more direct and fuel-efficient route.

The fly-over waypoints are positioned at the existing markers:

- For Runway 23R this first turn is at MCT D3.
- For Runway 23L, this is at D3.2 which is less than 1nm from DER, but this replicates the turn of the current procedure and therefore aligns to the Design Principle Safety.

23L: This follows an initial track over the ground that seeks to replicate the current route in the first right turn. This turn routes to the north of Knutsford and the route converges with the option for 23R close to Mere. The routes continue north until turning east to the south of Partington routing over Stretford and Urmston and terminating at 7,000ft overhead Levenshulme.

23R: This follows an initial track over the ground that seeks to replicate the current route in the first right turn. This turn routes to the north of Knutsford and the route converges with the option for 23L close to Mere. The routes continue north until turning east to the south of Partington routing over Stretford and Urmston and terminating at 7,000ft overhead Levenshulme.

An element of dispersion would be apparent in the turn due to the fly-over waypoint. A speed restriction of 200 KIAS is used for the first turn to create replication of the current route.

Rationale for inclusion

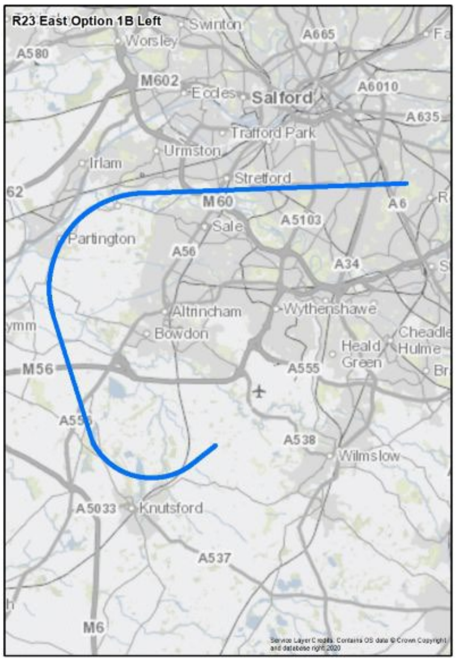
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

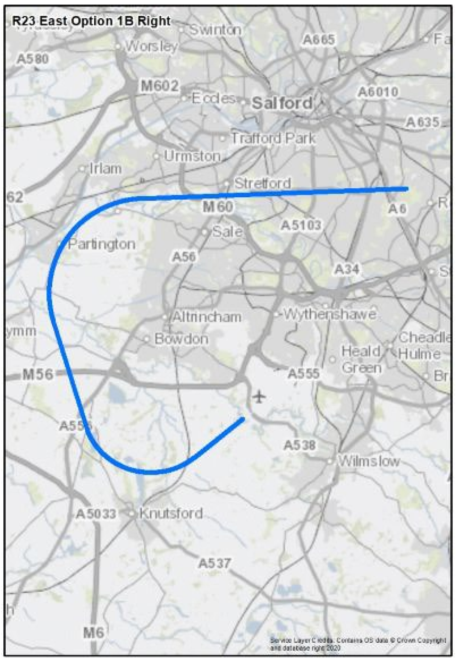
Noise N1: Using the existing turn points results in the routes avoiding the centre of Knutsford.

Has potential to reduce noise impacts by following the line of the River Mersey and routing through more sparsely populated areas to the south of Urmston and Stretford and north of Sale.

Noise N2: The turns will have an element of dispersion, which is consistent with Design Principle Noise N2.

Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.





14.6. Runways 23L/23R East Option 1C

Description

This option provides a similar initial **RNAV1** route to options 1A and 1B which are based on the existing conventional SID. However, aircraft will make the second right turn at an earlier point to route via an area of low population density to reduce noise impact.

This is aimed at recreating current ATC operational practice whereby aircraft are vectored to the east after passing 4,000ft.

An element of dispersion would be apparent in the turn due to the fly-over waypoint. These fly-over waypoints are positioned at the existing markers:

- For Runway 23R this first turn is at MCT D3.
- For Runway 23L, this is at D3.2 which is less than 1nm from DER, but this replicates the turn of the current procedure and therefore aligns to the Design Principle Safety.

23L: This follows an initial track over the ground that seeks to replicate the current route in the first right turn. This turn commences to the north of Knutsford and takes the route north where it converges with the option for 23R close to Mere. The routes continue north until turning right to the south of Partington through an area of low population density until Stretford and Urmston, where they turn right to head in an easterly direction routing south of Manchester city centre and terminating at 7,000ft overhead Gorton.

23R: This follows an initial track over the ground that seeks to replicate the current route in the first right turn. This turn commences to the north of Knutsford which takes the route north where it converges with the option for 23L close to Mere. The routes continue north until turning right to the south of Partington through an area of low population density until Stretford and Urmston, where they turn right to head in an easterly direction routing south of Manchester city centre and terminating at 7,000ft overhead Gorton.

A speed restriction of 200 KIAS is used for the first turn to create track replication of the current route.

Rationale for inclusion

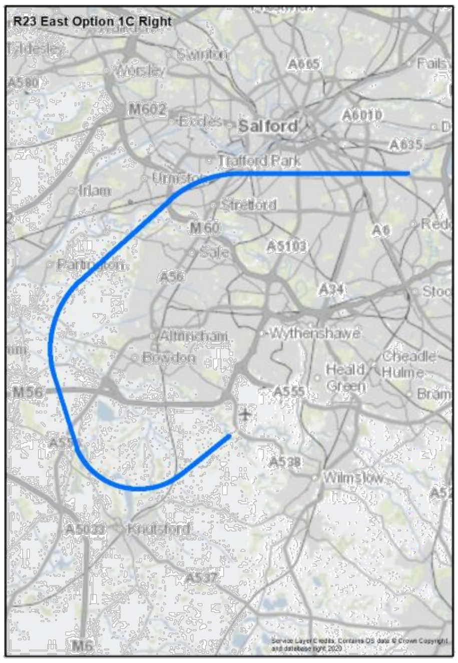
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

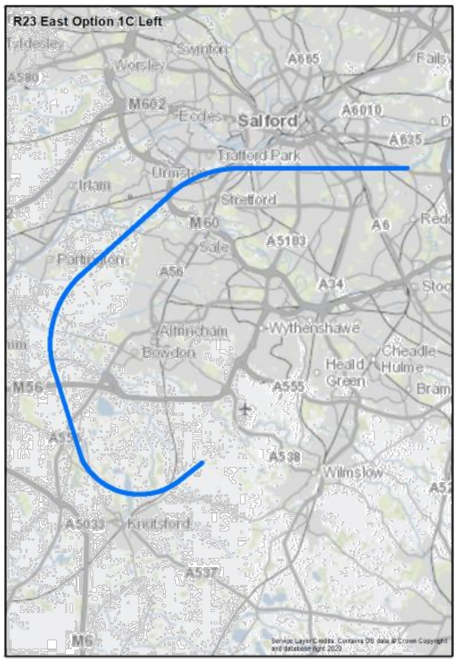
Noise N1: Using the existing turn points results in the routes avoiding the centre of Knutsford.

Has been created to route through more sparsely populated areas to the south of Partington and north-west of Altrincham.

Noise N2: The turns will have an element of dispersion, which is consistent with Design Principle Noise N2.

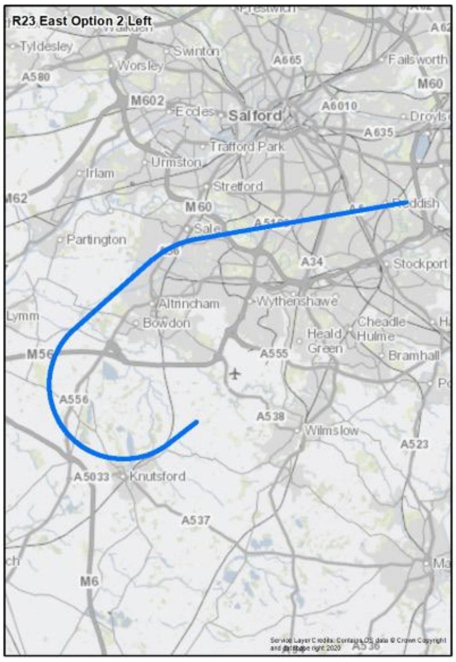
Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.

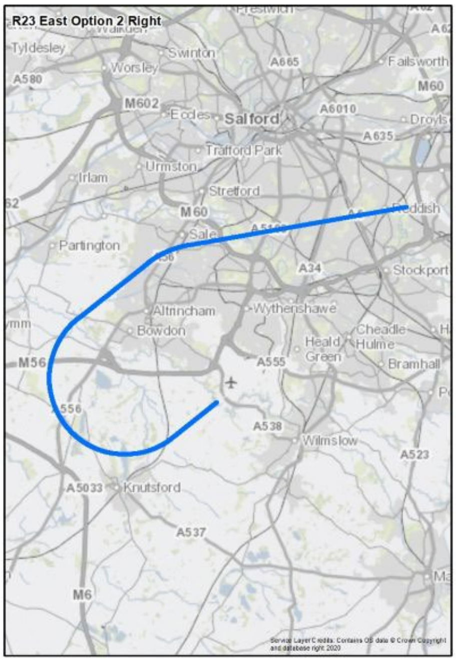




14.7. Runways 23L/23R East Option 2

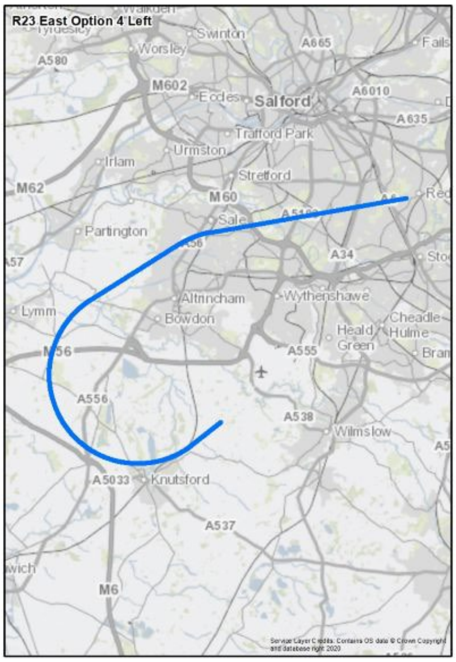
Description	Rationale for inclusion
This option provides an **RNP+RF** coded option that provides a more direct route to the east using a single right turn. It has been created by using a turn with the lowest possible speed to create a tight radius turn to the north-east initially, before making a second smaller turn to head east. The design aims to have aircraft make the first right turn no closer than 1nm from DER. **23L**: The first RF right turn starts to the north of Knutsford. This routes the aircraft between Mere and Over Tabley before heading in a north-easterly direction to avoid Bowdon and Altrincham. The route continues in this direction before making a second right turn to the east to route to the south of Sale before terminating at 7,000ft to the east of Reddish. **23R**: This route commences the single RF turn earlier than 23L, prior to Parkgate Industrial Area to route further to the north of Knutsford. This results in a turn over Mere before heading in a north-easterly direction to avoid Bowdon and Altrincham. It converges with the option for 23L south of Sale where it heads east before terminating at 7,000ft to the east of Reddish. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology**: Procedure uses latest technology (RNP+RF). **Noise N1**: Avoids the centre of Knutsford. Has been created to minimise noise impacts on Hale, Bowdon and Altrincham by routing in less populated areas to the north of those towns. **Emissions:** Provides a more direct routing and reduced fuel burn when compared to the replicated route. Uses the lowest speed to create a tight radius turn to reduce track miles.





14.8. Runways 23L/23R East Option 4A

Description	Rationale for inclusion
This is an **RNP1** option using RF coding that provides a more direct route to the east using a single right turn. It is similar to option 2A but at the CAP778 recommended speed of 210kts in the turn which results in a slightly wider track to the west and north. This speed may also permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The design aims to have aircraft make the first right turn no closer than 1nm from DER. **23L**: The first RF right turn starts to the north of Knutsford. This routes aircraft further west of Mere than option 2 but via Over Tabley before heading in a north-easterly direction to avoid Bowdon and Altrincham. The route continues in this direction before making a second right turn to the east to route to the south of Sale before terminating at 7,000ft near Heaton Chapel. **23R**: This route commences the single RF turn earlier than 23L, prior to route further to the north of Knutsford. This results in a turn just west of Mere before heading in a north-easterly direction to avoid Bowdon and Altrincham. It converges with the option for 23L south of Sale where it heads east before terminating at 7,000ft near Heaton Chapel. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions:** Provides a more direct routing and reduced fuel burn when compared to the replicated route. **Noise N1**: Avoids the centre of Knutsford. Has been created to minimise noise impacts on Hale, Bowdon and Altrincham by routing in less populated areas to the north of those towns. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.



14.9. Runways 23L/23R East Option 4B

Description

Option 4B is and **RNP1** option using RF coding included to increase the distance of routes from Knutsford through the use of a track adjustment to the north commencing at the DER. A 5° adjustment is used for Runway 23R and 15° for Runway 23L.

An RNP+RF turn follows the initial track adjustment (1nm from DER for 23L), and it then follows a similar track to option 4A.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: After passing DER this route has a 15° track adjustment to the north which continues until 1nm from DER. An RNP+RF turn is then commenced which results in the route passing north of Knutsford. This RF turn takes aircraft over Mere where it combines with the option for 23R before heading in a north-easterly direction to avoid Bowdon and Altrincham. The route continues in this direction before making a second right turn to the east to route to the south of Sale before terminating at 7,000ft near Heaton Chapel.

23R: After passing DER this route has a 5° track adjustment to the north. An RNP+RF turn is then commenced which results in the route passing north of Knutsford. This is continued until the vicinity of Mere where the route converges with the option for 23L. The combined routes head in a north-easterly direction to avoid Bowdon and Altrincham and continue in this direction before making a second right turn to the east to route to the south of Sale before terminating at 7,000ft near Heaton Chapel.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

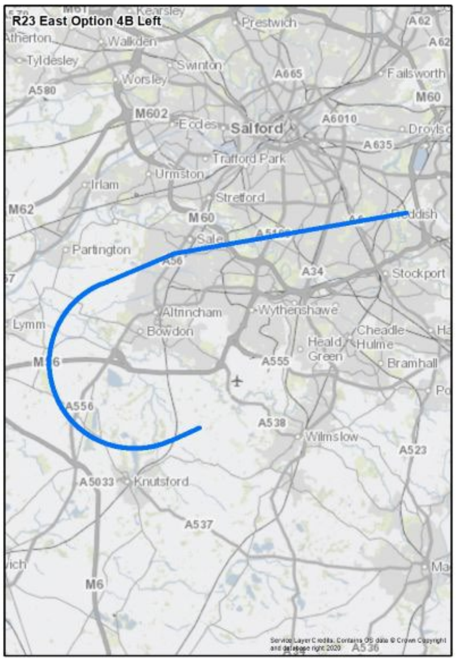
Technology: Procedure uses latest technology (RNP+RF).

Emissions: Provides a more direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: Uses the maximum track adjustment allowable under PANS-OPS to reduce the noise impact to Knutsford.

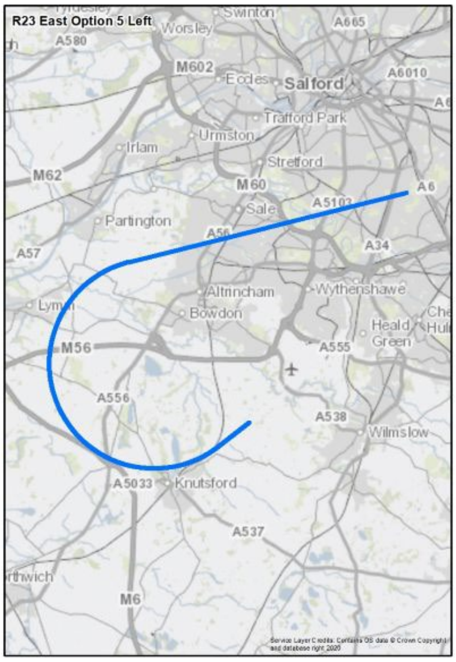
Has been created to minimise noise impacts on Hale, Bowdon and Altrincham by routing in less populated areas to the north of those towns.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.



14.10. Runways 23L/23R East Option 5

Description	Rationale for inclusion
This is an **RNP1** option using RF coding that provides a direct route to the east using a single right turn. It is similar to option 4A but with an increased speed in the turn which results in this option forming the westerly edge of the envelope in the initial turn The greater speed will also permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The design aims to have aircraft make the first right turn no closer than 1nm from DER. **23L**: This route commences the single RF turn to the north of Knutsford. The turn continues north via Over Tabley before heading in an easterly direction north of Altrincham. The route continues easterly heading and terminates at 7,000ft at Burnage. **23R**: This route commences the single RF turn earlier than 23L, prior to Parkgate Industrial Area to route further to the north of Knutsford. The turn continues to route between Over Tabley and Mere before heading in an easterly direction north of Altrincham. It then continues easterly heading and terminates at 7,000ft at Burnage. A speed restriction of 220 KIAS is used for the first turn which is 10kts higher than option 4A.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions:** Provides a direct routing and reduced fuel burn when compared to the replicated route. **Noise N1**: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.



14.11. Runways 23L/23R East Right Turn Viable but Poor Fit Options.

Note: Because the options development process for 23 East Right Turn and Left Turn took place simultaneously, the viable but poor fit options are identical and apply equally to both envelopes.

Option	Safety	Policy	Capacity
A3 Extended straight ahead then left turn to north-east	S	P	C
Originally **option 3**, after departure from Runways 23L/23R, aircraft would continue straight ahead until beyond Knutsford before gradually turning left towards the north-east towards the SID aiming point. Safety: This option would interact with traffic on the south departure envelopes requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with departures to the south, and MAN arrivals from the south, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			
B7 Extended straight ahead then right turn to north-east	S	P	C
After departure from Runways 23L/23R, aircraft would continue straight ahead until beyond Knutsford before gradually turning right towards the north-east, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north, which could limit the ability to enable best use of runway capacity.			
C9 Further extended straight ahead then left turn to north-east	S	P	C
After departure from Runways 23L/23R, aircraft would continue straight ahead for approximately 6nm until just before Northwich before gradually turning left towards the north-east, towards the SID aiming point. Safety: This option may cause additional interaction with LPL departures and arrivals. In addition, it may interact with traffic on the south departure envelopes requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with departures to the south, and arrivals from the south, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one-minute departure splits.			

D10 Further extended straight ahead then right turn to north-east	S	P	C

After departure from Runways 23L/23R, aircraft would continue straight ahead beyond Knutsford before gradually turning right towards the north-east, towards the SID aiming point.

Safety: This option may cause additional interaction with LPL departures and arrivals. It may also interact with other departure envelopes to the west and south-west requiring additional tactical mitigation to safely manage the flow of air traffic.

Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

15.SID Runways 23L/23R – East Left Turn

15.1. Introduction to 23L/23R East Left Turn Design Envelope

These options have been created for traffic routing to the east from Runways 23L/23R. Two envelopes have been created:

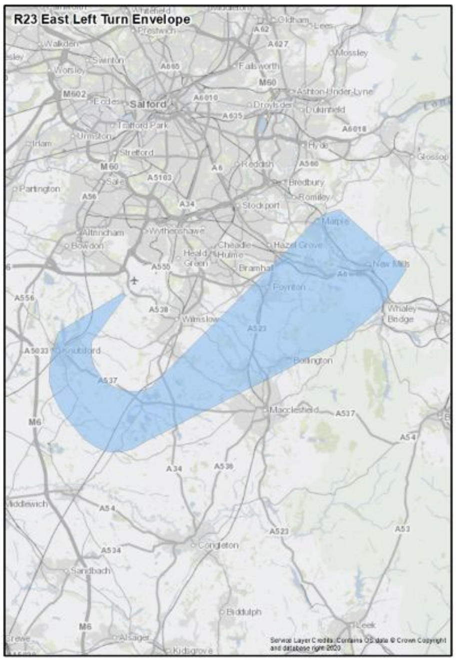
- A right turn envelope based on current departures (described in section 14).
- A new left turn envelope that routes to the south (this envelope).

This left turn envelope covers options 6-8 which are all new design options. There is no 'do minimum' option. It has been created to provide options to create additional capacity and to provide options for noise respite in line with the Design Principle Noise N2 when operated in conjunction with the 23 East Right Turn Design Envelope.

The envelope and options have been influenced by the constraints created by the base of controlled airspace to the east of MAN, and the consideration of the Camphill gliding site within that area. Whilst tactical routings through this area may still be possible, the design of systemized routes (which have limited ATC intervention), would not align with the Design Principle Safety due to possible interaction with gliders or commercial aircraft routing outside of controlled airspace. Further information on these constraints is detailed in section 5.8.

All options terminate at 7,000ft at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

15.2. Design Envelope Location Map



15.3. Runways 23L/23R East Left Turn Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
23 East 6A	Left Turn: This is an RNP1 option using RF coding and provides a direct route to the east following an initial wraparound left turn. 190 KIAS	A3	Extended straight ahead, left turn to north-east.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
23 East 6B	Left Turn: This is an RNP1 option using RF coding and provides a route to the east that is the same as 6A, except that after the wraparound turn, the track is further to the north. 190 KIAS	B7	Extended straight ahead then right turn to north-east.		

23 East 6C	Left Turn: This is an RNP1 option using RF coding but using turn points that are at a minimum (less than 1nm DER) to avoid Knutsford for noise purposes. **This option has an RF turn point less than 1nm to replicate the existing MCT D3.2 marker.* 190 KIAS	C9	Further extended straight ahead then left turn to north-east.		
23 East 8A	Left Turn: This is an RNP1 option using RF coding and provides a direct route to the east following an initial wraparound left turn. It is similar to options 6A but using a higher speed in the turn. 210 KIAS	D10	Further extended straight ahead then right turn to north-east.		
23 East 8B	Left Turn: This is an RNP1 option using RF coding and provides a route to the east following an initial single left turn. It is similar to options 6B but using a higher speed in the turn. 210 KIAS				
23 East 8C	Left Turn: This is an RNP1 option using RF coding but using turn points that are at a minimum (less than 1nm DER) to avoid Knutsford for noise purposes. It is similar to options 6C but using a higher speed in the turn. **This option has an RF turn point less than 1nm to replicate the existing MCT D3.2 marker.* 210 KIAS				

15.4. Runways 23L/23R East Left Turn Option 6A

Description

This is an **RNP1** left turn option using RF coding. It is included to provide a direct route to the east following an initial left turn and is intended to provide an alternative to the existing right turn departures.

This route is already used tactically by ATC in adverse weather conditions and therefore formalises these routes. The speed of the initial left turn has been applied to create the smallest radius and reduce the noise impact on Knutsford.

These routes do not converge until reaching 7,000ft.

23L: This route commences the single RF left turn close to Mobberley and routes aircraft to the south of Knutsford. The turn continues before heading in an easterly direction to the south of Alderley Edge and continues south of Poynton on an easterly heading to terminate at 7,000ft to the west of New Mills.

23R: This route commences the single RF turn slightly earlier than 23L, which results in a track slightly further south of Knutsford. The turn continues before heading in an easterly direction to the south of Alderley Edge and continues south of Poynton on an easterly heading to terminate and converge with the option for 23L at 7,000ft to the west of New Mills.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be asses*sed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

Rationale for inclusion

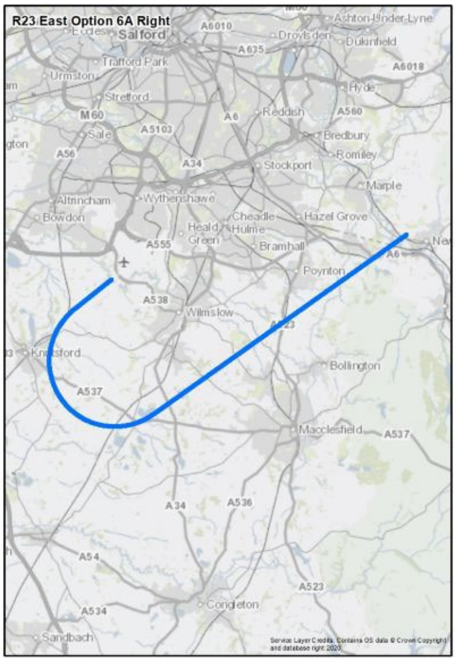
Technology: Procedure uses latest technology (RNP+RF).

Emissions: Provides a direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: The first turn has been created to reduce the impact of noise on Knutsford.

Has been created to avoid the centre of Manchester and to route via more sparsely populated areas to the south of the airport.

Noise N2: Offers potential to be used for noise respite when combined with right turn options.



15.5. Runways 23L/23R East Left Turn Option 6B

Description

This is an **RNP1** left turn option using RF coding that is identical to option 6A in the initial turn but terminates at 7,000ft further to the north. As with option 6A it is included to provide a direct route to the east following the initial left turn and to provide an alternative to the existing right turn departures. The speed of the initial left turn has been applied to create the smallest radius and reduce the noise impact on Knutsford.

23L: This route commences the single RF left turn close to Mobberley and routes aircraft to the south of Knutsford. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft south of Marple.

23R: This route commences the single RF turn slightly earlier than 23L, which results in a track slightly further south of Knutsford. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft south of Marple.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

Rationale for inclusion

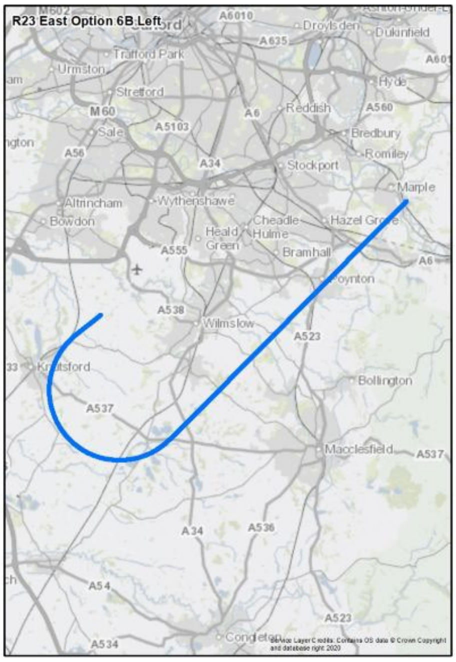
Technology: Procedure uses latest technology (RNP+RF).

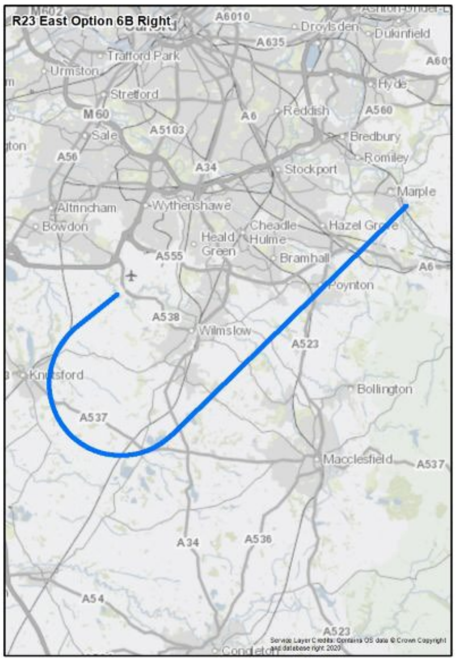
Emissions: Provides a direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: The first turn has been created to reduce the impact of noise on Knutsford.

Has been created to avoid the centre of Manchester and to route via more sparsely populated areas to the south of the airport.

Noise N2: Offers potential to be used for noise respite when combined with right turn options.





15.6. Runways 23L/23R East Left Turn Option 6C

Description

This is an **RNP1** left turn option using RF coding that has been created with an earlier turn point when compared to option 6A and 6B to increase the distance of routes from Knutsford. This turn point used is less than 1nm from the DER but is identical to that used by existing Runway 23 departures.

After the initial turn it routes in a similar direction to option 6B and is included to provide a direct route to the east following the initial turn and provide an alternative to the existing right turn departures. The speed of the initial left turn has been applied to create the smallest radius and reduce the noise impact on Knutsford.

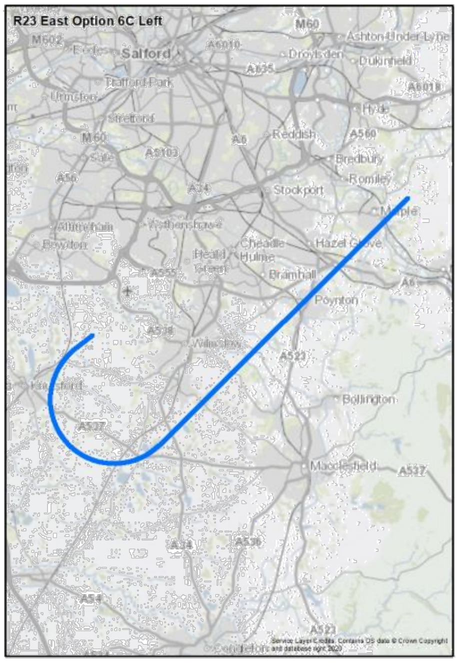
The waypoints for the first turn are positioned at the existing markers:

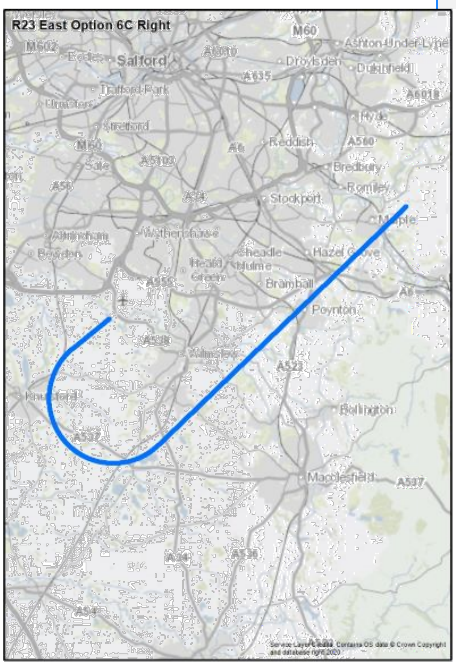
- For Runway 23R this first turn is at MCT D3.
- For Runway 23L, this is at D3.2 which is less than 1nm from DER, but this replicates the turn of the current procedure and therefore aligns to the Design Principle Safety.

23L: This route commences the single RF left turn close to Mobberley and routes aircraft further to the south of Knutsford when compared to option 6B. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft at Marple.

23R: This route commences the single RF turn slightly earlier than 23L, which results in a track slightly further south of Knutsford when compared to option 6B. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft at Marple.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.





Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: Provides a direct routing and reduced fuel burn when compared to the replicated route.

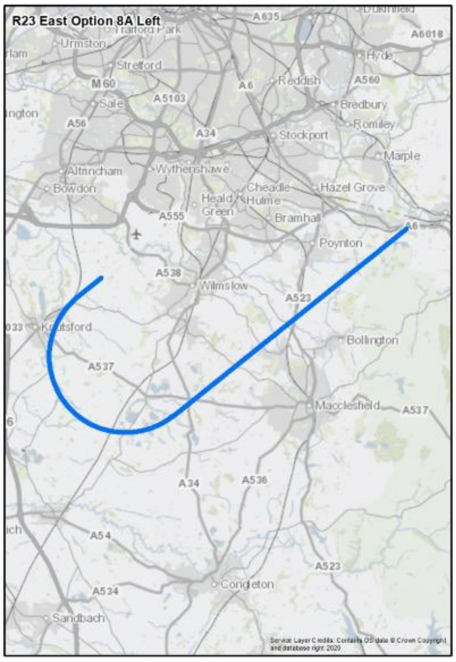
Noise N1: The first turn has been created to reduce the impact of noise on Knutsford.

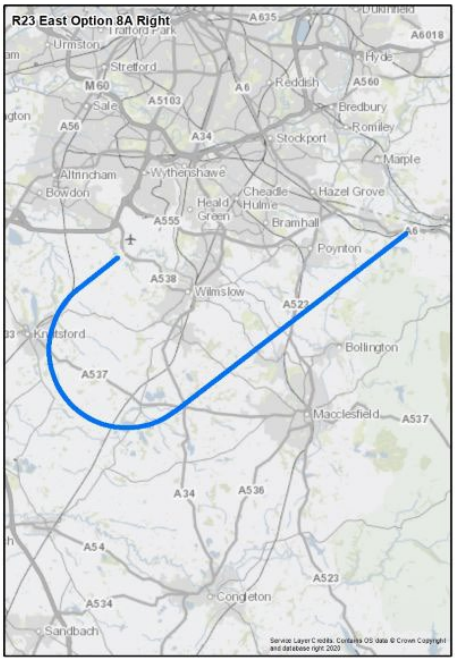
Has been created to avoid the centre of Manchester and to route via more sparsely populated areas to the south of the airport.

Noise N2: Offers potential to be used for noise respite when combined with right turn options.

15.7. Runways 23L/23R East Left Turn Option 8A

Description	Rationale for inclusion
This is an **RNP1** left turn option using RF coding that uses a higher speed in the initial turn but terminates in a similar area to option 6A. As with option 6A it is included to provide a direct route to the east following the initial left turn and to provide an alternative to the existing right turn departures. The speed of the initial left turn is the CAP778 recommended but this results in a track closer to Knutsford. The design speed may also permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L**: This route commences the single RF left turn close to Mobberley and routes aircraft close to the centre of Knutsford. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues to the north of Prestbury to terminate at 7,000ft close to Disley. **23R**: This route commences the single RF turn slightly earlier than 23L, which results in a track to the southern edge of Knutsford. The turn continues before heading in an easterly direction over Chelford to the south of Alderley Edge and continues to the north of Prestbury to terminate and converge with the route for 23L at 7,000ft close to Disley. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions:** Provides a direct routing and reduced fuel burn when compared to the replicated route. **Noise N1**: Has been created to avoid the centre of Manchester and to route via more sparsely populated areas to the south of the airport. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact. **Noise N2:** Offers potential to be used for noise respite when combined with right turn options.





15.8. Runways 23L/23R East Left Turn Option 8B

Description

This is an **RNP1** left turn option using RF coding that uses the same higher speed and identical initial turn as option 8A but terminates further north.

As with option 8A it is included to provide a direct route to the east following the initial left turn and to provide an alternative to the existing right turn departures.

The speed of the initial left turn is the CAP778 recommended but this results in a track closer to Knutsford. The design speed may also permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: This route commences the single RF left turn close to Mobberley and routes aircraft to the south of Knutsford. The turn continues before heading in an easterly direction to the south of Chelford and Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft south of Marple.

23R: This route commences the single RF turn slightly earlier than 23L, which results in a track slightly further south of Knutsford. The turn continues before heading in an easterly direction to the south of Chelford and Alderley Edge and continues via Woodford and Poynton to terminate at 7,000ft south of Marple.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

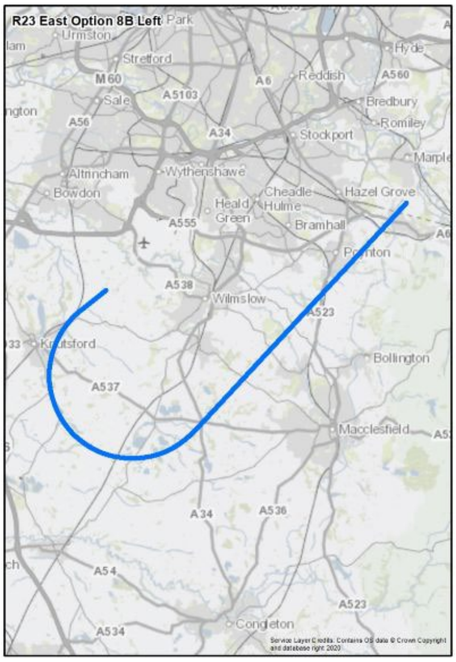
Technology: Procedure uses latest technology (RNP+RF).

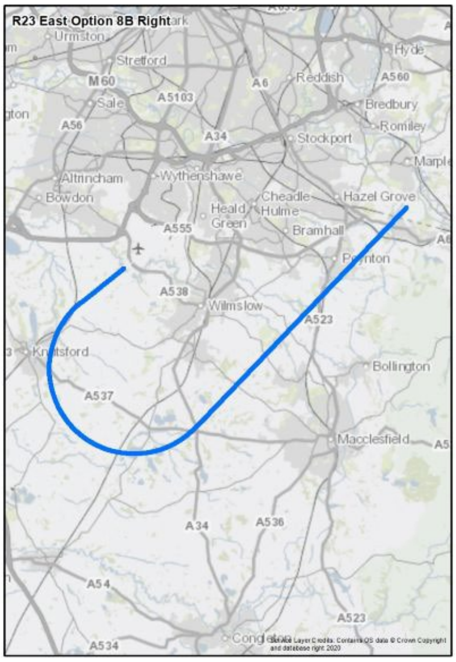
Emissions: Provides a direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: Has been created to avoid the centre of Manchester and to route via more sparsely populated areas to the south of the airport.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

Noise N2: Offers potential to be used for noise respite when combined with right turn options.





15.9. Runways 23L/23R East Left Turn Option 8C

Description

This is an **RNP1** left turn option using RF coding that has the higher CAP778 turn speed as options 8A and 8B but with an earlier turn point that aims to reduce the impact of noise on Knutsford. This turn point used is less than 1nm from the DER but is identical to that used by existing Runway 23 departures.

After the initial turn it routes in a similar direction to option 8B and is included to provide a direct route to the east following the initial turn and provide an alternative to the existing right turn departures.

The design speed may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The waypoints for the first turn are positioned at the existing markers:

- For Runway 23R this first turn is at MCT D3.
- For Runway 23L, this is at D3.2 which is less than 1nm from DER, but this replicates the turn of the current procedure and therefore aligns with the Design Principle Safety.

23L: This route commences the single RF left turn close to Mobberley and routes aircraft just to the south of Knutsford. The turn continues before heading in an easterly direction to the south of Chelford and Alderley Edge and continues via Woodford and Poynton to terminate south of Marple.

23R: This route commences the single RF turn slightly earlier than 23L, which results in a track slightly further south of Knutsford than 23L. The turn continues before heading in an easterly direction to the south of Chelford and Alderley Edge and continues via Woodford and Poynton to terminate south of Marple.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

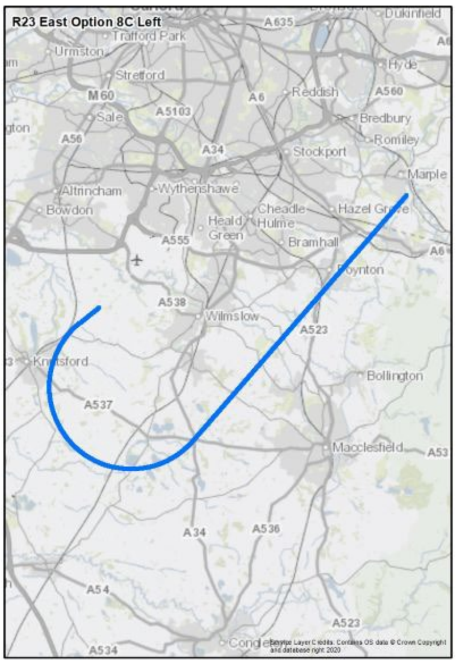
Technology: Procedure uses latest technology (RNP+RF).

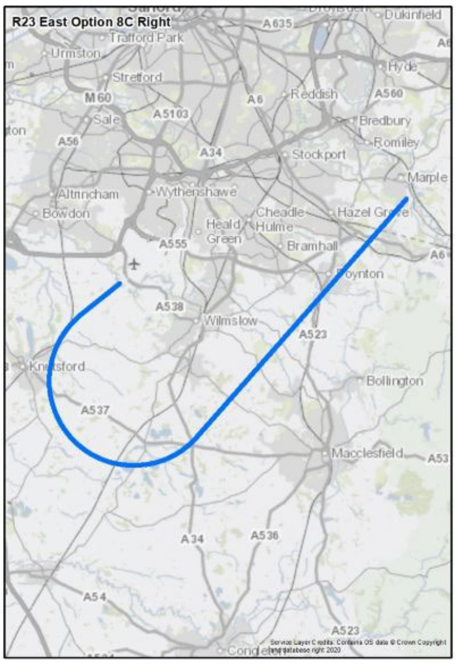
Emissions: Provides a direct routing and reduced fuel burn when compared to the replicated route.

Noise N1: Has been created to reduce the impact of noise on Knutsford.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

Noise N2: Offers potential to be used for noise respite when combined with right turn options.





15.10. Runways 23L/23R East Left Turn Viable but Poor Fit Options

Note: Because the options development process for 23 East Right Turn and Left Turn took place simultaneously, the viable but poor fit options are identical and apply equally to both envelopes.

Option	Safety	Policy	Capacity
A3 Extended straight ahead then left turn to north-east	S	P	C
Originally **option 3,** after departure from Runways 23L/23R, aircraft would continue straight ahead until beyond Knutsford before gradually turning left towards the north-east towards the SID aiming point. Safety: This option interacts with traffic on the south departure envelopes requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with departures to the south, and MAN arrivals from the south, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			
B7 Extended straight ahead then right turn to north-east	S	P	C
After departure from Runways 23L/23R, aircraft would continue straight ahead until beyond Knutsford before gradually turning right towards the north-east, towards the SID aiming point. Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with arrivals from the north, which could limit the ability to enable best use of runway capacity.			
C9 Further extended straight ahead then left turn to north-east	S	P	C
After departure from Runways 23L/23R, aircraft would continue straight ahead for approximately 6nm until just before Northwich before gradually turning left towards the north-east, towards the SID aiming point. Safety: This option may cause additional interaction with LPL departures and arrivals. In addition, it may interact with traffic on the south departure envelopes requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic a significant distance west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option is expected to interact with departures to the south, and arrivals from the south, which could limit the ability to enable best use of runway capacity or limit the ability to achieve one minute departure splits.			

D10 Further extended straight ahead then right turn to north-east	S	P	C

After departure from Runways 23L/23R, aircraft would continue straight ahead beyond Knutsford before gradually turning right towards the north-east, towards the SID aiming point.

Safety: This option may cause additional interaction with LPL departures and arrivals. It may also interact with other departure envelopes to the west and south-west requiring additional tactical mitigation to safely manage the flow of air traffic.

Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

16. SID Runways 23L/23R – South

16.1. Introduction to 23L/23R Design Envelope

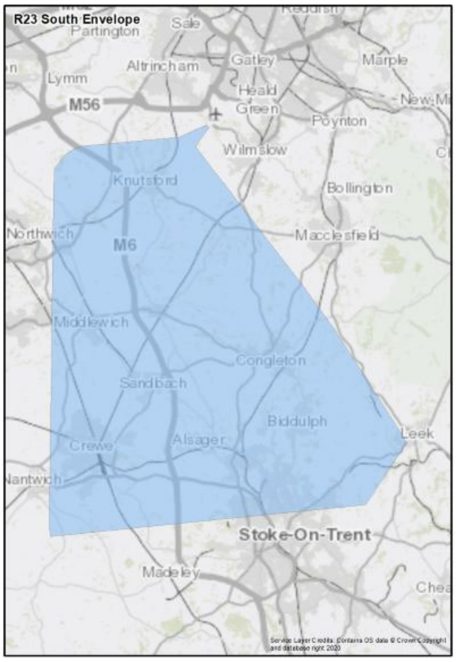
This envelope has been created for traffic routing to the south from Runways 23L/23R. The envelope is based around the existing LISTO 2R/2Y and SANBA 1R/1Y SIDs and includes additional design options to the south.

These dual routes to the south result in an envelope that is wider than others as shown in the diagram below. The east side of the envelope covers the replication of the LISTO SID, and design options based around that. The west side of the envelope covers the replication of the SANBA SID, and design options based around that.

The size of the envelope is also driven by the fact that southbound operations make up a high percentage of the total MAN traffic.

All options terminate at 7,000ft, and a minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

16.2. Design Envelope Location Map



16.3. Runways 23L/23R South Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
23 South 1	'Do minimum' This is an RNAV1 replication of the existing conventional SANBA 1R/1Y SID to 7,000ft. As a replication of the SANBA, this option routes to the west side of the envelope. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	A8	Left-hand wraparound.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.

23 South 2A	'Do minimum' This is an RNAV1 replication of the existing conventional LISTO 2R/2Y SID. As a replication of the LISTO, this option routes to the east side of the envelope. **This option has a turn point less than 1nm to replicate the existing MCT D2 and D3.2 markers.* 185 KIAS	B9	Right-hand wraparound.		
23 South 2B	This is an RNAV1 option that provides the same initial turn inside of Knutsford as the current LISTO 2R/2Y SID but then has a track to create the maximum divergence from other southbound routes. This creates a route more to the east that offers benefits in terms of capacity. **This option has a turn point less than 1nm to replicate the existing MCT D2 and D3.2 markers.* 185 KIAS	C10	Extended straight ahead then south.		

23 South 3	This is an RNAV1 option that provides a straight-ahead route and extended climb out over the Knutsford area before routing aircraft south. It is similar to the existing SANBA 1R/1Y SID but without the avoidance of Knutsford and terminates on the west side of the envelope. 220 KIAS	D11	Slight right after departure then 90 degree left turn to the south.		
23 South 4A	This is an RNAV1 option that provides an initial turn over the southern edge of Knutsford and heads in a south-west direction. It serves a similar purpose as the SANBA 1R/1Y SID and terminates on the west side of the envelope. 190 KIAS				
23 South 4B	This is an RNAV1 option that is similar to 4A and the SANBA 1R/1Y SID, except aircraft turn left earlier to avoid Knutsford. It heads in a south-west route following the initial turn and terminates on the west side of the envelope. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 190 KIAS				

23 South 4C	This is an RNAV1 option that is similar to option 4B and the SANBA 1R/1Y SID, but the track after the first turn has been designed to avoid Sandbach and Crewe to reduce noise impact. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 190 KIAS				
23 South 5A	This is an RNP1 option that seeks to replicate the initial left turn of the LISTO 2R/2Y SID using RF coding, but with a slightly more easterly heading once south of Chelford. This creates a route more to the east that offers benefits in terms of capacity. **This option has a turn point less than 1nm to replicate the existing MCT D2 and D3.2 markers.* 190 KIAS				

23 South 5B	This is an RNP1 option that seeks to replicate the initial left turn of the LISTO 2R/2Y SID using RF coding. However this left turn is continued to provide a route more to the east to avoid Congelton and Leek. This creates a route more to the east that offers benefits in terms of capacity. **This option has a turn point less than 1nm to replicate the existing MCT D2 and D3.2 markers.* 190 KIAS				
23 South 5C	This is an RNP1 option that seeks to replicate the initial left turn of the LISTO 2R/2Y SID using RF coding. However the turn is stopped earlier to provide a route to the south which passes west of Congelton and Stoke-on-Trent and east of Crewe. **This option has a turn point less than 1nm to replicate the existing MCT D2 and D3.2 markers.* 190 KIAS				

23 South 6	This option is included to provide a RNAV1 replication of the existing conventional SANBA 1R/1Y SID to 7,000ft. However unlike the 'do minimum' option 1 which uses fly-over waypoints, this option has been designed as an RNAV 1 route using fly-by waypoints. As a replicated route, this option avoids Knutsford and then routes to the south to terminate south-east of Sandbach. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS				
23 South 7A	This is an RNP1 option with RF coding that provides an alternative version of the existing LISTO 2R/2Y SID. It turns south before Knutsford but heads south slightly further west than option 2A (the LISTO replication) to terminate near Stoke-on-Trent. 190 KIAS				
23 South 7B	This is an RNP1 option with RF coding that provides an alternative version of the existing LISTO 2R/2Y SID. It is similar to option 7A but makes a turn to the west of Congleton to avoid Stoke-on-Trent. 190 KIAS				

16.4. Runways 23L/23R South Option 1

Description

Option 1 is an **RNAV 1** replication of the current SANBA 1R/1Y SID and uses a fly-by to fly-over waypoint sequence with CF path terminator coding to create an approximate replication.

As a replication of the SANBA, this option routes to the west side of the envelope.

The fly-by waypoints are positioned to replicate the turn at the existing markers:

- **23R** this first turn is at MCT D3.
- **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. This earlier turn is to avoid Knutsford.

As a replicated route it follows a similar track over the ground as the current published route. The first turn commences in the vicinity of Parkgate Industrial Area and the route kinks to the north of Knutsford before turning left to head south. The routes converge in the vicinity of Lostock Gralam and it then routes in a south easterly direction to pass west of Holmes Chapel and east of Sandbach and terminates at 7,000ft just west of Kidsgrove.

An element of dispersion would be apparent in the turns due to the fly-over waypoint and CF coding. A speed restriction of 200 KIAS, then 210 KIAS is used for the first and second turn to create replication of the current route.

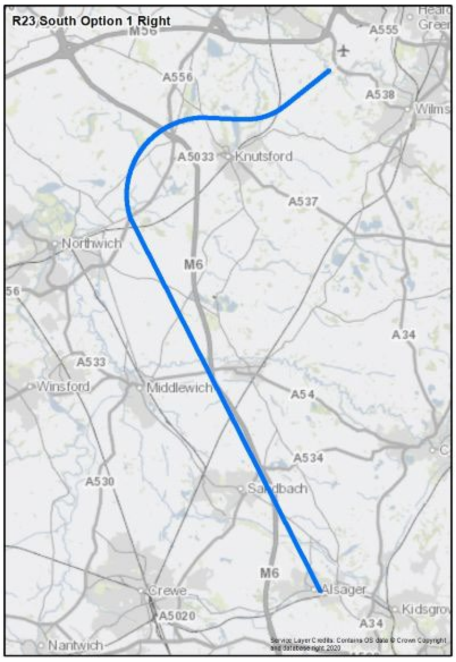
Rationale for inclusion

Aligns to a 'do minimum' option.

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

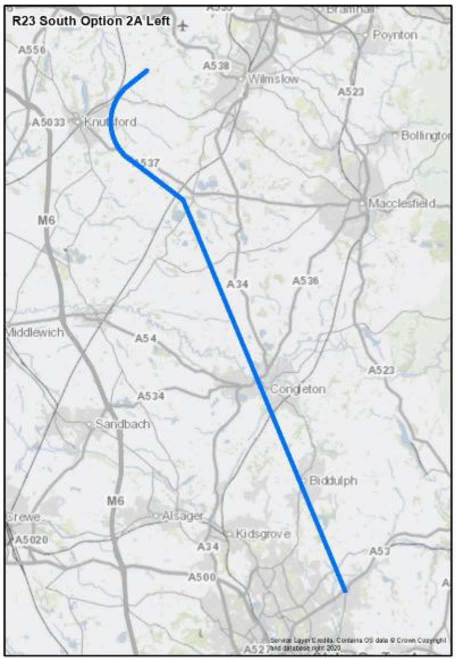
Noise N1: Has potential to reduce noise impact by avoiding the centre of Knutsford.

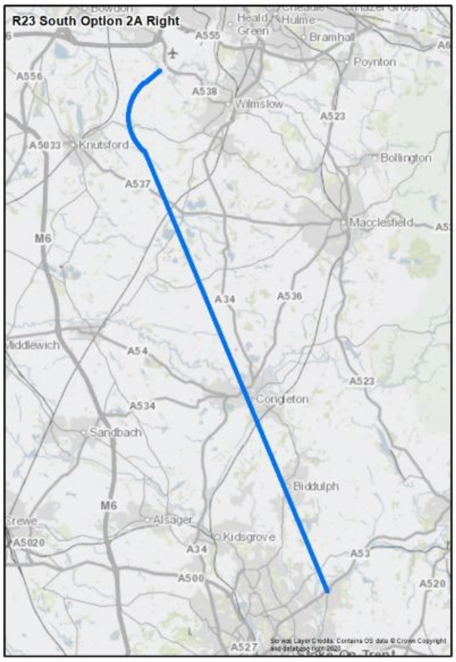
Noise N2: The second turn would have an element of dispersion, which is consistent with Design Principle Noise N2.



16.5. Runways 23L/23R South Option 2A

Description	Rationale for inclusion
This is an **RNAV1** replication of the current LISTO 2R/2Y SID which turns south before Knutsford. It uses a fly-over waypoint with CF path terminator coding to create an approximate replication. As a replication of the LISTO, this option routes to the east side of the envelope. The fly-by waypoints are positioned to replicate the turn at the existing markers: • **23R** this first turn is at MCT D3. • **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. This earlier turn is to avoid Knutsford. The first turn results in both routes avoiding Knutsford to the south-east and they converge in the vicinity of Chelford. It routes in a south-easterly direction to pass over Congleton and terminate just east of Stoke-on-Trent. An element of dispersion would be apparent in the turn due to the fly-over waypoint and CF coding. A speed restriction of 185kts is required for the initial turn for aircraft to avoid Knutsford.	Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Capacity**: Has the potential to aid departure utilisation and separation when operated in association with north and southbound departures. **Noise N1**: Has potential to reduce noise impact by avoiding the centre of Knutsford. **Noise N2**: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.





16.6. Runways 23L/23R South Option 2B

Description

This is an **RNAV1** option is included that provides the same initial turn inside of Knutsford as the current LISTO 2R/2Y SID but then has a track to create the maximum divergence from other southbound routes and to avoid the overflight of Congleton.

The aim is to provide a 45° track divergence from other southbound SIDs when created as a network which would enable a one-minute departure separation to align with the Design Principle Capacity.

In line with CAP493 (Manual of Air Traffic Services Pt1), the minimum departure separation can be reduced to one minute provided that the aircraft fly on tracks diverging by 45° or more immediately after take-off.

The option uses a fly-over waypoint with CF path terminator coding to create an approximate replication of the initial turn and a similar track over the ground as the current route. The waypoints are positioned to replicate the turn at the existing markers.

23L: After departure this route makes a left turn south at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south-east of Knutsford and the route continues on a south-easterly heading to pass west of Chelford. A right turn to the south is made to the north-east of Congleton where the routes converge and terminate at 7,000ft to the east of Leek.

23R: After departure this route makes a left turn south at MCT D3 which creates a route that passes just east of Mobberley. The route continues on a south-easterly heading to pass east of Chelford. A right turn to the south is made to the north-east of Congleton where the routes converge and terminate at 7,000ft to the east of Leek. The combined routes avoid Congleton to the east.

A speed restriction of 185kts is required for the initial turn for aircraft to avoid Knutsford.

Rationale for inclusion

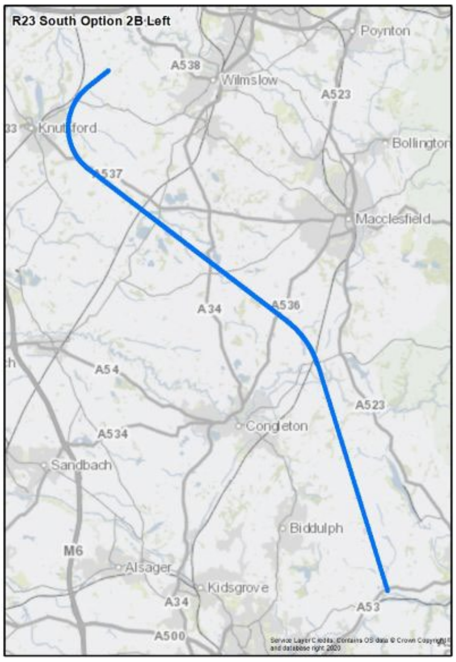
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

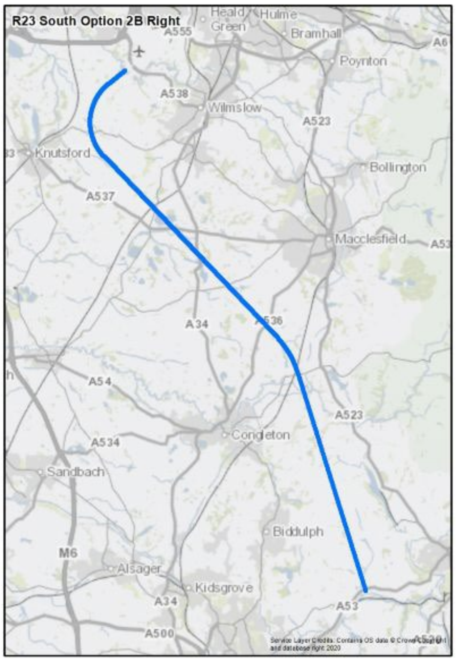
Capacity: Has the potential to aid departure utilisation and separation when operated in association with north and southbound departures.

Noise N1: Has potential to reduce noise impact by avoiding the centre of Knutsford.

Also the existing track to LISTO routes over Congleton, which this option avoids this and routes between Macclesfield, Congleton, and Leek.

Noise N2: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.





16.7. Runways 23L/23R South Option 3

Description

This is an **RNAV1** option that provides a straight-ahead route with an extended climb out over the Knutsford area before routing aircraft south. It is similar to the existing SANBA 1R/1Y SID but without the avoidance of Knutsford and it terminates on the west side of the envelope.

The procedure reduces fuel burn when compared to the current SANBA SID as it eliminates the kink to the north around Knutsford. This also has a positive impact on capacity by reducing interactions with other departure routes to the north and east that also follow the same initial track as the SANBA. The procedure uses a fly-by turn.

23L: After departure this route continues straight ahead before making a left turn south over Knutsford. It converges with the route for 23R to the south-west of Knutsford and then continues south, running parallel to the M6 motorway. It passes over Holmes Chapel and to the east of Sandbach and terminates at 7,000ft to the north-west of Newcastle-under-Lyme.

23R: After departure this route continues straight ahead before making a left turn south over Knutsford to converge with the route for 23L. The combined routes continue south, running parallel to the M6 motorway to pass over Holmes Chapel, to the east of Sandbach and terminates at 7,000ft to the north-west of Newcastle-under-Lyme.

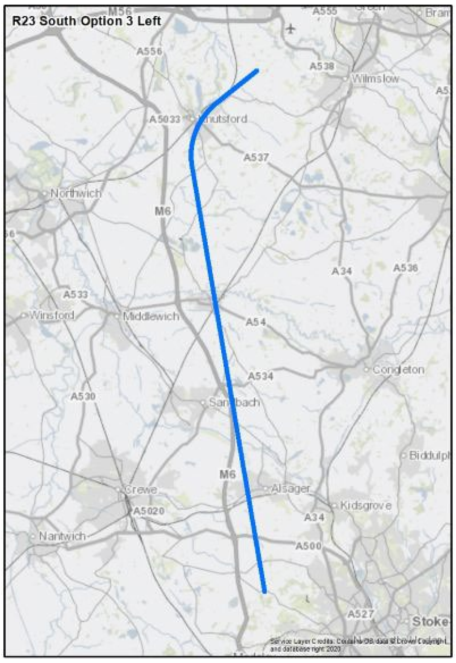
A speed restriction of 220 KIAS is used for the first turn.

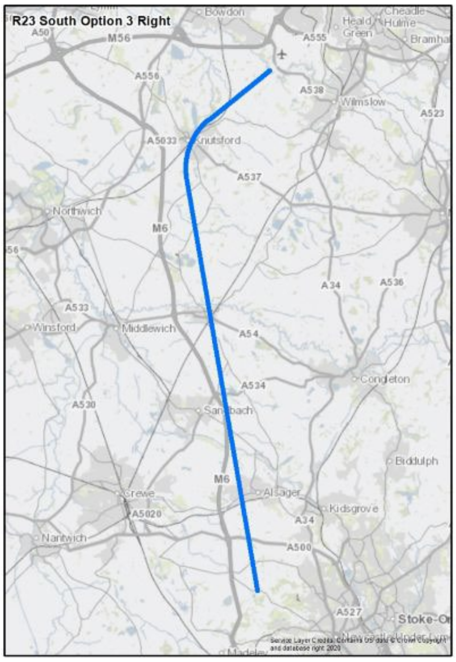
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Emissions: There is a reduction in track miles compared to the current SANBA SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.

Capacity: Has the potential to aid departure utilisation and separation when operated in association with north, east and southbound departures.





16.8. Runways 23L/23R South Option 4A (6%)

Description

This **RNAV1** option provides an initial turn over the southern edge of Knutsford and heads in a south-west direction. It serves a similar purpose as the SANBA 1R/1Y SID and terminates on the west side of the envelope.

The procedure uses a fly-over waypoint and can be coded as either course-to-fix, track-to-fix, or direct-to-fix. The climb gradient has been set at 6%.

An element of dispersion would be apparent in the turn due to the path terminator coding.

23L: After departure this route continues straight ahead before making a left turn to the south-west over Knutsford. It continues in this direction to the west of Holmes Chapel and Sandbach. It passes over the eastern edge of Crewe and converges with the option for 23R at the 7,000ft termination point just south of Crewe.

23R: After departure this route makes a left turn to the south-west to route between Knutsford and Mobberley and continues in this direction just to the west of Holmes Chapel and Sandbach. It passes over the eastern edge of Crewe and both routes converge at the 7,000ft termination point just south of Crewe.

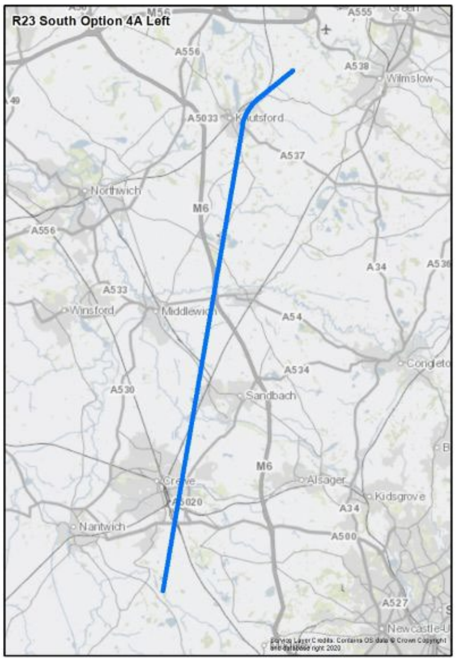
A speed restriction of 190 KIAS is applied to the first turn.

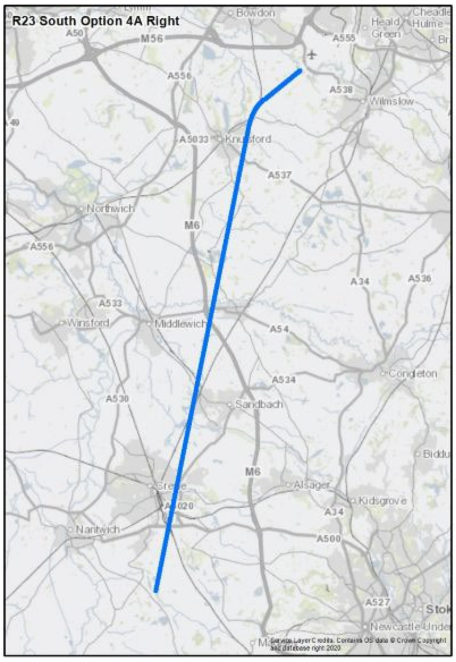
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Emissions: There is a reduction in track miles compared to the current SANBA SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.

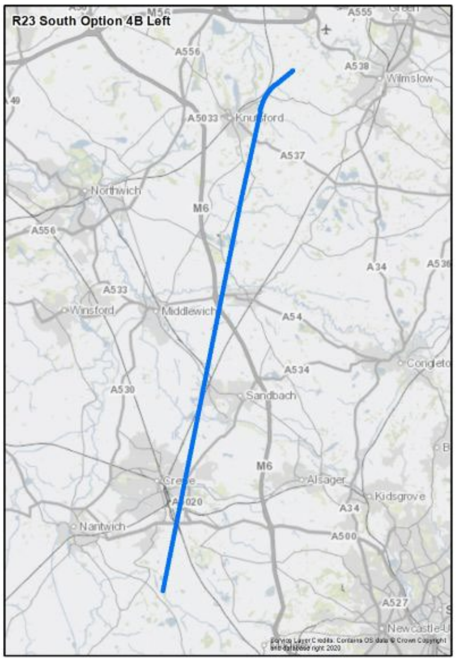
Noise N2: This may be used as a relief/respite routes in combination with other southbound options. In addition, the turn would have an element of dispersion, which is consistent with this Design Principle Noise N2.





16.9. Runways 23L/23R South Option 4B

Description	Rationale for inclusion
This **RNAV1** option provides a route that heads to the south-south-west of the envelope similar to 4A and the SANBA 1R/1Y SID, but with an earlier initial turn intended to avoid Knutsford. The option terminates at the same point as 4A, but the initial turn is now at: • For Runway 23L it is at MCT D3.2, which is 0.7nm from DER. • For Runway 23R it is at 1nm from DER. This combination allows the subsequent tracks to be further east than that of option 4A, creating more separation from Knutsford. The procedure uses a fly-over waypoint and can be coded as either course-to-fix, track-to-fix, or direct-to-fix. The climb gradient has been set at 6%. **23L:** After departure this route makes a left turn south-west at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south of Knutsford and the route continues on a south-westerly heading to the west of Holmes Chapel and Sandbach. It passes over the eastern edge of Crewe and converges with the option for 23R at the 7,000ft termination point just south of Crewe. **23R:** After departure this route makes a left turn to the south-west to route south of Knutsford and continues in this direction, passing just to the west of Holmes Chapel and Sandbach. It then routes over the eastern edge of Crewe and both routes converge at the 7,000ft termination point just south of Crewe. A speed restriction of 190 KIAS is applied to the first turn.	**Technology:** RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1:** The earlier turn has potential to reduce noise impact by avoiding Knutsford. **Noise N2:** This may be used as a relief/respite routes in combination with other southbound options. In addition, the turn would have an element of dispersion, which is consistent with the Design Principle Noise N2. **Emissions:** There is a reduction in track miles compared to the current SANBA SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.



16.10. Runways 23L/23R South Option 4C

Description

This **RNAV1** option provides a route that heads to the south-south-west of the envelope similar to the SANBA 1R/1Y SID but with the same earlier initial turn intended to avoid Knutsford as option 4B, and a left turn further down route to avoid Sandbach and Crewe.

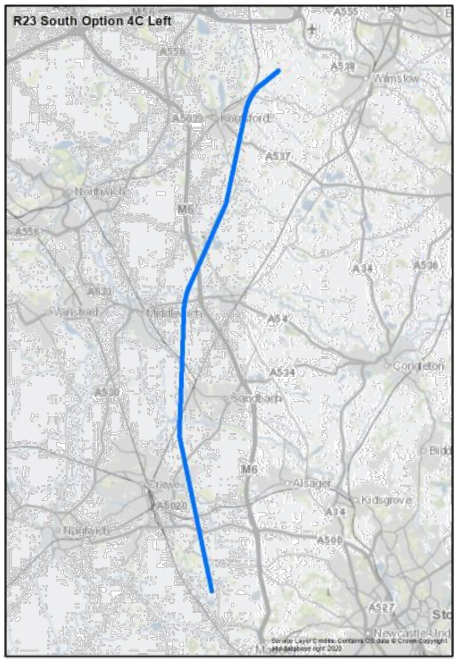
In common with option 4B the turn point for Runway 23L is at MCT D3.2, which is 0.7nm from DER. The turn point for Runway 23R is at 1nm from DER. This combination creates separation from Knutsford.

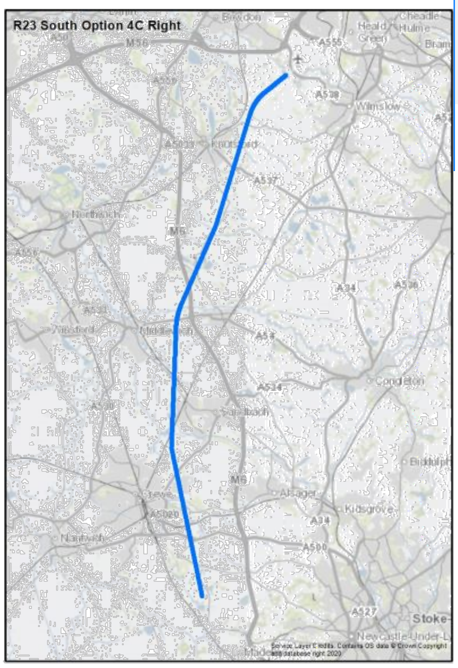
The procedure uses a fly-over waypoint and can be coded as either course-to-fix, track-to-fix, or direct-to-fix. The climb gradient has been set at 6%. An element of dispersion would be apparent in the turn due to the path terminator coding.

23L: After departure this route makes a left turn south-west at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south of Knutsford and the route continues on a south-westerly heading and combines with the 23R option midway between Lower Peover and Over Peover. The combined routes pass to the west of Holmes Chapel and Sandbach and then make a slight right turn to avoid Crewe and terminate at 7,000ft in the vicinity of Betley.

23R: After departure this route makes a left turn to the south-west to route south of Knutsford and combines with the 23L option midway between Lower Peover and Over Peover. The combined routes pass to the west of Holmes Chapel and Sandbach and then make a slight right turn to avoid Crewe and terminate at 7,000ft in the vicinity of Betley.

A speed restriction of 190 KIAS is applied to the first turn.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The earlier turn has potential to reduce noise impact by avoiding Knutsford.

In addition, the turns further down route will result in aircraft avoiding Holmes Chapel, Sandbach and Crewe.

Noise N2: This may be used as a relief/respite routes in combination with other southbound options. In addition, the turn would have an element of dispersion, which is consistent with the Design Principle Noise N2.

Emissions: There is a reduction in track miles compared to the current SANBA SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.

16.11. Runways 23L/23R South Option 5A

Description

This is an **RNP1** option that uses RF coding and follows a similar initial track to the existing LISTO SID which turns south before Knutsford. However, the track following the initial turn routes further south-east than the existing LISTO SID once south of Chelford.

The aim is to provide a 45° track divergence from other southbound SIDs when created as a network which would enable a one-minute departure separation to align with the Design Principle Capacity.

23L: After departure, this route makes a left turn at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south of Knutsford and the route continues on a south-easterly heading to route west of Chelford where it and combines with the 23R option. The combined routes avoid Congleton and Stoke-on-Trent and terminate at 7,000ft west of Leek.

23R: After departure this route makes a left turn to route south of Knutsford and combines with the 23L option to the west of Chelford. The combined routes avoid Congleton and Stoke-on-Trent and terminate at 7,000ft west of Leek.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius to avoid Knutsford. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

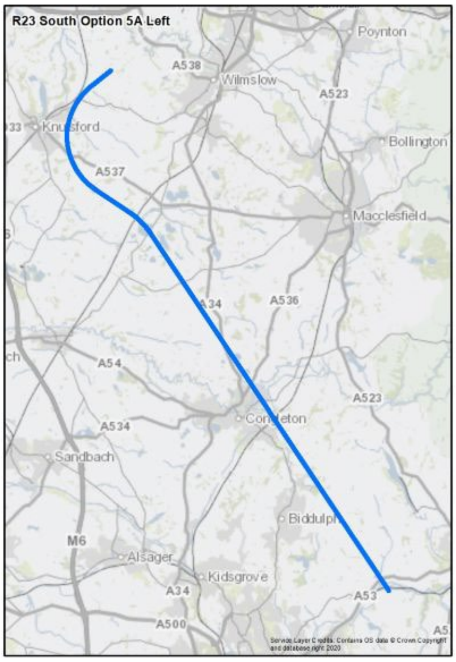
Rationale for inclusion

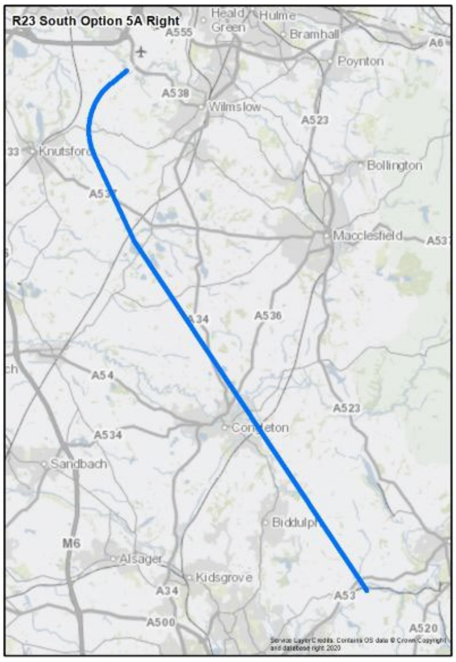
Technology: Procedure uses latest technology (RNP+RF).

Noise N1: The earlier turn has potential to reduce noise impact by avoiding Knutsford.

In addition, the route avoids built up areas including Stoke-on-Trent.

Capacity: Has the potential to aid departure utilisation and separation due to 45° track divergence from other southbound options.





16.12. Runways 23L/23R South Option 5B

Description

This is an **RNP1** option with RF coding that follows a similar initial track to option 5A and turns south before Knutsford. However, this left turn is continued to provide a route more to the east to avoid Congleton and Leek to aid capacity and departure separation.

In a similar way to options 2B and 5A, the aim is to provide a 45° track divergence from other southbound SIDs when created as a network which would enable a one-minute departure separation to align with the Design Principle Capacity.

23L: After departure this route makes a left turn at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south of Knutsford and the route continues on a south-easterly heading south-west of Chelford and then mid-way between Macclesfield and Congleton to avoid both towns. It combines with the 23R option south of Macclesfield and the combined routes turn south and terminate at 7,000ft between Stoke-on-Trent and Leek.

23R: After departure this route makes a left turn to route south of Knutsford and continues on a south-easterly heading over Chelford and then mid-way between Macclesfield and Congleton to avoid both towns. It combines with the 23L option south of Macclesfield and the combined routes turn south and terminate at 7,000ft between Stoke-on-Trent and Leek.

A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius to avoid Knutsford. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.

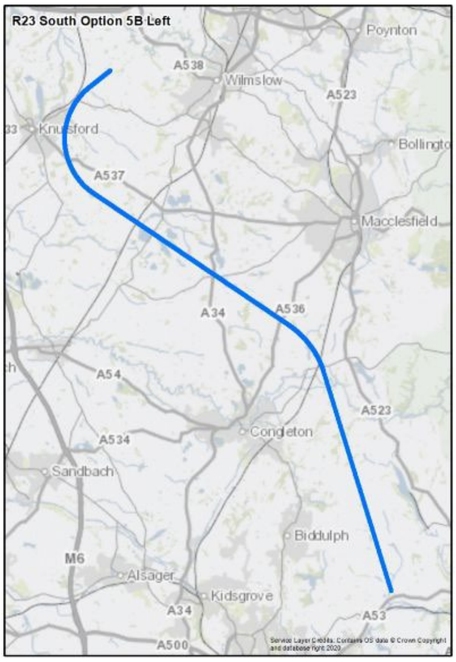
Rationale for inclusion

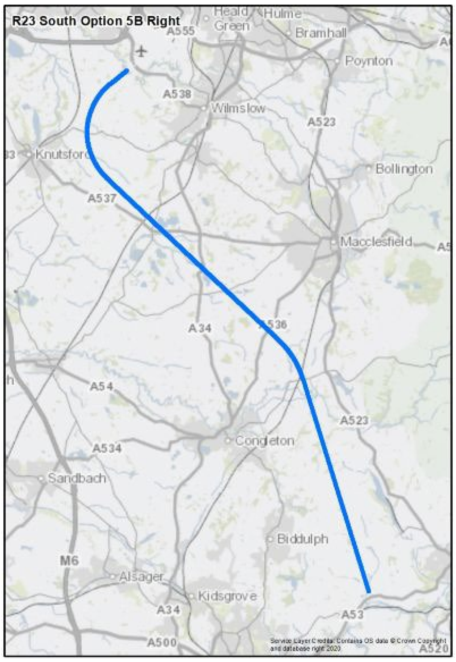
Technology: Procedure uses latest technology (RNP+RF).

Capacity: Has the potential to aid departure utilisation and separation due to 45° track divergence from other southbound options.

Noise N1: The earlier turn has potential to reduce noise impact by avoiding Knutsford.

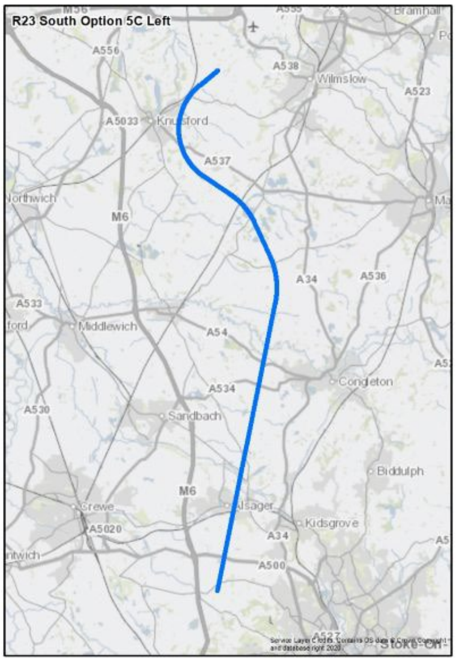
In addition the route avoids built up areas including Congleton, Leek and Stoke-on-Trent.

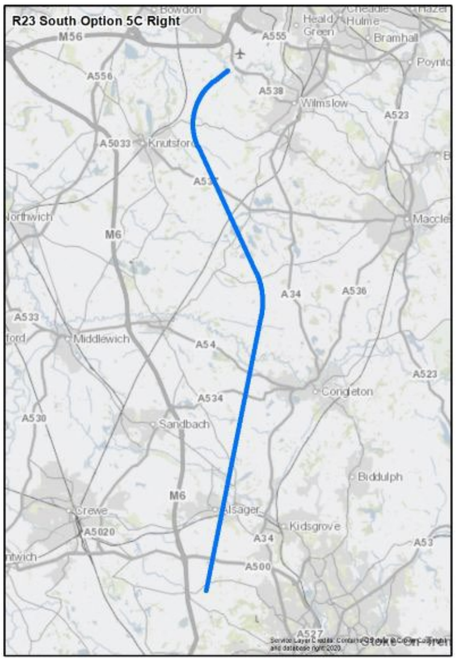




16.13. Runways 23L/23R South Option 5C

Description	Rationale for inclusion
This is an **RNP1** option with RF coding that follows a similar initial track to the existing LISTO 2R/2Y SID. However, the turn is stopped earlier to provide a route to the south which passes west of Congleton to terminate in the vicinity of that for the current SANBA SID. **23L:** After departure this route makes a left turn at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the south of Knutsford and the route continues on a south-easterly heading to the south of Chelford where it combines with the 23R option. The combined routes then turn south-west to avoid Congleton and Sandbach and terminate at 7,000ft west of Stoke-on-Trent. **23R:** After departure this route makes a left turn to route south of Knutsford and continues on a south-easterly heading to the south of Chelford where it combines with the 23L option. The combined routes then turn south-west to avoid Congleton and Sandbach and terminate at 7,000ft west of Stoke-on-Trent. A speed restriction of 190 KIAS is used for the first turn to avoid Knutsford. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology:** Procedure uses latest technology (RNP+RF). **Capacity:** Has the potential to aid departure utilisation and separation due to 45° track divergence from other southbound options. **Noise N1:** The earlier turn has potential to reduce noise impact by avoiding Knutsford. In addition, the route avoids built up areas including Sandbach, Congleton and Stoke-on-Trent. **Emissions:** There is a reduction in track miles compared to the current SANBA SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.





16.14. Runways 23L/23R South Option 6

Description

This option is included to provide a **RNAV1** replication of the existing conventional SANBA 1R/1Y SID to 7,000ft. However, unlike the 'do minimum' option 1 which uses fly-over waypoints, this option has been designed as an RNAV1 route using **fly-by** waypoints.

The benefit of fly over waypoints is more accurate track keeping. However, option 1 is more likely to be a better representation of existing operations with dispersion being apparent in the turn to the south.

The route has been designed as an RNAV1 route and uses fly-by waypoints. The climb gradient has been set at 6%.

23L: After departure, this route makes a right turn at MCT D3.2 which less than 1nm from DER. As this replicates the turn of the current procedure it aligns to the Design Principle Safety. This first turn routes to the north of Knutsford and following a short straight segment, then turns left to route south between Knutsford and Northwich where it combines with the 23R option. The combined routes pass just to the west of Holmes Chapel and to the eastern edge of Sandbach and terminate at 7,000ft south-east of Sandbach.

23R: After departure, this route makes a right turn to route north of Knutsford and following a short straight segment, then turns left to route south between Knutsford and Northwich where it combines with the 23L option. The combined routes pass just to the west of Holmes Chapel and to the eastern edge of Sandbach and terminate at 7,000ft south-east of Sandbach.

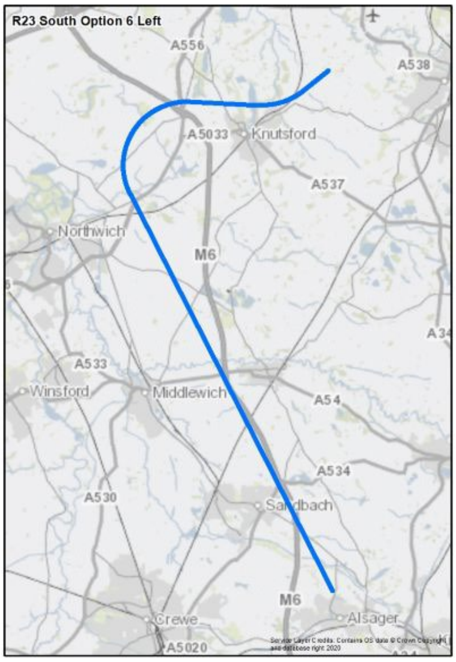
A speed restriction of 200 KIAS then 210 KIAS is used for the first turn and second turn.

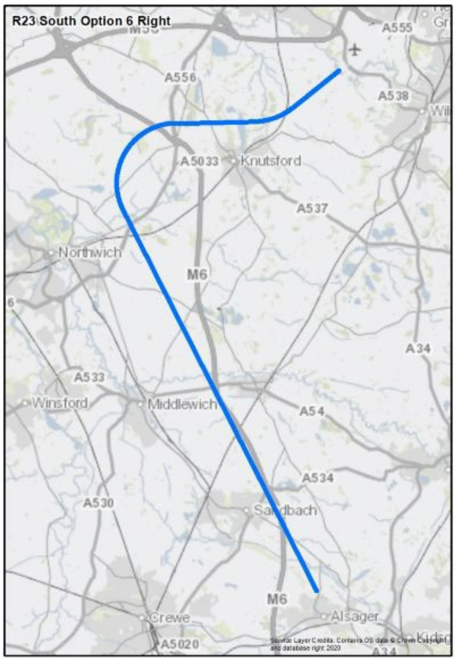
Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The position of the turn to the north replicates current operations which are intended to reduce noise impact on Knutsford.

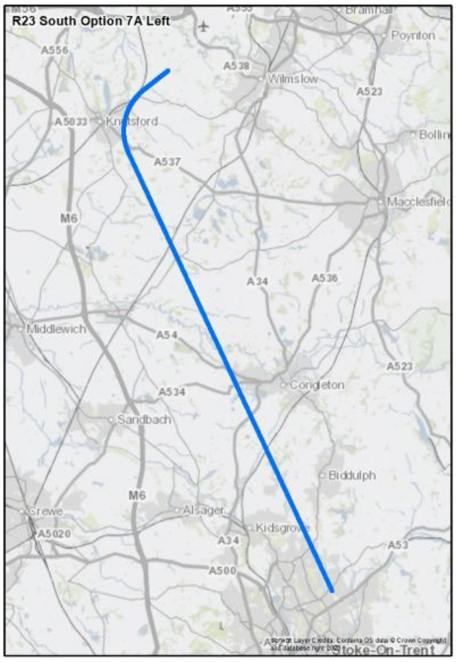
In addition, the use of fly over waypoints is intended to reduce dispersal and reduce the total number of people impacted by noise.

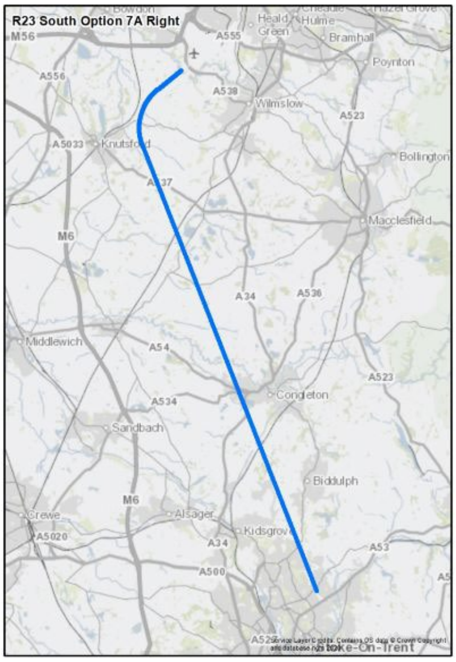




16.15. Runways 23L/23R South Option 7A

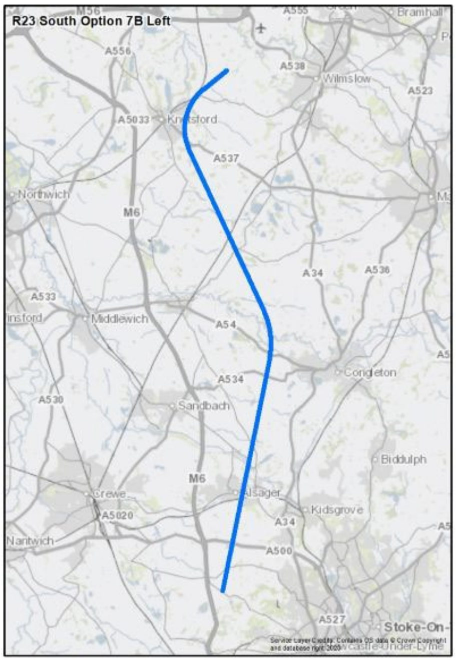
Description	Rationale for inclusion
This is an **RNP1** option with RF coding that provides an alternative version of the existing LISTO 2R/2Y SID. It turns south before Knutsford but heads south slightly further west than option 2A (the LISTO replication) to terminate near Stoke-on-Trent. It uses an RF turn at 1nm DER in accordance with PANS-OPS/CAP778 which has the effect of routing this option closer to the centre of Knutsford. **23L:** After departure this route makes a left turn south at 1nm from DER and routes to the south of Knutsford. It then routes to the west of Chelford and over the western edge of Congleton and terminates at 7,000ft to the north-east corner of Stoke-on-Trent. **23R:** After departure this route makes a left turn south at 1nm from DER which routes it over the south-east edge of Knutsford. It then routes over the western edge of Congleton and terminates at 7,000ft to the north-east corner of Stoke-on-Trent. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be asses*sed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology:** Procedure uses latest technology (RNP+RF). **Noise N1:** Routes slightly west of the existing SID to avoid Congleton. **Capacity:** Has the potential to aid departure utilisation and separation due to 45° track divergence from other southbound options.

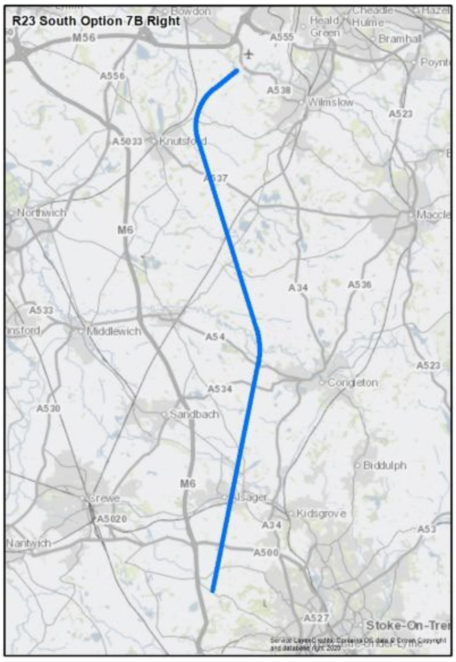




16.16. Runways 23L/23R South Option 7B

Description	Rationale for inclusion
This is an **RNP1** option with RF coding that provides an alternative version of the existing LISTO 2R/2Y SID. It is similar to option 7A but makes a turn to the west of Congleton to avoid Stoke-on-Trent. In common with option 7A, the RF turn is at 1nm DER in accordance with PANS-OPS/CAP778 which routes this option closer to the centre of Knutsford, however the final track is in a south-westerly direction. **23L:** After departure, this route makes a left turn south at 1nm from DER and routes to the south of Knutsford. It then routes to the west of Chelford before turning south-west to avoid Congleton. This has the effect of avoiding Stoke-on-Trent and the route terminates at 7,000ft to the west of the town. **23R:** After departure, this route makes a left turn south at 1nm from DER which routes it over the south-east edge of Knutsford. It then routes to the west of Chelford before turning south-west to avoid Congleton. This has the effect of avoiding Stoke-on-Trent and the route terminates at 7,000ft to the west of the town. A speed restriction of 190 KIAS is used for the first turn which allows the smallest radius. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology:** Procedure uses latest technology (RNP+RF). **Noise N1:** Routes slightly west of the existing SID to avoid Congleton. In addition, this option is intended to reduce the impact of noise on Stoke-on-Trent.





16.17. Runways 23L/23R South Viable but Poor Fit Options

Option	Safety	Policy	Capacity
A8 Left-hand wraparound	S	P	C

After departure from Runways 23L/23R, aircraft would make a left-hand turn, fly around the airport through the overhead and then begin heading south towards the SID aiming point.

Safety: This option risks interaction with other departure/arrival envelopes requiring additional tactical mitigation to safely manage the flow of air traffic.

Policy: This option involves greater track mileage than is necessary by taking traffic east and north before turning it south leading to increased fuel burn and emissions. Additionally, this option may hinder the achievement of CDAs for arriving aircraft from the south. Neither of these are aligned to the aims of the AMS.

Capacity: It is likely this option would interact with 23L/23R arrivals from the south and the SID 23L/23R East Design Envelope. In addition, this option would interact with northbound and eastbound departures and therefore does not support the requirement for one-minute departure splits to enable best use of runway capacity.

Option	Safety	Policy	Capacity
B9 Right-hand wraparound	S	P	C

After departure from Runways 23L/23R, aircraft would make a right-hand turn, fly around the airport through the overhead then begin heading south towards the SID aiming point.

Safety: This option risks interaction with other departure/arrival envelopes requiring additional tactical mitigation to safely manage the flow of air traffic. Furthermore, this option is expected to conflict with the Runway 23R MAP.

Policy: This option involves greater track mileage than is necessary by taking traffic north and east before turning it south leading to increased fuel burn and emissions. Additionally, this option may hinder the achievement of CDAs for arriving aircraft. Neither of these are aligned to the aims of the AMS.

Capacity: This option is likely to interact with 23L/23R arrivals which is likely to lead to a restriction in achieving the required capacity. In addition, this option would interact with northbound and eastbound departures and therefore does not support the requirement for one-minute departure splits to enable best use of runway capacity.

Option	Safety	Policy	Capacity
C10 Extended straight and then turn south	S	P	C

After departure from Runways 23L/23R, aircraft would continue straight ahead towards Northwich before turning south towards the SID aiming point.

Safety: This option may cause additional interaction with LPL departures and arrivals.

Capacity: This option is likely to interact with options within the South-west departure envelope which could limit the ability to enable best use of runway capacity and limit the ability to achieve one minute departure splits.

D11 Slight right after departure then 90 degree left turn to the south	S	P	C

After departure from Runways 23L/23R, aircraft would make a slight right-hand turn due west before making a 90 degree turn towards the south, towards the SID aiming point.

Safety: This option would infringe the LPL control zone, up to 2,500ft.

Capacity: This option is likely to interact with options within the South-west departure envelope which could limit the ability to enable best use of runway capacity and limit the ability to achieve one minute departure splits.

17. SID Runways 23L/23R – South-west

17.1. Introduction to 23L/23R South-west Design Envelope

This envelope has been created for traffic routing to the west and south-west from Runways 23L/23R. The envelope is based around the existing SIDs below and includes other options routing to the south-west.

- KUXEM 1R/1Y – currently used for traffic to the south-west.
- EKLAD 1R/1Y – currently used for traffic to the west.
- MONTY 1R 1Y – currently only used on a limited basis for traffic leaving controlled airspace.

It should be noted that a dedicated 23 West Design Envelope has also been created for traffic to the west.

The options within this envelope are based around current operations where aircraft routing to the south-west are frequently vectored off the SID once they are above 3,000ft. This takes them on a more direct track to either join the network to reduce fuel burn, or to resolve interactions with other traffic.

The design options seek to align with;

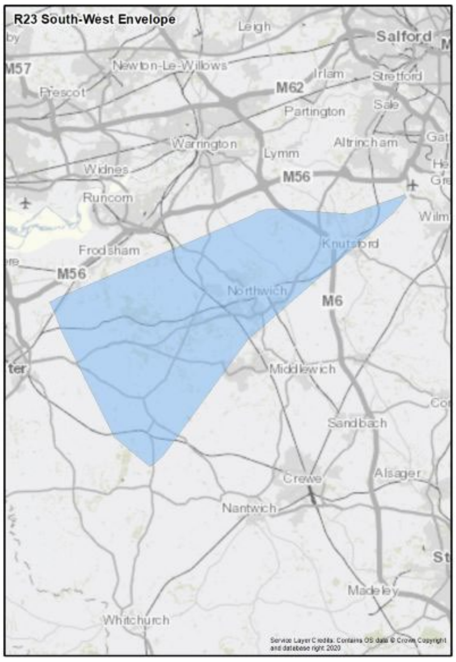
- This current operational practice,
- Feedback received within Stage 2 engagement,
- The ACOG facilitated collaborative design review with technical experts from LPL, MAN and NERL as detailed in section 5.11.

The meeting identified a number of design interactions and considerations which were also reflected in the LPL feedback to the engagement at MAN.

The combination of the LPL engagement feedback and the interactions discussed at this meeting were used in the development of modified design options 8, 9 and 10 within this envelope.

All options terminate at 7,000ft, at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track for each SID). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved.

17.2. Design Envelope Location Map



17.3. Runways 23L/23R South-west Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1A	'Do minimum' This option is included to provide a **RNAV1** replication of the **MONTY** 1R/1Y SID. As a replicated route it follows a similar track over the ground as the current route. This involves a right turn after departure to avoid Knutsford and Northwich, followed by a straight segment, and a final left turn to join the NATS network east of Chester. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* -200 KIAS	A11	Replicate the current KUXEM SID but with a termination point further south.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.
1B	This **RNAV1** option is the same as 1C, except it has an earlier turn north-west of Northwich, that routes aircraft south-west. It is included as an alternative to the KUXEM departure. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* -200 KIAS	B12	Route south-west earlier after departure.		

1C	'Do minimum' This option is included to provide a **RNAV1** replication of the **KUXEM** 1R/1Y SID. As a replicated route it follows a similar track over the ground as the current route. This involves a right turn after departure to avoid Knutsford and Northwich, followed by a straight segment, to terminate near Chester. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* -200 KIAS	C13	Left-hand wraparound		
1D	'Do minimum' This option is included to provide a **RNAV1** replication of the **EKLAD** 1R/1Y SID using a fly over waypoint sequence. As a replicated route it follows a similar track over the ground as the current route. This involves a right turn after departure to avoid Knutsford and Northwich, followed by a straight segment to terminate south-east of Ellesmere Port. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* -200 KIAS	D14	Right-hand wraparound		
2A	This is an **RNAV1** option that uses a 15° track offset from the runway bearing at the DER. It is provided as an alternative to the KUXEM SID. -250 KIAS	E15	Slight right turn after departure, then south-west.		

2B	This is an **RNP1** option using RF coding to route north of Knutsford, and then to route to the south-west. It is provided as an alternative to the KUXEM SID. -210 KIAS	F16	Left turn after departure, head direct south then turn west.		
3A	This is an **RNAV1** option that that replicates the initial track of the current KUXEM SID but then turns south-west earlier to make this a more fuel-efficient route than the existing departure -200 KIAS				
3B	This is an **RNP1** option with RF coding which uses a right turn to avoid Knutsford. It is similar to option 3A initially, but the track after the first turn is further north to provide greater avoidance from Northwich. -210 KIAS **This option has an RF turn at 1nm DER, in accordance with PANS-OPS/CAP778.*				
3C	This is an **RNP1** option with RF coding which uses a right turn to avoid Knutsford. It is similar to option 3B except the first turn is earlier to provide greater avoidance of Knutsford. It is provided as an alternative to the EKLAD SID. -210 KIAS **This option has an RF turn point less than 1nm to replicate the existing MCT D3.2 marker.*				

4B	This is an **RNP1** option with RF coding which routes fully around Knutsford and uses an RF turn initially followed by a left turn and right turn, routing over Northwich. -210 KIAS **This option has an RF turn at 1nm DER, in accordance with PANS-OPS/CAP778.*				
5	This **RNAV1** option provides a straight ahead climb to the south-west after departure to 7,000ft. There is no turn in this option. It is provided as an alternative to the KUXEM SID. -250 KIAS				
6	This option uses an **RNP1** RF turn initially to make a kink around Knutsford before tracking back on the extended runway centreline. It is similar to option 4B except that the radius of the turn is shorter resulting in a track that is more to the south of Northwich. It is intended as an alternative to the KUXEM SID -190 KIAS				

7a	This is an RNAV1 option included to provide a similar route to that of option 1A (MONTY SID); however, it uses an initial 15° track adjustment to the right from the DER to reduce noise impact on Knutsford, before connecting to the same track. -200 KIAS				
7b	This is an RNAV1 option included to provide a similar route to that of option 1B but using an initial 15° track adjustment to reduce the impact of noise on Knutsford. It then follows the same route as option 1B for the remainder of the route. -200 KIAS				
8	This is RNP1 option with RF coding option as an alternative to the KUXEM SID that aims to minimise the interactions with LPL following stakeholder feedback. It avoids Knutsford and then routes to the south-west and uses a 4.2nm buffer between this route and proposed Runway 27 arrival route to LPL. -190 KIAS				

9	This is RNP1 option with RF coding option as an alternative to the KUXEM SID that aims to minimise the interactions with LPL following stakeholder feedback. It is similar to option 8 but has a more direct track to the south-west following the second turn and requires a slightly higher climb gradient. It uses a 4.2nm buffer between this route and proposed Runway 27 arrival route to LPL. -190 KIAS				
10	This is RNP1 option with RF coding option as an alternative to the KUXEM SID that aims to minimise the interactions with LPL following stakeholder feedback. It is similar to option 8 but routes further south after Knutsford to avoid Northwich. It uses a 4.2nm buffer between this route and proposed Runway 27 arrival route to LPL. -190 KIAS				

17.4. Runways 23L/23R South-west Option 1A

Description

This option is included to provide a **RNAV1** *replication* of the **MONTY** 1R/1Y SIDs.

The procedure uses fly-by waypoints, positioned to replicate the turn at the existing markers:

- **23R** this first turn is at MCT D3.
- **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. This earlier turn is to avoid Knutsford.

As a replicated route it follows a similar track over the ground as the current SID. This routes aircraft to the north of Knutsford, before making a left turn to the west to route north of Northwich and then making a left to the south of Frodsham to route south-west.

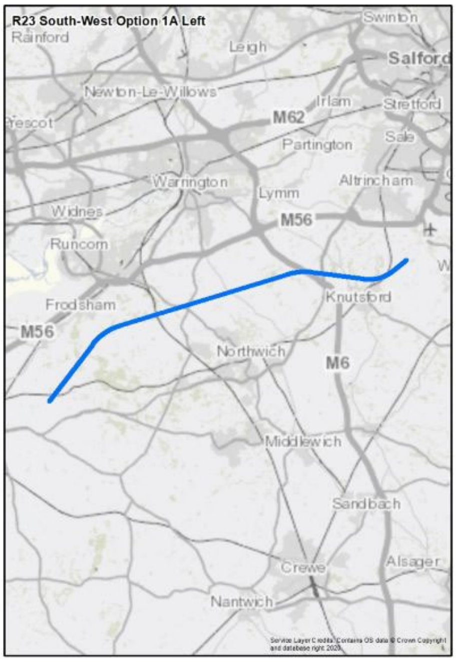
A speed restriction of 200 KIAS is used for the first turn, thereafter 250 KIAS would apply.

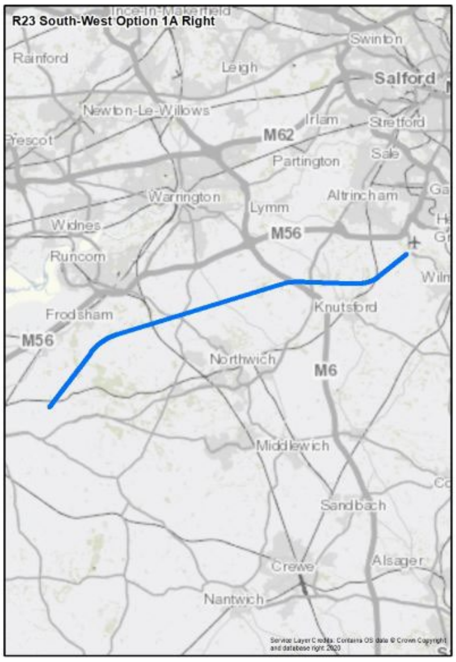
Rationale for inclusion

'Do minimum': Aligns to a 'do minimum' option.

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

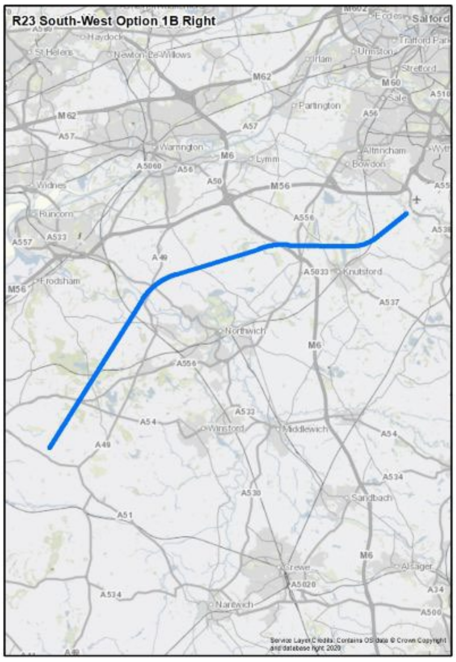
Noise N1: Avoids the centre of Knutsford.





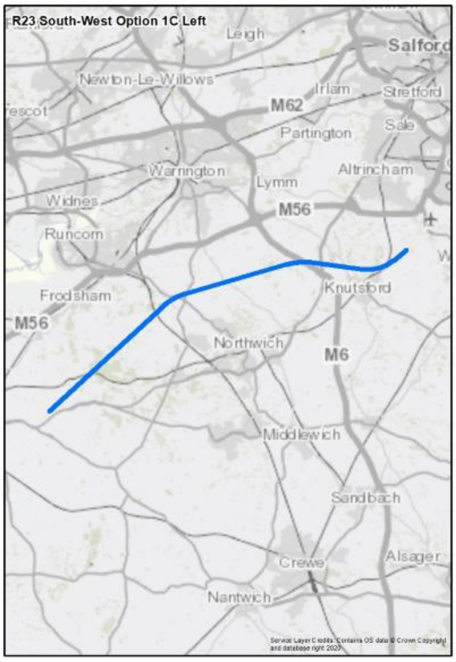
17.5. Runways 23L/23R South-west Option 1B

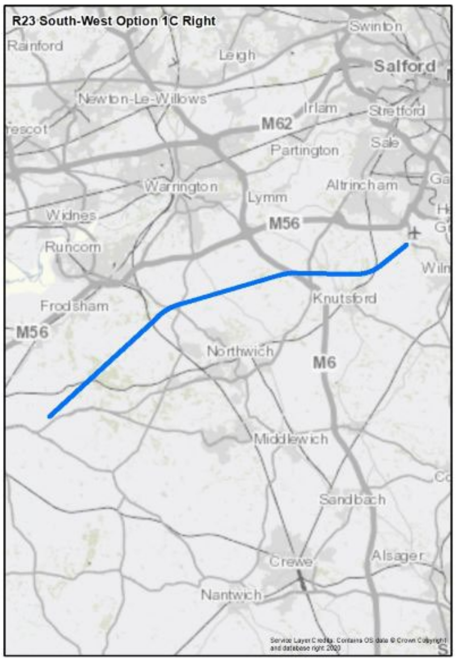
Description	Rationale for inclusion
Option 1b is an **RNAV1** option that avoids Knutsford in a similar way to the current *KUXEM* departure but the second turn to the south-west to join the network is earlier. The procedure uses fly-by waypoints. **23L:** After departure the route makes turn to the right to route to the north of Knutsford. This turn is at D3.2 which less than Design Principle Safety. Following a short straight segment, it then makes a left turn close to Over Tabley where it combines with the option for 23R. The combined routes continue in a south-westerly direction to avoid Northwich and then make a left turn to the south-west to terminate at 7,000ft south of Kelsall. **23R:** After departure the route makes turn to the right to route to the north of Knutsford. Following a short straight segment it then makes a left turn close to Over Tabley where it combines with the option for 23L. The combined routes continue in a south-westerly direction to avoid Northwich and then make a left turn to the south-west to terminate at 7,000ft south of Kelsall. A speed restriction of 200 KIAS is used for the first turn, thereafter 250 KIAS would apply.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Emissions**: More direct routing and reduced track miles when compared to replicated route. **Noise N1**: Avoids the centre of Knutsford.



17.6. Runways 23L/23R South-west Option 1C

Description	Rationale for inclusion
This is option is included to provide a RNAV 1 **replication** of the **KUXEM** 1R/1Y SIDs. The procedure uses fly-by waypoints, positioned to replicate the turn at the existing markers: • **23R** this first turn is at MCT D3. • **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. This earlier turn is to avoid Knutsford. As a replicated route it follows a similar track over the ground as the current route. This routes aircraft to the north of Knutsford, before making a left turn to the west to route north of Northwich. It then then makes a second left turn to the north-west of Northwich to route south-west and terminates at 7,000ft to the east of Chester. A speed restriction of 200 KIAS is used for the first turn, thereafter 250 KIAS would apply.	'Do minimum': Aligns to a 'do minimum' option. **Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1**: Avoids the centre of Knutsford.





17.7. Runways 23L/23R South-west Option 1D

Description

This option is included to provide a **RNAV1 replication** of the **EKLAD** 1R/1Y SIDs.

The procedure uses fly-by waypoints, positioned to replicate the turn at the existing markers:

- **23R** this first turn is at MCT D3.
- **23L** this is at MCT D3.2 which less than 1nm from DER but as this replicates the turn of the current procedure it therefore aligns to the Design Principle Safety. This earlier turn is to avoid Knutsford.

As a replicated route it follows a similar track over the ground as the current route. This routes aircraft to the north of Knutsford, before making a left turn to the west to route north of Northwich. The route continues in this direction until reaching 7,000ft to the north-east of Chester.

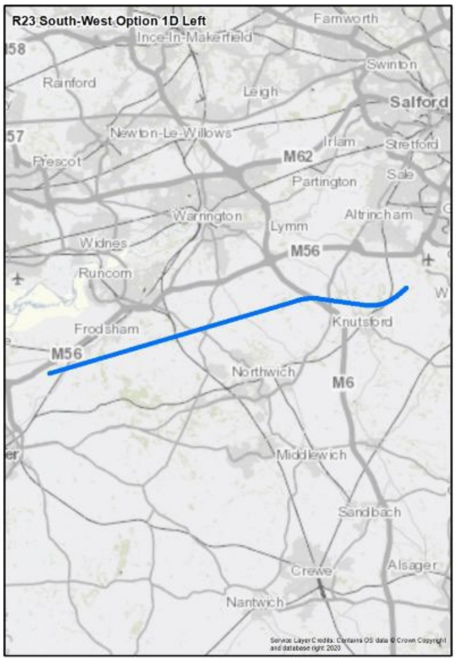
A speed restriction of 200 KIAS is used for the first turn, thereafter 250 KIAS would apply.

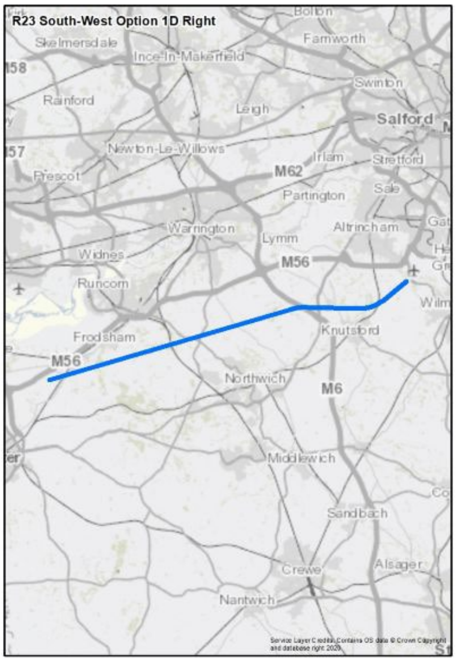
Rationale for inclusion

'Do minimum': Aligns to a 'do minimum' option.

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: Avoids the centre of Knutsford.





17.8. Runways 23L/23R South-west Option 2A

Description

This is an **RNAV1** option that is includes a 15° offset to the north (right) at the DER. The aim of this is to avoid overflight of built-up areas in a more fuel-efficient manner than the current KUXEM SID.

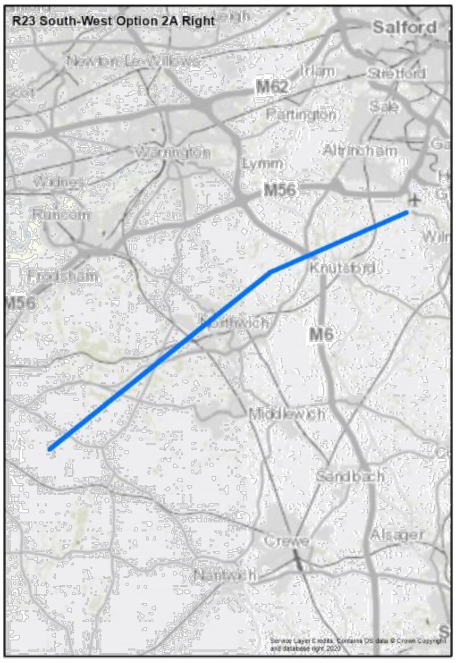
The higher design speed (when compared to the replicated route) will permit aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

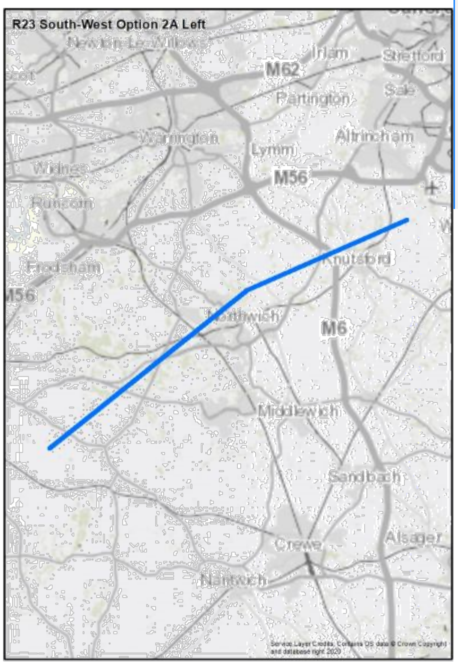
The procedure uses track-to-fix coding.

23L: Upon reaching the DER this route has a 15° offset to the right that routes it to the north of Knutsford. It continues in this direction until north of Northwich where it combines with the 23R option and makes a left turn onto a slightly more south westerly track. The routes terminate at 7,000ft between Kelsall and Tarporley.

23R: Upon reaching the DER this route also has a 15° offset to the right that routes it to the north of Knutsford via Over Tabley. A 15° track adjustment to the left is then made to the north of Northwich in order to re-combine with the 23L option and the combined routes terminate at 7,000ft between Kelsall and Tarporley.

There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. Some dispersion may be apparent close to the runway due to the track-to-fix coding although this is expected to be minimal.





Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Capacity: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options.

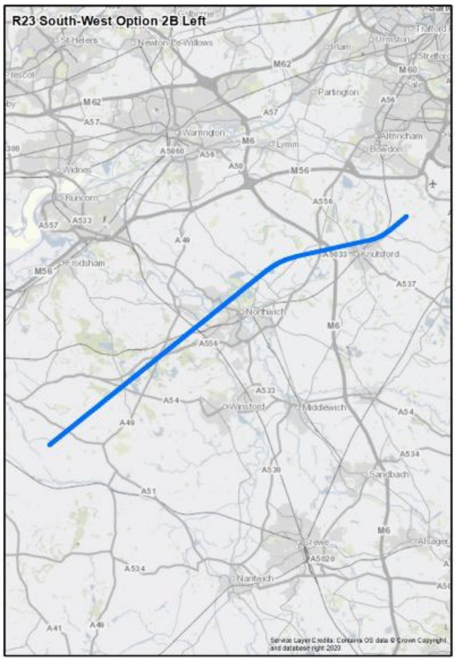
Noise N1: The offset has potential to reduce noise impact by avoiding Knutsford. In addition, the route avoids the centre of Northwich.

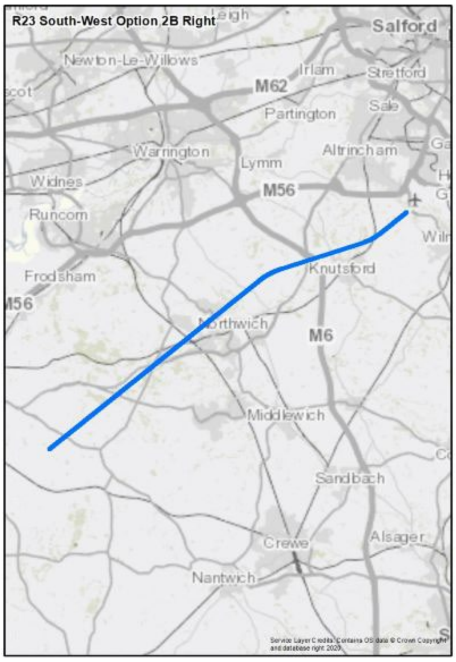
The design speed will allow aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Emissions: The offset provides a reduction in track miles compared to the current KUXEM SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.

17.9. Runways 23L/23R South-west Option 2B

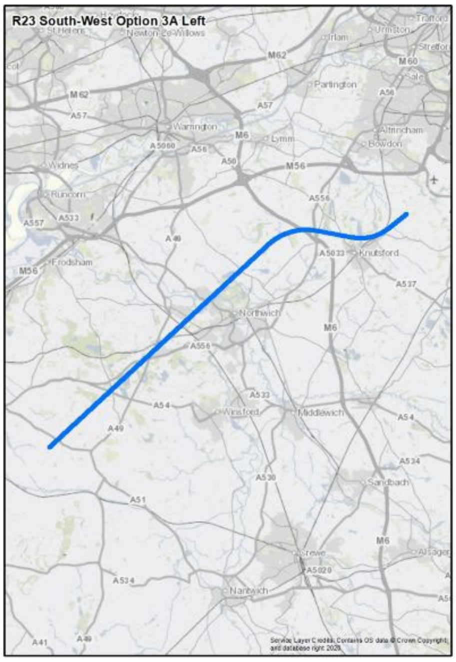
Description	Rationale for inclusion
Option 2B uses an **RNP1** with RF coding, connecting to the same south-west track as shown in option 2A. The aim of this is to avoid overflight of built-up areas in a more fuel-efficient manner than the current KUXEM SID by removing the legs using the MCT and POL VOR. The procedure uses radius-to-fix coding. **23L:** After departure the route makes an RF turn to the right to route to the north of Knutsford. It continues in this direction until north-east of Northwich where it combines with the 23R option and makes a left turn onto a slightly more south-westerly track. The routes terminate at 7,000ft between Kelsall and Tarporley. **23R:** After departure the route makes an RF turn to the right to route to the north of Knutsford. It continues in this direction until north-east of Northwich where it combines with the 23L option and makes a left turn onto a slightly more south-westerly track. The routes terminate at 7,000ft between Kelsall and Tarporley. A speed restriction of 210 knots would be applied to the first turn to ensure aircraft avoid the centre of Knutsford.	**Technology:** Procedure uses latest technology (RNP+RF). **Capacity:** Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options. **Noise N1:** The RF turn has potential to reduce noise impact by avoiding Knutsford. In addition, the route avoids the centre of Northwich. **Emissions:** The offset provides a reduction in track miles compared to the current KUXEM SID as it avoids the kink to the north around Knutsford. This makes it a more fuel-efficient route.

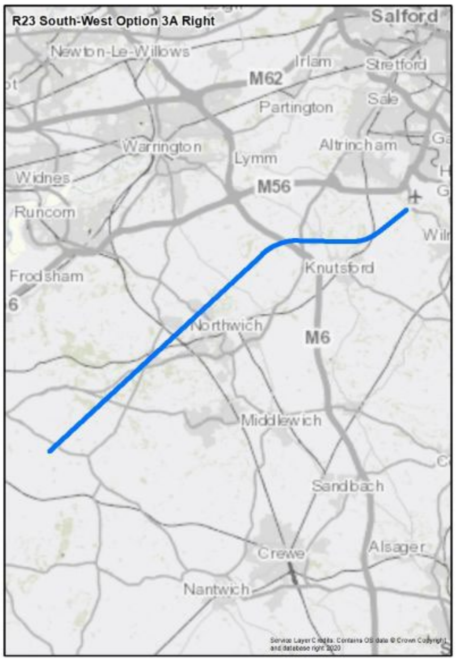




17.10. Runways 23L/23R South-west Option 3A

Description	Rationale for inclusion
This is an **RNAV1** option that that replicates the initial track of the current KUXEM SID but then turns south-west earlier to make this a more fuel-efficient route than the existing departure. This routes it towards the centre of the design envelope. The procedure uses a fly-over to fly-by sequence. An element of dispersion would be apparent in the turn due to the fly-over waypoint and DF coding. **23L:** After departure, the route makes turn to the right to route to the north of Knutsford. Following a short straight segment, it then makes a left turn close to Over Tabley where it combines with the option for 23R. The combined routes continue in a south-westerly direction to avoid Northwich and terminate at 7,000ft between Kelsall and Tarporley. **23R:** After departure, the route makes turn to the right to route to the north of Knutsford. Following a short straight segment, it then makes a left turn close to Over Tabley where it combines with the option for 23L. The combined routes continue in a south-westerly direction to avoid Northwich and terminate at 7,000ft between Kelsall and Tarporley. A speed restriction of 200 KIAS then 220 KIAS is used for the first turn and second turn.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Emissions:** There is a reduction in track miles compared to the current KUXEM SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich. **Noise N2**: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.





17.11. Runways 23L/23R South-west Option 3B

Description

This option uses an **RNP1** with RF coding right turn initially (1nm DER for Runway 23L) to avoid Knutsford. It is similar to option 3A initially, but the track after the first turn is further north to provide greater avoidance from Northwich.

This route increases fuel efficiency when compared to the replicated route by removing the legs using the MCT and POL VOR and routes towards the centre of the design envelope.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: After departure, the route makes an RF turn to the right to route to the north of Knutsford at 1nm from DER. Following a short straight segment, it combines with the option for 23R and turns left on a track that takes it well to the north of Northwich. It continues in this direction until north of Delamere and then turns left onto a more south-westerly track and terminates at 7,000ft close to Kelsall.

23R: After departure the route makes an RF turn to the right to route to the north of Knutsford at 1nm from DER. Following a short straight segment it combines with the option for 23L and turns left on a track that takes it well to the north of Northwich. It continues in this direction until north of Delamere and then turns left onto a more south-westerly track and terminates at 7,000ft close to Kelsall.

A speed restriction of 210 KIAS is applied to the first turn which is the PANS-OPS/CAP778 recommended speed.

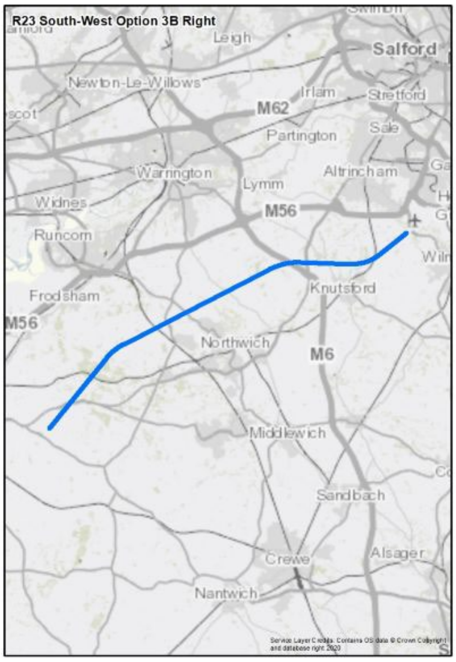
Rationale for inclusion

Technology: Procedure uses latest technology (RNP+RF).

Emissions: There is a reduction in track miles to join the network compared to the current KUXEM SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route.

Noise N1: The route has potential to reduce noise impact by avoiding Knutsford and the built-up area of Northwich.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact



17.12. Runways 23L/23R South-west Option 3C

Description

This option uses an **RNP1** with RF coding right turn in the same way as option 3B, except that the turn point for Runway 23L is earlier and replicates the current turn position of MCT D3.2 position (0.7nm DER). This provides greater avoidance of Knutsford.

This route is intended as an alternative to the EKLAD SID and routes towards the centre of the design envelope.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: After departure the route makes an RF turn to the right at 0.7nm from DER which replicates the turn of the current procedure and therefore aligns to the Design Principle Safety. It routes to the north of Knutsford and following a short straight segment it combines with the option for 23R and turns left on a track that takes it well to the north of Northwich and Kelsall and terminates at 7,000ft east of Chester.

23R: After departure the route makes an RF turn to the right to route to the north of Knutsford. Following a short straight segment it combines with the option for 23L and turns left on a track that takes it well to the north of Northwich. It continues in this direction until north of Delamere and then turns left onto a more south-westerly track and terminates at 7,000ft close to Kelsall.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

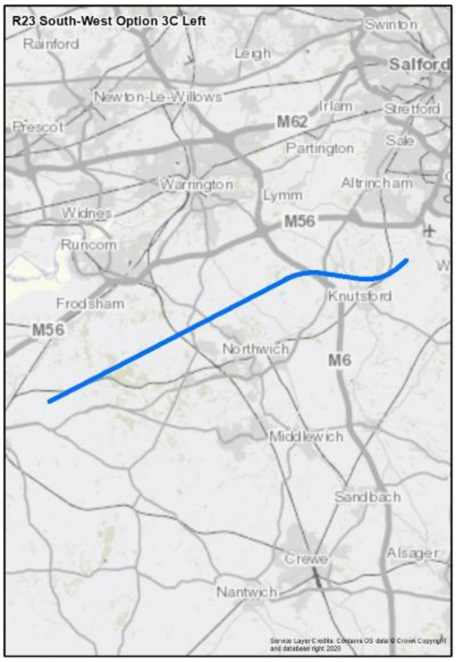
Rationale for inclusion

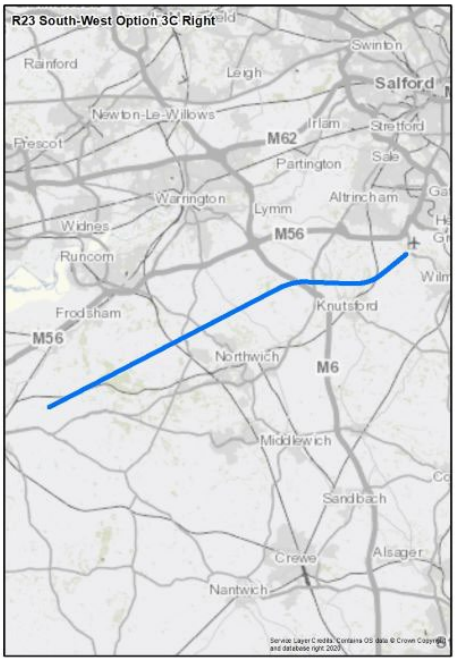
Technology: Procedure uses latest technology (RNP+RF).

Emissions: There is a reduction in track miles to join the network compared to the current EKLAD SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route.

Noise N1: The route has potential to reduce noise impact by avoiding Knutsford and the built-up area of Northwich.

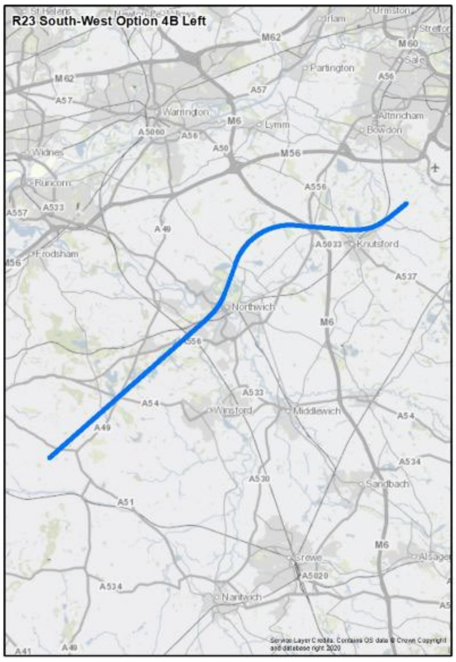
The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.





17.13. Runways 23L/23R South-west Option 4B

Description	Rationale for inclusion
This option routes fully around Knutsford and is **RNP1** with RF coding initially (1nm DER for Runway 23L), followed by a left turn and right turn, routing over Northwich. This route is similar to option 3A but routes slightly further south and is intended as an alternative to the EKLAD SID. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L:** After departure the route makes an RF turn to the right 1nm from DER to the north of Knutsford and following a short straight segment it then turns left and combines with the option for 23R. After a further short segment it then turns right to route over the northern edge of Northwich. It terminates at 7,000ft west of Tarporley. **23R:** After departure the route makes an RF turn to the right to the north of Knutsford and following a short straight segment it then turns left and combines with the option for 23L. After a further short segment it then turns right to route over the northern edge of Northwich. It terminates at 7,000ft west of Tarporley. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: There is a reduction in track miles to join the network compared to the current EKLAD SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.



17.14. Runways 23L/23R South-west Option 5

Description

This is an **RNAV1** option which is a straight climb from the DER out to 7,000ft. There is no turn in this option which results in the option overflying Knutsford.

The higher design speed (when compared to the replicated route) will permit aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The option maximises fuel efficiency by removing the turnaround Knutsford which use the MCT and POL VOR.

23L: After departure, the route continues straight ahead on runway heading to 7,000ft. This routes it overhead Knutsford and it then continues to the south of Northwich and just north of Winsford. It terminates at 7,000ft just east of Tattenhall.

23R: After departure, the route makes a slight track adjustment to combine with the 23L option. This routes it overhead Knutsford and it then continues to the south of Northwich and just north of Winsford. It terminates at 7,000ft just east of Tattenhall.

There would be no speed restrictions applied to the procedure; therefore, the maximum speed of 250 KIAS below FL100 would apply. No dispersion would be apparent as the track is straight ahead and track keeping should be optimum.

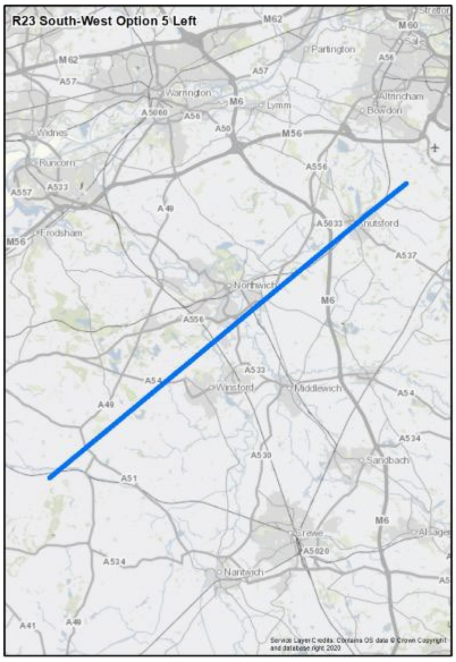
Rationale for inclusion

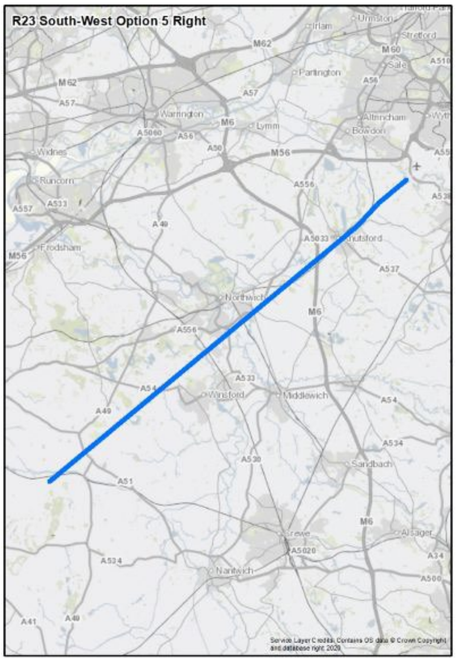
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

Emissions: This is the most direct route possible to join the network at 7,000ft. This results in a reduction in track miles compared to the current KUXEM SID which makes it a more fuel-efficient route.

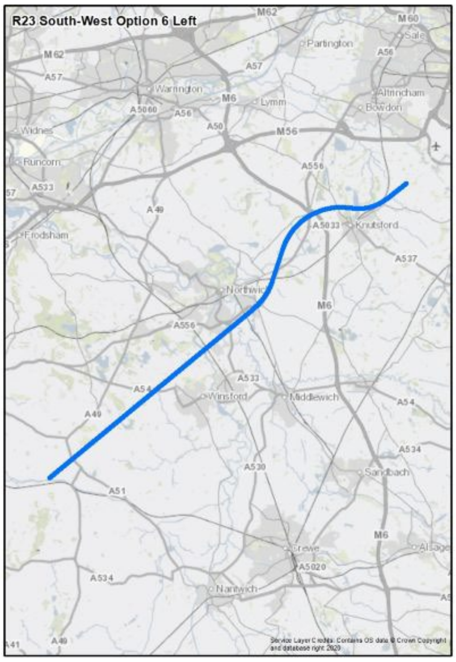
Capacity: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound departure options.

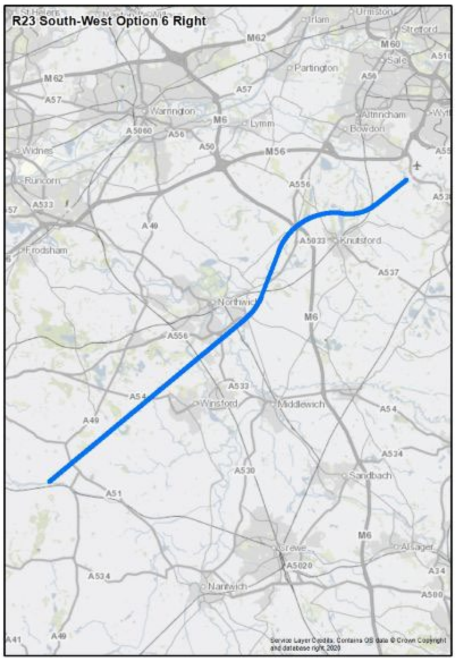




17.15. Runways 23L/23R South-west Option 6

Description	Rationale for inclusion
This is an **RNP1** with RF coding initially (1nm DER for Runway 23L) to make a kink around Knutsford before tracking back on the extended runway centreline. It is similar to option 4B except that the radius of the turn is shorter resulting in a track that is more to the south of Northwich. This route is intended as an alternative to the KUXEM SID and routes towards the south of the design envelope. **23L:** After departure, the route makes an RF turn to the right 1nm from DER which takes it just to the north of Knutsford. It then turns left and then right to return the route onto the extended runway centreline where it combines with the option for 23R. It continues to the south of Northwich and just north of Winsford and terminates at 7,000ft just east of Tattenhall. **23R:** After departure, the route makes an RF turn to the right which takes it just to the north of Knutsford. It then turns left and then right to return the route onto the extended runway centreline where it combines with the option for 23L. It continues to the south of Northwich and just north of Winsford and terminates at 7,000ft just east of Tattenhall. A speed restriction of 190 KIAS is applied to the first turn, 210 KIAS to the second turn and 250 KIAS thereafter.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: There is a reduction in track miles to join the network compared to the current KUXEM SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route. **Capacity**: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford.





17.16. Runways 23L/23R South-west Option 7A

Description

This is an **RNAV1** option included to provide a similar route to that of option 1A (the MONTY 1R /1Y SID) however, it uses an initial 15° track adjustment to the right (north) from the DER to reduce the impact of noise on Knutsford. It then follows the same route as the replicated route once beyond Mere.

The procedure uses fly-by waypoints.

23L: Aircraft make a 15° track adjustment at DER to the right to route to the north of Knutsford and to the south of Mere. It then follows the same track as 1A and routes west to combine with the option for 23R just west of Over Tabley. The routes continue in a south-westerly direction to avoid Northwich and then makes a left turn to the south of Frodsham to terminate at 7,000ft north of Tarvin.

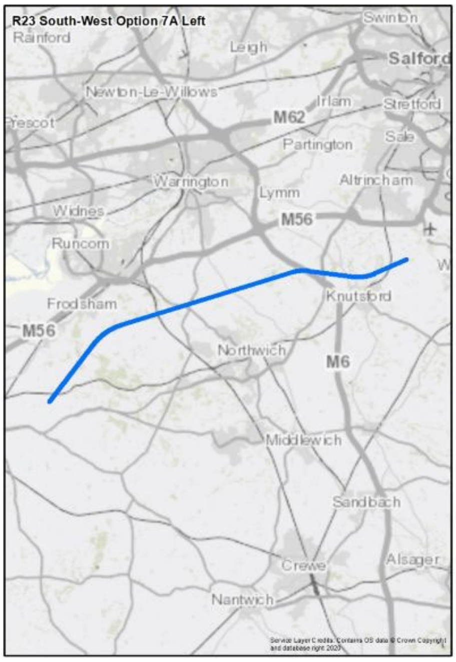
23R: Aircraft make a 15° track adjustment at DER to the right to route to the north of Knutsford. It then follows the same track as 1A just north of Knutsford and routes west to combine with the option for 23L around Bate Heath. The combined routes continue in a south-westerly direction to avoid Northwich and then makes a left turn to the south of Frodsham to terminate at 7,000ft north-west of Kelsall.

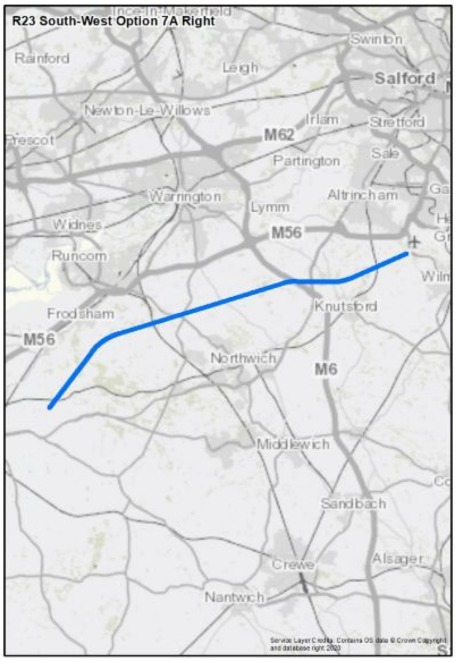
A speed restriction of 200/210 KIAS is used for the first and second turn, thereafter 250 KIAS would apply.

Rationale for inclusion

Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

Noise N1: The route has been created to reduce noise impact to Knutsford using the track adjustment.



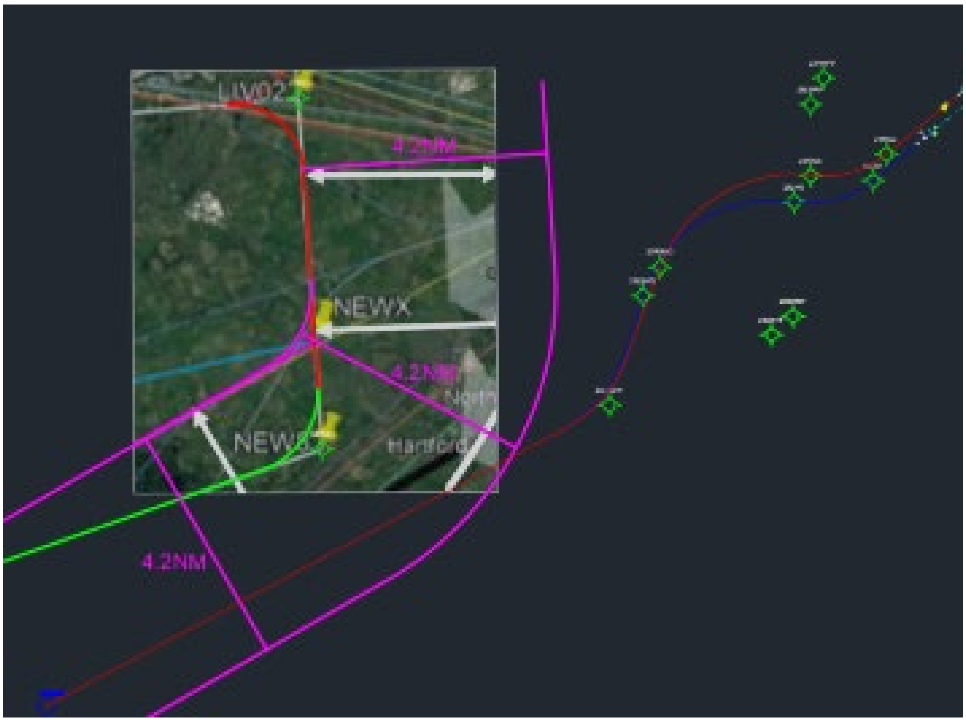


17.17. Runways 23L/23R South-west Option 7B

Description	Rationale for inclusion
This is an **RNAV1** option included to provide a similar route to that of option 1B but using an initial 15° track adjustment to the right (north) from the DER to reduce the impact of noise on Knutsford. It then follows the same route as option 1B for the remainder of the route. The procedure uses fly-by waypoints. **23L:** Aircraft make a 15° track adjustment at DER to the right to route to the north of Knutsford and to the south of Mere. It then follows the same track as 1B to combine with the option for 23R around Over Tabley. The combined routes continue in a south-westerly direction to avoid Northwich and then make a left turn north of Weaverham to terminate at 7,000ft south of Kelsall. **23R:** Aircraft make a 15° track adjustment at DER to the right to route to the north of Knutsford and to the south of Mere. It then follows the same track as 1B to combine with the option for 23L around Over Tabley. The combined routes continue in a south-westerly direction to avoid Northwich and then make a left turn north of Weaverham to terminate at 7,000ft south of Kelsall. A speed restriction of 200/210 KIAS is used for the first and second turn, thereafter 250 KIAS would apply.	**Technology:** RNAV is the lowest PBN specification and therefore usable by all aircraft. **Emissions:** More direct routing and reduced track miles when compared to replicated route. **Noise N1:** The route has been created to reduce noise impact to Knutsford using the track adjustment.

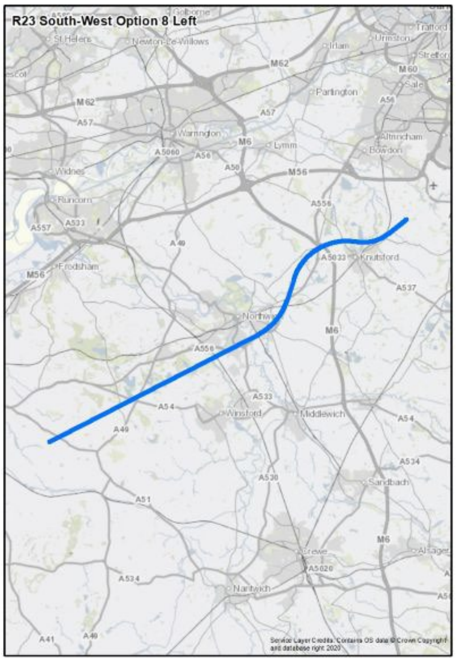
Runways 23L/23R South-west Option 8

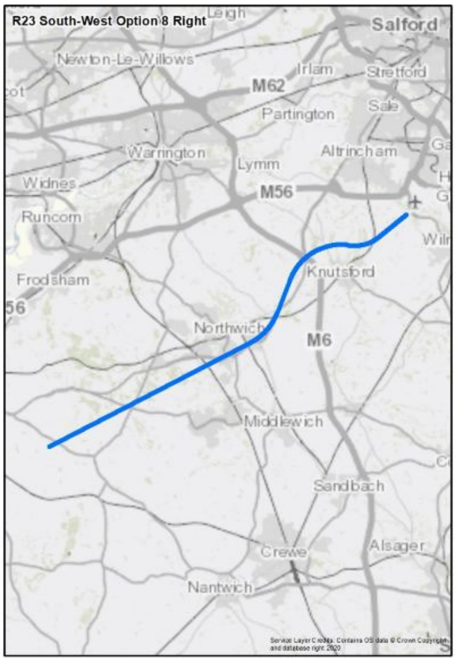
Description	Rationale for inclusion
This is as an alternative **RNP1** with RF coding option to the current KUXEM SID. This option has been designed following bilateral engagement with LPL that identified interactions with the proposed LPL Runway 27 VEGUN arrival route from the south, with the intention of resolving those interactions. This option has been assessed against a 4.2nm buffer from this arrival route in line with minimum radar separation criteria of 3nm plus a buffer of 1.2nm (in line with CAP1385) and seeks to eliminate the interaction using vertical separation. This option uses an RNP1 RF turn initially (1nm DER for Runway 23L) to make a kink around Knutsford. This is like other options, but the radius of the turn is shorter to create a track that is more to the south of Northwich. A third turn to the right routes aircraft north of the extended centreline by approximately 12° which creates a route to the expected network joining point and ensures containment within controlled airspace. The assessment of the route identifies that a PDG of less than 6% is required for both 23L/23R to achieve 3,500ft (the required vertical separation) at the 4.2nm buffer zone therefore aligning this option with the design principles Safety and Policy. Initially, a route south of the buffer line was considered to achieve the satisfactory lateral separation; however, this would not offer great flexibility to design options within this envelope, and so a route that achieved the required 1,000ft vertical separation was investigated. **23L:** After departure, the route makes an RF turn to the right 1nm from DER which takes it just to the north of Knutsford. It then turns left and then right to return the route north of the extended runway centreline where it combines with the option for 23R. It continues just to the south of Northwich and north of Winsford and terminates at 7,000ft south of Kelsall. **23R:** After departure, the route makes an RF turn to the right which takes it just to the north of Knutsford. It then turns left and then right to return the route north of the extended runway centreline where it combines with the option for 23L. It continues to the south of Northwich and north of Winsford and terminates at 7,000ft just south of Kelsall. A speed restriction of 190 KIAS is applied to the first turn, 210 KIAS to the second turn and 250 KIAS thereafter.	**Feedback**: Responds to stakeholder feedback and bilateral discussions with LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Policy**: Has been designed to minimise the interaction with arrivals to LPL. **Emissions**: There is a reduction in track miles to join the network compared to the current KUXEM SID. This makes it a more fuel-efficient route. **Capacity**: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford.



Option	Distance to 4.2NM Liverpool Offset	PDG (%) to 3500ft
8 23L	17802.0406	5.65%
8 23R	19768.2836	5.06%

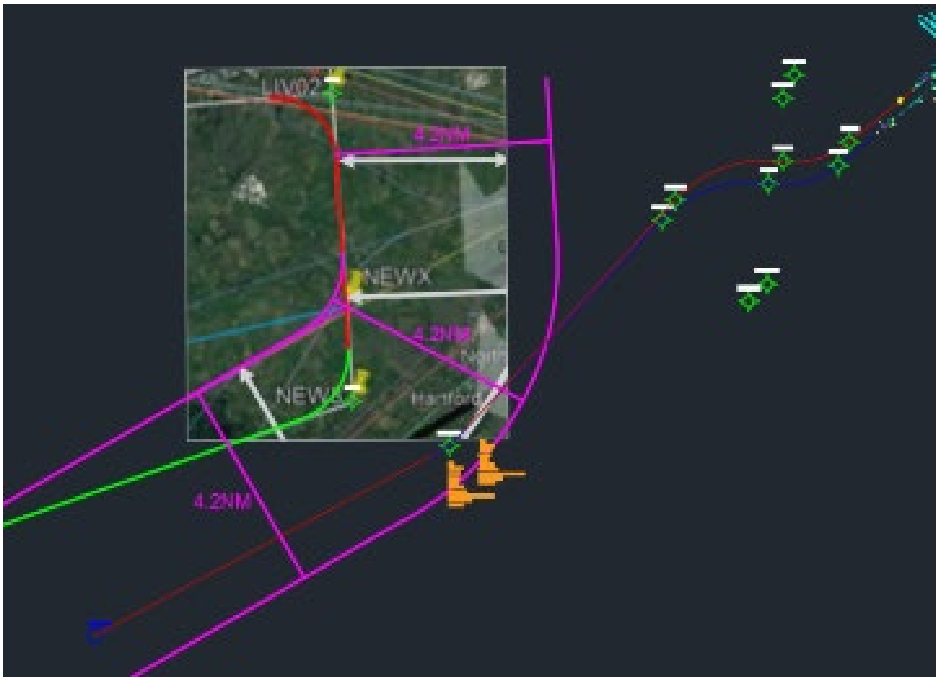
The expected altitude at 4.2nm offset at 6% climb 23L = 3707ft 23R = 4108ft





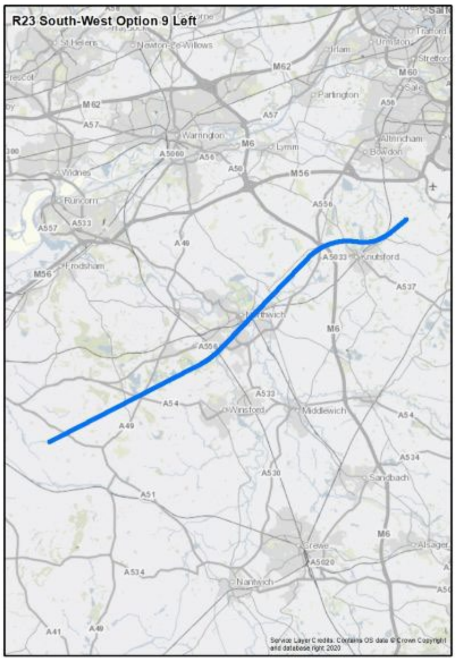
17.18. Runways 23L/23R South-west Option 9

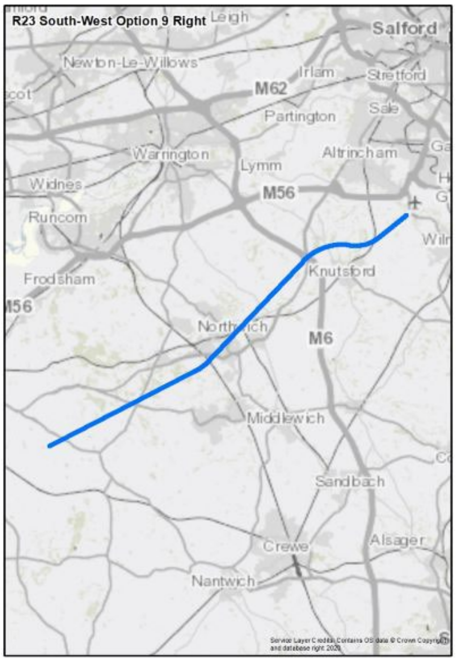
Description	Rationale for inclusion
This is as an alternative **RNP1** with RF coding option to the current KUXEM SID that aims to minimise the interactions with the proposed LPL Runway 27 VEGUN arrival route from the south. This option has been assessed against a 4.2nm buffer from this arrival route in line with minimum radar separation criteria of 3nm plus a buffer of 1.2nm (in line with CAP1385) and seeks to resolve the interaction using vertical separation. This option uses an RNP1 RF turn initially (1nm DER for Runway 23L) to make a kink around Knutsford, but then routes directly to the south-west after making the second turn. This track results in the need for a higher climb gradient on this option compared to option 8. The assessment of the route identifies a required PDG of 5.98% for 23R and 6.74% for Runway 23L to achieve 3,500ft (the required vertical separation) at the 4.2nm buffer zone. It terminates in the same position as option 8 to align to the expected network joining point and ensure containment within controlled airspace. The procedure uses radius-to-fix coding. Initially, a route south of the buffer line was considered to achieve the satisfactory lateral separation; however, this would not offer great flexibility to design options within this envelope, and so a route that achieved the required 1,000ft vertical separation was investigated. **23L:** After departure, the route makes an RF turn to the right 1nm from DER which takes it just to the north of Knutsford. It then turns left onto a direct track to the south-west which takes the route overhead Northwich after which it combines with the option for 23R. It then makes a slight right turn to head south-west and terminates at 7,000ft south of Kelsall. **23R:** After departure, the route makes an RF turn to the which takes it just to the north of Knutsford. It then turns left and then right to return the route north of the extended runway centreline where it combines with the option for 23L. It continues to the south of Northwich after which it combines with the option for 23L. It then makes a slight right turn to head south-west and terminates at 7,000ft south of Kelsall. A speed restriction of 190 KIAS is applied to the first turn, 210 KIAS to the second turn and 250 KIAS thereafter.	**Feedback**: Responds to stakeholder feedback and bilateral discussions with LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Policy**: Has been designed to minimise the interaction with arrivals to LPL. **Emissions**: There is a reduction in track miles to join the network compared to the current KUXEM SID. This makes it a more fuel-efficient route. **Capacity**: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford.



Option	Distance to 4.2NM Liverpool Offset	PDG (%) to 3500ft
9 23L	14904.3589	6.74%
9 23R	16743.7731	5.98%

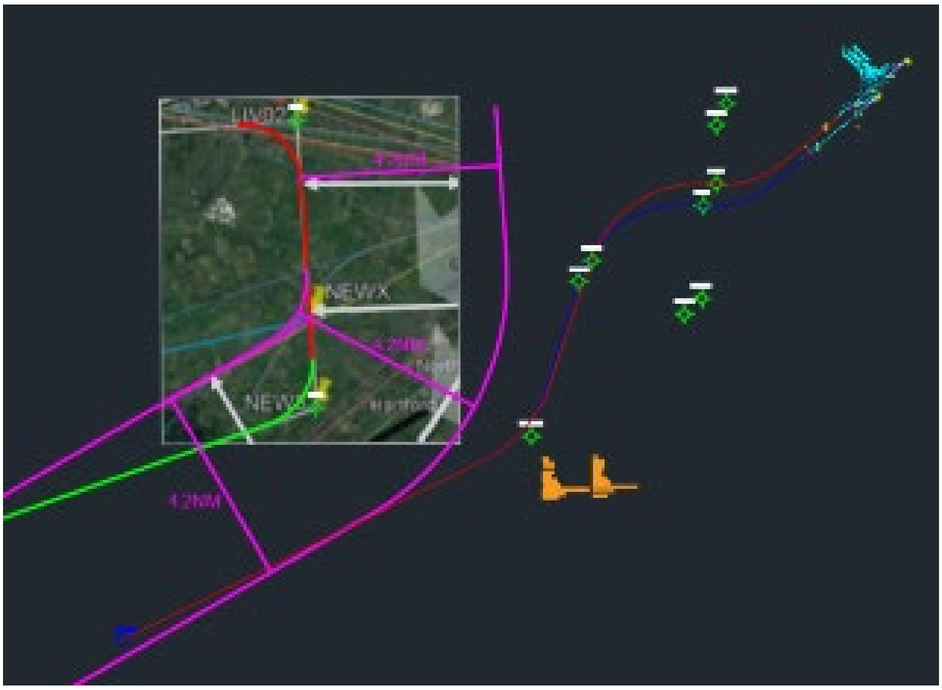
The expected altitude at 4.2nm offset at 6% climb 23L = 3137ft 23R = 3513ft





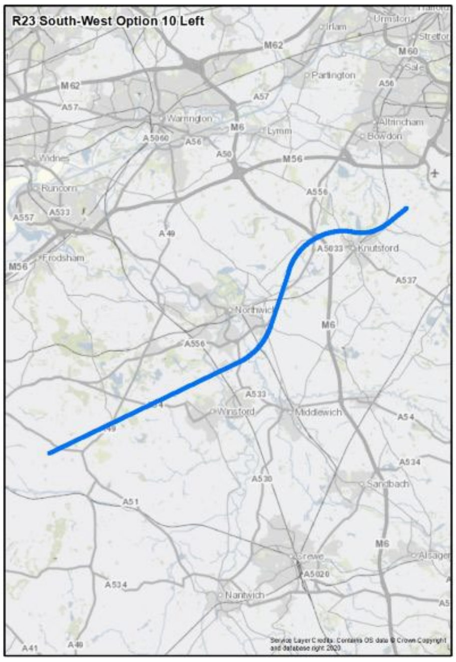
17.19. Runways 23L/23R South-west Option 10

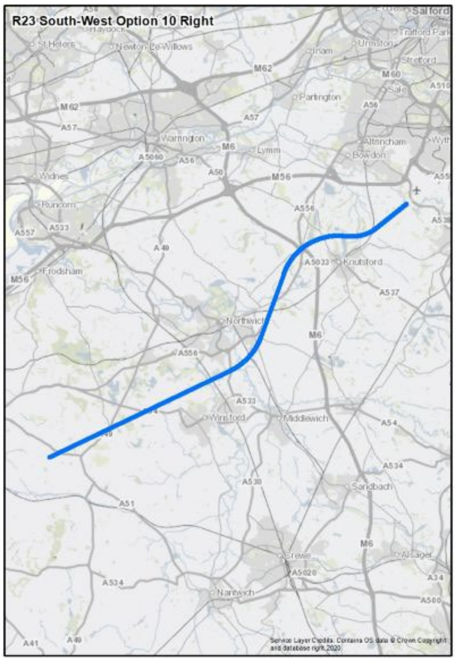
Description	Rationale for inclusion
This is as an **RNP1** option with RF coding as an alternative to the current KUXEM SID. It aims to minimise the interactions with the proposed LPL Runway 27 VEGUN arrival route from the south following stakeholder feedback It is similar to option 8 but routes further south after Knutsford to reduce noise impact on Northwich. This option has been assessed against a 4.2nm buffer from this arrival route in line with minimum radar separation criteria of 3nm plus a buffer of 1.2nm (in line with CAP1385) and seeks to resolve the interaction using vertical separation. This option uses an RNP1 RF turn initially (1nm DER for Runway 23L) to make a kink around Knutsford before tracking back north of the extended runway centreline. This is like other options, but the radius of the turn is shorter and the subsequent track to the south is longer to create an option that fully avoids Northwich. The assessment of the route identifies that a PDG of less than 6% is required for both 23L/23R to achieve 3,500ft at the 4.2nm buffer zone. The procedure uses radius-to-fix coding, and the climb gradient has been set at 6%. **23L:** After departure, the route makes an RF turn to the right 1nm from DER which takes it just to the north of Knutsford. It then turns left and routes south of Northwich where it combines with the option for 23R. It then turns left and routes to the south-west and terminates at 7,000ft south of Kelsall. **23R:** After departure, the route makes an RF turn to the right which takes it just to the north of Knutsford. It then turns left and routes south of Northwich where it combines with the option for 23L. It then turns left and routes to the south-west and terminates at 7,000ft south of Kelsall. A speed restriction of 190 KIAS is applied to the first turn, 210 KIAS to the second turn and 250 KIAS thereafter.	**Feedback:** Responds to stakeholder feedback and bilateral discussions with LPL. **Policy**: Has been designed to minimise the interaction with arrivals to LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: There is a reduction in track miles to join the network compared to the current KUXEM SID as it routes to the south-west at an earlier position. This makes it a more fuel-efficient route. **Capacity**: Has the potential to aid departure utilisation and separation when operated in association with other north and southbound options. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and Northwich.



Option	Distance to 4.2NM Liverpool Offset	PDG (%) to 3500ft
10 23L	24081.2951	4.17%
10 23R	26034.8275	3.84%

Expected alt at 4.2nm offset at 6% climb 23L = 4944ft 23R = 5342ft





17.20. Runways 23L/23R South-west Viable but Poor Fit Options

Option	Safety	Policy	Capacity
A11 Replicate the current KUXEM SID but with a termination point further south.	S	P	C
Originally designed as **option 4A**, this followed the initial tracks of the KUXEM SID and then routed more directly to the south-west on a track towards Whitchurch and Shrewsbury. Safety: This would route aircraft on a trajectory where there is no Controlled Airspace (CAS).			
B12: Route south-west earlier after departure.	S	P	C
Routes could turn left off departure and then route more south westerly (to provide a more direct route) shortly after departure to track between Winsford and Sandbach. Safety: However; a line between the MCT VOR and NANTI classifies a NERL sector boundary with traffic routing in the opposite direction to this departure. Flying in the opposite direction would not align with the Design Principle Safety.			
C13 Left-hand wraparound	S	P	C
After departure from Runways 23L/23R, aircraft would make a left-hand turn, fly around the airport and route back through the overhead then begin heading south-west towards the SID aiming point. Safety: This option would interact with other departure/arrival envelopes to the south requiring additional tactical mitigation to safely manage the flow of air traffic. Policy: This option involves greater track mileage than is necessary by taking traffic west before turning it east, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Additionally, this option may hinder CDAs for arriving aircraft from the south. Capacity: This option would interact with 23L/23R arrivals from the south and departures in the 23 East Design Envelope, both of which are likely to lead to a restriction in the ability to make best use of runway capacity. In addition, this option does not support one-minute splits between northbound and eastbound departures.			
D14 Right-hand wraparound.	S	P	C
After departure from Runways 23L/23R, aircraft would make a right-hand turn, fly around the airport and through the overhead and then begin heading south-west towards the SID aiming point. Safety: This option would interact with the 23 North and 23 East Design Envelopes and the arrivals from the north. This would require additional tactical mitigation to safely manage the flow of air traffic. Furthermore, this option is expected to conflict with the Runway 23R MAP. Policy: This option involves significantly greater track mileage than is necessary by taking traffic north and east before turning it south-west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Additionally, this option may hinder CDAs for arriving aircraft.			

Capacity: This option is likely to interact with 23L/23R arrivals from the north which is likely to lead to a restriction in the ability to make best use of runway capacity. In addition, this option does not support one-minute splits between northbound and eastbound departures.			
E15: Slight right turn after departure, then south-west.	S	P	C
After departure from Runways 23L/23R, aircraft would make a slight right-hand turn in a westerly direction, towards LPL before heading south-west, towards the SID aiming point. Safety: This option is expected to interact with LPL airspace and LPL arrivals from the north and possibly departures from LPL Runway 09. It would require tactical intervention rather than using a systemised approach.			
F16 Left turn after departure, head direct south then turn west	S	P	C
After departure from Runways 23L/23R, aircraft would make a left-hand turn and fly south towards Chelford before making a right-hand turn, south-west, towards the SID aiming point. Safety: There is not expected to be any non-compliances in terms of the Design Principle Safety. Policy: This option involves greater track mileage than is necessary by taking traffic south before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS. Capacity: This option would interact with departures in the south envelope, which would limit the ability to achieve one minute departure splits and not enabling best use of runway capacity.			

18.SID Runway 23L/23R – West Operations

18.1. Introduction to 23L/23R West Design Envelope

This is a new envelope created for traffic routing to the west from Runways 23L/23R. It is based around current operations where aircraft routing to the west via an EKLAD departure are vectored off the SID once they are above 3,000ft. This takes them on a more direct track to the west towards the Wallasey DVOR (WAL) which is done to reduce fuel burn.

The design options seek to align with;

- This current operational practice,
- Feedback received within Stage 2 engagement
- The ACOG facilitated collaborative design review with technical experts from LPL, MAN and NERL as detailed in section 5.11.

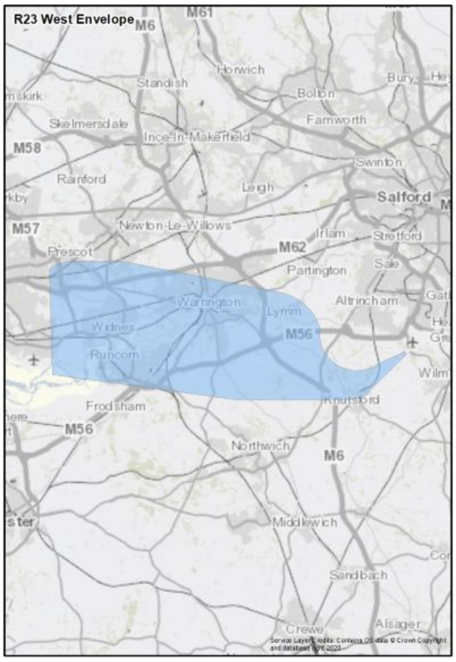
The meeting identified a number of design interactions and considerations which were also reflected in the LPL feedback to the engagement at MAN.

The combination of the engagement feedback from LPL and the interactions discussed at this meeting were then used in the development of modified design options 7 to 12 within this envelope. These have been designed with initially higher climb gradients than the other routes to provide options with vertical separation from current LPL airspace.

Because this is a new envelope, there is no 'do minimum' option.

All options terminate at 7,000ft, at a letterbox which is 4.5nm wide (2.25nm either side of the nominal track). A minimum climb gradient of 6% is used to determine the point at which 7,000ft is achieved on options 1-6. A SID specific climb gradient is used on options 7-12, but which seeks to create an average of 6% over the duration for the SID.

18.2. Design Envelope Location Map



18.3. Runways 23L/23R West Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
2	This is an RNAV1 option which provides an initial climb out to a fly-over waypoint and then a right turn to route north of Knutsford and direct towards Wallasey. 210 KIAS	A1	Extended straight ahead then route to WAL.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for noncompliance. This safety justification includes options where the first turn is less than PANS-OPS recommended distance in relation to the DER, but which is operated safely under current operations. Unviable options are those that are non-compliant with PANS-OPS in relation to: • MSD. • Position of the first turn in relation to DER if it is less than the current position within conventional procedures. • Turn radius based on speed, altitude and climb gradient. These options have not been designed and are not described further within this comprehensive list of design options.

3B	This is an RNAV1 option that aims to mimic the tracks taken by aircraft once they have been taken off the EKLAD SID by ATC. It provides an initial replication of the current EKLAD 1R SID, but aircraft then turn right to head north-west when north of Northwich. **This option has a turn point less than 1nm to replicate the existing MCT D3.2 marker.* 200 KIAS	B13	Combined replication of EKLAD and KUXEM.		
4	This is option is an RNP1 option with an RF turn that routes north of Knutsford and then direct towards Wallasey. 190 KIAS	C14	Left-hand wraparound.		
5A	This is an RNP1 option with an RF turn that routes north of Knutsford and then direct towards Wallasey. It is slightly further north than option 4 to route north of LPL but below the current MIRSI hold for MAN. 220 KIAS	D15	Right-hand wraparound.		
5B	This is an RNP1 option with an RF turn like option 5A, except that the turn point for Runway 23L is closer to the DER. This results in a route slightly further north of Knutsford with a route that is then direct towards Wallasey 220 KIAS				

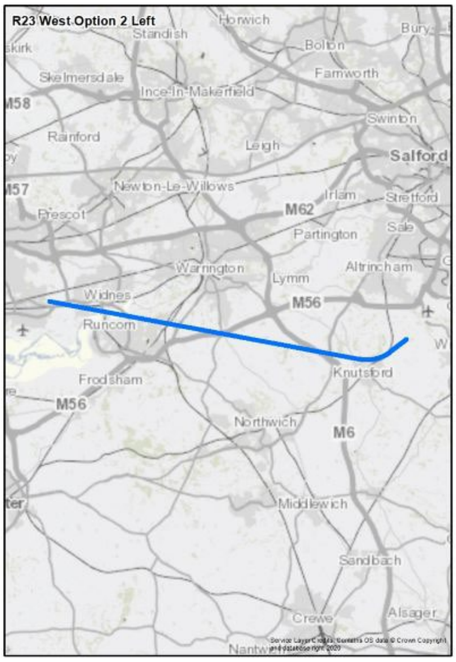
6	This is an RNP1 option with an RF turn that initially routes north before making a left turn direct to Wallasey. 210 KIAS				
7	This is an RNAV1 option that modifies option 2 to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 2 but has an increased climb gradient of 11.64% (Runway 23L) and 9.81% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 2. 210 KIAS				
8	This is an RNAV1 option that modifies option 3B to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 3B but has an increased climb gradient of 12.1% (Runway 23L) and 10.3% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 3B. 200 KIAS				

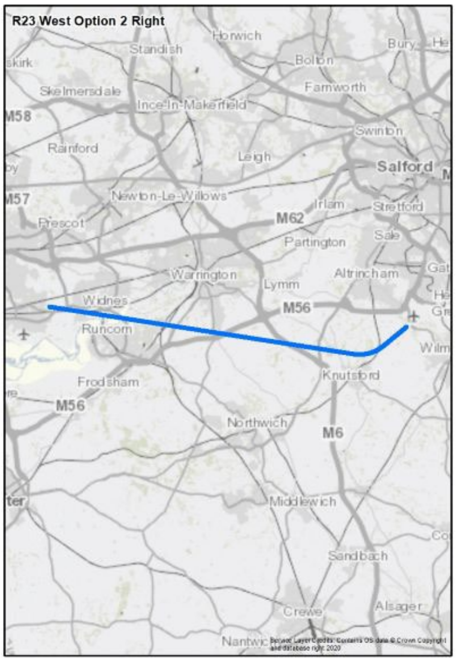
9	This is an RNAV1 option that modifies option 4 to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 4 but has an increased climb gradient of 11.7% (Runway 23L) and 9.9% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 4. 190 KIAS				
10	This is an RNAV1 option that modifies option 5A to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 5A but has an increased climb gradient of 11.3% (Runway 23L) and 9.7% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 5A. 220 KIAS				

11	This is an RNAV1 option that modifies option 5B to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 5B but has an increased climb gradient of 11.5% (Runway 23L) and 9.7% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 5B. 220 KIAS				
12	This is an RNAV1 option that modifies option 6 to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 6 but has an increased climb gradient of 11% (Runway 23L) and 8.9% (Runway 23R) up to the point the LPL delegated airspace buffer zone is overflown. Thereafter the gradient is reduced to terminate in the same location as option 6. 190 KIAS				

18.4. Runways 23L/23R West Option 2

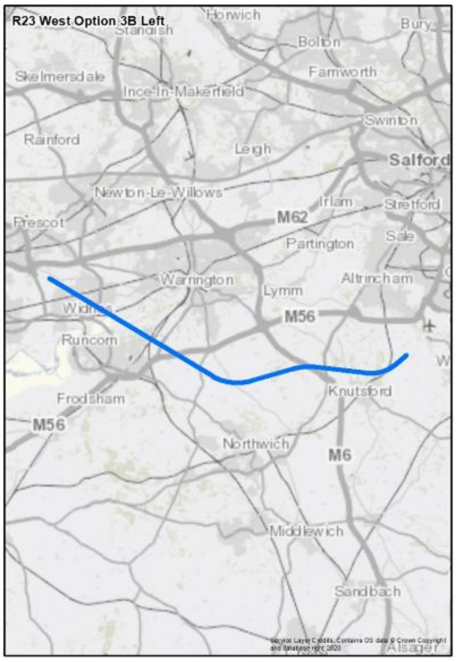
Description	Rationale for inclusion
Option 2 is an **RNAV1** option which provides an initial climb out to a fly-over waypoint and then a right turn to route north of Knutsford and direct towards Wallasey. It has been created to provide the most direct (fuel-efficient) route to the network joining point for westbound traffic at Wallasey. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The climb gradient has been set at 6% to design the envelope. **23L:** After departure, the route makes a turn to the right 1nm from DER which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington passing south of Widnes and north of Runcorn and terminates at 7,000ft to the south-east of Liverpool. **23R:** Similar to option for 23L, this route makes a right turn following take-off to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and passes south of Widnes and north of Runcorn and terminates at 7,000ft to the south-east of Liverpool. An element of dispersion would be apparent in the turn due to the fly-over waypoint and either CF or DF coding. A speed restriction of 210 KIAS is applied to the first turn.	**Technology**: RNAV is the lowest PBN specification and therefore usable by all aircraft. **Emissions**: This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. The design speed may permit some aircraft to fly this route in a clean configuration which has potential to reduce noise impact. **Noise N2**: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.

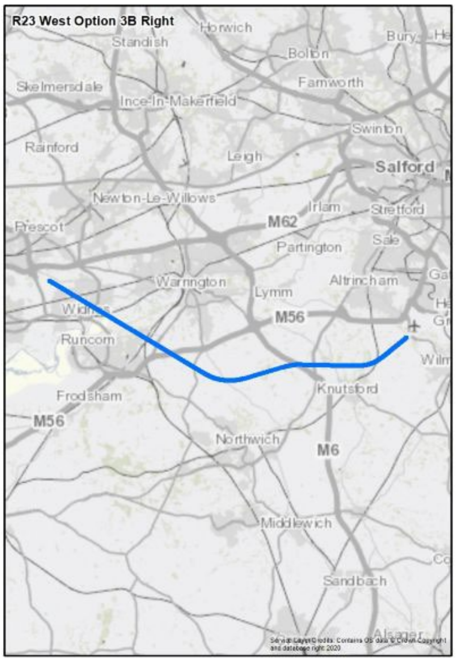




18.5. Runways 23L/23R West Option 3B

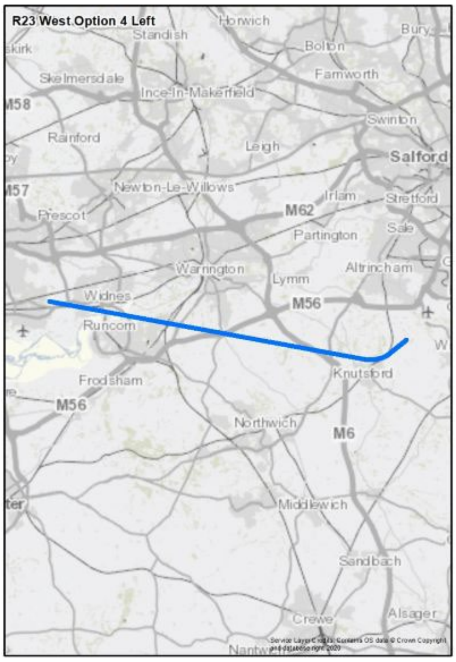
Description	Rationale for inclusion
This is an **RNAV1** option that aims to mimic the tracks taken by aircraft once they have been vectored off the EKLAD SID by ATC. This is done on the existing westerly SIDs once they have reached 3,000ft and so this option formalises the vectored routes flown today. The procedure uses a fly-over to fly-by sequence and the climb gradient has been set at 6%. The fly-over waypoints are positioned to replicate the turn at the existing MCT D3 and D3.2 markers. **23L:** After departure, the route makes a turn to the right at 0.7nm from DER which replicates the turn of the current EKLAD procedure and therefore aligns to the Design Principle Safety. It continues to replicate the EKLAD SID through Mere to the north of Knutsford and Northwich at which point it turns right onto a westerly heading which takes it overhead Widnes where it terminates at 7,000ft. **23R:** After departure, the route makes a turn to the right at 1nm from DER and replicates the track of the current EKLAD SID through Mere to the north of Knutsford where it combines with the route for 23L. It then routes north of Northwich at which point it turns right onto a westerly heading which takes it overhead Widnes where it terminates at 7,000ft An element of dispersion would be apparent in the turn due to the fly-over waypoint and either CF or DF coding. A speed restriction of 200 KIAS then 250 KIAS is used for the first turn and second turn.	**Technology:** RNAV is the lowest PBN specification and therefore usable by all aircraft. **Noise N1:** The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. **Noise N2:** The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.

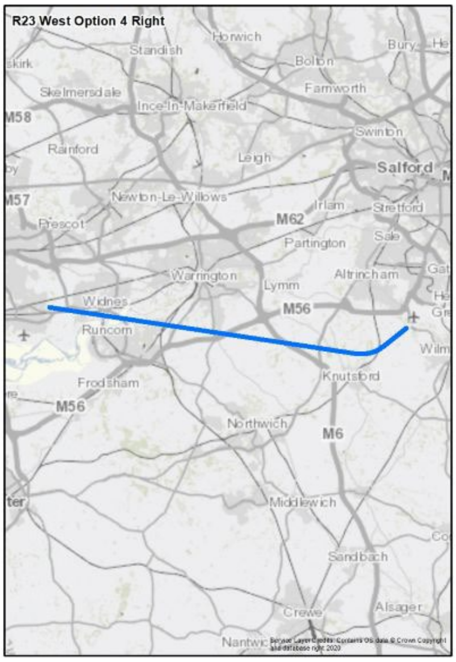




18.6. Runways 23L/23R West Option 4

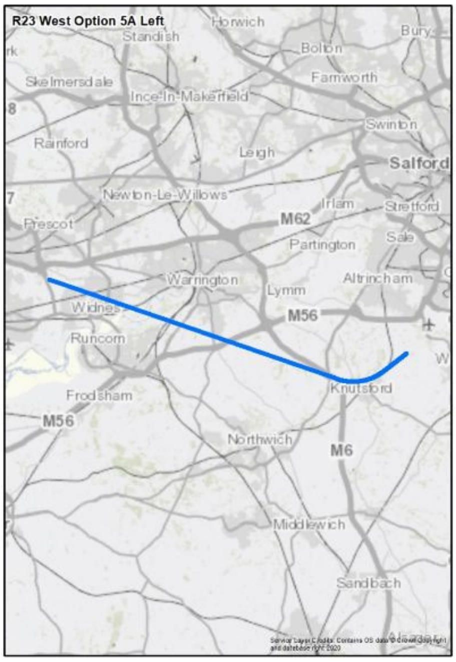
Description	Rationale for inclusion
This is option is an **RNP1** option with an RF turn that routes north of Knutsford and then direct towards Wallasey. It has been created to provide a direct (fuel-efficient) route to the network joining point for westbound traffic at Wallasey. It has an almost identical track across the ground as option 2 but to a higher navigation standard to provide more accurate track keeping. The climb gradient is set at 6%. **23L:** After departure, the route makes a turn to the right 1nm from DER which takes it just to the north of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington passes south of Widnes and north of Runcorn and terminates at 7,000ft to the south-east of Liverpool. **23R:** Similar to option for 23L, this route makes a turn to the right which takes it just to the north of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington passes south of Widnes and north of Runcorn and terminates at 7,000ft to the south-east of Liverpool. A speed restriction of 190 KIAS is used for the first turn, thereafter 250 KIAS would apply. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions:** This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1:** The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington.

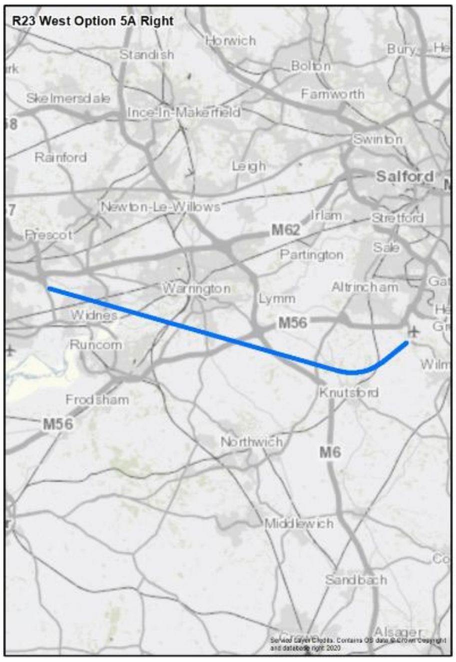




18.7. Runways 23L/23R West Option 5A

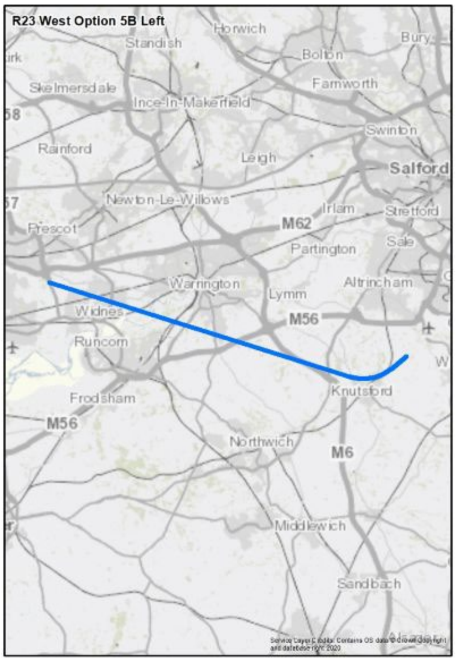
Description	Rationale for inclusion
This is an **RNP1** option with an RF turn that routes north of Knutsford and then direct towards Wallasey. It is slightly further north than option 4 to route north of LPL and below the current MIRSI hold for MAN. It has been created to provide a direct (fuel-efficient) route to the network joining point for westbound traffic at Wallasey. The design speed will permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. The climb gradient is set at 6%. **23L:** After departure, the route makes a turn to the right at 1nm from DER which takes it just to the north of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. **23R:** After departure, the route makes a turn to the right which takes it over the northern edge of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. A speed restriction of 220 KIAS is used for the first turn, thereafter 250 KIAS would apply.	**Technology:** Procedure uses latest technology (RNP+RF). **Emissions:** This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1:** The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

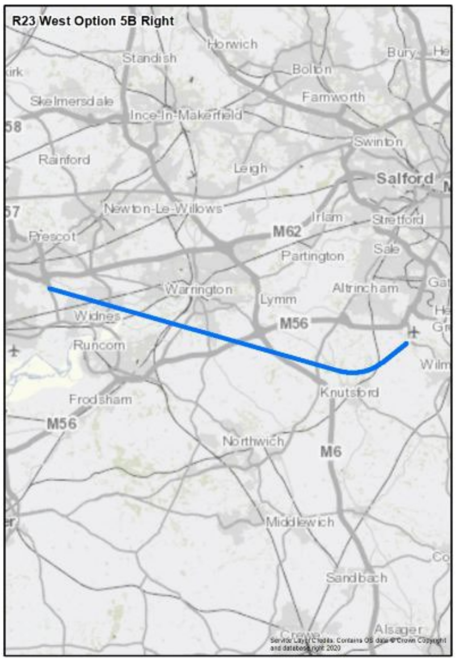




18.8. Runways 23L/23R West Option 5B

Description	Rationale for inclusion
This is an **RNP1** option with an RF turn like option 5A, except that the turn point for Runway 23L is closer to the DER to increase the separation from Knutsford. It has been created to provide a direct (fuel-efficient) route to the network joining point for westbound traffic at Wallasey but with greater emphasis on limiting noise. This earlier turn results in a track for 23L that is slightly further north than option 5A. The design speed will permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L:** After departure, the route makes a turn to the right at 1nm from DER which takes it to the north of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. **23R:** After departure, the route makes a turn to the right which takes it just to the north of Knutsford. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. A speed restriction of 220 KIAS is used for the first turn, thereafter 250 KIAS would apply.	**Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.





18.9. Runways 23L/23R West Option 6

Description

This is an **RNP1** option with an RF turn that initially routes north before making a left turn direct to Wallasey. It has been created as an option that seeks to deconflict MAN westbound departures from traffic to and LPL. This is achieved through an initial north bound route to gain altitude, before turning left towards the network joining point at Wallasey.

The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

The procedure uses RF coding, and the climb gradient has been set at 6%.

23L: After departure, the route makes a turn to the right at 1nm from DER which takes it to the north of Knutsford through Mere. It then heads north on a short straight segment before making a left turn to the west, just to the north of Lymm where it combines with the option from 23R. The combined routes continue in a westerly direction routing overhead Warrington and terminate at 7,000ft just north of Widnes.

23R: After departure, the route makes a turn to the right which takes it to the north of Knutsford through Mere. It then heads north on a short straight segment before making a left turn to the west, just to the north of Lymm where it combines with the option from 23L. The combined routes continue in a westerly direction routing overhead Warrington and terminate at 7,000ft just north of Widnes.

A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.

Rationale for inclusion

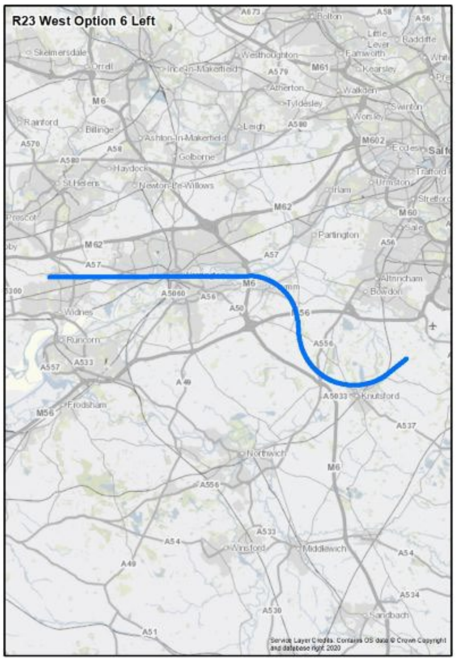
Technology: Procedure uses latest technology (RNP+RF).

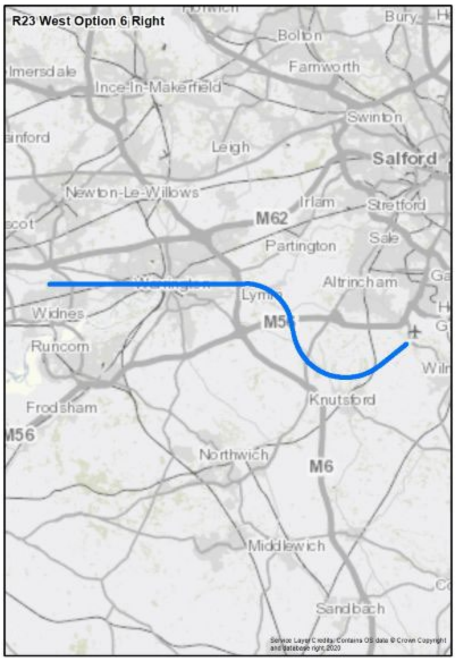
Policy: Has been designed to reduce the interaction with LPL in line with CAP1711 Airspace Modernisation Strategy.

Capacity: Has the potential to reduce departure delays and ATC intervention by reducing the interaction with LPL.

Noise N1: The route has potential to reduce noise impact by avoiding Knutsford.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.





18.10. Runways 23L/23R West Option 7

Description

This is an RNAV1 option that modifies option 2 to minimise the interactions with LPL airspace following stakeholder feedback.

It provides an initial climb out to a fly-over waypoint and then a right turn to route north of Knutsford and direct towards Wallasey to align with current operational practice. It follows the same lateral track as option 2 but following stakeholder feedback to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same location as option 2, which has been designed to a constant 6% gradient.

The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward.

The initial climb gradient has been set at 11.64% for 23L / 9.81% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace. Thereafter a maximum climb gradient of 4.2% is applied to terminate at 7,000ft at the same end position as option 2. Waypoints will be placed at the location of the 3nm boundary to specify that an altitude of 'at or above 3,500ft' is required to ensure safe separation.

The design speed may allow aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise.

23L: After departure, the route makes a turn to the right 1nm from DER which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft to the south-east of Liverpool.

23R: Similar to option for 23L, this route makes a right turn following take-off to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft to the south-east of Liverpool.

An element of dispersion would be apparent in the turn due to the fly-over waypoint and either CF or DF coding.

A speed restriction of 210 KIAS is applied to the first turn.

Rationale for inclusion

Feedback: A modification of route 2 that responds to stakeholder feedback and bilateral discussions with LPL.

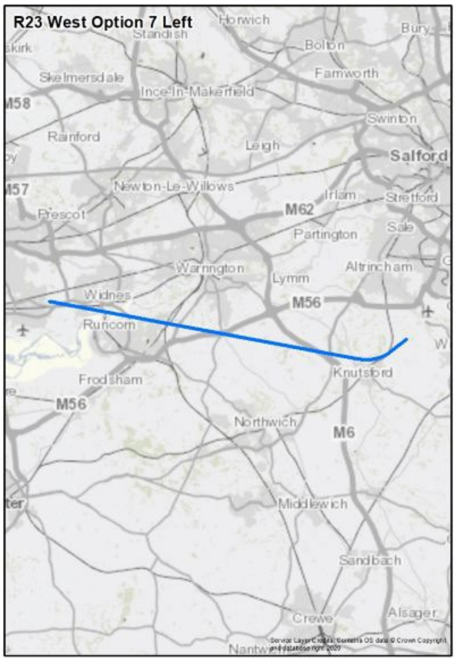
Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft.

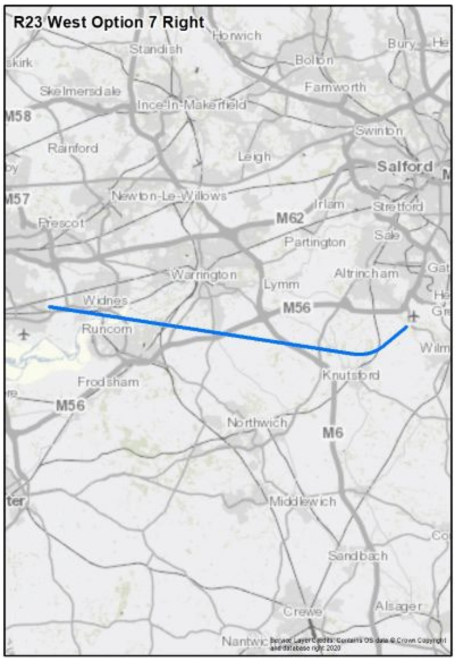
Policy: Has been designed to minimise the interaction with arrivals to LPL.

Emissions: This provides a direct routing and reduced track miles to the network joining point when compared to the current route being used.

Noise N1: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington.

The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

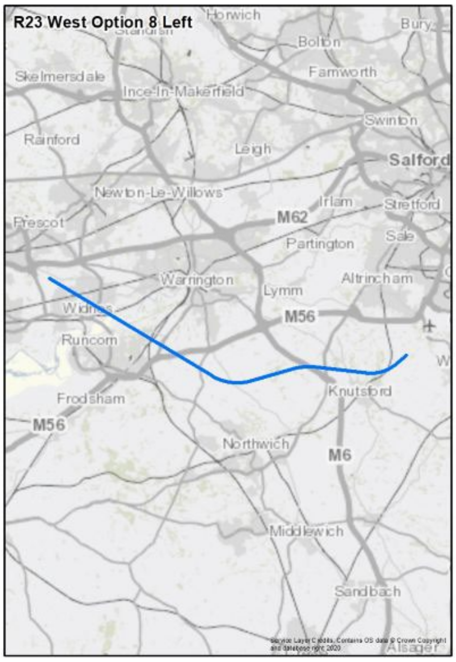

R23 West Option 7 Left
Horwich
Standish
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
M58
Swinton
Rainford
Leigh
Salford
M57
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Sale
Partington
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Crewe
Alsager

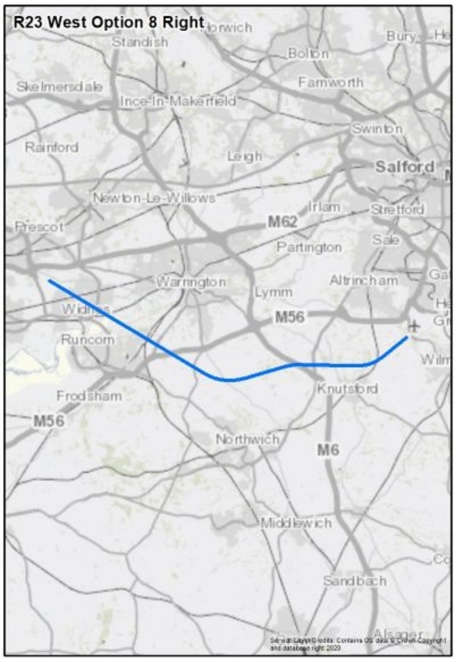

R23 West Option 7 Right
Horwich
Standish
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
M58
Swinton
Rainford
Leigh
Salford
M57
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Sale
Partington
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Crewe
Alsager
Nantwich

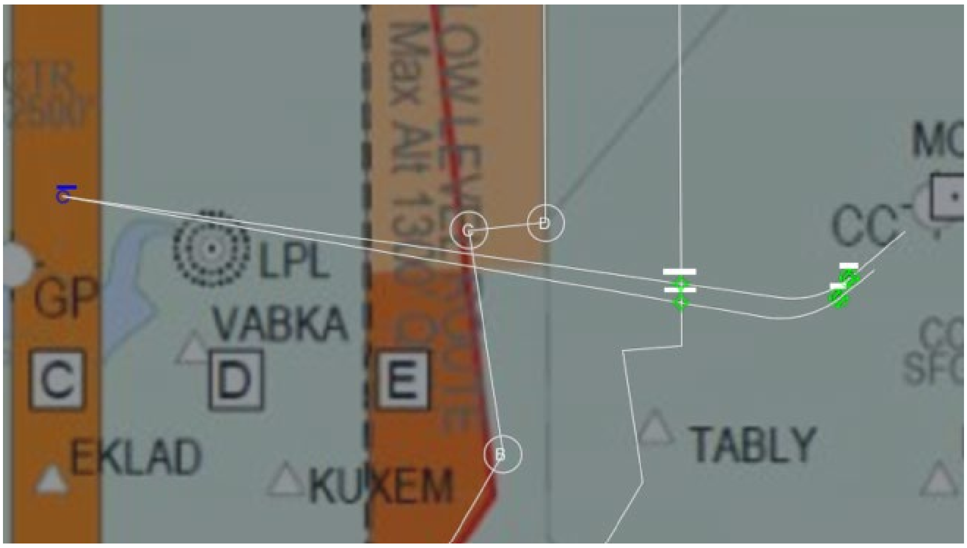

C
D

18.11. Runways 23L/23R West Option 8

Description	Rationale for inclusion
This is an RNAV1 option that modifies option 3B to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 3B but following stakeholder feedback to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same location as option 3B. The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward. The initial climb gradient has been set at 12.1% for 23L / 10.3% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace. Thereafter a maximum climb gradient of 3.7% is applied to terminate at 7,000ft at the same end position as option 3B. As the option is within a turn segment at the location of the airspace boundary, a waypoint cannot be placed on the intersection of the nominal track and the boundary. A restriction greater than 3,500 ft would need to be placed upon the second waypoint to follow the profile of the required climb to ensure that the correct altitude is met at the boundary. 23L: After departure, the route makes a turn to the right at 0.7nm from DER which replicates the turn of the current EKLAD procedure and therefore aligns to the Design Principle Safety. It continues to replicate the EKLAD SID to the north of Knutsford through Mere and passes north of Northwich at which point it turns right onto a westerly heading which takes it overhead Widnes where it terminates at 7,000ft. 23R: After departure, the route makes a turn to the right and replicates the track of the current EKLAD SID to the north of Knutsford through Mere where it combines with the route for 23L. It then routes north of Northwich at which point it turns right onto a westerly heading which takes it overhead Widnes where it terminates at 7,000ft An element of dispersion would be apparent in the turn due to the fly-over waypoint and either CF or DF coding. A speed restriction of 200 KIAS then 250 KIAS is used for the first turn and second turn.	Feedback: A modification of route 3B that responds to stakeholder feedback and bilateral discussions with LPL. Technology: RNAV is the lowest PBN specification and therefore usable by all aircraft. Noise N1: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. Noise N2: The turn would have an element of dispersion, which is consistent with Design Principle Noise N2.

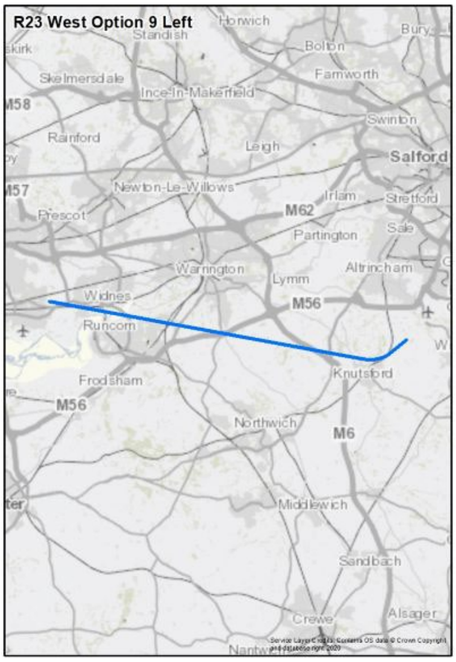

R23 West Option 8 Left
Horwich
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Partington
Sale
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Alsager

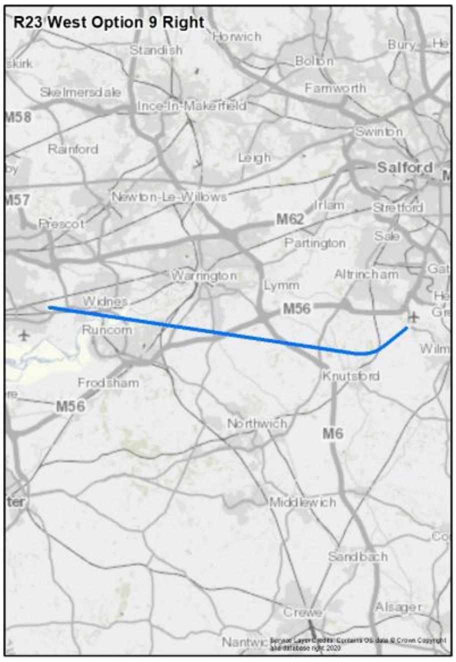

R23 West Option 8 Right
Standish
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Partington
Sale
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach


LPL
VABKA
GP
C
D
E
EKLAD
KUXEM
TABLY
Max Alt 13

18.12. Runways 23L/23R West Option 9

Description	Rationale for inclusion
This is an **RNP1** option that modifies option 4 to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 4 but following stakeholder feedback to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same location as option 4. It has an almost identical track across the ground as option 2 but to a higher navigation standard to provide more accurate track keeping. The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward. The initial climb gradient has been set at 11.7% for 23L / 9.9% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace. Thereafter a maximum climb gradient of 4.2% is applied to terminate at 7,000ft at the same end position as option 4. Waypoints will be placed at the location of the 3nm boundary to specify that an altitude of 'at or above 3,500ft' is required to ensure safe separation. **23L:** After departure, the route makes a turn to the right 1nm from DER which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft to the south-east of Liverpool. **23R:** Similar to option for 23L, this route makes a turn to the right which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft to the south-east of Liverpool. A speed restriction of 190 KIAS is used for the first turn, thereafter 250 KIAS would apply. Although PANS-OPS compliant it should be assess*ed* for flyability as part of the procedure validation process within Stage 4 of CAP1616.	**Feedback:** A modification of route 4 that responds to stakeholder feedback and bilateral discussions with LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Emissions:** This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1:** The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington.

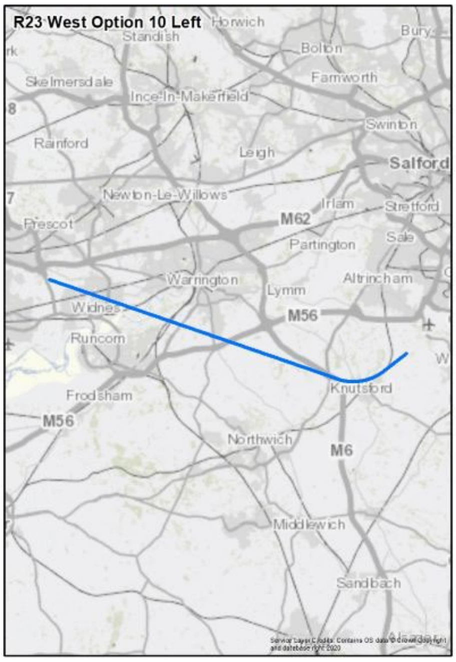

R23 West Option 9 Left
Standish
Horwich
Bolton
Bury
Farnworth
Skelmersdale
Ince-In-Makerfield
M58
Swinton
Rainford
Leigh
Salford
M57
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Sale
Partington
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Crewe
Alsager

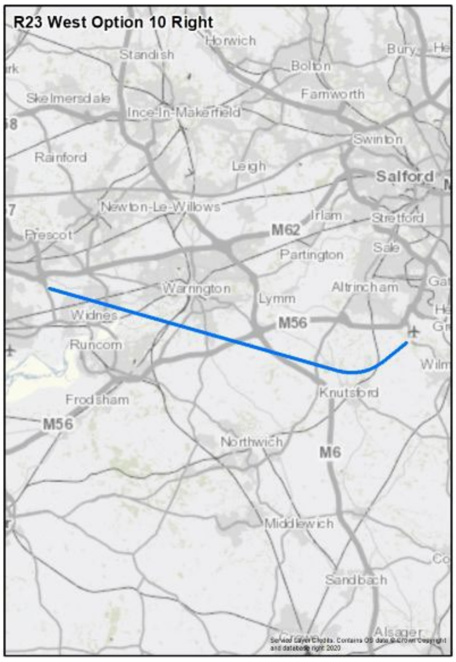

R23 West Option 9 Right
Horwich
Standish
Bolton
Bury
Farnworth
Skelmersdale
Ince-In-Makerfield
M58
Swinton
Rainford
Leigh
Salford
M57
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Sale
Partington
Warrington
Altrincham
Lymm
Widnes
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Crewe
Alsager

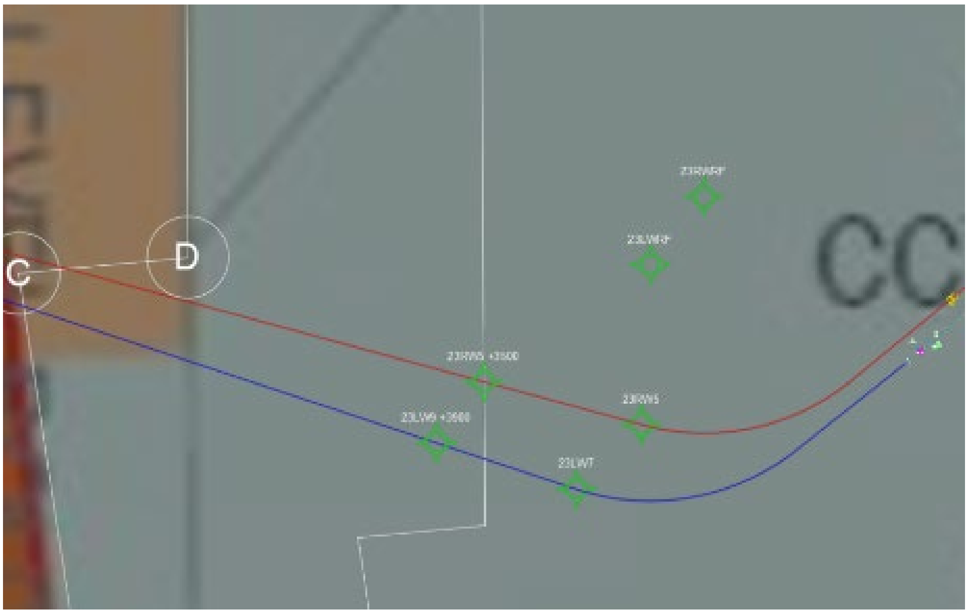

LPL
VABKA
C
D
E
GP
EKLAD
TABLY
CC
B

18.13. Runways 23L/23R West Option 10

Description	Rationale for inclusion
This is an **RNP1** option that modifies option 5A to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 5A with an RF right turn that routes north of Knutsford and then direct towards Wallasey to align with current operational practice. However, to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same position as option 5A, which has been designed to a constant 6% gradient. The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward. The initial climb gradient has been set at 11.3% for 23L / 9.7% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace. Thereafter a maximum climb gradient of 4.2% is applied to terminate at 7,000ft at the same end position as option 5A. Waypoints will be placed at the location of the 3nm boundary to specify that an altitude of 'at or above 3,500ft' is required to ensure safe separation. For 23L, placing a waypoint on this boundary may result in a segment length that is too short between the RF turn and the 3nm boundary (in accordance with PANS-OPS requirements). This could either be assessed in flight validation for FMS anomalies, or the waypoint can be located at the necessary distance from the RF turn and specified with a higher altitude than 3,500ft to follow the profile of the required climb to ensure that the correct altitude is met at the boundary. The route followed by the options is as follows: **23L:** After departure, the route makes a turn to the right at 1nm from DER which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. **23R:** After departure, the route makes a turn to the right which takes it over the northern edge of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. A speed restriction of 220 KIAS is used for the first turn, thereafter 250 KIAS would apply.	**Feedback:** A modification of route 5A that responds to stakeholder feedback and bilateral discussions with LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Policy**: Has been designed to minimise the interaction with arrivals to LPL. **Emissions**: This provides a direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.

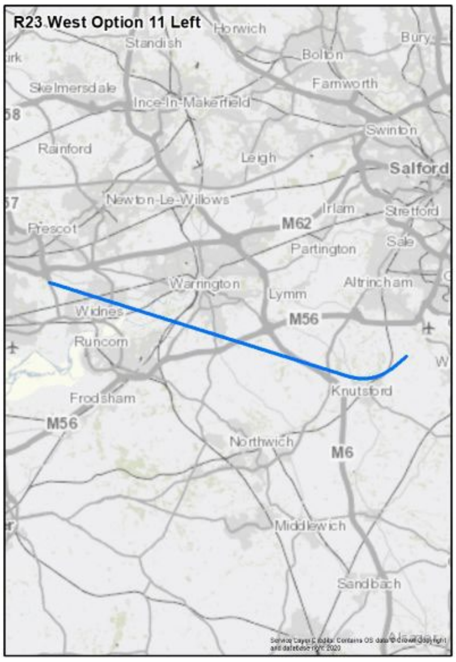

R23 West Option 10 Left
Horwich
Standish
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Partington
Sale
Warrington
Altrincham
Widnes
Lymm
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach

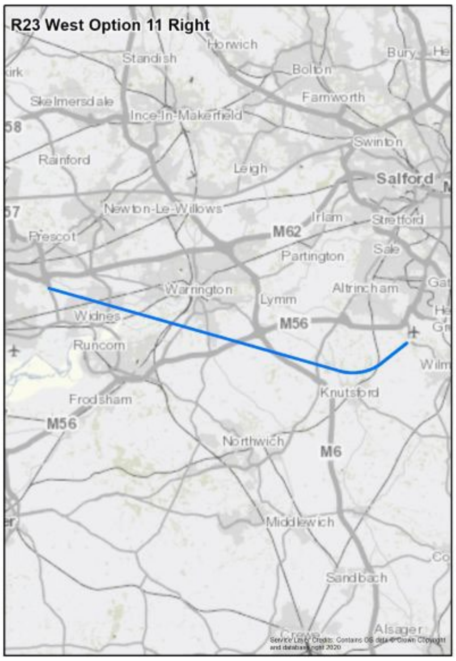

R23 West Option 10 Right
Horwich
Standish
Bury
Bolton
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Stretford
Prescot
M62
Partington
Sale
Warrington
Altrincham
Widnes
Lymm
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Alsager


C
D

18.14. Runways 23L/23R West Option 11

Description	Rationale for inclusion
This is an **RNP1** option that modifies option 5B to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 5B with an RF right turn that routes north of Knutsford and then direct towards Wallasey to align with current operational practice. However, to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same position as option 5B. The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward. The initial climb gradient has been set at 11.5% for 23L / 9.7% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace; thereafter a maximum climb gradient of 4.2% would be required to terminate at 7,000ft at the same end position as option 5B. Waypoints will be placed at the location of the 3nm boundary to specify that an altitude of 'at or above 3,500ft' is required to ensure safe separation. The design speed will permit a larger number of aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L:** After departure, the route makes a turn to the right at 1nm from DER which takes it to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. **23R:** After departure, the route makes a turn to the right which takes it just to the north of Knutsford through Mere. It then heads in a north-westerly direction routing to the south of Warrington and terminates at 7,000ft just west of Widnes. A speed restriction of 220 KIAS is used for the first turn, thereafter 250 KIAS would apply.	**Feedback:** A modification of route 4 that responds to stakeholder feedback and bilateral discussions with LPL. **Technology**: Procedure uses latest technology (RNP+RF). **Emissions**: This provides the most direct routing and reduced track miles to the network joining point when compared to the current route being used. **Noise N1**: The route has potential to reduce noise impact by avoiding Knutsford and avoids the built-up area of Northwich and Warrington. The design speed will allow most aircraft to fly this route in a clean configuration which has potential to reduce noise impact.

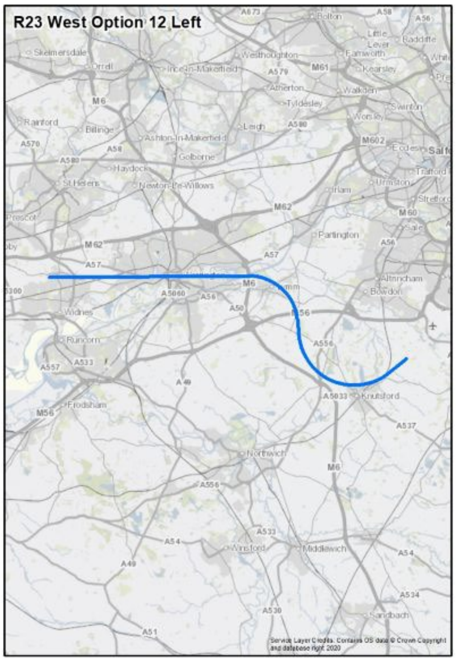

R23 West Option 11 Left
Horwich
Standish
Bolton
Bury
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Prescot
M62
Stretford
Partington
Sale
Warrington
Altrincham
Widnes
Lymm
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach


R23 West Option 11 Right
Horwich
Standish
Bolton
Bury
Skelmersdale
Farnworth
Ince-In-Makerfield
Swinton
Rainford
Leigh
Salford
Newton-Le-Willows
Irlam
Prescot
M62
Stretford
Partington
Sale
Warrington
Altrincham
Widnes
Lymm
M56
Runcorn
Knutsford
Frodsham
M56
Northwich
M6
Middlewich
Sandbach
Alsager


LPL
VABKA
C
D
E
Max Alt 1300
TARLY

18.15. Runways 23L/23R West Option 12

Description	Rationale for inclusion
This is an **RNP1** option that modifies option 6 to minimise the interactions with LPL airspace following stakeholder feedback. It follows the same lateral track as option 6 with an RF right turn that routes north before turning towards Wallasey. However, to eliminate interactions with LPL inbound traffic to Runway 27, it has an increased climb gradient up to the point the LPL delegated airspace is overflown. Thereafter the gradient is reduced to one that will result in the route terminating in the same position as option 6. The initial climb gradient in this option is greater than the 6% to 7,000ft that has been adopted for other routes and which was identified as flyable by all aircraft within the fleet equipage survey at section 5.6. This survey identified that some aircraft could exceed this 6% gradient, and because this initial climb gradient is only required to 3,500ft it will be assessed with the airlines to confirm viability should it be taken forward. The initial climb gradient has been set at 11.0% for 23L/8.9% for 23R for the portion of the SID prior to where the route meets the 3nm buffer of the LPL delegated airspace. Thereafter a maximum climb gradient of 4.4% is applied to terminate at 7,000ft at the same end position as option 6. As the option is within a turn segment at the location of the airspace boundary, a waypoint cannot be placed on the intersection of the nominal track and the boundary. A restriction greater than 3500ft would need to be placed upon the waypoints at the end of the RF turns to follow the profile of the required climb to ensure that the correct altitude is met at the boundary. The design speed aligns to the CAP778 recommendation and may permit some aircraft to fly this route in a clean configuration (without the use of flaps) which has potential benefits in terms of noise. **23L:** After departure, the route makes a turn to the right at 1nm from DER which takes it to the north of Knutsford through Mere. It then heads north on a short straight segment before making a left turn to the west, just to the north of Lymm where it combines with the option from 23R. The combined routes continue in a westerly direction routing overhead Warrington and terminate at 7,000ft just north of Widnes. **23R:** After departure, the route makes a turn to the right which takes it to the north of Knutsford through Mere. It then heads north on a short straight segment before making a left turn to the west, just to the north of Lymm where it combines with the option from 23L. The combined routes continue in a westerly direction routing overhead Warrington and terminate at 7,000ft just north of Widnes. A speed restriction of 210 KIAS is applied to the first turn which is the CAP778 recommended speed.	**Feedback:** A modification of route 4 that responds to stakeholder feedback and bilateral discussions with LPL. **Technology:** Procedure uses latest technology (RNP+RF). **Policy:** Has been designed to reduce the interaction with LPL in line with CAP1711 Airspace Modernisation Strategy. **Capacity:** Has the potential to reduce departure delays and ATC intervention by reducing the interaction with LPL. **Noise N1:** The route has potential to reduce noise impact by avoiding Knutsford. The design speed may allow some aircraft to fly in a more aerodynamic configuration which may reduce noise impact.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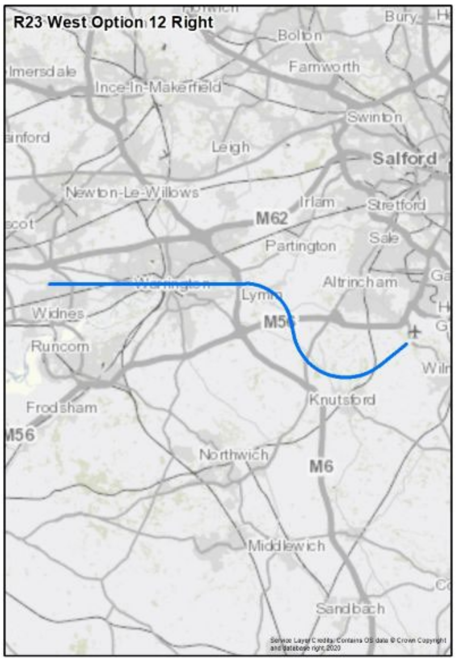

R23 West Option 12 Right
Bury
Bolton
Farnworth
Ince-In-Makerfield
Swinton
Leigh
Salford
Newton-Le-Willows
Irlam
Stretford
M62
Partington
Sale
Altrincham
Widnes
M56
Runcorn
Knutsford
Frodsham
Northwich
M6
Middlewich
Sandbach


LPL
VABKA
D
E

18.16. Runways 23L/23R West Viable but Poor Fit Options

<table>
<tr><th>Option</th><th>Safety</th><th>Policy</th><th>Capacity</th></tr>
<tr><td>A1 Extended straight ahead then route to WAL</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">Originally created as option 1, this seeks to align with current operations that are managed on a tactical basis by ATC. This assures safe separation between flights. In current operations, aircraft route initially south-west (on the EKLAD SID) before being vectored off the SID by ATC towards Wallasey (WAL).

Safety: In a systemised environment, there will be minimal ATC intervention. Because of the proximity of LPL and MAN, a route through this area may create interactions between flights from both airports. This would require additional tactical mitigation to safely manage the flow of air traffic.

Capacity: Creating interactions would limit the ability to enable best use of runway capacity.</td></tr>
<tr><td>B13 Combined replication of EKLAD and KUXEM</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">Originally created as option 3A, this was a combined EKLAD and KUXEM SID which separated close to the termination point.

Safety: This option would create issues with both flight planning and ATC procedures which may have resulted in safety incidents.</td></tr>
<tr><td>C14 Left-hand wraparound</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">After departure from Runways 23L/23R, aircraft would make a left-hand turn, fly around the airport, through the overhead and then begin heading west towards the SID aiming point.

Safety: From a safety perspective, this option would interact with arrivals from the south and would require additional tactical mitigation to safely manage the flow of air traffic.

Policy: This option involves greater track mileage than is necessary by taking traffic east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

Capacity: This option interacts with departures in the north, east and south envelopes, which would limit the ability to enable best use of runway capacity.</td></tr>
<tr><td>D15 Right-hand wraparound</td><td>S</td><td>P</td><td>C</td></tr>
<tr><td colspan="4">After departure from Runways 23L/23R, aircraft would make a right-hand turn, fly around the airport, though the overhead and then begin heading west towards the SID aiming point.

Safety: This option would interact with the 23 North and 23 East Design Envelopes and arrivals from the north requiring additional tactical mitigation to safely manage the flow of air traffic. Furthermore, this option is expected to conflict with the Runway 23R MAP.

Policy: This option involves greater track mileage than is necessary by taking traffic north and east before turning it west, leading to increased fuel burn and emissions which is not aligned to the aims of the AMS.

Capacity: This option would interact with the 23 North and 23 East Design Envelopes, which would limit the ability to enable best use of runway capacity.</td></tr>
</table>

19. Arrivals Designs – Introduction

19.1. Envelope and Design Option Details – Overview

Sections 20 to 36 of the DOR provide a technical overview of the arrivals design envelopes and a description of the design options within them. In line with CAP1616 guidance, the arrivals design options start at 7,000ft and end at the runway.

This section of the DOR contains details of:

- The process followed to create the arrivals design envelopes and design options (19.2).
- The process to create the viable arrivals design area (19.3).
- The design criteria used for CDAs (0).
- The design criteria for intermediate and final approach segments (19.5)
- The arrivals design assumptions and considerations (19.6).
- Details of the engagement with NATS on arrivals structures (19.7).
- The arrivals development strategy beyond this work and into Phase 3a (19.8) .
- Constraints and considerations relating to arrivals (19.9).
- The scope of design of the arrivals (19.10)

Sections 21 to 23 then provide a description of the final approach designs for Runways 05L/05R and sections 30 and 31 provide this description for Runways 23L/23R. These final approaches commence at the Final Approach Fix (FAF).

Sections 24 to 29 for Runways 05L/05R and sections 32 to 36 for Runways 23L/23R then provide details of the comprehensive list of arrivals design options considered with respect to each of the joining points.

These cover the scope of design including a diagram that displays the positions of all IAFs that form the comprehensive list of design options. The IAF is the start of the approach procedure, with an altitude of 7,000ft, to align with our design responsibilities under CAP1616. These sections include a summary of both the 'viable and good fit options' and the 'viable but poor fit' options that were developed for each envelope.

19.2. Development of Arrivals Options – Process

The arrivals design process was made up of a sequence of steps commencing with the creation of initial design envelopes (broad areas where it would be possible to design options) through to the development of multiple design options within these envelopes that join the final approach to the runway.

As described in section 5.7, the first step was to create a theoretical, circular omni directional arrivals boundary for arrivals which encompassed the current arrival holds at MIRSI, DAYNE and ROSUN.

In creating this boundary, the design principles on noise and emissions guided the process for where the boundary should be. The underlying rationale was that the quietest (Design Principle Noise N1) and most fuel-efficient method (Design Principle Emissions) of arriving was through a CDA. CAA and ICAO guidance provides for a range of acceptable gradients for a CDA, but in this first phase a gradient of 5.24% or 3° was used as this is aligns with recommendations within both CAA and ICAO documentation.

This boundary was used to understand the broad area within which we would expect aircraft to be at 7,000ft and to assist in the identification of design constraints and considerations that may impact this area or limit the positioning of the IAF – the place from which our arrivals from 7,000ft will start.

Further detail on these constraints and considerations are shown in section 5.8.

The next step was to refine this initial omni directional design area and to create a viable area for the design options. This refinement was based upon the application of the Design Principle Policy and the achievement of a CDA to both runway ends. Further details of the criteria and process for this are in section 19.3.

Details of this process, and this viable design area were presented during the first phase of stakeholder engagement. This included an explanation of the boundary for arrivals, the concept behind CDA from 7,000ft and how this resulted in the creation of the viable design area for arrivals. Feedback collected in this phase of engagement was considered and informed the creation of the arrivals design options within the design envelopes from 7,000ft to the runway.

The design options development process produced a comprehensive list of arrivals design options from a range of IAFs as detailed in section 20.5. These IAFs and design options were created to respond to the full range of design principles and also the feedback from Stage 1 stakeholder engagement which placed an emphasis on options aligned to the Design Principle Noise N1and N2.

Furthermore, the options sought to:

- Reduce the interaction with MAN departure options in accordance with the Design Principle Safety.
- Ensure routes remain within airspace boundaries in accordance with the design principles Safety and Policy.

These options were shared at the second phase of stakeholder engagement, and this covered routes from IAFs to both the north and the south of the airfield that joined the final approach at 2,500ft, 3,000ft and 3,500ft.

This engagement also covered the operational use of arrival routes in the future and the application of systemisation to reduce dispersal. It was also explained to stakeholders that some ATC vectoring would still be required to ensure aircraft are safely separated and runway capacity is maintained.

Feedback in this second phase of engagement was collected and informed post engagement revisions to the arrival options. This feedback included comments from LPL which were informed by an ACOG facilitated collaborative design review in June 2022 with technical experts from LPL, MAN and NERL. This workshop assessed the route interactions between the options at MAN and those for LPL which at the time of writing is paused at Stage 4 of the CAP1616 process. The meeting identified several design interactions and considerations which were reflected in the LPL feedback to the engagement at MAN. For arrivals, this feedback concentrated on MAN arrivals from the north envelope to Runways 05L/05R and the potential interaction with proposed departures from LPL when that airport is operating on Runway 09. This resulted in the development of a number of additional arrival design options that are within the viable design area for the north envelope to a FAF of 2,000ft in line with both the design principles Safety and Policy.

19.3. Arrivals Design - Creating the Viable Design Area

Within the design principles, the Design Principle Policy states that "Any changes must accord with the Civil Aviation Authority's Airspace Modernisation Strategy. Any airspace change must also allow connection to the wider UK en route network and be aligned with the Future Airspace Strategy Implementation for the North programme and take into consideration the needs of other airports". We sought guidance from three documents to inform this aspect of our design:

- The Transport Act 2000, which requires the CAA to take account of any guidance on environmental objectives given to it by the Secretary of State.
- The Air Navigation Guidance 2017 which includes a section on environmental objectives, which the CAA is required to take account of in respect of its air navigation functions and in accordance with the Transport Act 2000.
- CAP1711 AMS, which is also driven by the Transport Act 2000, chapter 3 sets out the ends that modernised airspace must deliver, derived from UK and international policies and laws.

These documents provide objectives on environmental aspects and managing noise and both the Air Navigation Guidance, and the AMS specifically highlight the use of CDAs as a means for achieving these objectives. We therefore concluded that any option that does not provide CDA for all runway ends would not be aligned to the 'must have' Design Principle Policy and can only be classed as 'viable but poor fit'. This also ensures that all our arrival options would be aligned with the Design Principle Technology.

The process followed was to create an arc for easterly arrivals to Runways 05L/05R and another for westerly arrivals to Runways 23L/23R which can be seen at Figure 21: MAN Arrivals: Viable Design Area. The outer limit of the arcs are the furthest away an aircraft could be at 7,000ft and expect to achieve a consistent CDA to that runway end based upon the criteria described previously.

The area within which the two arcs overlap is the area where this is possible to all runway ends, and this defined the Viable design area for creating design options.

This aligns with the viability process that is explained in detail section 5.14

Within these arcs, options can provide a CDA to both runway directions and these are classified as viable and good fit. Outside of these arcs, a CDA to only one runway is only possible in one landing direction, Runway 23 or Runway 05 and therefore any designs starting outside this area were classified as 'viable but poor fit'. Details of both the Viable and Good fit and Viable but Poor fit options are described in sections 25 to 36

The details of the process and rationale for this design area were shared with stakeholders within the engagement process as described in the SER.

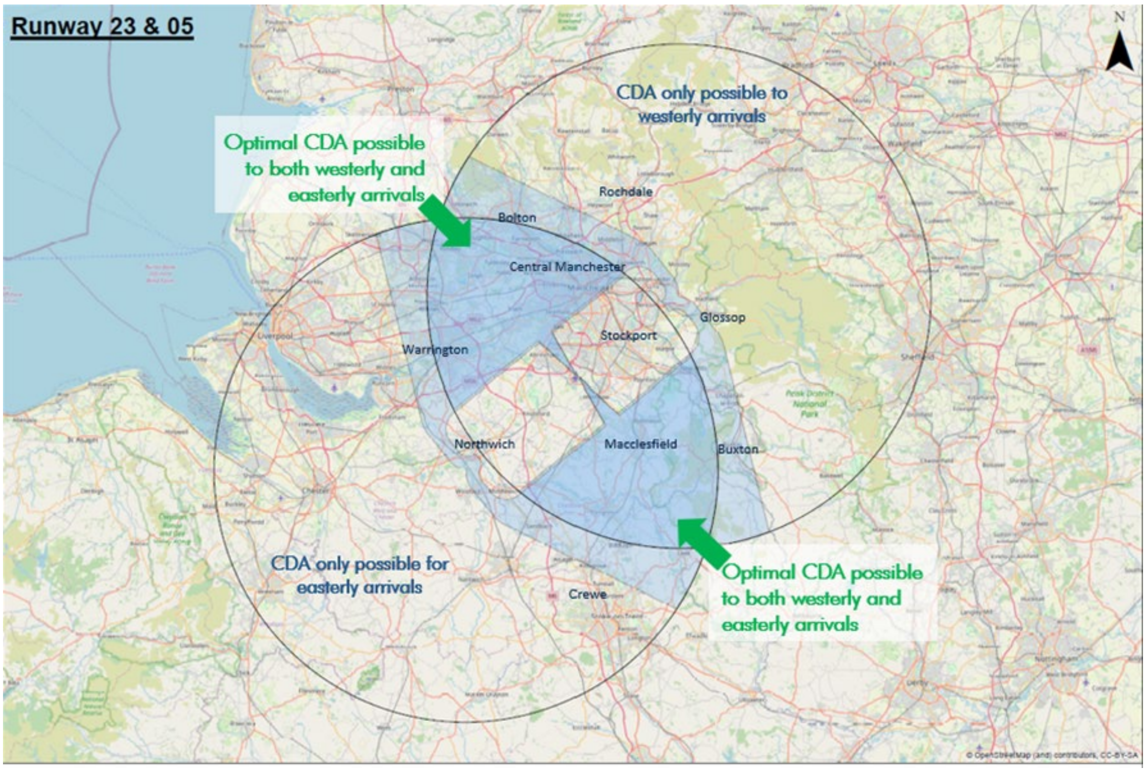


Figure 21: MAN Arrivals: Viable Design Area

19.4. CDA Design Criteria

A major government review of noise from arriving aircraft, published in 1999, identified that the use of Continuous Descent Arrivals was the primary means of reducing noise experienced on the ground beneath arriving aircraft. The report recommended the development of a code of practice to promote the use of CDAs and to monitor compliance. This was subsequently published in 2002 and a second edition published in 2006[3].

In 2017, research performed by CAA's Environmental Research and Consultancy Department (ERCD) identified that the original definition was not sufficiently sensitive to provide an effective noise measure. This has led to the development of CAP2302 A Low Noise Arrival Metric which refines the original definition of CDA. In particular this identified:

- Shallow angle approaches could be classified as a CDA but could be noisier at certain points on the approach compared to a traditional non-CDA approach.
- Newer aerodynamically efficient low drag aircraft cannot deliver optimal low noise arrivals with a higher gradient of CDA.

The arrivals options within this MAN airspace change have aligned to the optimum CDA criteria described in CAP2302 by creating viable good fit arrivals options within the following range:

- An upper limit for a CDA of 3°
- An optimum gradient of 2.5°
- A lower limit of 1.5°

These criteria are also aligned to the PANS-OPS recommended range for CDAs.

Options that have a gradient outside of this range are classified as Viable but Poor fit.

19.5. Intermediate and Final approach segments

As described in section 19.10 the approach transitions connect to an intermediate segment and then a final approach at the FAF which takes aircraft to the runway.

The segment lengths have been designed considering the appropriate speeds of aircraft in this phase of flight, which is highlighted in section AD2.22 of the MAN (EGCC) AIP entry; 'aircraft should fly within the speed band 210kt to 240kt during the approach phase, reducing to within the band 160kt to 180kt at a range of 12nm from touchdown'.

By keeping segment lengths to a minimum, this ensures aircraft maintain the required separation from the boundaries of controlled airspace. This is in line with the Design Principle Safety and the CAA containment policy for the design of controlled airspace structures.

Our designs assume a 2.5nm level intermediate segment. PANS-OPS allows for a range of this level segment of between 4.5nm and 1.5nm and our choice of 2.5nm aligns with CAA guidance on CDAs.

[3] Noise from Arriving Aircraft: An Industry Code of Practice, 2nd Edition, Department for Transport (DfT) et al., November 2006.

The final approaches have been designed as a standard T-Bar RNP final approach with joining points that align with current operations, and with additional options that create joining points at different ranges from landing. This is aligned to the Design Principle Noise N2 to provide noise relief. We have assumed that the ILS will continue to be the primary approach aid and that results in a 3° final approach descent angle.

We did not create options at altitudes above 3,500ft as this would result in there being no options capable of being flown on a CDA to both runway ends which is not in line with the design principles Policy and Noise N1.

19.5.1. Runways 23L/23R Final Approach Fix

For Runways 23L/23R the FAF options are as follows:

FAF ALTITUDE	Runway 23L Distance from threshold	Runway 23R Distance from threshold
3,500ft (Existing FAF)	10.1nm	10nm
3,000ft	8.55nm	8.47nm

Table 5: Runway 23: Final Approach Fix (FAF) distances.

By reducing the altitude of the FAF and designing the segment lengths to a minimum in accordance with PANS-OPS, the length of the final approach can be reduced. This is beneficial in aligning with the design principles Safety and Capacity as the airspace to the north-east of the aerodrome limits the ability to accommodate 3nm lateral separation from the boundaries of Class G airspace in line with CAA containment policy.

However, it would not be possible to create a FAF at either 2,500ft or 2,000ft because the dimensions of the Class D airspace do not permit early descent with sufficient range to touchdown. 3,000ft is therefore the minimum FAF altitude for viable and good fit options.

It would not be possible to create a FAF at altitudes above 3,500ft because of the interaction with NERL airspace to the east (Yorkshire CTA).

19.5.2. Runways 05L/05R Final approach fix

For Runways 05L/05R the FAF options are as follows:

FAF ALTITUDE	Runway 05L Distance from threshold	Runway 05R Distance from threshold
3,000ft (Existing FAF)	8.57nm	8.67nm
2,500ft	7.01nm	7.11nm
2,000ft	5.44nm	5.54nm

Table 6: Runway 05: Final Approach Fix (FAF) distances.

It would not be possible to create a FAF at 3,500ft or above for 05L/R because of the interaction with Liverpool delegated airspace.

By reducing the altitude of the FAF, and by designing the segment lengths to a minimum in accordance with PANS-OPS, the length of the approach can by reduced to increase the lateral separation from LPL Runway 09 departures.

A FAF altitude of 2,000ft is the minimum position of the FAF and has been included in response to bilateral discussions with LPL, with the aim of creating options that increase the lateral separation from LPL Runway 09 departures. Design options to this FAF have only been applied from a limited number of IAFs from the northern envelope. These will be used to inform ongoing bilateral discussions with LPL, NERL and ACOG as part of Step 3A activities. In addition, because of the reduced distance from touchdown of these options, work will be undertaken with airlines to investigate their flyability.

19.6. Design Assumptions and Considerations

a) PBN application to arrivals: The Design Principle Technology states that the route designs should be based upon the latest aircraft technology widely available. Based on the results from the fleet equipage survey, the arrivals designs would meet the requirements of all PBN mandates by utilising RNP APCH as the design standard for arrivals.

b) Systemisation and ATC vectoring: Consistent with the design principles Policy and Technology, the arrival design options have been designed to accommodate the principle of systemisation (minimal ATC intervention). However, the assumption is that some ATC vectoring will still be required to ensure safe spacing between aircraft is consistently maintained, either for wake turbulence, arrival-departure-arrival separation, or in periods of adverse weather. ATC vectoring may also be a tool to aid the provision of noise relief in line with Design Principle Noise N2 by using ATC instructions to vary the joining point onto final approach. This concept has been reflected in the construction of the multiple joining points onto final approach that are described in section 17.9.

c) Continuous Descent Approaches (CDAs): The Design Principle Technology specifically identifies the use of CDAs as a benefit of the future airspace design. This aligns with national policy and guidance from Government and the CAA. Both our arrivals envelopes and the design options within them have been designed with the intention of providing CDAs to both runway directions. Where possible, and in line with our Design Principle Noise N1we have also sought to apply latest CAA policy on low noise arrivals metrics as detailed in CAP2302.

d) Current arrivals noise procedures: To present a comprehensive list of viable design options, the design process has not been constrained by the existing Noise Abatement procedures. Any changes required to these procedures will be addressed separately as required.

e) 'Do minimum' for arrivals: As detailed in section 4.4.2 no replicated 'do minimum' design options for arrivals have been created because:

   - There are no existing intermediate approaches to replicate.
   - The existing IAFs that define the northern holds (MIRSI and ROSUN) are outside of the viable good fit design area and would not permit a CDA to both runway directions.

Rather, under the arrivals 'do minimum' scenario, aircraft would continue to be vectored from the hold to the final approach as they are today.

19.7. Arrivals – Engagement with NATS on Arrivals structures

Bilateral meetings have been held with NERL to discuss the factors affecting the placement of the MAN arrivals structure and the 7,000ft starting point for our arrivals, taking account of our requirements and design principles. Details of these meetings can be found in Stakeholder Engagement Report Appendix 2.

These discussions produced the following assumptions in relation to arrivals:

a) Arrivals holds will continue to be a design feature for contingency/resilience. These holds will be above 7,000ft and are therefore the responsibility of NERL.

b) The NERL network is not considering major changes to the UK network COP or the TOS. Traffic flows to and from neighbouring airspace will therefore remain substantially unchanged and MAN inbound traffic can be assumed to arrive in a similar pattern, and from a similar direction as it does today.

c) Previous simulation conducted by NERL prior to 2018 created a number of theoretical IAFs for MAN arrivals in order to prove operational concepts. Where these IAFs fall within the MAN 'viable design area' they have been used to create a design option as part of the comprehensive list. However, if the location would not permit a CDA to both runway directions (outside the overlapping arcs), it has not been used as a viable IAF.

d) These previous NERL simulations also made assumptions on the location and type of arrival structure above 7,000ft, and in particular the use of a Point Merge Structure for arrivals. However, because NERL are undertaking their own ACP under CAP1616, they are required to create a comprehensive list of options, including options for these airborne holds for airports. MAN and NERL have therefore engaged in collaborative design workshops as part of the NATS Project L6268 – TMA Definition Project which have examined a range of high-level concept options for managing MAN arrivals in the future. This will form part of the NERL Stage 2 ACP submission, and details of discussions are held within an Airspace Development Workshop Record (ADWR) which has been jointly agreed by MAN and NERL.

e) The area to the west and south-west of MAN is complex because of LPL and routes to and from that airport. The proximity of respective routes and the intensity with which they are used, make this unsuitable for an arrival structure in accordance with the design principles Safety and Capacity. This aligns with the constraints identified in section 5.8.1.

f) Similarly, the area to the east of MAN would be an unsuitable location because of MAN outbound connections to the network and inbound traffic LBA. These interactions would not align to the design principles Safety or Capacity.

g) We have therefore worked closely with colleagues in NATS/NERL to create a comprehensive list of arrival design options that provide flexibility and have the ability to integrate with both the NERL network and other airports within and around the MTMA. Our discussions with NERL took account of these discussions, and we then tested our designs with NERL during the formal stakeholder engagement process.

19.8. Arrivals Development Strategy – Step 3A

Whilst we have considered the current path of departures from MAN to inform the position of IAF's and the placement of routes, we have not designed our arrival design options as part of a network with our departures.

As a result of this process and the comments from the engagement process, we are carrying forward a comprehensive list of arrivals design options to the DPE. However, as the NERL designs progress, it is possible that some of our design options will either be misaligned or conflict with their choices (or those of other airports) and that some design options may need to be further refined or amended in response to the progress of their work. We will continue to work in bilateral discussions across the MTMA and in partnership with NERL and other airports to respond to any such interactions.

This is particularly the case for interactions between MAN and LPL. Work has already taken place to scope the required tasks to deliver a successful reintegration of LPL into the MTMA, and a framework plan to resolve design interaction issues has been created by ACOG. Further details on bilateral discussions with LPL and how feedback has been incorporated in arrivals designs is contained in section 5.11.

Further work is anticipated to involve a series of collaborative design workshops involving both airports and NERL and these will examine both departure and arrivals options. In some cases, it may not be possible to provide the required connectivity from the network which may result in design options being re-classified as 'viable but poor fit'. In such a scenario, our assessment of these design options would be discontinued.

Within Step 3A of the CAP1616 process the change sponsor will seek to optimise each aspect (departures and arrivals) and develop a system that encompasses departures and arrivals and takes account of other ACPs within the MTMA cluster. We will then use the process of bilateral discussions with NERL, to agree network connectivity and optimal positions that align with both the MAN design principles and the available airspace within the network, but also consider the cumulative impact of change. This process will also allow us to consider controlled airspace requirements and the needs of the wider aviation community including GA.

In respect to Cumulative Impact, MAN have already worked with ACOG to understand the application of the Cumulative Assessment Framework (CAF). The anticipation is that this will be used as an acceptable means of compliance for:

- Understanding and managing the environmental impacts of connected proposals (Ref: para B45 of CAP1616) and
- To align with the requirements CAP2156A Masterplan Acceptance Criteria which requires potential interdependencies, solutions to these interdependencies and trade-offs. (Ref: acceptance criteria B4-B6 from CAP2156A)

Further information on our proposed approach to Step 3A is provided at the Next Steps description in section **Error! Reference source not found.** of the DOR.

19.9. Arrivals - Constraints and considerations

As detailed in section 5.8, the constraints and considerations for arrivals were developed by analysing the airspace and current operations in MAN TMA (MTMA). This analysis identified constraints and considerations to the future designs:

- Constraints were defined as aspects that have a direct impact on designs, or limit where we can place our arrival design options.
- Considerations were defined as aspects that do not limit our designs but which we need to take account of in creating arrivals options.

For arrivals, the principal constraints are:

Liverpool John Lennon Airport (LPL) (Constraint and Consideration)

Liverpool John Lennon Airport (LPL) is located 20nm west of MAN. It is surrounded by controlled airspace which extends from the surface up to 2,500ft. Additionally, NATS Manchester and NERL Prestwick have delegated portions of airspace above Liverpool John Lennon Airport to Liverpool ATC. The delegation of airspace is necessary to enable the safe and efficient handling of arriving aircraft into LPL. The proximity of the airspace and their departure and arrival routes creates a potential interaction to the west and north-west of us. In particular, for arrivals, constraints may be created by:

- Arrival routes for LPL on Runway 27
- Departure routes from LPL Runway 09 that route to the east before turning left or right.

Leeds Bradford Airport (LBA) (Constraint)

The Leeds Bradford Control Area (LBA CTA) extends from the surface to FL85. It is unlikely that MAN arrivals will be able to operate through this area as this may result in interactions with LBA traffic. This has therefore been classed as a constraint in planning design options.

Camphill Gliding Area (Consideration)

The Camphill Gliding area is a piece of airspace to the east of MAN. The use of this airspace is shared between NATS Prestwick and the GA Gliding community. Gliding activity requires prior permission from NATS and can take place during the hours of daylight. When gliding occurs, the airspace cannot be used by commercial air traffic. The vertical dimensions of the airspace vary from FL65 to FL195, and no arrivals options have been created through this airspace.

Airspace to the south-west - Daventry Control Area (Consideration)

This area is currently classed as Uncontrolled Airspace from the surface to FL90. Flights by commercial aircraft are generally not permitted in Uncontrolled Airspace and there is no connectivity to the NATS network in this area. It would not be possible to design arrival options which use this area of airspace. There is also a parachute area at Tilstock which is regularly activated at weekends up to FL100 or occasionally FL110. Following conversation with NATS (NERL), this area is being treated as their constraint and they will consider the use of CAS or procedures which overfly this area. However, this will remain a consideration for MAN in planning design options.

NATS Network Traffic Flows (Consideration)

The Design Principle Policy states that our future airspace must allow connection to the wider en route network. The arrows within the diagram at Figure 12 show the network traffic. Flying against these flows would not be consistent with the Design Principle Policy and MAN designs will therefore route traffic in such a way that these connections can be safely and efficiently created.

City Airport (Manchester Barton) (Consideration)

City Airport (Manchester Barton) is one of our stakeholders and we will need to ensure their needs and access requirements are taken account of via bilateral engagement. Their airspace extends from surface to 2,000ft but the distance from MAN means this airspace will not impact our arrivals design options. Access arrangement to City Airport/ Barton via the Low-Level Route (LLR) should also remain a consideration (see MAN CONOPS).

19.10. Arrivals Design Options – Scope of Design

The diagram below provides a representation of the key elements of an arrival procedure.

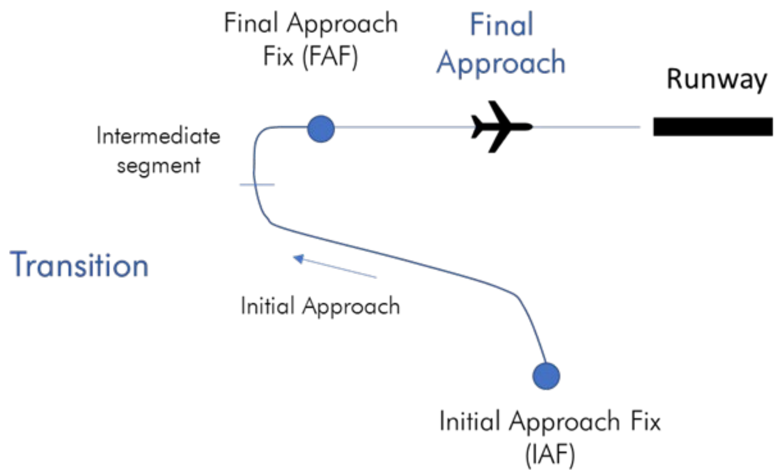


Figure 22: Segments within an arrivals option

Our designs have been created in accordance with PANS-OPS rules and comprise:

- Transition: The part of the arrival route between the IAF which is at 7,000ft and the FAF. The transition encompasses an initial approach and a short intermediate segment.
- Final Approach: The route taken by the aircraft between the FAF and landing on the runway. This is a straight line, normally guided by the ILS.

Section 19.6 provides further information on the criteria and assumptions used for our designs.

20. Arrivals Options – Continuous Descent Approach (CDA) Gradients

20.1. CDA Gradients Runways 05L/05R North

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 05L/R			
				RW05L Descent Gradient (%)	RW05L Descent Angle (°)	RW05R Descent Gradient (%)	RW05R Descent Angle (°)
NORTH	3000	STEAK	1A	3.50%	2.01	3.28%	1.88
		STEAK	2A	3.13%	1.79	2.92%	1.68
		IAF 1	6A	3.61%	2.07	3.41%	1.95
		IAF 2	7A	3.13%	1.79	2.98%	1.71
		IAF 3	8A	3.06%	1.75	2.90%	1.66
		IAF 4	9A	2.72%	1.56	2.58%	1.48 *

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 05L/R			
				RW05L Descent Gradient (%)	RW05L Descent Angle (°)	RW05R Descent Gradient (%)	RW05R Descent Angle (°)
NORTH	2500	STEAK	1B	4.24%	2.43	3.96%	2.27
		STEAK	2B	3.79%	2.17	3.53%	2.02
		IAF 1	6B	4.30%	2.46	4.06%	2.33
		IAF 2	7B	3.71%	2.12	3.52%	2.02
		IAF 3	8B	3.65%	2.09	3.45%	1.98
		IAF 4	9B	3.24%	1.86	3.07%	1.76

(* Option 9A for Runway 05R progressed to DPE due to only 0.02° variance against 1.5° CDA criteria).

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 05L/R RW05L Descent Gradient (%)	RW05L Descent Angle (°)	RW05R Descent Gradient (%)	RW05R Descent Angle (°)
NORTH	2000	IAF 2	7C	4.33%	2.48	4.12%	2.36
		IAF 11	12	3.94%	2.26	3.77%	2.16
		IAF 12	13	4.37%	2.50	4.09%	2.34

20.2. CDA Gradients Runways 05L/05R South

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 05L/R RW05L Descent Gradient (%)	Runway 05L/R RW05L Descent Angle (°)	Runway 05L/R RW05R Descent Gradient (%)	Runway 05L/R RW05R Descent Angle (°)
SOUTH	3000	TURKY	1A	3.45%	1.98	3.28%	1.88
		IAF7	6A	3.55%	2.03	3.38%	1.94
		IAF8	7A	3.17%	1.82	3.01%	1.73
		IAF9	8A	2.72%	1.56	2.63%	1.51
		IAF10	9A	3.21%	1.84	3.08%	1.77

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 05L/R RW05L Descent Gradient (%)	Runway 05L/R RW05L Descent Angle (°)	Runway 05L/R RW05R Descent Gradient (%)	Runway 05L/R RW05R Descent Angle (°)
SOUTH	2500	TURKY	1B	4.17%	2.39	3.95%	2.26
		IAF7	6B	4.26%	2.44	4.06%	2.33
		IAF8	7B	3.82%	2.19	3.62%	2.08
		IAF9	8B	3.20%	1.83	3.11%	1.78
		IAF10	9B	3.82%	2.19	3.67%	2.10

20.3. CDA Gradients Runways 23L/23R North

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 23L/R			
				RW23L Descent Gradient (%)	RW23L Descent Angle (°)	RW23R Descent Gradient (%)	RW23R Descent Angle (°)
NORTH	3500	STEAK	1A	2.99%	1.71	2.89%	1.65
		IAF 5	3A	3.35%	1.92	3.30%	1.89
		IAF 6	6A	3.26%	1.87	3.24%	1.86
		IAF 4	7A	3.64%	2.09	3.53%	2.02
		IAF 3	8A	2.84%	1.63	2.76%	1.58
		IAF 12	11A	3.59%	2.05	3.44%	1.97

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 23L/R			
				RW23L Descent Gradient (%)	RW23L Descent Angle (°)	RW23R Descent Gradient (%)	RW23R Descent Angle (°)
NORTH	3000	STEAK	1B	3.68%	2.11	3.54%	2.03
		IAF 5	3B	3.96%	2.27	3.93%	2.25
		IAF 6	6B	3.81%	2.19	3.80%	2.18
		IAF 4	7B	4.45%	2.55	4.32%	2.48
		IAF 3	8B	3.45%	1.98	3.36%	1.92
		IAF 2	9B	3.01%	1.72	2.94%	1.68
		IAF 1	10B	2.92%	1.67	2.84%	1.63
		IAF 12	11B	4.45%	2.55	4.27%	2.45
		IAF 11	12B	2.80%	1.61	2.75%	1.57

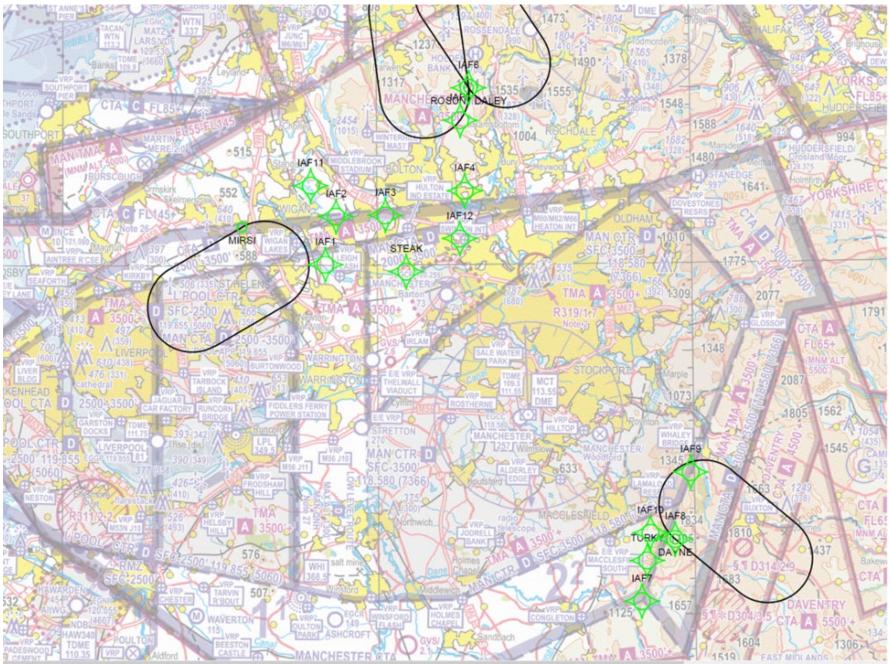
20.4. CDA Gradients Runways 23L/23R South

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 23L/R RW23L Descent Gradient (%)	RW23L Descent Angle (°)	RW23R Descent Gradient (%)	RW23R Descent Angle (°)
SOUTH	3500	TURKY	1A	3.15%	1.80	3.02%	1.73
		TURKY	2A	2.83%	1.62	2.73%	1.56
		IAF8	6A	3.41%	1.96	3.27%	1.87
		IAF9	7A	4.48%	2.57	4.24%	2.43
		IAF10	8A	3.42%	1.96	3.28%	1.88
		IAF7	9A	2.78%	1.59	2.69%	1.54

	Final Approach Fix (FAF) Altitude	Initial Approach Fix (IAF)	Option	Runway 23L/R RW23L Descent Gradient (%)	RW23L Descent Angle (°)	RW23R Descent Gradient (%)	RW23R Descent Angle (°)
SOUTH	3000	TURKY	1B	3.78%	2.17	3.63%	2.08
		TURKY	2B	3.38%	1.94	3.26%	1.87
		IAF8	6B	4.12%	2.36	3.94%	2.26
		IAF9	7B	5.50%	3.15	5.19%	2.97
		IAF10	8B	4.14%	2.37	3.95%	2.26
		IAF7	9B	3.33%	1.91	3.21%	1.84

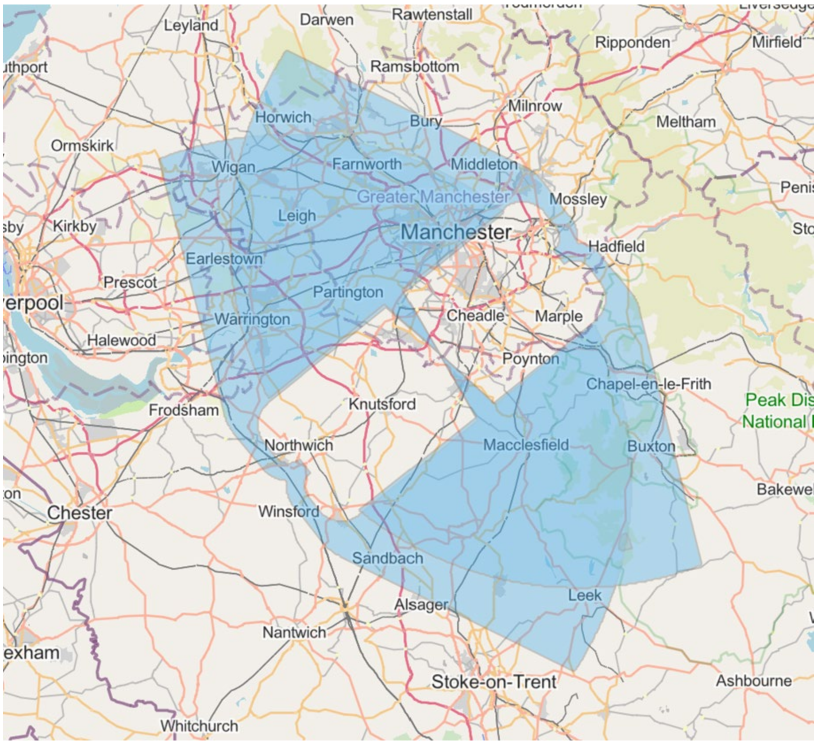
20.5. Summary Map – Placement of Initial Approach Fixes (IAF)

The map below details the geographical position of all IAFs considered as part of the comprehensive list of design options.



20.6. Arrivals Design Envelopes

The diagram below shows the design envelopes that contain the design options.



20.7. Arrivals Options Description – Example Layout

The following sections 21 to 36 detail the arrivals design envelopes and the design options created within them. Each section includes an introduction, followed by a description and graphic for the design envelope.

An options summary table is then provided which shows the comprehensive options for each design envelope. This includes design options from the numbered list (viable and good fit), the lettered list (viable and poor fit) and any unviable options we have considered but discounted.

This is followed by a more detailed description of each route. The graphic below provides an example of the summary table used for this description, and an explanation of the information contained within it.

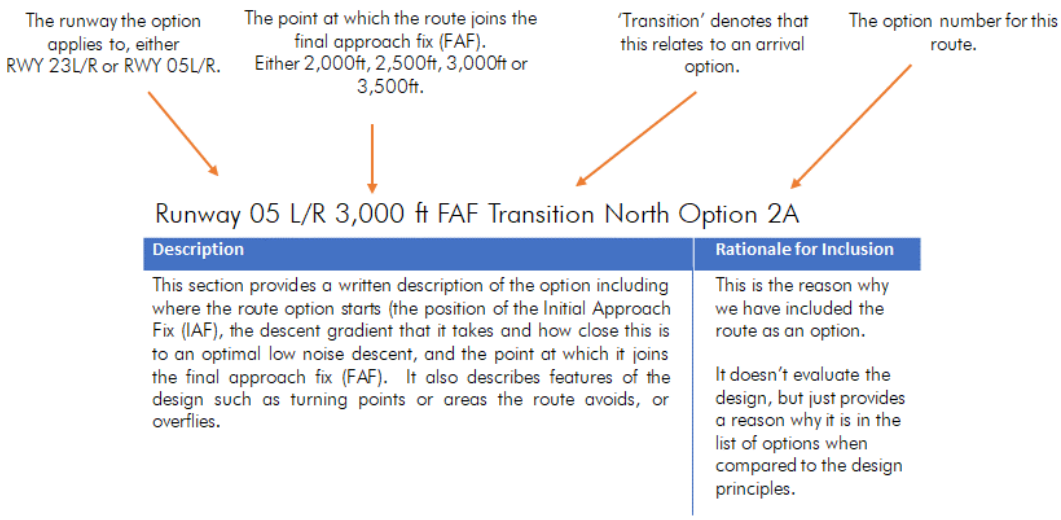


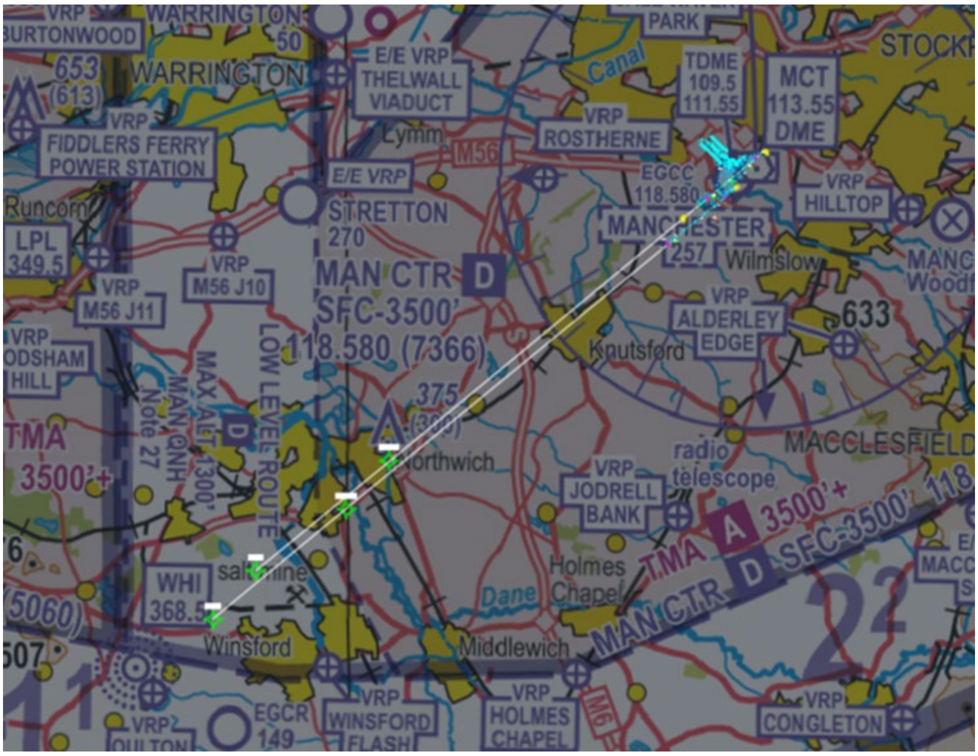
Figure 23: Example arrival design option table

As with the departures description, each option also contains a map.

21. Final Approach Runways 05L/05R – 3,000ft FAF

This final approach provides a 3° final approach descent gradient with a FAF of 3,000ft. The approach is aligned with the runway centreline, which aims to align with the track of the currently published ILS procedure for Runways 05L/05R.

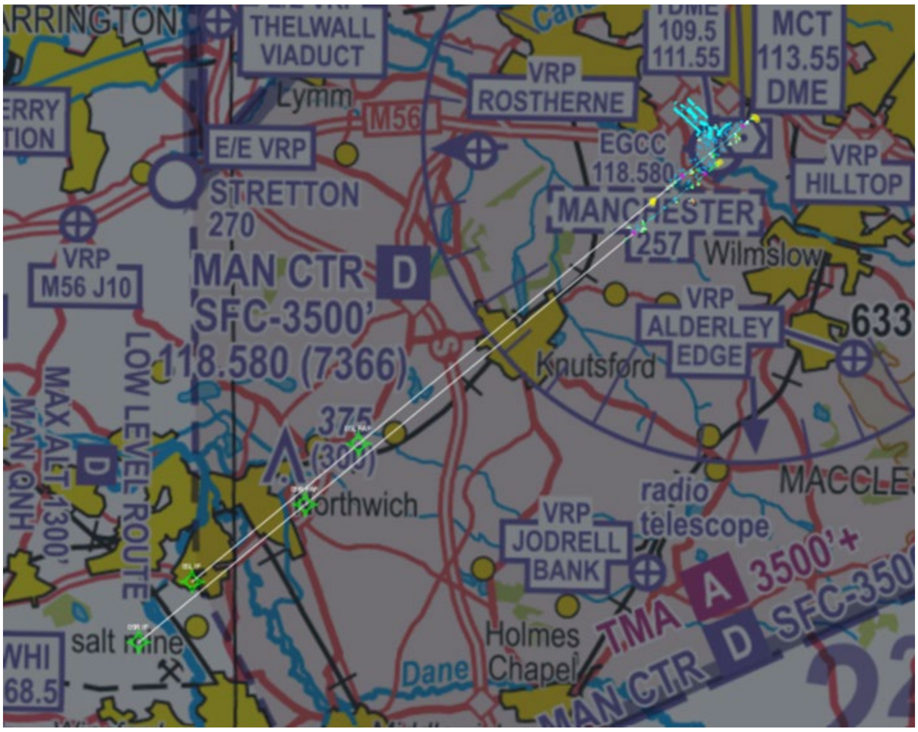
The intermediate segment length that precedes this segment caters for any turns in the transition at the Intermediate Fix (IF) of up to 90°, which provides sufficient distance for turn anticipation and the Minimum Stabilisation Distance (MSD) for a speed of 185 KIAS.



22. Final Approach Runways 05L/05R – 2,500ft FAF

This final approach provides a 3° final approach descent gradient with a FAF of 2,500ft. The approach is aligned with the runway centreline, which aims to align with the track of the currently published ILS procedure for Runways 05L/05R.

The intermediate segment length that precedes this segment caters for any turns in the transition at the IF of up to 90°, which provides sufficient distance for turn anticipation and the MSD for a speed of 185 KIAS.



23. Final Approach Runways 05L/05R – 2,000ft FAF

This final approach provides a 3° final approach descent gradient with a FAF of 2,000ft. The approach is aligned with the runway centreline, which aims to align with the track of the currently published ILS procedure for Runways 05L/05R.

The intermediate segment length that precedes this segment caters for any turns in the transition at the IF of up to 90°, which provides sufficient distance for turn anticipation and the MSD for a speed of 185 KIAS.

24. Runway 05L/05R – Approach Transitions

24.1. Introduction to 05L/05R Design Envelope

This envelope has been created for traffic routing to the RNP approach for Runway 05L/05R. It covers the transitions from the IAF at 7,000ft and the design of the final approach.

In current operations for arrivals from the north, ATC radar vector aircraft onto the Final Approach from either the MIRSI or ROSUN holds, and typically keep aircraft laterally above the low-level route (east of CTA4). Traffic is routed downwind to the north and west of the airfield to a base leg to the north of Northwich. From the south, ATC radar vector aircraft from the DAYNE hold to a base leg position to the north of Crewe. The transitions have been designed bearing this in mind, and to adhere to the UK CAA Containment Policy for RNAV1 STARs; 'Specified nominal tracks designed to RNAV 1 (RNP 1) standard should not be less than 3nm from the limits of controlled/advisory airspace'.

As detailed in section 19.6b), future airspace options have been developed on the principle of minimising ATC vectoring (the process known as systemisation) which is in line with the Design Principles Policy and Technology. However, some ATC vectoring will still be required in order to ensure safe separation and to maintain capacity.

The design process has created a suite of transitions which commence at the IAFs on the Instrument Approach Procedures (IAPs), where a 90° turn connects this segment to the intermediate segment. The segment lengths for the IAP have been designed considering the appropriate speeds of aircraft in this phase of flight, which is highlighted in AD2.22 of the MAN Aeronautical Information Publication (AIP) entry; 'aircraft should fly within the speed band 210kt to 240kt during the approach phase, reducing to within the band 160kt to 180kt at a range of 12nm from touchdown'.

By keeping segment lengths to a minimum, this helps to maintain the required separation for CAS, and keeps the tracks further to the east away from LPL Runway 27 arrivals.

As detailed at section 5.11.3, this design envelope was discussed at the bilateral workshop with LPL in June 2022. This is due to potential interactions between arrivals options within this envelope and LPL Runway 09 right turn departures. This resulted in the design of options 7c, 12 and 13 to a 2,000ft FAF.

Further work will take place in Stage 3 to fully understand and resolve these interactions with LPL.

24.2. Methodology

As detailed in section 19.3, arrivals to MAN are predominantly from the north and south. To ascertain an area of airspace for an arrival method that could accommodate approaches to both runways, an arc with a given radius was predicated on the IF of an approach procedure, based on a FAF altitude of 2,000ft. This process was replicated for Runway 23, and the two overlapping arcs produce a common area, within which we have placed IAFs which define the start of the arrivals design options.

The options for Runways 05L/05R were designed to the current FAF of 3,000ft, as well as reduced FAF altitudes of 2,500ft and 2,000ft.

Additionally, the arrivals design options took account of the constraints and considerations in section 19.9 which means that not all of the design envelope area can be used as potential airspace to design within.

24.3. Runways 05L/05R Design Envelope Location Map

25. Runways 05L/05R 3,000ft FAF Transition North

25.1. Runways 05L/05R 3,000ft FAF Transition North Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1A	IAF = STEAK This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operations. It is designed to facilitate a broadly equal CDA profile to all runways. (Runway 05L - 3.5%/2.01° with 2.5nm Flat Segment). (Runway 05R - 3.28%/1.88° with 2.5nm Flat Segment).	A3	A direct route from the position of a NATS proposed hold close to the current MIRSI hold. Potential to conflict with LPL arrivals. Does not align with the design principles Safety and Policy.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

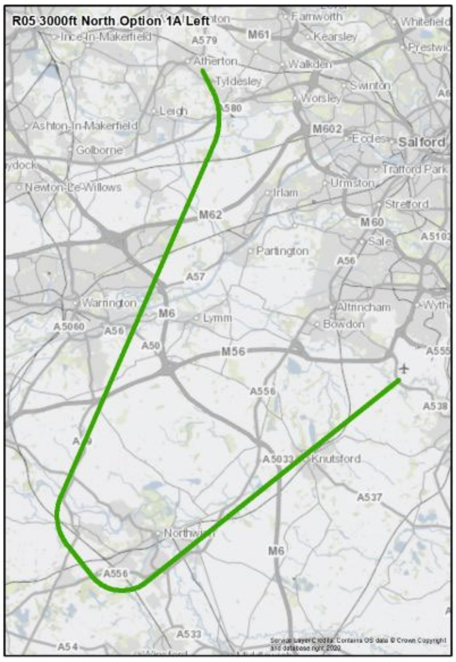
2A	IAF = STEAK This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operations. It is designed to facilitate a CDA profile to all runways. This option is longer than 1A and has a slightly less optimum CDA profile. (Runway 05L - 3.13%/1.79° with 2.5nm Flat Segment). (Runway 05R – 2.92%/1.68° with 2.5nm Flat Segment).	B4	A direct route from the position of a NATS proposed IAF location, west of the current MIRSI hold. Potential to conflict with LPL arrivals. Does not align with the design principles Safety and Policy.		
6A	IAF = IAF1 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Wigan and has been designed to reduce potential interactions with departures. This option has a more optimal CDA profile than options 1A and 2A. (Runway 05L - 3.61%/2.07° with 2.5nm Flat Segment). (Runway 05R – 3.41%/1.95° with 2.5nm Flat Segment).	C5	A direct route from a position north-west of the MIRSI hold. Potential to conflict with LPL arrivals. Does not align with the design principles Safety and Policy.		

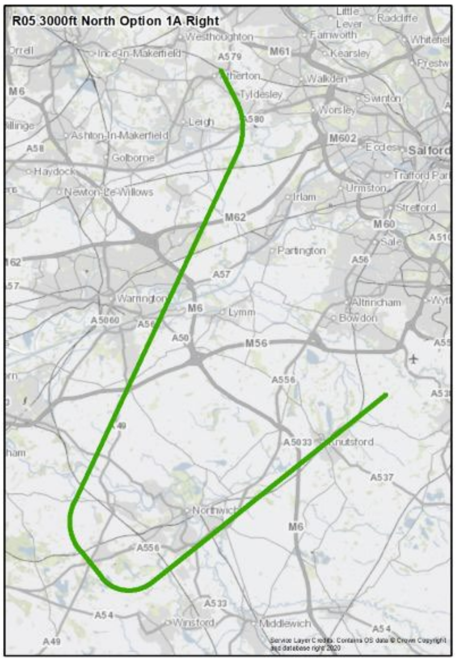
7A	IAF = IAF2 This option has an IAF at 7,000ft to the north-west of the airport to the east of Wigan and has been designed to reduce potential interactions with departures. It is slightly further north-east than option 6A to reduce the impact of noise on Wigan and the CDA profile is similar to 2A but not as optimal as 1A and 6A. (Runway 05L - 3.13%/1.79° with 2.5nm Flat Segment). (Runway 05R – 2.98%/1.71° with 2.5nm Flat Segment).	D10	Runway 05 straight-in approach transition. Potential to conflict with LPL arrivals and not aligned to the NATS upper airspace traffic flow. Does not align with the design principles Safety, Policy and Capacity.		
8A	IAF = IAF3 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Horwich. It has been designed to reduce potential interactions with departures and to facilitate a CDA profile to all runways. The IAF is further east than option 6A and 7A which results in the least optimal CDA profile of all the above options. (Runway 05L - 3.06%/1.75° with 2.5nm Flat Segment). (Runway 05R – 2.9%/1.66° with 2.5nm Flat Segment).	E11	IAF = IAF5 This option has an IAF co-located with the IAF for the 23L/23R option 3A but is not fully CDA compliant to both runways. This option does not align with the Design Principle Policy.		

9A	IAF = IAF4 This option has an IAF at 7,000ft to the north of the airport just east of Bolton and is designed to facilitate a CDA profile to all runways. It is co-located with the IAF for the Runways 23L/23R option 7A. It is the longest arrival transition and has the least optimum CDA profile. (Runway 05L – 2.72%/1.56° with 2.5nm Flat Segment). (Runway 05R – 2.58%/1.48° with 2.5NM Flat Segment).	F12	IAF = IAF6 This option has an IAF co-located with the IAF for the 23L/23R option 6A but is not fully CDA compliant to both runways. This option does not align with the Design Principle Policy.		

25.2. Runways 05L/05R 3,000ft FAF Transition North Option 1A

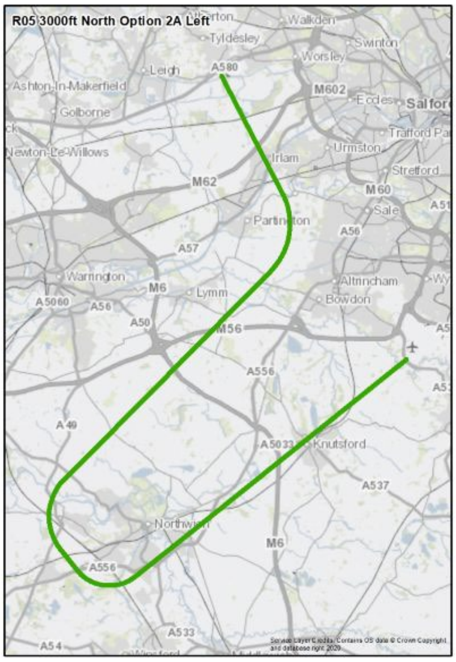
Description	Rationale for inclusion
Option 1A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operations. It is designed to facilitate an equal CDA profile to all runways. From this location the route splits and turns south-west, west of Urmston, Irlam, Partington, Cadishead and then east of Warrington before turning on to the final approach to the west of Northwich at 3,000ft for either Runway 05L or Runway 05R. The descent gradient to the FAF is 3.5%/2.01° for Runway 05L and 3.28%/1.88° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates an optimal CDA for both runway directions (05LR/23LR). **Emissions**: Equal track miles (fuel burn) for both easterly and westerly operations. Direct routing and minimal track miles from 7,000ft to the FAF. **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Warrington.

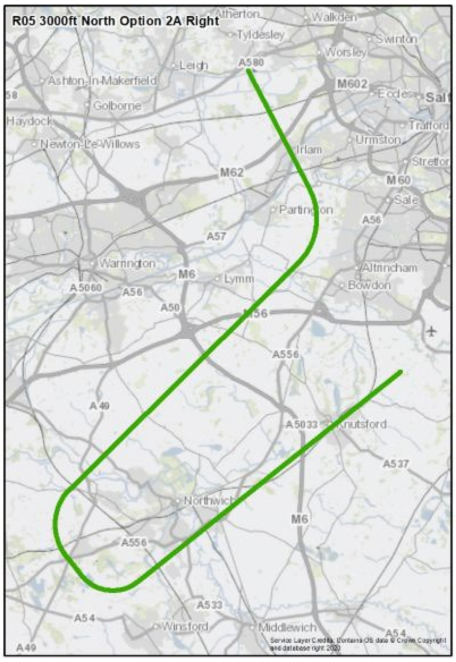




25.3. Runways 05L/05R 3,000ft FAF Transition North Option 2A

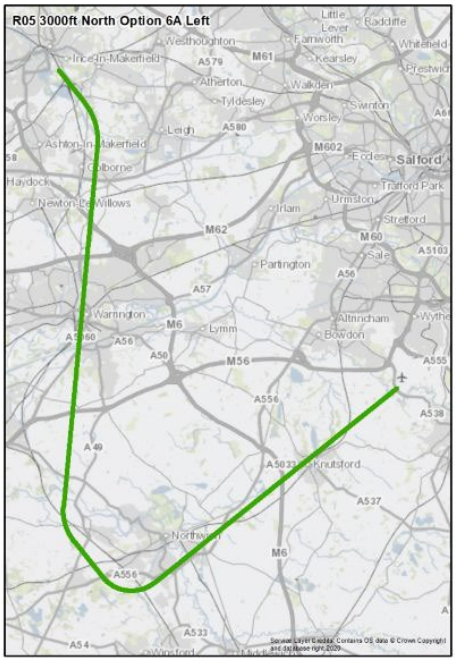
Description	Rationale for inclusion
Option 2A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operation. It is designed to facilitate an equal CDA profile to all runways. From this location the route follows an initial straight segment towards the airport where it splits before turning right on to the downwind leg overflying Partington. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.13%/1.79° for Runway 05L and 2.92%/1.68° for Runway 05R. These gradients are at the lower end of the optimum for low noise approach but still within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates CDA for all runways (05L/05R/23L/23R). **Emissions**: Equal track miles (fuel burn) for both easterly and westerly operations. **Noise N1**: Provides an ICAO compliant CDA gradient. Designed to limit the impact of noise by avoiding Warrington, Sale and Altrincham.

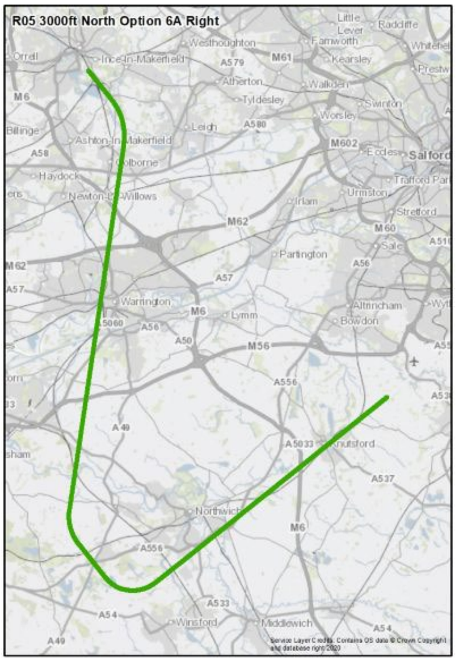




25.4. Runways 05L/05R 3,000ft FAF Transition North Option 6A

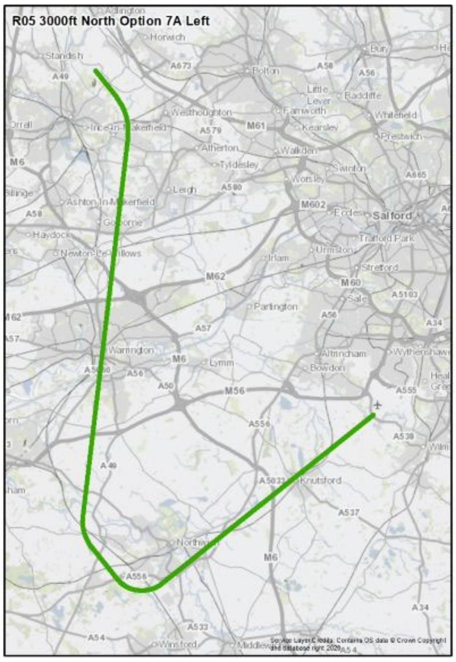
Description	Rationale for inclusion
Option 6A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Wigan and has been designed to reduce potential interactions with departures. From this location the route splits and heads south, overflying Warrington and to the east of Frodsham. Both routes then turn left to establish aircraft on final approach to the west of Northwich at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.61%/2.07° Runway 05L and 3.41%/1.95° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Capacity: Design options are intended to aid capacity by reducing interactions with departures. Noise N1: Optimal low noise CDA gradient. Emissions: Provides a direct routing and minimal track miles from 7,000ft to the FAF.

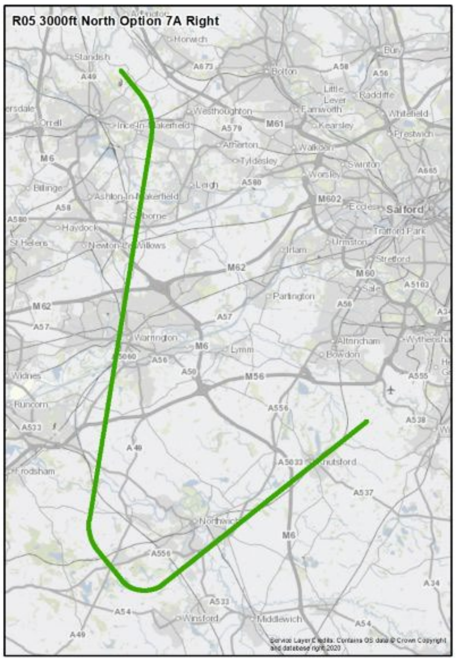




25.5. Runways 05L/05R 3,000ft FAF Transition North Option 7A

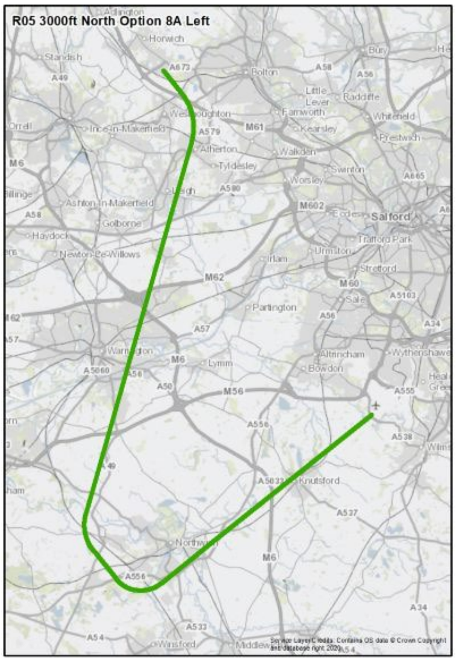
Description	Rationale for inclusion
Option 7A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull to the east of Wigan and has been designed to reduce potential interactions with departures. It has a similar track to option 6a but reduces the impact of noise on Wigan. This results in a CDA profile that is similar to option 2A but not as optimal as 1A and 6A.	**Capacity:** Design options are intended to aid capacity by reducing interactions with departures.
From this location the route splits and heads south, routing just east of Earlestown and overflying Warrington. Both routes then turn left to establish aircraft on final approach to the west of Northwich at 3,000ft for either Runway 05L or 05R.	**Emissions**: Provides a direct routing and minimal track miles from 7,000ft to the FAF.
The descent gradient to the FAF is 3.13%/1.79° for Runway 05L and 2.98%/1.71° for Runway 05R. These gradients are at the lower end of the optimum for low noise approach but still within the acceptable range for CDAs defined within ICAO guidance.	**Noise N1**: Provides an ICAO compliant CDA gradient. Designed to limit the impact of noise by avoiding Wigan.

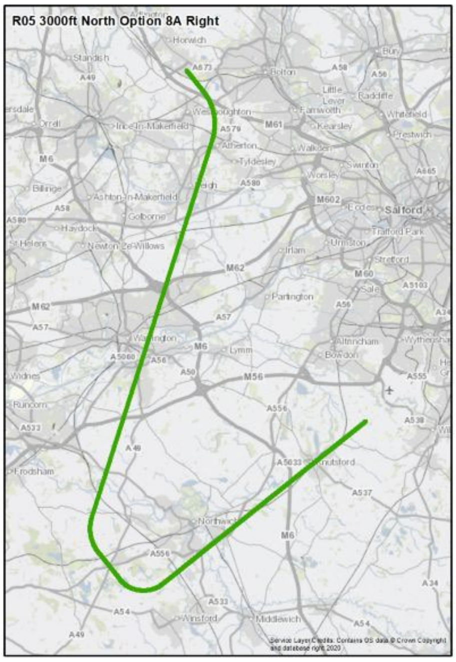




25.6. Runways 05L/05R 3,000ft FAF Transition North Option 8A

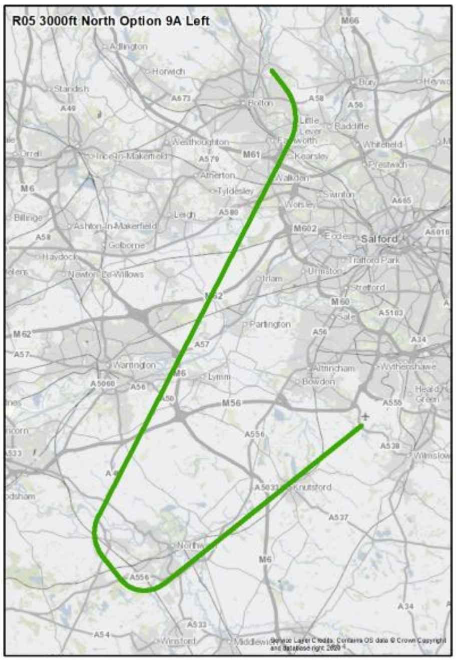
Description	Rationale for inclusion
Option 8A has an IAF at 7,000ft to the north-west of the airport in the vicinity of the Middlebrook Retail Park (marked on VFR charts as Middlebrook Stadium). It has been designed to reduce potential interactions with departures and to facilitate a CDA profile to all runways. It also provides a broadly equal CDA for both runway directions. From this location the route splits, and heads south-west in the vicinity of Atherton and routes just to the east of central Warrington. Both routes then turn left to establish aircraft on final approach to the west of Northwich at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.06%/1.75° for Runway 05L and 2.9%/1.66° for Runway 05R. These gradients are at the lower end of the optimum for low noise approach but still within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates a CDA for both runway directions (05L/05R/23L/23R). Emissions: Provides a direct routing and minimal track miles from 7,000ft to the FAF. Noise N1: Provides an ICAO compliant CDA gradient. Designed to limit the impact of noise by avoiding Wigan and Bolton.

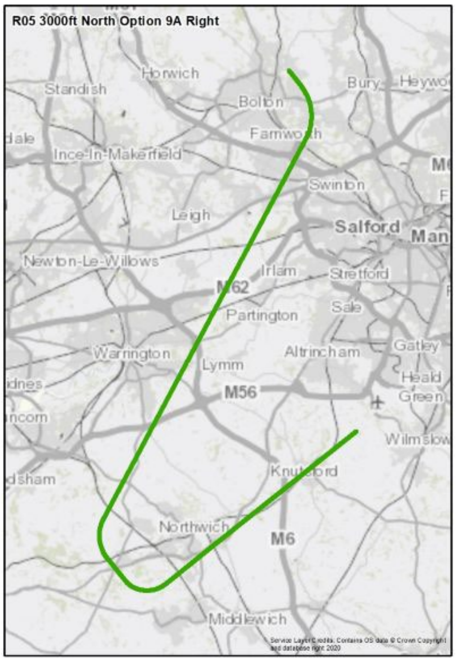




25.7. Runways 05L/05R 3,000ft FAF Transition North Option 9A

Description	Rationale for inclusion
Option 9A has an IAF at 7,000ft to the north of the airport just to the east of Bolton and is designed to facilitate a CDA profile to all runways. This position results in this being the longest transition for Runway 05 and therefore the least optimal CDA profile. From this location the route splits, heads initially south to avoid Bolton and then turns south-west to and tracks to the east of Warrington. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 2.72%/1.56° for Runway 05L and 2.58%/1.48° for Runway 05R. These gradients are below the optimum for low noise approaches but just within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates CDA for all runways (05L/05R/23L/23R). More optimal for the predominant westerly operations at MAN. **Noise N1**: Designed to limit the impact of noise by avoiding Bolton and Warrington.





25.8. Runways 05L/05R – 3,000ft FAF Transitions North: Viable but Poor Fit Options

Option	Safety	Policy	Capacity
Transition north option A3	S	P	C
This was initially designed as **option 3** and is a route based on an IAF located at the position of a NATS proposed hold close to the current MIRSI hold. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not comply with the Design Principle Safety. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. By creating interactions with traffic for other airports this option would not comply with this initiative (and therefore the Design Principle Policy) as it has the potential to require ATC intervention to resolve interactions.			
Transition north option B4	S	P	C
This was initially designed as **option 4** and is a route based on an IAF located to the east of the current MIRSI hold. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not comply with the Design Principle Safety. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. By creating interactions with traffic for other airports this option would not comply with this initiative (and therefore the Design Principle Policy) as it has the potential to require ATC intervention to resolve interactions.			
Transition north option C5	S	P	C
This was initially designed as **option 5** and is a route based on an IAF located at the position of a NATS proposed hold to the north-west of the current MIRSI hold. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not comply with the Design Principle Safety. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. By creating interactions with traffic for other airports this option would not comply with this initiative (and therefore the Design Principle Policy) as it has the potential to require ATC intervention to resolve interactions. In addition, the distance of this IAF from the runways may result in options being unable to provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact which is contrary to the AMS.			

Transition north option D10	S	P	C
An arrival procedure could be created to provide a straight-in transition from the west for Runway 05 at MAN. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the interaction between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not fully comply with the Design Principle Safety. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would create interactions with traffic for LPL and not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.			
Transition north option E11	S	P	C
This option is based on IAF5 which is co-located with the option 23L/23R North 3A. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.			
Transition north option F12	S	P	C
This option is based on IAF6, it is co-located with option 23L/23R North 6A, which is the approximate position of the current ROSUN hold. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.			

26. Runways 05L/05R 2,500ft FAF Transition North

26.1. Runways 05L/05R 2,500ft FAF Transition North Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1B	IAF = STEAK This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operations. It is designed to facilitate a CDA profile to all runways. (Runway 05L – 4.24%/2.43° with 2.5nm Flat Segment). (Runway 05R - 3.96%/2.27° with 2.5nm Flat Segment).	A3 (Formerly option 3)	Option B was considered which was a direct route from a proposed hold close to the MIRSI hold. This may conflict with LPL arrivals. The option does not align with the Design Principle Safety.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

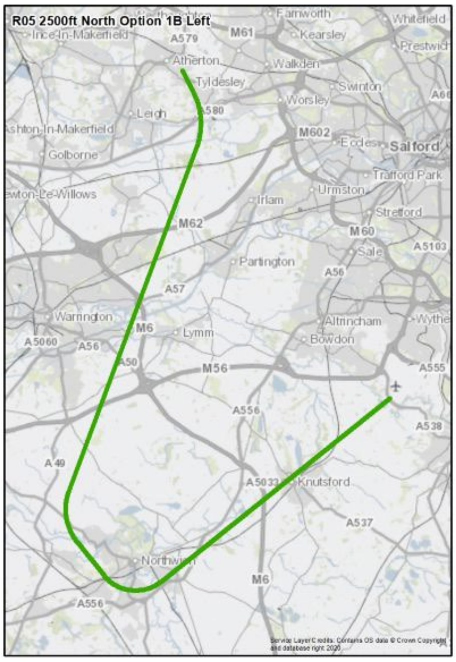
2B	IAF = STEAK This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton. It is designed to facilitate a CDA profile to all runways. This option is longer than 1B and has a slightly less optimum CDA profile. (Runway 05L - 3.79%/2.17° with 2.5nm Flat Segment). (Runway 05R – 3.53%/2.02° with 2.5nm Flat Segment).	B4 (Formerly Option 4)	Option C was considered which was a direct route from a position north-west of the MIRSI hold This may conflict with LPL arrivals. The option does not align with the Design Principle Safety.		
6B	IAF = IAF1 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Wigan and has been designed to reduce potential interactions with departures. It has a better CDA profile than options 1B and 2B. (Runway 05L – 4.3%/2.46° with 2.5nm Flat Segment). (Runway 05R – 4.06%/2.33° with 2.5nm Flat Segment).	C5 (Formerly Option 5)	Option D was considered which was a direct route from a position north-west of the MIRSI hold. This may conflict with LPL arrivals. The option does not align with the Design Principle Safety.		

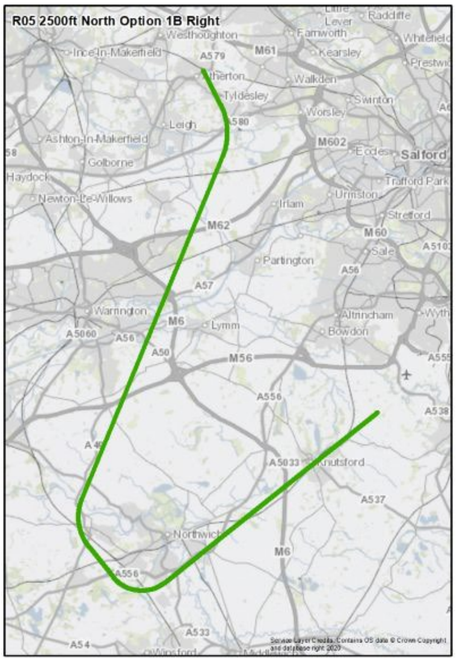
7B	IAF = IAF2 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions with departures. The IAF is further north-east than option 6B and the CDA profile is similar to 2B but not as optimum as 1B and 6B. (Runway 05L - 3.71%/2.12° with 2.5nm Flat Segment). (Runway 05R – 3.52%/2.02° with 2.5nm Flat Segment).	D10	Runway 05 straight-in approach transition. This may conflict with LPL arrivals to Runway 27 and would not align to the NATS upper airspace traffic flow. The option does not align with the Design Principle Safety.		
8B	IAF = IAF3 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of the Middlebrook Retail Park (marked on VFR charts as Middlebrook Stadium). It has been designed to reduce potential interactions with departures and to facilitate a CDA profile to all runways. The IAF is further east than option 6B and 7B and has the least optimum CDA profile of all the above options. (Runway 05L - 3.65%/2.09° with 2.5nm Flat Segment). (Runway 05R – 3.45%/1.98° with 2.5nm Flat Segment).	E11	IAF = IAF5 This option has an IAF co-located with the IAF for the 23L/23R option 3B. It was considered as an option to facilitate a CDA to both runways; however, the profile for runway 05L/05R would be sub optimal (<1.5°). This option does not align with the Design Principle Policy.		

9B	IAF = IAF4 This option has an IAF at 7,000ft to the north of the airport in the vicinity of Bolton and is designed to facilitate a CDA profile to all runways. It is co-located with the IAF for the Runways 23L/23R option 7B. It is the longest arrival transition and has the least optimum CDA profile. (Runway 05L – 3.24%/1.86° with 2.5nm Flat Segment). (Runway 05R – 3.07%/1.76° with 2.5nm Flat Segment).	F12	IAF = IAF6 This option has an IAF co-located with the IAF for the 23L/23R option 6B. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). This option does not align with the Design Principle Policy.		

26.2. Runways 05L/05R 2,500ft FAF Transition North Option 1B

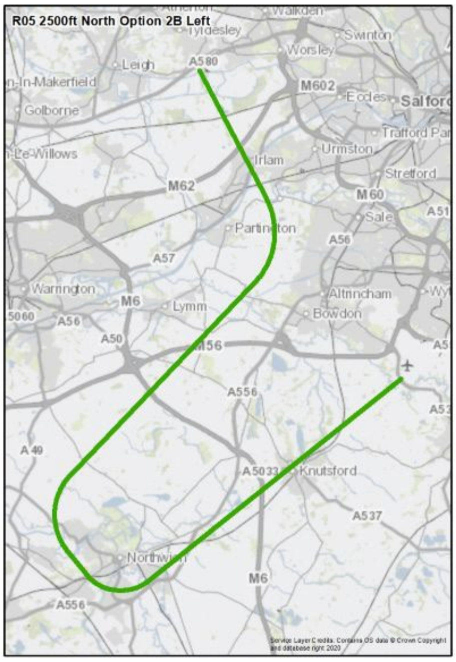
Description	Rationale for inclusion
Option 1B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operations. It is designed to facilitate a CDA profile to all runways. From this location the route turns south-west and splits, heading west of Urmston, Irlam and east of Warrington towards base-leg positions. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 4.24%/2.43° for Runway 05L and 3.96%/2.27° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Emissions: Direct routing and minimal track miles from 7,000ft to FAF. Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Warrington.

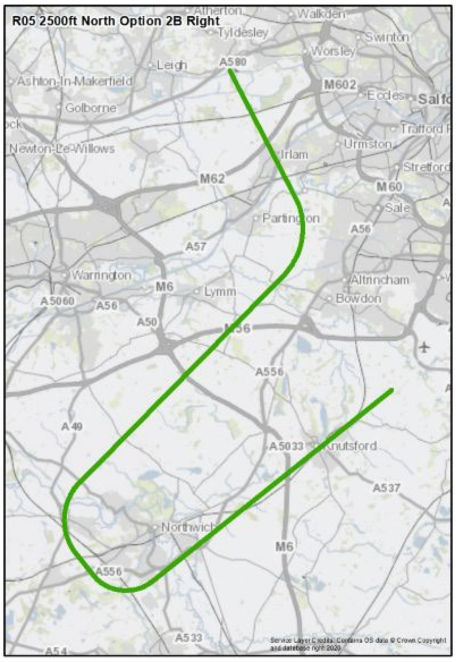




26.3. Runways 05L/05R 2,500ft FAF Transition North Option 2B

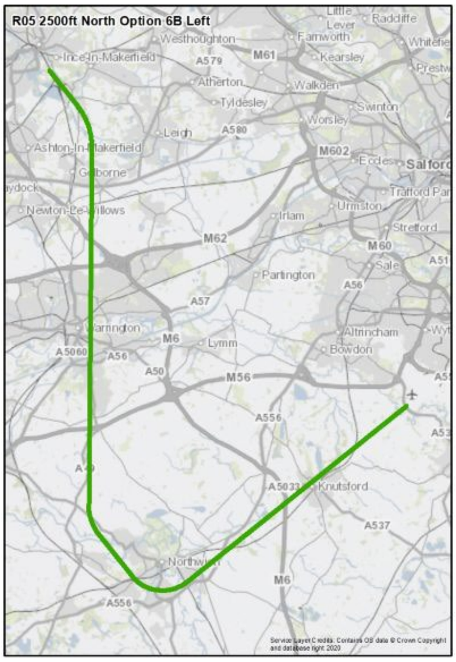
Description	Rationale for inclusion
Option 2B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Atherton and is equidistant to easterly or westerly operation. It is designed to facilitate a CDA profile to all runways. From this location the route follows an initial straight segment towards the airport where it splits before turning right on to the downwind leg overflying Partington. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.79%/2.17° for Runway 05L and 3.53%/2.02° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Warrington, Sale and Altrincham.

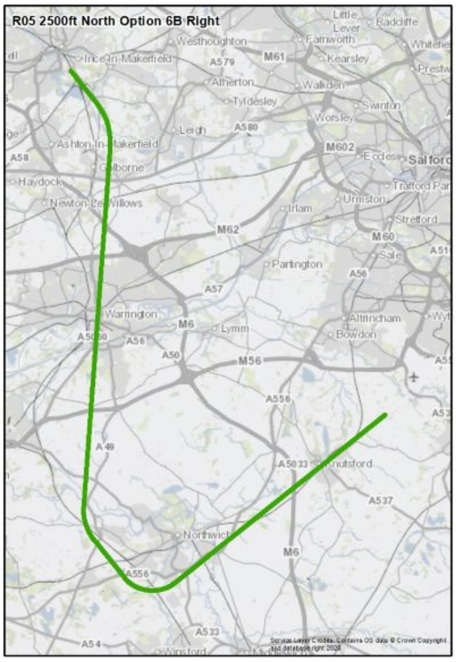




26.4. Runways 05L/05R 2,500ft FAF Transition North Option 6B

Description	Rationale for inclusion
Option 6B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Wigan and has been designed to reduce potential interactions with departures. From this location the route splits and heads south, overflying Warrington. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 4.3%/2.46° for Runway 05L and 4.06%/2.33° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Capacity: Routes intended to reduce interactions with departures. Noise N1: Optimal low noise CDA gradient. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.





26.5. Runways 05L/05R 2,500ft FAF Transition North Option 7B

Description

Option 7B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions with departures.

From this location the route splits and heads south, overflying Warrington. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R.

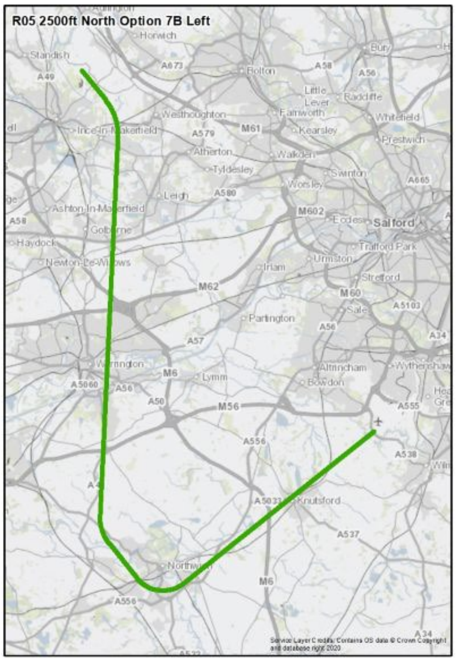
The descent gradient to the FAF is 3.71%/2.12° for Runway 05L and 3.52%/2.02° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.

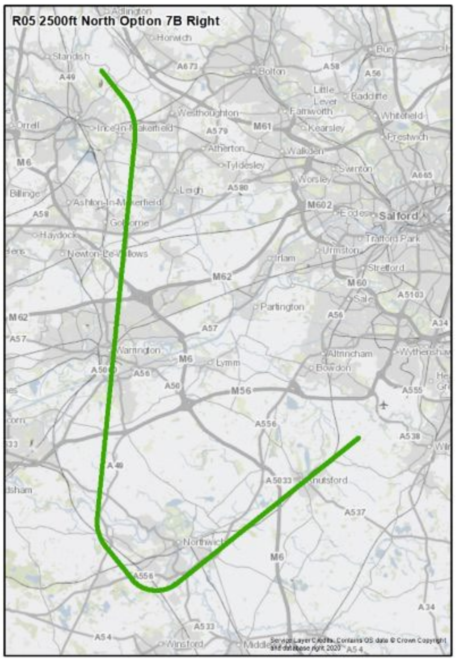
Rationale for inclusion

Capacity: Routes intended to reduce interactions with departures.

Noise N1: Optimal low noise CDA gradient.

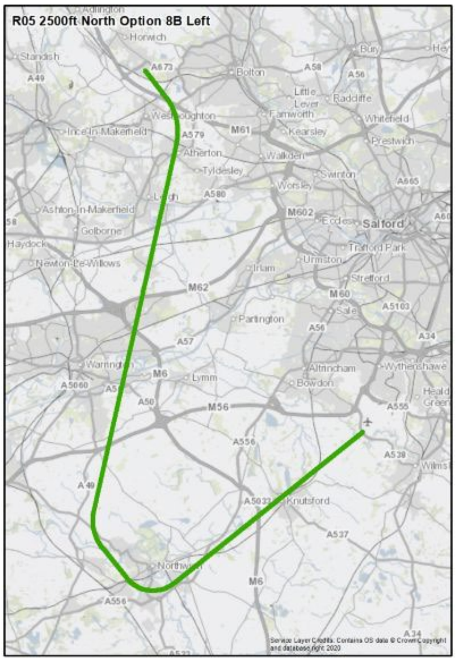
Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

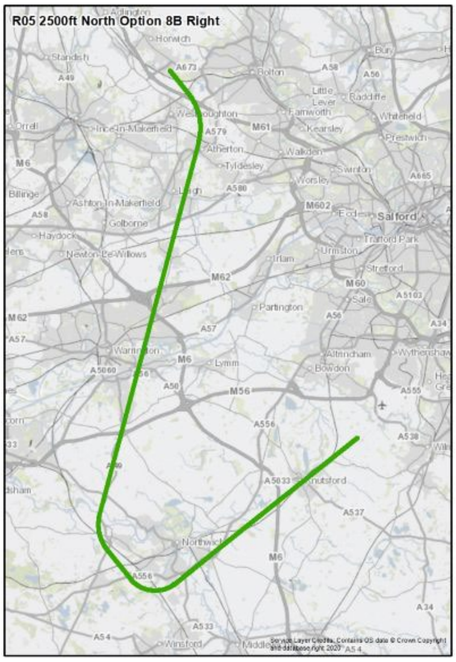




26.6. Runways 05L/05R 2,500ft FAF Transition North Option 8B

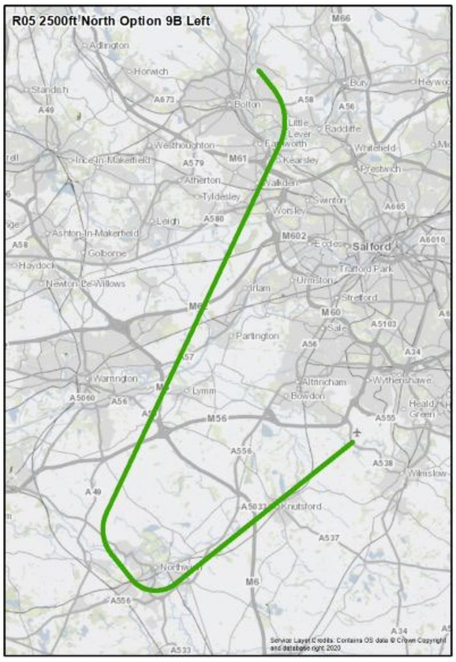
Description	Rationale for inclusion
Option 8B has an IAF at 7,000ft to the north-west of the airport in the vicinity of the Middlebrook Retail Park (marked on VFR charts as Middlebrook Stadium). It has been designed to reduce potential interactions with departures and to facilitate a CDA profile to all runways. From this location the route splits, heads south-west and routes to the east of Warrington. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.65%/2.09° for Runway 05L and 3.45%/1.98° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/23L/23R). **Noise N1**: Optimal low noise CDA gradient. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

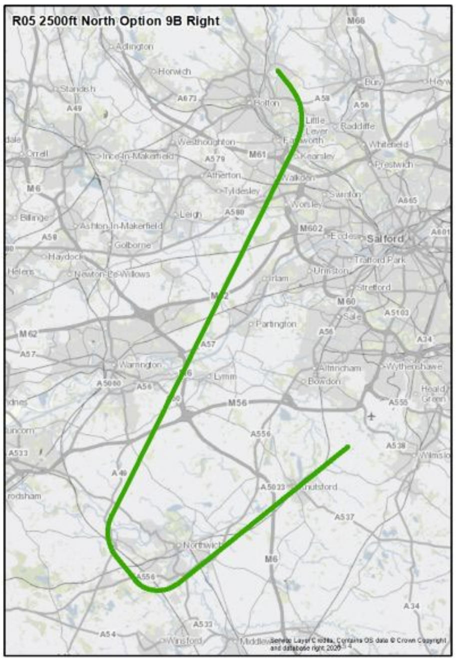




26.7. Runways 05L/05R 2,500ft FAF Transition North Option 9B

Description	Rationale for inclusion
Option 9B has an IAF at 7,000ft to the north of the airport in the vicinity of Bolton and is designed to facilitate a CDA profile to all runways. From this location the route splits, heads south-west and tracks to the east of Warrington. Both routes then turn left to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.24%/1.86° for Runway 05L and 3.07%/1.76° for Runway 05R. These gradients at the lower end of the optimum range for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Warrington.





26.8. Runways 05L/05R – 2,500ft FAF Transitions North: Viable but Poor Fit Options

Transition north option A3	S	P	C

This was initially designed as **option 3** and is a route based on an IAF located at the position of a NATS proposed hold close to the current MIRSI hold.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the interaction between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not fully comply with the Design Principle Safety.

Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would create interactions with traffic for LPL and not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.

Transition north option B4	S	P	C

This was initially designed as **option 4** and is a route based on an IAF located to the east of the current MIRSI hold.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not comply with the Design Principle Safety.

Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. By creating interactions with traffic for other airports this option would not comply with this initiative (and therefore the Design Principle Policy) as it has the potential to require ATC intervention to resolve interactions.

Transition north option C5	S	P	C

This was initially designed as **option 5** and is a design based on an IAF located at the position of a NATS proposed hold to the north-west of the current MIRSI hold.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not comply with the Design Principle Safety.

Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. By creating interactions with traffic for other airports this option would not comply with this initiative (and therefore the Design Principle Policy) as it has the potential to require ATC intervention to resolve interactions.

In addition, the distance of this IAF from the runways may result in options being unable to provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option C10	S	P	C

An arrival procedure could be created to provide a straight-in transition from the west for Runway 05 at MAN.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the interaction between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not fully comply with the Design Principle Safety.

Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would create interactions with traffic for LPL and not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.

Transition north option E11	S	P	C

This option is based on IAF5 which is co-located with the option 23L/23R North 3B. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option F12	S	P	C

This option is based on IAF6, it is co-located with option 23L/23R North 6B, which is the approximate position of the current ROSUN hold. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

27. Runways 05L/05R 2,000ft FAF Transition North

27.1. Runways 05L/05R 2,000ft FAF Transition North Options Summary Table

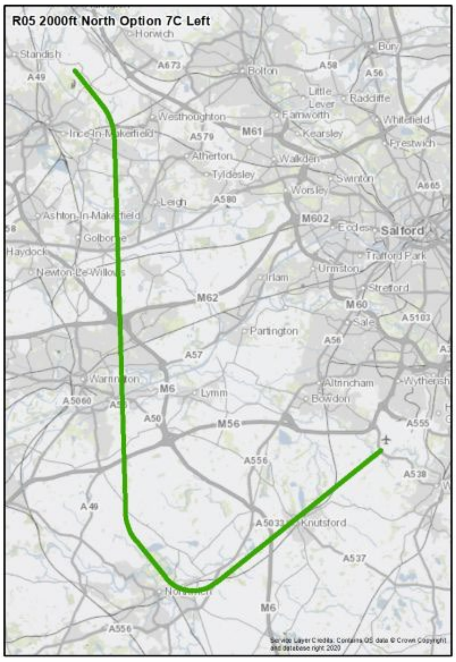
As detailed in section 5.11.3 and 19.5.2 design options to this FAF have only been applied from a limited number of IAFs from the northern envelope. This is in response to bilateral discussions with LPL airport, which discussed the interaction between LPL 09 departures and MAN 05 arrivals from the north. One possible solution is to reduce the length of the MAN final approach by moving the position of the MAN final approach fix further east, which equates to a reduced FAF altitude of 2,000ft. These options respond to this feedback and will be used to inform ongoing bilateral discussions with LPL, NERL and ACOG as part of Step 3A activities. In addition, because of the reduced distance from touchdown of these options, work will be undertaken with airlines to investigate their flyability.

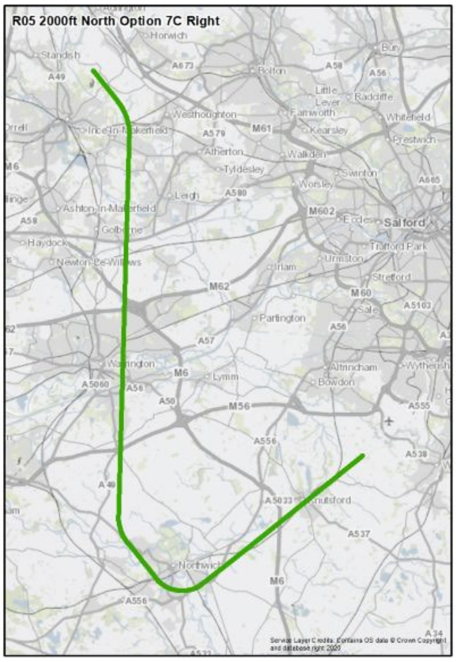
Viable and Good Fit		Viable but Poor Fit		Unviable	
7C	IAF = IAF2 This option has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions and increase the lateral separation from LPL Runway 27 arrivals. (Runway 05L – 4.33%/2.48° with 2.5nm Flat Segment). (Runway 05R – 4.12%/2.36° with 2.5nm Flat Segment).			U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

12	IAF = IAF11 Option 12 has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions and increase the lateral separation from LPL Runway 27 arrivals. (Runway 05L – 3.94%/2.26° with 2.5nm Flat Segment). (Runway 05R – 3.77%/2.16° with 2.5nm Flat Segment).				
13	IAF = IAF12 Option 13 has an IAF at 7,000ft to the north-north-west of the airport in the vicinity of Worsley and has been designed to reduce potential interactions and increase the lateral separation from LPL runways. (Runway 05L – 4.37%/2.50° with 2.5nm Flat Segment). (Runway 05R – 4.09%/2.34° with 2.5nm Flat Segment).				

27.2. Runways 05L/05R 2,000ft FAF Transition North Option 7C

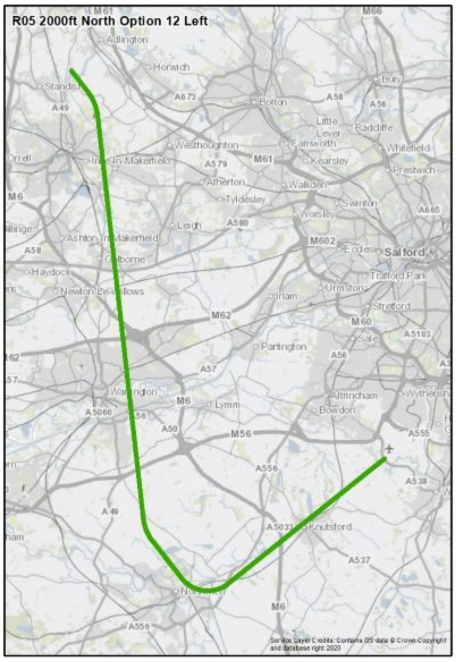
Description	Rationale for inclusion
Option 7C has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions and increase the lateral separation from LPL Runway 27 arrivals. From the Aspull area, east of Wigan, the route splits, and heads south overflying Warrington. Both routes then turn left to establish aircraft on final approach at 2,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 4.33%/2.48° for Runway 05L and 4.12%/2.36° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: The route seeks to reduce interaction with LPL. Noise N1: Optimal low noise CDA gradient. Emissions: Direct routing and minimal track miles from 7,000ft to FAF. Capacity: Routes intended to reduce interactions with departures.

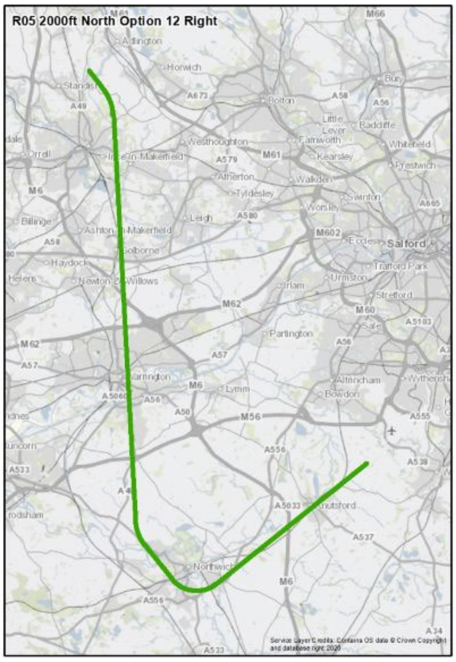




27.3. Runways 05L/05R 2,000ft FAF Transition North Option 12

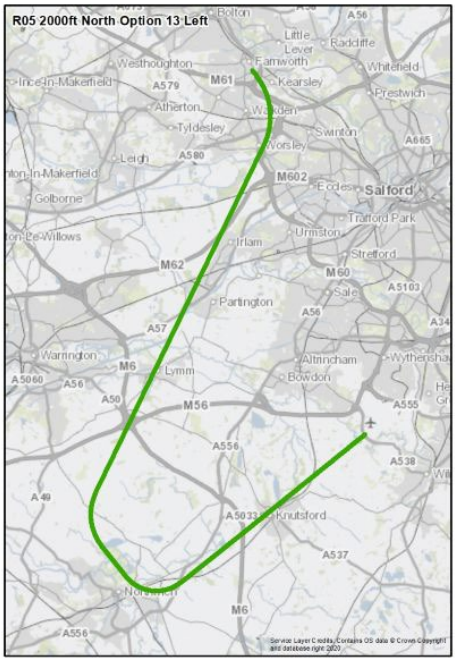
Description	Rationale for inclusion
Option 12 has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull and has been designed to reduce potential interactions and increase the lateral separation from LPL Runway 27 arrivals. It is similar to 7C, except the right turn direct to the base leg to join the approach is made earlier and aircraft route more directly overhead Warrington. The descent gradient to the FAF is 3.94%/2.26° for Runway 05L and 3.77%/2.16° for Runway 05R. These gradients are within the optimum range for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: The route seeks to reduce interaction with LPL. **Noise N1**: Optimal low noise CDA gradient. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF. **Capacity**: Routes intended to reduce interactions with departures.

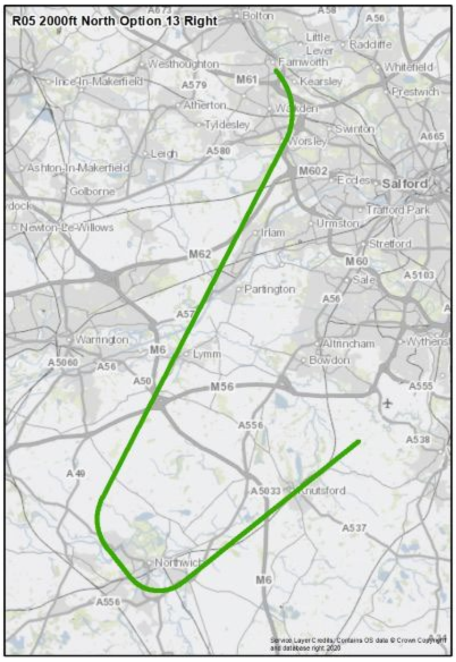




27.4. Runways 05L/05R 2,000ft FAF Transition North Option 13

Description	Rationale for inclusion
Option 13 has an IAF at 7,000ft to the north-north-west of the airport in the vicinity of Worsley, co-located with the IAF for option 23L/23R North 11A and has been designed to reduce potential interactions and increase the lateral separation from LPL Runway 27 arrivals. From the Worsley area, west of Prestwich, the route splits, and heads south-west just to the west of Irlam and overflying Cadishead and Lymm. Both routes then turn left to establish aircraft on final approach at 2,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 4.37%/2.50° for Runway 05L and 4.09%/2.34° for Runway 05R. These gradients are optimum for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: The route seeks to reduce interaction with LPL. Noise N1: Optimal low noise CDA gradient. Emissions: Direct routing and minimal track miles from 7,000ft to FAF. Capacity: Routes intended to reduce interactions with departures.





28. Runways 05L/05R 3,000ft FAF Transition South

28.1. Runways 05L/05R 3,000ft FAF Transition South Options Summary Table

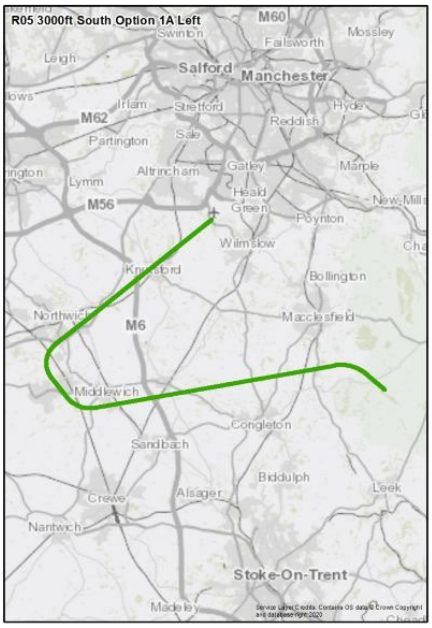
Viable and Good Fit		Viable but Poor Fit		Unviable	
1A	IAF = TURKY This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of Meerbrook and is equidistant to easterly or westerly operation. It is designed to facilitate a CDA profile to all runways. (Runway 05L - 3.45%/1.98° with 2.5nm Flat Segment). (Runway 05R - 3.28%/1.88° with 2.5nm Flat Segment).	A2 (Formerly option 2)	An option was considered that delivered alternative route from IAF 7, tracking close to the airport before turning downwind. The route may conflict with Runway 05 southbound departure. This option does not align with the design principles Safety or Policy.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

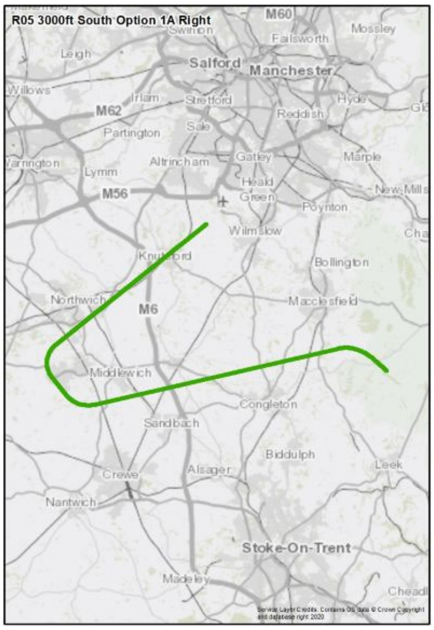
6A	IAF = IAF7 This option has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is designed to facilitate a CDA profile to all runways. It has less track miles than 1A and a slightly more optimum CDA profile. (Runway 05L - 3.55%/2.03° with 2.5nm Flat Segment). (Runway 05R – 3.38%/1.94° with 2.5nm Flat Segment).	B3	Runway 05 straight-in approach transition. This may conflict with LPL arrivals to Runway 27 and would not align to the NATS upper airspace traffic flow. The option does not align with the Design Principle Safety.		
7A	IAF = IAF8 This option has an IAF at 7,000ft co-located at the existing DAYNE hold. It is designed to facilitate a CDA profile to all runways. This has more track miles than 1A and 6A and a slightly less optimum CDA profile. (Runway 05L - 3.17%/1.82° with 2.5nm Flat Segment). (Runway 05R – 3.01%/1.73° with 2.5nm Flat Segment).	C4 (Formerly Option 4)	An option was considered that was a direct route from a new IAF to the south of Daventry CTA2. This option would fall outside of the design envelope as shown in section 24.3 and did not adhere to the airspace containment policy ensuring aircraft do not operate within 3nm of CAS. This option does not align with the Design Principle Policy.		

8A	IAF = IAF9 This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of Buxton. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. The option has the most track miles and least optimum CDA profile. (Runway 05L – 2.72%/1.56° with 2.5nm Flat Segment). (Runway 05R – 2.63%/1.51° with 2.5nm Flat Segment).	D5 (Formerly Option 5)	An option was considered that was a direct route from a new IAF located south-east of the existing DAYNE hold. The route does not adhere to the airspace containment policy ensuring aircraft do not operate within 3nm of CAS. This option does not align with the Design Principle Policy.		
9A	IAF = IAF10 This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. (Runway 05L – 3.21%/1.84° with 2.5nm Flat Segment). (Runway 05R – 3.08%/1.77° with 2.5nm Flat Segment).				

28.2. Runways 05L/05R 3,000ft FAF Transition South Option 1A

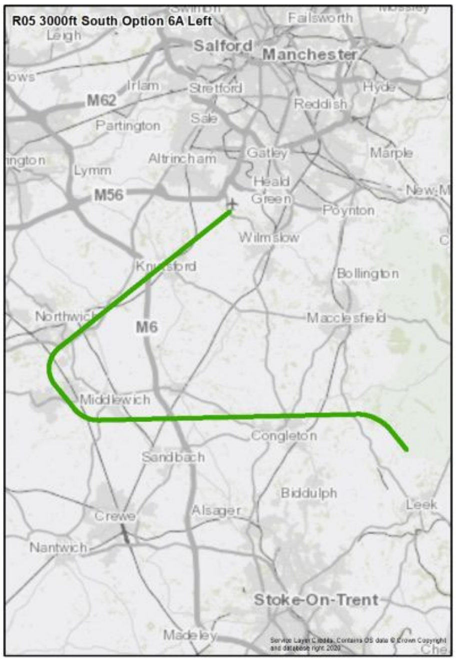
Description	Rationale for inclusion
Option 1A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Meerbrook and is equidistant to easterly or westerly operation. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, to the south of Macclesfield, north of Congleton. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.45%/1.98° for Runway 05L and 3.28%/1.88° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

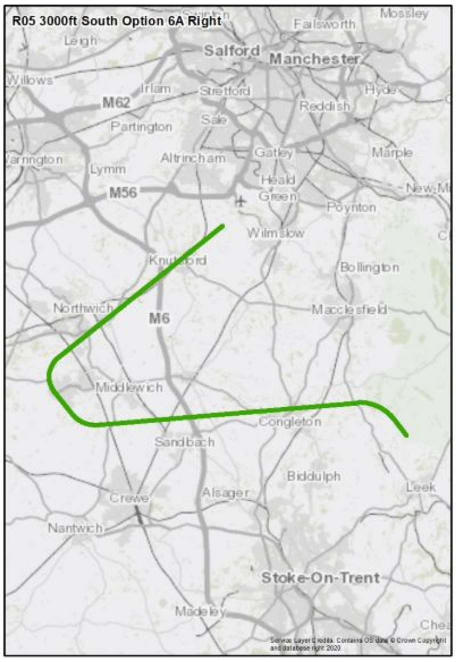




28.3. Runways 05L/05R 3,000ft FAF Transition South Option 6A

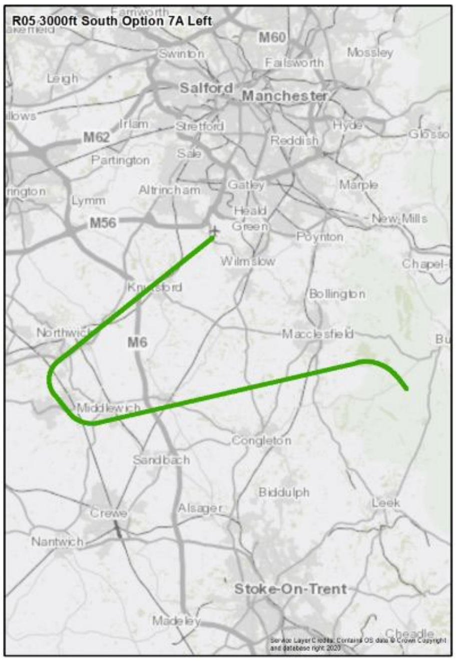
Description	Rationale for inclusion
Option 6A has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is co-located with the IAF for the 23L/23R option 9A and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, south of Holmes Chapel, north of Sandbach and over Middlewich. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 05L or 05R. This is the southernmost option and has been designed to maintain 3nm separation from the boundary of CAS in accordance with the CAA containment policy. The descent gradient to the FAF is 3.55% 2.03° for Runway 05L and 3.38%/1.94° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Holmes Chapel and Sandbach. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

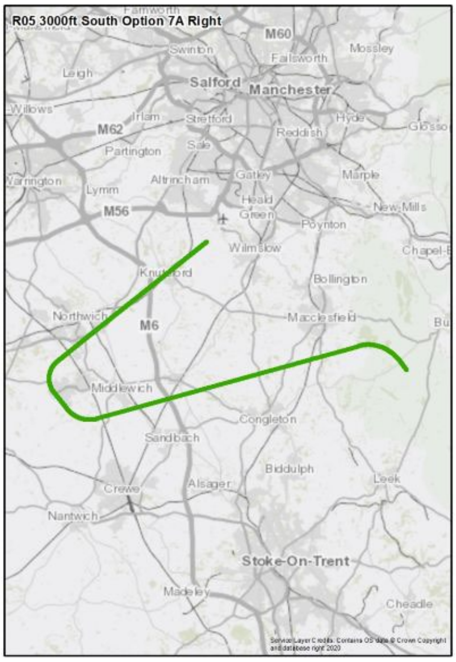




28.4. Runways 05L/05R 3,000ft FAF Transition South Option 7A

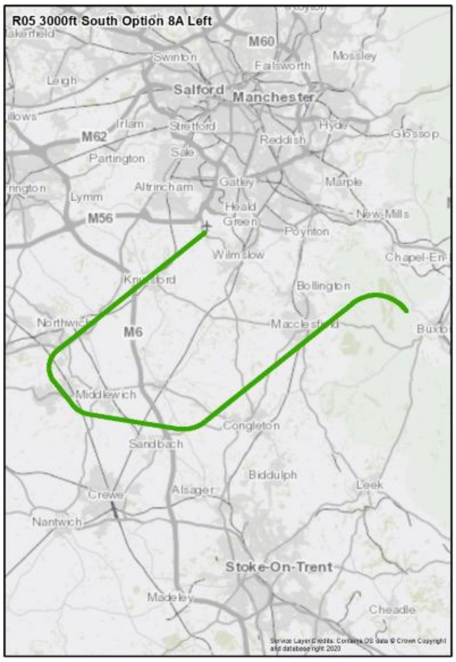
Description	Rationale for inclusion
Option 7A has an IAF at 7,000 ft co-located at the existing DAYNE Hold. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, south of Macclesfield, north of Congleton and Sandbach and then over Middlewich. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.17%/1.82° for Runway 05L and 3.01%/1.73° Runway 05R. These gradients are just below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

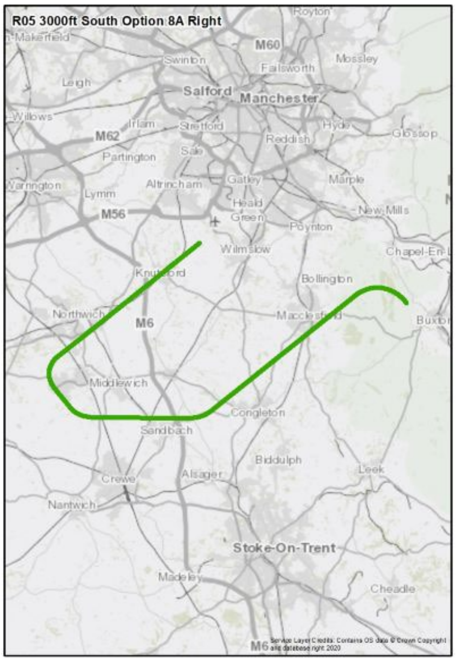




28.5. Runways 05L/05R 3,000ft FAF Transition South Option 8A

Description	Rationale for inclusion
Option 8A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Buxton. From this location the route splits and turns downwind, to the south of Macclesfield, just north of Congleton, then west just north of Sandbach and over Middlewich to establish aircraft on the final approach at 3,000ft for either Runway 05L or 05R. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. The descent gradient to the FAF is 2.72%/1.56° for Runway 05L and 2.63%/1.51° Runway 05R. These gradients are below the optimum for low noise approaches but just within the acceptable range for CDAs defined within ICAO guidance.	**Capacity:** Routes intended to reduce interactions with departures. **Noise N1:** Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach.





28.6. Runways 05L/05R 3,000ft FAF Transition South Option 9A

Description

Option 9A has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. It is co-located with the IAF for the 23L/23R option 8A and is designed to facilitate a CDA profile to all runways.

From this location the route splits and turns downwind, south-west to Congleton, then west just north of Sandbach and over Middlewich before turning on to the final approach at 3,000ft for either Runway 05L or 05R.

The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures.

The descent gradient to the FAF is 3.21%/1.84° for Runway 05L and 3.08%/1.77° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.

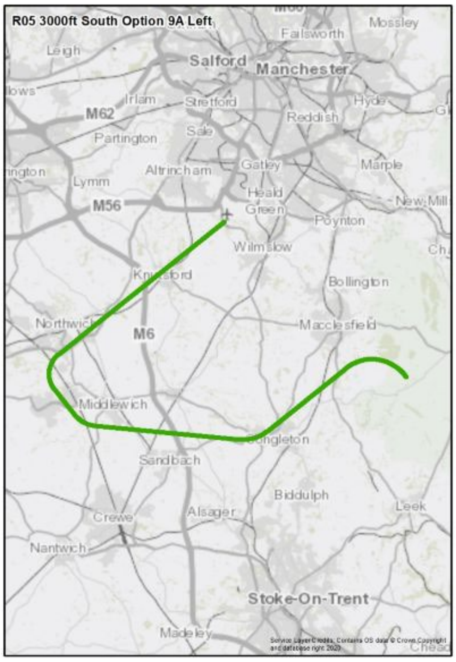
Rationale for inclusion

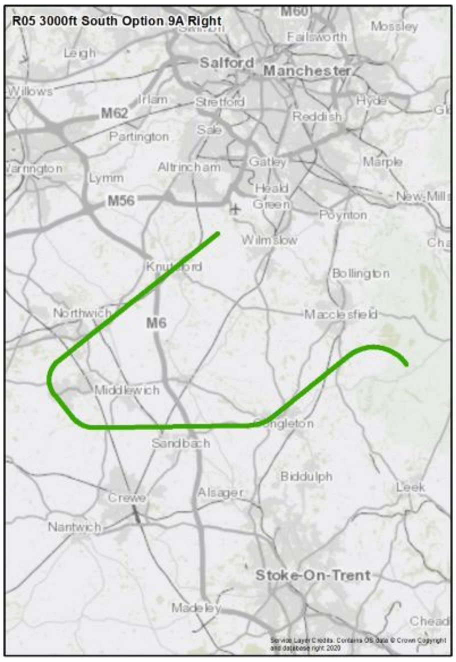
Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R).

Capacity: Routes intended to reduce interactions with departures.

Noise N1: Optimal low noise CDA gradient.

Designed to limit the impact of noise by avoiding Macclesfield, Holmes Chapel and Sandbach.





28.7. Runways 05L/05R – 3,000ft FAF Transitions South: Viable but Poor Fit Options

Transition south option A2	S	P	C
This was initially designed as **option 2** and is a route based on an IAF7 located to the south-east of the airport. The route has an initial straight leg from the IAF towards the airport where aircraft would make a left turn onto a downwind leg. <u>Safety</u>: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and MAN Runway 05 southbound departures. As a result, this option was deemed to not comply with the Design Principle Safety.			
Transition south option B3	S	P	C
This was initially designed as **option 3** this procedure could be created to provide a straight-in transition from the west for Runway 05 at MAN. <u>Safety</u>: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the interaction between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not fully comply with the Design Principle Safety. <u>Policy</u>: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would create interactions with traffic for LPL and not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.			
Transition south option C4	S	P	C
This was initially designed as **option 4** and is a route based on an IAF located south-east of the airport towards the south of Daventry CTA2. <u>Policy</u>: This option would fall outside of the Viable and Good fit design envelope as shown at Figure 14 and would also not adhere to the CAA containment policy statement requiring aircraft to remain within 3nm of the CAS boundary.			
Transition south option D5	S	P	C
This was initially designed as **option 5** and is a route based on an IAF located south-east of the existing DAYNE hold. <u>Policy</u>: This option would not adhere to the CAA containment policy requiring aircraft to remain within 3nm of the CAS boundary.			

29.Runways 05L/05R 2,500ft FAF Transition South

29.1. Runways 05L/05R 2,500ft FAF Transition South Options Summary Table

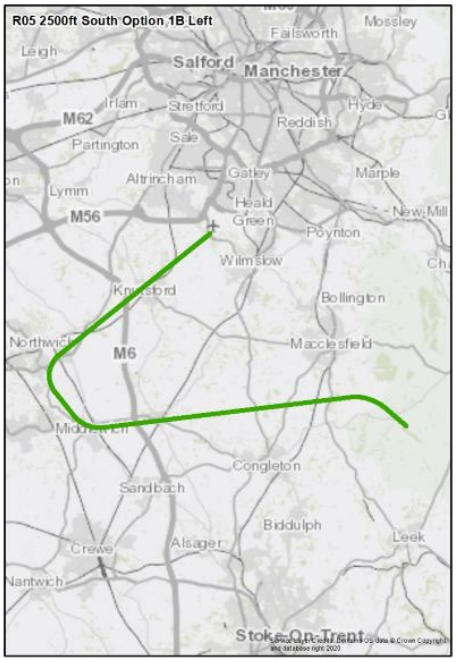
Viable and Good Fit		Viable but Poor Fit		Unviable	
1B	IAF = TURKY This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of Meerbrook and is equidistant to easterly or westerly operation. It is designed to facilitate a CDA profile to all runways. (Runway 05L – 4.17%/2.39° with 2.5nm Flat Segment). (Runway 05R - 3.95%/2.26° with 2.5nm Flat Segment).	B2	An option was considered that delivered alternative route from IAF 7, tracking close to the airport before turning downwind. The route may conflict with Runway 05 southbound departure. This option does not align with the Design Principle Safety.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

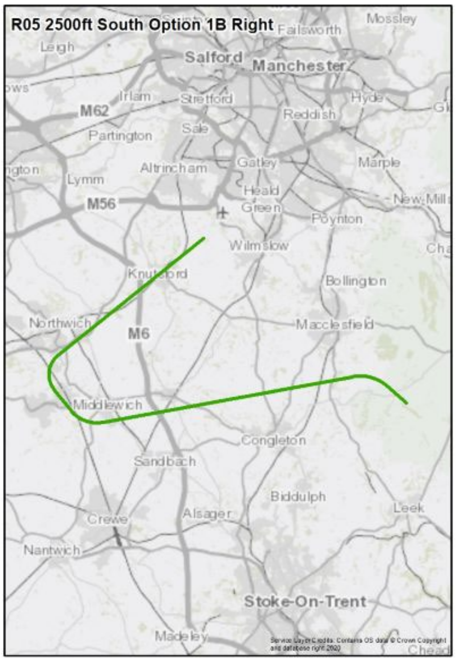
6B	IAF = IAF7 This option has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is designed to facilitate a CDA profile to all runways. (Runway 05L – 4.26%/2.44° with 2.5nm Flat Segment). (Runway 05R – 4.06%/2.33° with 2.5nm Flat Segment).	A3	Runway 05 straight-in approach transition. This may conflict with LPL arrivals to Runway 27 and would not align to the NATS upper airspace traffic flow. The option does not align with the Design Principle Safety.		
7B	IAF = IAF8 This option has an IAF at 7,000ft co-located at the existing DAYNE hold. It is designed to facilitate a CDA profile to all runways. (Runway 05L - 3.82%/2.19° with 2.5nm Flat Segment). (Runway 05R – 3.62%/2.08° with 2.5nm Flat Segment).	C4	An option was considered that was a direct route from a new IAF to the south of Daventry CTA2. This option would fall outside of the design envelope as shown in section **Error! Reference source not found.** and does not adhere to the airspace containment policy ensuring aircraft do not operate within 3nm of CAS. This option does not align with the Design Principle Policy.		

8B	IAF = IAF9 This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of Buxton. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. (Runway 05L – 3.2%/1.83° with 2.5nm Flat Segment). (Runway 05R – 3.11%/1.78° with 2.5nm Flat Segment).	D5	An option was considered that was a direct route from a new IAF located south-east of the existing DAYNE hold. The route does not adhere to the airspace containment policy ensuring aircraft do not operate within 3nm of CAS This option does not align with the Design Principle Policy.		
9B	IAF = IAF10 This option has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. (Runway 05L – 3.82%/2.19° with 2.5nm Flat Segment). (Runway 05R – 3.67%/2.1° with 2.5nm Flat Segment).				

29.2. Runways 05L/05R 2,500ft FAF Transition South Option 1B

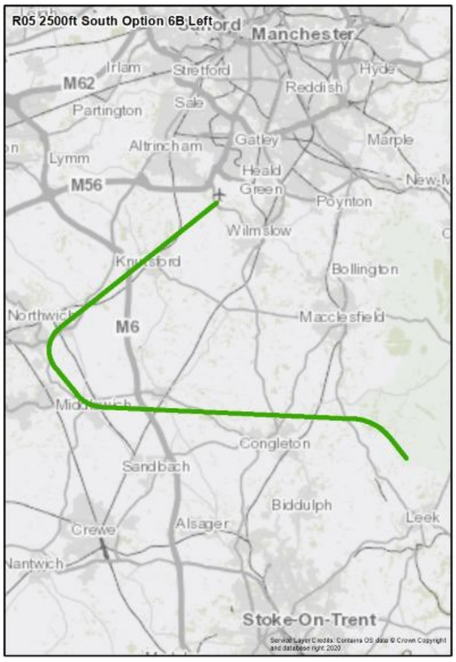
Description	Rationale for inclusion
Option 1B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Meerbrook and is equidistant to easterly or westerly operation. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, to the south of Macclesfield, north of Congleton and over Middlewich. Both routes then turn right to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 4.17%/2.39° for Runway 05L and 3.95%/2.26° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

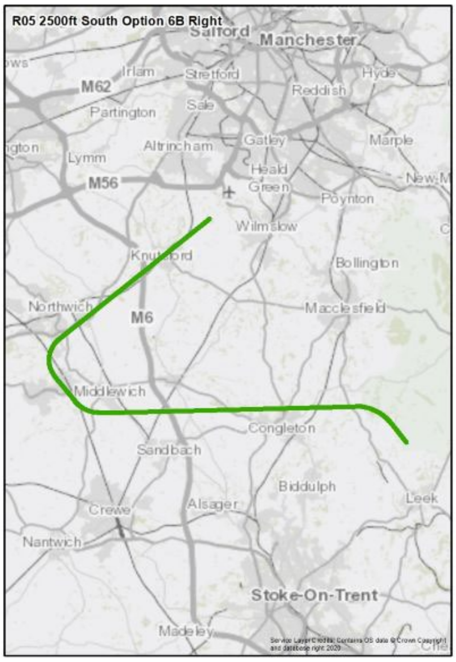




29.3. Runways 05L/05R 2,500ft FAF Transition South Option 6B

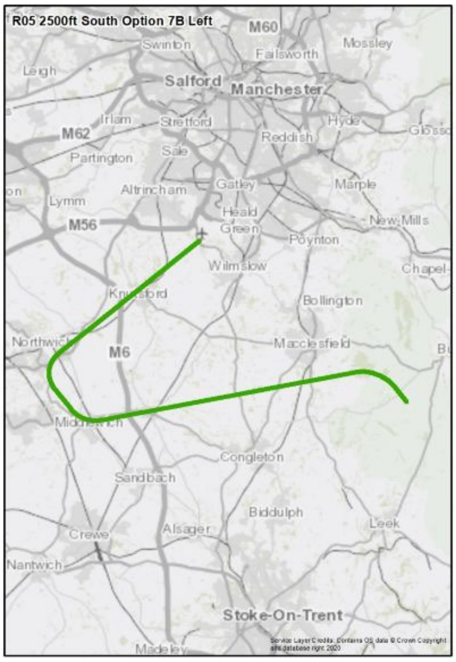
Description	Rationale for inclusion
Option 6B has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, south of Holmes Chapel, north of Sandbach and over Middlewich. Both routes then turn right to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. This is the southernmost option and has been designed to maintain 3nm separation from the boundary of CAS in accordance with the CAA containment policy. The descent gradient to the FAF is 4.26%/2.44° for Runway 05L and 4.06%/2.33° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Holmes Chapel and Sandbach. **Emissions:** Direct routing and minimal track miles from 7,000ft to FAF.

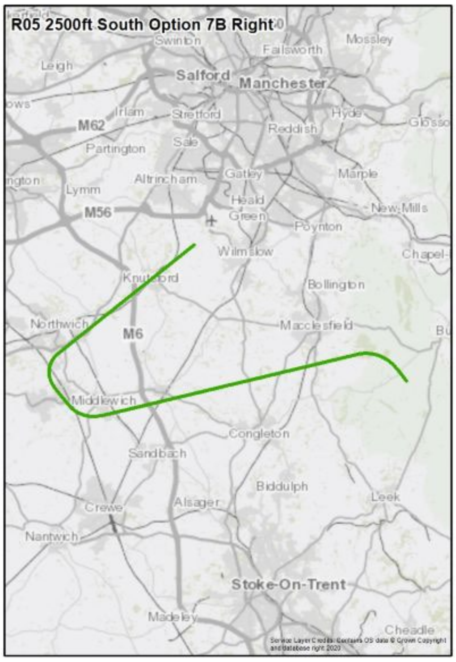




29.4. Runways 05L/05R 2,500ft FAF Transition South Option 7B

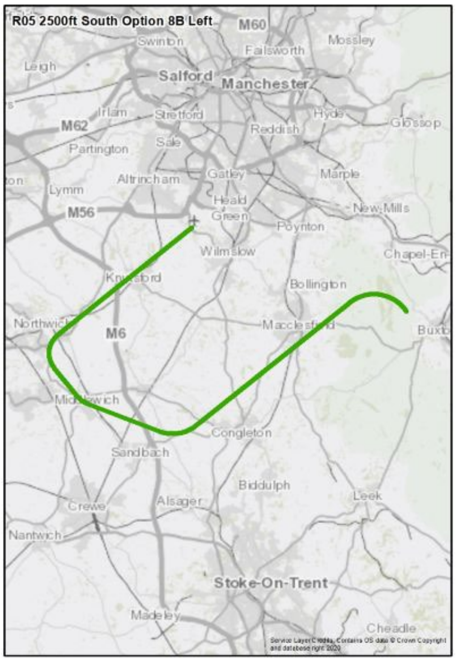
Description	Rationale for inclusion
Option 7B has an IAF at 7,000ft co-located at the existing DAYNE hold. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads west, south of Macclesfield, north of Congleton and over Middlewich. Both routes then turn right to establish aircraft on final approach at 2,500ft for either Runway 05L or 05R. The descent gradient to the FAF is 3.82%/2.19° for Runway 05L and 3.62%/2.08° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

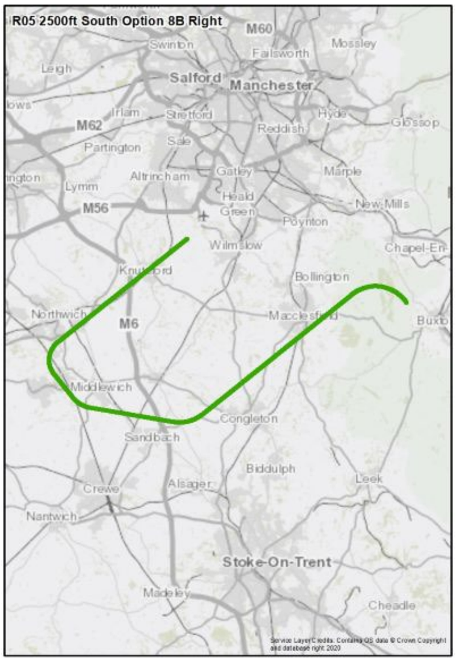




29.5. Runways 05L/05R 2,500ft FAF Transition South Option 8B

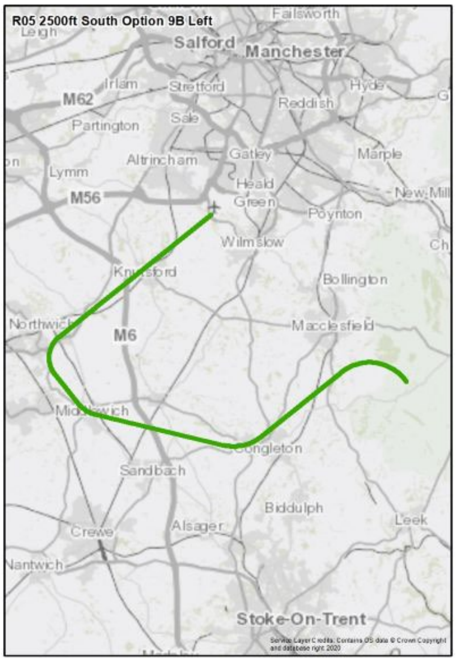
Description	Rationale for inclusion
Option 8B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Buxton. From this location the route splits and turns downwind, to the south of Macclesfield, just north of Congleton, then west just north of Sandbach and over Middlewich to establish aircraft on the final approach at 2,500ft for either Runway 05L or 05R. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. The descent gradient to the FAF is 3.2%/1.83° for Runway 05L and 3.11%/1.78° Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Capacity:** Routes intended to reduce interactions with departures. **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield, Congleton and Sandbach.

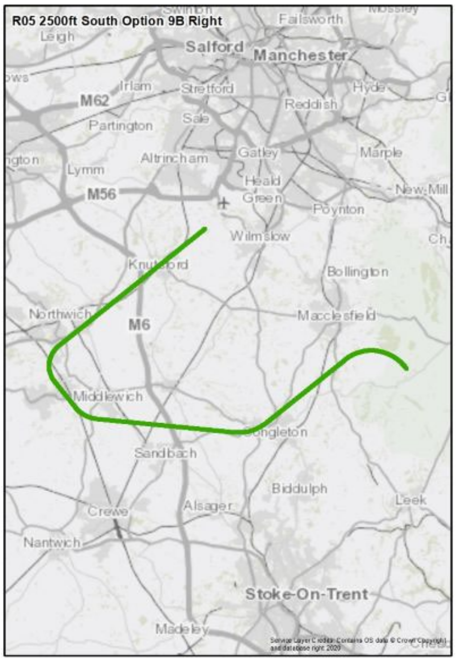




29.6. Runways 05L/05R 2,500ft FAF Transition South Option 9B

Description	Rationale for inclusion
Option 9B has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. From this location the route splits and turns downwind, south-west to Congleton, then west just north of Sandbach and over Middlewich before turning on to the final approach at 2,500ft for either Runway 05L or 05R. The route has been designed to replicate the existing vectoring patterns used by ATC and is anticipated to reduce interactions with Runway 05 southbound departures. The descent gradient to the FAF is 3.82%/2.19° for Runway 05L and 3.67%/2.1° for Runway 05R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Capacity:** Routes intended to reduce interactions with departures. **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield, Holmes Chapel and Sandbach.





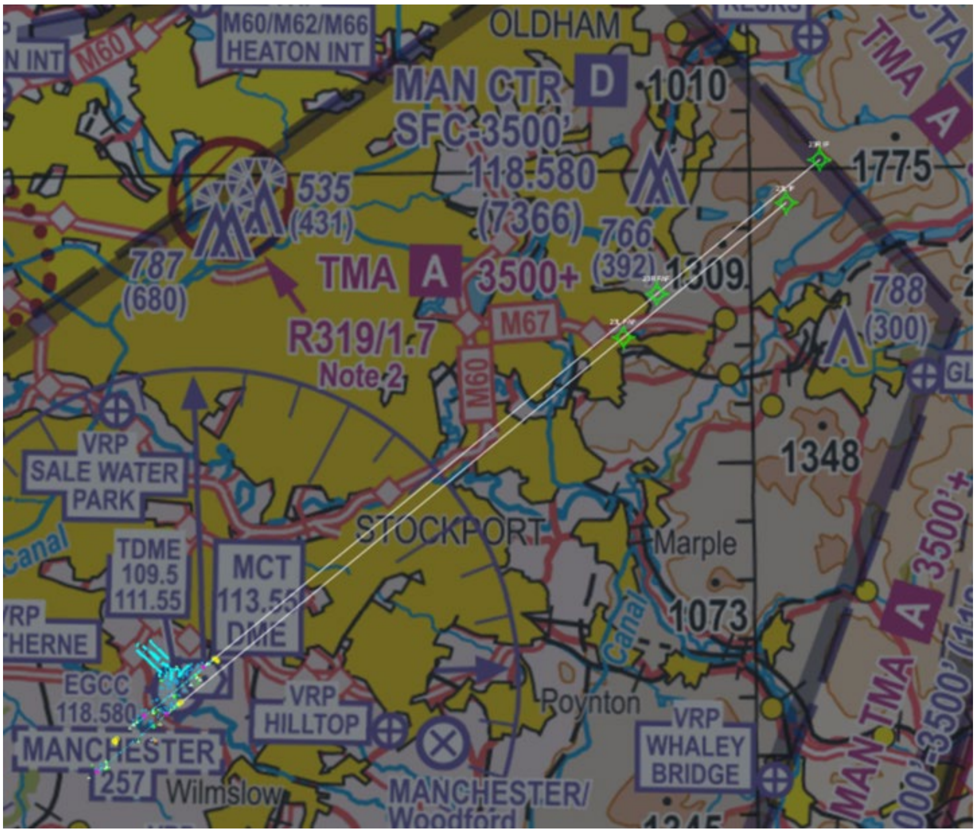
29.7. Runways 05L/05R – 2,500ft FAF Transitions South: Viable but Poor Fit Options

Transition south option A2	S	P	C
This was initially designed as option 2 and is a route based on an IAF7 located to the south-east of the airport. The route has an initial straight leg from the IAF towards the airport where aircraft would make a left turn onto a downwind leg. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and MAN Runway 05 southbound departures. As a result, this option was deemed to not comply with the Design Principle Safety.			
Transition south option B3	S	P	C
An arrival procedure could be created to provide a straight-in transition from the west for Runway 05 at MAN. Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the interaction between MAN arrivals and arrivals to LPL. As a result, this option was deemed to not fully comply with the Design Principle Safety. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would create interactions with traffic for LPL and not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.			
Transition south option C4	S	P	C
This was initially designed as option 4 and is a route based on an IAF located south-east of the airport towards the south of Daventry CTA2. Policy: This option would fall outside of the Viable and Good fit design envelope and would also not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the boundary of CAS.			
Transition south option D5	S	P	C
This was initially designed as option 5 and is a route based on an IAF located south-east of the existing DAYNE hold. Policy: This option would not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the boundary of CAS.			

30. Final Approach Runways 23L/23R – 3,500ft FAF

This final approach provides a 3° final approach descent gradient with a FAF of 3,500ft. The approach is aligned with the runway centreline, which aims to align with the track of the currently published ILS procedure for Runways 23L/23R.

The intermediate segment length that precedes this segment caters for any turns in the transition at the IF of up to 90°, which provides sufficient distance for turn anticipation and the MSD for a speed of 185 KIAS.



31. Final Approach Runways 23L/23R – 3,000ft FAF

This final approach provides a 3° final approach descent gradient with a FAF of 3,000ft. The approach is aligned with the runway centreline, which aims to align with the track of the currently published ILS procedure for Runways 23L/23R.

The intermediate segment length that precedes this segment caters for any turns in the transition at the IF of up to 90°, which provides sufficient distance for turn anticipation and the MSD for a speed of 185 KIAS.

32. Runways 23L/23R – Approach Transitions

32.1. Introduction to 23L/23R Design Envelope

This envelope has been created for traffic routing from 7,000ft to the RNP approach for Runways 23L/23R. It includes transitions to the approaches from various locations at which aircraft descend from 7,000ft.

In current operations for arrivals from the north, ATC radar vector aircraft onto the Final Approach from either the MIRSI or ROSUN holds, and typically route aircraft downwind to the north and east of the centre of Manchester to a base leg in the vicinity of Mossley. From the south, ATC radar vector aircraft from the DAYNE hold and route to the east of Macclesfield to a base leg in the vicinity of Glossop. The transitions have been designed bearing this in mind, and to adhere to the UK CAA Containment Policy for RNAV1 STARs; 'Specified nominal tracks designed to RNAV1 (RNP1) standard should not be less than 3nm from the limits of controlled/advisory airspace'.

The transitions connect to a standard T-Bar RNP approach at FAF altitudes of 3,000ft, 2,500ft and 2,000ft. Further detail on the intermediate and final approach criteria can be found in section 0.

As detailed in section 19.6b, future airspace options have been developed on the principle of minimising ATC vectoring (the process known as systemisation) which is in line with the design principles Policy and Technology. However, some ATC vectoring will still be required to ensure safe separation and to maintain capacity.

The design process has created a suite of transitions which commence at the IAFs on the IAPs, where a 90° turn connects this segment to the intermediate segment. The segment lengths for the IAP have been designed considering the appropriate speeds of aircraft in this phase of flight, which is highlighted in AD2.22 of the MAN Aeronautical Information Publication (AIP) entry; 'aircraft should fly within the speed band 210kt to 240kt during the approach phase, reducing to within the band 160kt to 180kt at a range of 12nm from touchdown'.

By keeping segment lengths to a minimum, this helps to maintain the required separation for CAS, and keeps the tracks further to the east away from LPL Runway 27 arrivals.

32.2. Methodology

As detailed in section 19.3, arrivals to MAN are predominantly from the north and south. To ascertain an area of airspace for an arrival method that could accommodate approaches to both runways, an arc with a given radius was predicated on the IF of an approach procedure, based on a FAF altitude of 2,000ft. This process was replicated for Runway 23, and the two overlapping arcs produce a common area, within which we have placed IAFs which define the start of the arrivals design options.

The design options for Runways 23L/23R were designed to the current FAF of 3,500ft, as well as a reduced FAF altitude of 3,000ft.

32.3. Design Envelope Location Map

33. Runways 23L/23R 3,500ft FAF Transition North

33.1. Runways 23L/23R 3,500ft FAF Transition North Options Summary Table

<table>
<tr><th colspan="2">Viable and Good Fit</th><th colspan="2">Viable but Poor Fit</th><th colspan="2">Unviable</th></tr>
<tr>
<td>1A</td>
<td>IAF = STEAK

Option 1A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull. It is designed to facilitate a CDA profile to all runways.

(Runway 23L – 2.99%/1.71° with 2.5nm Flat Segment).

(Runway 23R – 2.89%/1.65° with 2.5nm Flat Segment).</td>
<td>A2</td>
<td>An option was considered that delivered alternative route from IAF STEAK, tracking close to the airport before turning downwind.

The route may conflict with Runway 23 northbound departure.

This option does not align with the Design Principle Safety.</td>
<td>U</td>
<td>Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance.

These covers options that may be non-compliant with PANS-OPS in relation to:
• MSD and the turn onto final approach.
• Descent gradients above the PANS-OPS maximum.
• Turn radius based on speed, altitude, and descent gradient.

These options have not been designed and are not described further within this comprehensive list of design options.</td>
</tr>
</table>

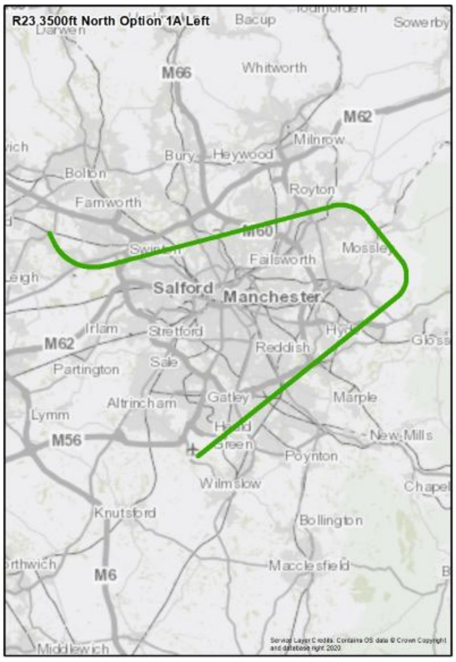
3A	IAF = IAF5 Option 3A has an IAF at 7,000ft to the north of the airport in the vicinity of Hawkshaw. The IAF is located approximately 2nm south of the ROSUN hold. The option has fewer track miles than 1A and a more favourable CDA profile. (Runway 23L – 3.35%/1.92° with 2.5nm Flat Segment). (Runway 23R – 3.3%/1.89° with 2.5nm Flat Segment).	B4	An option was considered with a new IAF located north of Blackburn and TMA1. The IAF for this option was located outside the design envelope for Runway 23 producing a sub optimal CDA profile. This option does not align with the Design Principle Policy.		
6A	IAF = IAF6 Option 6A has an IAF at 7,000ft to the north-west of the airport co-located with the ROSUN hold. This option has fewer track miles than 1A and a more favourable CDA profile, but slightly less favourable than 3A. (Runway 23L – 3.26%/1.87° with 2.5nm Flat Segment). (Runway 23R – 3.24%/1.86° with 2.5nm Flat Segment).	C5	An option was considered with a new IAF located north-west of ROSUN. The IAF for this option was located outside the design envelope for Runway 23 producing a sub optimal CDA profile. This option does not align with the Design Principle Policy.		

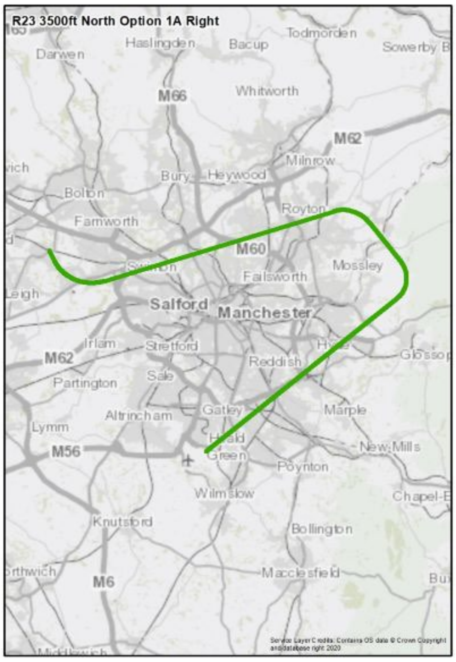
7A	IAF = IAF4 Option 7A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Harwood. It is designed to facilitate a CDA profile to all runways. This option is the shortest of all options in the 23 North arrivals envelope and has the most optimum CDA profile. (Runway 23L – 3.64%/2.09° with 2.5nm Flat Segment). (Runway 23R – 3.53%/2.02° with 2.5nm Flat Segment).	D9	IAF = IAF2 This option has an IAF co-located with the IAF for the 05L/05R option North 7A. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). This option does not align with the Design Principle Policy.		
8A	IAF = IAF3 Option 8A has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 8A. It is longer than the other options in the 23 North arrival envelope and therefore has least optimum CDA profile. (Runway 23L – 2.84%/1.63° with 2.5nm Flat Segment). (Runway 23R – 2.76%/1.58° with 2.5nm Flat Segment).	E10	IAF = IAF1 This option has an IAF co-located with the IAF for the 05L/05R option North 6A. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). This option does not align with the Design Principle Policy.		

11A	IAF = IAF12 Option 11A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Worsley, co-located with the IAF for option 05L/05R North 13. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.59%/2.05° with 2.5nm Flat Segment). (Runway 23R – 3.44%/1.97° with 2.5nm Flat Segment).	F12	IAF = IAF11 This option has an IAF co-located with the IAF for the 05L/05R option North 12 attempting to minimise interactions with LPL Runway 27 arrivals. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 05L/05R would be sub optimal (<1.5°). This option does not align with the Design Principle Policy.		

33.2. Runways 23L/23R 3,500ft FAF Transition North Option 1A

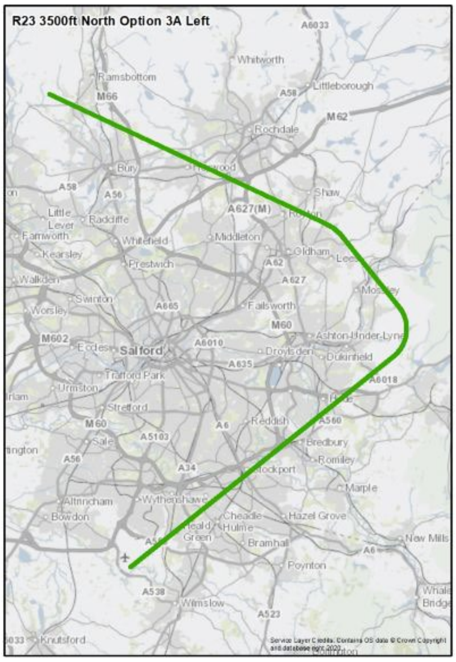
Description	Rationale for inclusion
Option 1A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads east, over Boothstown, Prestwich and Oldham but north of Manchester city centre. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 2.99%/1.71° for Runway 23L and 2.89%/1.65° for Runway 23R. These gradients are just below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Manchester city centre. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

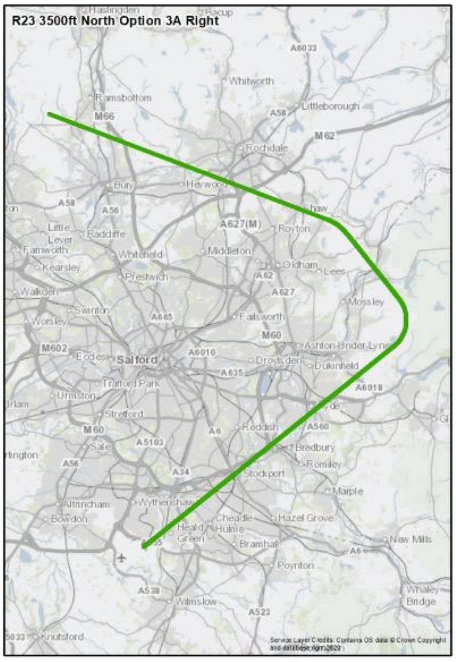




33.3. Runways 23L/23R 3,500ft FAF Transition North Option 3A

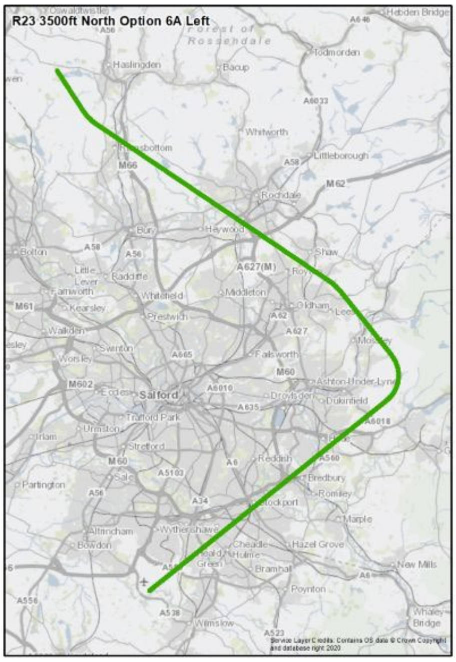
Description	Rationale for inclusion
Option 3A has an IAF at 7,000ft to the north of the airport in the vicinity of Hawkshaw approximately 2nm south of the ROSUN hold.	Noise N1: Optimal low noise CDA gradient.
From this location the route splits and heads south-east between Bury and Rochdale. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R.	Designed to limit the impact of noise by avoiding Bury and Rochdale.
The descent gradient to the FAF is 3.35%/1.92° for Runway 23L and 3.3%/1.89° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

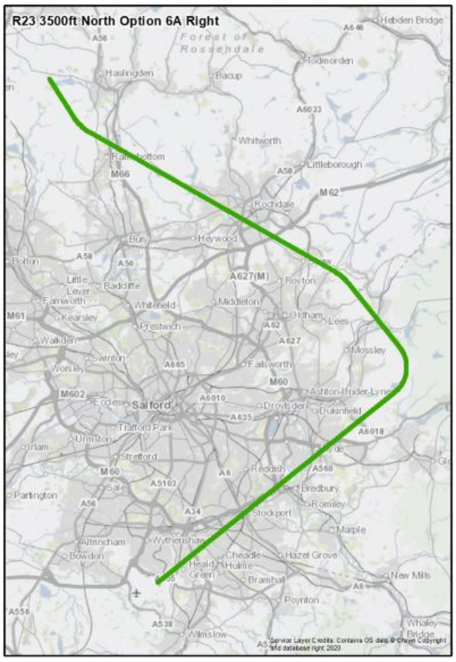




33.4. Runways 23L/23R 3,500ft FAF Transition North Option 6A

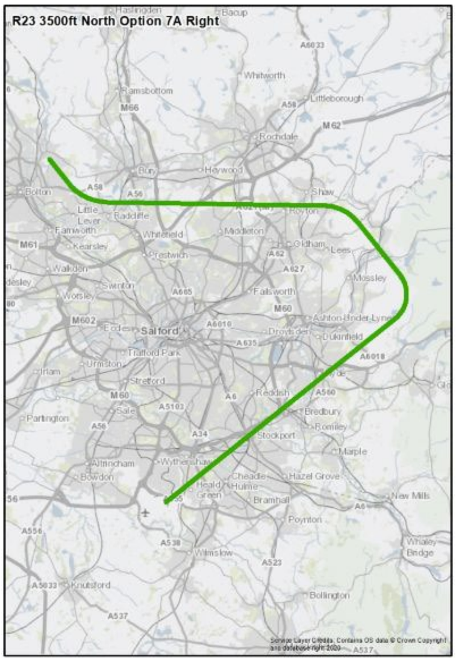
Description	Rationale for inclusion
Option 6A has an IAF at 7,000ft to the north-west of the airport co-located with the ROSUN hold.	**Noise N1**: Optimal low noise CDA gradient.
From this location the route splits and heads south-east, to the east of Bury but overhead Rochdale. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R.	Designed to limit the impact of noise by avoiding Bury.
The descent gradient to the FAF is 3.26%/1.87° for Runway 23L and 3.24%/1.86° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.





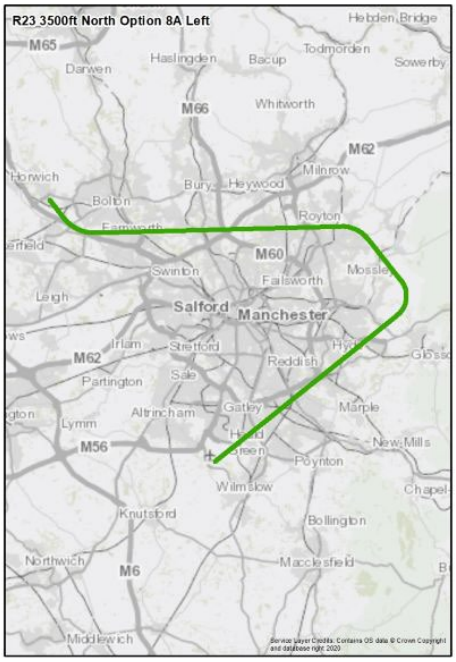
33.5. Runways 23L/23R 3,500ft FAF Transition North Option 7A

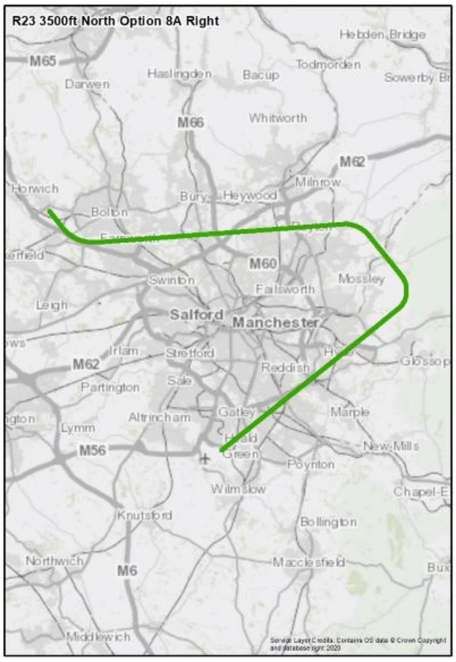
Description	Rationale for inclusion
Option 7A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Harwood. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads south-east between Bolton and Bury but overhead Oldham. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.64%/2.09° for Runway 23L and 3.53%/2.02° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Bury. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.



33.6. Runways 23L/23R 3,500ft FAF Transition North Option 8A

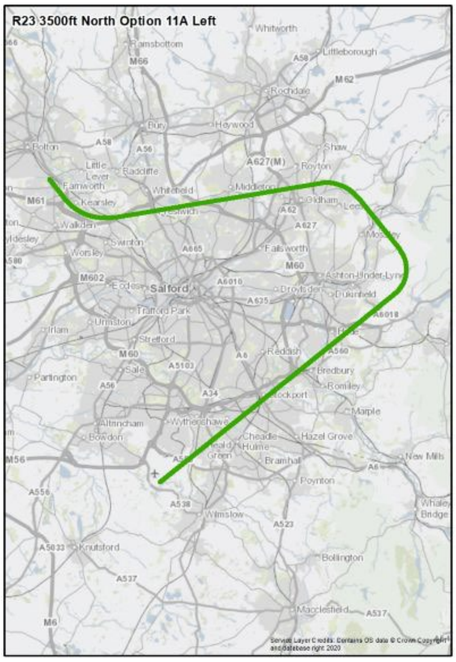
Description	Rationale for inclusion
Option 8A has an IAF at 7,000ft to the north-west of the airport in the vicinity of the Middlebrook Retail Park (marked on VFR charts as Middlebrook Stadium), co-located with the IAF for option 05L/05R North 8A. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads east, to the south of Bury and Rochdale. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 2.84%/1.63° for Runway 23L and 2.76%/1.58° for Runway 23R. These gradients are below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Bury, Bolton and Rochdale.

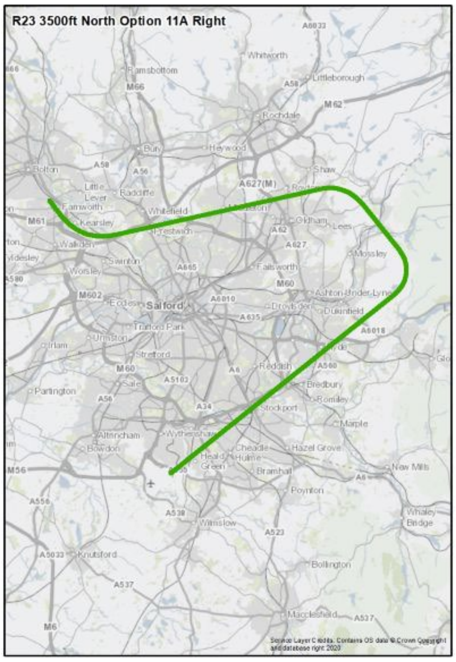




33.7. Runways 23L/23R 3,500ft FAF Transition North Option 11A

Description	Rationale for inclusion
Option 11A has an IAF at 7,000ft to the north-west of the airport in the vicinity of Worsley, co-located with the IAF for option 05L/05R North 13. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads south-east overhead Farnworth, then heads east, just to the north of Prestwich overhead Oldham. Both routes then turn right to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. This option is included to provide a design option from an IAF created specifically for Runways 05L/05R (05L/05R 2,000ft FAF option 13), where design options were required that minimise the impact on LPL Runway 27 arrivals. The descent gradient to the FAF is 3.59%/2.05° for Runway 23L and 3.44%/1.97° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Manchester city centre. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.





33.8. Runways 23L/23R 3,500ft FAF Transitions North: Viable but Poor Fit Options

Transition north option A2	S	P	C

This was initially designed as **option 2** and is a route based on the IAF STEAK located to the north-west of the airport. The route has an initial straight leg from the IAF towards the airport where aircraft would make a left turn onto a downwind leg.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and MAN Runway 23 northbound departures. As a result, this option was deemed to not comply with the Design Principle Safety.

Transition north option B4	S	P	C

This was initially designed as **option 4** and is a route based on an IAF located north of Blackburn and TMA1. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option C5	S	P	C

This was initially designed as **option 5** and is a route based on an IAF located north-west of the ROSUN hold. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option D9	S	P	C

An option was considered with a new IAF co-located with IAF7 for the 05L/05R option North 7A. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option E10	S	P	C

An option was considered with a new IAF co-located with the IAF for the 05L/05R option North 6A. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option F12	S	P	C

This was initially designed as **option 12** and has an IAF co-located with the IAF for the 05L/R option North 12. It was considered as an option minimise the interactions with LPL Runway 27 arrivals and to facilitate a CDA to both MAN runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

34. Runways 23L/23R 3,000ft FAF Transition North

34.1. Runways 23L/23R 3,000ft FAF Transition North Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1B	IAF = STEAK Option 1B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.68%/2.11° with 2.5nm Flat Segment). (Runway 23R – 3.54%/2.03° with 2.5nm Flat Segment).	A2	An option was considered that delivered alternative route from IAF STEAK, tracking close to the airport before turning downwind. The route may conflict with Runway 23 northbound departure. This option does not align with the Design Principle Safety.	U1	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

3B	IAF = IAF5 Option 3B has an IAF at 7,000ft to the north of the airport in the vicinity of Hawkshaw. The IAF is located approximately 2nm south of the ROSUN hold. The option has fewer track miles than 1B and a more favourable CDA profile. (Runway 23L – 3.96%/2.27° with 2.5nm Flat Segment). (Runway 23R – 3.93%/2.25° with 2.5nm Flat Segment).	B4	An option was considered with a new IAF located north of Blackburn and TMA1. The IAF for this option was located outside the design envelope for Runway 23 producing a sub optimal CDA profile. This option does not align with the Design Principle Policy.	U2	
6B	IAF = IAF6 Option 6B has an IAF at 7,000ft to the north-west of the airport co-located with the ROSUN hold. This option has fewer track miles than 1B and a more favourable CDA profile, but slightly less favourable than 3B. (Runway 23L – 3.8%/2.18° with 2.5nm Flat Segment). (Runway 23R – 3.8%/2.18° with 2.5nm Flat Segment).	C5	An option was considered with a new IAF located north-west of ROSUN. The IAF for this option was located outside the design envelope for Runway 23 producing a sub optimal CDA profile. This option does not align with the Design Principle Policy.		

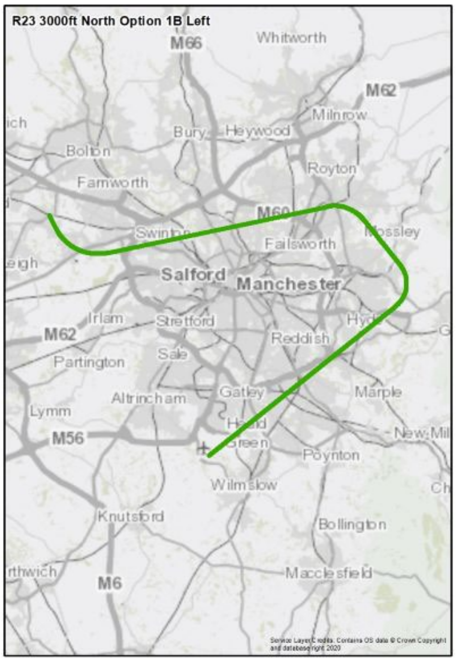
7B	IAF = IAF4 Option 7B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Astley Bridge. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 4.45%/2.55° with 2.5nm Flat Segment). (Runway 23R – 4.32%/2.48° with 2.5nm Flat Segment).				
8B	IAF = IAF3 Option 8B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 8B. It is longer than the other options in the 23 North arrival envelope and therefore has least optimum CDA profile. (Runway 23L – 3.45%/1.98° with 2.5nm Flat Segment). (Runway 23R – 3.36%/1.92° with 2.5nm Flat Segment).				

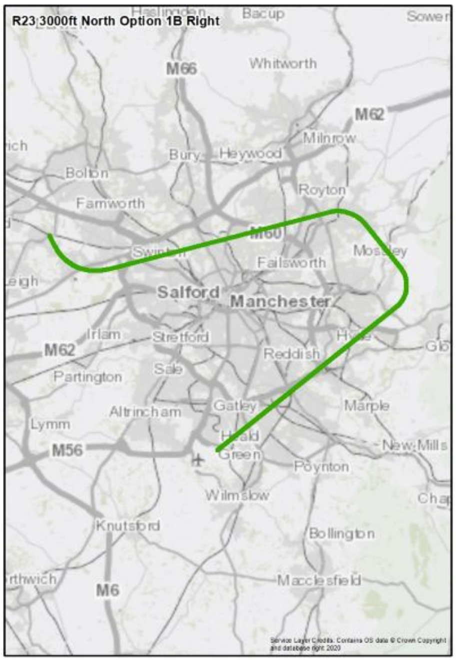
9B	IAF = IAF2 Option 9B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 7B. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.01%/1.72° with 2.5nm Flat Segment). (Runway 23R – 2.93%/1.68° with 2.5nm Flat Segment).				
10B	IAF = IAF1 Option 10B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 6B. It is designed to facilitate a CDA profile to all runways. This is the longest option with the least optimum CDA profile. (Runway 23L – 2.92%/1.67° with 2.5nm Flat Segment). (Runway 23R – 2.84%/1.63° with 2.5nm Flat Segment).				

11B	IAF = IAF12 Option 11B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Worsley, co-located with the IAF for option 05L/05R North 13. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 4.45%/2.55° with 2.5nm Flat Segment). (Runway 23R – 4.27%/2.45° with 2.5nm Flat Segment).				
12B	IAF = IAF11 Option 12B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Bolton, co-located with the IAF for option 05L/05R North 12. (Runway 23L – 2.80%/1.61° with 2.5nm Flat Segment). (Runway 23R – 2.75%/1.57° with 2.5nm Flat Segment).				

34.2. Runways 23L/23R 3,000ft FAF Transition North Option 1B

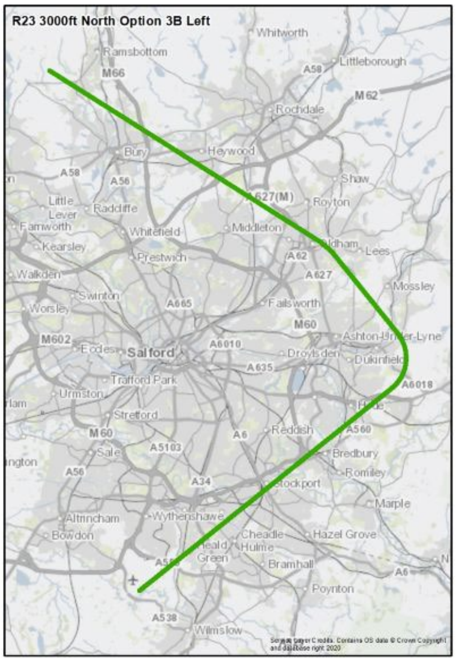
Description	Rationale for inclusion
Option 1B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Aspull. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads east, over Boothstown, Prestwich and Oldham but north of Manchester city centre. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.68%/2.11° for Runway 23L and 3.54%/2.03° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Manchester city centre. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

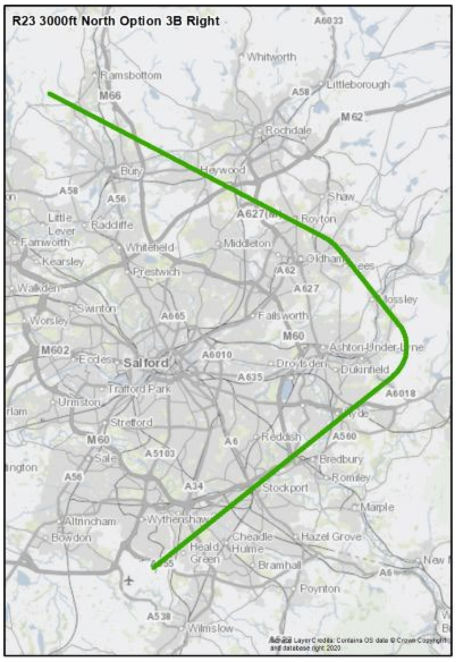




34.3. Runways 23L/23R 3,000ft FAF Transition North Option 3B

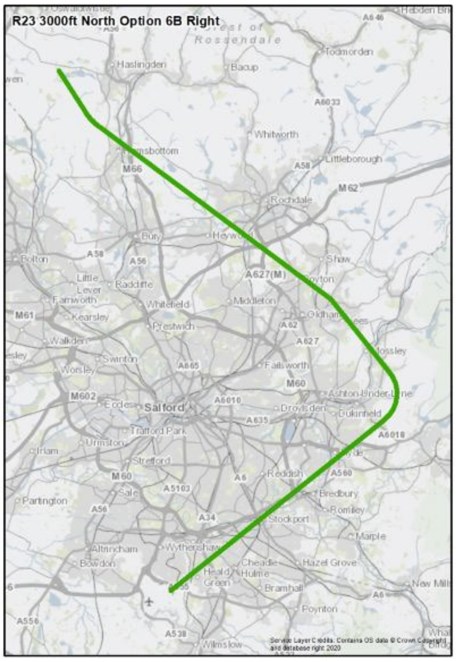
Description	Rationale for inclusion
Option 3B has an IAF at 7,000ft to the north of the airport in the vicinity of Hawkshaw approximately 2nm south of the ROSUN hold. From this location the route splits and heads south-east between Bury and Rochdale. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.96%/2.27° for Runway 23L and 3.93%/2.25° for Runway 23R. These gradients are within the optimum range for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Bury and Rochdale. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.





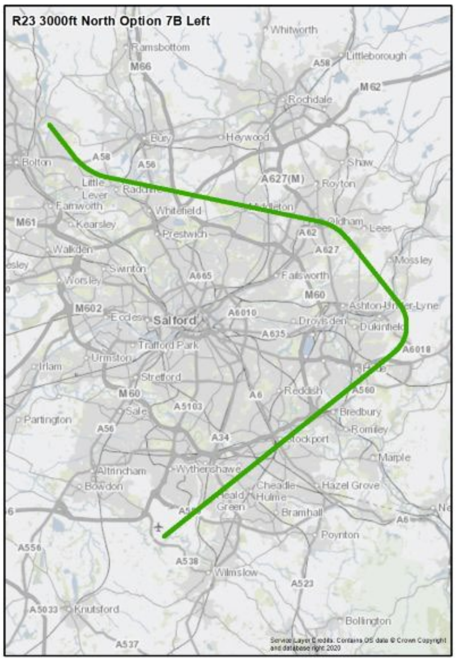
34.4. Runways 23L/23R 3,000ft FAF Transition North Option 6B

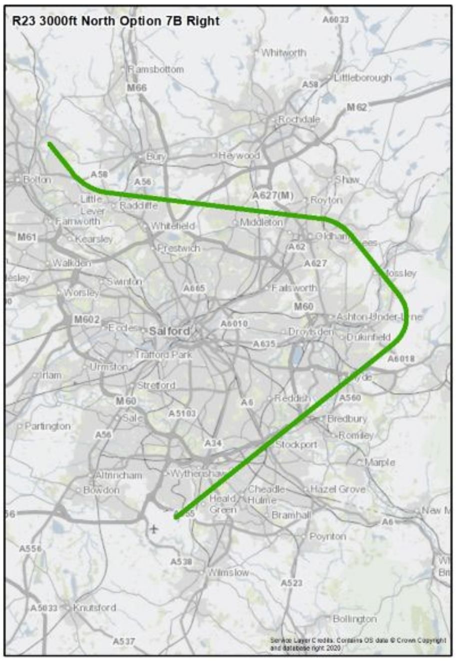
Description	Rationale for inclusion
Option 6B has an IAF at 7,000ft to the north-west of the airport co-located with the ROSUN hold. From this location the route splits and heads south-east, to the east of Bury but overhead Rochdale. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.81%/2.19° for Runway 23L and 3.8%/2.18° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Bury. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.



34.5. Runways 23L/23R 3,000ft FAF Transition North Option 7B

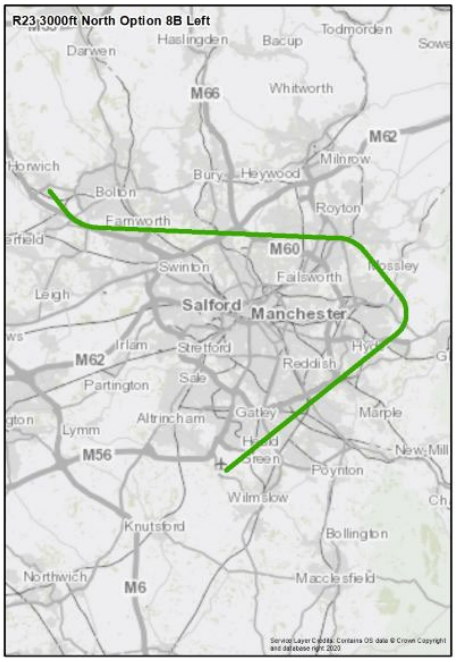
Description	Rationale for inclusion
Option 7B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Harwood. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads south-east between Bolton and Bury but overhead Oldham. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 4.45%/2.55° for Runway 23L and 4.32%/2.48° for Runway 23R. These gradients are optimal for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Bury. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

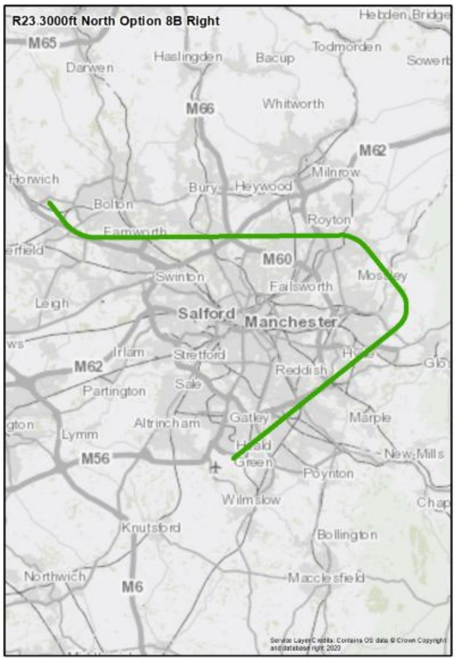




34.6. Runways 23L/23R 3,000ft FAF Transition North Option 8B

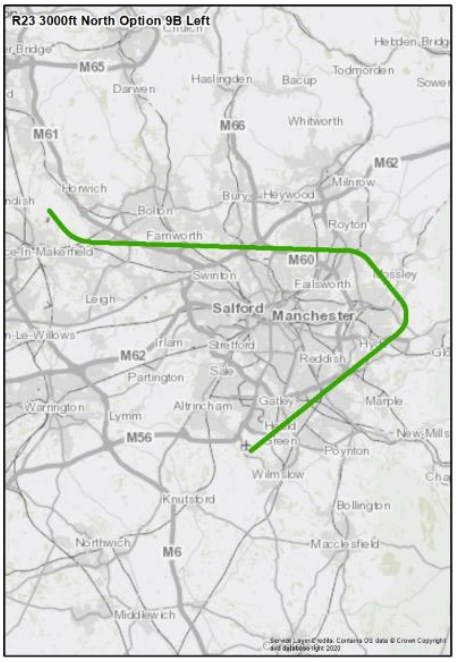
Description	Rationale for inclusion
Option 8B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 8A. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads east, to the south of Bury and Rochdale. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.45%/1.98° for Runway 23L and 3.36%/1.92° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Bury, Bolton and Rochdale.

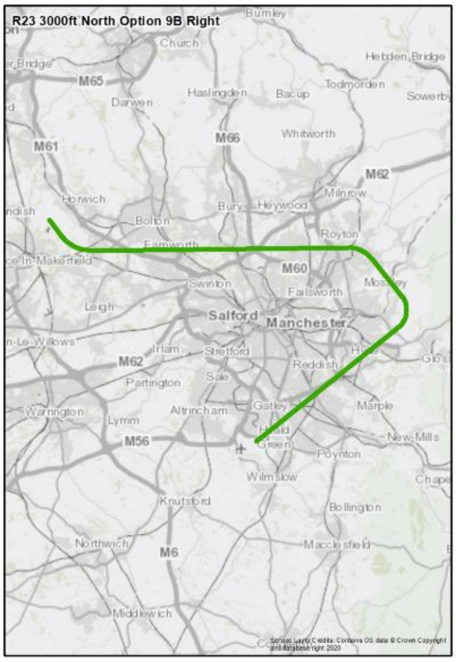




34.7. Runways 23L/23R 3,000ft FAF Transition North Option 9B

Description	Rationale for inclusion
Option 9B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/05R North 7B. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads east, to the south of Bolton and Bury but overhead Oldham. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.01%/1.72° for Runway 23L and 2.93%/1.68° for Runway 23R. These gradients are below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Bury, Bolton.





34.8. Runways 23L/23R 3,000ft FAF Transition North Option 10B

Description

Option 10B has an IAF at 7,000ft to the north-west of the airport co-located with the IAF for option 05L/R North 6B. It is designed to facilitate a CDA profile to all runways.

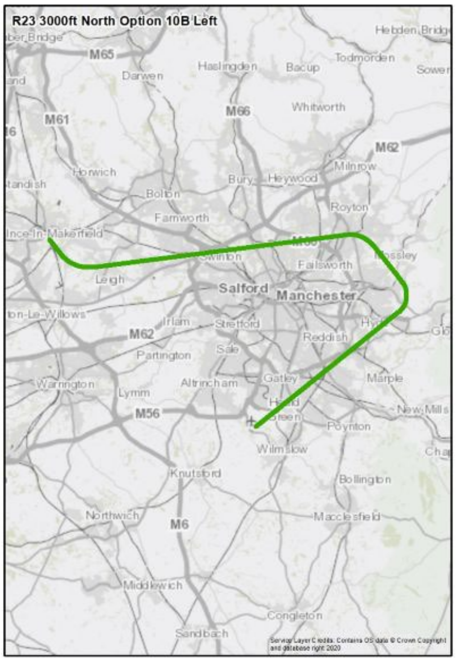
From this location the route splits and heads east, overhead Prestwich, Chadderton and Oldham but north of Manchester city centre. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R.

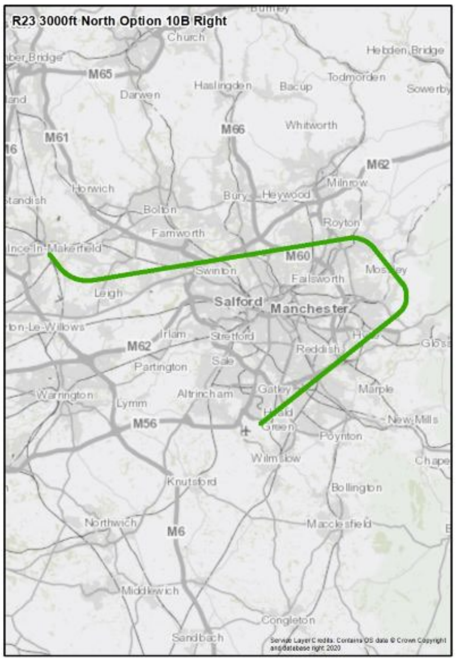
The descent gradient to the FAF is 2.92%/1.67° for Runway 23L and 2.84%/1.63° for Runway 23R. These gradients are below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.

Rationale for inclusion

Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R).

Noise N1: Designed to limit the impact of noise by avoiding Manchester city centre.





34.9. Runways 23L/23R 3,000ft FAF Transition North Option 11B

Description

Option 11B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Worsley, co-located with the IAF for option 05L/05R North 13. It is designed to facilitate a CDA profile to all runways.

From this location the route splits and heads south-east overhead Farnworth, then heads east, just to the north of Prestwich overhead Oldham. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R.

This option is included to provide a design option from an IAF created specifically for Runways 05L/05R (05L/05R 2,000ft FAF option 13), where design options were required that minimise the impact on LPL Runway 27 arrivals.

The descent gradient to the FAF is 4.45%/2.55° for Runway 23L and 4.27%/2.45° for Runway 23R. These gradients are optimal for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.

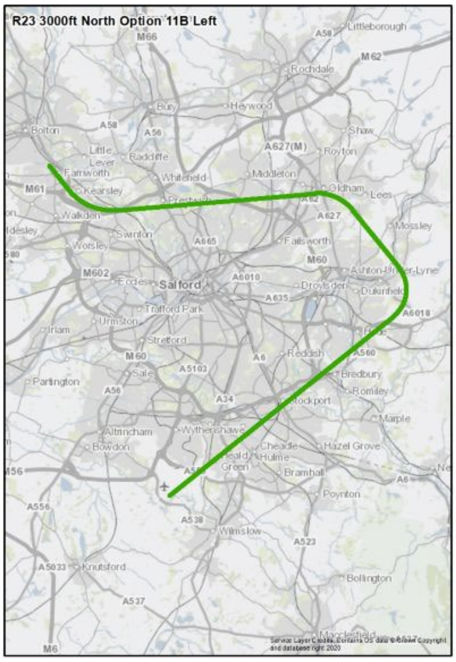
Rationale for inclusion

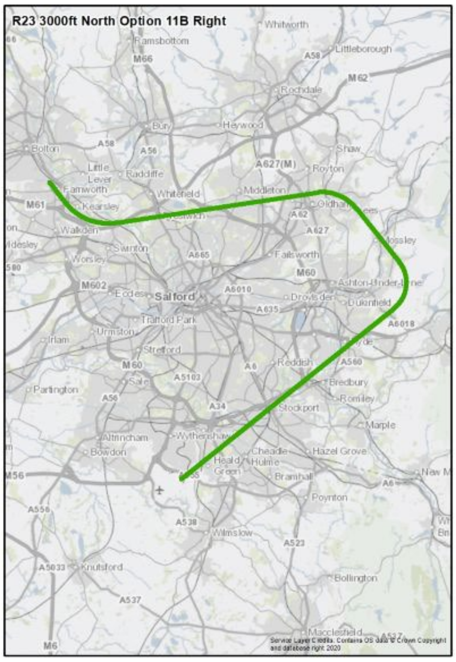
Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R).

Noise N1: Optimal low noise CDA gradient.

Designed to limit the impact of noise by avoiding Manchester city centre.

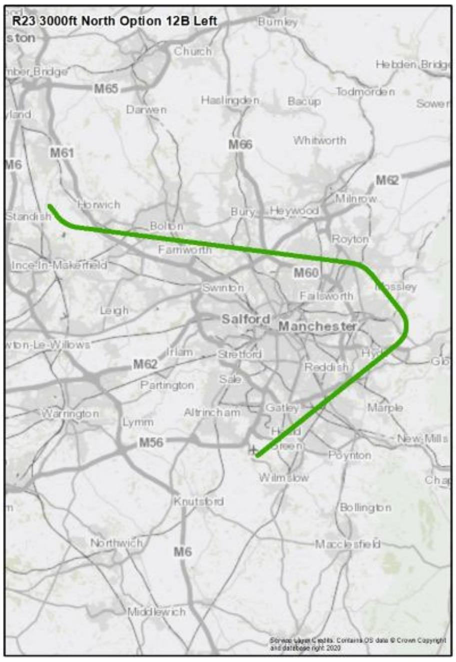
Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

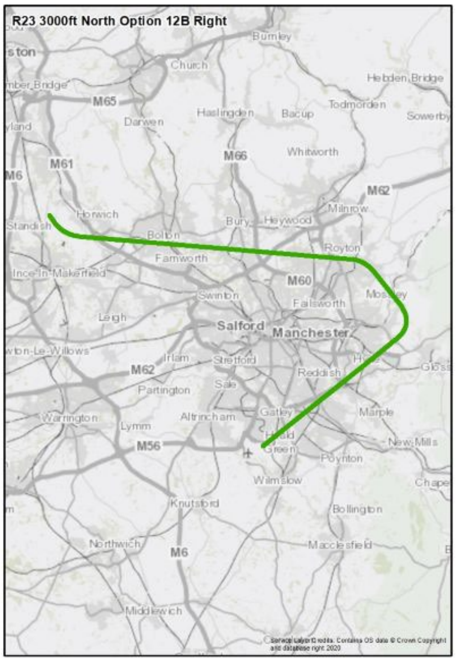




34.10. Runways 23L/23R 3,000ft FAF Transition North Option 12B

Description	Rationale for inclusion
Option 12B has an IAF at 7,000ft to the north-west of the airport in the vicinity of Bolton, co-located with the IAF for option 05L/05R North 12. From this location the route splits and heads east overhead Bolton and Oldham but north of Manchester city centre. Both routes then turn right to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. This option is included to provide a design option from an IAF created specifically for Runways 05L/05R (05L/05R 2,000ft FAF option 12), where design options were required that minimise the impact on LPL Runway 27 arrivals. The descent gradient to the FAF is 2.80%/1.61° for Runway 23L and 2.75%/1.57° for Runway 23R. These gradients are below the optimum for low noise approaches but within the acceptable range for CDAs defined within ICAO guidance.	Noise N1: Designed to limit the impact of noise by avoiding Manchester city centre.





34.11. Runways 23L/23R – 3,000ft FAF Transitions North: Viable but Poor Fit Options

Transition north option A2	S	P	C

This was initially designed as **option 2** and is a route based on the IAF STEAK located to the north-west of the airport. The route has an initial straight leg from the IAF towards the airport where aircraft would make a left turn onto a downwind leg.

Safety: The Design Principle Safety requires design options to be safe in accordance with national and international industry standards and regulations. This option raised safety concerns with regards to the separation between MAN arrivals and MAN Runway 23 northbound departures. As a result, this option was deemed to not comply with the Design Principle Safety.

Transition north option B4	S	P	C

This was initially designed as **option 4** and is a route based on an IAF located north of Blackburn and TMA1. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy) as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

Transition north option C5	S	P	C

This was initially designed as **option 5** and is a route based on an IAF located north-west of the ROSUN hold. It was considered as an option to facilitate a CDA to both runways; however, the profile for Runways 23L/23R would be sub optimal (<1.5°).

Policy: Within the AMS, one of the initiatives that revised airspace must deliver is improved environmental performance. This option would not comply with this initiative (and therefore the Design Principle Policy as it would not provide a CDA to both runway direction directions, leading to increased fuel burn and noise impact.

35. Runways 23L/23R 3,500ft FAF Transition South

35.1. Runways 23L/23R 3,500ft FAF Transition South Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1A	IAF = TURKY Option 1A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.15%/1.80° with 2.5nm Flat Segment). (Runway 23R – 3.02%/1.73° with 2.5nm Flat Segment).	A3	This option was the result of early concept work in collaboration with NERL but was not developed due to perceived Network connection issues to the south-east of the airport.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

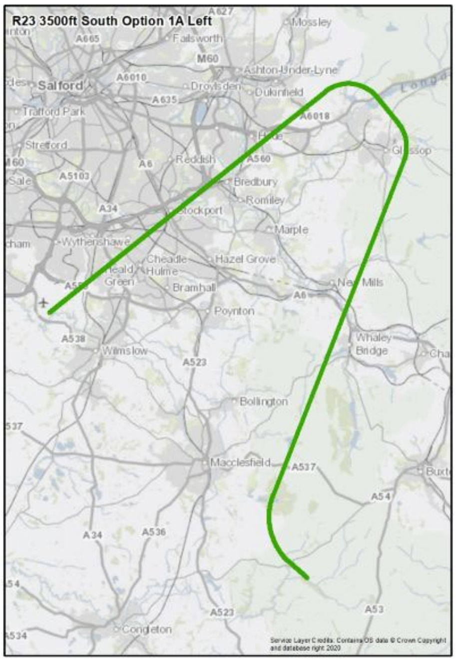
2A	IAF = TURKY Option 2A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 2.83%/1.62° with 2.5nm Flat Segment). (Runway 23R – 2.73%/1.56° with 2.5nm Flat Segment).	B4 (Formerly Option 4)	An option was considered with a new IAF located south-east of the existing DAYNE hold. This option did not ensure 3nm separation from the Daventry CTA 10 airspace boundary and therefore did not conform with the CAA airspace containment policy. This option does not align with the Design Principle Policy.		
6A	IAF = IAF8 Option 6A has an IAF at 7,000ft to the south-east of the airport co-located with the DAYNE hold. It is designed to facilitate a CDA profile to all runways. This option has fewer track miles than 1A and 2A and a more optimum CDA profile. (Runway 23L – 3.41%/1.96° with 2.5nm Flat Segment). (Runway 23R – 3.27%/1.87° with 2.5nm Flat Segment).	C5 (Formerly Option 5)	An option was considered with a new IAF located south of the existing DAYNE Hold. This option did not ensure 3NM separation from the Daventry CTA 10 airspace boundary and therefore did not conform with the CAA airspace containment policy. This option does not align with the Design Principle Policy.		

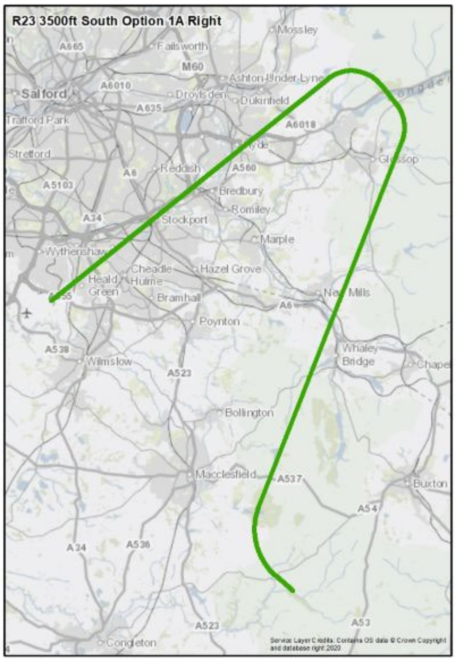
7A	IAF = IAF9 Option 7A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Goyt Valley. It is co-located with the IAF for the 05L/R option 8A and is designed to facilitate a CDA profile to all runways. This has the fewest track miles of all options and the most optimal CDA profile. (Runway 23L – 4.48%/2.57° with 2.5NM Flat Segment). (Runway 23R – 4.24%/2.43° with 2.5NM Flat Segment).				
8A	IAF = IAF10 Option 8A has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. It is co-located with the IAF for the 05L/05R option 9A and is designed to facilitate a CDA profile to all runways. This option provides a similar track mileage and CDA profile to option 6A. (Runway 23L – 3.42%/1.96° with 2.5nm Flat Segment). (Runway 23R – 3.28%/1.88° with 2.5nm Flat Segment).				

9A	IAF = IAF7 Option 9A has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is co-located with the IAF for the 05L/05R option 6A and is designed to facilitate a CDA profile to all runways. This option has the most track miles of all options and the least optimum CDA profile. (Runway 23L – 2.78%/1.59° with 2.5nm Flat Segment). (Runway 23R – 2.69%/1.54° with 2.5nm Flat Segment).				

35.2. Runways 23L/23R 3,500ft FAF Transition South Option 1A

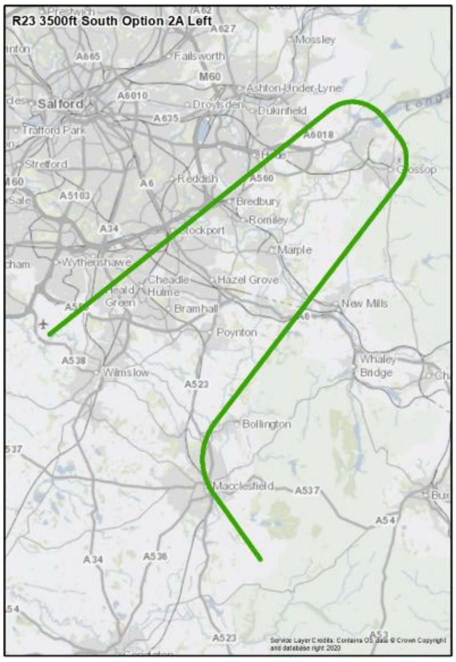
Description	Rationale for inclusion
Option 1A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.15%/1.80° for Runway 23L and 3.02%/1.73° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

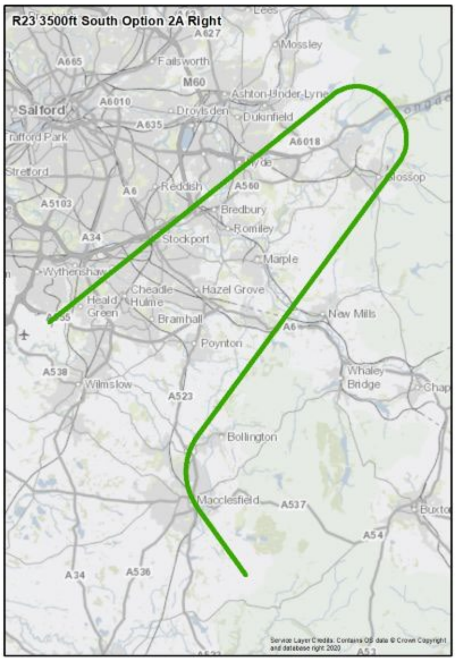




35.3. Runways 23L/23R 3,500ft FAF Transition South Option 2A

Description	Rationale for inclusion
Option 2A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. From this location the route overflies Macclesfield, splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 2.83%/1.62° for Runway 23L and 2.73%/1.56° for Runway 23R. These gradients are below the optimum for low noise approaches but just within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R).





35.4. Runways 23L/23R 3,500ft FAF Transition South Option 6A

Description

Option 6A has an IAF at 7,000ft to the south-east of the airport co-located with the DAYNE hold. It is designed to facilitate a CDA profile to all runways.

From this location the route splits and heads north-east, to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R.

The descent gradient to the FAF is 3.41%/1.96° for Runway 23L and 3.27%/1.87° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.

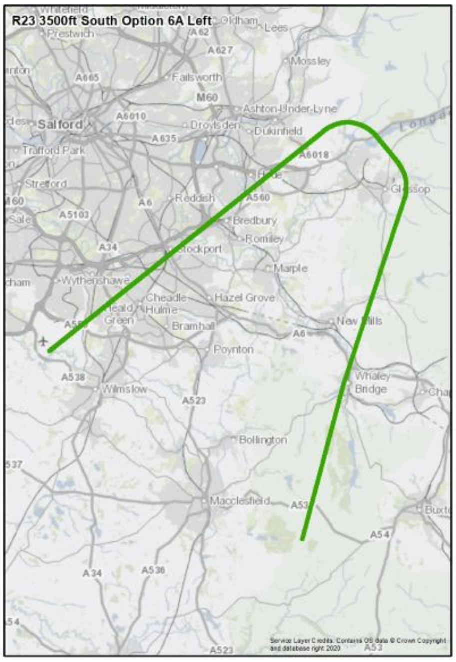
Rationale for inclusion

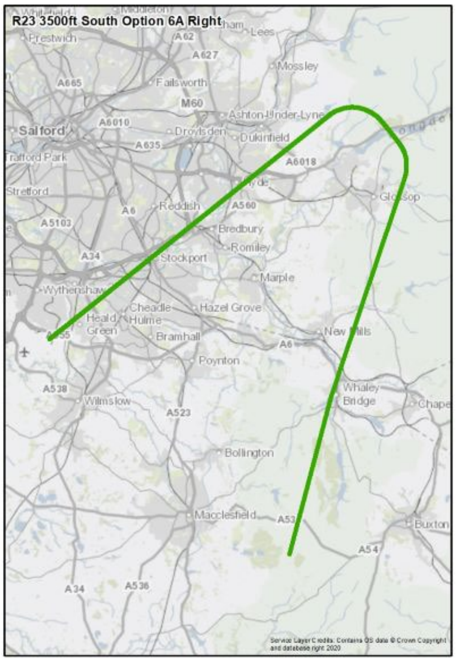
Policy: Facilitates CDA for all runways (05L/05R/23L/23R).

Noise N1: Optimal low noise CDA gradient.

Designed to limit the impact of noise by avoiding Macclesfield.

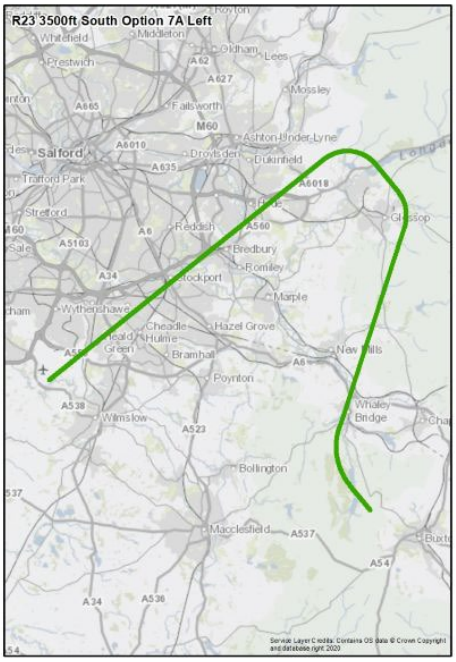
Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

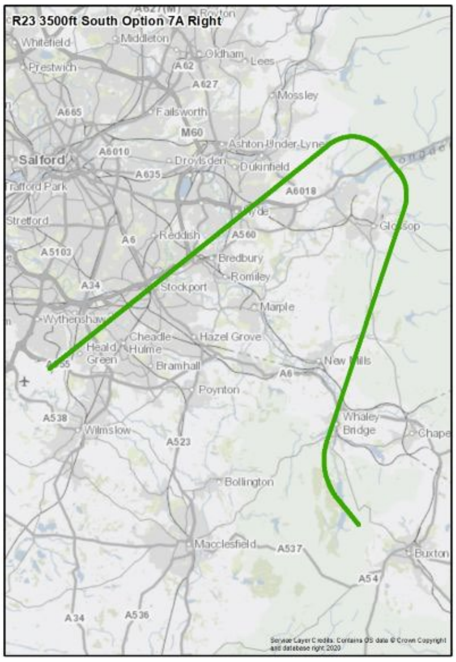




35.5. Runways 23L/23R 3,500ft FAF Transition South Option 7A

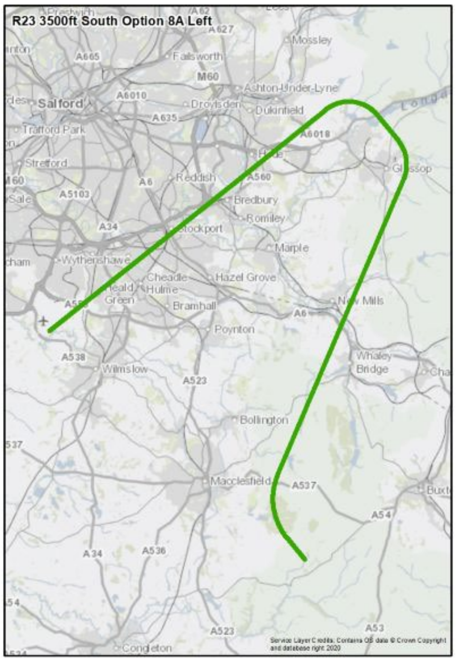
Description	Rationale for inclusion
Option 7A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Goyt Valley. It is co-located with the IAF for the 05L/05R option 8A and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 4.48%/2.57° for Runway 23L and 4.24%/2.43° for Runway 23R. These gradients are optimal for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

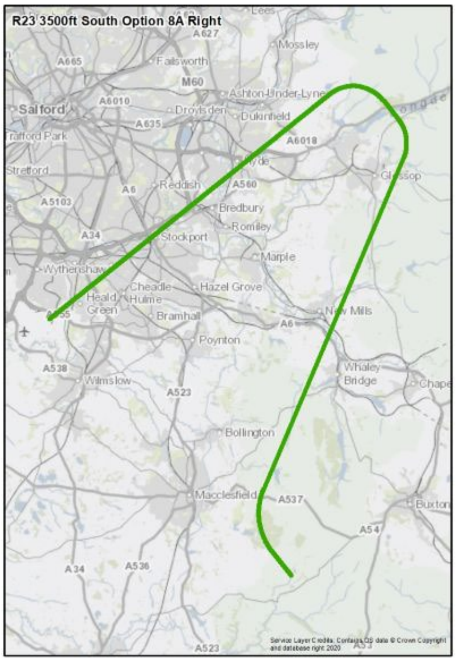




35.6. Runways 23L/23R 3,500ft FAF Transition South Option 8A

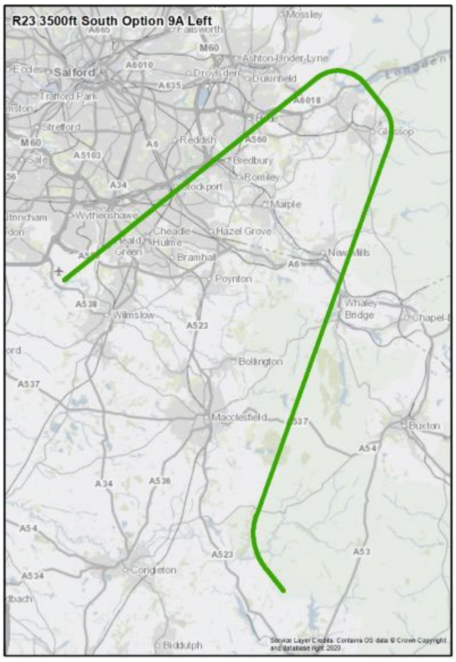
Description	Rationale for inclusion
Option 8A has an IAF at 7,000ft to the south-east of the airport in the vicinity of the Roaches. It is co-located with the IAF for the 05L/05R option 9A and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.42%/1.96° for Runway 23L and 3.28%/1.88° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

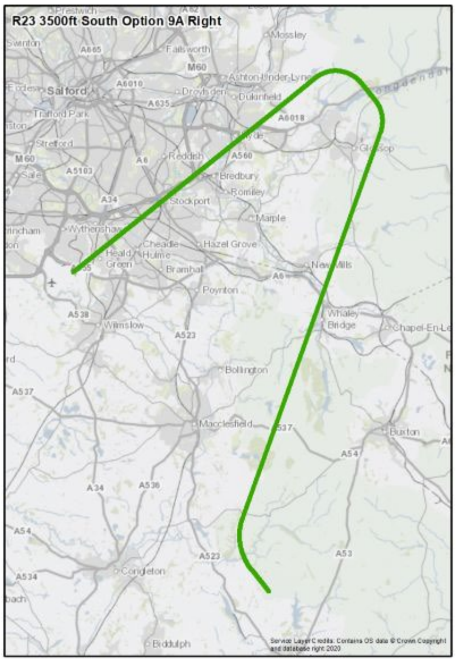




35.7. Runways 23L/23R 3,500ft FAF Transition South Option 9A

Description	Rationale for inclusion
Option 9A has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is co-located with the IAF for the 05L/05R option 6A and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east between Macclesfield and Buxton, overhead Whaley Bridge and Glossop. Both routes then turn left to establish aircraft on final approach at 3,500ft for either Runway 23L or 23R. The descent gradient to the FAF is 2.78%/1.59° for Runway 23L and 2.69%/1.54° for Runway 23R. These gradients are below the optimum range for low noise approaches but just within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Designed to limit the impact of noise by avoiding Macclesfield and Leek. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.





35.8. Runways 23L/23R 3,500ft FAF Transition South Viable but Poor Fit Options

Transition south option A3	S	P	C
This option was the result of early concept work in collaboration with NERL as **option 3** but was not developed due to perceived Network connection issues to the south-east of the airport. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.			
Transition south option B4	S	P	C
This was initially designed as **option 4** and is a route based on an IAF located south-east of the existing DAYNE hold. Policy: This option would not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the CAS boundary (Daventry CTA10).			
Transition south option C5	S	P	C
This was initially designed as **option 5** and is a route based on an IAF located south of the existing DAYNE hold. Policy: This option would not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the CAS boundary (Daventry CTA10).			

36. Runways 23L/23R 3,000ft FAF Transition South

Runways 23L/23R 3,000ft FAF Transition South Options Summary Table

Viable and Good Fit		Viable but Poor Fit		Unviable	
1B	IAF = TURKY Option 1B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Danebridge. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.78%/2.17° with 2.5nm Flat Segment). (Runway 23R – 3.63%/2.08° with 2.5nm Flat Segment).	A3	This option was the result of early concept work in collaboration with NERL but was not developed due to perceived network connection issues to the south-east of the airport.	U	Unviable options for this envelope are those that would not comply with PANS-OPS 8168 design criteria or did not have a supporting safety justification for non-compliance. These covers options that may be non-compliant with PANS-OPS in relation to: • MSD and the turn onto final approach. • Descent gradients above the PANS-OPS maximum. • Turn radius based on speed, altitude, and descent gradient. These options have not been designed and are not described further within this comprehensive list of design options.

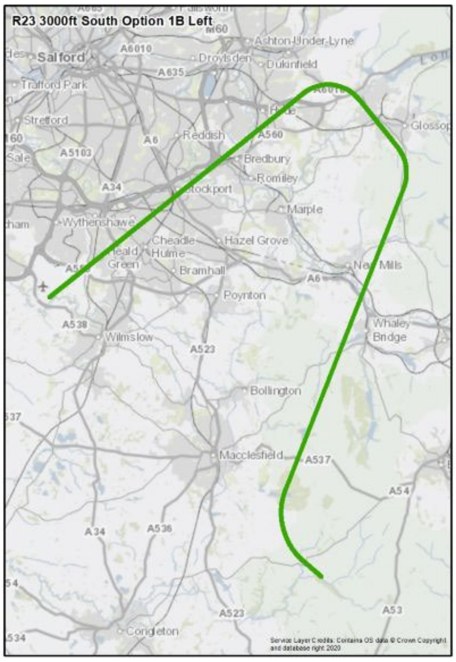
2B	IAF = TURKY Option 2A has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.38%/1.94° with 2.5nm Flat Segment). (Runway 23R – 3.26%/1.87° with 2.5nm Flat Segment).	B4 (Formerly option 4)	An option was considered with a new IAF located south-east of the existing DAYNE hold. This option did not ensure 3nm separation from the Daventry CTA 10 airspace boundary and therefore did not conform with the CAA airspace containment policy. This option does not align with the Design Principle Policy.		
6B	IAF = IAF8 Option 6B has an IAF at 7,000ft to the south-east of the airport co-located with the DAYNE hold. It is designed to facilitate a CDA profile to all runways. This option has fewer track miles than 1B and 2B and a more optimum CDA profile. (Runway 23L – 4.12%/2.36° with 2.5nm Flat Segment). (Runway 23R – 3.94%/2.26° with 2.5nm Flat Segment).	C5 (Formerly option 5)	An option was considered with a new IAF located south-east of the existing DAYNE hold. This option did not ensure 3nm separation from the Daventry CTA 10 airspace boundary and therefore did not conform with the CAA airspace containment policy. This option does not align with the Design Principle Policy.		

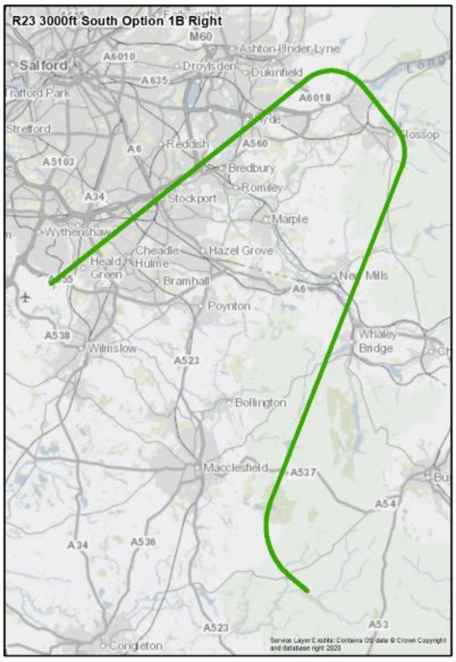
7B	IAF = IAF9 Option 7B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Goyt Valley. It is co-located with the IAF for the 05L/05R option 8B and is designed to facilitate a CDA profile to all runways. This has the fewest track miles of all options and the steepest CDA profile. (Runway 23L – 5.5%/3.15° with 2.5nm Flat Segment). (Runway 23R – 5.19%/2.97° with 2.5nm Flat Segment).				
8B	IAF = IAF10 Option 8B has an IAF at 7,000ft to the south-east of the airport in the vicinity of The Roaches. It is co-located with the IAF for the 05L/05R option 9B and is designed to facilitate a CDA profile to all runways. This option provides a similar track mileage and CDA profile to option 6B. (Runway 23L – 4.14%/2.37° with 2.5nm Flat Segment). (Runway 23R – 3.95%/2.26° with 2.5nm Flat Segment).				

9B	IAF = IAF7 Option 9B has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is co-located with the IAF for the 05L/05R option 6B and is designed to facilitate a CDA profile to all runways. (Runway 23L – 3.33%/1.91° with 2.5nm Flat Segment). (Runway 23R – 3.21%/1.84° with 2.5nm Flat Segment).				

36.1. Runways 23L/23R 3,000ft FAF Transition South Option 1B

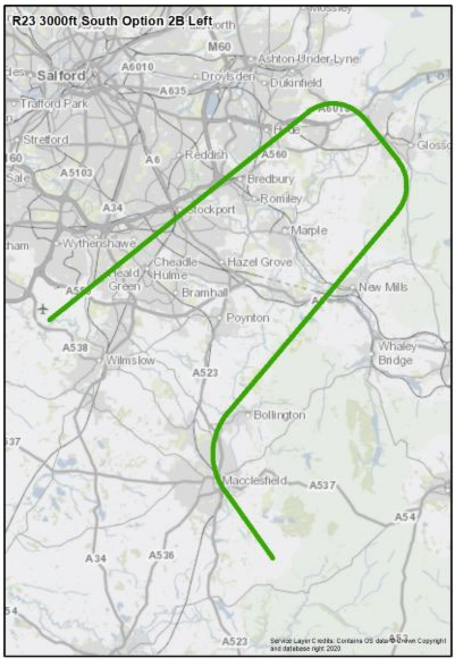
Description	Rationale for inclusion
Option 1B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Danebridge. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.78%/2.17° for Runway 23L and 3.63%/2.08° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

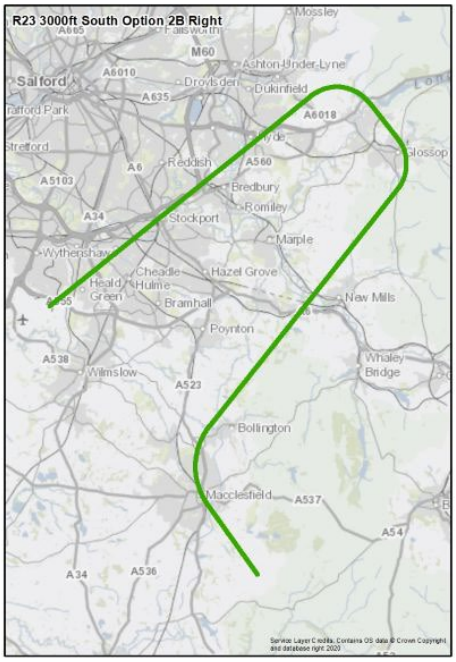




36.2. Runways 23L/23R 3,000ft FAF Transition South Option 2B

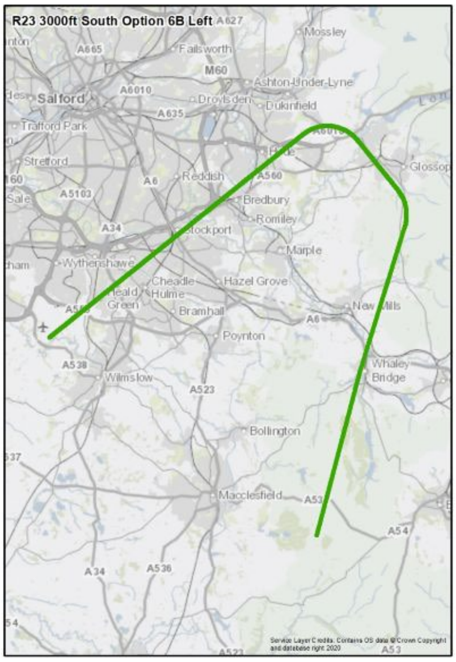
Description	Rationale for inclusion
Option 2B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Sutton. It is designed to facilitate a CDA profile to all runways. From this location the route overflies Macclesfield, splits, and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.38%/1.94° for Runway 23L and 3.26%/1.87° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient.

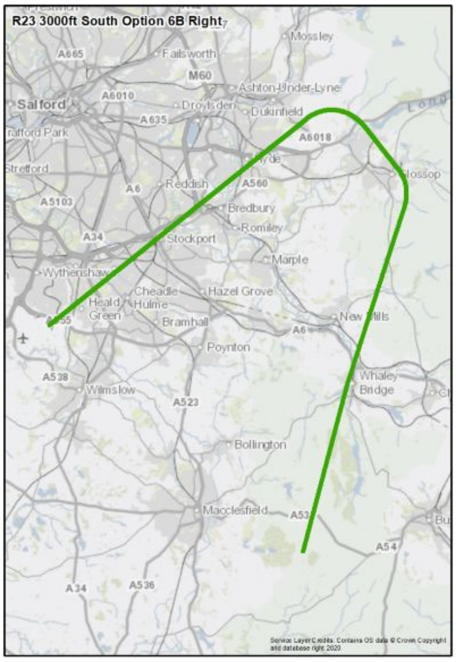




36.3. Runways 23L/23R 3,000ft FAF Transition South Option 6B

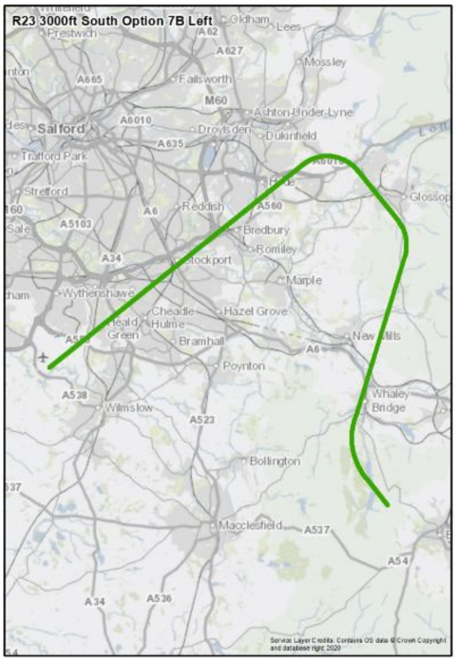
Description	Rationale for inclusion
Option 6B has an IAF at 7,000ft to the south-east of the airport co-located with the DAYNE hold. It is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 4.12%/2.36° for Runway 23L and 3.94%/2.26° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.

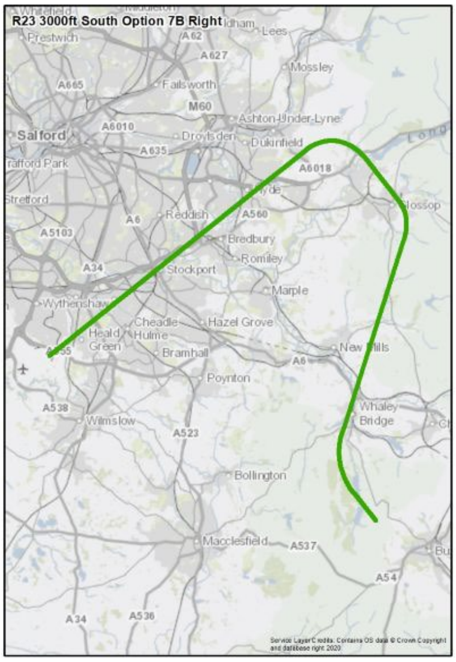




36.4. Runways 23L/23R 3,000ft FAF Transition South Option 7B

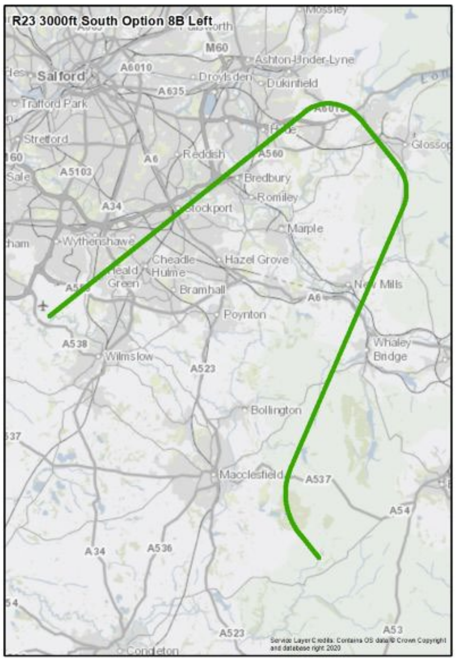
Description	Rationale for inclusion
Option 7B has an IAF at 7,000ft to the south-east of the airport in the vicinity of Goyt Valley. It is co-located with the IAF for the 05L/R option 8B and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 5.5%/3.15° for Runway 23L and 5.19%/2.97° for Runway 23R. These gradients are just above the range for low noise approaches but are still within the acceptable range for CDAs defined within ICAO guidance.	**Policy:** Facilitates CDA for all runways (05L/05R/ 23L/23R). **Noise N1**: Designed to limit the impact of noise by avoiding Macclesfield. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

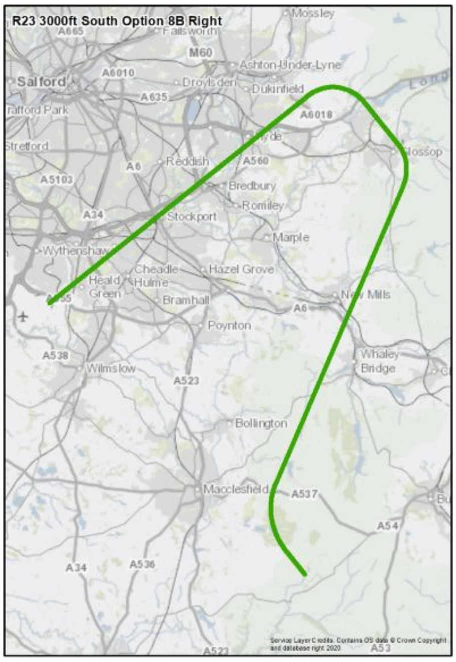




36.5. Runways 23L/23R 3,000ft FAF Transition South Option 8B

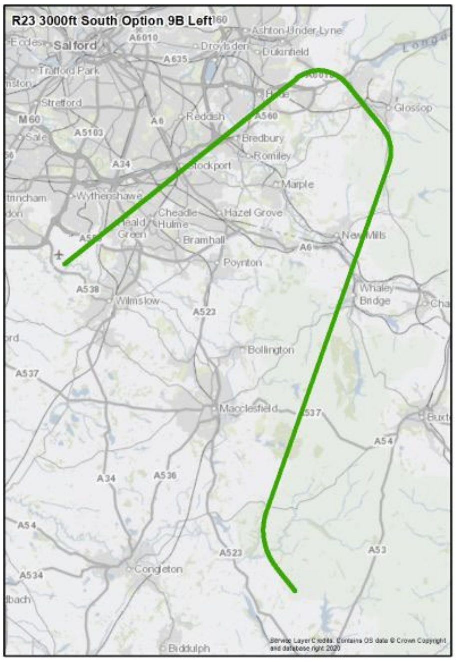
Description	Rationale for inclusion
Option 8B has an IAF at 7,000ft to the south-east of the airport in the vicinity of the Roaches. It is co-located with the IAF for the 05L/05R option 9B and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east, just to the west of Whaley Bridge and then overhead Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 4.14%/2.37° for Runway 23L and 3.95%/2.26° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	**Policy**: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield. **Emissions**: Direct routing and minimal track miles from 7,000ft to FAF.

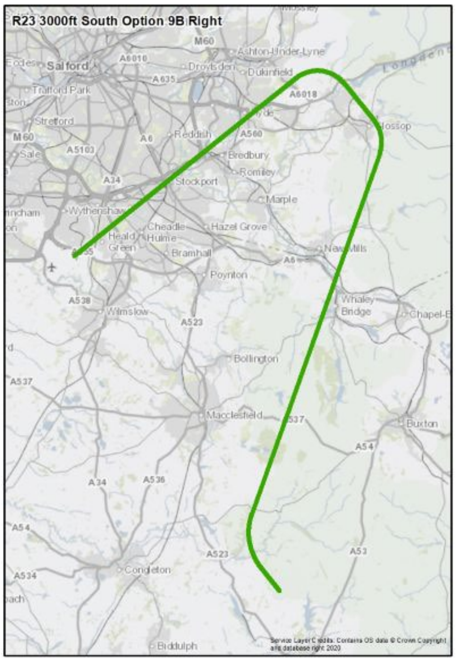




36.6. Runways 23L/23R 3,000ft FAF Transition South Option 9B

Description	Rationale for inclusion
Option 9B has an IAF at 7,000ft to the south-east of the airport, just to the north of Leek. It is co-located with the IAF for the 05L/05R option 6B and is designed to facilitate a CDA profile to all runways. From this location the route splits and heads north-east between Macclesfield and Buxton, overhead Whaley Bridge and Glossop. Both routes then turn left to establish aircraft on final approach at 3,000ft for either Runway 23L or 23R. The descent gradient to the FAF is 3.33%/1.91° for Runway 23L and 3.21%/1.84° for Runway 23R. These gradients are within the optimum range for low noise approaches and within the acceptable range for CDAs defined within ICAO guidance.	Policy: Facilitates CDA for all runways (05L/05R/ 23L/23R). Noise N1: Optimal low noise CDA gradient. Designed to limit the impact of noise by avoiding Macclesfield and Leek. Emissions: Direct routing and minimal track miles from 7,000ft to FAF.





36.7. Runways 23L/23R – 3,000ft Transitions South: Viable but Poor Fit Options

Transition south option A3	S	P	C
This option was the result of early concept work in collaboration with NERL but was not developed due to perceived network connection issues to the south-east of the airport. Policy: Within the AMS, revised airspace must deliver efficiency and the expeditious flow of traffic including greater runway throughput. This option would not align to the NATS network traffic flow. As a result, this option would not comply with the AMS and therefore the Design Principle Policy.			
Transition south option B4	S	P	C
This was initially designed as option 4 and is a route based on an IAF located south-east of the existing DAYNE hold. Policy: This option would not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the CAS boundary (Daventry CTA10).			
Transition south option C5	S	P	C
This was initially designed as option 5 and is a route based on an IAF located south of the existing DAYNE hold. Policy: This option would not adhere to the CAA containment policy requiring aircraft to remain 3nm or more from the CAS boundary (Daventry CTA10).			

37. Glossary

ACOG	Airspace Change Organisation Group formed in 2019 as a fully independent organisation within NATS under the direction of the UK Government Department for Transport and Civil Aviation Authority, who are the co-sponsors of the AMS.
ACP	Airspace Change Proposal.
ADWR	Airspace Development Workshop Record - the output from bilateral discussions with NERL to record and inform their comprehensive list of options for the network that interfaces with MAN traffic.
Agl	Above ground level.
AIP	Aeronautical Information Publication - A document published by the UK CAA which contains information essential to air navigation (www.aurora.nats.co.uk/htmlAIP/Publications/2022-07-14-AIRAC/html/index-en-GB.html).
Altitude Based Priorities	The ANG sets out a framework of 'Altitude Based Priorities', to be taken into account when considering the potential environmental impact of airspace changes.
AMS	Airspace Modernisation Strategy (CAP1711) - this is the Government's strategy and plan for the use of UK airspace, including the modernisation of airspace (www.caa.co.uk/cap1711).
Amsl	Above mean sea level.
ANG	Air Navigation Guidance 2017 - Guidance to the CAA (from DfT) on its environmental objectives when carrying out its air navigation functions, and to the CAA and wider industry on airspace and noise management (www.gov.uk/government/publications/uk-air-navigation-guidance-2017).
ANSP	Air Navigation Service Provider - an organisation which operates the technical system, infrastructure, procedures, and rules of an air navigation service system, which includes air traffic control.
AONB	Area of Outstanding Natural Beauty - an area of countryside which has been designated for conservation because of its significant landscape value, recognising its national importance.
AQMA	Air Quality Management Area - designated by a local authority and subject to a Local Air Quality Management Plan.
ASMIM[4]	A navigation fix to the north-west of Manchester used by departing aircraft.
ATC	Air Traffic Control - service from an air navigation service provider providing guidance to aircraft through Controlled Airspace.
ATM	Air Transport Movement - an aircraft operation for commercial purposes, as opposed to a flight for recreational or personal reasons.
ATS	Air Traffic Services.
Biodiversity	The variability among living things from all ecosystems (including terrestrial, marine, and aquatic amongst others) and the ecological complexes of which they are part, including diversity within species, between species and of ecosystems.
CAA	Civil Aviation Authority -the aviation industry's regulator.
CAP	Civil Aviation Publication - a document published by the UK CAA which can provide information, guidance or policy depending on the subject covered. The list of all CAPs is published on the CAA website (www.caa.co.uk/our-work/publications).
CAP1385	The CAA's PBN enhanced route spacing guidance (www.caa.co.uk/cap1385).

[4] The language to communicate between a pilot and an Air Traffic Controller needs to be clear and avoid misunderstanding. Names need to sound different and be incapable of confusion with others, particularly others close by.

CAP1498	The CAA's definition of overflight - the report defines overflight as it relates to airspace regulation; and an overflight metric which may be used to quantitatively compare different airspace options (www.caa.co.uk/cap1498).
CAP1616	The CAA's airspace change guidance document - it sets out the regulatory process which all airspace change proposals must follow (www.caa.co.uk/cap1616).
CAP1616a	A technical annex to CAP1616- guidance on the regulatory process for changing airspace design including community engagement requirements. This annex outlines relevant methodologies for use in environmental assessments relating to airspace change (www.caa.co.uk/cap1616a).
CAP1781	The CAA's DVOR/DME/NDB Rationalisation - guidance for the use of RNAV Substitution (www.caa.co.uk/cap1781).
CAP1711	Airspace Modernisation Strategy - this is the Government's strategy and plan for the use of UK airspace, including the modernisation of airspace (www.caa.co.uk/cap1711).
CAP1991	Procedure for the CAA to review the classification of airspace (www.caa.co.uk/cap1991).
CAP2091	CAA Policy on Minimum Standards for Noise Modelling -document defines categories of noise modelling sophistication and sets out requirements of the minimum category which different stakeholder or sponsor groups should use when providing noise calculations to the CAA. (www.caa.co.uk/cap2091).
CAP2156A	Airspace change masterplan - CAA acceptance criteria, the criteria against which the CAA will make the decision whether to accept the airspace change masterplan into the Airspace Modernisation Strategy (www.caa.co.uk/cap2156A).
CAP2302	A Low Noise Arrival CAP2302 - a report that makes recommendations to implement low noise arrivals (www.caa.co.uk/cap2303).
CAP493	Manual of Air Traffic Services - contains procedures, instructions and information which are intended to form the basis of air traffic services within the United Kingdom (www.caa.co.uk/cap493).
CAP725	The CAA's airspace change process guidance document that preceded CAP1616 (www.caa.co.uk/cap725).
CAP760	CAA's Guidance on the Conduct of Hazard Identification, Risk Assessment, and the Production of Safety Cases (www.caa.co.uk/cap760).
CAP778	The CAA's Policy and Guidance for the Design and Operation of Departure Procedures in UK Airspace (www.caa.co.uk/cap778).
CAA Controlled Airspace Containment Policy Statement	The CAA Controlled Airspace Containment Policy Statement (January 2014 superseded in August 2022) sets out the minimum criteria applicable to containment of instrument flight procedures for airports already within Controlled Airspace (CAS). Annex B provides the design criteria that have been applied to the arrival and departure routes in this ACP. (https://publicapps.caa.co.uk/docs/33/Policy%20for%20the%20Design%20of%20Controlled%20Airspace%20Structures%20110822.pdf).
CAS	Controlled Airspace is airspace within which air traffic services are provided. There are different classifications which define the air traffic control service provided and the requirements of aircraft flying within it. All commercial (passenger) flights fly within Controlled Airspace.
CCO	Continuous Climb Operations - allows departing aircraft to climb continuously, which reduces the level of noise heard on the ground, reduces fuel burn and emissions.
CDA	Continuous Descent Approach - allows arriving aircraft to descend continuously which reduces the level of noise heard on the ground, reducing fuel burn and emissions.
CF	Course to Fix - a path that terminates at a fix with a specified course at that fix.

Change sponsor	An organisation that proposes, or sponsors, a change to the airspace design in accordance with the CAA's airspace change process.
Comprehensive list	The full list of design options that are viable designs as required by Stage 2 of the CAP1616 process and which are detailed in the Design Options Report.
CONOPS	Concept of Operations - a document that outlines how we want the airspace system to work in the future and the standards that we will use.
COVID-19	Coronavirus disease 19 is a contagious disease caused by a virus that was identified in 2019 and which resulted in a pandemic in the year 2020.
CP	Country Park - areas of land designated and protected by local authorities to provide access to the countryside.
Cumulative Impact	Where an environmental topic/receptor is affected by impacts from more than one source/project at the same time and the impacts act together.
CTA	Control Area - the controlled airspace that exists in the vicinity of an airport
DAYNE	One of three existing hold stacks used at Manchester Airport.
dB	Decibels - a unit used to measure noise levels.
DEFRA	Department for the Environment, Food and Rural Affairs (UK Government).
DER	Departure End of Runway - a term that, when used in PANS-OPS 8168, determines the start point for the design of a departure procedure.
DESIG	A navigation fix to the north-east of Manchester used by departing aircraft.
Design envelopes	Broad areas where it is possible to design routes and which are the areas where we have created design options for arriving and departing aircraft.
Design option	An output from the route design process that responds to the design principles and the Statement of Need (SoN). Design options are a requirement of the CAP1616 process. During the engagement carried out at Stage 2, design options were also referred to as "route options".
Design principles	The principles encompassing the safety, environmental and operational criteria, and the strategic policy objectives that the change sponsor seeks to achieve in developing the airspace change proposal. They are an opportunity to combine local context with technical considerations and are therefore drawn up through discussion with affected stakeholders and in Manchester's case - members of the public. The design principles at Manchester Airport were established during Stage 1 of the CAP1616 process.
DF Coding	Direct to Fix coding - type of waypoint used in the design of PBN procedures.
DfT	Department for Transport.
DME	Distance Measuring Equipment - a ground-based beacon that allows aircraft to measure their precise distance from its location, often used to define a turn point.
DOE	Design Options Evolution - shows the evolution of the design options through Stages 2A and 2B of the CAP1616 process. Included as Appendix A to the Stage 2 Summary Document.
DOR	Design Options Report - this responds to the requirements of CAP1616 to develop a comprehensive list of options that address the SoN and that align with the design principles. It details the design process and the output of that process in the form of design options for both departures and arrivals.
DPE	Design Principle Evaluation - the document that undertakes an evaluation of the viable and good fit options described in this report against the design principles.
DVOR	Doppler VHF Omni-directional Range - ground-based radio navigation beacon used by pilots to assist in aircraft navigation.
EASA	European Union Aviation Safety Agency.

Education (facilities)	For our analysis we have used the 'Ordnance Survey Address Base' count of educations facilities, details of which they receive from the local government contributing authority. These include all educational services including College, Further Education, Higher Education, Children's Nursery / Crèche, Preparatory / First / Primary / Infant / Junior / Middle School, Non State Primary / Preparatory School, Secondary / High School, Non State Secondary School, University, Special Needs Establishment and Other Educational Establishments.
EGCC	The four-letter ICAO code for Manchester Airport.
EU	The European Union - an economic and political union of 27 countries.
EKLAD[4]	A navigation fix to the west of Manchester used by departing aircraft.
FAF	Final Approach Fix - The point at which an aircraft starts its final approach to land.
FASI-N	Future Airspace Strategy Implementation – North: The programme of airspace changes across the northern part of the UK, including Manchester, that is implementing the Governments Airspace Modernisation Strategy.
FIR	Flight Information Region - airspace delegated to a country by ICAO. In the UK there are two FIRs, London and Scottish.
FL85	FL means 'Flight Level' and uses the standard international pressure (1013.2 hPa) to express altitude in hundreds of feet. FL85 equates to 8,500ft calculated according to the 'constant' pressure altitude rather than local pressure (QNH). So FL90 would mean 9,000ft.
Flat segment	A defined period of level flight as required by a PANS-OPS PBN Approach procedure.
Flightpath	The routes taken by aircraft within airspace.
Flight Level	A means to separate aircraft (above the transition altitude) by using a standard pressure setting for all aircraft.
FMS	Flight Management System - a specialised computer system that automates a wide variety of in-flight tasks, reducing the workload on the flight crew.
FOA	Full Options Appraisal - the options appraisal carried out at Stage 3 of the CAP1616 process.
Focus group	Group of representative stakeholders brought together to discuss proposals and offer feedback.
Ft	Feet.
Future housing sites	Future housing sites with a reasonable prospect of being developed based on Local Plan allocations and Local Authority five-year Housing Land Supply Assessment data. During engagement we have used the term 'Future Housing Sites' to represent the broader phrase of Planned Property Development as we are not aware of other future noise sensitive developments that would sit within this category. Data was collated by CBRE and supplied to MAN on 17th March 2022 with updates included to the Cheshire East Borough Council and Staffordshire Moorlands District Council areas in July and August 2022.
GA	General Aviation - defined by ICAO as 'all civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire.
GBAS	Ground Based Augmentation System - augments the existing GPS by providing corrections to aircraft in the vicinity of an airport to improve the accuracy of, and provide integrity for, the aircrafts' GPS navigational position.
GDPR	The General Data Protection Regulations.
GIS	Geographic Information System.
GNSS	Global Navigation Satellite System - a term used to describe a system that uses satellites for position fixing.
GPS	Global Positioning System - a satellite-based radionavigation system owned by the United States government and operated by the United States Space Force.

HAZID Workshop	Hazard Identification workshop - held with air traffic control experts from the Future Airspace team, NATS Manchester, NATS En Route and Liverpool John Lennon Airport as well as airline representatives operating from Manchester Airport.
HON	Abbreviation for the HONILEY DVOR navigation beacon that is to the south of Manchester and is used by departing aircraft as a navigation point.
IAF	Initial Approach Fix - the start of the approach phase of flight. For the Manchester arrival design options, the IAF is at 7,000ft unless stated otherwise.
IATA	The International Air Transport Association - a trade association that supports aviation with global standards for airline safety, security, efficiency and sustainability.
ICAO	International Civil Aviation Organisation - an agency of the United Nations
IFP	Instrument Flight Procedure.
ILS	Instrument Landing System - a radio navigation system that provides vertical and horizontal guidance to arriving aircraft to help them land safely, especially in bad weather.
Instrument Approach Procedures (IAPs)	A series of predetermined manoeuvres for the orderly transfer of an aircraft operating under instrument flight rules from the beginning of the initial approach to a landing, or to a point from which a landing may be made visually.
IOA	Initial Options Appraisal - the document that is the first iteration of the three option appraisals required by CAP1616 - the design options appraised within the IOA are the outputs from the DPE.
KIAS	Knots of indicated airspeed - the number shown on the airspeed indicator.
KUXEM[4]	A navigation fix to the south-west of Manchester used by departing aircraft.
LISTO[4]	A navigation fix to the south of Manchester used by departing aircraft.
LBA	The three letter IATA code for Leeds Bradford Airport.
LDA	Localiser Directional Aid - an assisted approach not aligned with the landing runway, used in places where terrain or other factors prevent the localiser antenna from being aligned with the runway that it serves.
LLR	Low-Level Route - the Manchester LLR is Class D airspace within which the CAA have exempted aircraft from requiring an ATC clearance to fly within the route (http://publicapps.caa.co.uk/docs/33/ORS4%20No.1545%20Correction.pdf).
LOAEL	Lowest Observed Adverse Effect Level - below this level, there is no detectable effect on health and quality of life due to the noise.
LNAV	Lateral Navigation - a term for lateral (left/right) navigation used within Performance Based Navigation.
LPL	The three letter IATA code for Liverpool John Lennon Airport.
m	Metres.
MAGIC map	Interactive map managed by DEFRA containing authoritative geographic information about the natural and built environment from across Government.
MAP	Missed Approach Procedure - on occasions, inbound aircraft are unable to land successfully on their first approach and perform an action known as a 'Go-Around'. The Missed Approach Procedure outlines a mechanism to route the aircraft, without conflict with departing or arriving aircraft, and re-establish on to the arrivals path for another approach.
MAN	The three letter IATA code for Manchester Airport.
MANTIS	Manchester Airport Noise and Track Information System - a system that monitors and records the path and noise of aircraft arriving and departing from Manchester Airport.
Masterplan	The strategic plan for the coordinated national programme of airspace change, created by the ACOG under the direction of the CAA and DfT.

MCT	Abbreviation for the Manchester DVOR navigation beacon and routes that use that as a navigation point.
Medical (facilities)	For our analysis we have used the 'Ordnance Survey Address Base' count of 'Medical', details of which they receive from the local government contributing authority. These include Dentist, General Practice Surgery / Clinic, Health Centre, Health Care Services, Hospital, Hospice, Medical / Testing / Research Laboratory, Professional Medical Service, Assessment / Development Services. Not all of these are 'noise sensitive' receptors and in Stage 3 those which are not 'noise sensitive' will be removed from future analysis.
MIRSI	One of three existing hold stacks used at Manchester Airport.
MONTY[4]	A navigation fix to the south-west of Manchester used by departing aircraft.
MSD	Minimum Stabilisation Distance - a design criteria within PANS-OPS 8168 that ensures aircraft stability when flying a procedure.
MTMA	Manchester Terminal Manoeuvring Area - the designated area of Controlled Airspace for Manchester Airport.
NANTI	A navigation fix to the south-west of Manchester used by Liverpool aircraft.
NATS	The air navigation service provider for the UK, formerly National Air Traffic Services. NATS 'En Route' manage the traffic in the upper airspace and climbing and descending to land in the Manchester area.
NERL	NATS En Route Ltd - the part of NATS that delivers en route air traffic control.
Nm	Nautical miles.
NNR	National Nature Reserves - designated under the National Parks and Access to the Countryside Act 1949 and the Wildlife and Countryside Act 1981 to protect important habitats, species or geology.
Noise abatement	Activity to reduce the emission of noise from a given source (aircraft operations).
Noise-sensitive receptors	Specific locations or developments identified as likely to be adversely affected by noise from or due to aircraft operations. Individual locations will have varying degrees of sensitivity (measured noise exposure levels) depending upon their use. These provide a useful reference to the design principles N1, N2 and N3 where the number of people affected by noise, noise effects and noise sensitive areas are referenced.
NP	National Park - designated areas under the National Parks and Access to the Countryside Act 1949 to protect landscapes because of their special qualities.
Overflight	According to CAP1498, the definition of overflight is 'an aircraft in flight passing an observer at an elevation angle (approximately the angle between the horizon and the aircraft) that is greater than an agreed threshold, and at an altitude below 7,000ft.'
PANS-OPS	An ICAO document that stands for Procedures for Air Navigation Services Document 8168 outlines the rules and criteria for designing aircraft flying procedures - commonly shorted to PANS-OPS.
PBN	Performance Based Navigation - a range of specifications that requires aircraft to navigate to specific accuracy standards, mainly by using satellite-based navigation systems. It is designed to improve track-keeping accuracy for departing and arriving aircraft. The transition to PBN is a UK and International policy requirement and a foundation of the AMS and this ACP.
PBN IR	The PBN IR introduces the gradual implementation of PBN flight procedures to support safer, greener, and more efficient aircraft operations. The Regulation is binding in its entirety and directly applicable in all EU Member States.
Peak District	The Peak District - an upland area in England at the southern end of the Pennines. Mostly in Derbyshire, it extends into Cheshire, Greater Manchester, Staffordshire, West Yorkshire and South Yorkshire.

PDG	Procedure Design Gradient.
Places of Worship	For our analysis we have used the 'Ordnance Survey Address Base' count of 'Places of Worship', details of which they receive from the local government contributing authority. These include any Abbey, Baptistery, Cathedral, Church, Chapel, Citadel, Gurdwara, Kingdom Hall, Methodist, Mosque, Minster, Stupa, Succah, Synagogue, Tabernacle or Temple.
PNR	Preferred Noise Route - lines of tolerances widen from the runway ends out to 1.5km each side of the Standard Instrument Departure route. The area encompassed by these 1.5km tolerances is commonly recognised as the PNR.
Point Merge	Is based on a specific precision-area navigation (P-RNAV) route structure, consisting of a point (the merge point) and pre-defined legs (the sequencing legs) equidistant from this point. The sequencing is achieved with a "direct-to" instruction to the merge point at the appropriate time.
POL	Abbreviation for the Pole Hill DVOR navigation beacon and routes that is to the north of Manchester and is used by departing aircraft as a navigation point
Q&A	Question and Answer - a list of questions (and their answers) that help the reader understand the subject material.
Radius to fix	Radius to Fix (RF) is defined as a constant radius circular path around a defined turn centre that terminates at a fix.
RAG	Red, Amber, Green - a means of assessing a project's status using the traffic light colours.
RF	Radius to Fix is defined as a constant radius path around a defined turn centre. It is a type of waypoint used in PBN procedures and provides highly accurate track keeping in a turn.
RNAV1	Area Navigation 1 is one of the specifications within PBN. Aircraft must maintain specific navigational accuracy within the flight. The '1' suffix refers to the accuracy requirement in the procedure, in this case aircraft must fly within +/-1 nautical mile of the centreline of the designed route.
RNP APCH	Required Navigation Performance Approach - a type of RNP procedure used in the descent phase of flight.
RNP1	Required Navigation Performance - one of the specifications under PBN. Aircraft must maintain specific navigation accuracy, and in RNP are aided by on-board performance monitoring and alerting. It provides slightly more predictable track-keeping when compared to RNAV1. The '1' suffix refers to the accuracy requirement in the procedure, in this case aircraft must fly within +/-1 nautical mile of the centreline of the designed route.
RNP1+RF	Required Navigation Performance with Radius to Fix turns.
ROSUN	One of three existing hold stacks used at Manchester Airport.
Route option	A term used in engagement to describe the design options that have been created in this step of the Airspace Change Process.
SAC	Special Area of Conservation - Designated under the Conservation of Habitats and Species Regulations 2017 as making a significant contribution to the conserving of the habitats of protected species.
Safety Case	A written demonstration of evidence and due diligence provided by a corporation to demonstrate the ability to operate safely and effectively control hazards.
SANBA[4]	A navigation fix to the south of Manchester used by departing aircraft.
SARG	Safety and Airspace Regulation Group which drives UK Civil Aviation Authority (CAA) safety standards including overseeing aircraft, airlines and air traffic controllers. They are also responsible for the planning and regulation of UK airspace.
Secretary of State	The title typically held by Cabinet Ministers in charge of Government Departments.

SESAR	The Europe-wide Single European Sky Air Traffic Management Research programme - a joint undertaking is an institutionalised European partnership between private and public sector partners set up to accelerate through research and innovation the delivery of the Digital European Sky (www.sesarju.eu).
SID	Standard Instrument Departure - pre-determined flightpath set by Air Traffic Control that aircraft follow when departing an airport.
SME	Subject Matter Expert(s) is a person (are people) who has (have) accumulated great knowledge in a particular field or topic.
SoN	Statement of Need - the means by which the change sponsor sets out what airspace issue or opportunity it is seeking to address and what outcome it wishes to achieve, without specifying solutions, technical or otherwise. Manchester Airport's SoN can be found online (airspacechange.caa.co.uk/documents/download/602).
SONEX[4]	A navigation fix to the east of Manchester used by departing aircraft.
SPA	Special Protection Area - protected areas for birds classified under the Wildlife and Countryside Act 1981 and protected under the Conservation of Habitats and Species Regulations 2017.
SSSI	Sites of Special Scientific Interest - areas of importance designated and protected by Natural England under the Wildlife and Countryside Act 1981 to recognise the land's wildlife, geology or landform is of special interest.
STAR	Standard Terminal Arrival Route - a pre-determined flightpath set by Air Traffic Control that aircraft follow when arriving at an airport.
Step 1B Design Principles Report	A document that formed part of Manchester Airport's Stage 1 submission to the CAA (https://airspacechange.caa.co.uk/documents/download/1382).
T-Bar	A name given to a type of RNAV final approach procedure. There is a final approach based on an extended centreline from the runway and then perpendicular to that, two Initial Approach Segments are connected to form a 'T' shape.
TABLY	A navigation fix to the south-west of Manchester used by departing aircraft.
Technical Coordination Group	Created by ACOG the Group regularly meet to discuss and resolve policy and technical issues affecting airspace design across all airports.
TODA	Take off Distance Available - The length of the paved surface of the take-off runway plus the length of the clearway.
TOS	Traffic Orientation Structure ensures smooth traffic flows and decrease the safety risks associated with crossing traffic.
Track to fix	A Track to Fix (TF) leg is used in PBN procedures to create a line between two waypoints. It is defined by the flight track to the following waypoint and Track to a Fix leg are sometimes called point-to-point legs for this reason.
Tranquillity	There is no universally accepted definition of tranquillity and therefore no accepted metric by which it can be measured. In general terms it can be defined as a state of calm. The consideration of impacts upon tranquillity for airspace change 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.
Transition	The part of the arrival route from the IAF at 7,000ft where aircraft are descending prior to joining the final approach at the FAF.
Transition Altitude	The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes. Above this, the reference is to a Flight Level.

Transport Act 2000	The Transport Act 2000 is an Act of the Parliament of the United Kingdom. The Act provided for a number of measures across the transport industry. In the aviation sector, the Act set a framework for creation of a public-private partnership of National Air Traffic Services.
Uncontrolled Airspace	Uncontrolled airspace is airspace where an ATC service is not deemed necessary or cannot be provided for practical reasons.
Unviable	Options which would not comply with the rules or for flight procedure design, specifically the requirements of ICAO PANS-OPS 8168, or if they are not compliant with these rules, did not have a supporting safety justification.
VHF	Very High Frequency.
Viable and good fit	Options that are viable to design and which would be expected to meet the three design principles with which all design options 'must' comply (design principles Safety, Policy, and Capacity).
Viable but poor fit	Options that are viable to design, but which would not be expected to meet the requirements of the design principles Safety, Policy and Capacity.
VNAV	Vertical Navigation - a term for vertical (up/down) navigation used within Performance Based Navigation.
VRP	Visual reference point.
WAL	Abbreviation for the Wallasey DVOR navigation beacon that is to the west of Manchester and is used by departing aircraft as a navigation point.
XORBO[4]	A navigation fix to the north-east of Manchester used by departing aircraft.
XUMAT[4]	A navigation fix to the north of Manchester used by departing aircraft.

Appendix A: Design Decisions

The below table details the key Design Decisions and Assumptions made in the design process to date which have informed the design envelopes and the comprehensive list of design options shown in this DOR, for both arrivals and departures.

The next logical step in considering airspace change is for individual design options to be combined into operating networks. This will support ongoing engagement and, in turn, will allow for a more detailed evaluation against the design principles.

In addition, as the shortlisted design options are combined into operating networks, it is likely that some of the design options will respond less well to the design principles. For example, they may prove to be incompatible with other design options, may conflict with the proposals from other change sponsors or may result in a higher cumulative impact. This may mean that certain design options will be discounted, because they are highly unlikely to perform as well as other options. As such, they would not be taken forward to the full options appraisal or public consultation at Stage 3.

Consistent with the developing national masterplan, it is recognised that 'trade-offs will be identified by ACP sponsors during the development of the initial and full options appraisals (Steps 2B and 3A of the CAP1616 process) and in collaboration with ACOG when assessing the combined and net impacts of interdependent options'.

Further refinement of design options whereby certain options is not to be appraised fully at Stage 3 will be fully explained in preparing for Stage 3. We will ensure that affected stakeholders are afforded the opportunity to provide feedback prior to the full options appraisal.

Decision		Rationale
D1	Envelope Dimensions	All 7,000ft letterboxes to be designed with a width of 8km or 4.5nm. This uses the rationale and diagrams within CAP1498 and 1616a on definition of overflight and noise distribution. A 1,888m lateral displacement at 7,000ft will result in a 3db reduction which is the minimum difference that can ordinarily be perceived on the ground. By using a 4,000m lateral displacement either side of centreline this will equate to a total letterbox width of 8,000m or 4.32nm. For design purposes, this has been rounded up to 4.5nm to create a wide dispersal of noise across the letterbox.
D2	Position of First Turn	Where new routes are proposed the nominal turn point shall be no closer than 1nm from the DER, unless the option has an early turn for environmental purposes. This is in line with CAP778 which states, Para 3.5.1 Competing airspace demands and the CAA's requirement for any volume of CAS to be the minimum necessary to meet the requirements of a specific operation has led the CAA to conclude that, for ATM purposes, the following additional requirements could apply to SID designs:

		a) An initial climb to achieve a minimum of 500ft Aal at 1nm DER. b) Thereafter, a minimum climb gradient for ATM purposes (or in order to satisfy CAS containment requirements where CAS already exists, and to ensure route separation requirements where necessary) is to apply. The selected ATM-related climb gradient is to be based upon the results of local traffic surveys undertaken to determine the actual climb performance of departures from the subject aerodrome. In addition, section 5 states: 5.1 The UK has considered the relationship of ATT in the calculation of the position of the first waypoint in any RNAV departure procedure. It is recognised that the current PANS-OPS criteria may restrict the point at which the first turn may be initiated, and this could have significant impact on runway utilisation and departure separation requirements. 5.2 For a Fly-by waypoint the minimum distance from DER to the first waypoint is the sum of; a) turn initiation (which will vary with turn angle), AOB and True Airspeed (TAS); b) ATT; and c) the distance required for the aircraft to achieve minimum turn height (above DER). 5.3 Taking into consideration the ICAO criteria for height at DER, and minimum PDG (3.3%), the minimum turn height equates to 394ft. However, it is UK policy that the lowest turn height is to be 500ft. Applying an assumed height of 5m (16 ft) over DER and a minimum PDG of 8%, aircraft will achieve 500ft at 1nm beyond DER; therefore, the turn point shall be no closer to DER than 1nm. And 3.5.3 Evaluation of aircraft performance has indicated that: a) aircraft can achieve heights in excess of 5m over DER. b) climb gradients in excess of 3.3% can be achieved for ATM purposes. c) the earliest turn can be achieved at 1nm DER and not below 500ft. However, CAP 778 also states that a turn point less than 1nm from DER may be accepted for specific environmental purpose. By applying the above, and taking into consideration actual aircraft climb performance, the following have been applied to the design options: a) When creating replicated ('do minimum') options, the turn point used is the same as that of the current procedure, even if this is less than 1nm. This is based upon these current procedures being proven safe and flyable. (see also Decision 3 and 4).

		b) When creating new options, the default process was to use a minimum distance of 1nm from the DER to aid the climb profile and to avoid irregularities in early turn behaviour caused by aircraft FMS'. c) Where an environmental benefit was apparent by turning less than 1nm from the DER, this was explored. However, no turns specified shall be closer to the DER than what is flown currently, the smallest distance being 0.61nm DER (see also Decision 3). d) Options with a turn less than 1nm for environmental purposes will require a supporting safety case and evidence that aircraft can fly the options without any FMS irregularities or safety issues. This will be subject to CAA approval. e) Under no circumstance shall turns be specified closer than 0.6nm beyond DER, unless arising through a 'turn at an altitude'.
D3	Earliest position of First Turn	No nominal turn points for the first turn shall be closer to the DER than that currently flown unless this distance is equal to or greater than 1nm, or if the option replicates the existing DME fixes (which may be a 'Do Minimum' option) to allow for an early turn for environmental purposes. Some of the existing MCT DME ranges result in less than 1nm from the DER. These are. MONTY 1Y – D3.2 results in 0.73nm from DER. KUXEM 1Y EKLAD 1Y – D3.2 results in 0.73nm from DER. LISTO 2S – D1.2 results in 0.74nm from DER. LISTO 2Y – D3.2 results in 0.73nm from DER. LISTO 2R – D2 results in 0.61nm from DER. POL 1Y – D3.2 results in 0.73nm from DER. SONEX 1Y – D3.2 results in 0.73nm from DER. SANBA 1Y – D3.2 results in 0.73nm from DER.
D4	Position of first turn - – Replicated ('Do Minimum') options.	'Do minimum' options included in this report seek to replicate existing routes and as such try and replicate existing turn points. In some instances, this is less than 1nm from the DER. Where options have been replicated as a 'do minimum' option, the existing turn points have been copied to achieve the best possible outcome. See also decision D3.

D5	Where new routes are proposed and an RF turn is used, the nominal turn point shall be no closer than 1nm from the DER, unless the option has an early turn for environmental purposes.	Although it is seen in the UK AIP that existing procedures flown today have the start of the turn less than 1nm from DER, PANS-OPS states that the minimum distance from the DER to the waypoint at the start of the RF turn shall be 1,852m (1nm). Where an environmental benefit was apparent by turning less than 1nm from the DER, this was explored. See also decision D3.
D6	Bank Angles	Bank Angles of no greater than 25° are used below 2,000ft aal for RF turns. PANS OPS states that bank angles up to 25° may be used for any turn above 400ft above aerodrome elevation. Turns shall not be initiated below 400ft above aerodrome elevation. This criteria has been applied and a minimum turn altitude of 500ft aal, which is the UK requirement, supersedes the above statement.
D7	Design Option termination points.	Envelopes and design options within them should not be constrained to the current SID termination points. In order to consider the widest range of options, the letterboxes should be defined by the routes, rather than a fixed end point. The 7,000ft altitude point with the baseline 6% climb gradient will determine the end position of the letterbox for each developed option.
D8	Optimising available design space.	Design options should make maximum use of envelope dimensions as long as technically feasible and the envelope aligns with the identified airspace constraints. This will result in a range of possibilities, and although some will be more closely aligned to design principles than others, this will allow an effective comparison to be made by stakeholders during engagement activities and within subsequent options analysis.
D9	Criteria used to determine a route that is "Unviable"	Unviable design options are defined as design options that have been considered but would not meet the requirements of the Design Principle Safety in respect of: • They would not fully comply with the requirements of PANS-OPS 8168 or; • Would not have an approved safety justification for the lack of compliance with the PANS-OPS criteria. This includes those that may be non-compliant with PANS-OPS in relation to: • Minimum Stabilization Distance (MSD).

		• Position of the first turn in relation to departure end of runway (DER) within PANS-OPS . • Turn radius based on speed, altitude and climb gradient. • Procedure Design Gradient (PDG). In addition it covers options that may conflict with, or cause aircraft to fly through notified Danger Areas. The full explanation of Viable and Good Fit and Viable but Poor Fit is provided at section 5.14.
D10	Arrival descent gradients (CDA).	The descent gradient required for an arrivals option to be classified as Viable and Good fit is between 3.5° and 1.5°. This is within PANS-OPS CDO recommended range for CDAs and also encompasses the optimal descent gradient identified within CAA Low Noise Arrival Metric (CAP2302). Options that have a gradient outside of this range are classified as Viable but Poor fit.
D11	Path Terminator use.	Due to Design Principle Noise N2, path terminators and waypoint types will be varied in the options list, to create procedures with and without elements of dispersion. Fly-over waypoints with course-to-fix and direct-to-fix coding will provide dispersion within the design, particularly where large track changes occur, whereas fly-by waypoints with track-to-fix and radius-to-fix (RF) coding will help track keeping and keep dispersion to a minimum.
D12	Departure climb gradients.	The baseline climb gradient is 6% (supported by the fleet equipage survey), Further work needs to be conducted to ascertain the percentage of operators that could meet a higher climb gradient that is present in some design options.
D13	Airspace containment.	Design options should confirm with the CAA Controlled Airspace Containment Policy Statement (January 2014 superseded in August 2022) and remain 3nm or more from the boundary of Class G airspace.

D14	Arrivals: Position of Final Approach Fix (FAF)	For **Runways 23L/23R** FAF options have been created at 3,500ft and 3,000ft. It would not be possible to create a FAF at either 2,500ft or 2,000ft because the dimensions of the Class D airspace do not permit early descent with sufficient range to touchdown. 3,000ft is therefore the minimum FAF altitude for viable and good fit options. It would not be possible to create a FAF at altitudes above 3,500ft because of the interaction with NERL airspace to the east (Yorkshire CTA). For **Runways 05L/05R** FAF options have been created at 3,000ft, 2,500ft and 2,000ft. It would not be possible to create a FAF at 3,500ft for 05L/R because of the interaction with Liverpool delegated airspace. The maximum FAF altitude is therefore 3,000ft which creates lateral separation from Liverpool airspace. A FAF altitude of 2,000ft is the minimum position of the FAF and has been included in response to bilateral discussions with LPL, with the aim of creating options that increase the lateral separation from LPL Runway 09 departures.

Appendix B: NERL Requirements

As detailed in section 3 the design of the airspace at MAN and the NATS (NERL) network must be aligned in order to be compliant with the aims of the Airspace Modernisation Strategy. A set of airspace requirements have been agreed between MAN and the FASI-N NERL project teams to create this alignment in the designs of both parties as part of the FASI-N project.

These requirements detail what MAN require the NERL airspace to deliver as part of their ACP.

Requirement no.	Requirement of the NERL Network
1	The NERL airspace shall enable MAN airport to make best use of existing runway capacity in line Government policy.
2	The design of the NERL airspace above 7,000 ft shall not cause traffic to and from Liverpool to adversely impact the spacing of departures and arrivals to MAN.
3	The design of the NERL airspace above 7,000 ft shall not cause traffic to and from East Midlands to adversely impact the spacing of departures and arrivals to MAN.
4	The NERL airspace shall minimise the use of Short-Term Air Traffic Management measures (STAMs).
5	The NERL project shall ensure that airspace systemisation effectively manages arrivals and departures within the MTMA.
6	The design and placement of any delay absorption structures shall not result in additional military transit and test aircraft from Warton impacting the MAN operation.
7	The NERL project shall design the airspace to provide routes to support Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO) through 7,000 ft into and out of Free Route Airspace (FRA).
8	The NERL airspace design shall accommodate flexible arrival spacing to ensure MAN Approach can deliver the required arrival gaps required by the tower on a tactical and pre-tactical basis.
9	The NERL airspace design shall ensure the network design above 7,000ft effectively integrates with the airport airspace.
10	The NERL airspace design shall be capable of managing closure of an MTMA runway in a mass diversion scenario.

11	The NERL project shall ensure that the airspace is capable of managing positioning flights between the airports within the MTMA.
12	The NERL project shall ensure that the airspace design can be accommodated within the minimum amount of controlled airspace. This design shall continue to provide access to GA users on an equitable basis with other airspace users. In addition, the NERL project shall minimise requirement for additional controlled airspace.
13	The NERL project should provide multiple options at 7,000 ft to allow for varying flight climb profiles.
14	The NERL airspace design shall safely manage the effects of unusual events including aircraft emergencies, a partial ATC system failure, adverse weather conditions. It shall also have the ability to detect and correct deviations from airborne routes, including PBN routes, for each workload condition.
15	The airspace shall be designed and optimised to meet safety requirements
16	The NERL airspace design shall accommodate the minimum prescribed separation standard between departing and arriving traffic.
17	The Airspace above 7,000ft shall be capable of supporting departure splits of 1 minute as per current ICAO standards.
18	The NERL project shall design the airspace to provide a delay absorption methods (including holds) to the airport above 7,000ft.
19	The NERL airspace design should accommodate the Flexible Use of Airspace (FUA) where necessary.

MAG Manchester Airport

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