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Initial Options Appraisal

LJLA Airspace Change

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1 Introduction

1.1 Regulatory Requirement for Change

Liverpool John Lennon Airport (LJLA) is required to comply with Resolution 36/23 ratified by the 36th International Civil Aviation Organisation (ICAO) General Assembly, as well as with the UK Airspace Modernisation Strategy (CAP1711[1]) published by the Civil Aviation Authority (CAA)[2]. To comply with these directives, and alongside other UK airports, LJLA is required to explore options for alternative Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs) that are compliant with Performance Based Navigation (PBN) criteria. Essentially, this means introducing procedures to arrive and depart from the airport that are designed and flown with reference to Global Positioning Systems (GPS) rather than the traditional ground-based navigation aids.

The foundation for PBN is 'area navigation' or RNAV; aircraft arriving and departing LJLA using the proposed RNAV procedures will do so based on their PBN capability

In additional as Liverpool is a European Union Aviation Safety Agency (EASA) regulated aerodrome, EU Implementing Regulation 2018/1048 requires all airports to implement Performance Based Navigation (PBN) procedures by 2030 and that conventional procedures are thereafter only to be used as contingency. LJLA already has an PBN aRea Navigation (RNAV) approach to each end of the runway and whilst this could enable them to meet the regulatory requirement, these stop short of LJLA's obligation to support the UK Airspace Modernisation Strategy – see Constraints in paragraph 1.4.2.

The removal of ground-based navigation aids in accordance with the DVOR[3] Rationalisation and NDB[4] Withdrawal Programme necessitates the introduction of GPS technology to define future GPS routes that will be more accurate and reliable; these routes will be used by the increasing numbers of aircraft suitably equipped and capable of using GPS technology. Removal of the ground-based network of navigational aids will render LJLA's conventional procedures obsolete as they depend on aircraft referencing this equipment.

1.2 CAP1616 Airspace Change Process

The implementation of any changes to UK airspace is subject to the guidance contained in CAP1616. CAP 1616 is a seven-stage process published by the CAA that provides guidance on the process to follow when seeking to change the way airspace is used. The whole LJLA CAP 1616 process is envisaged to take 2½ years. The seven stages of the process are as follows:

- Stage 1 – Define
- Stage 2 – Develop and Assess (current stage)
- Stage 3 – Consultation
- Stage 4 – Update and Submit
- Stage 5 – Decide

[1] CAP1711 Airspace Modernisation Strategy
https://publicapps.caa.co.uk/docs/33/CAP%201711%20Airspace%20Modernisation%20Strategy.pdf
[2] The CAA is the UK's independent airspace regulator
[3] Doppler VHF (Very-High-Frequency) Omnidirectional Range.
[4] Non Directional [*radio]* Beacon.

- Stage 6 - Implement
- Stage 7 – Post-Implementation Review

LJLA are currently at Stage 2 which requires the development of options that seek to meet the original Statement of Need. The options are required to align, where practicable, with the Design Principles generated in Stage 1. These options are then assessed to understand the positive/negative impacts before progressing to the Stage 2 Gateway.

1.3 Progress So Far

In February 2018, LJLA submitted a Statement of Need to the CAA. This is the formal explanation as to why the Airport wishes to change the airspace. The CAA indicated that an airspace change was an appropriate mechanism to achieve the objectives in LJLA's Statement of Need. A copy of the Statement of Need and other associated documentation can be viewed at www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

At the end of November 2018, the first stage in the change process was successfully completed when the Airport's submission passed through the Stage 1 DEFINE Gateway.

The work undertaken during Stage 1 established a prioritised shortlist of Design Principles to act as a framework against which Design Options have been drawn up. The prioritised list of Design Principles can be found in the documents uploaded at Stage 1B on the portal.

1.4 Step 2A – Options Development

1.4.1 Introduction

During Step 2A, LJLA developed a list of design options for the new procedures. The options took into account the fixed constraints identified during Stage 1A and the Design Principles established in Stage 1B.

New SIDs, Approaches and Transitions are proposed.

1.4.2 Constraints

Five constraints were identified during Stage 1 ASSESS:

- C1: Instrument Flight Procedures must be PANS OPS 8168 compliant;
- C2: Instrument Flight Procedures must be safe
- C3: Integration with Future Airspace Strategy (North) - FASI (N)[5]
    - Manchester TMA
    - Scottish Terminal Control Area
    - Belfast Terminal Control Area
    - Irish Sea Sector Ops
- C4: Fixed airway entry and exit points, and runway position
- C5: Integration with other local airspace users
    - Prestwick Centre;
    - Manchester Airport
    - City Airport

[5] FASI(N) is a combination of airspace redesign modules that comply with the UK's Future Airspace Strategy through the provision of Performance Based Navigation routes, Standard Instrument Departures and Standard Arrival Routes which facilitate continuous climb and continuous descent operations, user preferred routes, Flexible Use of Airspace and simplified boundaries between controlled and uncontrolled airspace. The redesign and modification will include the Manchester Terminal Control Area, Scottish Terminal Control Area, Belfast Terminal Control Area and Irish Sea sector operations.

- Hawarden Aerodrome
- RAF Shawbury
- BAES Warton
- Blackpool Airport
- Tilstock Parachute Centre
- General Aviation Community

1.4.3 Application of the Constraints to the Options Development

All design options must be PANS OPS 8168 compliant (Constraint **C1**) which means that the parameters of the IFP, e.g. shape, accuracy, turn areas and obstacle clearances, must all meet the criteria set out in ICAO document *Aircraft Operations – Volume 2 Construction of Visual and Instrument Flight Procedures*. This is the international standard for all IFPs.

The IFPs must be safe (**C2**). The primary means by which it is intended to provide safety assurance evidence to support the options is a Safety Case developed in accordance with CAP760[6]. The Safety Case is under development and the first stage (Hazard Identification) took place during Stage 2B. More information on the Safety Assessment is contained in Section 5.

Constraints **C3** and **C4** are the necessary starting points for developing the design options to ensure connection to the enroute airways structure:

- The options for the SIDs have a fixed start point (the runway) and a fixed end point for integration into the enroute structure.
- The design of Approach Procedures are standard T-bar shaped RNAV Approaches which must line up to the runway.
- The Transitions link the enroute Standard Arrival Routes (STAR) to the start of the Approach procedure into LJLA; Transitions are required to follow the most expeditious route.

The integration of the proposed procedures into FASI (N) (**C4**) requires LJLA to liaise with industry groups to ensure that the proposed procedures and timeframes for implementation can be aligned to the wider requirements of FASI (N) and the Airspace Modernisation Strategy. LJLA recognise the recent establishment of the new governance structure for airspace modernisation including the Airspace Change Organising Group (ACOG) of which FASI (N) is a subgroup and are working to ensure their proposal aligns. ACOG are responsible for the delivery and governance of a UK-wide road map of airspace changes necessary to fulfil the modernisation strategy.

C5, integration with other local airspace users is considered during the design process and through the engagement of those users during the CAP1616 process. For example, Blackpool Airport confirmed that the proposed routes were all clear of their operations, whilst Hawarden Airport raised some concerns during engagement activities. The Police provided neutral but helpful comments regarding their ability to fly IFPs.

1.4.4 Application of the Design Principles to the Options Development

LJLA first applied the constraints to the design process as above to produce an initial list of viable options. These were refined to take into account the Design Principles, for example tighter turns were incorporated to avoid overflying sensitive areas such as schools, hospitals and residential areas such as those in Runcorn and The Wirral. Further efforts

[6] CAP760: Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: For Aerodrome Operators and Air Traffic Service Providers

were made to route aircraft above the motorways or industrial areas where higher ambient noise already exists or to route aircraft over the Mersey to avoid overflight of residential areas. A new hold was designed to ensure aircraft waiting for clearance for final approach would be kept over the sea instead of flying the race track pattern above the airport and the villages in the vicinity.

In order to meet the other design principles relating to emissions and fuel burn, amendments were made with the aim of finding the most expeditious routes that would facilitate optimum aircraft performance.

An original long list of Design Options was shared with the stakeholders and representative bodies that contributed to the development of the Design Principles in Stage 1. The airport invited the stakeholders to a face-to-face event where they could view the options on a large map. The airport produced acetate overlays of all the options which facilitated interactive discussion on the options – stakeholders were offered the option to draw on the acetate layers to make suggestions about alternative routes, tighter turns, or to mark sensitive areas that may have been missed. Stakeholders were invited to state their preferences for the various options and to give reasons e.g. fewer people overflown, fewer track miles or less conflict with neighbouring airport operations.

Following this stakeholder engagement, LJLA added three additional options to the longlist – one SID was re-routed up the Mersey to reduce the number of people overflown, and two further options related to addressing the position of the Missed Approach Procedure hold.

The final longlist of options was subjected to a formal Design Principle Evaluation setting out how the options responded to the Design Principles. The publication of the longlist of options and the Design Principle Evaluation onto the CAA Airspace portal completed Stage 2A.

1.5 Step 2B – Initial Options Appraisal

At Step 2B, the longlist of options was tested against the criteria contained in CAP1616, with the addition of a Qualitative Safety Assessment and a Qualitative Noise Assessment as required for a Level 1 change at this stage.

The methodology used for the Initial Options Appraisal is discussed in Section 2.

The Initial Options Appraisal is summarised in Section 4 and it resulted in a shortlist of options to be taken forward to Stage 3 for detailed technical design and consultation. The Shortlist is contained in Section 6.

2 Guidance and Methodology for Options Appraisal

CAP1616 requires sponsors to complete a formal Options Appraisal process that assesses the benefits of the various options compared to a baseline. At the Initial Options Appraisal, the requirement is only to determine the high-level criteria and then conduct a qualitative assessment against each option. This Initial Options Appraisal serves as the foundation for a more quantitative assessment later in the process.

2.1 CAP1616 Options Appraisal Requirements

The Options Appraisal process is carried out in accordance with the guidance in CAP1616, and in conjunction with The Green Book[7] and the Department of Transport's WebTAG[8], which constitute best practice in options appraisal.

Options Appraisal is used as a tool throughout the CAP1616 process to help refine the options from an initial longlist, down to a short list and a final set of preferred options. The process is iterative with Initial Options Appraisal (this document) being used to whittle down the longlist in Stage 2B, Full Options Appraisal of the shortlist taking place in Stage 3 for consultation, with the Final Options Appraisal supporting the submission of the ACP application to the CAA.

The Options Appraisal consists of the following elements:

- High-level objective and assessment criteria.
- Baseline definition – current operations.
- Longlist of options (including a do-nothing/minimum option).
- Shortlist of options.
- Preferred or final option(s).

The options appraisal requirement of CAP1616 evolves through three iterations with the CAA reviewing at each phase as follows:

1. 'Initial' appraisal at Step 2B with the CAA review at the 'Develop and assess' gateway;
2. 'Full' appraisal at Step 3A with the CAA review at Step 3B and the subsequent 'Consult' gateway;
3. 'Final' appraisal at Step 4A, with the CAA review after the formal submission of the airspace change proposal at the end of Stage 4.

[7] The Green Book: Appraisal and Evaluation in Central Government;
https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government

[8] DfT transport analysis guidance WebTAG:
https://www.gov.uk/guidance/transport-analysis-guidance-webtag

Iteration 1, Initial Options Appraisal, is the subject of this document to be submitted to the CAA as part of Step 2B. The remainder of this section of the document focusses on the definition of the 'high-level objective and design principles' and the assessment method.

2.2 High Level Objectives and Assessment Criteria

For a Level 1 Airspace Change, the Criteria against which the appraisal options must be assessed are contained in Table E2 of CAP1616. Table 1 – Assessment Criteria for Level 1 ChangeTable 1 below describes these with the addition of the Safety Assessment Criteria at the bottom.

Affected Group	Impact	Description
Communities	Noise impact on health and quality of life	Requires consideration of noise impact on communities including residents, schools, hospitals, parks and other sensitive areas.
Communities	Air Quality	Any change in air quality is to be considered.
Wider Society	Greenhouse Gas impact	Assessment of changes in greenhouse gas levels in accordance with WebTAG is required
Wider Society	Capacity and resilience	A qualitative assessment of the impact on overall UK airspace structure
General Aviation	Access	A qualitative assessment of the effect of the proposal on the access to airspace for GA users
General Aviation / commercial airlines	Economic impact from increased effective capacity	Forecast increase in air transport movements and estimated passenger numbers or cargo tonnage carried.
General Aviation / commercial airlines	Fuel burn	The change sponsor must assess fuel costs based on its assumptions of the fleets in operation.
Commercial airlines	Training costs	An assessment of the need for training associated with the proposal

Commercial airlines	Other costs	Where there are likely to be other costs imposed on commercial aviation, these should be described.
Airport / Air navigation service provider	Infrastructure costs	Where a proposal requires a change in infrastructure, the associated costs should be assessed.
Airport / Air navigation service provider	Operational costs	Where a proposal would lead to a change in operational costs, these should be assessed.
Airport / Air navigation service provider	Deployment costs	Where a proposal would lead to a requirement for retraining and other deployment, the costs of these should be assessed.
Safety Assessment	Safety Assessment	CAP1616 requires a safety assessment of the proposal to be undertaken in accordance with CAP760.

Table 1 – Assessment Criteria for Level 1 Change

2.3 Method

2.3.1 Overview

The Initial Options Appraisal was carried out by comparing all of the options side by side against the CAP1616 criteria in tabular form. The Appraisal also included the results of a Qualitative Safety Assessment as described in Section 5, and the noise impact for communities was supported by a qualitative noise assessment as described in Appendix A1. The full analysis of all the options is described in Appendix A2 and included as a separate MS Excel spreadsheet (saved as a PDF on the airspace portal).

The Options Appraisal also compared the implementation of each of the proposed RNAV procedures against the 'Do Nothing' Option which maintains the existing conventional navigation for the given procedure. Paragraph 3.1 contains the full list of conventional procedures as part of the Baseline Definition.

2.3.2 The Appraisal Team

The appraisal team consisted of the following Suitably Qualified and Experienced Personnel (SQEP) who discussed and agreed the assessment of each option against the criteria:

- ATCSL[9] Head of Air Traffic Services
- LJLA Head of Environment
- ATCSL Group ATC Training & Standards Manager

[9] ATCSL – Air Traffic Control Services Ltd are the Air Navigation Services Provider for LJLA

- The following SQEP from LJLA's appointed Aviation Consultancy:
  - Principal ACP Consultant (ACP Project Manager)
  - Principal Safety Engineer
  - Senior ACP Consultant
  - Senior Approved Airspace Designer

2.3.3 Shortlisting

Once all the options had been assessed against the criteria, the appraisal team reconvened to identify the short list to be taken forward to Stage 3.

The Shortlist and the method by which it was derived is contained in Section 6.

3 LJLA Baseline Definition - Current Operations

3.1 Extant Conventional Procedures

The baseline operational environment includes the following list of conventional procedure routes:

- SIDs from each runway end via the following waypoints:
  - POLE HILL (POL) – North
  - REXAM for departures to South
  - NANTI for departures to the South
  - WALLASEY (WAL) for departures to the West
  - BARTON for departures to the East
- Approaches to 09 and 27
  - ILS/DME/NDB(L) Runway 09 and 27
  - LOC/DME/NDB(L) Runway 09 and 27
  - NDB(L)/DME Runway 27
  - SRA RTR 2NM Runway 09 and 27
  - RNAV Approaches (straight in approaches to both runway directions)
- Transitions – there are no transitions, aircraft are vectored from the enroute Standard Arrival Procedures (STAR)

Each of the above procedures will be used as a baseline to assess the new options designed to replace that route.

3.2 Current Arrival and Departure Tracks

To provide some insight into the distribution of aircraft tracks currently arriving and departing from LJLA, Figure 1 and Figure 2 below show LJLA arrivals in red and departures in blue. The tracks shown are those where aircraft arrive and depart along the LJLA published IFPs i.e. using the conventional procedures listed above in paragraph 3.1. It should be understood, that General Aviation (GA) aircraft are not shown in these Figures; GA aircraft arrive and depart from the aerodrome along published VFR[10] routes, or routes agreed between the aircraft Captain and LJLA Air Traffic Control (ATC). These VFR routes are not part of this airspace change project, however the impact on GA is one of the assessment criteria for the Options Appraisal (see paragraph 3.4).

Figure 1 depicts operations from Runway 27; this is normally the preferred runway because aircraft normally take-off and land into the prevailing westerly wind. Figure 2 depicts operations from Runway 09, associated with easterly winds. The aircraft tracks shown in each Figure were generated during one week of Summer of 2018.

[10] VFR – Visual Flight Rules (a set of regulations under which a pilot operates an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going).

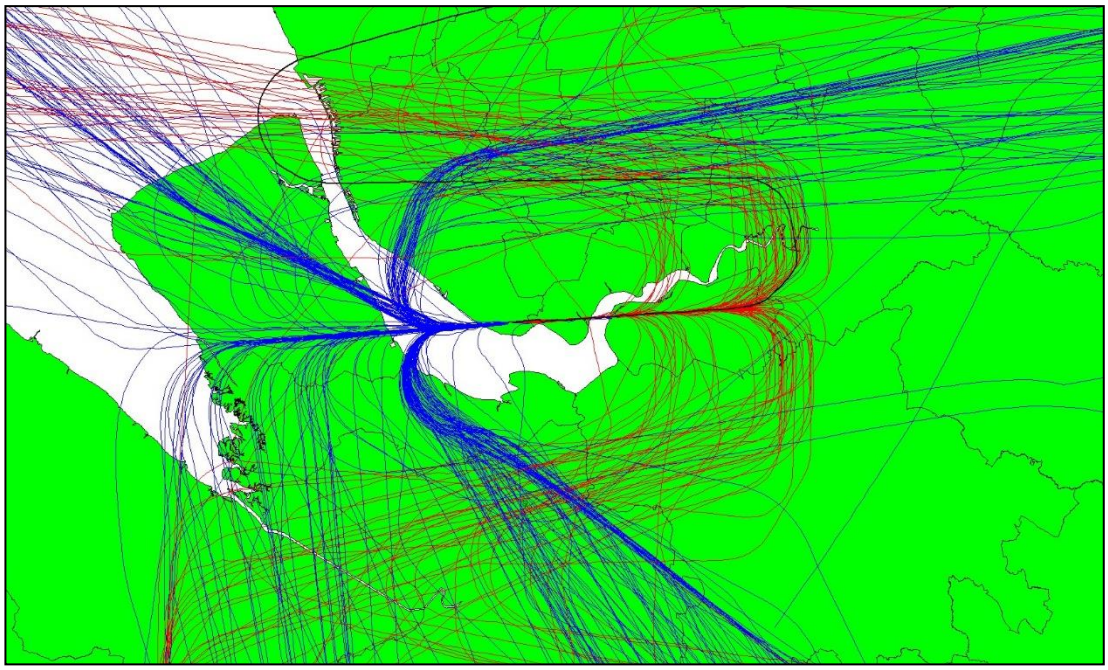

Figure 1 - Runway 27 Commercial Airline Arrivals (red) and Departures (blue) (First Week of August 2018)

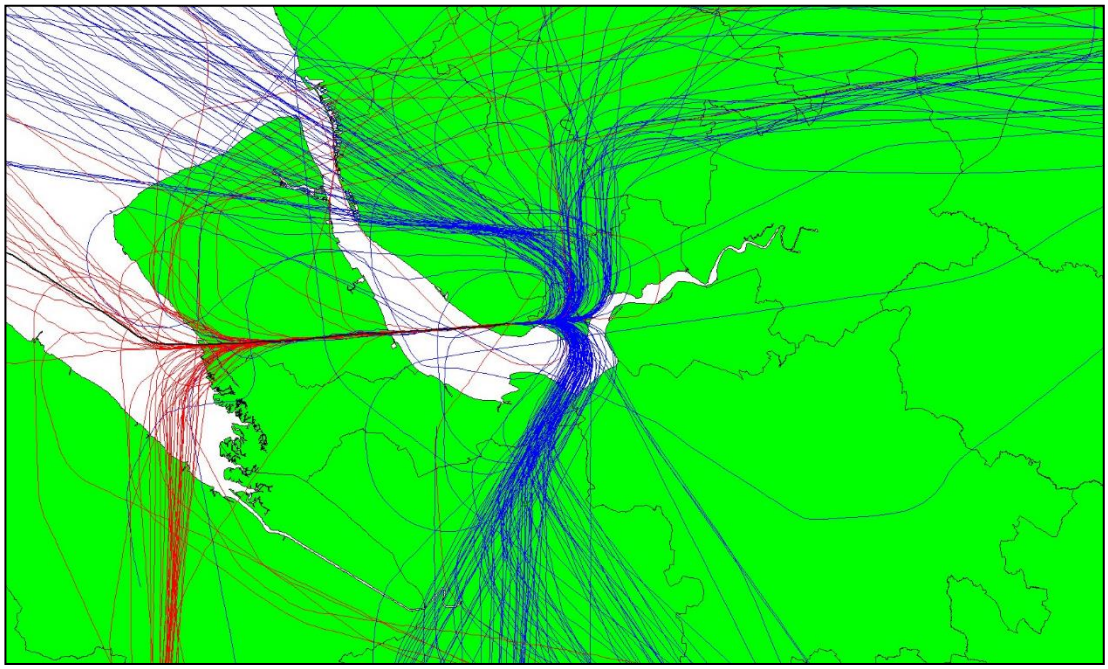

Figure 2 - Runway 09 Commercial Airline Arrivals (red) and Departures (blue) (First Week of July 2018)

3.3 Current Noise Impact for Communities

Aircraft flying along the procedures above in Figure 1 and Figure 2 generate a level of noise on the ground that may have an impact on local communities. Figure 3 below shows the calculated noise contour that represents the area around the airport within which noise levels can be expected to exceed 51dBA $L_{Aeq\ 16hr}$. The Department for Transport (DfT) directs that the CAA must consider this noise contour alongside many other environmental factors when reaching its decisions. This contour represents the average noise levels for the

16-hour period between 0700 and 2300 hrs during the summer season. DfT policy also regards this level as the point at which adverse effects begin to be seen on a community basis. However, LJLA recognises that people are likely to be concerned about noise beyond this contour.

As can be seen from the contour shown below, the majority of the noise associated with the airport is predominantly distributed to the south and west, in the immediate vicinity of the airport itself, or over sparsely-populated areas. We would not expect this noise contour to change, as the intial take-off and final approach tracks will remain the same with any new designs. A noise assessment will be undertaken as part of the Full Options Apprasial at Stage 3.

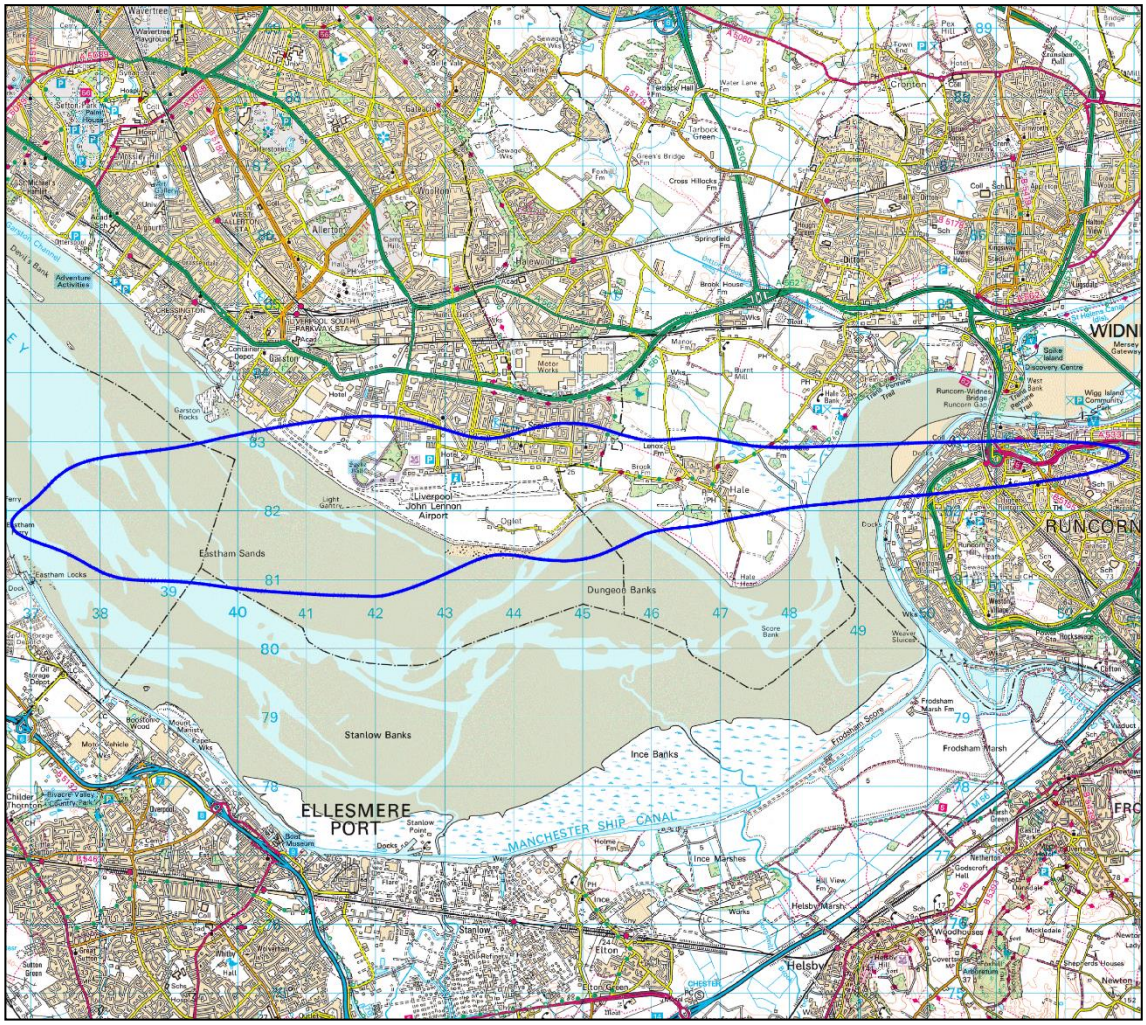

Figure 3 - Noise Contour 51dBA $L_{Aeq\ 16hr}$

3.4 Air Quality

Most of the area around LJLA is within an Air Quality Management Area (AQMA); there are two declared areas in Widnes within Halton Borough Council (HBC) area, however the airport is mainly within the Liverpool City Council (LCC) area. The entirety of Liverpool City is considered to be an AQMA.

In partnership with LCC the airport has undertaken NO_x monitoring at nine locations around the airport boundary with passive tubes for over ten years. The Air Quality Standards (AQS) have not been breached during that time and therefore air quality is considered to be generally good.

Engagement to date with the environmental health authorities at HBC and LCC suggests that no changes are expected. No changes to current tracks over the ground are proposed below 1000ft where air quality is typically measured. Therefore, no changes to air quality are expected; however, this will be assessed during the Full Options Appraisal at Stage 3.

3.5 Emissions

Extant procedures do not support optimum performance of aircraft and therefore are predicted to have a greater environmental impact compared to the proposed options due to parameters that contribute to higher engine power settings, more track miles and greater emissions:

- routes are unpredictable in length - conventional procedures rely on intervention from ATC in terms of giving height clearances and radar vectoring;
- the routes incorporate height restrictions and lead to ATC clearance delays.
- continuous climb/descent not supported due to height restrictions to coordinate with Manchester traffic – results in extended periods of level flight;
- radar vectoring of aircraft arriving from the airways to join approaches mean that aircraft do not always follow the most expeditious route.
- The tracks flown by aircraft using conventional procedures are less predictable; the exact route taken relies on the pilot interpreting ground-based beacon information and therefore the procedures as published often don't represent actual tracks flown. See Figure 1 and Figure 2 in paragraph 3.2 to see the typical spread of routes flown.

3.6 Capacity and Resilience

Maintaining extant procedures would maintain current capacity however resilience would be significantly affected. LJLA would fail to meet regulatory requirements and would fail to meet the airspace modernisation priorities including coordination with FASI (N).

3.7 General Aviation Access

General Aviation (GA) aircraft may arrive and depart from the aerodrome along published VFR routes, or routes agreed between the aircraft Captain and LJLA Air Traffic Control (ATC). These VFR routes are not the subject of this airspace change project and no changes are proposed to the way GA aircraft operate at LJLA.

No changes are proposed to the parameters of the current airspace and therefore no change to airspace access is predicted.

3.8 Economic Impact: Commercial Airliners and GA

No increase in effective capacity is anticipated at LJLA for the continued use of extant procedures and therefore no economic benefit expected for commercial airliners or GA users.

3.9 Fuel Burn: Commercial Airliners and GA

Fuel burn predicted to be greater (and less predictable) for current conventional procedures versus the new PBN procedures due to:

- Potential extended track miles in level flight due to:
  - height restrictions and clearance delays;
- unpredictable routes due to:
  - pilot/onboard system interpretation of navigation equipment;
  - tactical ATC intervention, including radar vectoring of arrivals onto final approach.
- The opportunity to optimise aircraft performance through continuous climb/descent is unsupported by the conventional procedures.

3.10 Infrastructure Costs

Existing infrastructure is subject to rationalisation programme - no additional infrastructure is required to maintain extant conventional procedures however maintaining access to ground-based equipment has been considered by airports elsewhere in the UK and generally found to be prohibitively expensive or technologically infeasible due to equipment obsolescence.

3.11 Operational Costs

No changes to operational costs are attributable to maintaining the extant procedures except were linked to maintenance of infrastructure (see above).

3.12 Training Costs

No additional training predicted.

3.13 Other Costs

It is not proportionate for LJLA to assess potential other costs for commercial airlines - there may be costs associated with maintaining legacy systems to continue flying conventional navigation but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

3.14 Deployment Costs

No deployment costs attributable to continued use of extant procedure.

3.15 Safety Assessment

The primary means by which it is intended to provide safety assurance evidence to support the LJLA ACP is a Safety Case. The Safety Case is under development and with reference to the baseline; the Safety Case includes claims, arguments and evidence that current operations at LJLA are safe, including use of the extant conventional and RNAV procedures.

It is a key assumption of the Safety Assurance Activities in Stage 2 that extant operations are safe. Assurance evidence that extant operations are safe will be provided in the Full Options Appraisal during Stage 3.

4 Initial Options Appraisal Results

4.1 Introduction

This section of the report summarises the full longlist of options and presents a summary of the results extracted from Appendix A2. Section 6 describes how the shortlist derived from the longlist. The complete analysis is contained in Appendix A2 to this report 'Initial Options Appraisal Tables'.

4.2 Proposed Options and Do Nothing Options

4.2.1 Proposed New Procedures

The proposed new procedures include the following:

- SIDs from each runway end via the following waypoints:
  - CAVEN for departures to the North
  - AGGER for departures to the East
  - CORKA for departures to the South
  - TEMP2 for departures to the South
    WAL for departures to the West
- Standard T-bar Approaches to 09 and 27
- Transitions to both runway directions from the following waypoints marking the end of the STARs:
  - DIOUF for arrivals from the North
  - NOMSU for arrivals from the West
  - VEGUN for arrivals from the South

4.2.2 Longlist of Options

Table 2 presents a summary of the procedures and the longlist of options under consideration. For each proposed procedure, the 'Do Nothing' procedure against which all the options are compared, is identified in column 1. The Table includes additional options added to the longlist at Stage 2A; three new options derived from the engagement[11] and safety assurance activities[12] during Stage 2A.

'Do Nothing' Baseline Procedure	Proposed Procedure	No of options	Basic Description

[11] An additional option for SID 27 AGGER derived from exposure of the initial longlist to the stakeholders during step2A.
[12] During the Hazard Identification activities and workshop, some safety implications were identified that required either alternative options to be developed or revisions to be made to existing options.

'Do Nothing' Baseline Procedure	Proposed Procedure	No of options	Basic Description
SID 27 via BARTON	SID 27 via AGGER	4	Options include: an immediate right turn to AGGER; a later right hand turn to AGGER; and a left hand turn to AGGER. The 4th option derived from engagement activities with the aim of providing a PANS OPS compliant route that overflew fewer residential areas.
SID 27 via WAL (conventional)	SID 27 via WAL	2	Options include: a right hand turn overhead the Mersey to WAL; and a later right hand turn overland to WAL.
SID 27 via REXAM	SID 27 via TEMP2	1	Only one option available to balance aircraft performance versus noise sensitive areas
SID 09 via BARTON	SID 09 via AGGER	2	Both options follow similar series of right hand turns to achieve 11,000ft by AGGER. Left hand turns not feasible to achieve height by AGGER.
SID 09 via POLE HILL	SID 09 via CAVEN	4	Two options turning left, and two turning right to CAVEN.
SID 09 via REXAM	SID 09 via CORKA	3	Two options turning right to CORKA and one turning left
Radar Vectoring from TIPOD or KEGUN	Transition to runway 27 from DIOUF	1	Only one option available to achieve continuous descent profile from starting altitude.
Radar Vectoring from TIPOD or KEGUN	Transition to 27 from NOMSU	1	Only one option due to conflict with Manchester arrivals.
Radar Vectoring from TIPOD or KEGUN	Transition to 27 from VEGUN	2	One option routes aircraft to join the approach procedure from the north and the other offers a shorter transition from southeast.
Radar Vectoring from TIPOD or KEGUN	Transition to runway 09 from DIOUF	1	Only one option for continuous descent and optimal length.
Radar Vectoring from TIPOD or KEGUN	Transition to runway 09 from NOMSU	1	Only one option considered: optimal route remains over the sea
Radar Vectoring from	Transition to runway	1	Only one option for continuous

'Do Nothing' Baseline Procedure	Proposed Procedure	No of options	Basic Description
TIPOD or KEGUN	09 from VEGUN		descent and optimal length
Conventional Approaches; RNAV 27 Straight in approach; Existing hold at LPL NDB.	RNAV Approach 27	4	Three traditional T-bar approaches of varying lengths with defined Missed Approach Procedures (MAP). Includes a 4th options with revised MAP derived from stage 2 safety assurance activities. A new hold over the sea is included as a result of engagement activities.
Conventional Approaches; RNAV 09 Straight in approach; Existing hold at LPL NDB.	RNAV Approach 09	4	Three traditional T-bar approaches of varying lengths with defined MAP. Includes a 4th Opition with revised MAP derived from stage 2 safety assurance activities. A new hold over the sea is included as a result of engagement activities.
Total number of Options in Longlist		31	

Table 2 – Summary of number of options and comparative baseline

The full list of options, including map overlays is published on the CAA airspace portal at Step 2A.

The Design Principles Evaluation (DPE) resulted in the rejection of two options which failed to meet the constraints or failed to meet the mandatory/high priority design principles. The new options derived during Stage 2A are also included in the DPE. The full DPE has been uploaded to the airspace portal at Step 2A.

4.3 Results Summary

The table containing the full analysis carried out at the Initial Options Appraisal stage is delivered as a separate Appendix to this document – see Appendix A2 for details.

Table 3 below summarises the Initial Options Appraisal.

Colour Key					
Carry Forward	Meets objectives, insignificant impact, and is the Preferred Option for this procedure				
Carry Forward	Meets objectives or has an insignificant impact but is less attractive				
Reject	Fails to meet one or more objectives or has a significant impact that cannot be effectively mitigated				
Procedure	**Do Nothing**	**Proposed Option**	**Proposed Option**	**Proposed Option**	**Proposed Option**
SID 27 via AGGER	SID 27 via BARTON	SID 27 AGGER Option 1	PE SID 27 AGGER Option 1b	SID 27 AGGER Option 2	SID 27 AGGER Option 3
SID 27 via WAL	SID 27 via WAL (conventional)	SID 27 WAL Option 1	SID 27 WAL Option 2		
SID 27 to TEMP2	SID 27 via REXAM	SID 27 TEMP2			
SID 09 via AGGER	SID 09 via BARTON	SID 09 AGGER Option 1	SID 09 AGGER Option 2		
SID 09 via CAVEN	SID 09 POLE HILL	SID 09 CAVEN Option 1	SID 09 CAVEN Option 2	SID 09 CAVEN Option 3	SID 09 CAVEN Option 4
SID 09 via CORKA	SID 09 via REXAM	SID 09 CORKA Option 1	SID 09 CORKA Option 2	SID 09 CORKA Option 3	
Transition to runway 27 from DIOUF	Radar Vectoring from TIPOD or KEGUN	Trans 27 DIOUF			

Colour Key					
Carry Forward	Meets objectives, insignificant impact, and is the Preferred Option for this procedure				
Carry Forward	Meets objectives or has an insignificant impact but is less attractive				
Reject	Fails to meet one or more objectives or has a significant impact that cannot be effectively mitigated				
Procedure	**Do Nothing**	**Proposed Option**	**Proposed Option**	**Proposed Option**	**Proposed Option**
Transition to 27 from NOMSU	Radar Vectoring from TIPOD or KEGUN	Trans 27 NOMSU			
Transition to 27 from VEGUN	Radar Vectoring from TIPOD or KEGUN	Trans 27 VEGUN	Trans 27 VEGUN (CC05)		
Transition to runway 09 from DIOUF	Radar Vectoring from TIPOD or KEGUN	Trans 09 DIOUF			
Transition to runway 09 from NOMSU	Radar Vectoring from TIPOD or KEGUN	Trans 09 NOMSU			
Transition to runway 09 from VEGUN	Radar Vectoring from TIPOD or KEGUN	Trans 09 VEGUN			
RNAV Approach 27	Conventional Approaches RNAV 27 Straight in approach	Approach 27 Option 1	Post Engagement Approach 27 Option 1b	Approach 27 Option 2	Approach 27 Option 3
RNAV Approach 09	Conventional Approaches RNAV 09 Straight in approach	Approach 09 Option 1	Approach 09 Option 2	Approach 09 Option 3	Post Engagement Approach 09 Option 3b

Table 3 – Initial Options Appraisal results summary

5 Qualitative Safety Assessment

5.1 Safety Assessment Activities Required by CAP1616

A qualitative Safety Assessment is required for all options identified during Step 2B, and a detailed final safety assessment must be completed by the change sponsor prior to submission in Step 4B. LJLA is carrying out the safety assessment activities in accordance with CAP760, the separate guidance provided by the CAA for safety assessment.

LJLA is developing a full four-part Safety Case iteratively throughout the CAP1616 process which will be submitted to the CAA at Step 4B. CAP1616 requires a non-technical/plain English summary of the safety assessment for publication on the airspace portal.

5.2 Assessment Method

The Qualitative Safety Assessment uses the results of a formal Hazard Identification (HazID) workshop held at LJLA on 10th April 2019 during which the hazards, causes and consequences relating to each of the longlist of options were identified.

5.3 Additional Options Derived from the Safety Appraisal

Two new Approach options were added to the longlist post HazID in order to provide mitigation for hazardous conditions identified for one or more Missed Approach Procedures.

A third additional option was developed to mitigate the PANS OPS 8168 non-compliance of the original Option 1 for SID 27 AGGER that was rejected during DPE at step 2A. This third option also took into account engagement feedback from stakeholders when the longlist of options were tested with them during Step 2A; they asked if it would be possible to create an option 'in between Option 1 and 2' to enable aircraft to be routed above the Mersey instead of over populated areas.

	New Option	Description
1	SID 27 AGGER Option 1b	This option was developed as a result of engagement activities to explore the possibility of a PANS OPS 8168 compliant procedure routing traffic over the Mersey to offer a reduced impact in terms of noise/people overflown versus the other SID via AGGER options. The nominal routing is between the routing taken by SID 27 AGGER options 1 and 2.
2	APPROACH 27 Option 3b	The initial approach remains the same as Approach 27 options 1 and 2. The position of the hold has been moved to a position over the sea to the west of LJLA in the vicinity of Wallasey.

	New Option	Description
3	Approach 09 Option 3b	This procedure is the same as Approach 09 option 3 except that the direction of the hold has been adjusted so that the aircraft will remain over the sea when in the hold.

Table 4 – New Options derived from Engagement and Safety Assessment Activities

5.4 Safety Assessment Results – Non-Technical Summary

The HazID identified a number of dependencies and/or influencing factors that were common to all the IFP options e.g. Loss of GNSS signal in space.

The findings of the qualitative safety assessment of the individual options are summarised as:

- Two IFP options have significant Safety implications – one was not compliant with ICAO design rules (PANS-OPS) and one resulted in the infringement of other airspace. These IFP options were rejected during the DPE or Initial Options Appraisal stages.
- No other significant safety implications have been identified with the IFP options and any identified hazards will be managed throughout the development of the Safety Case to ensure any appropriate mitigation is identified and implemented:
    - A number of SIDs conflict with transition IFPs for the same Runway. However, mitigation in the form of vertical separation does exist in these instances and can be managed operationally.
    - A number of the proposed IFPs will not integrate with the Manchester Airport IFPs. These will be mitigated through coordination with Airport ACP development.
    - The proposed IFPs to the south of LJLA are potentially in conflict with Hawarden traffic. Altitude restrictions on the IFPs are planned in mitigation.
    - As designed, the transition IFPs have no holds meaning that aircraft with differing speeds may require tactical intervention from ATC to maintain separation. Addition of holds is offered to relieve this scenario.
    - The holds for some of the IAPs are in conflict with the approach segment of the IAPs. New hold at Wallasey is proposed to resolve this issue.

Except for the options rejected during the DPE stage, the safety considerations for all options are not considered to be significant at this stage. Notwithstanding this, those options that are taken forward to shortlist are subject to a full risk assessment as an element of developing the four-part Safety Case prior to submission of the ACP proposal at Step 4B.

The safety considerations relating to the individual options are contained in the full Options Appraisal Analysis Tables referenced as Appendix A2 of this report, which has been uploaded to the airspace portal as a separate file.

6 Design Options Shortlist

6.1 Shortlisting Method

Once the Initial Options Appraisal was complete, the LJLA team convened to consider the results and to decide how to reduce the options to a shortlist.

In total 31 Options were developed and appraised against the CAP1616 criteria, safety and noise assessment. The appraisal team discussed the analysis and worked through the options in Appendix A2 to agree on the selection of the shortlist based on the colour coding in Table 5.

Result	Description
Carry Forward	Meets objectives, insignificant impact, and is the Preferred Option for this procedure
Carry Forward	Meets objectives or has an insignificant impact but is less attractive
Reject	Fails to meet one or more objectives or has a significant impact that cannot be effectively mitigated

Table 5 – Colour coding Key

The preferred option was chosen from the green options, with viable alternative options being selected from the amber options. No red options were taken forward to the short list.

6.2 Rejecting the Do Nothing Option

The Do Nothing options for each procedure were ruled out due to non-compliance with emerging and future regulatory requirements. Notwithstanding this, due to equipment obsolescence and navigation aid rationalisation programme, the costs of maintaining the extant procedures are likely to be prohibitively expensive and technologically infeasible, rendering LJLA unable to maintain capacity and resilience beyond the short term. For these reasons the Do Nothing option was rejected at the Initial Options Appraisal stage.

However, the extant procedures are carried through for further assessment during the Full Options Appraisal required at Stage 3 in order to make a comparison of the proposed procedures against the baseline levels of noise, emissions, fuel burn, and other stakeholder impacts.

6.3 Shortlist of Options Taken Forward

Table 6 presents the shortlist of options carried forward to Stage 3 along with the associated Initial Appraisal Outcome for that option. The original 31 Options were reduced to thirteen preferred options and seven less attractive but viable options.

Shortlist Option	Initial Appraisal Outcome
SID 27 AGGER Option 1b	Carried Forward - Preferred Option Shortest route, minimising track miles, noise, fuel burn and emissions.
SID 27 AGGER Option 3	Carried Forward – viable but less attractive Longer but viable alternative to Option 1b
SID 27 WAL Option 2	Carried Forward - Preferred Option Shortest possible route over fewer residential areas, minimising track miles, noise, fuel burn and emissions.
SID 27 WAL Option 1	Carried Forward – viable but less attractive Shortest possible distance but with increased residential exposure; remains a viable alternative to Option 2
SID 27 TEMP2	Carried Forward - Preferred Option Only one practical option offering the shortest possible route over fewer residential areas (avoiding most southern parts of the Wirral), minimising track miles, noise, fuel burn and emissions.
SID 09 AGGER Option 2	Carried Forward – Preferred Option Avoids sensitive areas, minimising noise exposure. Alternative options were slightly longer and overflew residential areas in Runcorn.
SID 09 CAVEN Option 1	Carried Forward – Viable alternative Option This is the most direct route but exposes more people to noise than Option 4
SID 09 CAVEN Option 3	Carried Forward – Viable alternative Option Less attractive than Option 4 due to more people exposed to noise
SID 09 CAVEN Option 4	Carried Forward – Preferred Option Shortest route minimising track miles and noise exposure.
SID 09 CORKA Option 2	Carried Forward – Viable alternative Option Less attractive than Option 3 due to more people exposed to noise and more track miles.
SID 09 CORKA Option 3	Carried Forward – Preferred Option Most direct route, minimising emissions, noise and people overflown.

Shortlist Option	Initial Appraisal Outcome
Trans 27 DIOUF	Carried Forward – Preferred Option Only one option: environmental and noise impacts minimised within the constraints
Trans 27 NOMSU	Carried Forward – Preferred Option Only one option: environmental and noise impacts minimised within the constraints
Trans 27 VEGUN	Carried Forward – Preferred Option Environmental and noise impacts minimised within the constraints
Trans 27 VEGUN (CC05)	Carried Forward – Viable Alternative Environmental and noise impacts not minimised but this Option is required in order to deconflict LJLA arrivals from Manchester arrivals when Manchester runway 05 in use.
Trans 09 DIOUF	Carried Forward – Preferred Option Only one option: environmental and noise impacts minimised within the constraints
Trans 09 NOMSU	Carried Forward – Preferred Option Only one option: environmental and noise impacts minimised within the constraints
Trans 09 VEGUN	Carried Forward – Preferred Option Only one option: environmental and noise impacts minimised within the constraints
Approach 27 Option 1b	Carried Forward – Preferred Option Offers fewest practical track miles, the minimal exposure to noise and people over the ground - amended original Option 1 with stakeholder input. Initial Options Appraisal resulted in only one option for 27 Approach being taken forward.
Approach 09 Option 3b	Carried Forward – Preferred Option This Option was developed post DPE and post engagement to redesign the missed approach procedure to avoid conflict with Hawarden, and to locate the hold over the sea to minimise overflight of residential areas. Initial Options Appraisal resulted in only one option for 09 Approach being taken forward.

Table 6 – Shortlist of options carried forward to Stage 3

A1 Appendix A1: Qualitative Noise Assessment

A1.1 Qualitative Noise Assessment

In order to support the assessment of the noise related criteria in Section 4, LJLA carried out a qualitative assessment of the likely noise impacts of each option on people on the ground. A comparative assessment was made amongst the options for each procedure taking into account the following contributors to noise exposure:

- length of track overpopulated areas/qualitative assessment of numbers overflown;
- overflight of sensitive areas and communities below 7000ft e.g. schools, hospitals;
- overflight of national parks, parkland, habitats;
- comparative power setting of aircraft engines required to execute the procedure;
- continuous ascent/descent profile of procedure;

Four Design Principles are applicable to the assessment of noise.

- **Design Principle 3:** Procedures should be designed to avoid overflight of sensitive areas, e.g. hospitals, schools, country parks, high risk industrial sites.
- **Design Principle 4a:** Procedures must be designed to minimise the impact of noise below 7,000ft.
- **Design Principle 6/ 7b:** Procedures should be designed to enable more continuous climbs/descents.
- **Design Principle 12b:** Procedures should be designed to concentrate routes to minimise the numbers overflown.

The qualitative noise assessment[13] of the options was supported by analysis of whether each option met the above stated design principles.

In general, the increased accuracy associated with the introduction of PBN procedures would minimise the spread of people overflown and concentrate the noise exposure onto fewer people with little opportunity for respite. The majority of the options enable continuous ascent or descent which minimises noise associated with steep climb changes or prolonged segments of level flight. Some options do not enable continuous ascent/descent, but this is necessary to meet constraints and to deconflict LJLA traffic from arrivals and departures at Manchester Airport.

[13] See assessment against 'Communities, Noise Impact on health and Quality of life' criteria in Appendix A2

A2 Appendix 2: Initial Options Appraisal (Full Table Analysis)

This Appendix **is delivered as a separate MS Excel based file** with the format as in the extract below. The Appendix contains the full analysis carried out on the longlist of Options and is colour coded to identify the rejected options, the preferred options and the alternative viable options considered during CAP1616 Stage 2 DEVELOPAND ASSESS. **For the full Analysis, see document reference** 71137 054 Initial Options Appraisal Tables Issue 1 on the portal – please note that the Excel format has been converted to a PDF as required by the portal.

INITIAL OPTIONS APPRAISAL			Reason for Category	Rejected - Does not meet constraints (e.g. airspace modernisation, nor does it meet technical criteria of CAP1616); Will be carried forward to Full Options Appraisal to enable environmental comparison of proposal against the baseline.	Rejected at DPE stage due to non-PANS OPS Compliance	Preferred by stakeholders - This is a Post Engagement option where stakeholders had their input. Fewer track miles and fewer overflown.
KEY	Carry Forward	Meets objectives, insignificant impact, and is the Preferred Option for this procedure				
	Carry Forward	Meets objectives or has an insignificant impact but is less attractive				
	Reject	Fails to meet one or more objectives or has a significant impact that cannot be effectively mitigated				
Group	Impact	Level of Analysis	High-level Appraisal for the introduction of PBN/RNAV	Do Nothing - continue with extant procedures	SID 27 AGGER Option 1	PE SID 27 AGGER Option 1b
Communities	Noise impact on health and quality of life	Initial Options Appraisal: Qualitative	In general RNAV procedures are predicted to reduce noise exposure versus extant conventional procedures due to the facilitation of continuous climb/descent profiles and optimum aircraft performance. However it is not always possible to deliver these characteristics and each Option has been assessed to determine whether noise is minimised through these measures. The assessment also assessed the exposure of communities to noise i.e. whether the option minimises overflight of sensitive areas, public spaces and parks, built up environments and residential areas. Consideration of the altitude and flight profile (below 7000ft) has also been included.	The tracks flown by aircraft using conventional procedures are less predictable; the exact route taken relies on the pilot interpreting ground-based beacon information and therefore the procedures as published often don't represent actual tracks flown and instead, aircraft are spread out over a wider area. Height restrictions (4000ft or below) to deconflict traffic from Manchester Airport means that aircraft can spend extended time in level flight; are unable to fly with optimum power settings potentially creating more noise.	Option rejected at DPE stage due to non-compliance with PANS OPS 8168 (turns/waypoint spacing).	Flown at optimum aircraft performance and with continuous climb profile to minimise noise. The procedure takes a more direct route to AGGER; aircraft remain over the River Mersey during the initial right hand turn after take-off. Routing takes the aircraft over populated areas of Liverpool but will be above approximately 4,000 ft before flying over this area. The procedure avoids direct overflight of sensitive areas although a school and a hospital are close to the planned flightpath; aircraft will be above approximately 4,000 ft at these points. Incorporates a continuous climb profile to minimise noise and minimises residential areas overflown.