Stage 3 Full Options Appraisal

LJLA Airspace Change

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1 Introduction

1.1 About this Document

This document contains the Full Options Appraisal of the Liverpool John Lennon Airport (LJLA) Airspace Change Proposal (ACP) and is a formal deliverable for Stage 3 of the CAP1616 process. It also describes the process by which LJLA have developed options to arrive at the shortlist presented in the Stage 3 consultation materials.

1.2 From Statement of Need to Shortlist Options

1.2.1 Stage 1, Step 1A – Statement of Need, Assess

In February 2018, LJLA submitted a Statement of Need (SoN) to the CAA describing the airspace issue the airport is seeking to address with this ACP. This is the formal explanation as to why the Airport wishes to change the airspace. In summary, LJLA's SoN stated that the sponsor 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 Design Principles Report at Stage 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] 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.

The CAA indicated that an airspace change proposal (ACP) was an appropriate mechanism to achieve the objectives in LJLA's Statement of Need. A copy of the full Statement of Need and other associated documentation can be viewed on the CAA portal at Stage 1A here: www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

1.2.2 Stage 1, Step 1B Design Principles, Define

Work undertaken at Step 1B established, through two-way stakeholder engagement, a prioritised shortlist of Design Principles predicated to act as a framework against which Design Options would be developed to satisfy the SoN. The prioritised list of Design Principles and the method of their development can be found in the documents uploaded at Stage 1B on the portal here: 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**.

1.2.3 Stage 2 – Options Development and Initial Options Appraisal

During Stage 2 LJLA developed a comprehensive list of design options (Step 2A) for the new procedures and carried out an Initial Options Appraisal (Step 2B).

During Stage 2A, LJLA developed options for new PBN based SIDs, Approaches and Transitions; In order to develop the options, the procedure designers took into account:

- The SoN.
- Any fixed constraints identified during Stage 1A.
- the Design Principles established through stakeholder engagement activity in Stage 1B.

The initial list of all possible options was tested with the key aviation and non-aviation stakeholders before LJLA evaluated each option against the Design Principles in order to define the longlist to carry forward to Step 2B (Initial Options Appraisal).

A detailed explanation of how the constraints, Design Principles and high-level criteria were applied to the options development can be found in *LJLA Options Development Step 2A Issue 4* that is uploaded to the portal in Step 2A here:

www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

At Step 2B, the longlist of options was subjected to Initial Options Appraisal; each procedure was tested against the criteria contained in CAP1616, Appendix E, Table E2 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 pertaining to the Initial Options Appraisal is can be found in Initial Options Appraisal Issue 3 that is uploaded to the portal in Step 2B here:

www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

The Initial Options Appraisal generated a short list of options to take forward to Stage 3. At the end of June 2019, Stage 2 of the change process was successfully completed when the Airport's submission passed through the **Stage 2 DEVELOP AND ASSESS Gateway**.

1.3 Shortlist of Options Carried Forward to Stage 3

The shortlist of options carried forward to Stage 3 for detailed technical design and Full Options Appraisal (this document) are shown in Table 1 below. Please note that during the detailed technical design, the procedures names were rationalised. The reasons for changing the names was that the original options were numerically identified and when options were discarded, the resulting shortlist appeared to have gaps in it. For example, Option 1 might be followed by Option 4 – with no Option 2 or 3 present. It was felt that rationalising to a non-numerical but unique set of names would avoid the confusion over the 'gaps' and also enable procedures to be identified by a name that was closer to the naming convention that would be eventually implemented and published in the LJLA entry of the UK Aeronautical Information Publication (UK AIP[5]).

Table 1 shows the 'original' procedure name used during engagement activities and the 'new' name that will be used hereafter for the purposes of consultation. Other changes to the options since the Stage 2 submission are explained in 1.4. The procedures are henceforth referred to by their new names.

Original Procedure Name	Note	New Procedure Name
SID 27 AGGER Option 1	Rejected[6]	
Post Engagement SID 27 AGGER Option 1b		SID 27 AGGER AR
SID 27 AGGER Option 2	Previously rejected – See 1.4	SID 27 AGGER
SID 27 AGGER Option 3		SID 27 AGGER Option
SID 27 WAL Option 1		SID 27 WAL AR
SID 27 WAL Option 2		SID 27 WAL
SID 27 TEMP2		SID 27 TEMP2
SID 09 AGGER Option 1	Rejected	
SID 09 AGGER Option 2		SID 09 AGGER
SID 09 CAVEN Option 1		SID 09 CAVEN Option 2

[5] The UK AIP: for the lay reader, this is the repository for aeronautical information and charts pertaining to all licensed aerodromes and airports in the UK – it is used for flight planning and for ascertaining administrative information regarding facilities and operations at the destination airport.

[6] The method and rationale for rejecting these options can be found in Initial Options Appraisal Issue 3 that is uploaded to the portal in Step 2B www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

Original Procedure Name	Note	New Procedure Name
SID 09 CAVEN Option 2	Rejected[7]	
SID 09 CAVEN Option 3		SID 09 CAVEN Option
SID 09 CAVEN Option 4		SID 09 CAVEN
SID 09 CORKA Option 1		SID 09 CORKA Option 2
SID 09 CORKA Option 2		SID 09 CORKA Option
SID 09 CORKA Option 3		SID 09 CORKA
Trans 27 DIOUF		Trans 27 DIOUF
Trans 27 NOMSU		Trans 27 NOMSU
Trans 27 VEGUN		Trans 27 VEGUN
Trans 27 VEGUN (CC05)		Trans 27 VEGUN (CC05)
Trans 09 DIOUF		Trans 09 DIOUF
Trans 09 NOMSU		Trans 09 NOMSU
Trans 09 VEGUN		Trans 09 VEGUN
Approach 27 Option 1	Rejected	
Post-Engagement Approach 27 Option 1b		Approach 27
Approach 27 Option 2	Rejected	
Approach 27 Option 3	Rejected	
Approach 09 Option 1	Rejected	
Approach 09 Option 2	Rejected	
Approach 09 Option 3	Rejected	

[7] The method and rationale for rejecting these options can be found in Initial Options Appraisal Issue 3 that is uploaded to the portal in Step 2B www:airspacechange.caa.co.uk/PublicProposalArea?pID=28.

Original Procedure Name	Note	New Procedure Name
Post-Engagement Approach 09 Option 3b		Approach 09

Table 1 Shortlist from Stage 2: Original and New Procedure Names

1.4 Changes to options since Stage 2 Submission

During the detailed technical IFP design activities in Stage 3, SID 27 AGGER AR was found to require a minor deviation from PANS-OPS criteria associated with the position of the first waypoint. SID 27 AGGER AR derived from engagement activities when stakeholders raised the possibility of having a procedure where aircraft turned right over the Mersey shortly after take-off rather than turning later overhead communities in The Wirral, thus providing a shorter SID with lower noise and environmental impacts.

Despite this minor deviation, SID 27 AGGER AR remains a viable option however, LJLA decided to reintroduce the fully compliant original option considered during stakeholder engagement: SID 27 AGGER. This alternative option is fully compliant and therefore attractive from a regulatory point of view, but it results in increased track miles and a greater noise impact due to the later right-hand turn over The Wirral versus SID 27 AGGER AR.

The Full Options Appraisal (this document) assesses the implementation of SID 27 AGGER AR against SID 27 AGGER; SID 27 AGGER has been included in the proposed consultation package in order to ensure a fully PANS-OPS compliant alternative is presented to the public and is fully considered throughout the consultation process.

2 Assessment Criteria and Methodology

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[8] and the Department of Transport's WebTAG[9], 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 an Initial Options Appraisal being used to whittle down the longlist in Stage 2; a Full Options Appraisal (this document) of the shortlist takes place in Stage 3 for consultation; and the Final Options Appraisal will support the final submission of the ACP application to the CAA at the end of Stage 4.

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).

2.2 High Level Objectives and Assessment Criteria

For a Level 1 Airspace Change, the appraisal Criteria against which the options must be assessed are contained in Table E2 of CAP1616. Table 2 below describes these. In line with CAP1616 guidance, the Initial Options Appraisal in Stage 2 was a qualitative assessment whereas for the Full Options Appraisal (this document), the assessment must be quantified and monetised where applicable with reference to the DfT WebTAG (see footnote 10).

Please note that a full CAP760[10] compliant safety assessment of the options is required for the Final Options Appraisal phase at CAP1616 Stage 4 SUBMISSION and therefore Safety is not included as an assessment criterion in this document.

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

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

[10] CAP760 – CAA Guidance on the Conduct on Hazard Identification, Risk Assessment and the Production of Safety Cases: for Aerodrome Operators and Air Traffic Service Providers.

Affected Group	Impact	Level	Description for Full OA
Communities	Noise impact on health and quality of life	Monetise and Quantify	Requires consideration of noise impact on communities including residents, schools, hospitals, parks and other sensitive areas.
Communities	Air Quality	Qualitative or Quantitative and Monetise depending on scope	Any change in air quality is to be considered.
Wider Society	Greenhouse Gas impact	Monetise and quantify	Assessment of changes in greenhouse gas levels in accordance with WebTAG is required
Wider Society	Capacity and resilience	Qualitative	Sponsors should qualitatively assess the effect of the proposal on the overall UK airspace infrastructure.
General Aviation	Access	Qualitative	Sponsors should qualitatively assess the effect of the proposal on the access to airspace for General Aviation.
General Aviation / commercial airlines	Economic impact from increased effective capacity	Quantify	Forecast increase in air transport movements and estimated passenger numbers or cargo tonnage carried.
General Aviation / commercial airlines	Fuel burn	Monetise and Quantify	Fuel costs and the relative efficiency of aircraft are readily obtainable from market data. The change sponsor must seek to quantify and monetise these costs based on its assumptions of the fleets in operation.
Commercial airlines	Training costs	Monetise and Quantify	Where a proposal would lead to a need for retraining, this should be quantified and where possible monetised.
Commercial airlines	Other costs	Monetise and Quantify	Where there are likely to be other costs imposed on commercial aviation, these should be described. Where these costs are quantifiable, an assessment should be made.

Affected Group	Impact	Level	Description for Full OA
Airport / Air navigation service provider	Infrastructure costs	Monetise and Quantify	Where a proposal requires a change in infrastructure, the associated costs should be monetised.
Airport / Air navigation service provider	Operational costs	Monetise and Quantify	Where a proposal would lead to a change in operational costs, these should be monetised
Airport / Air navigation service provider	Deployment costs	Monetise and Quantify	Where a proposal would lead to a requirement for retraining and other deployment, the costs of these should be quantified and where possible monetised.

Table 2 Assessment Criteria for Level 1 Change

2.3 Methodology Overview

The methodology for Operational Assessment is outlined as follows:

- Determine the options appraisal team.
- Operational Analysis: Determine all viable combinations of individual procedures that work together to deliver a coherent operational picture at LJLA.
- Qualitative Shortlisting: Selection of the preferred combinations to take forward to Environmental Assessment.
- Full Options Appraisal of the 'Do Nothing'; the preferred option; and the alternative attractive options.

The above steps are explained in detail throughout the remainder of this section.

2.4 The Options Appraisal Team

The options 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[11] Head of Air Traffic Services
- LJLA Head of Environment
- ATCSL Group ATC Training & Standards Manager
- ATCSL ATC team members
- 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

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

2.5 Operational Analysis: Combinations of Procedures

During Stage 2, the Initial Options Appraisal was carried out by comparing all of the options for **individual procedures** side by side against the CAP1616 (Appendix E) costs and benefits criteria in tabular form. Discussion regarding assessment methods with CAA at a meeting on 6th June 2019 lead to an agreement that LJLA would carry out the environmental and economic assessment on **combinations** of those procedures that function together to provide a complete operational picture of the actual implementation LJLA would end up with. Therefore our 'options' at the consultation stage would become 'combinations of procedures' rather than asking the consultees to comment on individual routes.

The combinations were determined during the operational analysis workshop as described below.

2.6 Operational Analysis Workshop

Following the detailed technical design of the procedures, LJLA held a workshop attended by operational Air Traffic Control (ATC) staff, including ATC officers, Head of Air Traffic Services, Head of Environment, the CAA Approved Procedure Designer (APD) and the consultant analysis team. The aim of the workshop was to identify the combinations of procedures that worked together to represent a viable operational environment for LJLA. For example, some departure route options could conflict with arrival route options meaning that ATC would not be able to sequence traffic effectively, if at all.

During the meeting, the APD used specialist design software to overlay combinations of the procedures onto a background representing LJLA operational environment. Each combination was assessed with reference to:

- Runway direction in use
- Conflicting LJLA inbound/outbound routes
- Relative heights of overlapping procedures
- Ease of sequencing LJLA traffic:
  - Probability of on-ground delays
  - Probability of in air delay (hold)
  - Availability of Holding patterns
  - ATC workload
  - Probability of controller intervention
- Ease of sequencing with traffic arriving/departing neighbouring airports
- Conflict with neighbouring airports
- Flexibility/alternatives to resolve sequencing conflicts
- Performance of aircraft (rate of climb)

All of the viable combinations associated with Runway 27 being in use are shown in Table 2, and the viable combinations for Runway 09 are show in Table 3.

2.7 Runway 27 Procedure Combinations

Table 2 below shows all the viable combinations of procedures (departures and arrivals) when Runway 27 is in use. The colour coding represents the results of the Initial Options

Appraisal in Stage 2B for each individual procedure i.e. green = preferred/least impact[12] solution and amber = meets objectives but less attractive in terms of impact. Note that *Trans 27 VEGUN* and *Trans 27 VEGUN (CC05)* are both required to be implemented but would not be in use at the same time – *Trans 27 VEGUN (CC05)* is required to deconflict LJLA traffic from Manchester traffic when Manchester is using their Runway 05. *Trans 27 VEGUN* is a more direct route and is therefore the preferred default route.

	SID			Transition				Approach
A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
B	SID 27 AGGER AR	SID 27 WAL AR	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
D	SID 27 AGGER	SID 27 WAL AR	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
E	SID 27 AGGER Option	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
F	SID 27 AGGER Option	SID 27 WAL AR	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27

Table 3 Runway 27 Procedure Combinations

[12] The assessment of impacts was based on criteria in Table E2 of CAP1616 and included a qualitative assessment based on estimated track miles, communities overflown, emissions due to engine settings for non-continuous climbs/height restrictions and consideration of sensitive receptors such as schools and tranquil areas.

2.9 Runway 09 Procedure Combinations

Table 3 below shows all the possible combinations of procedures for Runway 09. To avoid alpha-numerical confusion, a Combination O is not included. The colour coding represents the results of the Initial Options Appraisal in Stage 2B for each individual procedure i.e. green = preferred/least impact solution and amber = meets objectives but less attractive in terms of impact.

	SID			**Transition**			**Approach**
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
Q	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option 2	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
S	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
T	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA Option 2	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
U	SID 09 AGGER	SID 09 CAVEN Option 2	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
V	SID 09 AGGER	SID 09 CAVEN Option 2	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
W	SID 09 AGGER	SID 09 CAVEN Option 2	SID 09 CORKA Option 2	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09

Table 4 Runway 09 Procedure Combinations

2.10 Qualitative Shortlisting of Combinations for Full OA

As described in paragraph 2.7 above there are six possible combinations (A-F) of procedures for the operational environment associated with Runway 27. And in paragraph 2.8, nine combinations (N-W) are possible for the Runway 09 operational environment. The eventual implemented solution will include one combination for when Runway 27 is in use and one combination for times when Runway 09 is in use. This results in a total of 6*9 = 54 possible options for the eventual implementation at LJLA.

It is neither pragmatic nor proportionate for LJLA to carry out Full Options Appraisal on 54 options or indeed to ask consultees to consider this number of options. The environmental and economic assessment would be required to consider all 54 options (55 including the Baseline) 'at implementation' i.e. in 2021 and at 10 years post-implementation. CAP1616 minimum primary and secondary metrics for assessing noise would require six separate noise assessments per option resulting in over 300 assessments involving weeks of data processing. Therefore, a further round of qualitative assessment was undertaken during the operational analysis workshop to reduce these combinations to manageable set of preferred and alternative options that:

- **Were most operationally achievable:**
  - requiring least ATC intervention
  - having least impact on neighbouring airports
- **Appeared (qualitatively) to have the least environmental impact:**
  - in terms of communities overflown, fuel burn, greenhouse gases and other CAP1616 criteria
  - Included more direct routes and contained mostly 'green' results

The result of this further round of qualitative assessment is shown below in Table 5.

There are two combinations for Runway 27, and three for Runway 09 – a total of 2*3 = 6 operational combinations for the eventual implementation at LJLA.

	Runway 27 Combinations Taken Forward							
	SID			Transition				Approach
A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27

	Runway 09 Combinations Taken Forward						
	SID			Transition			Approach
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN	Approach 09

Table 5 Combinations taken forward to Full Options Appraisal

2.11 Environmental Assessment Combinations

The six combination options for eventual implementation (choosing one combination for runway 27 and one for runway 09) are as below. These six still result in a significant volume of environmental assessments (over 60 runs of the complex environmental modelling software) to gather all the required metrics. These six combinations are the options considered in Full Options Appraisal as detailed in Section 3 onwards.

2.11.1 Combination 1 A-N

A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.11.2 Combination 2 C-N

C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.11.3 Combination 3 A-P

A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.11.4 Combination 4 C-P

C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.11.5 Combination 5 A-R

A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.11.6 Combination 6 C-R

C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

2.12 Full Options Appraisal: CAP 1616 Requirements and Metrics

2.12.1 Overview

The Full Options Appraisal requires an assessment against the costs and benefits contained in Table E2 of CAP1616, building on the analysis completed at Initial Options Appraisal. A number of qualitative, quantitative and monetised measures need to be produced, requiring a range of environmental assessments and metrics; these are described in more detail below.

2.12.2 Tools and Software

The calculation of noise contours, fuel burn and emissions have been performed using the U.S. Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT), version 2d[13].

Track statistical analysis and visualisation was performed using LJLA's consultant's own inhouse suite of track analysis tools.

2.12.3 Data Sources and Strategy

The primary data sources for this study are LJLA's:

- **ANOMS -** Noise and Track Keeping (NTK) system 'ANOMS', recorded between 16th June and 15th September 2019. The NTK system records relevant track positional data, in local time, from Air Traffic Control (ATC) Secondary Surveillance Radar (SSR) and Automatic Dependent Surveillance - Broadcast (ADS-B) and combines this with supplementary flight information including call sign, aircraft registration, aircraft type and destination airport.
- **CHROMA -** Export of aircraft activity from the operations database 'CHROMA', between the 16th June and 15th September 2019. It is notable that the CHROMA system is also used to inform reporting to the CAA on airport movement statistics and is considered to be a reliable record of movements.

2.12.4 Traffic Forecast Modelling

The environmental study that supports this Full Options Appraisal, models LJLA operations at the date of ACP implementation (assumed 09/09/2021) and 10 years later (assumed 09/09/2031). Therefore, to model the predicted levels of traffic, it must be determined how the number of movements changes from current levels as defined by the ANOMS/CHROMA data for Summer 2019.

LJLA provided movement forecasts from Financial Year (FY) 2020 to FY 2030 for their commercial operations. These are depicted in Figure 1. It is assumed that there is no change for non-commercial operations[14]. For this study, the same growth rate is assumed and applied to all commercial operations (including commercial passenger aircraft, cargo aircraft and business jets) and does not vary by carrier or aircraft type. It is assumed that the growth is uniform for all routes in the airspace. The study assumes that the same growth rates will apply for both the 'with scheme' and 'without scheme' cases.

[13] This was the latest version of AEDT at the time the LJLA assessment was commenced.
[14] General aviation users and VFR traffic is not affected by this ACP as they will continue to operate as they do today.

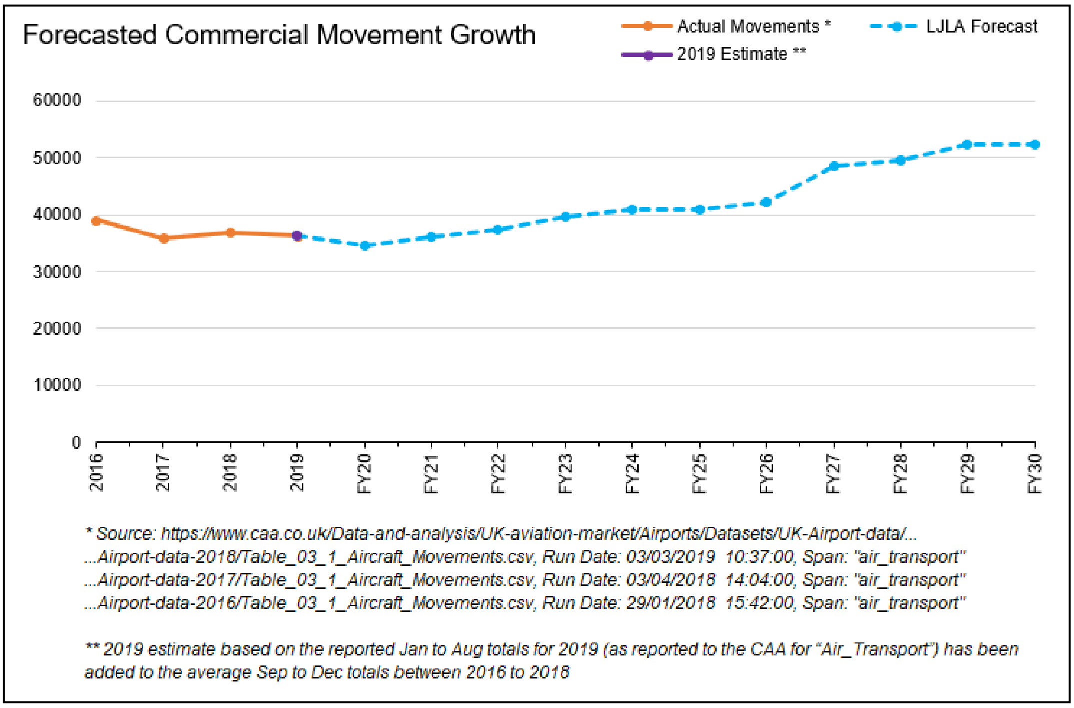

Figure 1 – LJLA Forecasted Commercial Movement Growth

It is assumed that LJLA financial year forecasts are representative of calendar year movements, and that figures for FY30 are representative of what might happen in the calendar year 2031 in the absence of 2031 forecasts.

The predicted and modelled change in movements is therefore:

- -0.7% (decrease) between 2019 and 2021
- +44.7% (increase) between 2019 and 2031

2.12.5 Noise Requirements

Day Flights (0700hrs to 2300hrs): CAP1616 requires the following in order to compare the relative impact of each option against the Baseline in terms of noise associated with day flights for both the opening year and the forecast year:

- WebTAG outputs for determining total significant adverse impacts
- For stakeholder engagement purposes:
    - LAeq contours portrayed – from high to low in 3dB increments down to 51 dBA LAeq 16 hour
    - LAeq contours – population counts for each 3dB increment contour to 51 dBA LAeq 16 hour

Night Flights (2300hrs to 0700hrs): CAP1616 requires the following to assess noise from night flights for both the opening year and the forecast year:

- WebTAG outputs for determining total significant adverse impacts
- For stakeholder engagement purposes:
    - Leq contours portrayed – to 45 dBA Leq 16 hour
    - Leq contours – population counts for each contour to 45 dBA Leq 16 hour

The LAeq contours for all of the Options are contained in A5.

2.12.6 Calculating Mass of Fuel Burn and Carbon Dioxide

CAP 1616 requires the calculation of the total annual (and corresponding change in) mass of fuel burned, and hence CO_2 equivalent (CO_2e) emissions, resulting from the airspace change.

The AEDT fuel consumption metric calculates the mass of fuel burned in metric tonnes (as required by the CAA). The corresponding mass of CO_2 emitted is estimated by multiplying the mass of fuel burned by a factor of 3.18 (in accordance with CAP 1616a guidance) to provide a value for the mass of CO_2 emitted for each baseline and for each of the 6 options in the 2021 and 2031 timeframes. As the AEDT model represents an average summer day, the value is multiplied by 365 to provide an annual figure.

Osprey has used WebTAG guidance (see Section 2.12.7) to derive a monetised value for these changes as an annual total.

The modelling assumes that there will be no aircraft technical performance improvements for the timescales modelled in this study. The modelling also assumes that aircraft capacity and load factors will remain unchanged during these timescales.

2.12.7 Calculating Financial Impacts (WebTAG for Greenhouse Gasses)

The monetised value of non-traded and traded CO_2e emissions was calculated in accordance with the limited aviation guidance provided in TAG Unit A3. The assessment first involved the calculation of fuel burn and CO_2 emissions as described in 2.12.6. The results provide the inputs required in the WebTAG Greenhouse Gases Workbook.

In accordance with the LJLA assessment of traffic growth (see 2.12.4), over the period in question a linear interpretation between the opening year (2021) and the +10 year (2031) was made in order to complete the input required in the Greenhouse Gases Workbook.

TAG Unit A3 specifies that aviation was included in 2012 within the 'traded sector' of the EU Emissions Trading System (UE ETS). However, there is also a requirement to determine the proportion of flights from/ to LJLA to destinations beyond the EEA[15]. The EU ETS covers all 28 EU member states, plus Iceland, Norway and Liechtenstein.

The CO_2e figures for with scheme and without scheme were then entered in the Greenhouse Gases Workbook in the traded and non-traded sector rows, as determined by the proportions of flights inside and beyond the EEA (97%, 3% respectively). These proportions of flights were determined from the CHROMA data supplied by LJLA. There is no difference, as expected, if these figures are entered in the road or rail rows; for consistency the rail rows were populated with the appropriate data for each option.

2.12.8 Other Quantified and Monetised Impact Assessments

CAP1616 also requires the quantitative and monetised assessment of the effect of each option compared to the Baseline in terms of the following impacts:

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. 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. LJLA engaged with the relevant authorities during Stage 2 and they were content that as there are no changes expected below 1000ft there was

[15] European Economic Area.

unlikely to be any impact. With no change predicted, there is no benefit to quantifying Air Quality in this ACP.

Biodiversity: The airport is not aware of any potential impacts on biodiversity in the area covered by this ACP. However, the airport remains aware of the Wildlife and Countryside Act 1981 and currently supports beekeeping on Airport land to contribute to biodiversity (through pollination) in the local area. The beekeeping is managed through a partnership between South Liverpool Homes (housing association) and Blackburn House, a charity supporting local people to make the first step into employment.

Tranquillity: There are no National Parks or AONBs within the area however LJLA have considered noise sensitive historic places and parks during the design options development. Natural England and the Environment Agency were engaged through face to face meetings in Stage 2. Additional national organisations associated with environmental groups, parks and trusts are included as stakeholders for the formal consultation.

3 LJLA Baseline 'Do Nothing' Assessment

3.1 Do Nothing Option Rejected at Stage 2

The Do-Nothing option, including the extant conventional and RNAV approaches[16], was ruled out at Stage 2 Initial Options Appraisal due to non-compliance with emerging and future regulatory requirements. Notwithstanding this, due to potential future equipment obsolescence and navigation aid rationalisation programmes, the costs of maintaining the extant procedures are likely to be prohibitively expensive and technologically unviable, rendering LJLA unable to maintain capacity and resilience beyond the next few years.

However, as required by CAP1616 the extant procedures were assessed during the Full Options Appraisal in order to make a comparison of the proposed options against the Baseline levels of noise, emissions, fuel burn, and other CAP1616 criteria.

3.2 Extant Conventional and RNAV Procedures

The Baseline operational environment includes the following list of procedure routes that are currently flown by aircraft operating from and to LJLA:

- 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 in the Baseline; aircraft are currently vectored from the enroute Standard Arrival Procedures (STAR).

The above procedures were combined according to the runway direction and used as a Baseline to assess the new combinations that have been designed to replace the current procedures.

3.3 Defining the Baseline

The nominal tracks of the procedures listed above are defined by the published charts in the UK AIP, however there will be some natural dispersion either side of the tracks due to several variables including aircraft performance, pilot actions, ATC intervention and vectoring. In order to determine the dispersal and hence the actual routes flown by aircraft, Osprey performed a complex analysis of the track positional data contained within the ANOMS data set. ANOMS is LJLA's Noise and Track Keeping (NTK) system. The NTK system records relevant track positional data, in local time, from Air Traffic Control (ATC) Secondary Surveillance Radar (SSR) and Automatic Dependent Surveillance - Broadcast

[16] The Missed Approach Procedure for the extant RNAV approaches references the ground-based NDB and NDB hold and will therefore be affected by future equipment obsolescence.

(ADS-B) and combines this with supplementary flight information including call sign, aircraft registration, aircraft type and destination airport.

The analysis enabled LJLA to visualise the distribution of aircraft arriving and departing from LJLA over the specified period. These traffic patterns are the most accurate representation of the Baseline scenario and provide a true record of where aircraft currently fly.

The results of this analysis are complex, but illustrations depicting the results are included for context in Annex A3.

3.4 Full Options Appraisal of the Baseline

Table 6 contains the assessment of the Baseline in opening year 2021, the date the changes are planned for implementation; and in the forecast year 2031, ten years after implementation.

Affected Group	Impact	Level	Assessment	# and £
Communities	Noise impact on health and quality of life	Monetise and Quantify	The Baseline noise associated with the airport is predominantly distributed to the east and west, in the sparsely-populated areas in the immediate vicinity of the airport itself, or over the Mersey Estuary. However, due to their proximity, the communities in and around Speke, Hale, Halebank and Runcorn are the main receptors of noise. See the average noise contours in **Error! Reference source not found.** in p aragraph 3.5.	N/A
Communities	Air Quality	Qualitative or Quantitative and Monetise depending on scope	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. The airport is mainly within the Liverpool City Council (LCC) area. The entirety of Liverpool City is 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.	N/A

Affected Group	Impact	Level	Assessment	# and £
Wider Society	Greenhouse Gas impact	Monetise and quantify	Extant procedures have parameters that contribute to higher engine power settings, more track miles and consequently 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. • CO2 emissions are measured – the calculations for other emitted gasses are considered to be too complex, and scientific understanding of the impact too poor for inclusion in environmental assessment of ACPs. See CAP1616a Environmental requirements technical annex: https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=8128	Calculated mass of CO2 emitted by the Baseline option in opening year (2021) is 45,534 metric tonnes Calculated mass of CO2 emitted in forecast year (2031) is 66,039 metric tonnes

Affected Group	Impact	Level	Assessment	# and £
Wider Society	Capacity and resilience	Qualitative	Maintaining extant procedures would not necessarily maintain current capacity at LJLA as it may become harder to efficiently integrate LJLA traffic into a system where neighbouring airports and the en-route ATS have adopted PBN. LJLA's reliance on conventional procedures would have a negative impact on the capacity of the overall UK airspace infrastructure due to inefficiencies in integration of this traffic; capacity in the Manchester TMA and at NATS Prestwick Centre in particular could be affected. LJLA would also fail to meet regulatory requirements and would fail to meet the airspace modernisation priorities including coordination with FASI (N). There is also a potential impact on resilience due to the current reliance on ground-based navigation aids; some of which may be subject to current or future rationalisation programmes. E.g. of the 48 VOR covering the UK, only 18 will remain after the current rationalisation programme.	N/A
General Aviation	Access	Qualitative	No changes are proposed to the parameters of the current airspace and therefore no change to airspace access is predicted.	N/A
General Aviation / commercial airlines	Economic impact from increased effective capacity	Quantify	The anticipation is that the continued use of the current procedures represents a limitation in effective capacity and therefore a limit on the economic benefits. Limited scope for real economic benefit can be expected for commercial airliners - unless they choose to raise prices or change the fleet capacity in response to demand overtaking capacity as a result of this limitation. No economic benefit is anticipated for GA users; they will continue to use the airport as they do today. However, limitations in capacity could mean that the capacity for handling GA aircraft in the future is affected by the need to prioritise commercial airline traffic. It is disproportionate for LJLA to quantify the economic benefit to individual airlines due to the many variables associated with an airline's reactionary response to capacity limitations.	Limited

Affected Group	Impact	Level	Assessment	# and £

General Aviation / commercial airlines	Fuel burn	Monetise and Quantify	Extant procedures have parameters that contribute to higher engine power settings, more track miles and potentially greater fuel burn, resulting in:
			• 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.
				Fuel burn associated with the Baseline/do nothing scenario in opening year (2021) is 14,319 metric tonnes
				Fuel burn for forecast year (2031) is 20,767 metric tonnes

Commercial airlines	Training costs	Monetise and Quantify	No additional training predicted.	£0

Affected Group	Impact	Level	Assessment	# and £
Commercial airlines	Other costs	Monetise and Quantify	It is not proportionate for LJLA to assess other potential 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. There is evidence[17] that delays are experienced at LJLA both on the ground and in the air, and one of the aims of the ACP is to address such inefficiencies – the use of more accurate navigation and routes, aligned with the airspace modernisation strategy is predicted to lead to fewer instances of controller intervention/vectoring and therefore have a positive effect versus this Baseline. Research on the cost of delays identifies a non-linear relationship between time and cost of delay i.e. an appropriate reaction is required by the airline depending on the length of delay (reactionary costs), and the number of variables is significant (aircraft type, crew costs, on-apron costs, electricity, fuel, compensation etc.) It is therefore not proportionate for LJLA to assess these costs quantitatively.	N/A
Airport / Air navigation service provider	Infrastructure costs	Monetise and Quantify	Some existing infrastructure is or may be subject to current and future rationalisation programme e.g. TRENT VOR[18] which supports one of the arrival routes for LJLA- no additional infrastructure is required to maintain extant conventional procedures. However, maintaining access to ground-based equipment that is being removed has been considered by airports elsewhere in the UK and generally found to be prohibitively expensive or technologically infeasible due to equipment obsolescence.	N/A
Airport / ANSP	Operational costs	Monetise and Quantify	No changes to operational costs are attributable to maintaining the extant procedures. LJLA costs would continue at present levels when associated with the maintenance of the current infrastructure (see above).	£0

[17] University of Westminster Research referenced in CAP1616a at the following link: https://westminsterresearch.westminster.ac.uk/download/4f36e280555fa19735237e067f8ea1b5bc14343273e062dc9a4769002ab256fa/1664611/European%20airline%20delay%20cost%20reference%20values%20-%20updated%20and%20extended%20values%20%28V4.1%29.pdf
[18] VOR - VHF Omni-directional Range; a radio navigational aid; this particular one being designated TRENT and will be removed as part of the NATS DVOR rationalisation programme.

Affected Group	Impact	Level	Assessment	# and £
Airport / ANSP	Deployment costs	Monetise and Quantify	No deployment costs are attributable to continued use of extant procedures.	£0

Table 6 Full Options Appraisal of the Baseline in opening year 2021 and forecast year 2031

3.6 Current Noise Impact for Communities

CAP 1616 requires the production of LAeq noise contours to portray noise impacts. LAeq is the equivalent continuous sound level[19], measured in decibels[20] (dB). The 'A' subscript means A-weighted (which matches the frequency response of the human ear) and the 'eq' subscript is an abbreviation of the word equivalent. Separate contours are produced for day and night[21] operations:

- Daytime: LAeq 16hr, representing the 16-hour period from 07:00:00 to 22:59:59 inclusive (local time), down to 51dBA at 3 dBA intervals.
- Night-time: LAeq8hr, representing the 8-hour period from 23:00:00 to 06:59:59 inclusive (local time), down to 45dBA at 3 dBA intervals.

A number of figures are shown on the following pages to show current noise levels:

- Figure 2 Baseline 2019 16hr Noise Contours above 51dBA LAeq 16hr
- Figure 3 Baseline 2019 8hr Night Noise Contours above 45dBA LAeq 16hr
- Figure 4 Baseline 2021 16hr Noise Contours above 51dBA LAeq 16hr
- Figure 5 Baseline 2021 8hr Night Noise Contours above 45dBA LAeq 16hr
- Figure 6 Baseline 2031 16hr Noise Contours above 51dBA LAeq 16hr
- Figure 7 Baseline 2031 8hr Night Noise Contours above 45dBA LAeq 16hr

2021 is the opening year or planned implementation year of the proposed change and 2031 is the forecast year at ten years post implementation as required by CAP1616. Households in and around Speke, Hale, Halebank and Runcorn are primarily affected in all cases with the remainder of the noise contours extending over sparsely populated, industrial areas or over the Mersey Estuary.

The comparative noise contours for the proposed options in the opening and forecast years can be found in Annex A5 to this report.

[19] The level of hypothetical steady sound which, over the measurement period, would contain the same (frequency-weighted) sound energy as the actual variable sound.
[20] Decibel is the unit used to describe the magnitude of sound. The decibel scale is logarithmic, and it ascribes equal values to proportional changes in sound pressure. Increasing the sound energy by a factor of k, i.e. k times as much, increases the dB value by 10 log10 k. Thus, doubling the sound energy results in an increase of 3 dBA.
[21] As the ACP is associated with an airport that has 50,000 or more air transport movements in a year.

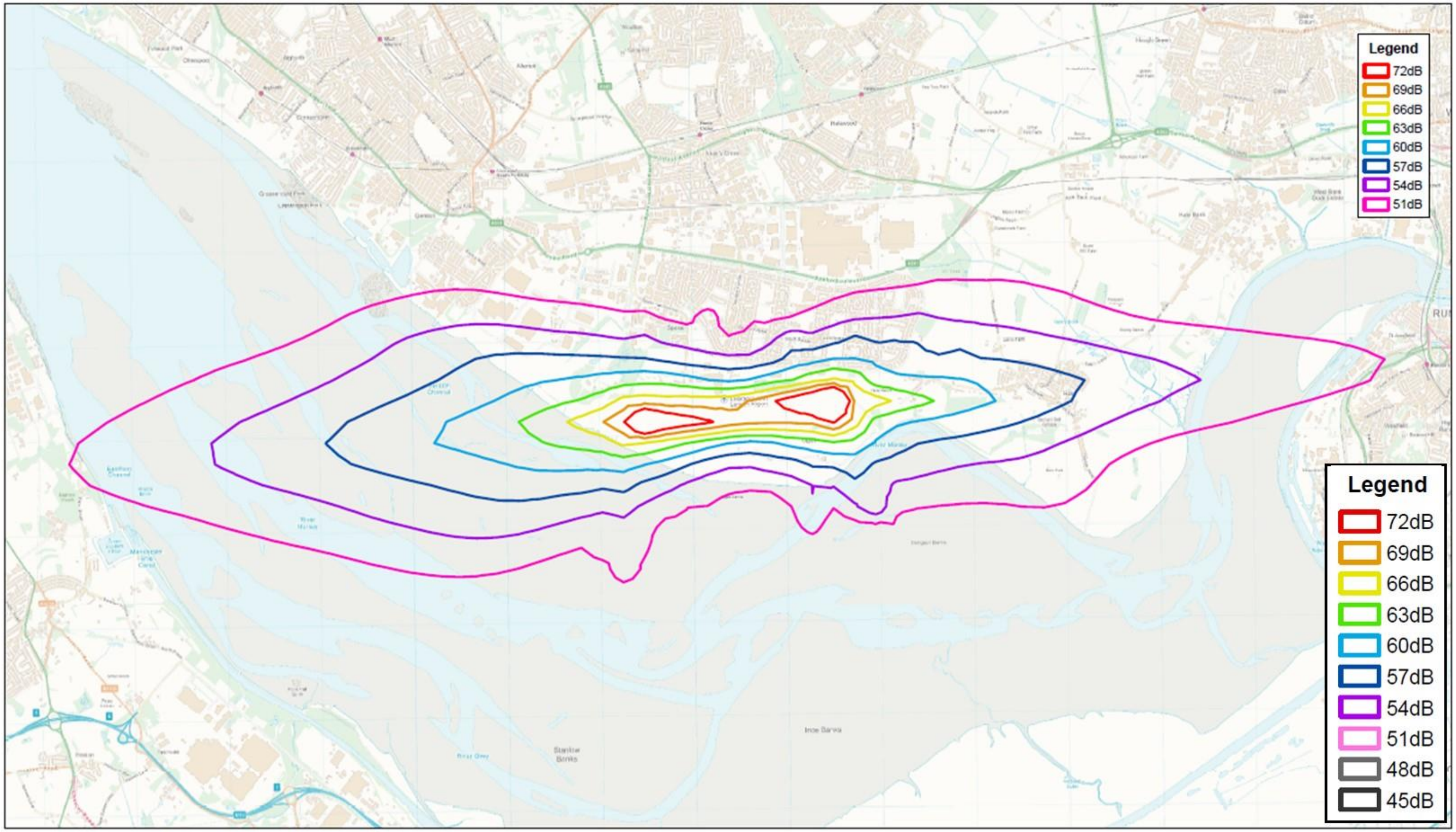

Figure 2 Baseline 2019 16hr Noise Contours above 51dBA $L_{Aeq\ 16hr}$

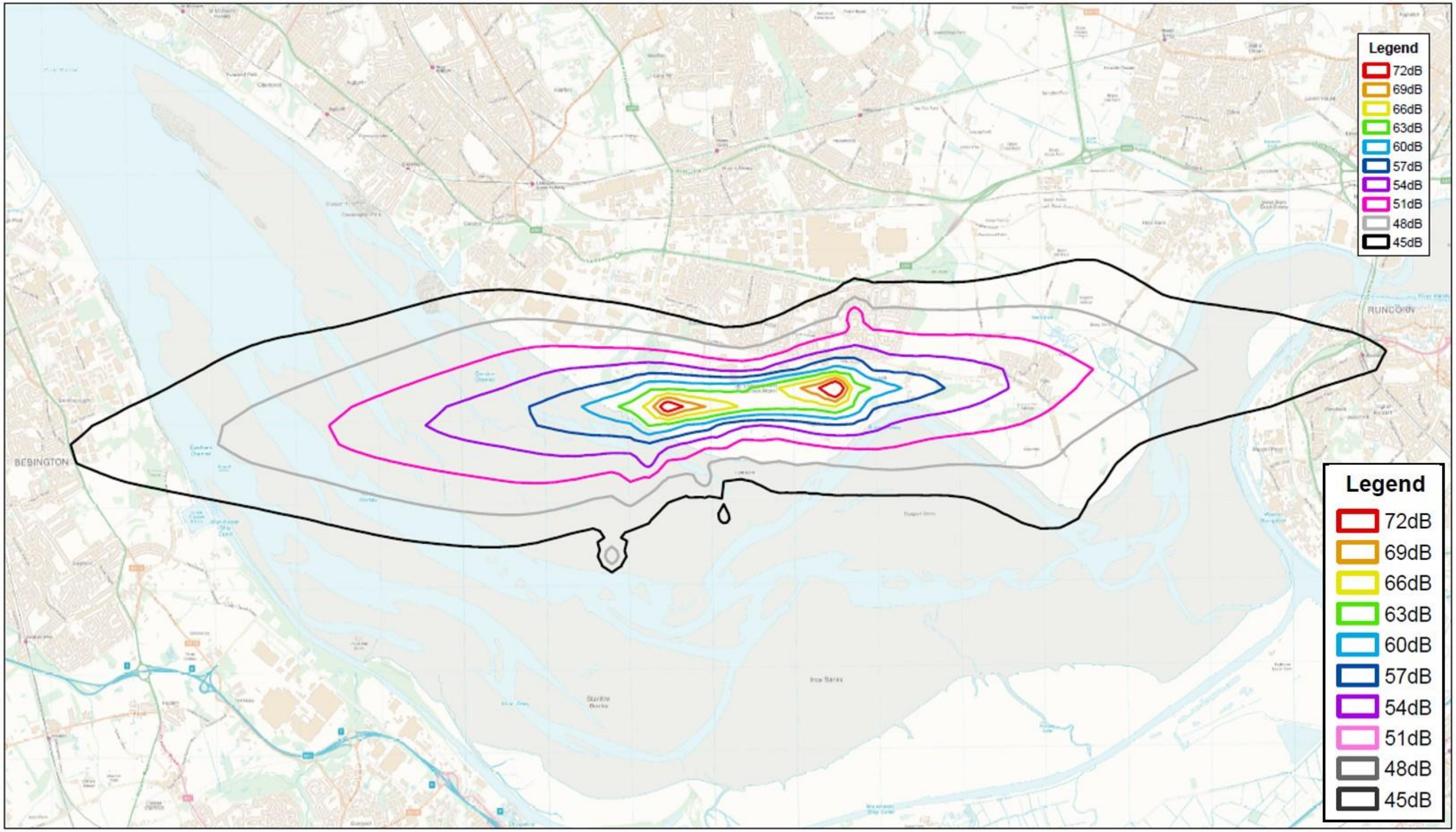

Figure 3 Baseline 2019 8hr Night Noise Contours above 45dBA $L_{Aeq\ 16hr}$

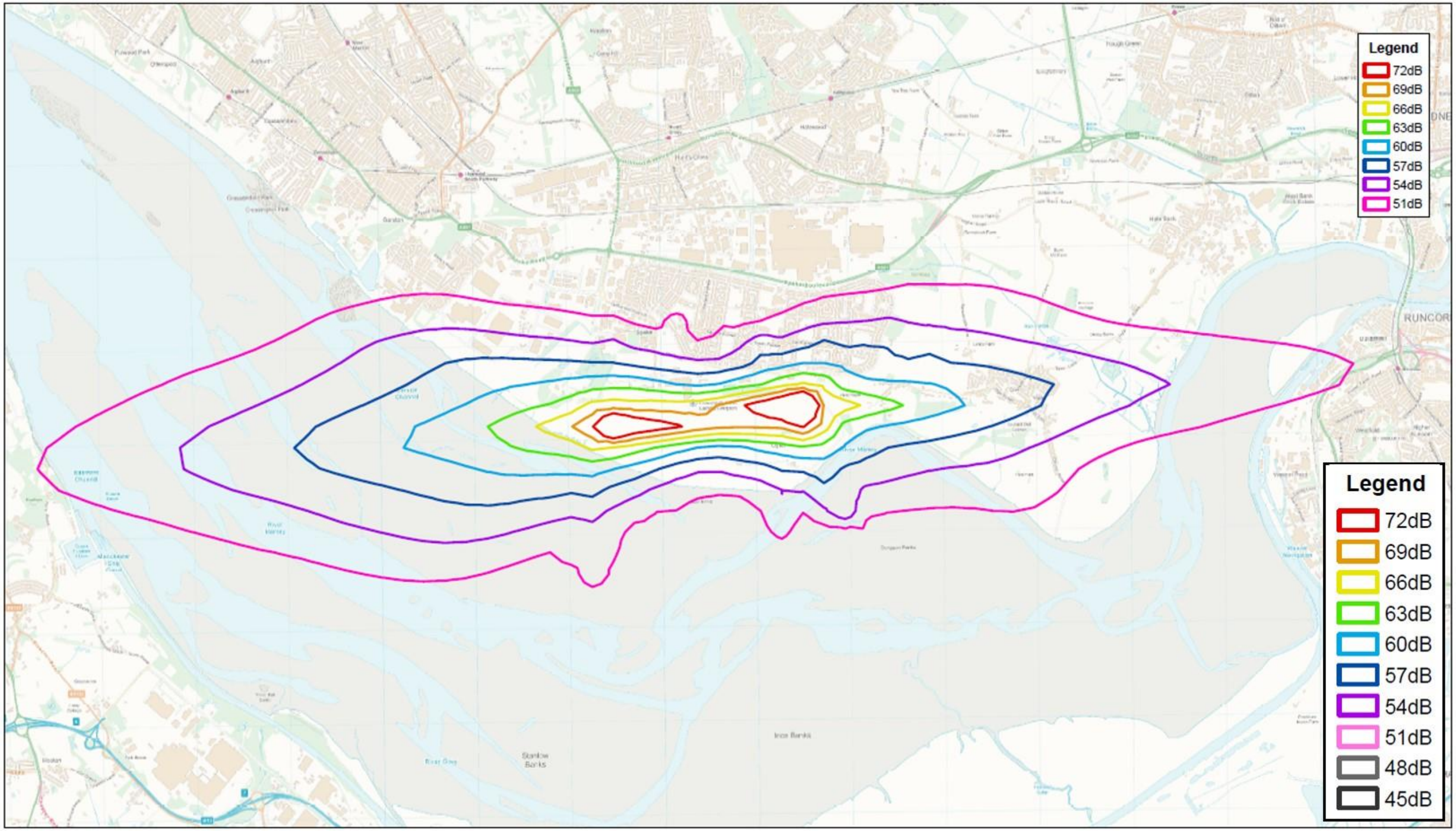

Figure 4 Baseline 2021 16hr Noise Contours above 51dBA $L_{Aeq\ 16hr}$

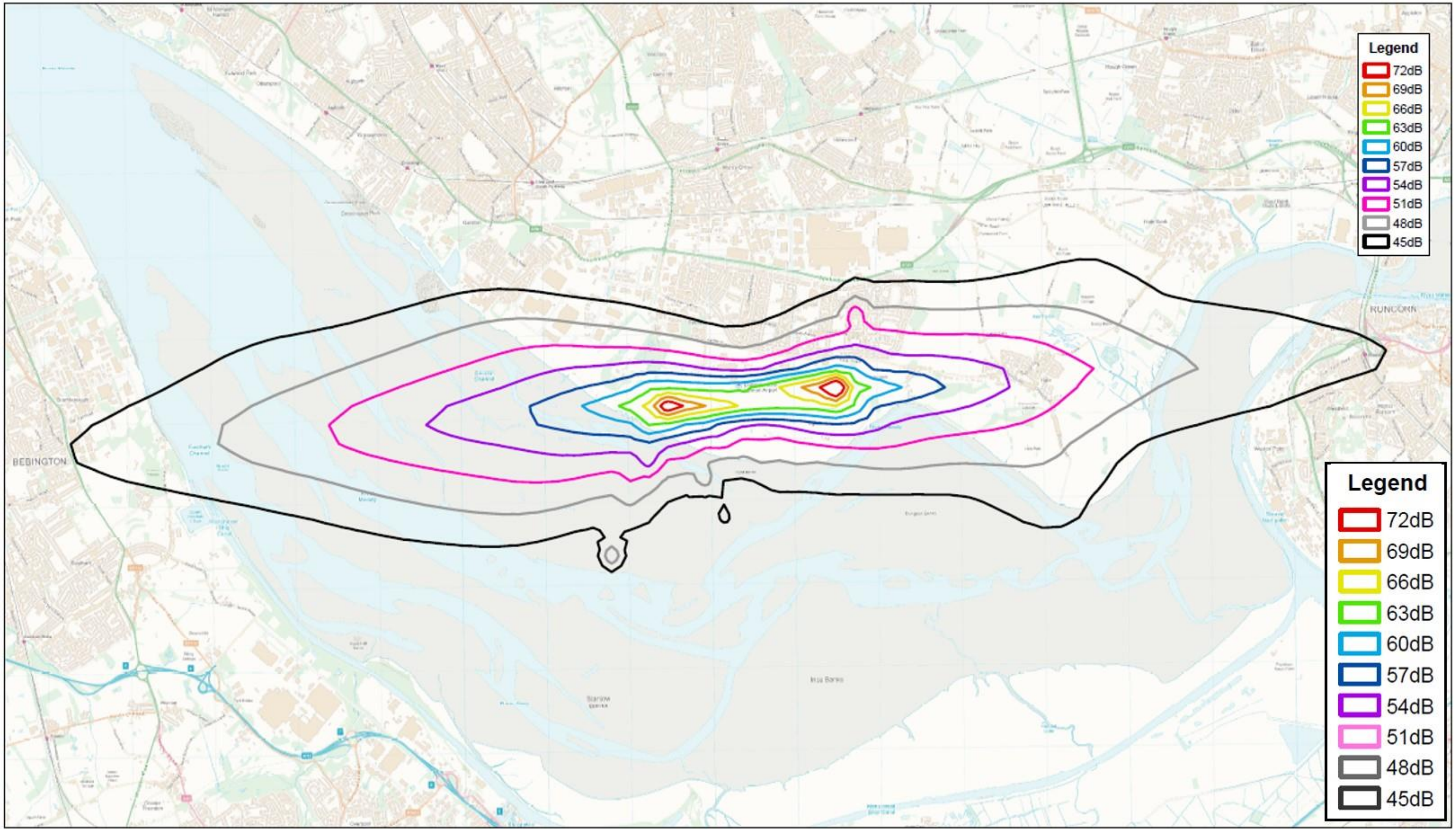

Figure 5 Baseline 2021 8hr Night Noise Contours above 45dBA $L_{Aeq\ 16hr}$

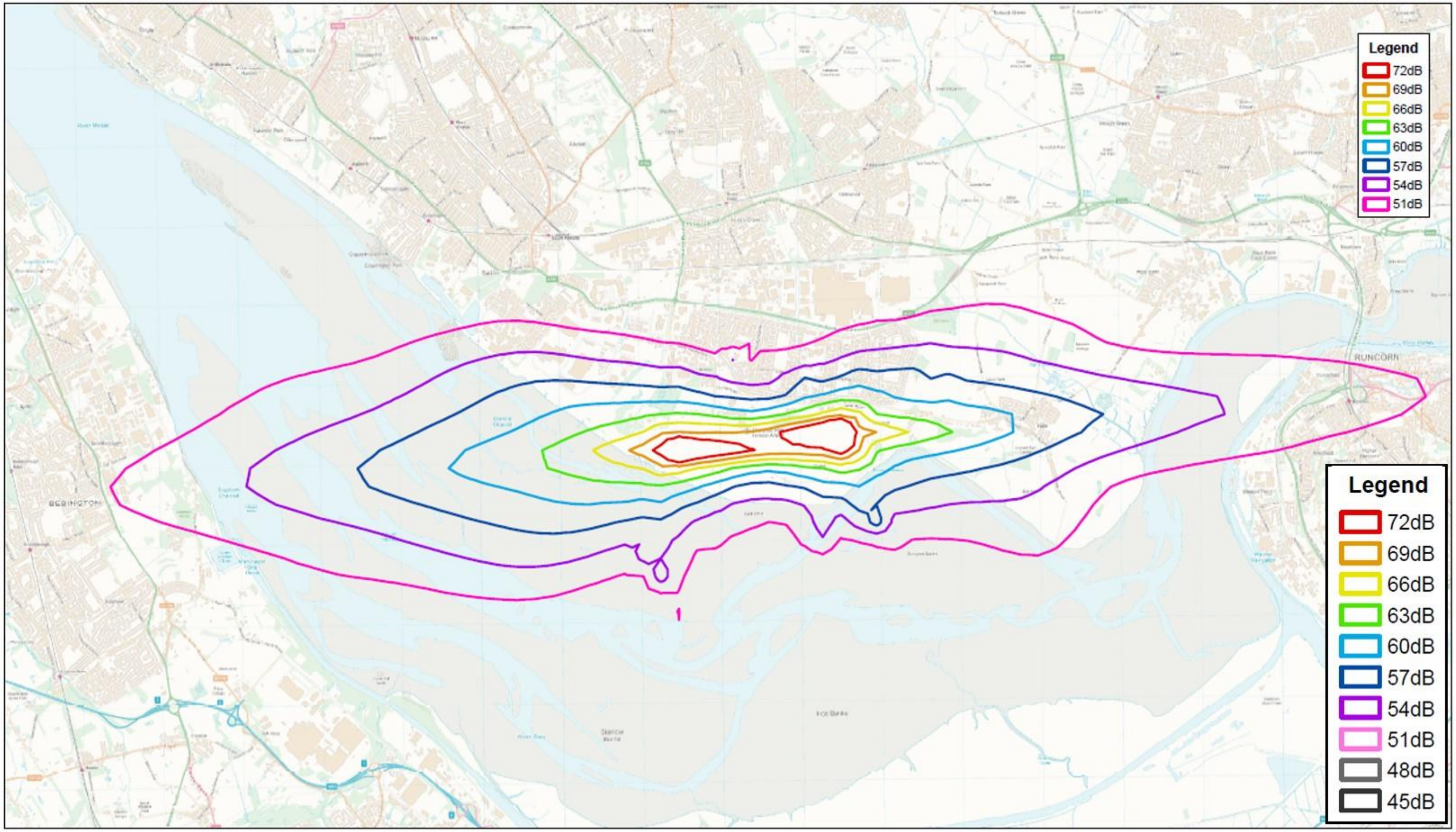

Figure 6 Baseline 2031 16hr Noise Contours above 51dBA $L_{Aeq\ 16hr}$

Liverpool John Lennon Airport
Faster. Easier. Friendlier.

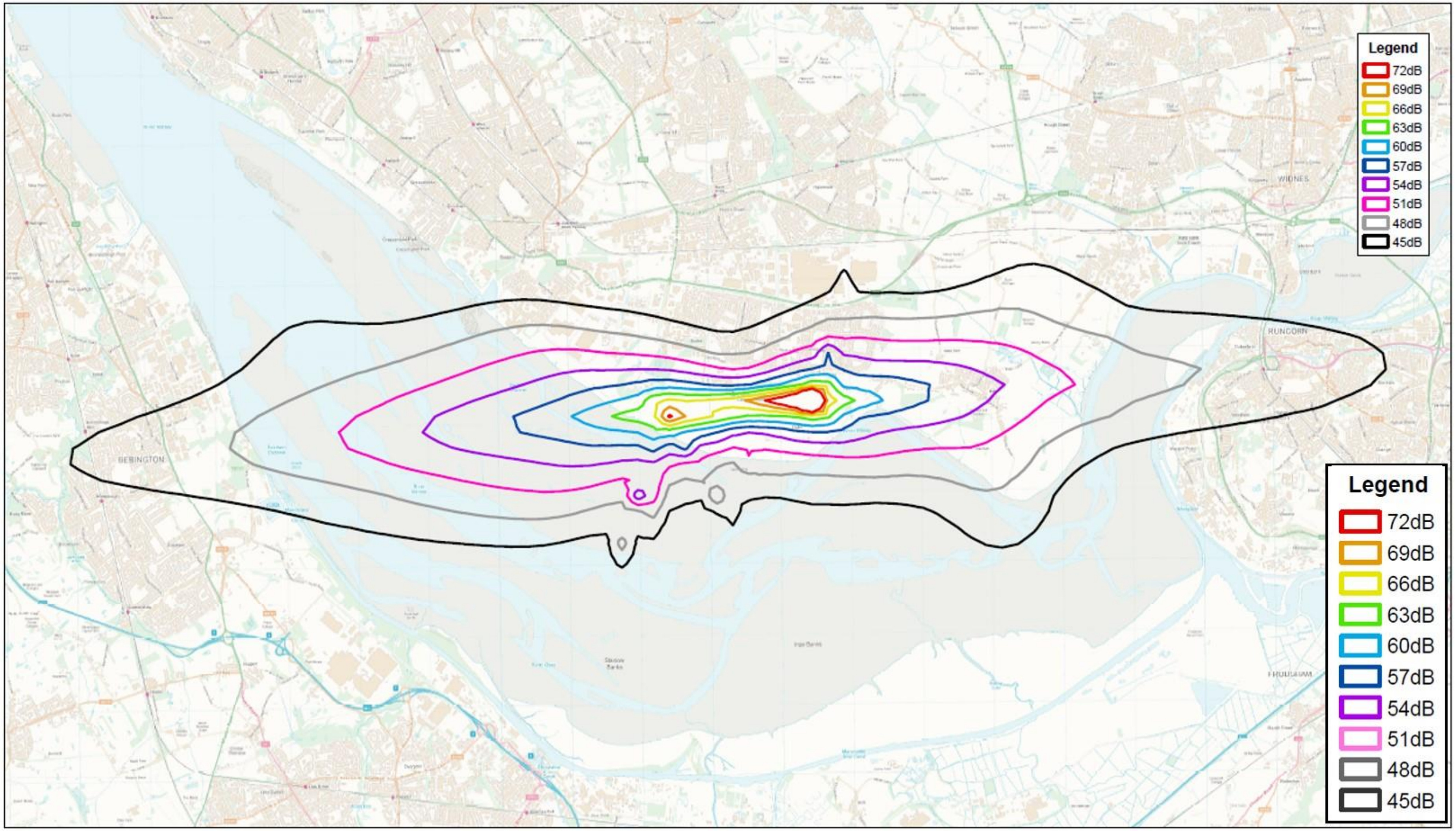

Figure 7 Baseline 2031 8hr Night Noise Contours above 45dBA $L_{Aeq\ 16hr}$

3.7 Fuel Burn and CO2: Commercial Airliners and GA

The Baseline fuel burn and CO2 calculations for the current conventional procedures are likely to be affected by a number of variables compared to the new PBN procedures which will be more accurate and predictable. The factors affecting the extant procedures include:

- Potential extended track miles in level flight due to height restrictions and clearance delays as a result of their non-alignment with wider UK airspace modernisation.
- Unpredictable routes due to:
    - Variable pilot/onboard system interpretation of ground-based navigation equipment.
    - Tactical ATC intervention, including radar vectoring of arrivals onto final approach (vectoring is required as there are no Transition procedures in the Baseline; Transitions define the route aircraft can use to exit the airways and join the approach).
- The opportunity to optimise aircraft performance through continuous climb/descent is unsupported by the conventional procedures.

The unpredictability of the extant routes can be seen in the dispersal of track data in the images at Annex A3.

The WebTAG fuel and CO2 calculations assume that there are no delays or other impact on aircraft performance that would increase fuel burn and consequently CO2 emissions. For example, a delay at the terminal building means that the aircraft uses more power to provide air conditioning and lighting for passengers; a delay on the taxi-ways or holding on the runway can burn unnecessary fuel; and where aircraft are delayed in the air subject to level (height) restrictions, the engine settings may be sub-optimal thus burning more fuel than would otherwise be required for a smooth ascent to the airways.

The opening year and forecast year figures for the Baseline, and for all options, assume that the mix of aircraft types flying at LJLA - 'the fleet' - remains the same. In practice, evolution of the fleet will naturally take place; aircraft are becoming more efficient, and airlines are generally looking at efficiencies of flying fewer larger aircraft in place of smaller types at many airports.

The nominal assessment of fuel and CO2 for the Baseline is contained in Table 7 showing what the figures are today (based on 92-day radar data of all tracks during 2019 summer period) and the predicted figures for the opening year (2021), and for the forecast year (2031). The 2021 and 2031 figures are based on forecast growth assumptions made by LJLA as part of the Airport Master Plan.

Study Name	Total Daily Fuel (Metric Tonnes)	Annual Fuel (Metric Tonnes)	Annual CO2 calc. (Metric Tonnes)
Baseline 2019	39.5	14,418	45,850
Baseline Opening Year (2021)	39.23	14,319	45,534
Baseline Forecast Year (2031)	56.9	20,767	66,039

Table 7 WebTAG fuel burn and CO2 calculations for the Baseline (Metric Tonnes)

4 Full Options Appraisal – Comparing against the Baseline

4.1 Noise: NPV of Impacts

Table 8 presents the WebTAG noise assessment results in terms of Net Present Value (NPV) in 2019 prices of a range of impacts. The figures represent a comparison of each of the options against the Baseline in the forecast year 2031. A positive £ figure indicates a positive benefit over the 2031 Baseline. All of the proposed options are predicted to deliver a positive benefit over the Baseline ‘do nothing’ option in the forecast year. These figures responded positively to the sensitivity testing included in the WebTAG assessment outputs.

£ Impact	A-N	A-P	A-R	C-N	C-P	C-R
Change in noise	£5,570,676	£4,554,822	£4,574,690	£3,858,439	£5,948,503	£5,672,222
Sleep disturbance	£1,046,305	£755,611	£660,621	£667,675	£1,144,770	£1,621,198
Amenity	£4,094,341	£3,423,226	£3,586,097	£2,916,996	£4,332,312	£3,641,614
AMI[22]	£6,112	£6,112	£5,740	£5,569	£6,407	£6,407
Stroke	£168,941	£147,422	£128,444	£106,930	£185,308	£160,616
Dementia	£254,977	£222,450	£193,788	£161,270	£279,706	£242,387

Table 8 NPV of noise impact

Figure 8 on the next page shows a chart of the NPV of the impact of each options; the taller the bars on the chart, the bigger the benefit.

[22] AMI = Acute Myocardial Infarction (Heart Attack)

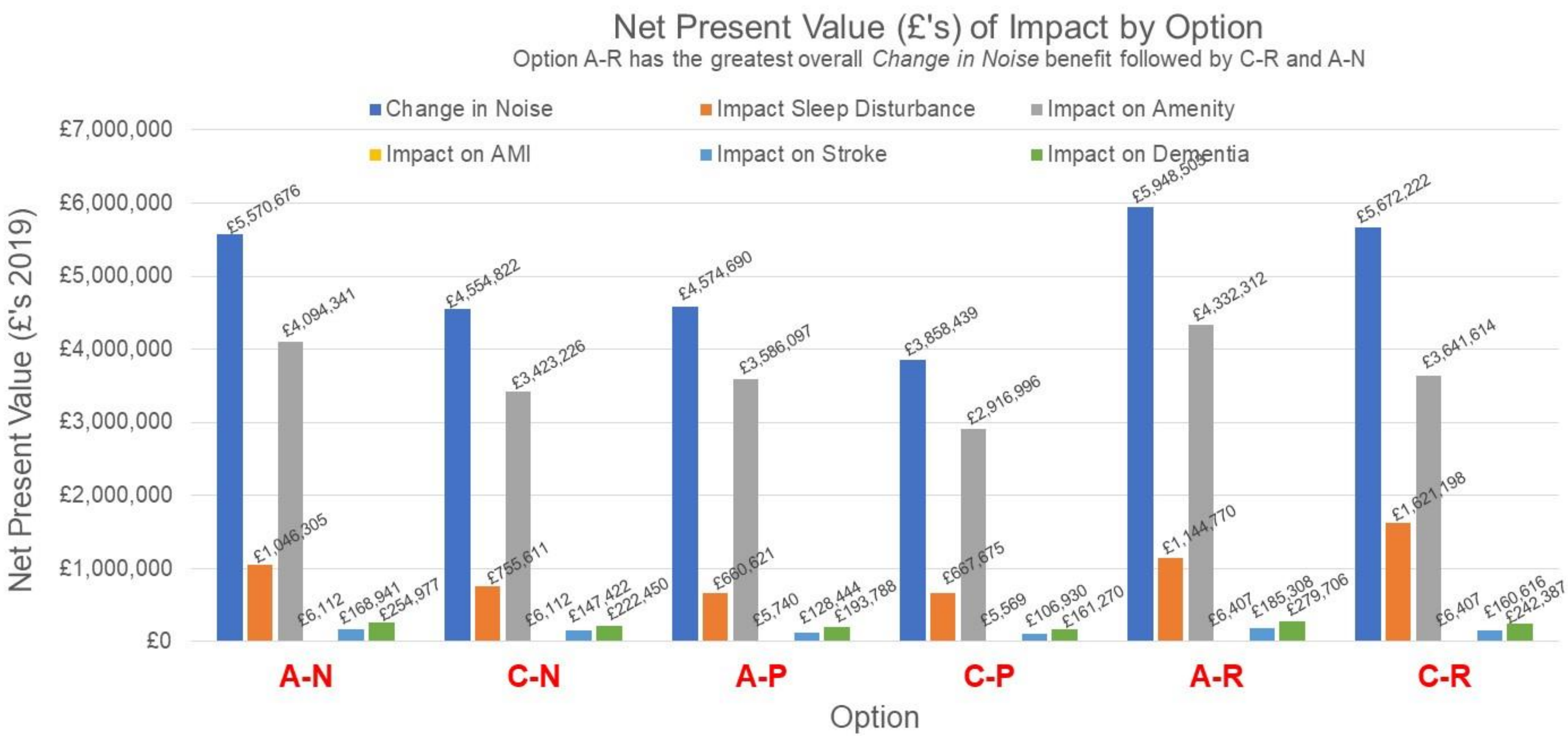

Figure 8 Net Present Value of impact by option versus the Baseline

4.2 Noise: Quantitative population exposure to change in noise

Table 9 presents the WebTAG derived quantitative assessment of the number of individuals experiencing either an increase of or a decrease in noise levels for each of the option combinations.

Quant. Change	A-N	C-N	A-P	C-P	A-R	C-R
Increased day noise	4,008	9,610	5,531	11,150	3,710	9,567
Reduced day noise	59,145	53,404	53,318	47,689	60,821	54,813
Increased night noise	3,873	6,096	5,190	6,096	3,841	6,064
Reduced night noise	15,081	12,438	12,258	12,438	16,053	12,511

Table 9 Quantitative assessment of population exposure to change in noise levels

Figure 9 shows a chart of the number of households experiencing changes in average noise levels versus the Baseline, for each of the option combinations.

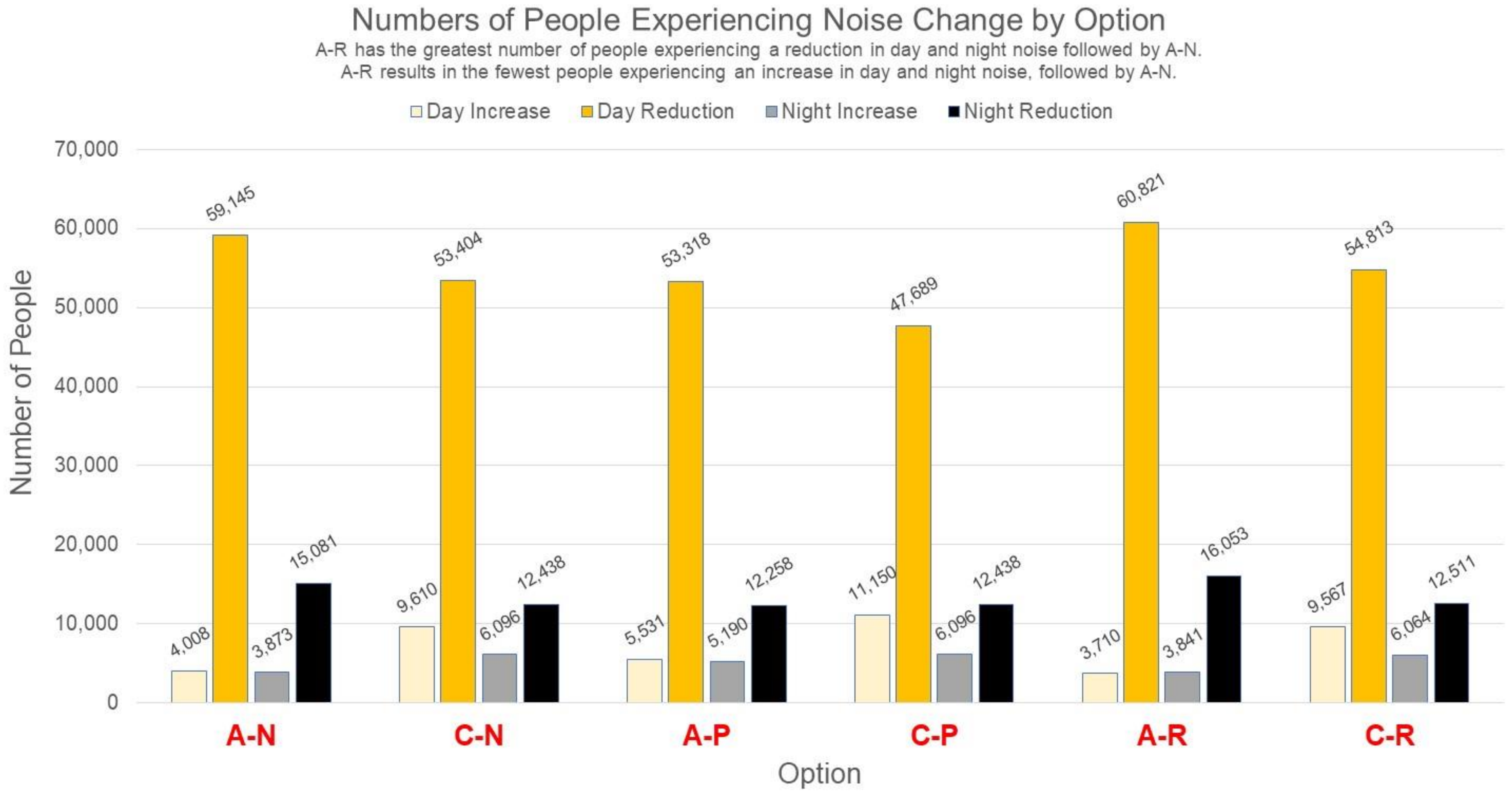

Figure 9 Number of households experiencing change in noise versus Baseline by option

4.3 Population by dBA LAeq16hr level

The number of people deemed to be exposed to daytime noise in each dBA level from 51dBA in 3dB increments up to 72dBA has been determined during the environmental assessment. These figures can be seen in Annex A4 to this report which contains all of the results of the WebTAG analysis used throughout the Full Options Appraisal process.

4.4 Population by dBA LAeq8hr level

The number of people deemed to be exposed to night time noise in each dBA level from 45dBA in 3dB increments up to 72dBA has been determined during the environmental assessment. These can also be seen in the Full Options Appraisal Analysis Table in Annex A4 to this report.

4.5 Fuel and CO2

Table 10 presents the WebTAG results of the fuel burned and associated CO2 emissions of each option in metric tonnes; the change versus the Baseline is also presented – a negative figure indicates a benefit i.e. a reduction versus the Baseline (highlighted in green).

Study name	Total Daily Fuel	Annual Fuel	Annual CO2 calc.	Fuel vs. Baseline	CO2 vs. Baseline	% fuel	% CO2
Baseline 2021	39.23	14319	45534	-	-	-	-
Baseline 2031	56.90	20767	66039	-	-	-	-
A-N 2021	38.98	14227	45243	-91.52	-291.02	-0.64%	-0.64%
A-N 2031	56.60	20660	65698	-107.31	-341.25	-0.52%	-0.52%
A-P 2021	39.41	14385	45744	66.06	210.09	0.46%	0.46%
A-P 2031	57.23	20888	66425	121.41	386.07	0.58%	0.58%
A-R 2021	38.61	14093	44816	-225.95	-718.51	-1.58%	-1.57%
A-R 2031	55.93	20415	64920	-351.97	-1119.27	-1.69%	-1.69%
C-N 2021	39.29	14339	45599	20.26	64.42	0.14%	0.14%
C-N 2031	57.05	20822	66214	55.03	175.00	0.26%	0.26%
C-P 2021	39.72	14497	46100	177.84	565.53	1.24%	1.24%
C-P 2031	57.67	21051	66942	283.88	902.72	1.37%	1.37%
C-R 2021	38.92	14205	45171	-114.14	-362.97	-0.80%	-0.79%
C-R 2031	56.51	20627	65595	-139.80	-444.57	-0.67%	-0.67%

Table 10 Comparison of Options Fuel and CO2 against the Baseline

Figure 10 shows the daily and annual fuel burn and the annual CO2 emissions associated with each of the options versus the Baseline.

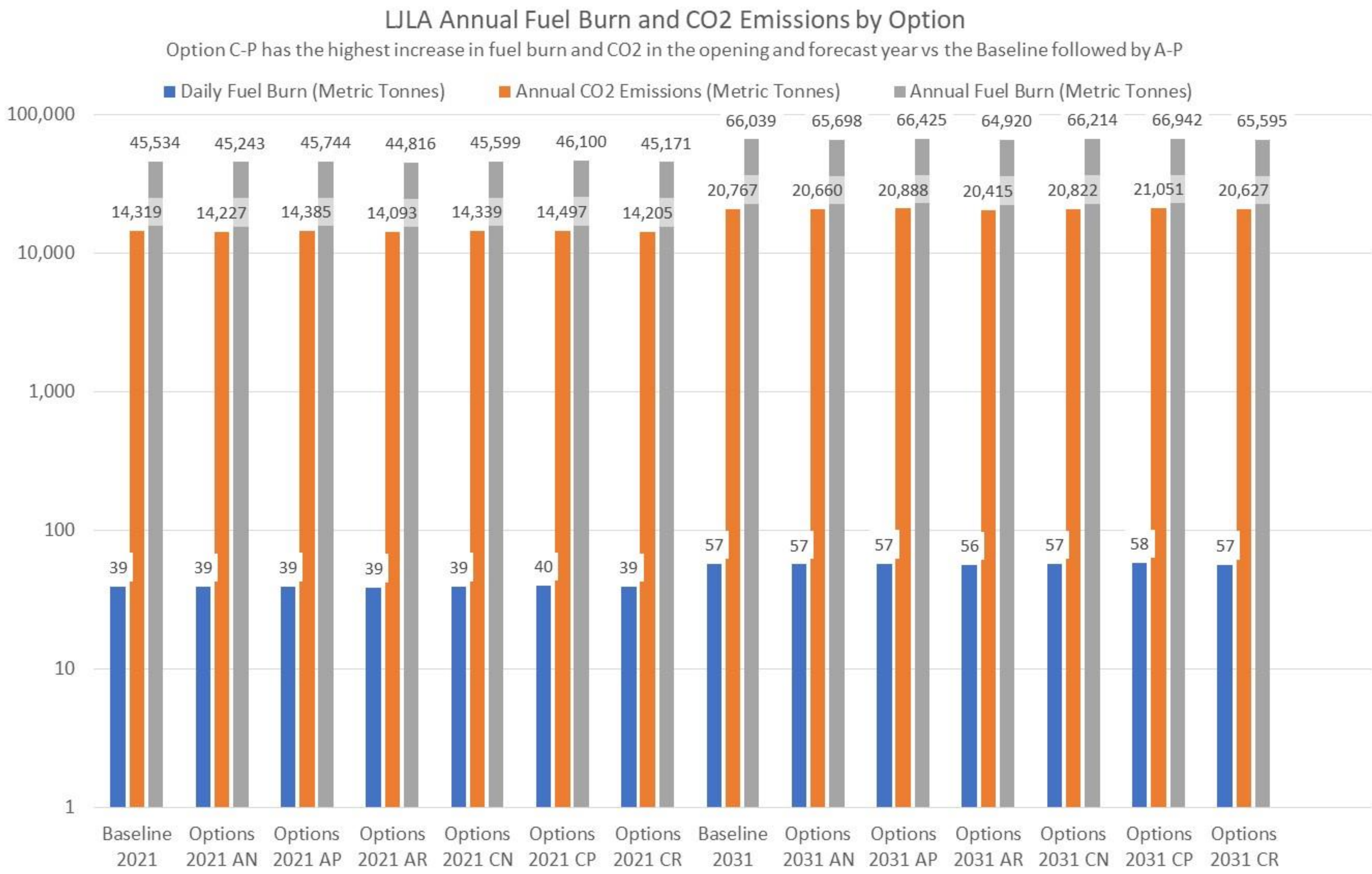

Figure 10 LJLA Daily and Annual Fuel Burn and CO2 emissions by Option

4.6 Financial Impacts (WebTAG for Greenhouse Gases)

The Overall Assessment Score in each case and the Quantitative Assessment (which shows the result of the NPV[23] of traded sector CO_2 equivalent emissions (tCO_2e) in GBP (£) are the results of this assessment summarised for each option in the figure below. A positive figure indicates a benefit to society versus the Baseline (highlighted in green).

WebTAG Assessment	AN	CN	AP	CP	AR	CR
Overall Assessment NPV CO_2e CO2 Equivalent emissions	£ 4,025	£ -15,054	£ -37,867	£ - 93,013	£ 116,465	£ 51,368
Quantitative Assessment NPV tCO_2e emissions	£ 89,846	£ -36,432	£ -88,101	£ -214,447	£ 267,858	£ 115,212

Table 11 Financial impacts of greenhouse gases for proposed options

Figure 11 below presents a chart of these results.

[23] Net Present Value.

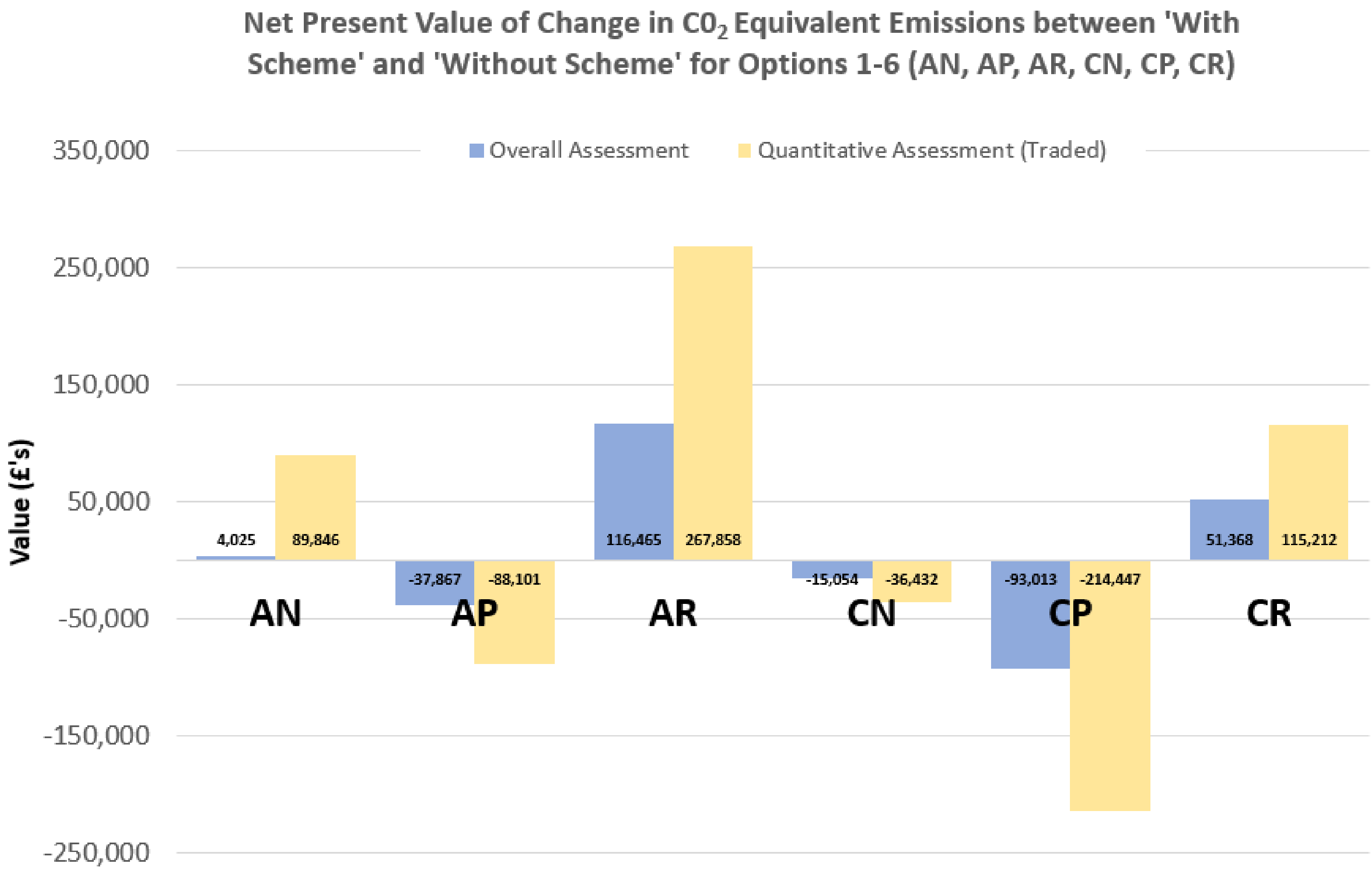

Figure 11 NPV of change in CO2 Equivalent emissions with scheme and without scheme

5 Full Options Appraisal Results by Combination

5.1 Introduction

This section of the report presents the full options appraisal of each of the combination options and presents a summary of the results. The complete analysis of all combination options side by side is contained in Annex A4 of this report and as a separate file 'Full Options Appraisal Tables' available on the CAA airspace portal at Stage 3.

The LAeq 16hr (day) and 8hr (night) noise contours for all of the combination options are shown in Annex A5.

5.2 Combination Option A-N

SID				Transition				Approach
A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	4,008
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	59,145
Communities		Individuals experiencing increased night time noise in forecast year:	3,873
Communities		Individuals experiencing reduced night time noise in forecast year:	15,081

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO_2 in opening year versus Baseline (%)	-0.64%
		Change in annual CO_2 in forecast year versus Baseline (%)	-0.52%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	£ 4,025
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	£ 89,846
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Benefit
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%) versus Baseline	-0.64%
		Change in annual fuel burn in forecast year (%) versus Baseline	-0.52%
Commercial airlines	Training costs*	N/A	N/A

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

^It is not proportionate for LJLA to assess other potential costs for commercial airlines - there may be other costs associated with achieving ability to fly PBN but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

5.4 Full Options Appraisal Combination C-N

	SID			Transition				Approach
C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
N	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	9,610
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	53,404
Communities		Individuals experiencing increased night time noise in forecast year:	6,096
Communities		Individuals experiencing reduced night time noise in forecast year:	12,438

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO2 in opening year versus Baseline (%)	0.14%
		Change in annual CO2 in forecast year versus Baseline (%)	0.26%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	-£ 15,054
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	-£ 36,432
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Benefit
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%) versus Baseline	0.14%
		Change in annual fuel burn in forecast year (%) versus Baseline	0.26%
Commercial airlines	Training costs*	N/A	-

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

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5.5 Full Options Appraisal Combination A-P

	SID			Transition				Approach
A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	5,531
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	53,318
Communities		Individuals experiencing increased night time noise in forecast year:	5,190
Communities		Individuals experiencing reduced night time noise in forecast year:	12,258

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO2 in opening year versus Baseline (%)	0.46%
		Change in annual CO2 in forecast year versus Baseline (%)	0.58%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	-£ 37,867
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	-£ 88,101
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Benefit
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%) versus Baseline	0.46%
		Change in annual fuel burn in forecast year (%) versus Baseline	0.58%
Commercial airlines	Training costs*	N/A	-

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

^It is not proportionate for LJLA to assess other potential costs for commercial airlines - there may be other costs associated with achieving ability to fly PBN but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

5.6 Full Options Appraisal Combination C-P

	SID			Transition				Approach
C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
P	SID 09 AGGER	SID 09 CAVEN	SID 09 CORKA Option	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	11,150
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	47,689
Communities		Individuals experiencing increased night time noise in forecast year:	6,096
Communities		Individuals experiencing reduced night time noise in forecast year:	12,438

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO2 in opening year versus Baseline (%)	1.24%
		Change in annual CO2 in forecast year versus Baseline (%)	1.37%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	-£ 93,013
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	-£ 214,447
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Positive
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%) versus Baseline	1.24%
		Change in annual fuel burn in forecast year (%) versus Baseline	1.37%
Commercial airlines	Training costs*	N/A	-

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

^It is not proportionate for LJLA to assess other potential costs for commercial airlines - there may be other costs associated with achieving ability to fly PBN but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

5.7 Full Options Appraisal Combination A-R

	SID			Transition				Approach
A	SID 27 AGGER AR	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	3,710
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	60,821
Communities		Individuals experiencing increased night time noise in forecast year:	3,841
Communities		Individuals experiencing reduced night time noise in forecast year:	16,053

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO2 in opening year versus Baseline (%)	-1.57%
		Change in annual CO2 in forecast year versus Baseline (%)	-1.69%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	£ 116,465
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	£ 267,858
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Limited Change
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%)versus Baseline	-1.58%
		Change in annual fuel burn in forecast year (%)versus Baseline	-1.69%
Commercial airlines	Training costs*	N/A	-

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

^It is not proportionate for LJLA to assess other potential costs for commercial airlines - there may be other costs associated with achieving ability to fly PBN but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

5.8 Full Options Appraisal Combination C-R

	SID			Transition				Approach
C	SID 27 AGGER	SID 27 WAL	SID 27 TEMP2	Trans 27 DIOUF	Trans 27 NOMSU	Trans 27 VEGUN	Trans 27 VEGUN (CC05)	Approach 27
R	SID 09 AGGER	SID 09 CAVEN Option	SID 09 CORKA	Trans 09 DIOUF	Trans 09 NOMSU	Trans 09 VEGUN		Approach 09

Group	Notes	Quantitative noise assessment results compared to Baseline	Assessment result
Communities	Opening Year 2021	Individuals experiencing increased daytime noise in forecast year:	9,567
Communities	Forecast Year 2031	Individuals experiencing reduced daytime noise in forecast year:	54,813
Communities		Individuals experiencing increased night time noise in forecast year:	6,064
Communities		Individuals experiencing reduced night time noise in forecast year:	12,511

Group	Other Impact	Assessment compared to Baseline	Assessment result
Communities	Air Quality	No change versus Baseline as no changes are taking place to aircraft tracks below 1000ft	none
Wider Society	Greenhouse Gas impact. Negative figure = decrease versus Baseline	Change in annual CO2 in opening year versus Baseline (%)	-0.79%
		Change in annual CO2 in forecast year versus Baseline (%)	-0.67%
	Greenhouse Gas CO_2e: positive figures are a benefit; negative are a cost to society	Overall Assessment NPV CO_2 Equivalent emissions	£ 51,368
		Quantitative Assessment NPV CO_2 Equivalent emissions (traded)	£ 115,212
Wider Society	Capacity and resilience	Impact on capacity and resilience (aligns with AMS)	Benefit
General Aviation (GA)	Access	Change to access arrangements for GA	No change
GA / commercial airlines	Economic impact from increased effective capacity	Impact on delays versus Baseline	Limited Change
GA / commercial airlines	Fuel burn	Change in annual fuel burn in opening year (%) versus Baseline	-0.80%
		Change in annual fuel burn in forecast year (%)versus Baseline	-0.67%
Commercial airlines	Training costs*	N/A	-

Group	Other Impact	Assessment compared to Baseline	Assessment result
Airport /ANSP	Other costs^	Change in en-route and taxi delay costs (U of W Research[17])	Benefit
Airport / ANSP	Infrastructure costs	Infrastructure cost/benefit (qualitative) No additional airport infrastructure is required to support the implementation of the new IFPs.	Benefit
Airport / ANSP	Operational costs	Operational cost/benefit (qualitative) No additional operational costs are predicted for the implementation of the new IFPs.	Benefit
Airport / ANSP	Deployment costs	No change beyond sunk costs associated with ACP	none

Notes

*It is not proportionate for LJLA to assess potential training costs for commercial airlines that are directly associated with the proposal at LJLA. Due to national and international regulation and the advance of technology, airlines are moving towards PBN in order to realise the benefits for all departures and destinations.

^It is not proportionate for LJLA to assess other potential costs for commercial airlines - there may be other costs associated with achieving ability to fly PBN but there are too many variables (e.g. aircraft types, onboard system capability etc.) to consider these effectively.

6 Conclusions

6.1 Options Taken Forward to Consultation

Once the Full Options Appraisal was complete, the LJLA Options Appraisal Team convened a workshop on 6th November 2019 to consider the Full Options Appraisal results and to select the preferred option and a shortlist suitable for Consultation. Table 12 below contains a summary of the results of the appraisal.

The team felt that in general, the six options offered a delicate balance of benefits and all of the options might appeal to the stakeholders for different reasons; for example the one that offered the greatest noise benefit, concentrated all traffic over fewer individuals – those affected by this would understandable have a view. Two options offered clear benefits in terms of efficiency of operations at the airport, however there was merit in the alternatives as they offered environmental benefits. The two preferred options A-N and C-N are operationally equivalent in terms of the efficiencies they offer to LJLA; A-N is selected as the first preferred options as it reduces the impact on the communities of Bebington.

Whilst A-R and C-R appeared to have the greatest potential environmental benefits, the operational assessment was that these were unlikely to be realised due to the operational delays that would be incurred in order to coordinate traffic with Hawarden Airfield (as all runway 09 departures turn right towards Hawarden). Despite the operational inefficiencies of these two options, it was felt that they could not be ruled out as the WebTAG results ranked these two 1st and 2nd according to their NPV of noise benefits. C-P is ranked 6th (and last) due to having the least overall benefit and an increase in fuel and CO2 emissions. However it was agreed that this option could not be ruled out as it offers operational efficiencies over A-R and C-R, and offers a credible alternative to A-P.

The difference between the 'A' and the 'C' options is that the 'A' options include SID 27 AGGER AR which requires a slight deviation from PANS-OPS requirements (see paragraph 1.4). The 'A' Options keep traffic over the Mersey and offer clear benefit to the communities around Bebington but in order to offer fully compliant alternative to SID 27 AGGER AR, the decision was taken to carry all 'A' and 'C' (SID 27 AGGER) options forward for consultation.

Option	Overall Rank and Status Considering operations, noise and CO2/Fuel		Notes
A-N	1	Preferred Option	A-N is the preferred option because it is anticipated to have the least impact on the environment, and result in fewest delays operationally. **Environment:** Offers a significant reduction in night noise. Ranked 2nd overall on Fuel/CO2 but A-R scores are operationally unrealistic (due to delays) so A-N moves into 1st place.

Option	Overall Rank and Status Considering operations, noise and CO2/Fuel		Notes
			Operations: Operationally, having left hand turn SID 09 CAVEN reduces the impact of coordination with Hawarden Airport traffic.
C-N	2	Second Preferred Option	C-N is ranked 2nd because it is operationally equivalent to A-N but A-N offers greater reduction in noise, especially at night, for the communities of Bebington **Environment:** has a greater noise impact than A-N due to overflight of Bebington and an insignificant change in fuel/C02 over Baseline. **Operation:** Operationally A-N and C-N are equally acceptable (Runway 09 IFPs are the same) Only difference between A-N and C-N is the replacement of SID 27 AGGER AR with SID 27 AGGER.
A-P	3	Alternative Option 1	A-P is ranked 3rd as it slightly better than C-N on noise (avoidance of Bebington) but less beneficial in terms of Fuel/CO2. **Environment:** Fuel/C02 impact greater due to longer left-hand turn to CORKA. Has 2nd largest CO2/Fuel increase overall versus the Baseline. **Operation:** The left-hand SID 09 CORKA crosses the Approach to Runway 09 so could lead to some inefficiencies or delays.
A-R	4	Alternative Option 2	A-R is ranked 4th; although it appears to offer the greatest environmental benefit, inefficiencies in operation are likely to cancel these out. **Environment:** appears to offer the greatest overall reduction CO2/Fuel but these may not be realised due to likelihood of delays to coordinate with Hawarden Airport. **Operation:** inefficient operationally and the one most at risk of delays due to all Runway 09 SID turning right-hand after departure; the CO2/Fuel benefits are likely to be cancelled out by delays on apron/taxiing to coordinate traffic with Hawarden Airport. Only difference between A-N (preferred option) and A-R is the right-hand SID 09 CAVEN which in combination with other right-hand SIDs causes the inefficiency.

Option	Overall Rank and Status Considering operations, noise and CO2/Fuel		Notes
C-R	5	Alternative Option3	C-R is ranked 5th; although it has the second greatest overall benefit in terms of noise, the operational assessment of the likelihood of delays makes this less attractive than those ranked 1-4. **Environment:** C-R less beneficial overall than A-R due to overflight of Bebington. Fuel and CO2 benefits may not be realised due to likelihood of delays. **Operation:** As with A-R above, C-R Runway 09 Departures at risk of delays due to all Runway 09 SID turning right hand after departure; the CO2/Fuel benefits will not be realised due to delays on apron/taxiing to coordinate traffic with Hawarden Airport.
C-P	6	Alternative Option 4	C-P is ranked 6th due to it having the least overall benefit in terms of noise; it also has the biggest increase in Fuel burn and CO2 over the baseline. **Environment:** least overall noise benefit and has the largest increase in CO2/Fuel over the Baseline. **Operation:** offers a credible alternative to Option A-P however the difference in overall benefit between C-P and all other options assures it is ranked 6th.

Table 12 Preferred and Alternative Options taken forward to Consultation

6.2 Full Results Summary

The table containing the full analysis carried out at the Full Options Appraisal stage is delivered as a separate Appendix to this document – see Appendix A4 for details.

A1 Statement of Need

A1.1 LJLA SoN in Full (November 2018)

Liverpool John Lennon Airport (LJLA) wishes to comply with Resolution 36/23 ratified by the 36th International Civil Aviation Organisation (ICAO) General Assembly and also with the UK Future Airs pace Strategy (FAS) published by the Civil Aviation Authority (CAA), by introducing routes and procedures compliant with Performance Based Navigation (PBN) criteria; it is understood that States are required to make these changes by 2024. The introduction PBN procedures at LJLA must be aligned with the FASI(N) project to ensure the complex interactions between UK northern airports are considered. This will also help to ensure the FASI(N) project can also deliver the stated environmental and efficiency benefits.

The Liverpool Control Zone (CTR) currently operates below the Manchester Control Area (CTA) up to 2,500 ft AMSL (Class D airspace). The ATZ dimensions are Surface to 2,000 ft and the Liverpool CTR extends from the Surface to 2,500 ft AMSL. West of a north-south line through Liverpool, the Liverpool CTA extends from 2,500 ft to 3,500 ft AMSL (Class D airs pace). To the west and north of Wallasey the Liverpool CTA extends from 1,500 ft to 3,500 ft (Class D airspace) in order to create an overland route for General Aviation traffic around the Wirral peninsular to Wallasey. To the west of Liverpool, coincident with Airways L10 and L975, are 8nm long portions of Class D airspace extending up to 3500 ft AMSL (airway bas e) and designated as Liverpool CTA. Further airspace is delegated to Liverpool by PC Wallasey Sector, but close cooperation with Manchester Approach is necessary when operating in these areas. A further area of Class A airs pace to the south is also delegated to Liverpool up to 4,000 ft AMSL.

A previous ACP commenced in July 2015 and introduced GNSS Lateral Navigation (LNAV) and combined Lateral/Vertical Navigation (LNAV/VNAV) Instrument Approach Procedures (IAP) for Runways 09 and 27 at LJLA. The VNAV component of the procedures is Baro-VNAV. The procedures were introduced as a contingency for those occasions when the Instrument Landing System (ILS) was unavailable, and also to support training and currency requirements. These changes are contained entirely within controlled airspace and the CAA decision on 7 Apr 16 supported these changes.

LJLA ATC currently operate H24 as required, from a single asphalt runway, dimensions 2285m x 46m. The thresholds are at 60 ft (Rwy 09) and 78 ft (Rwy 27). The airport offers Approach, Tower and Radar services and has an ILS on both runways as well as the RNAV (GNSS) procedures and ILS/DME/NDB procedures on both runways.

Total movements at LJLA for 2016 were 61,577 (average of 5,131 per month). During the 5-year period 2013-20 17 the average movement levels were 62,131. During the last complete year (2017) these were split proportionately as follows: Commercial 58%, Club 37%, Non-Commercial 3%, Other 2%.

During 2016 LJLA dealt with 4.8 million passengers. Due to the last recession, the 2007 Master plan growth forecasts were not achieved. However, it is anticipated that the 2007 growth forecasts will now recover in future years, but over a longer period. The Airport has ambitious plans to serve more destinations, including long haul, with passenger forecasts indicating the potential to grow passenger numbers from 4.8 million passengers per year in 20 16 to 7.8 million by 2030, and then to 11 million by 2050 . These increases will require investment in a proposed expansion of the terminal building, additional car parking, passenger facilities including hotels, retail, food and drink services and a potential extension of the runway. There is also significant potential to grow cargo operations at LJLA, to attract specialist aviation businesses and to develop a cluster of related high-quality employment opportunities. The investments in the Airport's physical infrastructure has the potential to increase total annual GVA impact to £625 million and will enable it to support 12,280 jobs across the City Region by 2030, benefitting the wider Northern Powerhouse.

LJLA sits on the northern bank of the River Mersey directly opposite Ellesmere Port to the south. The westerly approach is above the town of Runcorn, 3.75 nm from touchdown. The easterly approach is also above the Bromborough area on the Wirral Peninsula, at a similar distance from touchdown.

In moving forward with this project LJLA will be able to meet airline demand for PBN infrastructure and improve the resilience and redundancy of its airport operations. The improved efficiencies will also help to protect capacity for any future growth. Introduction of PBN procedures will drive new procedure designs that minimise delays and allow for more efficient interfaces with adjacent air traffic organisations. An aspiration of LJLA is to introduce new procedures that also offer environmental benefits, wherever possible within the constraints of PANS OPS compliant final designs.

A2 Design Principles

Error! Reference source not found. contains the prioritised list of Design Principles as defined during Stage 1 of the ACP process.

Prioritised DP (a)	DP No (b)	Design Principle (c)	Category (d)
1	10	Procedures must be designed to meet acceptable levels of flight safety.	Safety
2	8	Procedures must be designed to minimise aircraft emissions to reduce air pollution.	Environmental
3	5	Procedures should be designed to avoid overflight of sensitive areas, e.g. hospitals, schools, country parks, high risk industrial sites.	Environmental
=4	1	Procedures must be designed to minimise the impact of noise below 7,000ft.	Environmental
=4	4	Procedures should be designed to be technically flyable and maintain existing operational performance, and capacity.	Technical
6	3	Procedures should be designed to enable more continuous climbs.	Technical
=7	2	Procedures should be designed to fit within existing airspace constraints and boundaries.	Technical
=7	6	Procedures should be designed to enable more continuous descents.	Technical
9	11	Procedures should be designed that minimise the number of track miles flown.	Operational
10	13	If the design of the new procedures requires a smaller volume of airspace, airspace design or classification should be altered for the benefit of other airspace users.	Technical

Prioritised DP (a)	DP No (b)	Design Principle (c)	Category (d)
11	12	Procedures should be developed to allow for alternative routes to offer respite.	Environmental
=12	9	Procedures should be designed to minimise the need for aircraft vectoring to reduce Air Traffic Controllers (ATCOs) workload.	Operational
=12	15	Procedures should be designed to concentrate routes to minimise the numbers overflown.	Environmental
14	7	Procedures should be designed to ensure predictability of tracks for consistency of operations.	Operational
15	14	Procedures should be designed to include alternative routes to avoid other aviation operators.	Technical

Table 13 Prioritised Design Principles

A3 Baseline Traffic Distribution vs Future Nominal Tracks

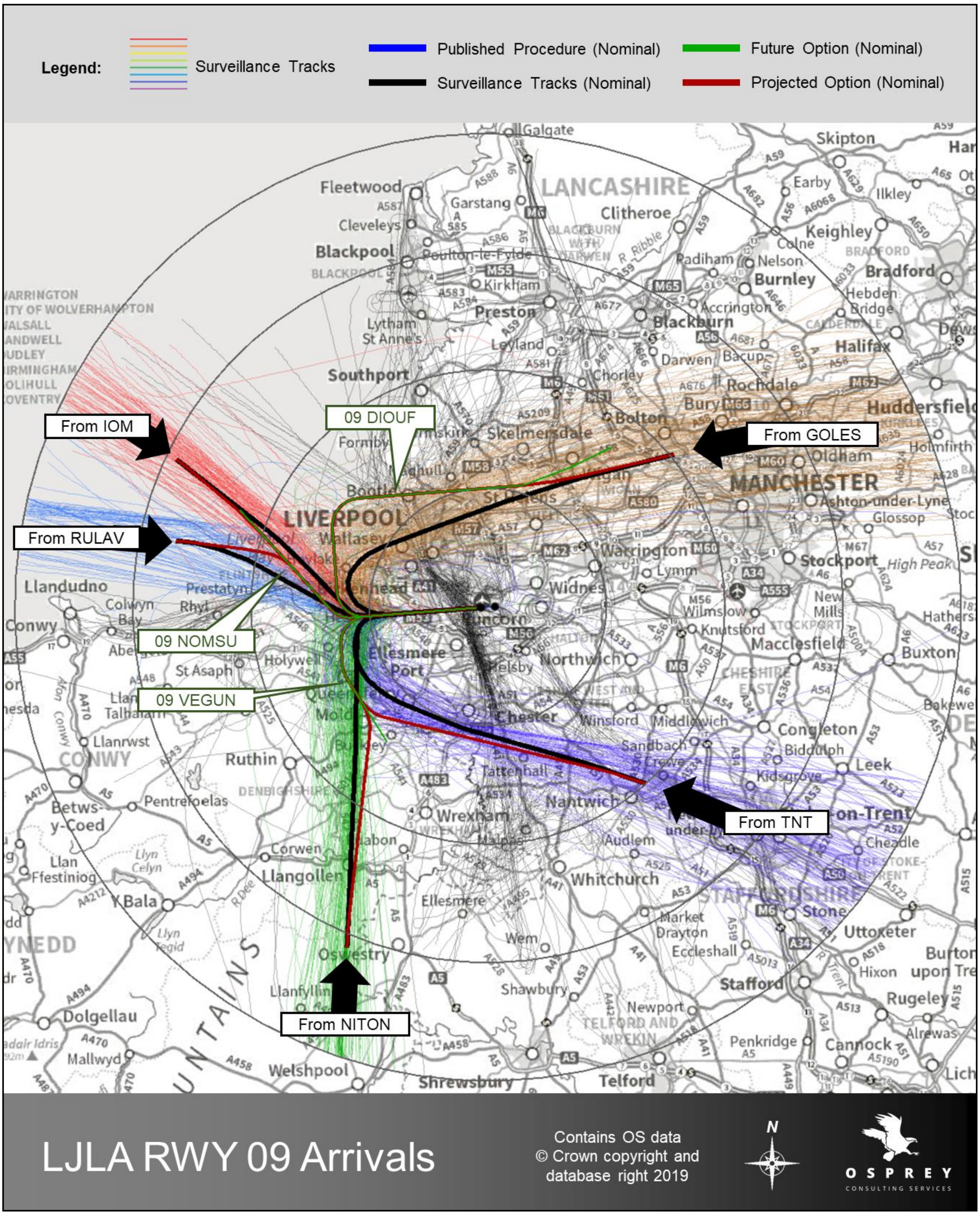


Figure 12 LJLA Baseline Traffic Distribution vs Future Options (RWY 09 Arrivals)

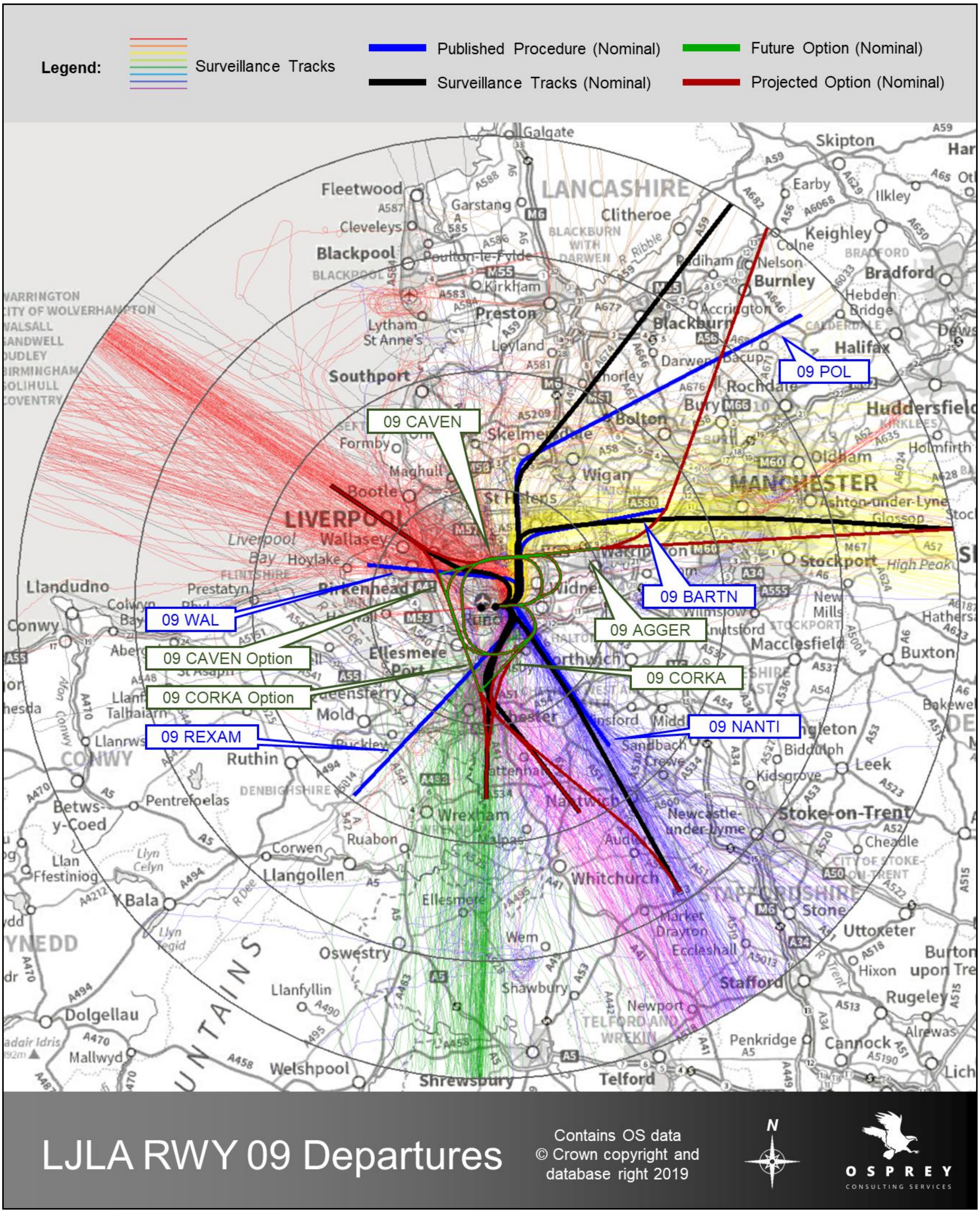


Figure 13 LJLA Baseline Traffic Distribution vs Future Options (RWY 09 Departures)

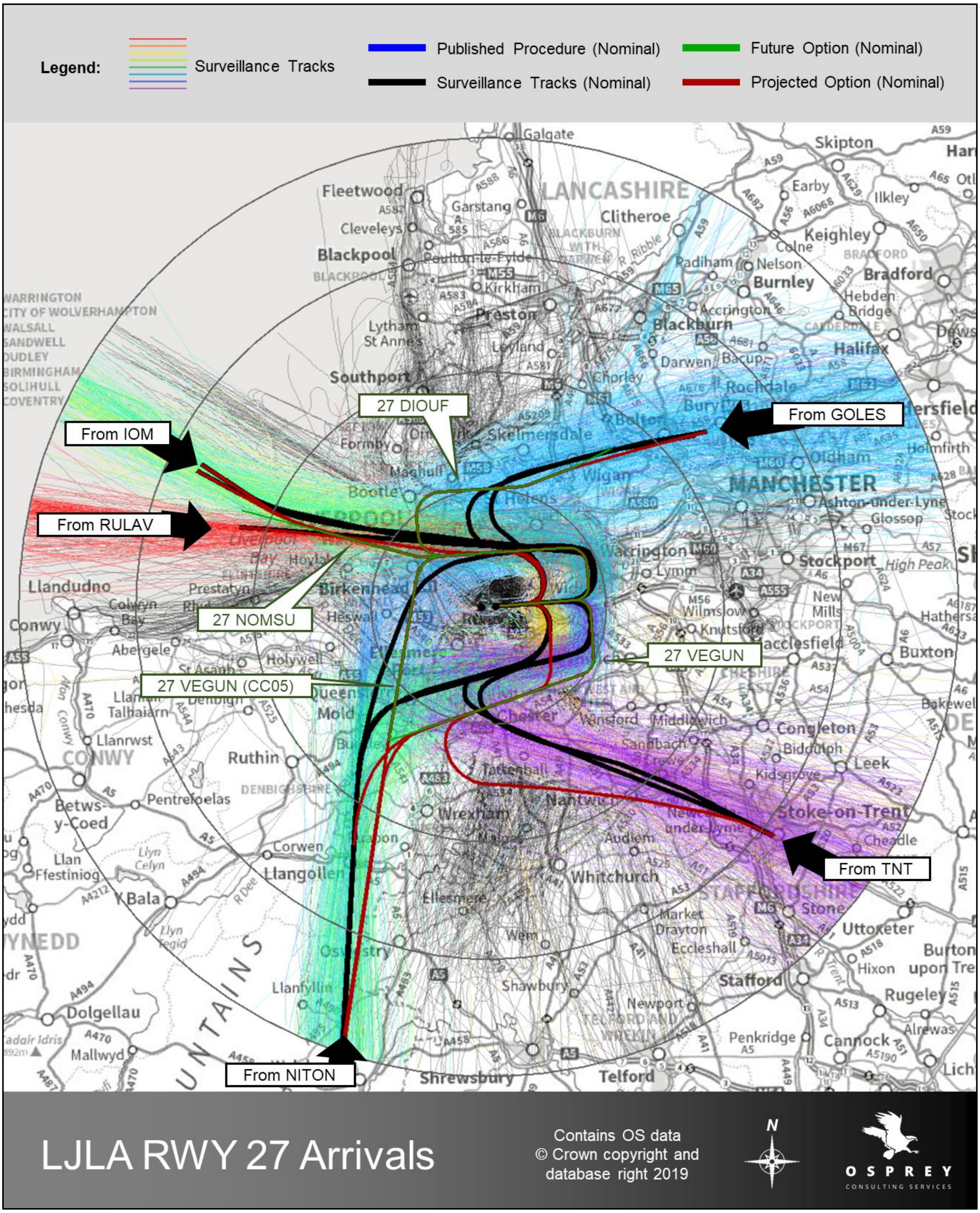


Figure 14 LJLA Baseline Traffic Distribution vs Future Options (RWY 27 Arrivals)

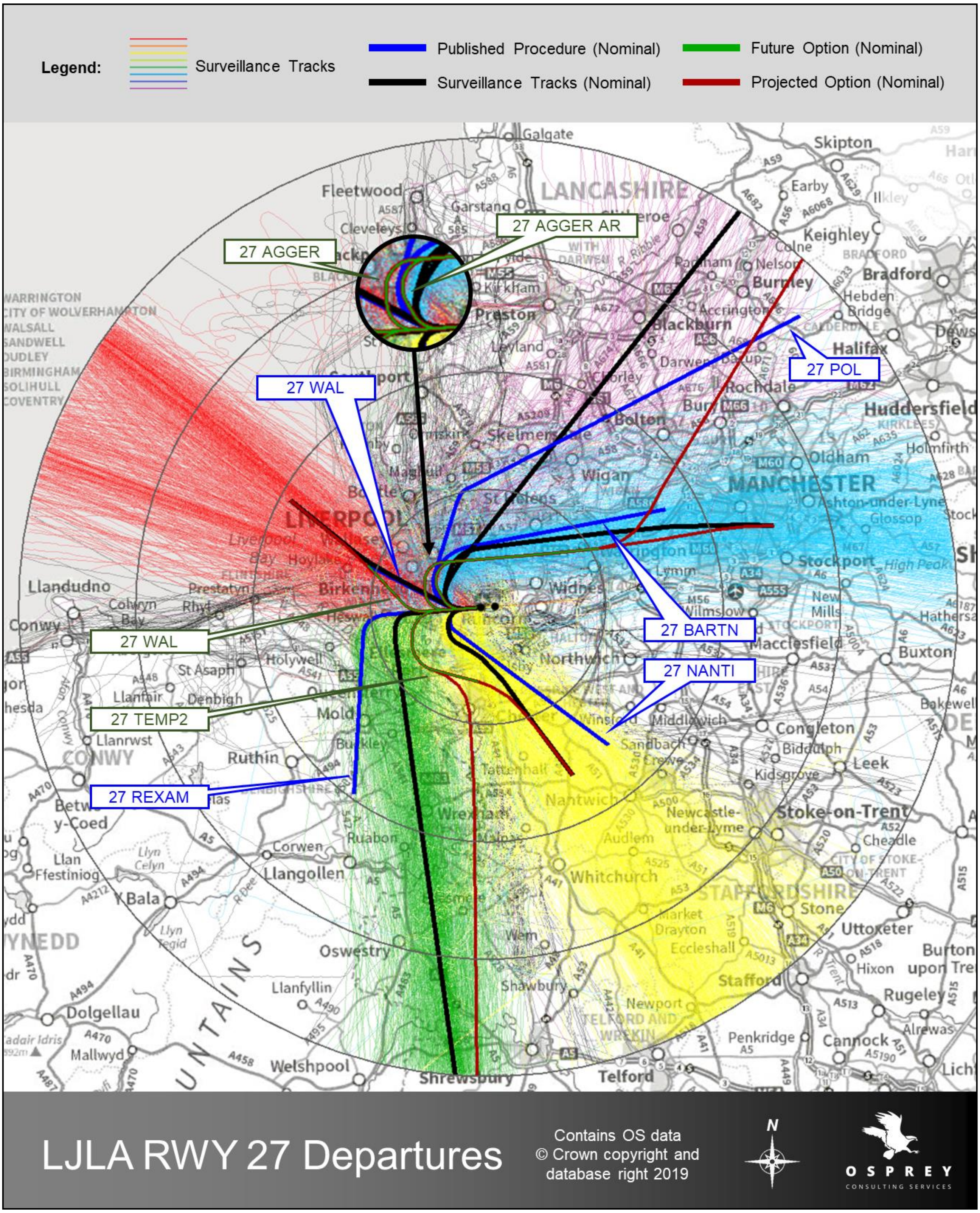


Figure 15 LJLA Baseline Traffic Distribution vs Future Options (RWY 27 Departures)

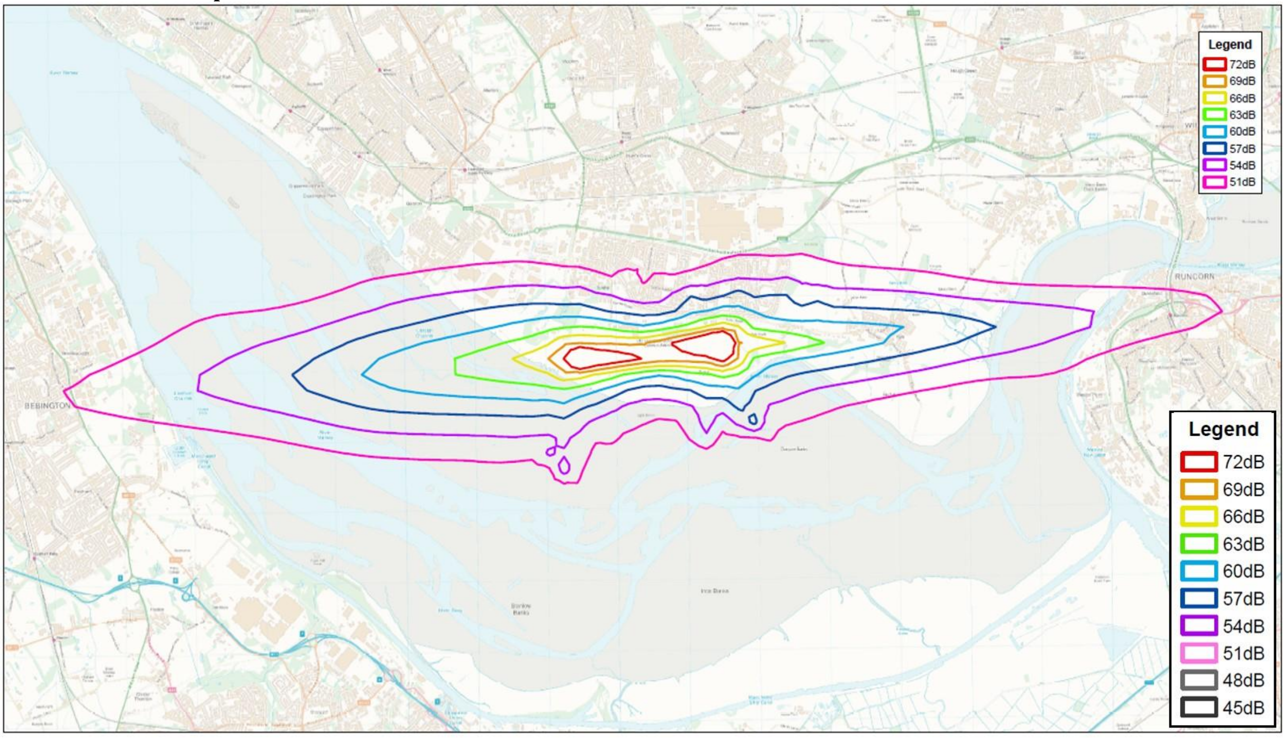
A4 Full Options Appraisal (Full Table Analysis)

The Full Options Appraisal tables below are delivered in larger format as a separate MS Excel worksheet – reference 71137 060a available on the Airspace Portal Step 3C.

				Operational Assessment:						
Present Value base year	2010		Appears to have Greatest benefit	A-N and C-N offer greatest operational efficiencies	A-N has greater noise benefits than C-N	3rd place operational efficiency	Least overall benefit but operationally efficient	Operationally least attractive due to impact on Hawarden and delays to LJLA traffic to coordinate with Hawarden		
Current year	2019		2nd place							
Proposal Opening Year	2021		3rd place							
Forecast Year	2031		Least benefit							
	Aviation		**Forecast Year 2031**	**AN**	**CN**	**AP**	**CP**	**AR**	**CR**	
Affected Group	**Impact**	**Level**	**WebTAG assessment (noise)**	**Preferred**	**Preferred Alternative**	**Alternative 3**	**Alternative 6**	**Alternative 4 Env not realistic - delays**	**Alternative 5 Env not realistic - delays**	**Baseline Totals**
Communities	Noise impact on health and quality of life	££ and Quant	NPV of change in noise (£, 2019 prices):	£5,570,676	£4,554,822	£4,574,690	£3,858,439	£5,948,503	£5,672,222	-
			NPV of impact on sleep disturbance (£, 2019 prices):	£1,046,305	£755,611	£660,621	£667,675	£1,144,770	£1,621,198	-
			NPV of impact on amenity (£, 2019 prices):	£4,094,341	£3,423,226	£3,586,097	£2,916,996	£4,332,312	£3,641,614	-
			NPV of impact on AMI (£, 2019 prices):	£6,112	£6,112	£5,740	£5,569	£6,407	£6,407	-
			NPV of impact on stroke (£, 2019 prices):	£168,941	£147,422	£128,444	£106,930	£185,308	£160,616	-
			NPV of impact on dementia (£, 2019 prices):	£254,977	£222,450	£193,788	£161,270	£279,706	£242,387	-
			Quantitative noise results							
			Individuals experiencing increased daytime noise in forecast year:	4008	9610	5531	11150	3710	9567	-
			Individuals experiencing reduced daytime noise in forecast year:	59145	53404	53318	47689	60821	54813	-
			Individuals experiencing increased night time noise in forecast year:	3873	6096	5190	6096	3841	6064	-
			Individuals experiencing reduced night time noise in forecast year:	15081	12438	12258	12438	16053	12511	-
	Impact	**Level**	**WebTAG assessment**	**AN**	**CN**	**AP**	**CP**	**AR**	**CR**	**Baseline Totals**
Communities	Air Quality	Qual/ ££ and Quant	Cost of change below 1000ft	none	none	none	none	none	none	-
Wider Society	Greenhouse Gas impact	££ and Quant	Change in annual CO2 in opening year versus baseline	-291	64	210	566	-719	-363	45534
			% Change in annual CO2 in opening year versus baseline	-0.64%	0.14%	0.46%	1.24%	-1.58%	-0.80%	
			Change in annual CO2 in forecast year versus baseline	-341	175	386	903	-1119	-445	66039
			% Change in annual CO2 in forecast year versus baseline	-0.52%	0.26%	0.58%	1.37%	-1.69%	-0.67%	
			Overall Assessment NPV CO2E CO2 Equivalent emissions	£ 4,025	-£ 15,054	-£ 37,867	-£ 93,013	£ 116,465	£ 51,368	
			Quantitative Assessment NPV CO2 Equivalent emissions	£ 89,846	-£ 36,432	-£ 88,101	-£ 214,447	£ 267,858	£ 115,212	
Wider Society	Capacity and resilience	Qualitative	Impact on capacity and resilience (aligns with AMS)	Benefit	Benefit	Benefit	Benefit	Benefit	Benefit	Negative
General Aviation (GA)	Access	Qualitative	Change to access arrangements for GA	no change	no change	no change	no change	no change	no change	
GA / commercial airlines	Economic impact from increased effective capacity	Quantify	Impact on delays versus baseline	Benefit	Benefit	Benefit	Benefit	Limited	Limited	-
GA / commercial airlines	Fuel burn	££ and Quant	Change in annual fuel burn in opening year (metric tonnes)	-92	20	66	178	-226	-114	14319
			%Change in annual fuel burn in opening year	-0.64%	0.14%	0.46%	1.24%	-1.58%	-0.80%	
			Change in annual fuel burn in forecast year (metric tonnes)	-107	55	121	284	-352	-140	20767
			% Change in annual fuel burn in forecast year	-0.52%	0.26%	0.58%	1.37%	-1.69%	-0.67%	
Commercial airlines	Training costs	££ and Quant	N/A	-	-	-	-	-	-	-
Commercial airlines	Other costs	££ and Quant	Change in en-route and taxi delay costs (U of W Research)	Benefit	Benefit	Benefit	Benefit	Benefit	Benefit	-
Airport / ANSP	Infrastructure costs	££ and Quant	Infrastructure cost/benefit (qualitative)	Benefit	Benefit	Benefit	Benefit	Benefit	Benefit	Cost
Airport / ANSP	Operational costs	££ and Quant	Operational cost/benefit (qualitative)	Benefit	Benefit	Benefit	Benefit	Benefit	Benefit	Cost
Airport / ANSP	Deployment costs	££ and Quant	No change beyond sunk costs associated with ACP	none	none	none	none	none	none	none
Secondary Metrics	**Population per dB level, nearest 50**	**Level**	**WebTAG assessment**	**AN**	**CN**	**AP**	**CP**	**AR**	**CR**	**Baseline**
		Quantitative	Population exposed to daytime noise 72dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to daytime noise 69dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to daytime noise 66dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to daytime noise 63dB	100	100	100	100	<51	100	150
		Quantitative	Population exposed to daytime noise 60dB	1550	1550	1550	1550	300	1400	1650
		Quantitative	Population exposed to daytime noise 57dB	4000	4000	4000	4000	3000	4000	4500
		Quantitative	Population exposed to daytime noise 54dB	6050	6050	6050	6050	5000	6050	6900
		Quantitative	Population exposed to daytime noise 51dB	12500	14000	13950	15450	8350	13650	16600
		Quantitative	Population exposed to nightime noise 72dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to nightime noise 69dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to nightime noise 66dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to nightime noise 63dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to nightime noise 60dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Population exposed to nightime noise 57dB	200	200	200	200	50	200	300
		Quantitative	Population exposed to nightime noise 54dB	2800	3100	2800	3050	1250	3100	2800
		Quantitative	Population exposed to nightime noise 51dB	4600	4350	4600	4350	3550	4350	5000
		Quantitative	Population exposed to nightime noise 48dB	7050	6650	7650	7250	5450	6600	8050
		Quantitative	Population exposed to nightime noise 45dB	20950	23400	22550	24950	11050	23350	27800
Secondary Metrics	**Number of Houses per dB level, nearest 50**	**Level**	**WebTAG assessment**	**AN**	**CN**	**AP**	**CP**	**AR**	**CR**	**Baseline**
		Quantitative	Number of houses exposed to daytime noise 72dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to daytime noise 69dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to daytime noise 66dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to daytime noise 63dB	50	50	50	50	<50	50	50
		Quantitative	Number of houses exposed to daytime noise 60dB	650	650	700	700	150	600	700
		Quantitative	Number of houses exposed to daytime noise 57dB	1850	1850	1850	1850	1350	1850	2050
		Quantitative	Number of houses exposed to daytime noise 54dB	2700	2700	2700	2700	2250	2700	3100
		Quantitative	Number of houses exposed to daytime noise 51dB	5700	6300	6400	7100	3750	6200	7550
		Quantitative	Number of houses exposed to nightime noise 72dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to nightime noise 69dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to nightime noise 66dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to nightime noise 63dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to nightime noise 60dB	<50	<50	<50	<50	<50	<50	<50
		Quantitative	Number of houses exposed to nightime noise 57dB	100	100	100	100	0	100	150
		Quantitative	Number of houses exposed to nightime noise 54dB	1200	1350	1200	1350	550	1350	1250
		Quantitative	Number of houses exposed to nightime noise 51dB	2050	1950	2050	1950	1600	1950	2250
		Quantitative	Number of houses exposed to nightime noise 48dB	3150	2950	3400	3250	2450	2950	3600
		Quantitative	Number of houses exposed to nightime noise 45dB	9450	10550	10300	11400	5000	10550	12750
Secondary Metrics	**No of Large Users per dB level**	**Level**	**WebTAG assessment**	**AN**	**CN**	**AP**	**CP**	**AR**	**CR**	**Baseline**
		Quantitative	No of Large Users exposed to daytime noise 72dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to daytime noise 69dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to daytime noise 66dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to daytime noise 63dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to daytime noise 60dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to daytime noise 57dB	8	8	8	8	<5	8	8
		Quantitative	No of Large Users exposed to daytime noise 54dB	8	8	8	8	8	8	8
		Quantitative	No of Large Users exposed to daytime noise 51dB	14	15	18	19	8	14	19
		Quantitative	No of Large Users exposed to nightime noise 72dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 69dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 66dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 63dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 60dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 57dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 54dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 51dB	<5	<5	<5	<5	<5	<5	<5
		Quantitative	No of Large Users exposed to nightime noise 48dB	8	8	9	9	8	8	8
		Quantitative	No of Large Users exposed to nightime noise 45dB	20	22	19	21	11	21	24

A5 Annex 5 LAeq Noise Contours for all Options

The LAeq 16hr (day) and 8hr (night) noise contours for each of the six proposed options A-N, A-P, A-R, C-N, C-P, C-R are provided below.



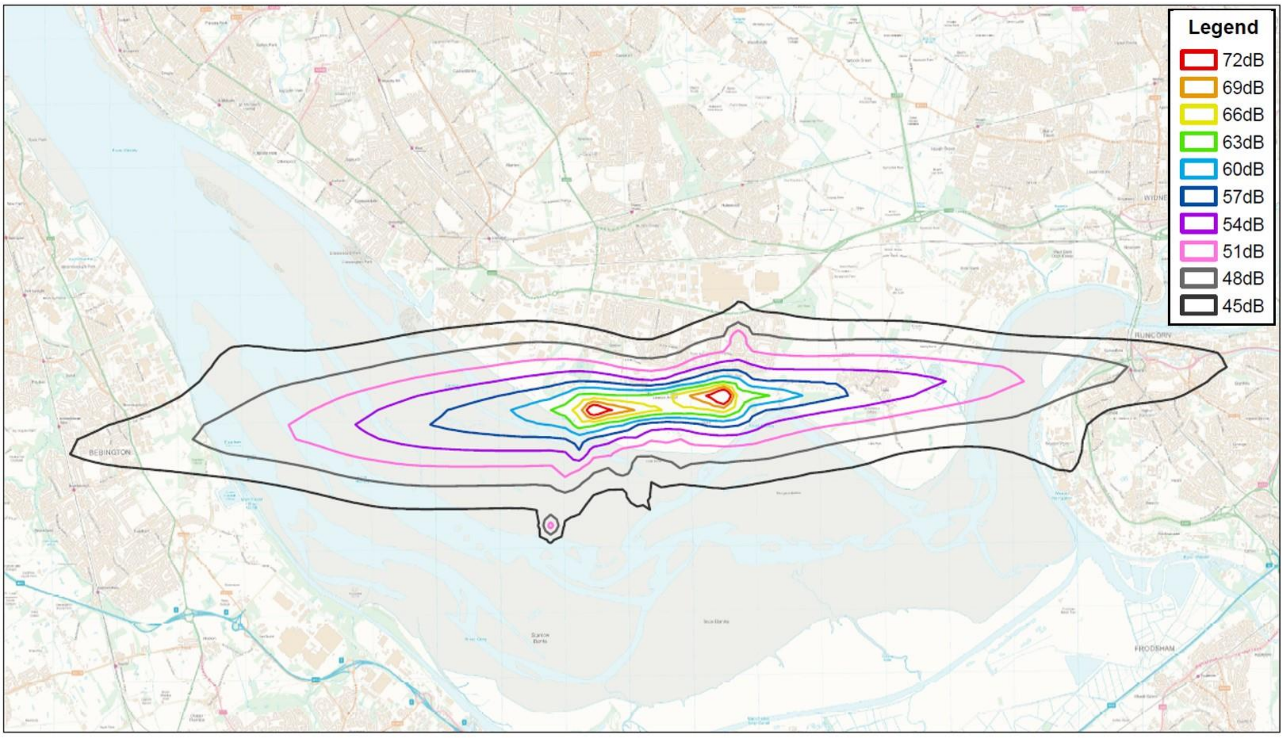
Liverpool John Lennon Airport
Options A - N - 2031 16 Hr LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES
Contains OS data © Crown Copyright and database right (2019)

0 0.65 1.3 1.95 2.6 Kilometers

N W E S

Osprey Ref: Options2031ANLEQ16
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options A - N - 2031 8 Hr LAeq

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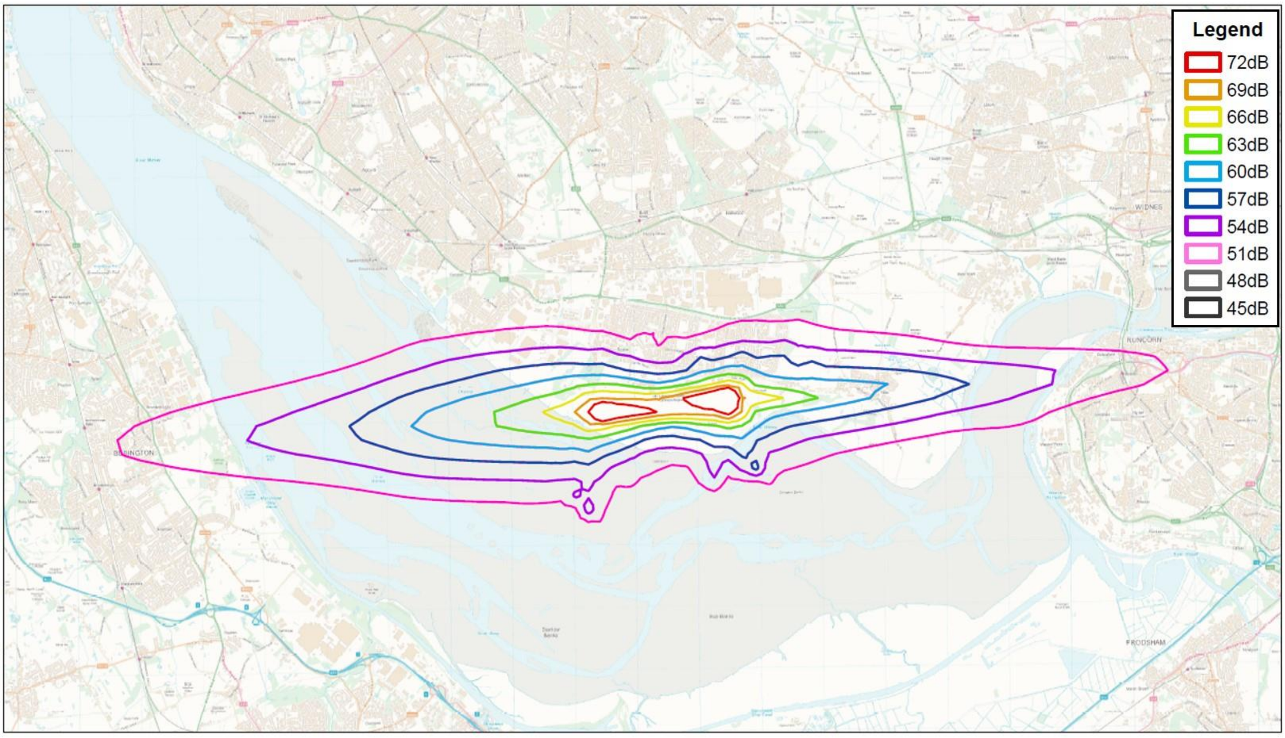
0 1 2 3 4 Kilometers

Osprey Ref: Options2031ANLEQ8
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options C - N - 2031 16 Hr LAeq

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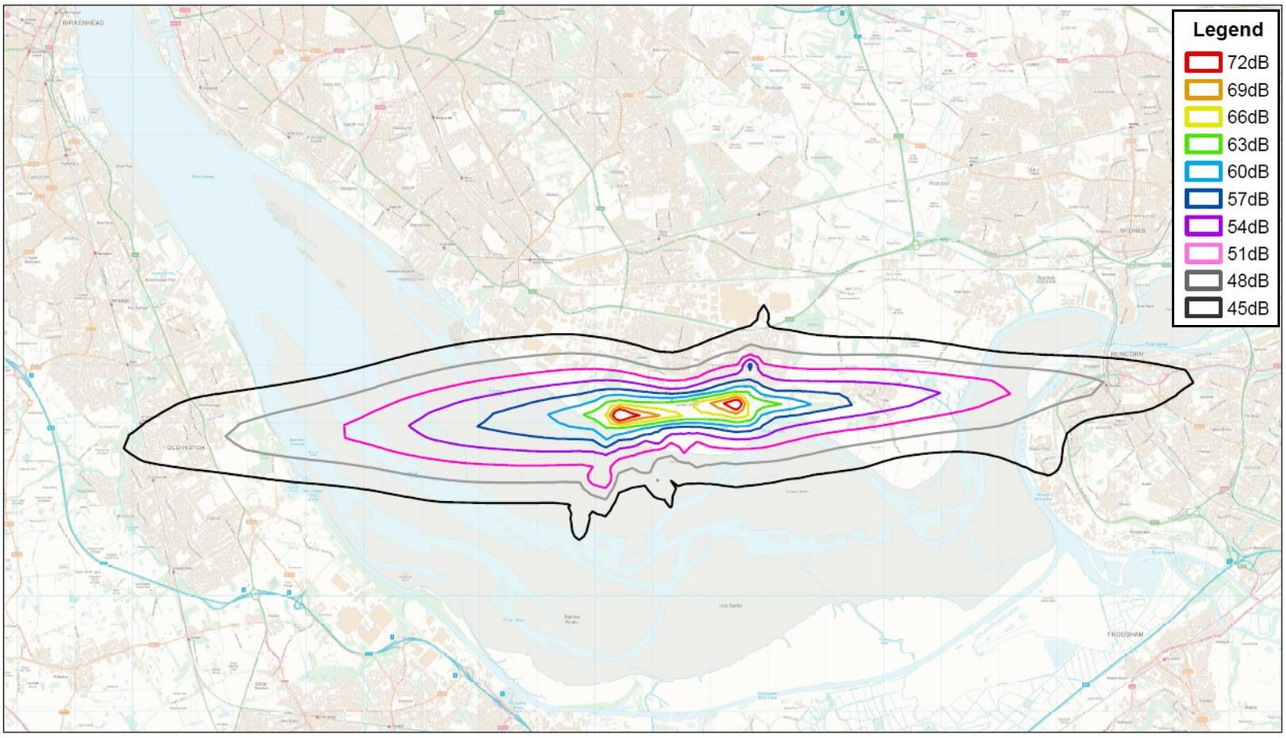
0 0.7 1.4 2.1 2.8 Kilometers

Osprey Ref: Options2031CNLEQ16
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options C - N - 2031 8 Hr LAeq

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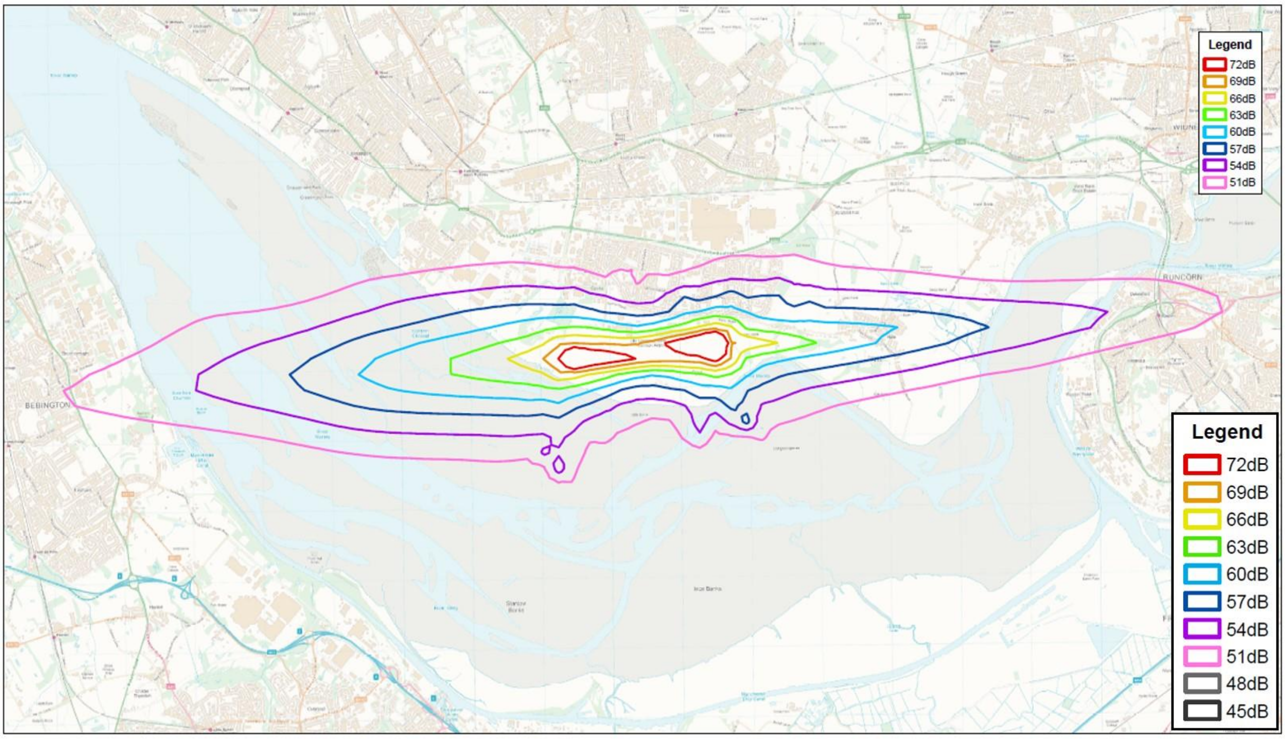
0 0.45 0.9 1.35 1.8 Kilometers

Osprey Ref: Options2031CNLEQ8
Version: 1.0
Date: 11th November 2019
Client: Liverpool John Lennon Airport

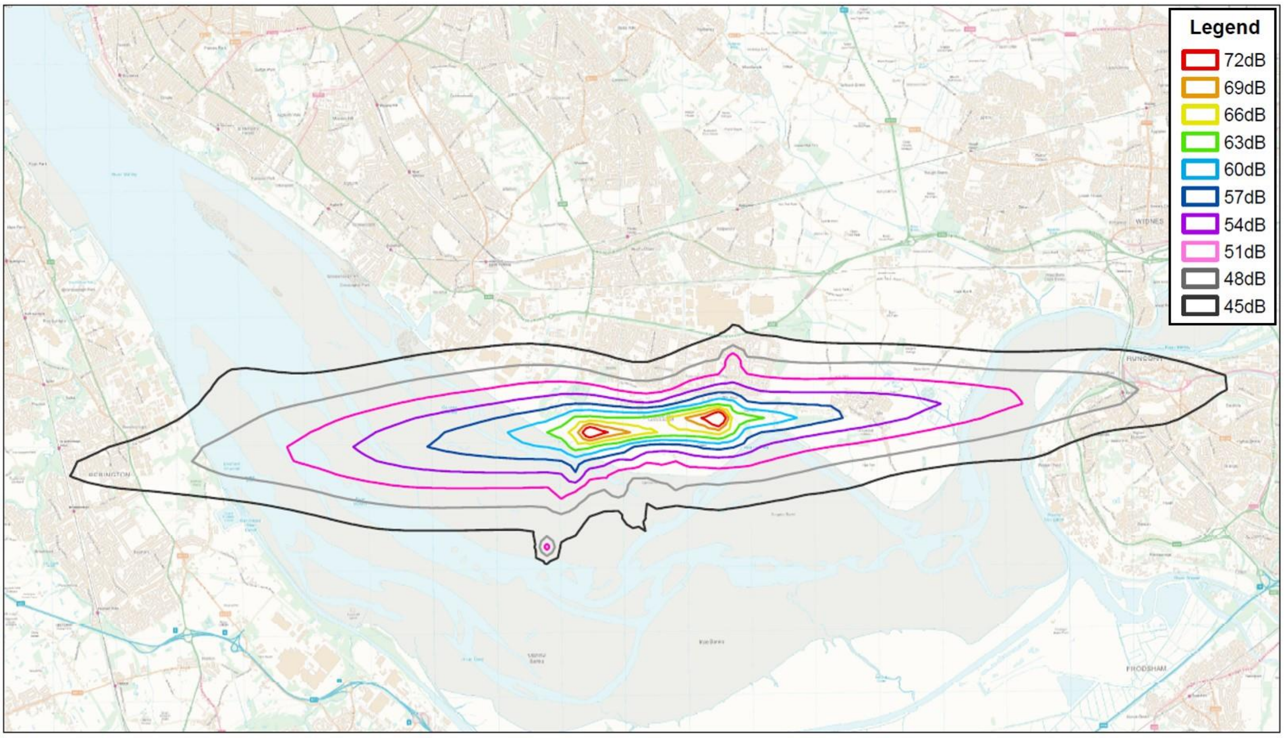


Liverpool John Lennon Airport
Options A - P - 2031 16 HR LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES

Kilometers 0 0.65 1.3 1.95 2.6

Osprey Ref: Options2031APLEQ16
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport

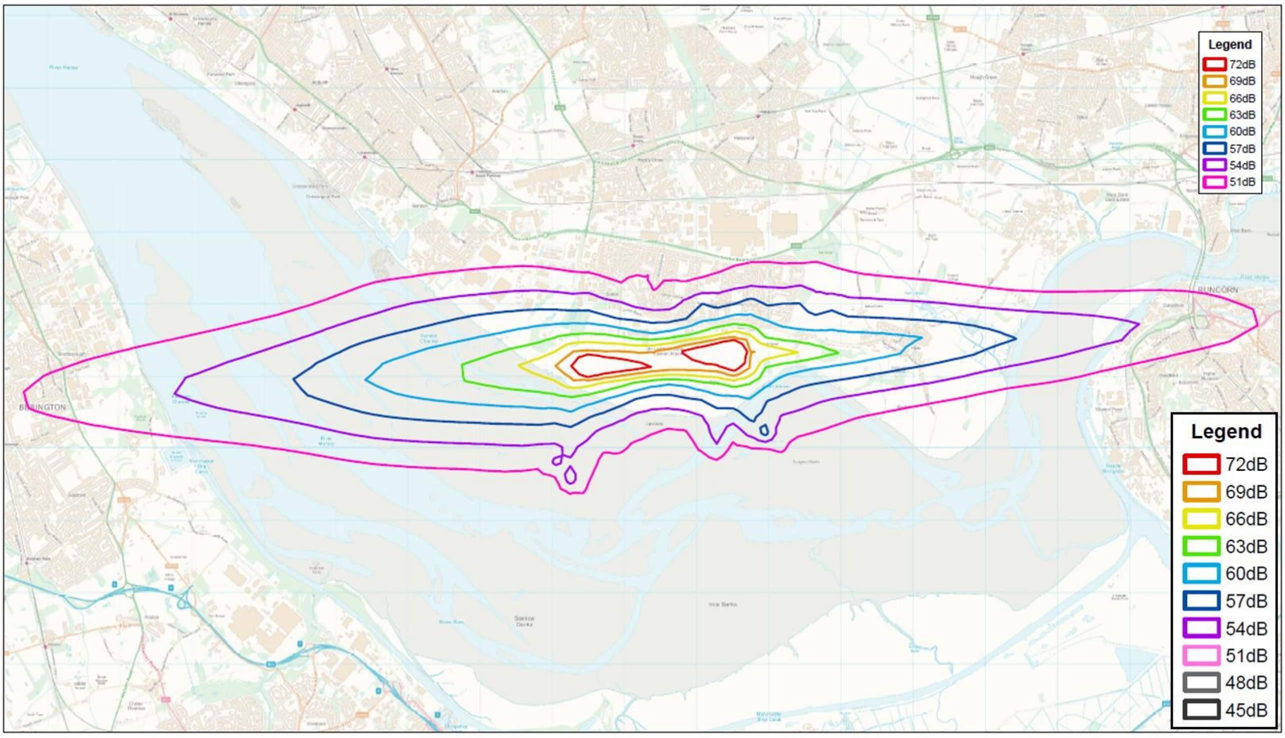


Liverpool John Lennon Airport
Options A - P - 2031 8Hr LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES

Kilometers 0 0.7 1.4 2.1 2.8

Osprey Ref: Options2031APLEQ8
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options C - P - 2031 16 Hr LAeq

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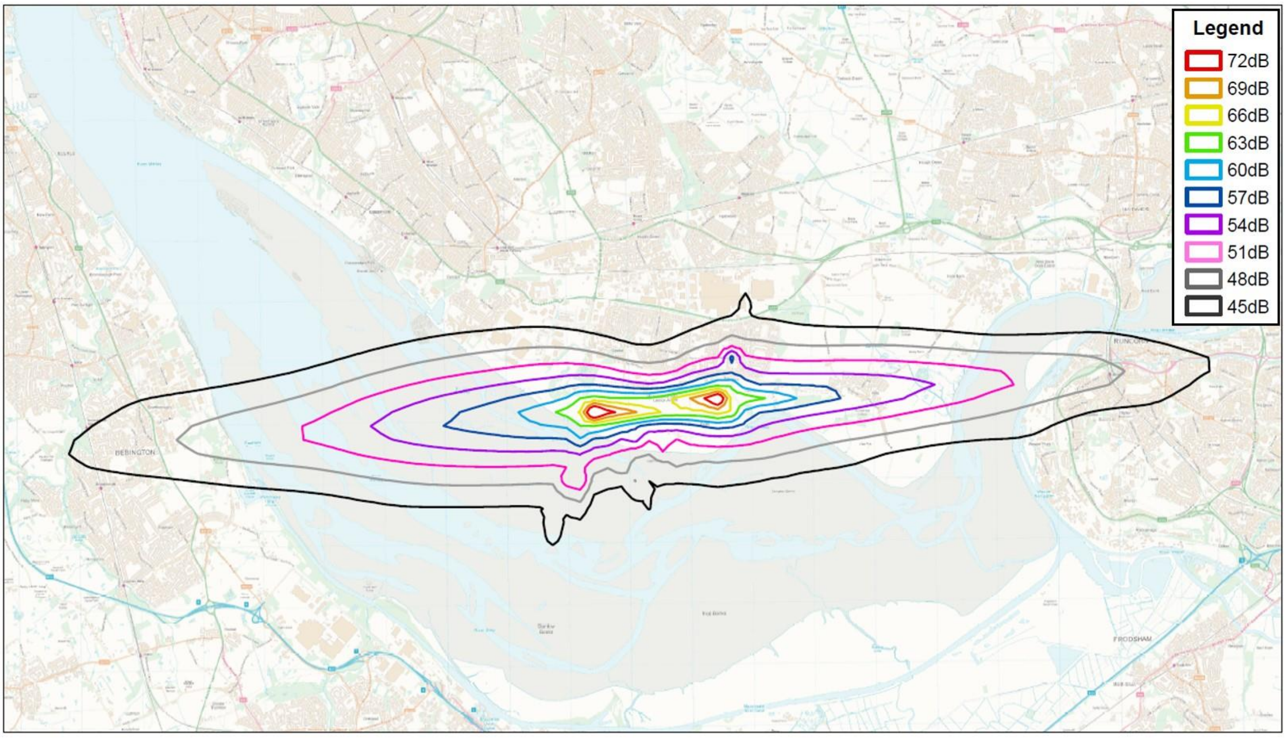
Kilometers: 0 0.45 0.9 1.35 1.8

N W E S

Osprey Ref: Options2031CPLEQ16
Version: 1.0
Date: 11th November 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options C - P - 2031 8 Hr LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES
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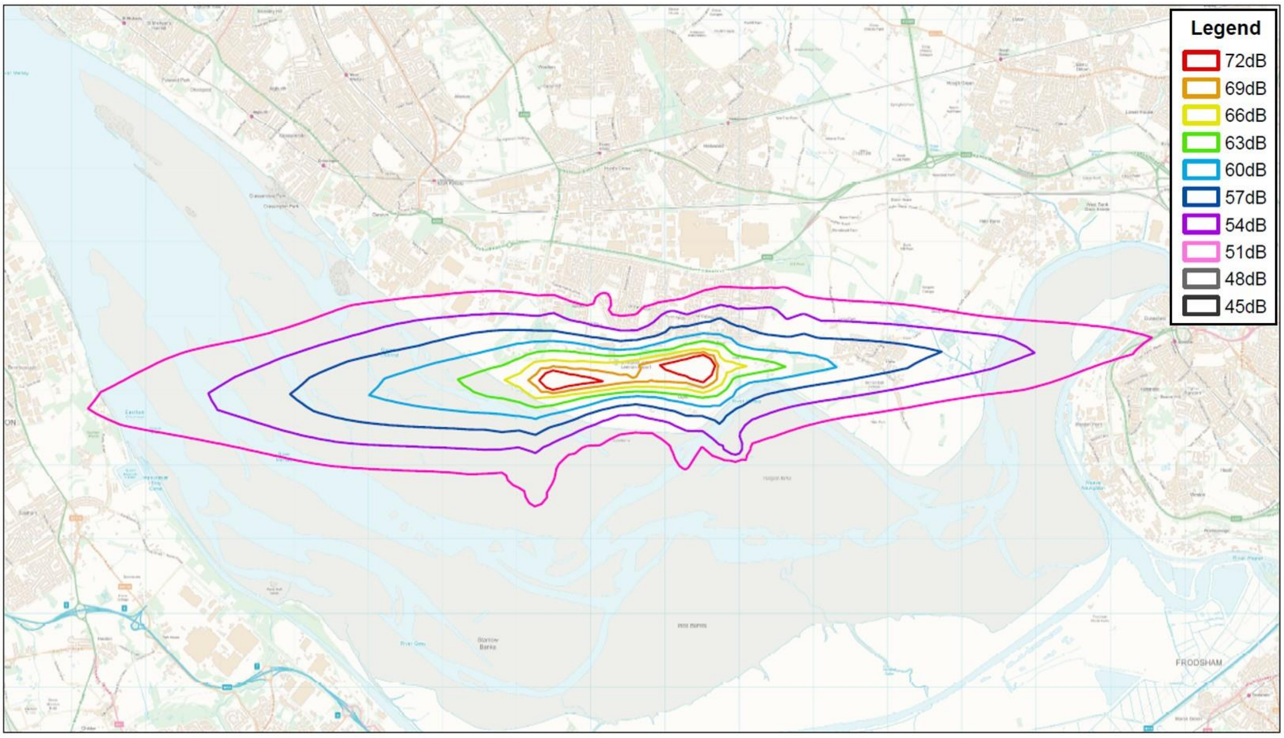
Kilometers: 0 0.7 1.4 2.1 2.8

N W E S

Osprey Ref: Options2031CPLEQ8
Version: 1.0
Date: 11th November 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options A - R - 2031 16 Hr LAeq

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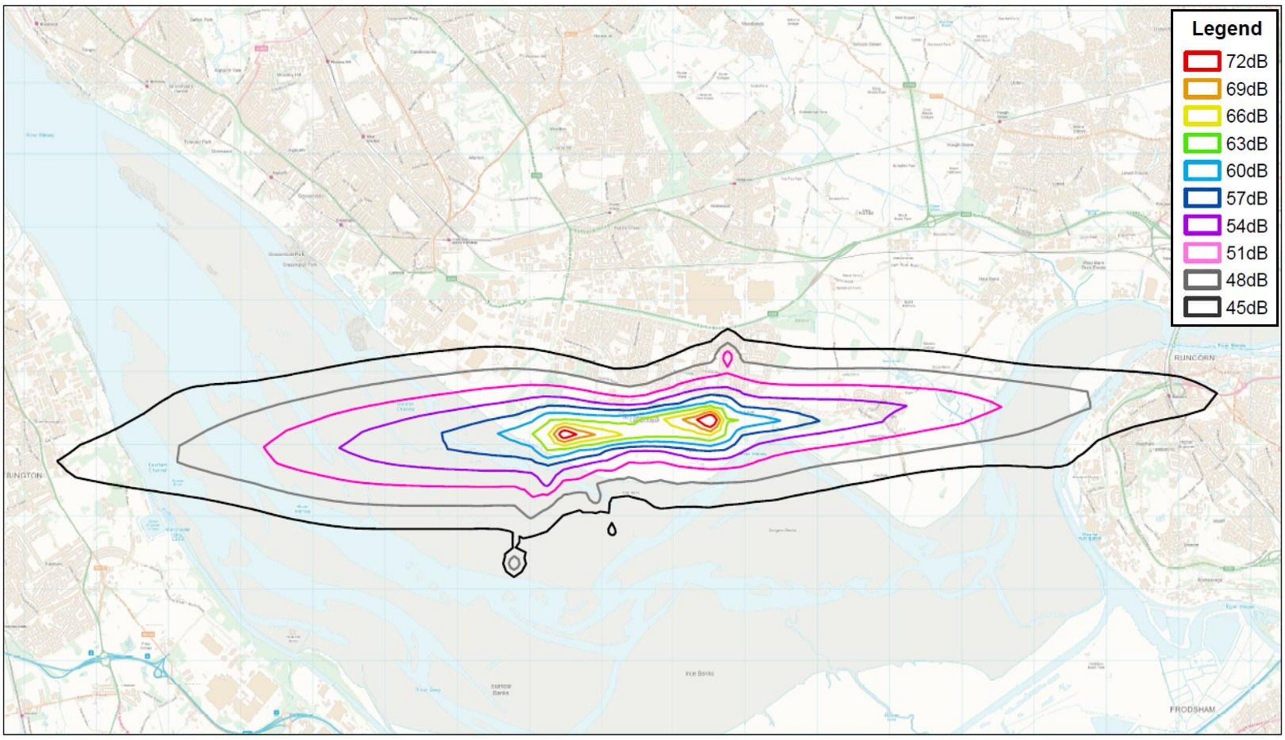
0 0.35 0.7 1.05 1.4 Kilometers

Osprey Ref: Options2031ARLEQ16
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options A - R - 2031 8 Hr Leq

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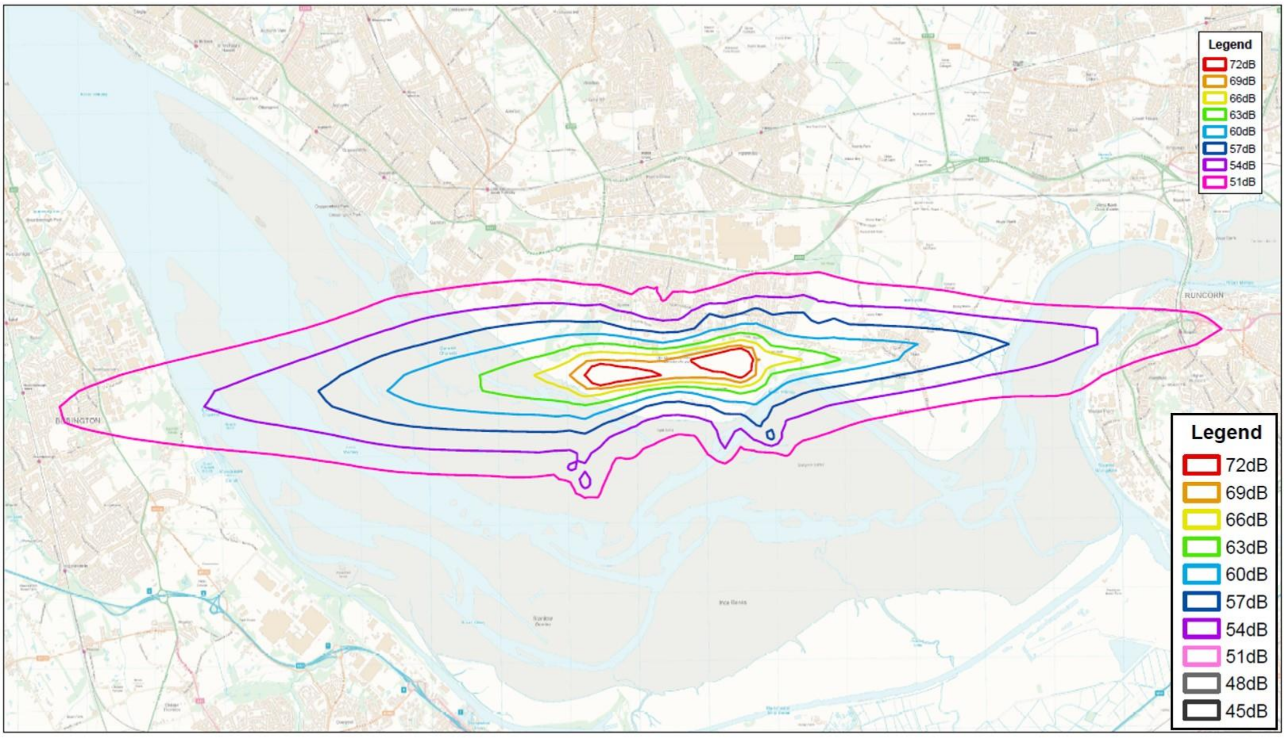
0 0.45 0.9 1.35 1.8 Kilometers

Osprey Ref: Options2031ARLEQ8
Version: 1.0
Date: 31st October 2019
Client: Liverpool John Lennon Airport

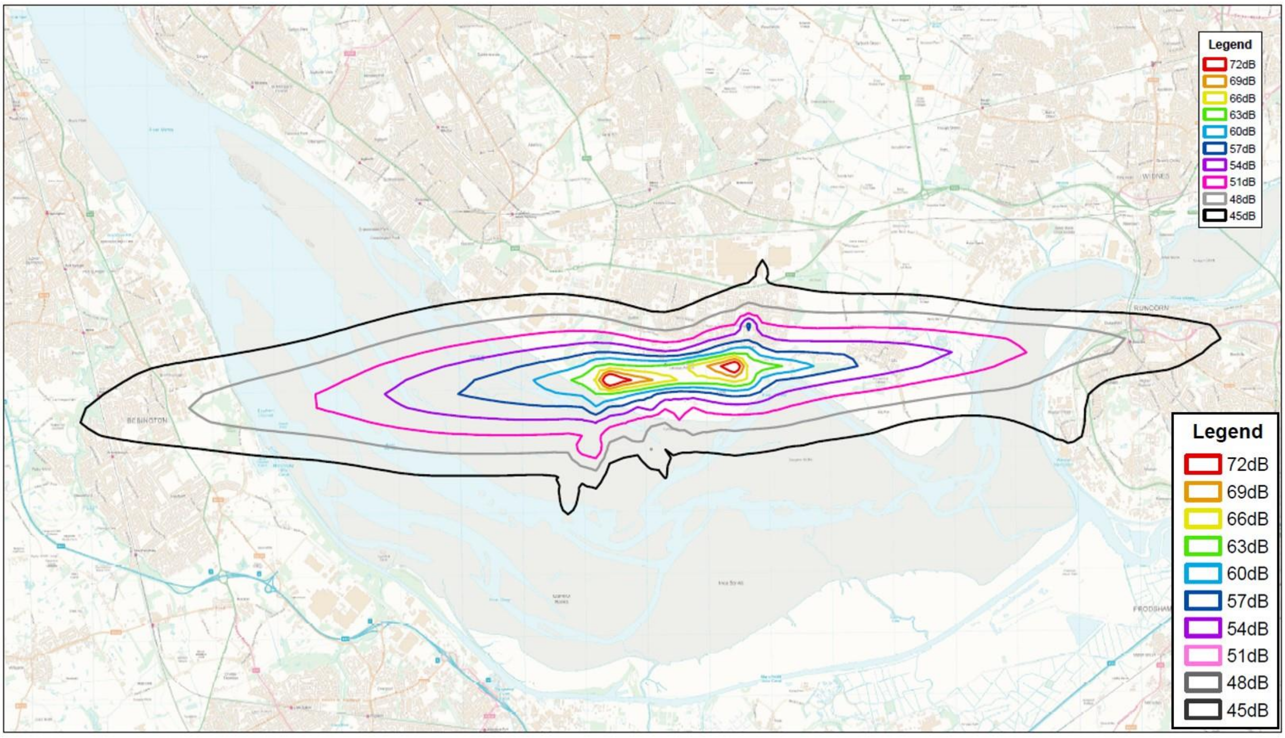


Liverpool John Lennon Airport
Options C - R - 2031 16 Hr LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES

Kilometers 0 0.65 1.3 1.95 2.6

Osprey Ref: Options2031CRLEQ16
Version: 1.0
Date: 11th November 2019
Client: Liverpool John Lennon Airport



Liverpool John Lennon Airport
Options C - R - 2031 8 Hr LAeq

DO NOT USE FOR FLIGHT PLANNING OR NAVIGATIONAL PURPOSES

Kilometers 0 0.8 1.6 2.4 3.2

Osprey Ref: Options2031CRLEQ8
Version: 1.0
Date: 11th November 2019
Client: Liverpool John Lennon Airport

A6 Overflight Metrics

A6.1 Overflight Assessment

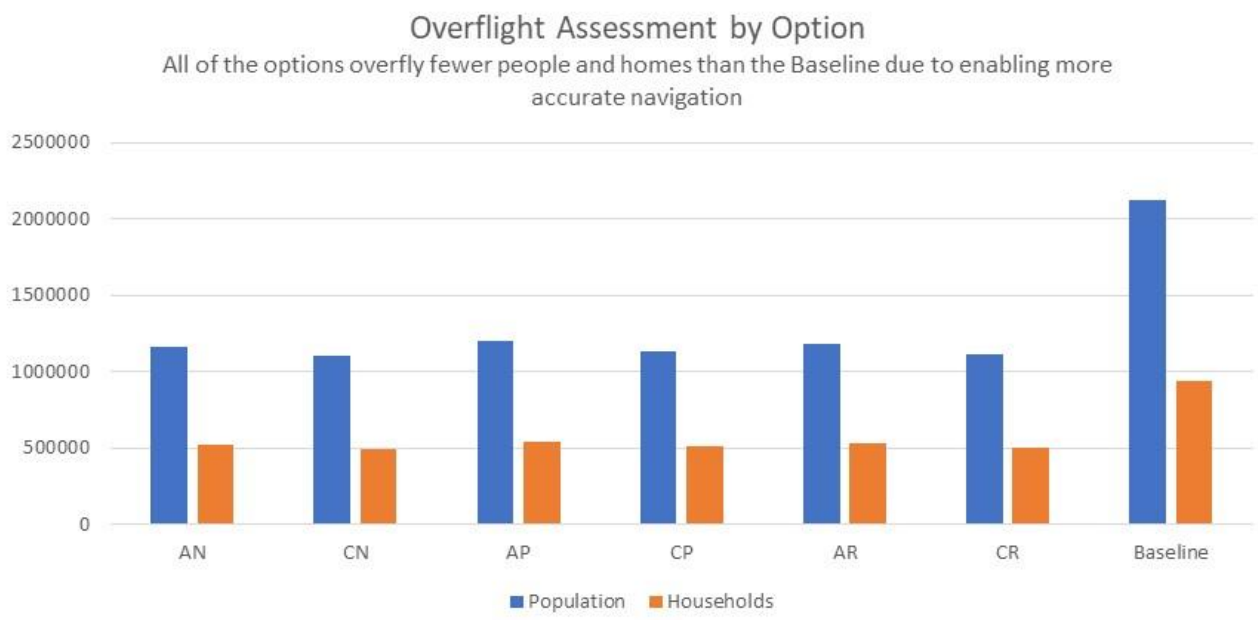
We have carried out an 'overflight' assessment to determine the number of people, homes and large users (schools, hospitals, places of worship) perceived to be overflown by aircraft in the different options. This is not a measure of noise but a demonstration of the pattern and dispersal of traffic i.e. a perception of overflight.

Measure	AN	CN	AP	CP	AR	CR	Baseline
Population overflown	1,166,250	1,098,650	1,199,000	1,136,450	1,184,500	1,116,900	2,127,500
House-holds overflown	521,550	490,400	536,000	507,600	529,250	498,100	941,900
Large Users overflown	1,950	1,950	2,000	1,950	2,000	1,950	3,250
Hospitals	31	30	32	31	32	31	46
Schools	468	441	479	455	476	449	748
Planned Develop-ments	262	258	261	257	261	257	312

Table 14 Overflight Assessment

A6.3 Overflight: Population and Households

The chart below shows the population and number of households perceived to be overflown in the forecast year.



A6.5 Overflight: Hospitals, Schools and Planned Developments

The chart below shows the number of hospitals, schools and new planned developments perceived to be overflown by the options and the Baseline in the forecast year.