TAYLOR | AIREY

D/020/016/015

PBN Implementation Benchmarking

March 2020

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A note on the date of publication of this report:

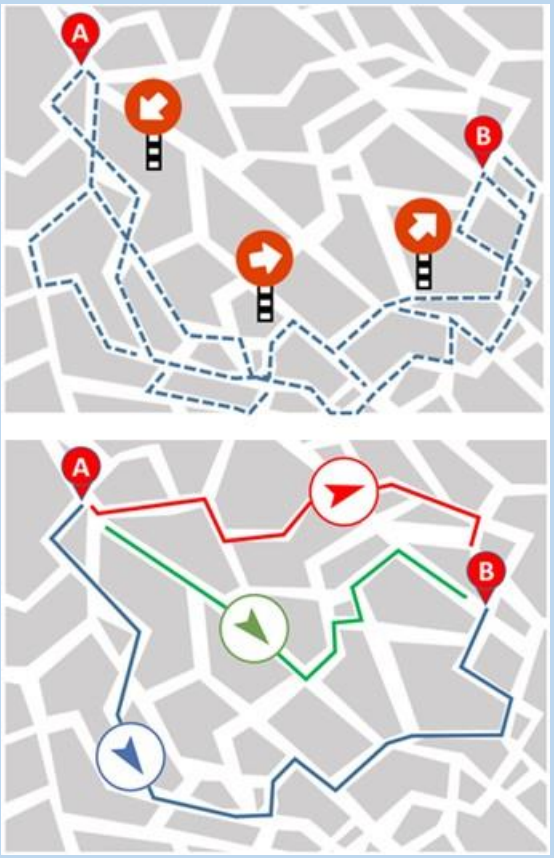
This study, on behalf of the HCNF, commenced in October 2019. A number of workshops, focused on developing this report, were held with various representatives of the HCNF between October 2019 and March 2020. The study was originally due to report at the HCNF in March 2020, however this meeting was cancelled due to the Covid-19 Pandemic.

The Covid-19 Pandemic has caused significant disruption to aviation on a global basis, including at Heathrow. As a consequence of its impact Heathrow has undergone significant changes in operations, personnel and managerial structure. The combined impact of the pandemic and these changes caused a delay in the publication of this report.

This report was reviewed, accepted and published by Heathrow in April 2022

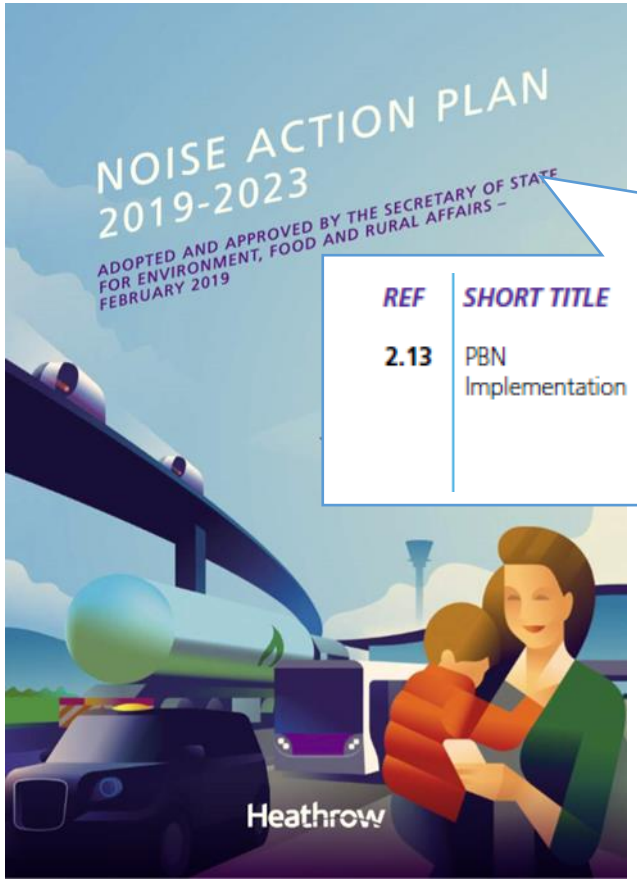
PBN is being introduced around the world, with varying approaches to design, engagement and implementation

- Around the world investments are being made in infrastructure to enhance the safety and efficiency of air navigation. A key technology supporting these programmes is Performance Based Navigation (PBN).
- PBN encompasses a shift from current ground-based navigation aids emitting signals to aircraft receivers, to systems in the aircraft that receive satellite signals.
- These signals determine the aircraft's position by meeting specific accuracy and integrity requirements
- While PBN can increase airspace efficiency by providing more direct paths, (thereby reducing aircraft fuel burn and emissions), it tends to result in aircraft flying more precisely-defined flight paths. This can exacerbate noise impacts and annoyance for communities overflown.



To understand the effects of PBN we can draw an analogy with conventional satellite navigation, as is used in many modern vehicles. Traditional navigation through a town, from point A to point B would rely on conventional signposts; this results in a distribution of traffic across multiple routes. Introducing satellite navigation using predefined routes directs all traffic along those specific routes.

This benchmarking study was commissioned by Heathrow as part of its Noise Action Plan



Quieter Procedures

We will work with all our stakeholders to explore and employ best practice, lower noise operating procedures to reduce the impact of aircraft on residents

REF	SHORT TITLE	ACTIONS	DATE	PERFORMANCE INDICATOR	TARGET	IMPACT	COMMUNITIES AFFECTED
2.13	PBN Implementation	With the HCNF we will develop a scope for a study on the benchmarking of Performance Based Navigation (PBN) implementation including international experiences and publish a report by 2019.	2019	Scope developed	Report published	Arrivals Departures	Communities within and beyond 55dB L_{den}

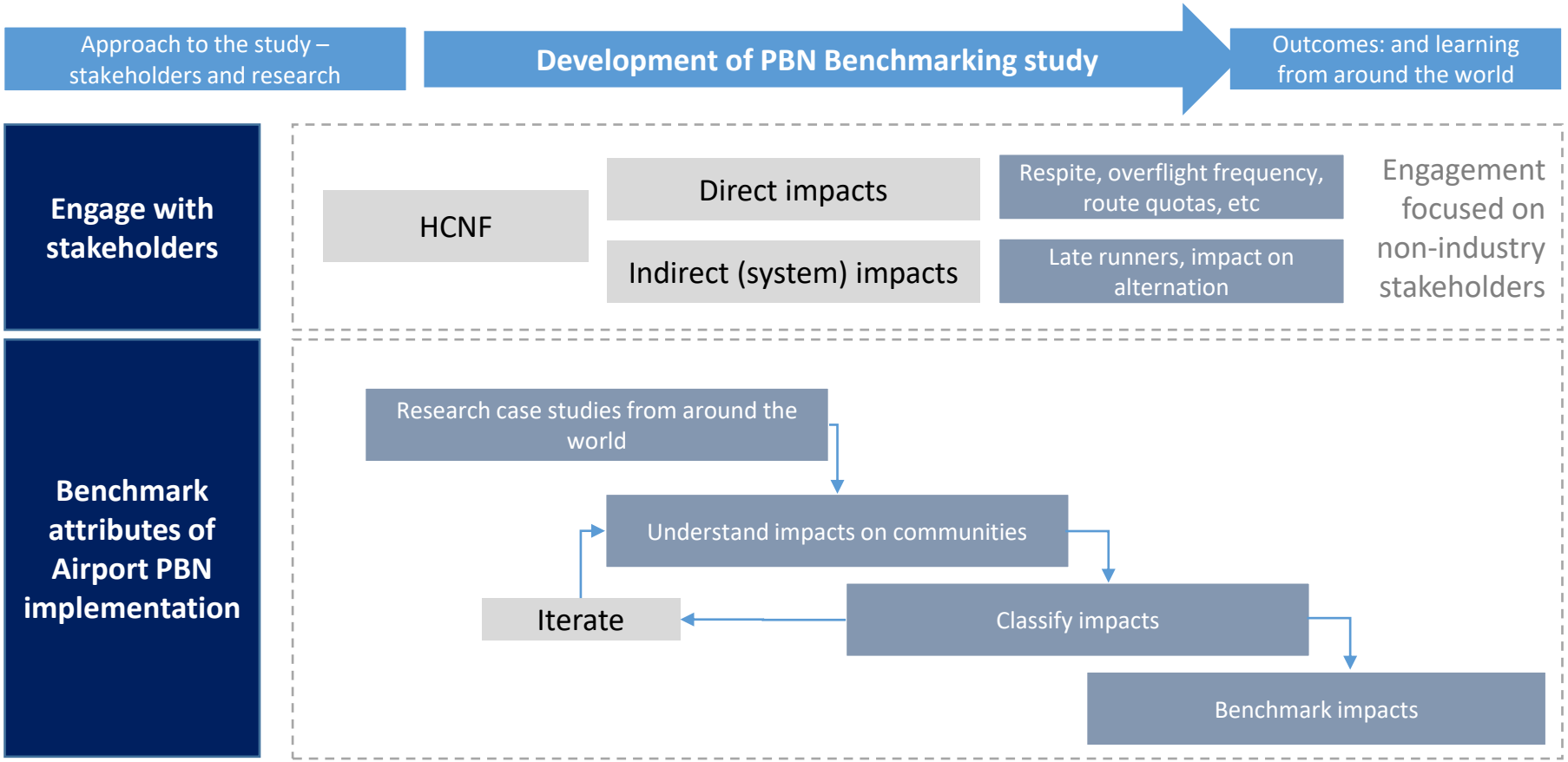
- Develop a common understanding of PBN
- Understand the perceptions of the stakeholder communities to PBN
- Identify good and bad practice in
  - PBN design
  - stakeholder engagement and
  - implementation
- Perform benchmarking analysis and case studies to:
  - draw conclusions
  - make recommendations

The approach to this study was informed and shaped by engagement with members of the HCNF*

PBN explanation & selection of peer group	Develop a common explanation of PBN and outline implications for airspace design Provide list of comparator airports and rationale
Benchmarking - Policy & Design	Consider the approach to PBN implementation from policy development to impact assessment. Questions to address: is there a clear policy on concentration vs dispersion? Has respite been considered and, if so, how is this defined?
Benchmarking - Communication	Consider how airspace changes are communicated, stakeholders engaged and feedback sought through consultation
Results	Benchmarking results - all airports provide learning opportunities with those at the extremes providing examples of good and bad practice
Conclusions	Key findings and recommendations for the future

* Heathrow Community Noise Forum

The study drew information from Heathrow's community stakeholders and desk-based research on other airports



HCNF provided feedback on Heathrow's engagement on airspace to date, and suggested comparator airports

- Four stakeholder workshops were held with members of the HCNF during the course of this study, each attended by 2-6 members of the HCNF. An email address was set up to support this
- Each workshop discussed PBN and the proposed framework for this study, and gathered feedback on the proposed assessment categories
- The key areas of concern from communities focused on the potential impact of flightpath concentration
- An update workshop was held with members of the HCNF in February 2020 where details of the assessment criteria were shared, although the benchmarking itself was conducted independently by Taylor Airey
- In response to the points raised in these workshops, London City was included as a case study. Note this case study was added after the benchmarking exercise had been completed

Comparator airports have implemented PBN and have information publicly available

- We have included comparator airports that:
  - Are implementing PBN
  - Have attracted a high level of protest or are relatively open/transparent with public data available
  - Provide learning opportunities for Heathrow and are comparable in size
- We analysed airspace changes at a city level since the airspace changes generally covered multiple airports (e.g. all New York airports)

- **UK:** Heathrow
- **North America:**
  - **East:** New York, Washington DC, Boston
  - **West:** Los Angeles, San Francisco, Seattle
  - **Central:** Phoenix (PBN rescinded), Chicago, Denver, Charlotte
  - **Canada:** Vancouver, Toronto, Calgary
- **Europe:** Amsterdam, Vienna

Available information

Significant publicity

Useful Heathrow comparators

- **Europe:** Frankfurt
- **Asia-pacific:** Sydney, Brisbane, Auckland
- As a result of community workshops London city was included as a case study

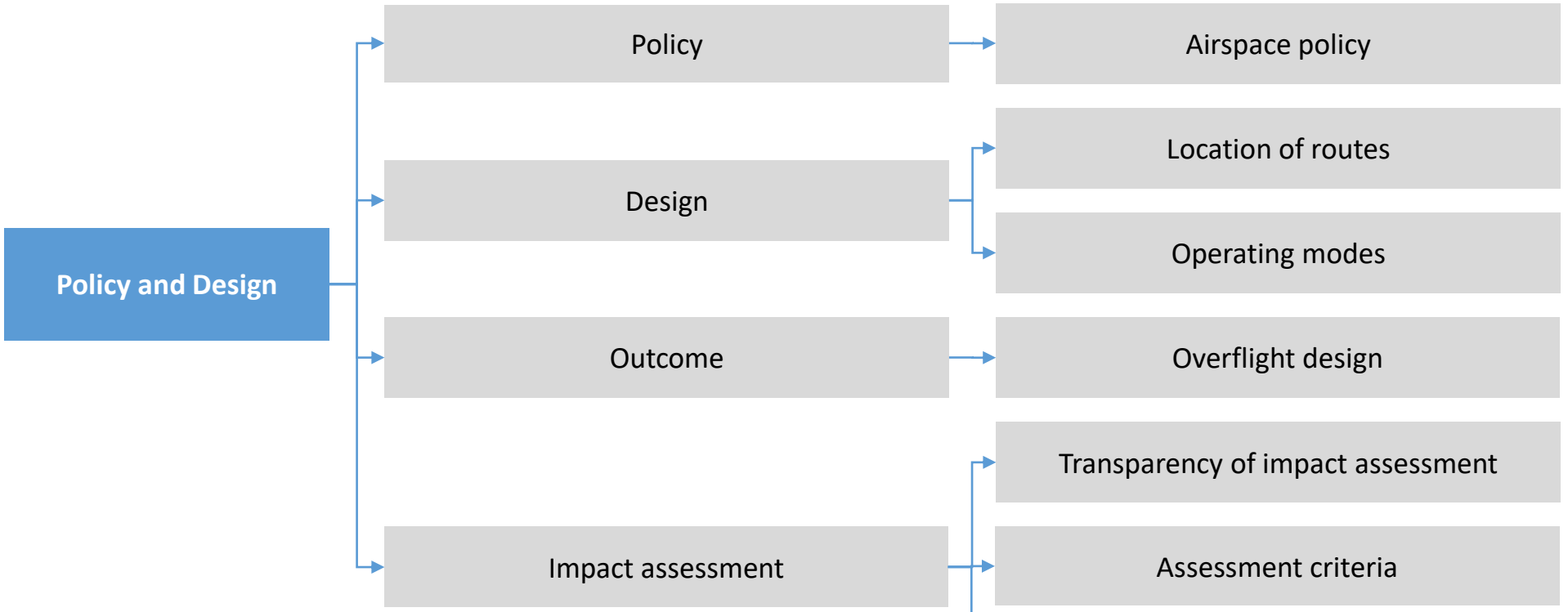
Recommended from community workshops

Benchmarking focussed on policy, design and communications

- An initial set of benchmarking categories was developed and shared with HCNF members via four community workshops
- The proposed benchmarking framework was revised following community feedback, to focus on areas most relevant to the Heathrow experience

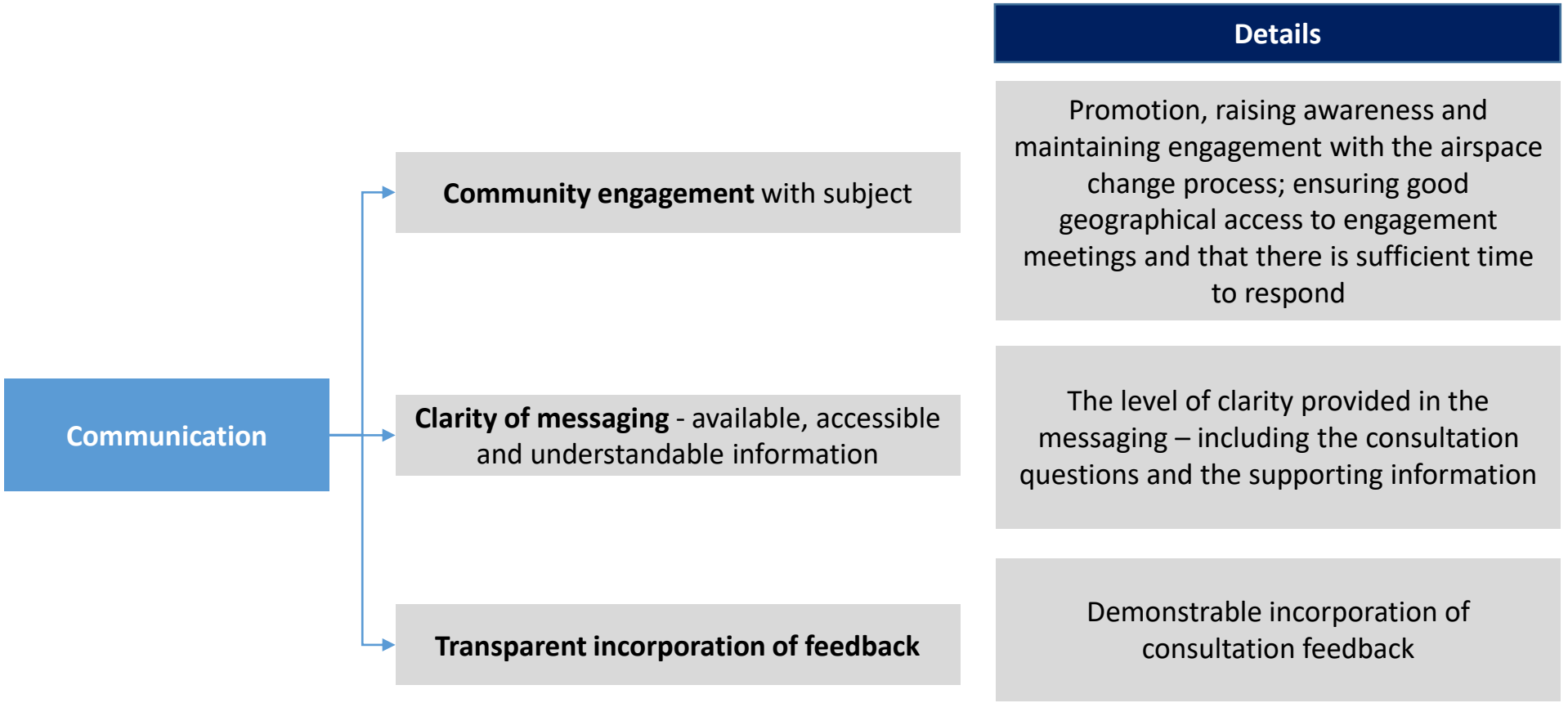
Heathrow was included in the benchmarking, despite not having implemented any PBN routes at the time of the study: the scores applied to Heathrow are therefore based on early indications of Heathrow's approach to design and engagement on the airspace change proposals underway in 2019-20 (Compton, IPA and Expansion)

We assessed the presence of suitable PBN policy and how that policy is then reflected in the airspace design



Note 1: Details of the scoring criteria applied to each category are found in Appendix II. Note 2: The categorisation of benchmarks was updated in response to workshop output during the study. Those previously discussed can be found in Appendix III for reference. Note 3: Although the categories have changed the same issues are covered by this new framework, as detailed in Appendix II.

We assessed the adequacy of engagement with local communities and how feedback is reflected in the design



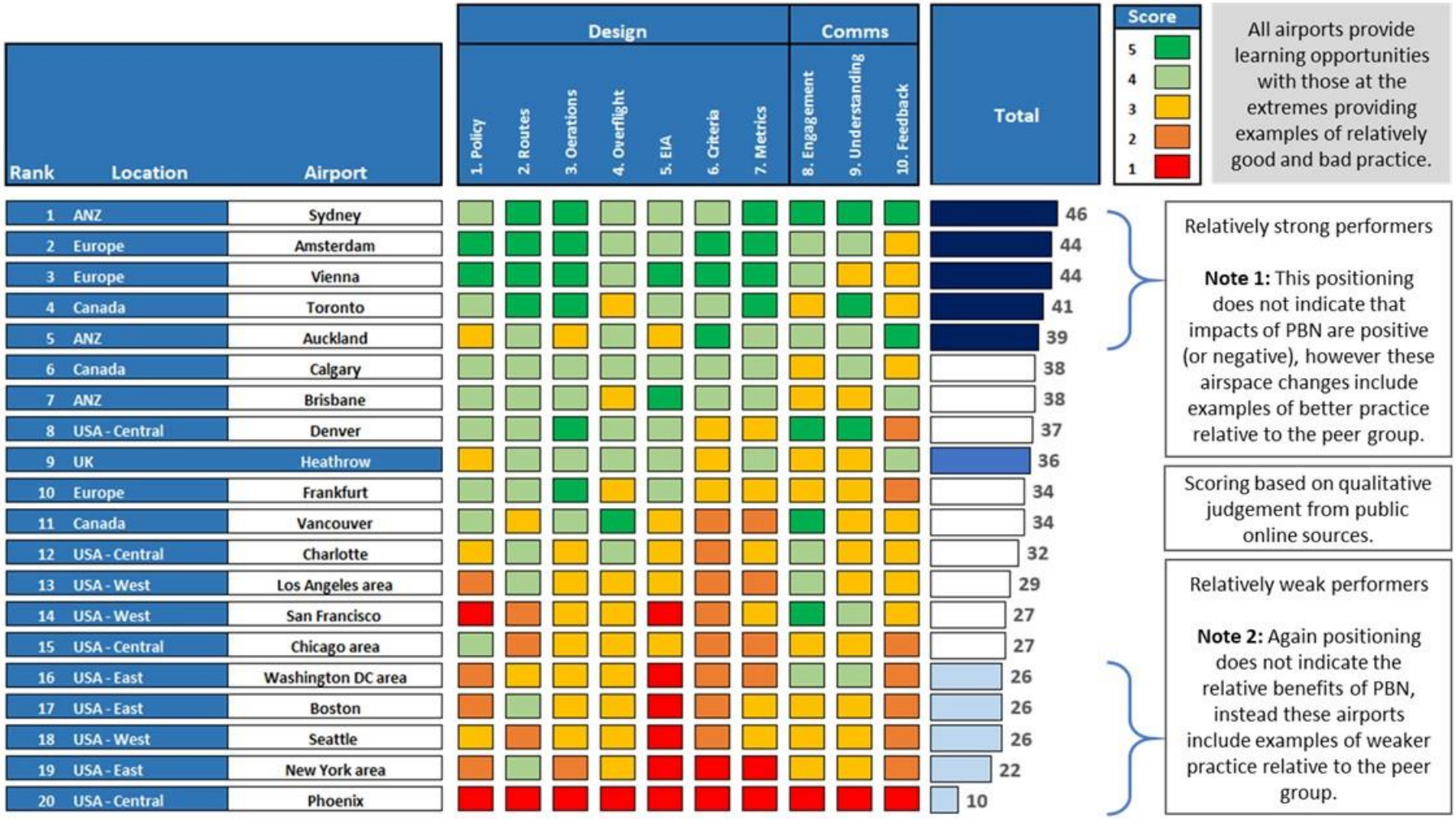
Note : Important lessons can be learnt from a recent FAA review of US PBN implementation, outlined in Appendix V. An example of good communications around airspace changes include emerging use of innovative technologies and the community workshops around the Compton Airspace change; PBN Mitigation presented in CAA CAP1378 also provides a useful starting point.

Twenty airports, including Heathrow, were assessed across ten categories

Assessment Criteria		
1	Airspace policy	What national and local policy was in force during the development of the airspace changes?
2	Location of routes	What consideration was given to minimising noise (and emissions) when designing location of routes?
3	Operating modes	What consideration was given to minimising noise (and emissions) when designing operation of routes?
4	Overflight design	How effective is the airspace design at offering respite for overflown communities? (i.e. the outcome from categories 2 and 3, based on real-world impacts or modelled outcomes)
5	Transparency of impacts	How open and transparent was the airport about the likely environmental impacts of the proposed design?
6	Assessment criteria	How detailed and appropriate was the assessment of impacts?
7	Metrics	How suitable were the metrics used in the assessment?
8	Community Engagement	How effective was the promotion and awareness raising of the airspace change?
9	Understanding	How accessible and understandable was the community engagement material?
10	Use of feedback	Was community feedback demonstrably included in the subsequent airspace design?

Lessons can be learned from the best and worst performers

Appendix II provides details of the scoring criteria for each category



All airports provide learning opportunities with those at the extremes providing examples of relatively good and bad practice.

Relatively strong performers

Note 1: This positioning does not indicate that impacts of PBN are positive (or negative), however these airspace changes include examples of better practice relative to the peer group.

Scoring based on qualitative judgement from public online sources.

Relatively weak performers

Note 2: Again positioning does not indicate the relative benefits of PBN, instead these airports include examples of weaker practice relative to the peer group.

Heathrow's scores placed them middle of the table, based on policy, design and communication on ACPs to date

Assessment Criteria		Score	Rationale
1	Airspace policy	3	While there is a detailed policy framework and guidelines in place describing how to consult with those affected by the airspace changes (i.e CAP1616) no definitive position on policy objectives is offered by CAA or Government (e.g concentration of noise over existing routes vs maximum dispersal etc.)
2	Location of routes	4	Heathrow has considered multiple approaches to delivering respite, including multiple PBN routes and airspace alternation. However noise and overflight objectives are not closely defined in UK Government policy.
3	Operating modes	4	Heathrow indicated consideration of using flight path alternation (where dispersed PBN flight paths are used for set periods on a predictable basis) under design principle 6c. "Maximising sharing through predictable respite"
4	Overflight design	4	Heathrow's design principle 6d included avoiding overflying communities with multiple routes, including consideration of routes to/from other airports. Heathrow's design envelopes suggest investigation of 'switching off' sections of airspace to provide respite.
5	Transparency of impacts	4	As part of the CAP1616 process and the Airports National Policy Statement (ANPS), Heathrow is required to use a robust methodology that considers spatial planning, airspace management and environmental management.

Heathrow's scores placed them middle of the table, based on policy, design and communication on ACPs to date

Assessment Criteria		Score	Rationale
6	Assessment criteria	3	Heathrow had not, at the time of assessment, published graphics or resources in addition to noise contours to illustrate overflight intensity and typical height over the ground (e.g. Google earth files)
7	Metrics	4	In relation to noise, the Airports NPS (National Policy Statement) requires Heathrow expansion plans to avoid adverse (negative) effects on health and quality of life and to minimise the negative effects from aircraft operating at Heathrow: Heathrow will need to evaluate using a broad range of metrics
8	Community Engagement	3	Heathrow had not, at the time of assessment, designed targeted campaigns in the areas to be affected by the changes, since no route locations had yet been developed
9	Understanding	3	Heathrow had not, at the time of assessment, provided a clear and understandable explanation of airspace changes via an easy to navigate website. Instead the Heathrow website mainly provided a repository of .pdf files of varying degrees of detail that were difficult to cross-reference
10	Use of feedback	4	Involvement of community in the design of airspace routes for the proposed new Compton departure route was evidenced during community engagement sessions

Key findings: Policy and design

In relation to the overarching policy & design of PBN-related airspace change:

- The **overarching policy objectives** of PBN must be clearly articulated. There is a lack of an evidence-based policy framework in the UK, particularly in relation to the health impacts of repeated overflight
- **Routes should be located to minimise noise impact**, as per policy objectives, with impacts assessed in line with international standards and supported by a reliable and verifiable evidence base
- **Operating modes** used on these routes should examine how:
  - Noise can be dispersed;
  - Respite can be provided for affected communities;
  - A swathe of routes might be recreated using 'managed dispersion', if possible, to help mitigate noise impact
- The **overflight impact** on all stakeholders should be calculated, assessed and communicated transparently using useful, agreed & validated metrics; this should include the use of a framework for assessing health impacts related to noise and flight path change
- **'Do nothing' should be considered** as a viable outcome of a transparent and open assessment process if it is determined that PBN implementation is detrimental overall (e.g. through WebTag analysis)
- The **analysis must be robust and traceable** and include sensitivity tests to all assumptions (which must be clear and explained). Airports should be able to demonstrate that feedback provided has been listened to and taken into account
- **Engagement must be timed appropriately** to allow for meaningful dialogue. The CAA's airspace change process can itself present challenges to building trust with communities. CAP1616 provides a process suitable for a relatively straightforward airspace change but it does not necessarily reflect the complexities inherent for a large airport such as Heathrow. For example it was noted that the CAP1616 process prevents airports from developing flight path options as early as some stakeholders would like.

Key findings: Communication and consultation

In relation to communication and consultation of PBN airspace changes:

- The **amount and quality of community engagement must be appropriate** to meet the needs of all affected stakeholders
- Readily **available**, **accessible and understandable information** must be provided
- A **sufficiency of time** must be allowed to ensure the consultation is accessible; this should be **supported by engaging websites and novel communication techniques** to encourage engagement and understanding
- The consultation must adhere to the **'Gunning' principles,** with proposals at formative stage, with sufficient information provided to give 'intelligent consideration', adequate time for consideration and response and 'concientious consideration' is given to the consultation responses before a decision is made
- Communications during airspace consultations need to be **open, honest, transparent and consistent**, pursing best practice in community engagement. It was recognised this will help to **build trust** with stakeholders. Examples of good airspace change communication materials are provided by airports in Australia and New Zealand.
- Airspace consultation websites should be reviewed for ease of access. This could be supported by a digital content strategy focused on providing **intuitive navigation** to its users (in addition to acting as a repository of .pdf documents providing a mixture of high-level summaries and detailed technical content).
- It was noted that the broad scope and size of the design envelopes consulted on by Heathrow in January 2019 restricted meaningful discussions about specific routes, designs or operating concepts as insufficient detail was available.
- There is a risk of 'over consultation' / 'over-engagement' at Heathrow; multiple airspace change projects running in parallel and additional, non-statutory, consultations taking place can result in confusion.

This study has identified recommendations for airports introducing PBN, and for UK Government

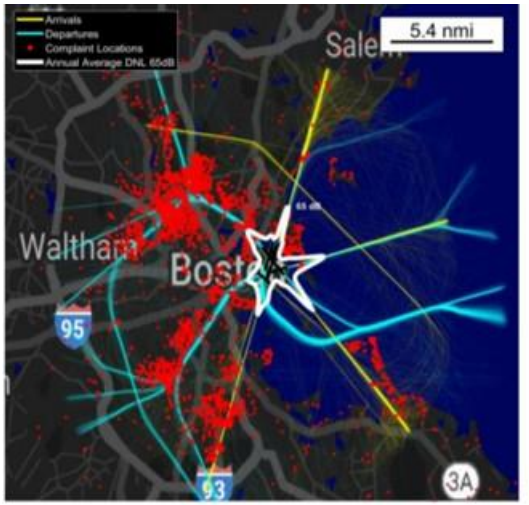
Policy	1	**Recommendation for UK Government: UK government policy offers no definitive statement on the preference for flight path dispersion/concentration and the resultant health impacts.** Currently the guidance is vague & non-committal (eg around concentration vs. dispersion; the definition of respite, etc.) Policy detail would allow all stakeholders to optimise proposals against clear objectives.
	2	**Recommendation for UK Government/UK CAA:** There is **insufficient joint sponsorship, accountability, authority and responsibility for the airspace changes affecting the London area**. The UK airspace change process has resulted in a highly fragmented and complicated situation with multiple sponsors, governance bodies and coordination groups; this makes it difficult for sponsors and confusing/burdensome for stakeholders. More robust governance is needed. FMS limitations to multiple PBN routes should be challenged in appropriate governance groups (eg ACOG).
Design / Assessment	3	**Recommendation for UK Government & airspace change sponsors:** The **standard metrics used to assess noise** (and to a lesser extent local air quality) **impact are under strong challenge**, as is their **transparency and relevancy**. More meaningful metrics are needed, responsive to the needs of the affected community.
Engagement	4	**Recommendation for airspace change sponsors:** Engagement is a continuous process and relies on honesty, transparency and empathy. The **earlier in the process that flight paths are identified** and **the affected communities are engaged in a genuine consultation, the greater is the opportunity to take feedback into account and modify the design**. This relies on targeted communications to affected communities and a willingness to be open with all stakeholders.

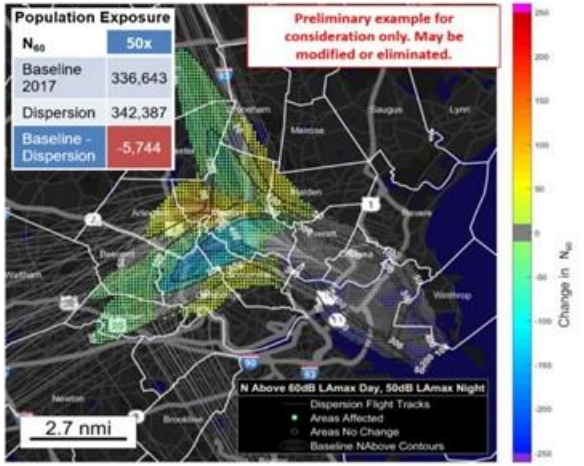
Supporting Material

- Appendix I. Explaining PBN & its impacts
- Appendix II. Benchmarking assessment criteria
- Appendix III. Initial assessment categories
- Appendix IV. Case studies
  - Case study 1. London City
  - Case study 2. Auckland
  - Case study 3. Sydney
  - Case study 4. Vienna
- Appendix V. US PBN Summary
- Appendix VI. Examples of good practice in airspace change communications

There are a number of areas where future work could inform effective PBN implementation

- Further work should be conducted by public and private organisations, in collaboration with Government & public health bodies where necessary, examining the health impacts of concentrated/dispersed flight paths
- Public and private bodies must work together for the collaborative development of meaningful metrics to help communities understand the impacts of flight path change, with particular reference to the appropriateness of noise contours and 'average' impacts
- More detailed forecasting of future flight path impacts is required, using local population & flight data to help quantify the impact to communities (e.g. as illustrated on this slide – showing the *change* in noise impact)
- Best practice guidelines around PBN engagement strategy should be developed, identifying:
  - **How websites and meetings can be engaging and accessible** for a wide audience and tailored to specific needs, learning lessons from implementations in the US, Europe and elsewhere
  - **Who should be targeted for engagement**, at what point and how (traditional mailshots, community based events, websites, etc.). Heathrow should consider what opportunities exist to ensure consultations are targeted to those likely to be impacted
  - **How airspace change sponsors can develop and use novel technologies to best communicate change**
- The responsibility for these areas of future work should be coordinated across the stakeholders involved in this work (Airports, ANSPs, Government, Regulator and Communities)





Pictures sourced from: 13th USA/Europe Air Traffic Management Research and Development Seminar (ATM 2019), Advanced Operational Procedure Design, Concepts for Noise Abatement, Hansman et al. Massachusetts Institute of Technology Cambridge, MA, USA; RTCA Blueprint Community Outreach Task Group, Approved by the NextGen Advisory Committee June 2016

Appendix I – Explaining PBN

What is PBN?

Background	Around the world large investments are being made in infrastructure and systems to make sure growing volumes of air traffic are managed safely and efficiently. A key technology tool supporting these programmes is Performance Based Navigation (PBN).
Technology	PBN encompasses a shift from current ground-based navigation aids emitting signals to aircraft receivers, to systems in the aircraft that receive satellite signals (such as the United States' Global Positioning System [GPS] - the European Union, Russia and China also have such systems) These signals determine the aircraft's position by meeting specific accuracy and integrity requirements.
How it works	**There are two elements to PBN:**

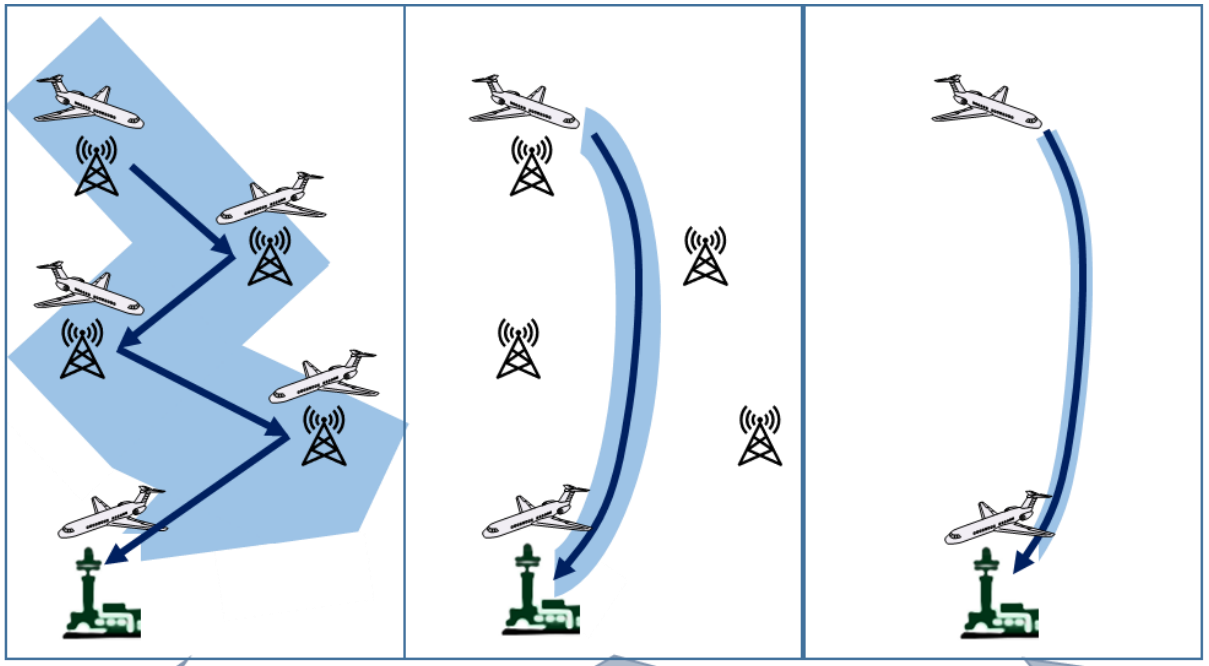
Area Navigation (RNAV) – this allows pilots to use a combination of satellite signals and other systems on-board aircraft to fly any desired flight path by reducing the limitations imposed by ground-based navigation systems.

Required Navigation Performance (RNP) – this is a more advanced form of RNAV as it adds monitoring capabilities to the cockpit to alert the pilot when the aircraft cannot meet specified navigation performance requirements. Key features of RNP are the ability to fly precise, curved approaches and provide predictable flight paths

Note that a full and detailed technical understanding of PBN is provided in ICAO Doc 9613 AN/937

What is PBN?

While PBN can increase airspace efficiency by providing more direct paths, (thereby reducing aircraft fuel burn and emissions), it also results in aircraft concentrating along their particular route.



The key difference between **RNP** and **RNAV** them is that RNP requires on-board performance monitoring and alerting. This increases confidence in the accuracy of navigation and can enable closer spacing between routes.

With **Traditional Navigation**, aircraft have been required to fly routes between and over ground-based navigational aids. The performance of these aids is low so flight paths are dispersed and routes must be widely spaced

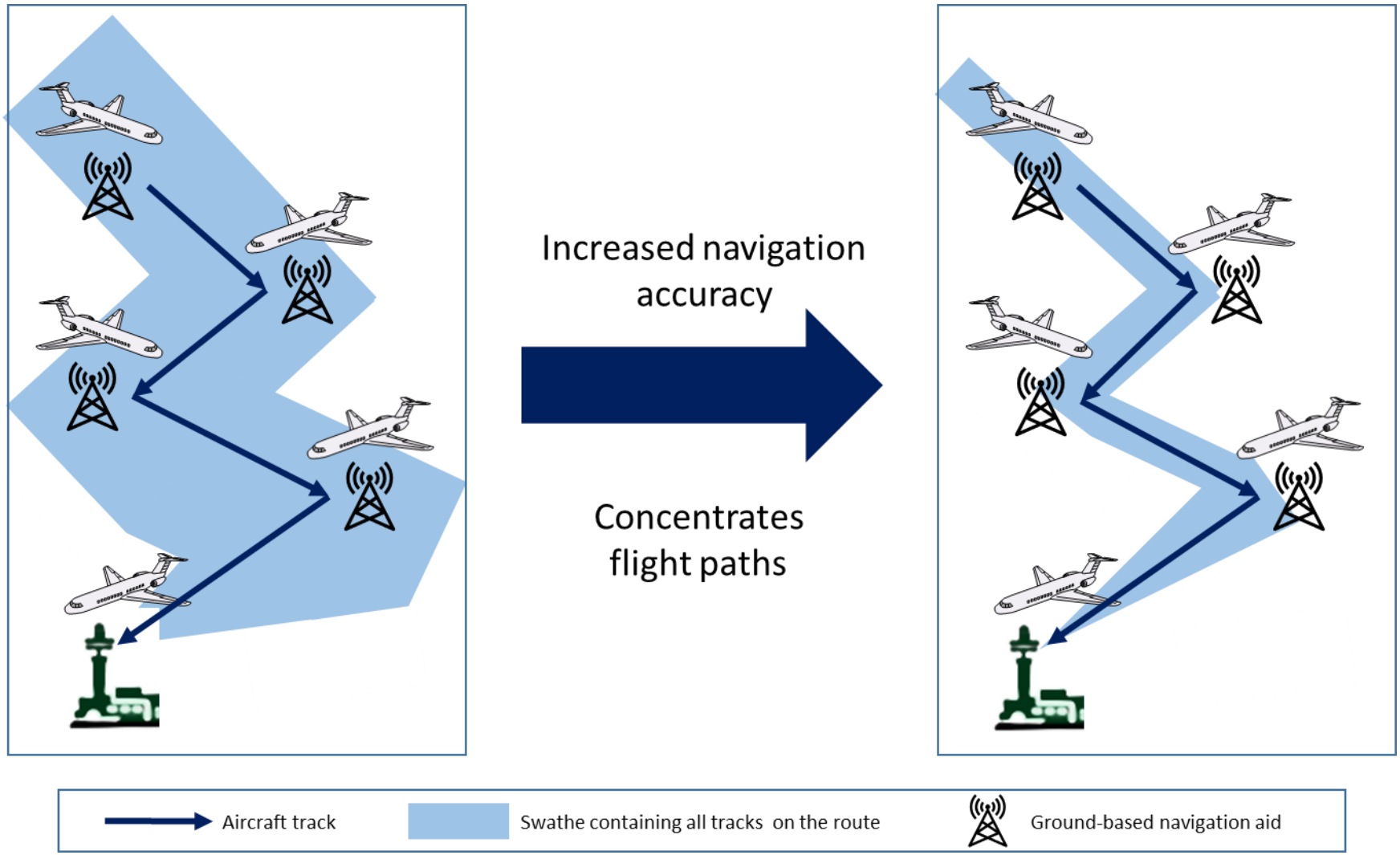
Area Navigation (RNAV) – Area navigation allows an aircraft to choose any course within a network of ground-based navigation beacons rather than navigating directly to and from the beacons. Flight paths are more direct than in traditional navigation and because navigation accuracy is increased, flights follow routes more precisely

Required Navigation Performance (RNP) – RNP is a type of PBN where the aircraft monitors its navigation performance

Aircraft track | Swathe containing all tracks on the route | Ground-based navigation aid

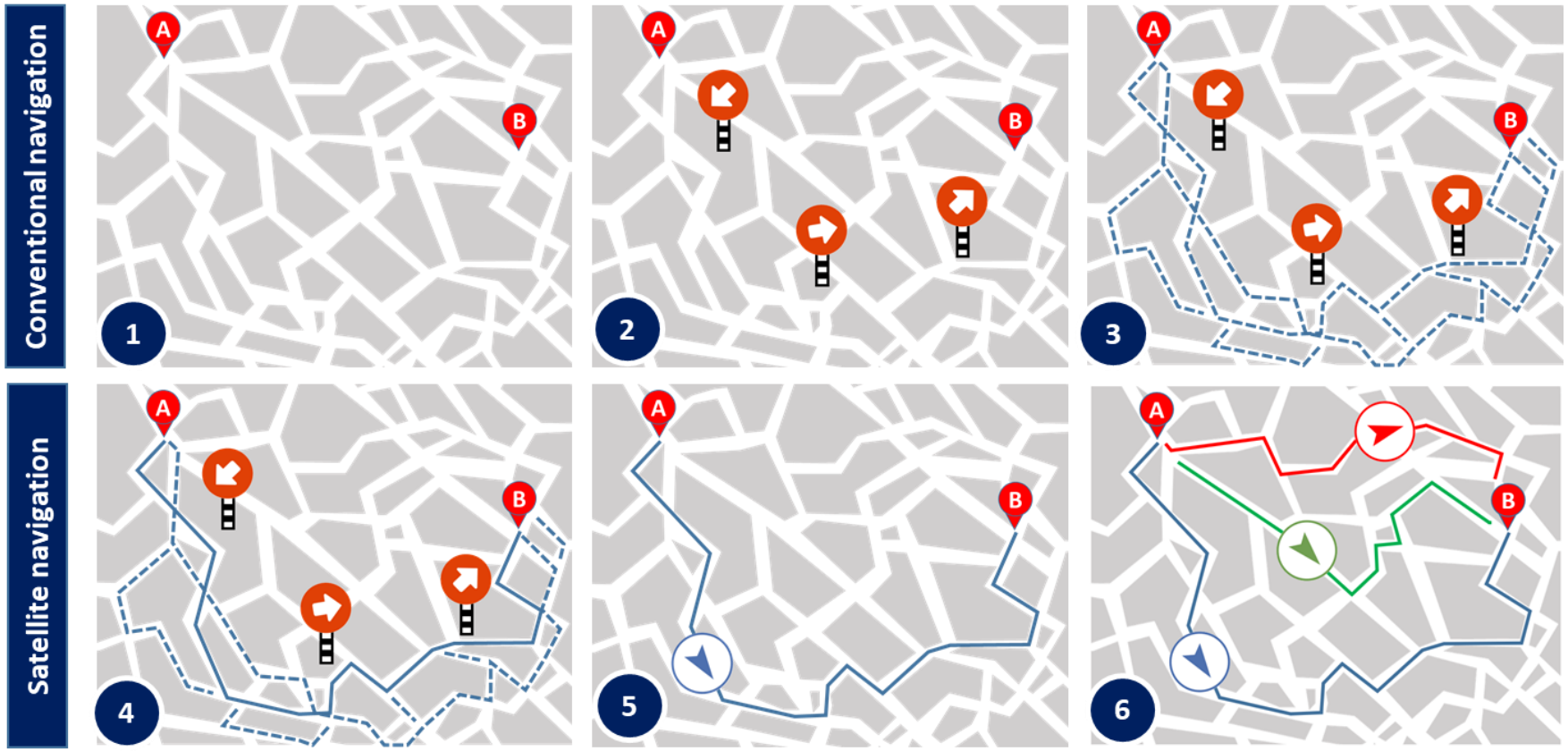
Source: Taylor Airey analysis, Explanation of PBN: transport.govt.nz/air; FAA Metroplex Programme Report oid.dot.gov; UK CAA https://www.caa.co.uk/Performance-based-navigation/

Even without PBN



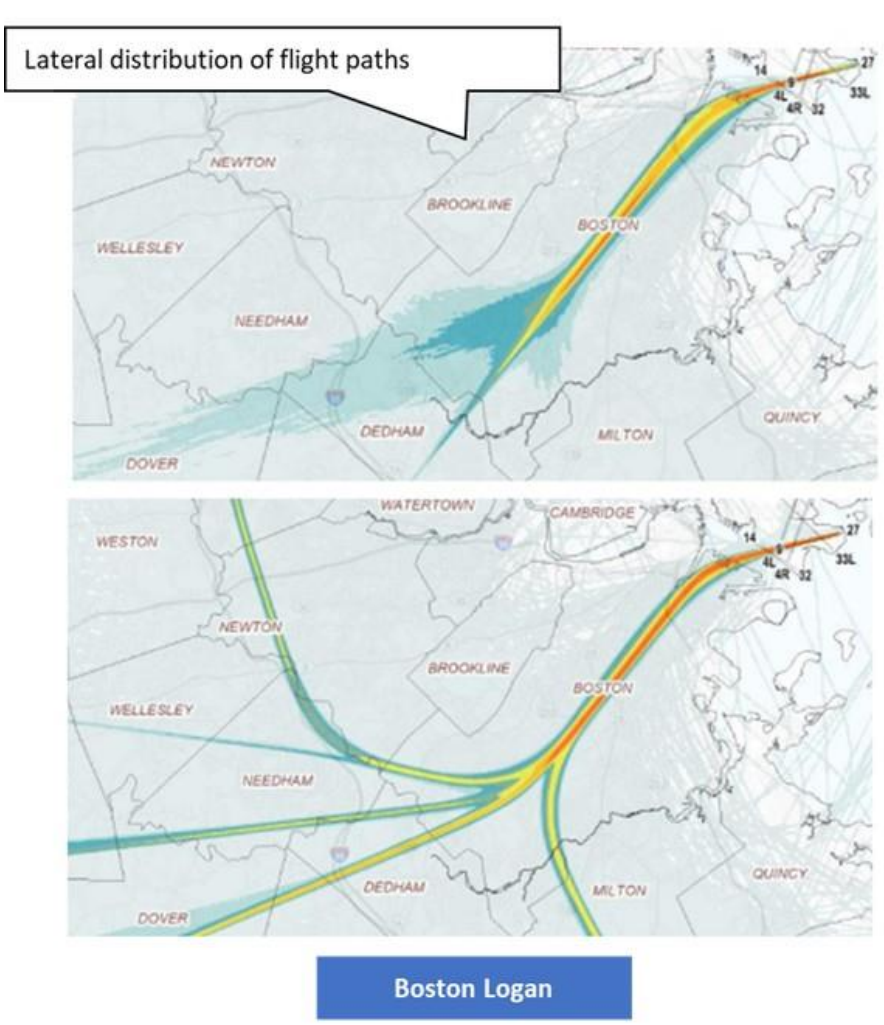
PBN – an analagy to navigating through a town

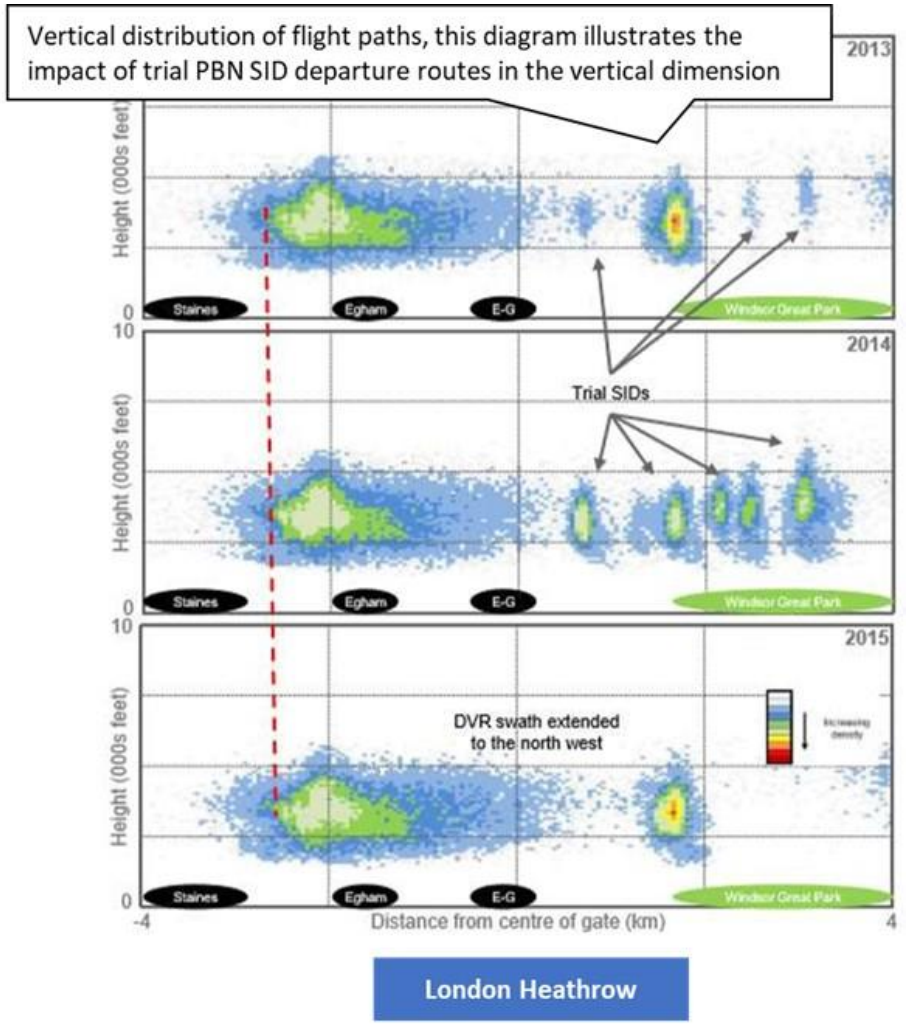
To understand the effects of PBN we can draw an analogy with conventional ground-based satellite navigation, as is used in many modern vehicles. Traditional navigation through a town, from point A to point B (1), would rely on a set of conventional signposts (2); this results in a distribution of traffic across multiple routes (3). Introducing satellite navigation using a predefined route (4) concentrates all traffic along the route (solid line) (5). This traffic can be dispersed by distributing traffic across multiple pre-defined routes (6). It should be noted that this is only a working analogy; in reality only a relatively small number of routes (4-5) can be pre-programmed into the aircraft's Flight Management System (FMS) for each airport approach route.



Note that a full and detailed technical understanding of PBN can be found in of PBN is provided in ICAO Doc 9613 AN/937

Studies have shown clear evidence of concentration due to PBN





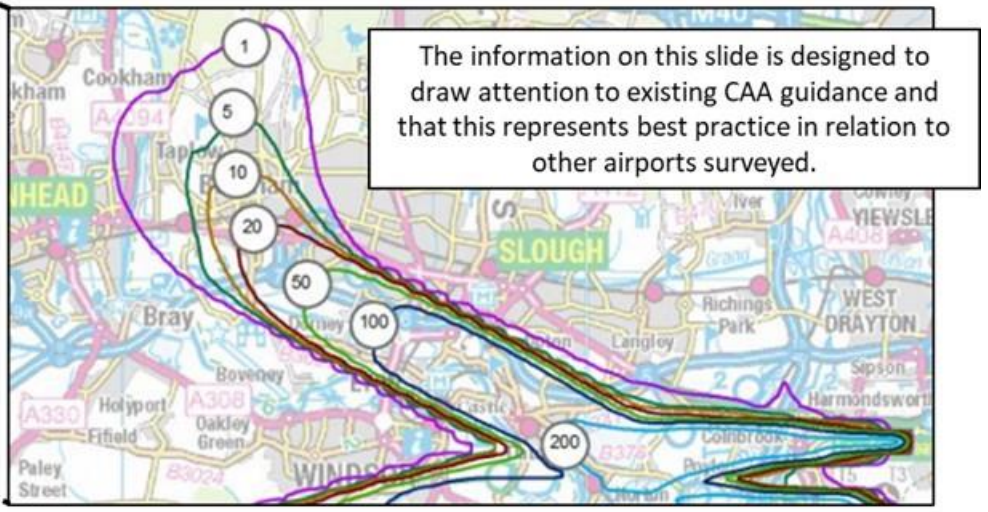
Boston Logan

London Heathrow

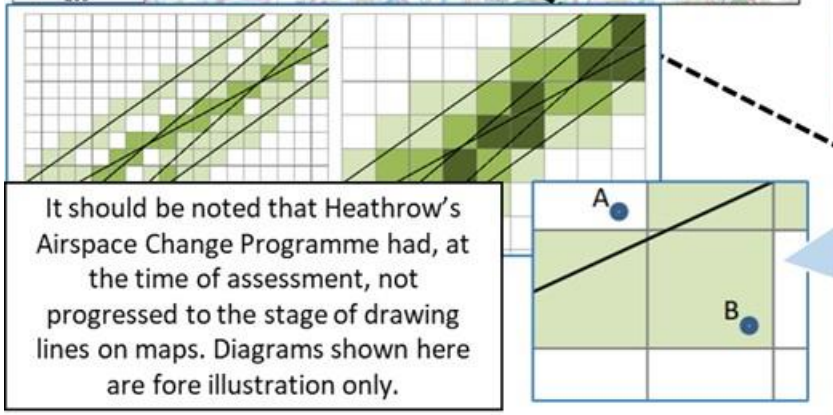
Source: Track density plots on left hand: MIT Centre International Centre for Air Transportation, Block 1 Procedures Recommendations for Boston Logan Airport community Noise Reduction, J Hansman, December 2017; Right side: 3 Villages study flight Path Analysis Report, PA Consulting for Heathrow, January 2016

Higher levels of overflight density should be used to target consultations at those most impacted

When a potential PBN route is identified a Communications strategy targeting the affected communities / areas along the line of the proposed PBN route should be put into action in accordance with CAA guidance setting out the 'cone of impact' from overflight



The information on this slide is designed to draw attention to existing CAA guidance and that this represents best practice in relation to other airports surveyed.



It should be noted that Heathrow's Airspace Change Programme had, at the time of assessment, not progressed to the stage of drawing lines on maps. Diagrams shown here are fore illustration only.

Shading of grid squares identifies areas impacted by a given route. Note that coarser grids (larger squares) result in more reported overflights than fine grids (small squares) & that it is important to ensure adequate consideration is given to those areas that may not be directly overflown but still impacted by overflight (see point A [in an square 'not overflown'] vs. point B [in a square that is overflown], despite point A being closer to route).

Source: CAA's definition of overflight, CAP1498. CAP1498 Provides a definition of overflight using a 'cone' 48.5° from the position of the aircraft concerned. This produces a resulting overflight intensity plot for Heathrow's current flight paths (up to 4000ft). Example shows a 'typical' day of easterly operations at Heathrow.

Impact of concentration

Context

Feedback from community groups highlighted the importance of quantifying the impact of concentration terms of **total population overflown** and the **frequency of overflight**. Some stakeholders requested the study assess how concentrated flight paths impact specific locations compared with more distributed routes.

Proposed method

While a comprehensive environmental impact assessment is beyond the scope of this study it is possible to develop illustrative examples of how concentrated flight paths might alter the total population overflown and the frequency of overflight they are exposed to.

Recommendation

This analysis methodology could be extended into a more comprehensive comparative assessment of PBN impact using data sets local to comparator airports, using the following data:

- the population distribution (including density and geographic spread) surrounding an airport, including all those areas affected by either arrivals or departures up to 7000ft
- historic flight records (to identify the location and size of the traditional arrival and departure 'swathes')
- information detailing the positioning of the flight routes (either currently flown or planned)

The data will need to be of appropriate granularity to facilitate a meaningful analysis, however the availability of this data may vary from case to case. If desired the study could also include an assessment of PBN impact on particular noise sensitive locations (schools, hospitals, areas of outstanding natural beauty, outdoor amenities, etc.) and across multiple airports' flight routes (recognising some locations are overflown by multiple flight paths to multiple airports. We would recommend that further work is performed in this area to generate useful 'rules of thumb' that would assist in preliminary planning and impact assessment. This may need to be conducted at a strategic UK level (eg ACOG).

Source: Input received from attendees at the Study workshop, Taylor Airey & Community representatives, Heathrow, February 2020

Appendix II – Assessment criteria and scoring

Please note:

1. Benchmarking scores are based on the publicly available information about all the benchmarked airports, including publicly available plans published on airport websites. This includes the published information Heathrow's future airspace & its approach to airspace change.
2. The assessment of Heathrow was made on the basis of publicly available information relating to Heathrow's consultations to date (www.heathrow.com and www.heathrowconsultation.com). This assessment was made between September 2019 and March 2020.
3. The assessment of Heathrow's PBN implementation was performed on the basis of the published plans at the time of the study (including the published flight envelopes, the consultations that had taken place and the CAP1616 Airspace Change Process), and what these consisted of (i.e. design envelopes, rather than lines on maps).
4. Note that no PBN flight paths had been implemented at Heathrow as a result of the CAP1616 Airspace Change Programme at the time of writing of the report and that the airspace change process had only reached the 'design envelopes' stage.

1. Benchmark: Airspace policy

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- What national and local policy was in force during the development of the airspace changes?

1	2	3	4	5
Complete absence of high-level policy framework or local guidance relating airspace modifications to population overflight, noise or spatial planning.	**Some relevant policy in place, but typically formulated either ad-hoc, retrospectively or by applying general planning considerations** from non-aviation transport modes (eg Road, Rail). Any policy in place must provide commentary on design objectives (eg avoiding population overflown, dispersing vs concentrating noise, etc) and level of consultation required on them.	**Detailed policy framework and guidelines in place describing specifically how to consult with those affected by the airspace changes**, especially where there are significant noise impacts or changes to procedures affecting new populations. Airspace design objectives are discussed in a national policy but no definitive position is offered by regulator or government (eg concentration of noise over existing routes vs maximum dispersal; minimise total number affected vs total newly affected; minimising overall level of change; minimise impact on noise sensitive locations, etc.).	**The national airspace noise policy objectives are articulated clearly using a set of tightly defined and objective measures** (eg number of newly overflown people, total noise exposure, degree of lateral dispersion, etc.). These design objectives are explicit in how they will safeguard the population impacted by the changes (eg by specifying an objective either to disperse noise or to concentrate it). The noise impacts are assessed in line with overarching frameworks on Public Health.	**Airspace policy is integrated into broader noise management policies** and means of consulting affected parties. Such holistic p**olicy formulated in consultation with the affected population, enshrined in legal processes** and integrated with government strategy at national and local levels (including any objectives for eg airport expansion; noise level, local air quality, wellbeing, health, economic, etc. analysing trade-offs using a 'common currency'). Local Air Quality concerns are in line with ICAO standards (i.e. up to 3000ft)

2. Benchmark: Location of routes

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- What consideration was given to minimising noise (and emissions) when designing location of routes?

1	2	3	4	5
Little or no evidence to suggest that airspace routes are planned to minimise population overflight or noise exposure.	**Multiple options are designed for one PBN route, all of which are feasible and operable.** A clear rationale is provided for the preferred option, (if one is provided), justifying how this will minimise noise impacts compared to other possible options. Rationale uses commonly accepted environmental impact assessment modelling techniques and suitable overflight metrics as appropriate.	**Evidence of multiple options for multiple routes** determining noise impact, population overflown, etc. This is distinct from route option selection as described in level 2 where some consideration is also given to minimising aircraft emissions in addition to noise.	**Transparent evidence of route optimisation using multiple routes,** using performance metrics optimised over a number of key dimensions (eg overall noise exposure, population overflown, etc.). Multiple PBN routes can be used to create 'managed dispersion' of noise, within the limitations of the FMS. It is important to recognise that PBN cannot support an infinite number of route options.	**Noise and overflight objectives are closely defined using a series of metrics enshrined in policy.** Route options are optimised across a set of weighted variables designed to meet the policy objectives (eg noise level, local air quality, wellbeing, health, etc. analysing trade-offs using a 'common currency'). This 'common currency' will have been developed through public consultation and aligned with associated policy areas (eg spatial planning). Thereby the location of all PBN route options are optimised with respect to a given set of criteria; aligned to top level policy objectives (see note)

Note: It is not possible to produce a 'one size fits all' formula to determine route locations; instead the focus should be on alignment of the process with relevant national policy and close public consultation in developing specific options for route locations, and usage (dispersion, concentration, alternation, etc.), using fair, open and targeted communications / consultations.

3. Benchmark: Operating modes

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- What consideration was given to minimising noise (and emissions) when designing operation of routes?

1	2	3	4	5
No noise sensitive operating modes in place	**Runway alternation employed to help achieve respite.** Alternating runways are used for allotted periods of time on a predictable basis, depending on operating mode (where feasible). Some restrictions in place on night-time operations.	**Dispersed multiple PBN paths are used to laterally spread flights paths around a given airway route.** This provides additional noise relief in addition to runway alternation (where this is in operation). All PBN flight paths are used and there are no specific limits or quotas in place on them. The means of dispersing flights can include, for example, the use of different 'coding houses' to laterally spread flights around a given PBN route.	**Use of flight path alternation: where dispersed PBN flight paths are used for set periods on a predictable basis** for a given operating mode to provide predictable periods of noise respite. The meaning of respite itself is well defined Airspace alternation - 'switching off' large blocks of airspace used by PBN routes for given periods of time on a predictable basis - will use flight path alternation, coordinated at a TMA level.	**Use of route quotas/controls:** Noise or overflight load limited by restrictions along a given route, typically using a system of route quotas set over a given period of time. Hours of operation along certain PBN routes may be restricted to take account of both noise sensitive locations and hours of noise sensitivity (eg schools, hospitals, residential areas, parks, etc). Specific night-time restrictions are placed on a route cognisant of noise sensitive locations.

4. Benchmark: Overflight design

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- How effective is the airspace design at offering respite for overflown communities? (i.e. the outcome from categories 2 and 3, based on real-world impacts or modelled outcomes)

1	2	3	4	5
Little or no evidence to suggest that airspace routes and their operation are planned to minimise population overflight or noise exposure.	**PBN route network is defined with adequate resilience to provide the designed capacity,** avoiding 'bottlenecks' in air traffic flow and night flights caused by a lack of airspace capacity during the day.	**Airspace network is designed to minimise noise nuisance by avoiding noise sensitive locations** at certain times of day and/or provide respite through airspace/runway alternation.	**Airspace is designed at the Terminal Manoeuvring Area (TMA) level** to enable all airports affected by the airspace change to coordinate their designs, understand how the entire volume of airspace will operate and communicate changes to stakeholders effectively This 'joined up' approach allows determination of where different volumes of airspace can be 'switched off' to provide respite (see note 1). Impact of noise on tranquillity	**Investigations are conducted to understand the feasibility of using PBN to generate maximum lateral dispersal using 'managed dispersion' where this is desirable.** Such a system would require a significant number of PBN routes to be defined and a means of safely allocating the air traffic across these routes to disperse overflight. Such a concept of operations has not yet been developed and its feasibility is yet to be researched in detail for congested airspace regions.

Note this metric is an outcome from applying the operating restrictions to the route locations for the option under consideration. The benchmarking score is based either on actual real-world impacts or modelled outcomes where airspace changes are still in the design phase.

5. Benchmark: Transparent impact assessment

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- How open and transparent was the airport about the likely environmental impacts of the proposed design?

1	2	3	4	5
Impact assessment is either completed too late to allow the community adequate opportunity to properly scrutinise the findings, or uses a flawed methodology of insufficient detail when compared to similar studies elsewhere.	**EA (Environmental Assessment) methodology is in line with international standards & norms,** however the modelled impacts (or the business management) fails to adequately anticipate an increase in impacts and where these are set to originate from.	**Impact assessment demonstrates a good level of transparency back to models and input data.** Community enquiries are actively managed and discussed through proactive community engagement. Proactive community engagement provides guidance around impact assessment methodologies.	**EA methodology is transparent, understandable and directly relatable to government policy in spatial planning, airspace management and environmental management.** Anticipated impacts are linked to overall policy statement and options are assessed.	**Airspace change authorities publishes full findings of impact assessment and facilitates** further analysis by interested parties through data sharing & production of useful resources (eg Google earth .kml files). Clear and understandable logic sequence is established between the defined 'cost function' and the chosen route options.

6. Benchmark: Assessment criteria

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- How suitable were the metrics used in the assessment?

1	2	3	4	5
Only high-level assessment criteria are produced, typically in the form of fuel savings or a reduction in carbon emissions. Little evidence of a assessment criteria being evaluated.	**A comprehensive set of overflight assessment criteria & maps are produced and include measures relating to the population** impacted by noise from the airspace changes. This includes the production of relevant noise contours (eg L_{DEN}, L_{Aeq}, etc.).	**Material produced well in advance of the minimum airspace consultation period.** **Assessment Criteria are aligned to relevant national and local policy (where available, eg WebTag); such as noise, spatial planning, etc.** These assessment criteria are generally accepted by both the local community and industry as providing necessary and useful indication of the impacts being considered.	**In addition to noise contours other graphics or resources (such as Google earth files) are produced** to illustrate overflight intensity and typical height over the ground.	**Multiple assessment criteria are used to explain the impact of the design on the affected area** beyond that required by existing policy guidance. **Overflight maps are illustrated to include the areas affected by direct overflight and those in the immediate vicinity (affected by noise).**

7. Benchmark: Metrics

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- Will the proposed PBN route offer benefits to the affected community compared to a 'do nothing' comparable baseline scenario?

1	2	3	4	5
Only high-level metrics are produced, typically in the form of fuel savings or a reduction in carbon emissions. Little evidence of a comprehensive environmental impact assessment being conducted.	**A comprehensive set of overflight metrics & maps are produced and include measures relating to the population** impacted by noise from the airspace changes. This includes the production total population impacted by noise and the number of newly affected people.	**Material produced well in advance of the minimum airspace consultation period.** Overflight metrics are produced showing the difference between a meaningful baseline and proposed scenarios (either using a heat map, coloured dots or similar).	**Metrics used demonstrate that multiple routes have been analysed** and the chosen design has been optimised primarily minimise noise impacts, in line with Government policy.	Metrics used to explain impacts are developed in collaboration with the community, so a meaningful understanding is developed. Metrics and graphics are used to communicate the amount of respite that may be experienced, where this is located, and for what times of day this would be in place.

8. Benchmark: Community engagement

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- How effective was the promotion and awareness raising of the airspace change?

1	2	3	4	5
Airspace change sponsor does not recognise community engagement as being integral to the PBN implementation process and minimal resources are provided for engagement. No public engagement events or forums are in place and this results in changes being made without any community engagement.	**Information on PBN implementation is available, however it is either overly technical** (so as to be generally inaccessible to the lay audience) **or lacking sufficient detail** (making it too vague to allow meaningful comment by a more technical audience) in relation to the consultation questions being posed. Minimal public engagement forums or workshops are put in place.	Engagement in the subject is actively promoted and advertised through multiple channels, including leaflet drops, accessible offline information (including hard copies of all public documents available in community centres), advertisements in the affected built environment, local & regional press. Creation of working groups, and community engagement forums and design workshops with interested groups. Engagement viewed as an opportunity to build trust in the consultation / airspace change process.	**Significant community outreach activities are planned, including targeted campaigns in the areas to be newly or severely affected by the changes** (ie. along a tight swathe around planned routes and in areas not previously affected by significant overflights). All relevant public engagement materials, events and forums are publicised well in advance and are designed to be readily accessible so as to be useable by people with disabilities.	**Targeted presence established in the areas to be severely impacted.** The airspace change sponsor seeks to effectively engage the community and provide all relevant information early on; this could include, for example, establishing a temporary office in the local environment likely to be to be impacted by the airspace change, to explain the changes to the community.

9. Benchmark: Understanding

Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- How accessible and understandable was the community engagement material?

1	2	3	4	5
Minimal information is available about either current operations or changes to them; lack of resources and knowledgeable experts to explain airspace operations to local communities.	**Open, transparent and understandable communications informing the affected community about current operations** (including regular performance reporting, accessibility of online tools such as Webtrack, etc.). Communication about airspace changes through both online and offline sources (eg printed materials made available in community centres). These are produced in line with legal requirements. Consultation documents are supported by suitable maps, diagrams, videos and supporting technical annexes	**Route location options are published early on, and well in advance of any statutory consultation period**, to allow enough time to convey a meaningful understanding to those who may be impacted through targeted engagement. Such openness minimises any lack of community awareness. **Impacts on the community are conveyed in such a way as to be readily understandable** using both traditional face to face discussions and, where appropriate, novel & innovative technologies (eg sound booths, simulators, tabletop graphics, etc.).	**Clear and understandable explanation of airspace changes is provided via an easy to navigate website.** 'Headline' documents readily explain both the changes and the overall change process to the lay audience, together with the uncertainties and complexities involved. **Information about upcoming operational changes (trials, introduction to service periods, etc.) are widely disseminated to the local communities.** This includes overflight maps indicating those areas affected by direct overflight and those in the immediate vicinity.	Bespoke & responsive flight and noise analysis provides the affected community with data sets on reasonable request.

10. Benchmark: Use of feedback

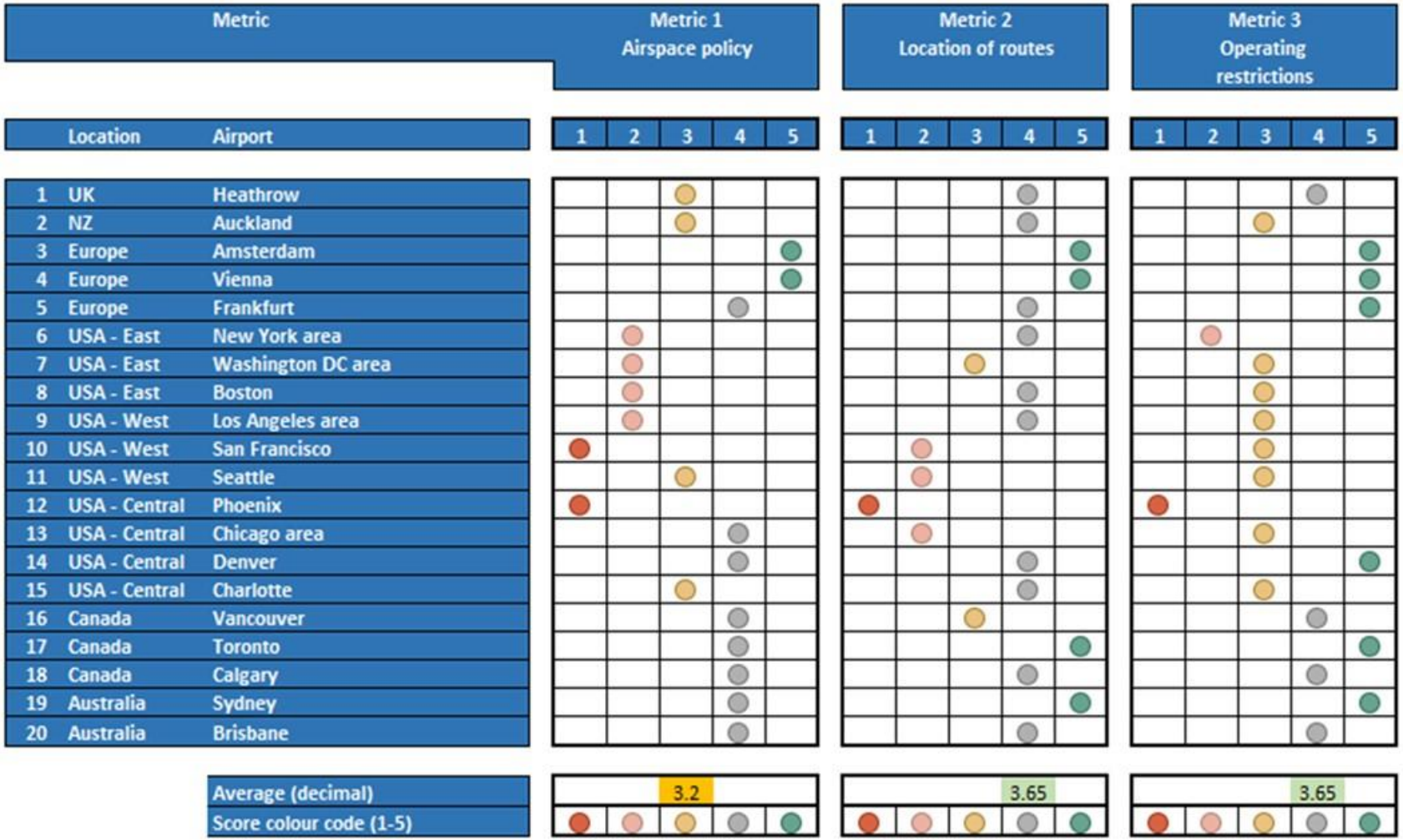
Scoring applied using published information in the public domain (airport, government and community based websites), and validated through stakeholder workshops and feedback

- Was community feedback demonstrably included in the subsequent airspace design?

1	2	3	4	5
Either no feedback is sought (no consultation takes place), or there is no evidence that feedback from the consultation is considered.	**Consultation does take place, however the details of those areas potentially impacted by higher flight volumes receive insufficient or poorly timed communications** about the airspace changes and location of new routes. This results in a lack of meaningful feedback, either in overall volume or in the quality of the responses. There is a demonstrable lack of any consultation feedback being considered in the subsequently implemented design.	**Full public consultation adheres to the 'Gunning' / Sedley principles** : - consultation at a time when proposals at a formative stage; - that the proposer must give sufficient reasons to permit of intelligent consideration; - that adequate time is given for consideration and response; and; - that the product of consultation is taken into account when finalising the decision. **PBN route details are published early on allowing time for communities to prepare prior to consultation.** Consultation questions are framed to be accessible and allow meaningful feedback from the local community.	**Involvement of community in the design,** (eg using interactive 'workshop' sessions, demonstrating how the design team arrived at the route options proposed and any restrictions they are working with such as a minimum altitude, etc.). Airspace change sponsor develops a meaningful understanding of community feedback and any emerging consensus. The definition of 'consensus' needs to be agreed and, where possible, articulated as a set of metrics. The consultation (and the consensus itself) must be balanced. Consultations should be used to inform communities of the positive benefits and negative drawbacks of changes and provide sufficient information	**The new airspace design is subject to a review after the first year of implementation.** There is a clear process in place for rescinding airspace change if success criteria, defined prior to the change by the sponsor, are not met.

Results: Policy and Design

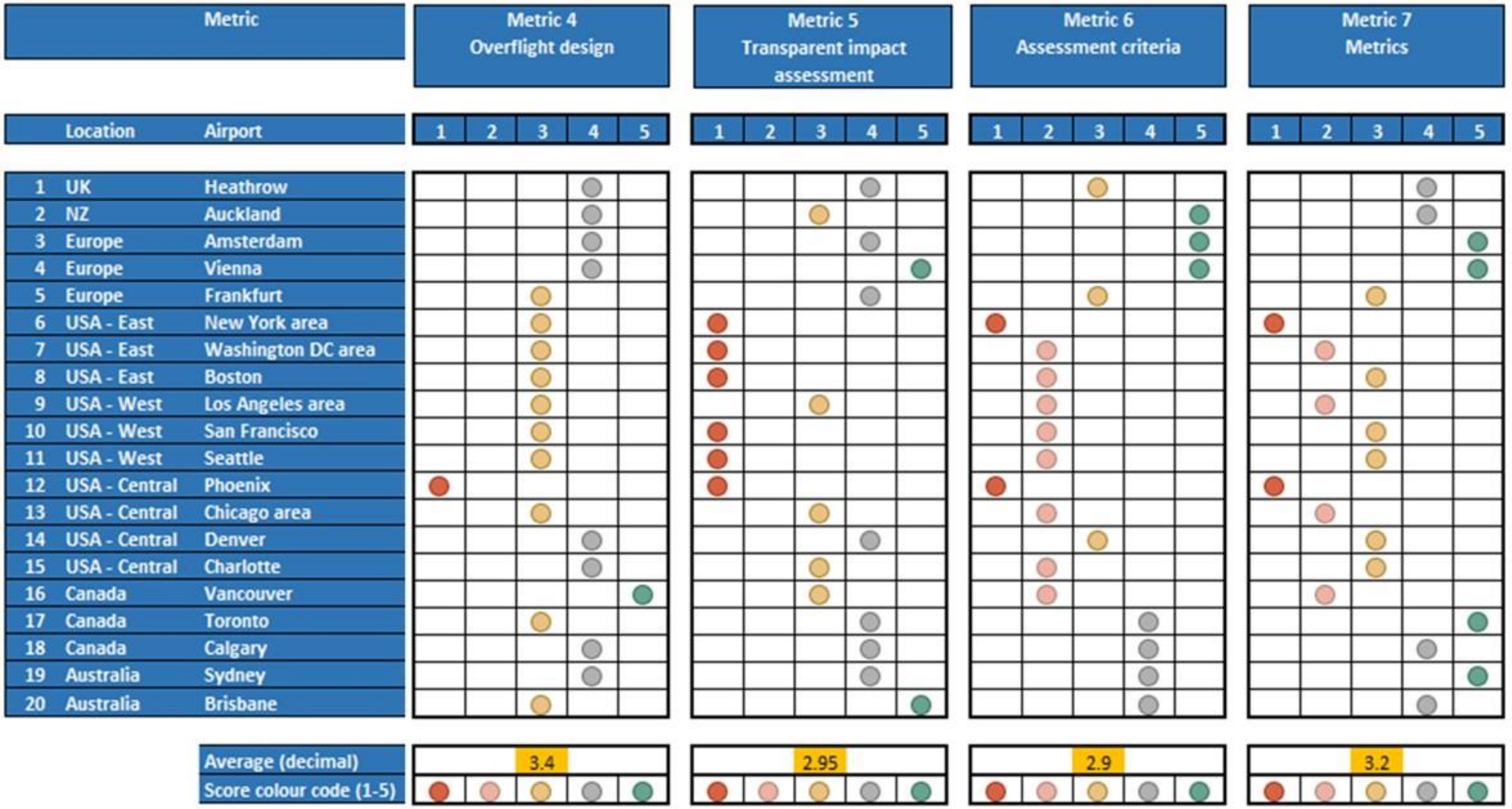
Scoring applied using published information in the public domain



	Metric		Metric 1 Airspace policy					Metric 2 Location of routes					Metric 3 Operating restrictions				
	Location	Airport	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	UK	Heathrow			●						●					●	
2	NZ	Auckland			●						●				●		
3	Europe	Amsterdam					●					●					●
4	Europe	Vienna					●					●					●
5	Europe	Frankfurt				●					●						●
6	USA - East	New York area		●							●			●			
7	USA - East	Washington DC area		●						●					●		
8	USA - East	Boston		●							●				●		
9	USA - West	Los Angeles area		●							●				●		
10	USA - West	San Francisco	●						●						●		
11	USA - West	Seattle			●				●						●		
12	USA - Central	Phoenix	●					●					●				
13	USA - Central	Chicago area				●			●						●		
14	USA - Central	Denver				●					●						●
15	USA - Central	Charlotte			●						●				●		
16	Canada	Vancouver				●				●						●	
17	Canada	Toronto				●						●					●
18	Canada	Calgary				●					●					●	
19	Australia	Sydney				●						●					●
20	Australia	Brisbane				●					●					●	
		Average (decimal)			3.2						3.65					3.65	
		Score colour code (1-5)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Results: Design and Assessment

Scoring applied using published information in the public domain



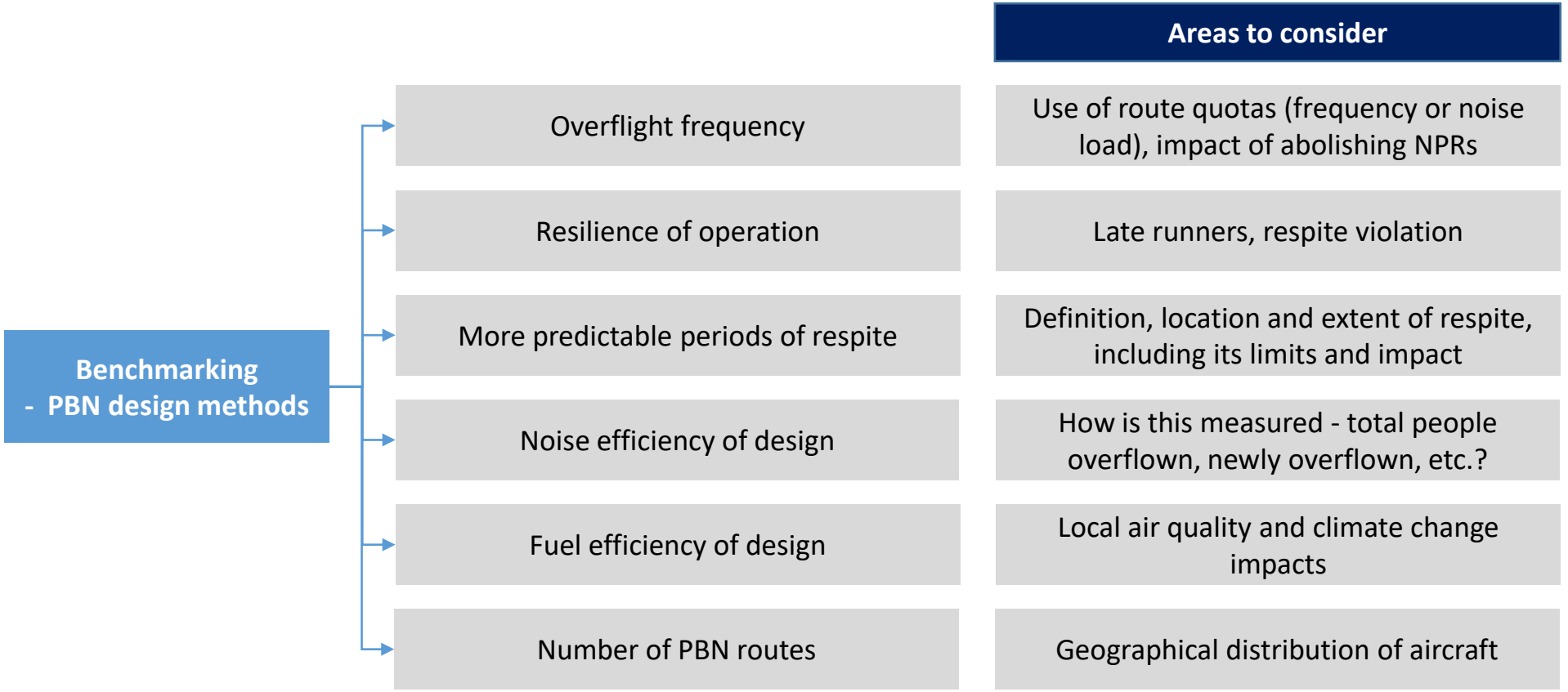
Results: Communication and Engagement

Scoring applied using published information in the public domain

Appendix III – Initial assessment categories (revised during community workshops)

Benchmarking PBN – Design and Implementation

- Where will PBN routes be placed, when are they used & rationale?



Benchmarking PBN – Communication

- What mechanisms exist to engage the community?
- How best to understand concerns around PBN?

		Key messages to be communicated
Benchmarking - PBN Communication	Promotion of engagement with subject	What it is & why it is important?
	Readily available, accessible and understandable information	Where are the routes what are their impacts?
	Promotion of consultation and feedback; how to maintain engagement	How can the community be effectively engaged with the consultation?
	Transparent incorporation of feedback	Use of best practice guidelines (eg Cap 1616)
	Clear communication around introduction into service	Use of written and electronic material, meetings, etc.

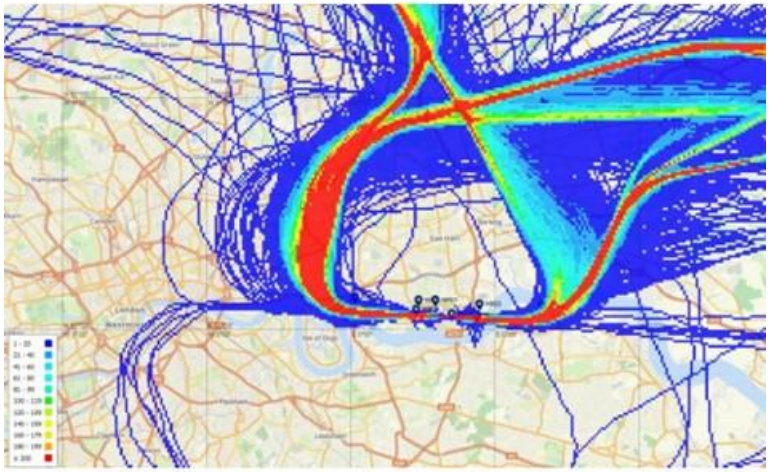
Appendix IV – Case studies

Case studies:
London City, Auckland, Sydney, Vienna

London City

London City was widely criticised for a lack of communication and consultation

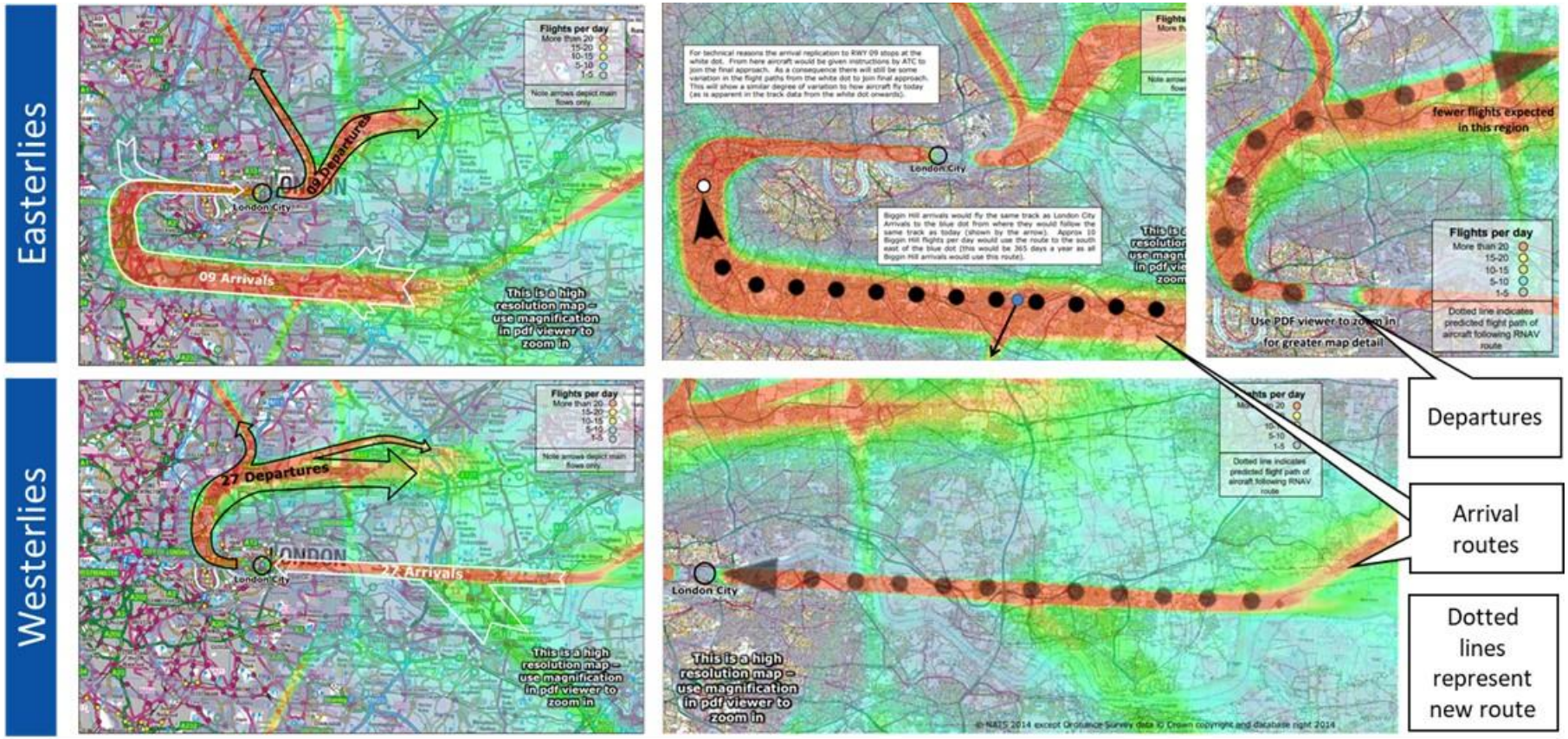
- In 2014/15 London City Airport generated extensive criticism for a relatively low level of engagement around flight path changes to introduce PBN
- Consultation was mainly conducted through the airport's consultative committee without public meetings, advertised community events, or engagement with local authorities; similarly no written communications were targeted at the affected areas
- The new routes were designed to mimic existing routes and reduce the overall number of people exposed to aircraft noise
- The lack of communication and wide consultation prior to the change attracted significant criticism
- Subsequent to this Airspace Change the CAA published refreshed guidelines on the process for Airspace change (CAP1616 replacing CAP725)
- London City is now following the revised process for airspace change; in November 2019 the CAA approved Stage 1 of the airport's flight paths as part of the Airport's Airspace strategy 'Our Future Skies – Design Principles'



This situation resulted in a deterioration of trust between the airport and the local community, generating the formation of opposition groups opposed not only to the flight path changes but also to airport expansion

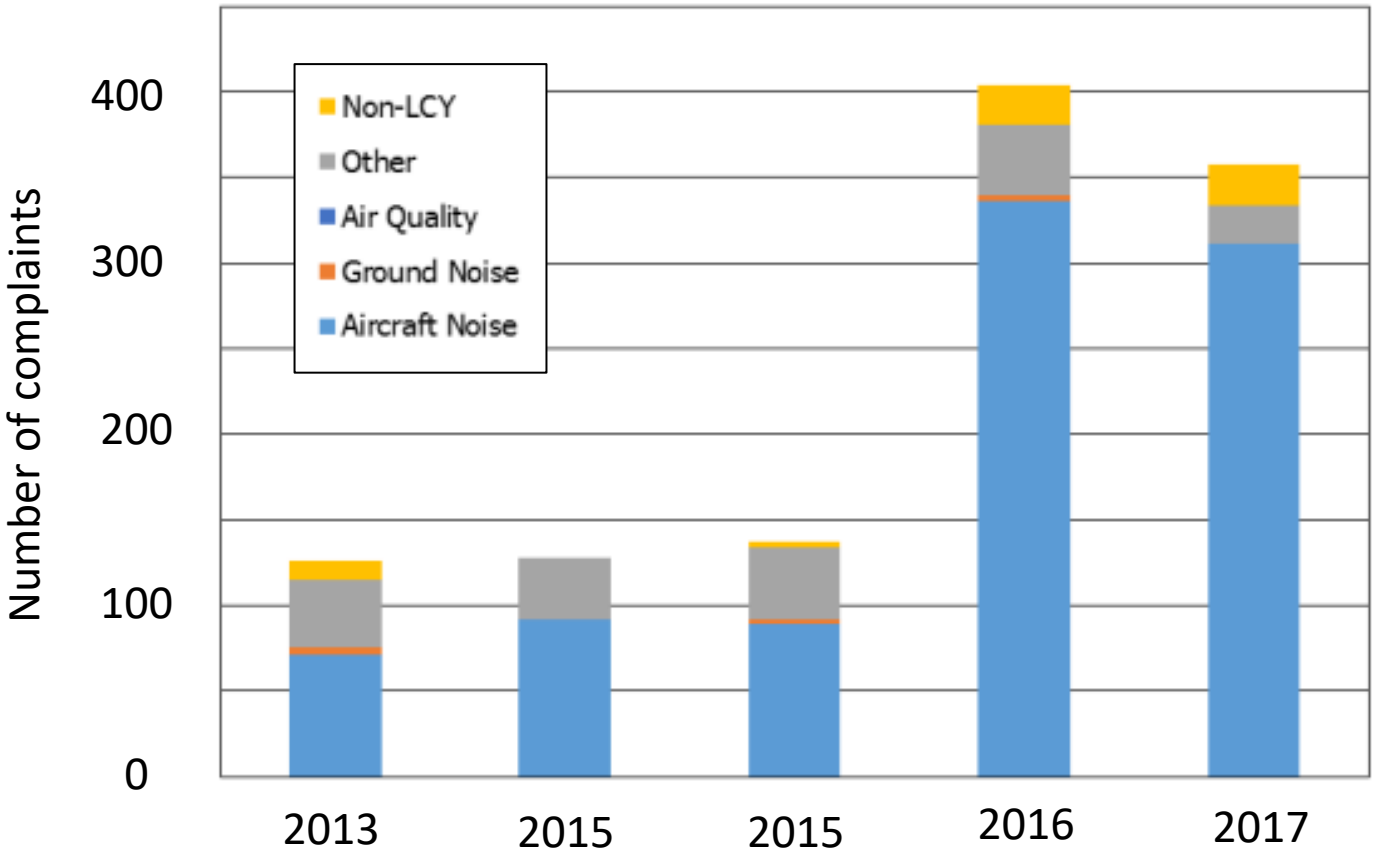
Source: CAP 725, CAA Guidance On The Application Of The Airspace Change Process, March 2007; CAP 724, CAA Airspace Charter which defines the authorities, responsibilities and principles; Civil Aviation Authority, Future Airspace Strategy for the United Kingdom 2011 to 2030 publicapps.caa.co.uk; HACAN East www.hacaneast.org.uk

Routes inside existing swathes generated a large increase in complaints



Source: Total Environmental complaints received by London City Airport(2013 – 2017), London City Airport Noise Action Plan 2018—2023, londoncityairport.com/corporate/ & London City Airport RNAV Replications Stakeholder Consultation Document, September 2015 & London City RNAV Replications Consultation Feedback Report February 2015, publicapps.caa.co.uk

London City Complaints



Source: Total Environmental complaints received by London City Airport(2013 – 2017), London City Airport Noise Action Plan 2018—2023, londoncityairport.com/corporate/ & London City Airport RNAV Replications Stakeholder Consultation Document, September 2015 & London City RNAV Replications Consultation Feedback Report February 2015, publicapps.caa.co.uk

The CAA conducted a Post Implementation Review following negative feedback from local communities

- London City did not forecast any impact on the airport's L_{eq} noise contours, so did not anticipate any increase in noise complaints
- However the airport did consider that there was likely to be some change in noise dispersion:
  - "Some residents should experience a reduction in noise impacts because they would have fewer flights overhead as a result of redistribution arising from concentration; no feedback identified from locations experiencing a decrease in noise impact. Some residents already under the nominal tracks of the conventional SIDs the subject of this proposal, were likely to experience more overflight and more noise as a result of this concentration."
- The airport acknowledged that
  - a number of individuals challenged the adequacy of the consultation associated with this airspace change proposal
  - the majority of noise complaints were generated by individuals/organisations residing directly under the route centrelines
- These noise complaints focused on
  - the concentration of traffic patterns
  - the general burden of aircraft noise/overflight
  - the need to introduce respite routes
  - the unfairness of the regulatory decision

London City forecast a significant decrease in the numbers of people overflown by the new flight paths. However, they underestimated the strength of feeling against the concentration of traffic and the majority of noise complaints were generated by individuals directly under the route centrelines

Table 2 – Summary of overflights (persons overflown)

Modules B & C – London City	Pre-implementation (2013)	Post-implementation (2016)	Increase / decrease
Arrivals			
Direct overflight - Ground to below 4,000ft	881,000	331,000	-550,000
Direct overflight - 4,000ft to below 7,000ft	404,900	72,100	-332,800
Direct overflight - Ground to below 7,000ft	1,285,900	403,100	-882,800
"CAP1498 swathe"	2,439,700	1,231,300	-1,208,400
Departures			
Direct overflight - Ground to below 4,000ft	672,900	416,300	-256,600
Direct overflight - 4,000ft to below 7,000ft	184,800	115,100	-69,700
Direct overflight - Ground to below 7,000ft	857,700	531,400	-326,300
"CAP1498 swathe"	1,447,200	1,317,100	-130,200

Source: Report of the CAA's Post Implementation Review of the London Airspace Management Programme (LAMP) Phase 1A Module B Airspace Change Proposal – London City Airport RNAV-1 Replications, CAA repository, 2016

Further references – London City

- London City Airport RNAV Replications Stakeholder Consultation Document, CAA repository, September 2014, CAA
- London City Airport RNAV Replications Consultation Feedback Report, CAA repository, February 2015, CAA repository
- LAMP Phase 1A Airspace Change Proposal – Module B, London City Airport RNAV Replications, CAA repository, 2015
- LAMP Phase 1A CAA Decision: Part applicable to LAMP Phase 1A Module C, CAA repository, May 2016
- Airspace Design Guidance: Noise mitigation considerations when designing PBN departure and arrival procedures, CAA repository, CAP 1378
- Report of the CAA's Post Implementation Review of the London Airspace Management Programme (LAMP) Phase 1A Module B Airspace Change Proposal – London City Airport RNAV-1 Replications, CAA repository, 2016
- Departure Noise Mitigation: Summary Report, CAA repository, 2018,
- Airspace Modernisation - Design Principles Development, Future Skies, 2018
- London City Airport Noise Action Plan, 2018 – 2023, City Airport, 2018

Auckland

Auckland airport demonstrated good practice by undertaking trials prior to full implementation

Auckland Airport trialled multiple new approach options…

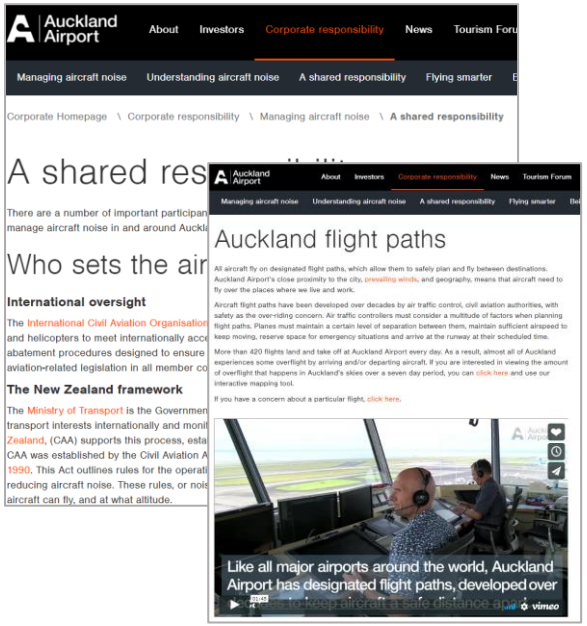
…feedback on the trials led to the approach route to the north of the city being moved further east

In particular, the airspace change process here provided good examples of:

- Clear communication between stakeholders, supported by in person events and suitable online resources
- Clear guidelines from government and transparent oversight of trials
- Active listening during a consultation / trial period, and the ability to alter the location of PBN routes in response to feedback

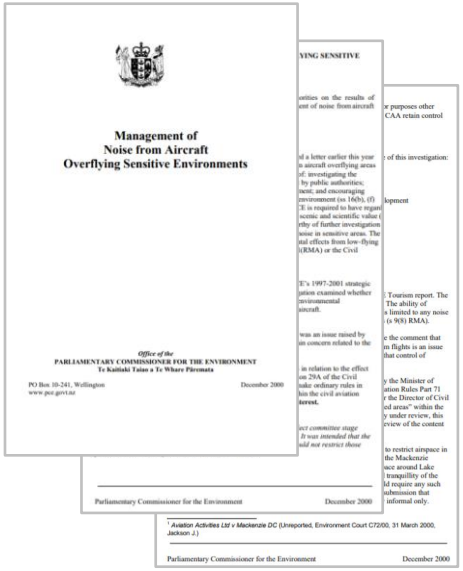
The airport provided clear communications, incremental implementation and a responsive design process

Easy to navigate and understand website



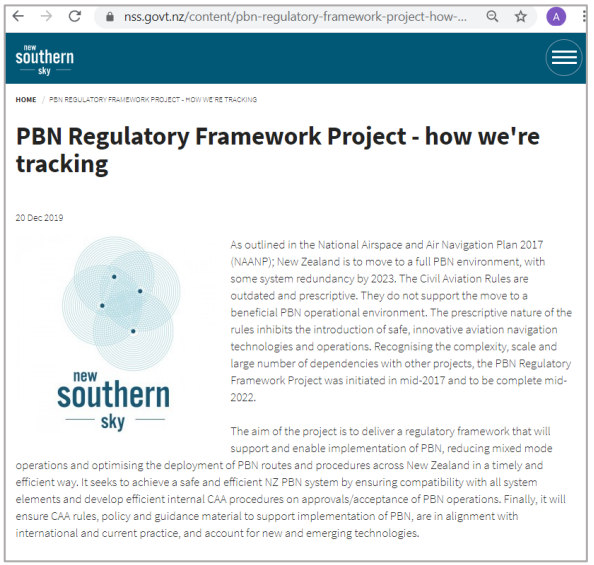
Online resources explain current and future operations & how they are governed using clear and accessible published material and easy to navigate websites

Clear guidance around airspace change



Clear guidelines are provided from government around the airspace change process and the implementation of PBN

Good communications around the airspace change



Regular updates keep stakeholders informed and engaged using a well defined reporting process and understandable status updates.

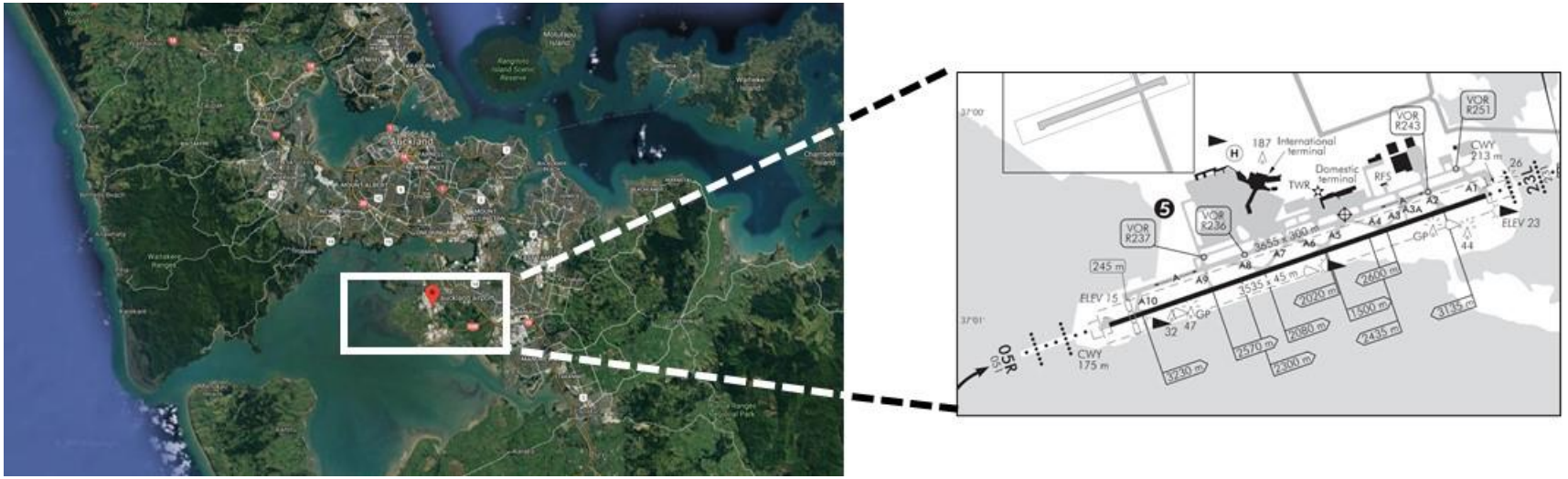
Government, airport and community worked collaboratively to produce an efficient airspace change process

Close monitoring and feedback	Responsive airspace change design process	Outcome
• Use of a trial implementation period, regular status updates, a full impact assessment trial report followed by a 3 month consultation period with the local community • Noise was monitored by Auckland Airport during the trial with changes in noise level found to be 'just perceptible' but not significant. • Opportunity provided for members of the community to present their submissions in person at a "town hall" style event	• Introduction into operations initially limited the use of the PBN route to a maximum of 6 /day. Subject to certain conditions, including Airport consulting on noise, could see the flights lifted to 10 /day. Route operating hours initially restricted • Flight path routes changed post-trial to avoid populated areas • While noise complaints increased immediately after PBN implementation, they are understood to have since declined.	• The gradual introduction approach to the implementation of flight paths has received generally positive reviews in local media 

While not all lessons may be applicable to Heathrow's situation, (due to the congested airspace and extensive urban conurbation surrounding Heathrow making overflight avoidance challenging) a key observation is the importance of good communications and iterative designs that incorporate local community feedback.

Further references – Auckland Airport

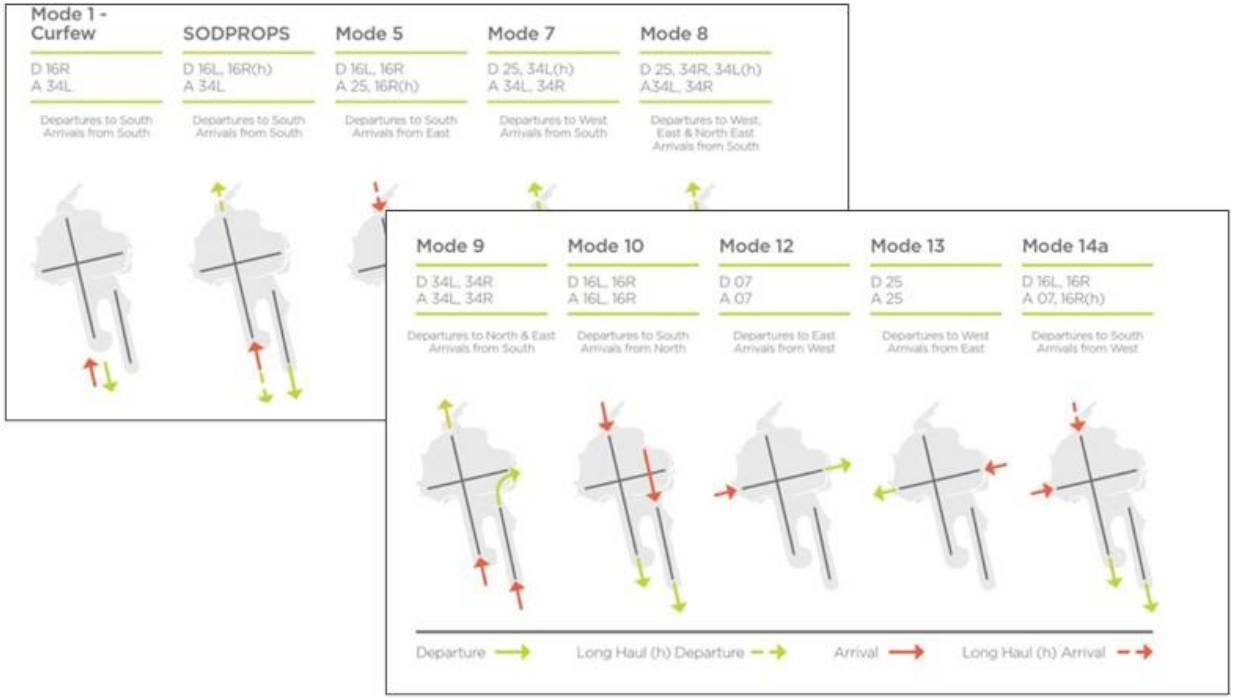
- Noise Strategy – A shared responsibility, Auckland Airport Website, 2019/20
- Understanding Airport Noise, Auckland Airport, 2020
- Auckland Flight Paths, Understanding Aircraft Noise, Auckland Airport website, 2020
- Managing Aircraft noise – flying smarter, Understanding Aircraft Noise, Auckland Airport website, 2020
- New Zealand PBN Regulatory Framework Project, Progress tracking website, 2020
- Performance Based Navigation, New Zealand Government Advice, 2018/19
- Performance Based Navigation – Guidelines for Aircraft Noise, New Zealand Parliament website, 2018



Source: Diagram of Auckland Airport surroundings and Airport layout, Google Earth, New Zealand AIP http://www.aip.net.nz/

Sydney

Sydney Airport offers many runway operating modes

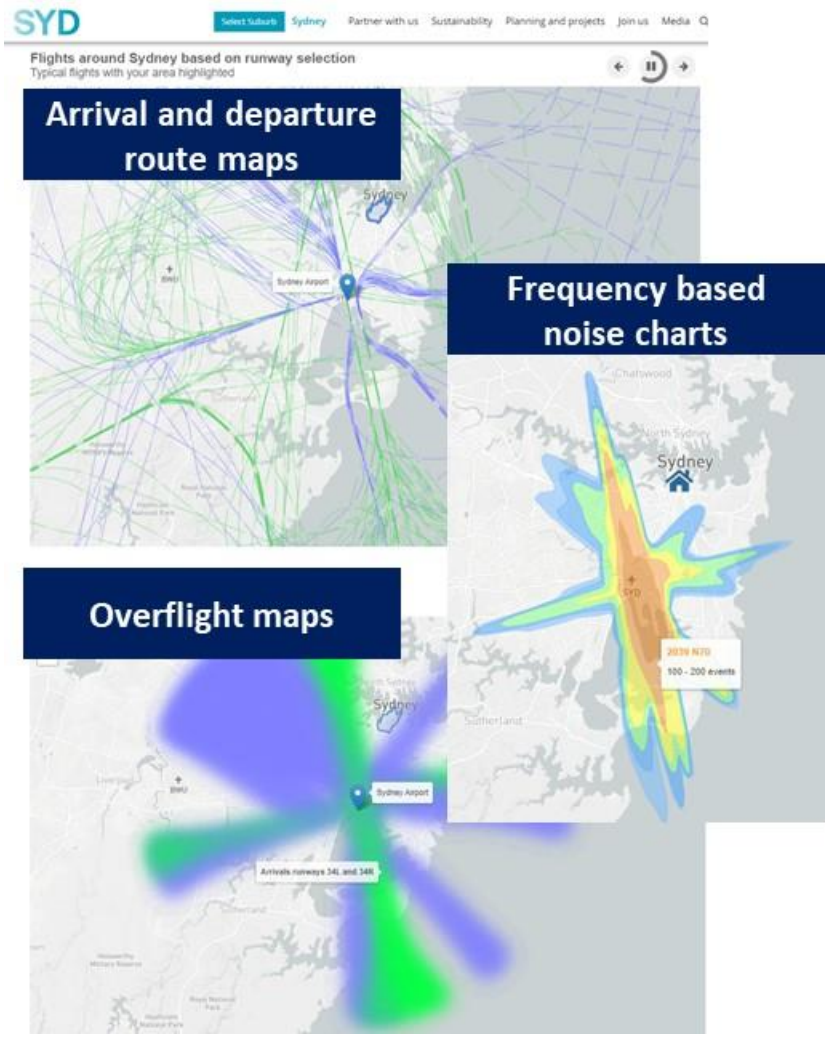


Airspace management and change processes appear well developed at Sydney. Extensive consultation and investment in community relations has taken place over a of number years

Source: Sydney Airport Masterplan 2039, April 2019; Airservices Australia, Key Airport Noise facts, 2020;

Sydney provides useful examples of clear communications around airport noise impacts

- Communication materials around the impact of noise are well presented using intuitive and engaging techniques including animations and videos
- In addition the airport's noise website offers a tailored experience for local communities
- Further information is readily accessible, including future planned developments as part of the 2039 airport Masterplan, role of governance bodies and frequency based noise charts
- Formal communication channels are also well developed, with the impact of overflight from the airport being reported in local land searches



Source: Sydney Airport Aircraft Noise website, https://aircraftnoise.sydneyairport.com.au/; Sydney Long Term Operating Plan (LTOP) http://www.airservicesaustralia.com/; Sydney Airport ANEF 2039; Home search solutions https://www.homesearchsolutions.com.au/sydney-flight-paths/

Sydney demonstrates a good level of engagement with local groups

Good level of engagement
Sydney Airport Community Forum monitors the operational restrictions imposed on Sydney Airport, acting as a powerful focal point for the local community, government & regulator to shape environmental and noise operating restrictions.

Long term operating strategy
A Long Term Operating Plan (LTOP) is set out by the Community forum and Airport, outlining: • Noise abatement procedures, including runway alternation, respite, operating procedures (CDA, CCD) • Future noise forecasts with a focus on the impact of frequency of overflight • Curfews, noise certification, cap on total movements within a given timeframe (24 hour period)

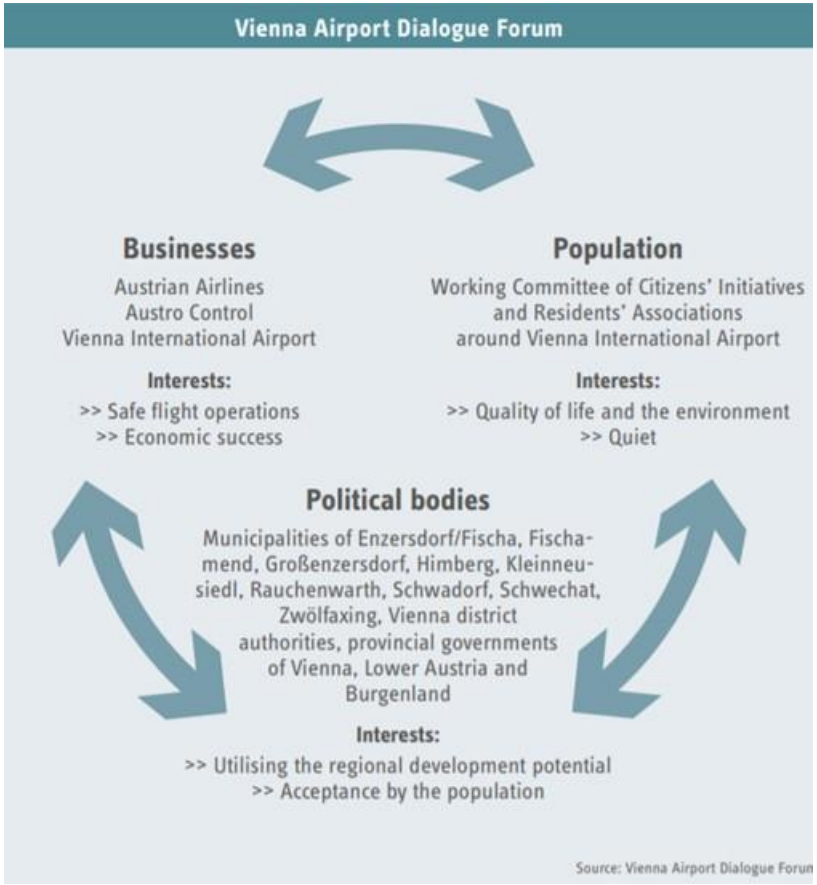
Notable best practice from elsewhere in Australia
Melbourne: Implemented procedures for preferential runway use and flight paths to reduce flights over residential areas. When local operating conditions permit flights are directed over the 'green wedge' areas to the north and west of the airport and over non-residential areas; both using PBN procedures. If flying over suburbs cannot be avoided, a minimum height restriction is applied over these areas. **Brisbane:** PBN arrivals routing make use of the 'River Track' (along the Brisbane River) to minimise the impact of noise over residential areas.

Source: Sydney Airport Masterplan 2039, April 2019; Airservices Australia, Key Airport Noise facts, 2020; Sydney Airport Traffic; https://aircraftnoise.sydneyairport.com.au/#FutureNoiseExposure

Vienna

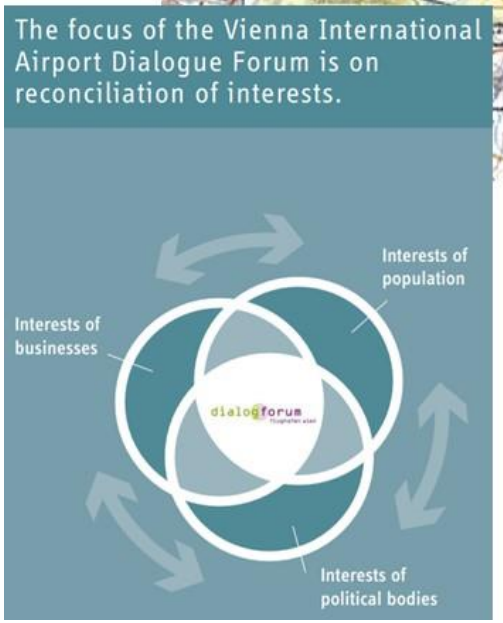
Vienna airport is often cited as best practice in terms of open, fair and transparent stakeholder engagement

- This engagement utilises two primary channels:
  - **Neighbourhood Committee:** composed of the airport managing director and the mayors of surrounding municipalities
  - **Dialogue Forum:** non-profit organisation financed by the airport and functioning as an information and communication platform; provides mediation with 120 municipalities, regional provinces, and citizens' action groups representing 2 million people
- The Dialogue Forum:
  - Monitors the compliance with the agreements concluded during mediation process.
  - Deals with issues, questions and conflicts arising through the development of air traffic and enlargement of the airport
  - Topics covered include: night flight restrictions, noise caps, an environment fund and noise prevention programmes, PBN routings and timetable of implementation
  - Critically municipalities and citizens can use the leverage of the forum to influence rule-based changes and, as such, affect changes to how the airport is run



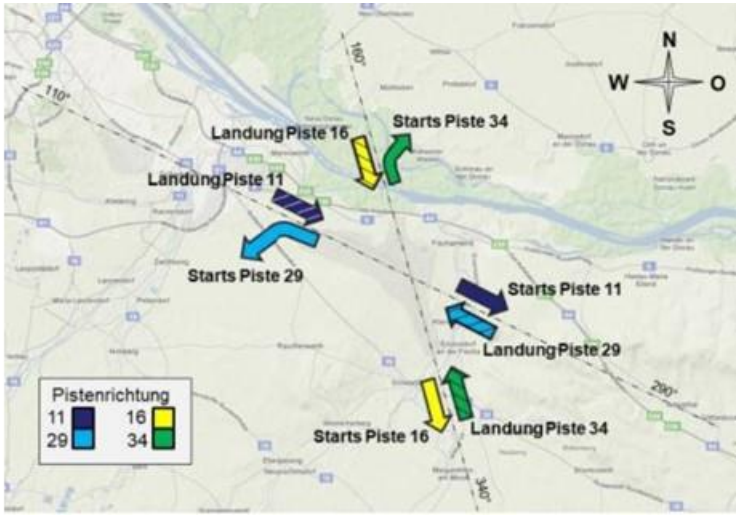
PBN was implemented in Vienna to reduce noise exposure and reduce track miles

- PBN implemented to reduce noise exposure to the local community, enable reduction in track miles and use curved approaches
- Extensive community engagement through the local dialogue forums has provided a useful platform from which consultations on specific route options can be developed with the local community
- PBN was implemented in line with existing operating restrictions including a
  - Preferential runway system
  - Ban on weekend night flights
  - Cap on aircraft movement numbers along given arrival and departure routes over a set period of time
- As part of SESAR (Single European Sky Research Project) the airport is investigating the possibility of recreating non-PBN ‘swathes’ by using multiple PBN routes



Further references for Vienna

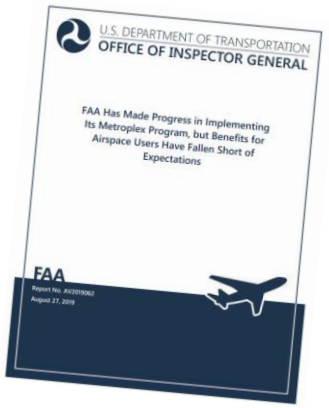
- PBN Experience from Real Implementations, Austro Control, Vienna/Austria, SDM PBN Workshop, October 2017
- Environment and Aviation; facts, measures & perspectives, Austrian Air Transport Industry Publication, November 2018
- Dialogue with surrounding communities & mediation processes, Vienna International Airport, 2020
- Dialogue Forum – Flughafen Wein, Community Website, 2020
- Noise Protection Programme, Vienna Airport, 2018
- Noise Management, Vienna Airport, 2020
- Online flight tracking and management system, Vienna Airport, 2020



Appendix V – US PBN Summary

The HCNF highlighted a recent report from US authorities on the impacts and progress of PBN implementation in the US

- This report assessed the FAA's (Federal Aviation Administration's) progress in implementing its Metroplex[1] programme. It compared planned to actual benefits for PBN identified by FAA and assessed the soundness of the methods used by FAA to forecast PBN benefits
- Findings of the report included:
  - FAA has completed PBN implementation in 7 of 12 Metroplex locations. The Agency does not expect to complete all remaining locations until 2021, four years later than originally planned.
  - Delays have occurred largely due to increased community concerns about aircraft noise
  - Delays have been compounded by a lack of automated decision support tools for controllers, unclear terminology used by pilots and controllers for referring to flight paths, and the lengthy procedure amendment process
  - Metroplex benefits to airspace users have fallen short of predictions: in post-implementation reports, FAA estimated annual benefits of $31.1 million, which is $30.5 million (49.5%) less than the minimum amount initially expected when FAA first planned each Metroplex site
  - Finally, FAA's methods for estimating benefits overly rely on judgment and are not well documented, limiting the ability to readily test the estimates' robustness and replicate results
- The key recommendation of the report is that community engagement should be focused, supported by an action plan and accompanied by improved documentation



Note 1: A metroplex is a geographic area covering several airports, serving major metropolitan areas. Further details of the programme can be found at Metroplex (faa.gov)

PBN implementation in the US demonstrates key learnings, including the risk of underestimating impacts

Airport	Impact assessment	Reported impact	Result
Baltimore	FAA issued a **Finding of No Significant Impact**. Implemented without proper environmental review and without the coordination with communities	Increase in frequency, density & concentration over limited area	Working group created - identify alternative routeings - Examine alternative procedures
Boston Logan	FAA undertook an Environmental Assessment (EA)	EA showed that communities would affected the same or more; but that certain communities would see a concentration of flights FAA projected noise changes as negligible from ground	FAA is working with Massport & Logan Airport Community Advisory Committee to develop a **runway-use system to provide relief from noise**
Charlotte	FAA issued a Finding of No Significant Impact. Changes were made without conversations involving most affected.	Concentrated flight paths	Airport Community Roundtable established
Chicago	Found that the **FAA does not communicate the range of uncertainty or complex factors associated with NextGen implementation** to Congress, aviation stakeholders, or the traveling public	Impacts compounded by a change in runway use at the same time as procedures introduced. Multi directional runways led to communities being constantly overflown	Noise mitigation plan (address airport noise was proposed in 2015: focused abatement, mitigation, communication, reporting and citizen involvement). Increase the number of runways allowed at O'Hare from 8 to 10 to reduce jet noise affecting some neighbourhoods and suburbs. Runway rotation/ alternation.

Source: FAA Has Made Progress in Implementing Its Metroplex Program, but Benefits for Airspace Users Have Fallen Short of Expectations, US Department of Transportation, Office of Inspector General www.oversight.gov

PBN implementation in the US demonstrates key learnings, including the risk of underestimating impacts

Airport	Impact assessment	Reported impact	Result
Denver	FAA Environmental Assessment	Routes moved since 2013; with more concentration and higher frequency during the late evening/early night period.	FAA **held community workshops** in 2017 - **procedures designed by communities**.
Los Angeles	FAA issued a Finding of No Significant Impact and Record of Decision. Held public meetings	Flight path has moved and become more concentrated.	FAA has proposed adding a new 6,000-foot minimum altitude requirement Noise mitigation programme implemented
Phoenix	FAA made significant changes without properly notifying the public or allowing the public to provide input	Routes condensed and lowered flight corridors over homes, historic districts, natural preserves and parks	Following a court ruling **the FAA agreed to reach out to residents while temporarily resuming the previous departure routes. FAA will develop satellite-based procedures for the original routes, seeking community feedback** throughout the process
San Francisco	Significantly increased noise levels distributed in narrow corridors. Palo Alto found itself under flight paths from all three major Bay Area airports	Eastward shift in flight paths, more low-flying aircraft that previously travelled over water began flying over parts of Santa Cruz	A 12-member appointed committee and an airport **roundtable committee** made recommendations in 2016 to solve the identified problems

PBN implementation in the US demonstrates key learnings, including the risk of underestimating impacts

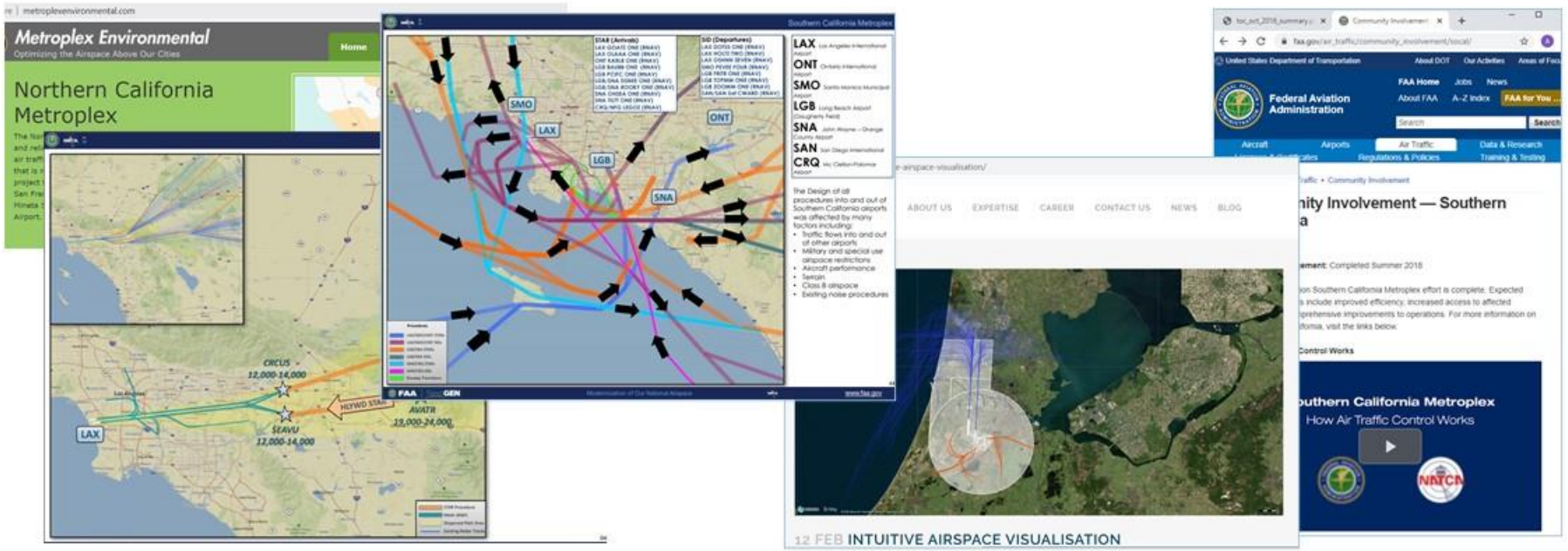
Airport	Impact assessment	Reported impact	Result
Seattle	FAA did not provide public with information or seek public comment or input	Narrower flight paths, resulting in a higher volume of aircraft travelling over effected homes. Some areas would be eliminated from the flight path, others that remained would be subjected to increased noise and pollution	**Some flight patterns changed after legal action** **Quiet Skies Coalition**
Washington DC - Ronald Regan	Residents **maintained that they were not given adequate notice of changes** to flight patterns that resulted in a significant increase in noise.	Replaced old flight patterns with new ones Major departure path routes aircraft alongside historic Georgetown	Establishing of pressure group ' DC Fair Skies' FAA held community workshops
Calgary	**Community outreach as part of the Canadian Airspace Change Protocol.** This included: public comment period, information on websites and newspaper adverts; Introductory presentations to the Airport Community Consultative Committee (ACCC); Information published on www.yyc.com (presentations, informative video, feedback forms and Open House locations and dates); Newspaper advertisements; Eight open house events with (1 to 1 dialogues); and A public feedback survey	**Reduction of complaints in relation to new flight paths**, whose aim was to reduce excessive aircraft noise over populated areas in the city. Drop in quantity of complaints correlated with use of RNP approaches – community supportive of increased use of RNP to reduced noise over specific neighbourhoods	Results: **process review after one year of implementation** and every 5 years; **Airport Community Consultative Committee** engaged in dialogue; The airport was able to make use of particular local geography and direct flights along PBN routes away from noise sensitive areas, including along the course of rivers and over industrial estates

Appendix VI – Examples of good practice in airspace change communications

Community engagement workshops are increasingly being complemented with computer visualisations…

1 **Visualisation**

US Airports implementing PBN allow the proposed flight paths to be downloaded as .kml files for use in 3D visualisation software, (eg Google earth). These files are supported by websites detailing the route locations and traffic patterns. Other organisations in Europe are using 3D visualisation tools, webtrack applications to tracking flights either in near real-time or see traffic patterns averaged over a longer period.



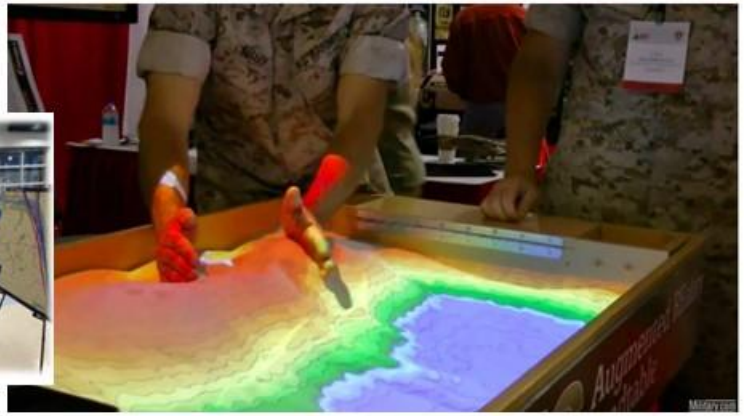
The availability of clear and accessible maps (both current and proposed future operations) is vital

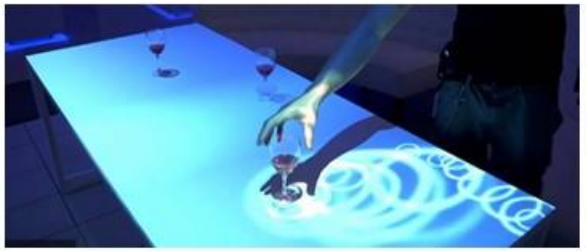
Source: Online sources of information and communication tools; faa.gov; metroplexenviornmnetal.com; https://to70.com/intuitive-airspace-visualisation/

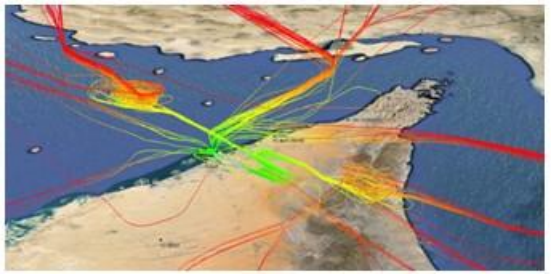
…and increasingly innovative technologies, to communicate concepts and route locations

2 **Innovative technologies**

Innovative technologies are being used to support traditional community engagement activities such as workshops, newsletters mailshots and presentations. For example sound booths are being used at using Heathrow to provide a demonstration of the experienced sound levels.







Source: Examples of advanced technologies used to augment traditional community presentations (centre); Average departure route swathes from Heathrow, (Webtrackmyneighbourood Heathrow.com), sound booths (https://www.arup.com/projects/virtual-reality-soundbooths and possible examples of future technology - Tabletop visualisations from desktop research including www.Heathrowconsultation.com