Brisbane New Parallel Runway Flight Paths Post Implementation Review

Independent Review

Final Report

Version 1.0

July 2022

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Summary

1. This report was produced by Trax International Limited (Trax). It describes the outcomes of our Independent Review of the Brisbane Airport New Parallel Runway (NPR) Flight Paths. Airservices Australia (ASA) commissioned Trax in January 2022 to provide impartial assurance of the NPR Flight Paths Post Implementation Review (PIR).[1] Trax is a global air traffic management advisory company specialising in flight path design, environmental impact assessments and stakeholder engagement. The Trax team reported directly to the ASA CEO and were tasked with identifying potential improvement opportunities across all aspects of the PIR. We have worked separately to the ASA team leading the PIR, conducting our own independent analysis. The scope of the Independent Review concentrated on the environmental performance and operational efficiency of the NPR flight path design, with a particular focus on the opportunities to limit and, where possible reduce the impacts of aircraft noise. In the context of this review, the NPR flight path design includes the arrival and departure routes that serve the dual runway operation at Brisbane Airport following the introduction of the NPR in July 2020. The procedures used by Air Traffic Control (ATC) to manage the progress of flights safely and efficiently and the airspace structures that integrate Brisbane traffic with the wider enroute network.

2. The Independent Review was conducted in two phases between February 2022 and July 2022. In the first phase, during February and March 2022, we engaged directly with ATC experts and airspace designers from ASA to understand the technical features of the NPR flight path design. We observed directly how the NPR flight paths are managed by ATC at the Brisbane Tower and Terminal Control Unit (TCU). We discussed the approach to the PIR, the issues raised by Brisbane residents following the introduction of the NPR and the potential for improvements with representatives from the local community through the Brisbane Airport Post Implementation Review Advisory Forum (BAPAF). Our analysis during phase 1 was also informed by engagements with Brisbane Airport Corporation (BAC), airlines operating at the airport, other aviation stakeholders, the Australian Civil Aviation Safety Authority (CASA) and the Department of Defence (Defence). The outputs of these engagements provided a wide range of operational, analytical and community perspectives on the performance of the NPR flight path design.

3. The first phase of the Independent Review identified an initial 'long list' of 49 potential improvement opportunities related to the NPR flight paths, ATC procedures, supporting technology and the approach to governance and stakeholder engagement. The potential improvement opportunities were set out in an Interim Report that provided a high-level evaluation of our initial observations.[2] We organised the opportunities identified during phase 1 into groups based on their potential to support five key objectives arising from the stakeholder engagement; to

   - Maximise flights over water;
   - Reduce noise impacts when overflying populations;
   - Optimise noise sharing arrangements;
   - Support sustainable growth in the airport's operations; and
   - Enhance engagement, coordination and governance processes.

[1] More information about the ASA led Brisbane Airport Flight Paths PIR, including the Terms of Reference are here

[2] The Brisbane NPR Flight Paths PIR Independent Review, Interim Report, Trax International Limited, March 2022 is here

4. The Interim Report emphasized that, although technically viable, some of the potential improvement opportunities may not be considered feasible or sufficiently beneficial on further examination, especially when evaluated in the context of other interdependent opportunities. We offered examples in the Interim Report of opportunities that may make sense to deliver before others and trade-off decisions where different opportunities pursue similar outcomes and a choice is needed about which approach to follow. The Interim Report concluded that the various options for proposed changes to the NPR flight path design should be considered collectively over the short, medium and longer term, as part of a coherent assessment that is influenced by engagement with all affected community and aviation stakeholder groups.

5. The second phase of the Independent Review was delivered between April and June 2022. The scope of phase 2 was to analyse the feasibility, benefits, impacts and dependencies of the potential improvements and consolidate the viable opportunities into manageable work packages. To support the analysis we conducted a series of additional stakeholder meetings, including Community Focus Groups and several workshops with BAC, key Airline Operators and the ASA team. The feedback gathered from the Community Focus Groups is summarised in Section 2 of this report and has helped to inform the scope of the work packages described in Section 3. This Final Report sets out the scope of the four work packages arising from the analysis and our specific recommendations regarding the approach to developing options for proposed changes to the NPR flight path design. The five key objectives, long-list of potential improvement opportunities from the Interim Report and the work packages and recommendations from this Final Report are mapped to one another in appendix A.

6. Figure 1 summarises the timeline of our activities and outputs across phases 1 and 2 of the Independent Review, from February to July 2022.

Figure 1: Timeline of activities and outputs across phases 1 and 2 of the Independent Review

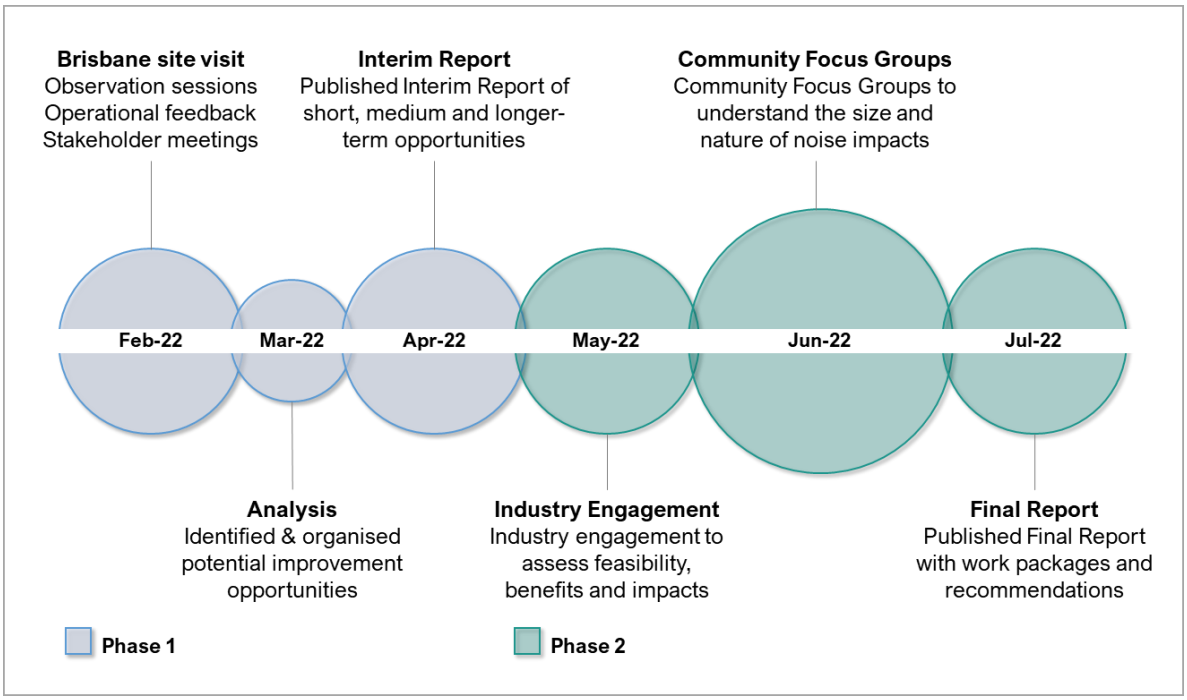


Table 1 summarises the scope of the work packages describe in the Final Report

Table 1: Summary of the work packages in the Final Report

#	Work package	Description
1	Strong, transparent and representative governance	Work package 1 aims to establish a strong, transparent and representative governance mechanism to oversee the development and assessment of options for change proposals included in packages 2, 3 and 4. It is envisaged that the governance mechanism is established in 2022 to coordinate the stakeholders required to participate in the work packages as part of a single joined-up Programme. Work package 1 includes options for the creation of a programme oversight, management and assurance function, a communications and engagement process and a long-term Noise Action Plan.
2	Maximise flights over water	Work package 2 aims to maximise the total number of flights that operate over water, reducing the noise and other adverse effects of aircraft overflying communities. It includes options for the development of changes to ATC procedures and adjustments to the airspace structure that may be deployed relatively quickly to extend the use of simultaneous opposite direction parallel runway operations (SODPROPS) when the meteorological (met) conditions and traffic levels permit.
3	Reduce the frequency and concentration of flights over communities	Work package 3 aims to reduce the frequency and concentration of aircraft overflying communities at lower altitudes through the development, assessment and engagement on options for small modifications to the existing NPR flight paths that remain aligned with the existing compass operations model. The options are intended to deliver short-term improvements in the management of noise, including targeted sharing where it is considered appropriate following engagement with all affected stakeholder groups.
4	Optimise the performance of the wider Brisbane airspace system	Work package 4 aims to optimize the environmental performance and operational capacity of the wider Brisbane airspace system through the development, assessment and engagement on a more expansive set of options for proposed changes to the airport's runway modes and flight paths that deviate from the compass operations model. It includes options for the introduction of noise sharing runway modes, the use of multiple routes for planned respite and how these broader changes to the NPR flight path design might be enabled by enhancements to the airspace structures that integrate Brisbane traffic with the wider enroute network.

7. It is important to emphasize that the options for proposed changes to the NPR flight path design included in the work packages are the outcome of the Trax team's independent analysis. ASA has conducted its own analysis of the NPR flight paths, ATC procedures and wider Brisbane airspace system through the PIR process. We expect ASA to consider our recommendations in the context of the PIR findings and undertake further detailed analysis, including a safety risk assessment, evaluation of policy and regulatory compliance and stakeholder engagement exercise before deciding how to proceed.

Final Report Recommendations

8. The Final Report Recommendations are set out in Table 2. The recommendations are organised into the four work packages, along with a description of the terms by which each recommendation may be addressed by the organisations responsible for developing options for the proposed changes.

Table 2: Final Report Recommendations

PACKAGE ONE: STRONG, TRANSPARENT AND REPRESENTATIVE GOVERNANCE
TIMELINES: DEVELOPMENT & IMPLEMENTATION IN Q3-Q4 2022

Ref	Recommendation	Description
1.1	Establish a Programme Oversight, Management and Assurance function that coordinates the development and assessment of options for change proposals to the NPR flight path design	The function may include a variation of the following: a) A senior-level oversight group tasked with coordinating the various activities at a strategic level to ensure they are coherent, transparent and aligned to the achievement of a balanced set of objectives. b) A programme management office that provides the disciplines required to ensure that roles and responsibilities are clear, stakeholders work to a common plan, activities are adequately resourced and the risks to delivering the proposed changes are well understood and managed. c) A technical coordination group to support the development of options from a technical perspective. d) An options development and assessment framework that ensures the criteria and methods used to evaluate the impacts of different options for change proposals are comprehensive and consistent. e) An independent assurance process that coordinates the engagement of qualified third parties not directly involved in the development of the change proposals to challenge specific aspects of the Programme from a technical and process perspective and build trust with external stakeholders.

1.2	Implement a joined-up Communications Plan for the aviation organisations that are responsible for developing options to communicate effectively with community stakeholders	a) Without an effective and well managed approach to communications, flight path changes may generate outcomes that are unacceptable to stakeholders and vociferously challenged. b) The importance of an effective communications is based on the expectation that, when done well, it improves the social, environmental and economic outcomes of flight path changes and increases stakeholders' trust in the process for the future.
1.3	Define the engagement process that will be followed to gather meaningful inputs from community and aviation stakeholders to help shape the change proposals	a) The engagement process should confer legitimacy on the development and assessment of options for change proposals. b) Those who may be affected by options for change proposals should be encouraged to actively participate in the development and assessment process. c) To be effective, stakeholders should be offered the information, time and support to make meaningful contributions. d) The outputs of community engagement must be considered conscientiously by the proponents and have the potential to influence the final designs.
1.4	Produce a long-term Noise Action Plan that clearly lays out how the change proposals and other measures not related to flight path design will contribute to limiting and where possible reducing noise over the short, medium and long-term as traffic levels grow	In this capacity the Noise Action Plan could: a) Ensure that the specific noise mitigation measures included as part of the plan as it evolves (including trials, research projects and major changes) are scoped effectively, with agreed objectives, milestones, accountabilities and performance measures. b) Track the progress of options development, assessment, engagement and implementation plans linked to specific noise mitigation measures. c) Manage the dependencies associated with noise mitigation measures over time, including the rate and scale at which the ATC operation and aircraft operators can adapt to successive changes.

		d) Resolve issues that may impact the achievement of agreed milestones toward the development and implementation of noise mitigation measures. e) Maintain cross-industry and community stakeholder involvement and momentum behind the development and implementation of options to manage and where possible reduce the impacts of aircraft noise.

PACKAGE TWO: MAXIMISE FLIGHTS OVER THE WATER

TIMELINES: DEVELOPMENT & IMPLEMENTATION IN 2023

Ref	Recommendation	Description
2.1	Develop and implement an ATC Operating Plan to extend the use of SODPROPS	a) Develop and implement an ATC Operating Plan to extend the use of SODPROPS with a focus on weekday evenings, Saturday afternoons and Sunday mornings, when the met conditions and traffic levels permit. b) Examine the costs, benefits and operational impacts of extending the use of SODPROPS, including the provision for a moderate amount of flight delay to maintain the use of the mode when traffic demand approaches the maximum capacity for simultaneous opposite direction parallel operations.
2.2	Reduce the workload and complexity for Brisbane ATC associated with extending the use SODPROPS	a) Engage with Defence and RAAF Base Amberley to consider options for the targeted release and/or shared use of specific portions of Amberly segregated airspace to reduce the workload and complexity for Brisbane ATC associated with extending the use of SODPROPS. b) Examine options to amend the ATC procedures for coordinating flights that route through the Brisbane airspace system inbound to other destinations and may constrain Brisbane ATC's ability to extend the use of SODPROPS. c) Examine options to amend specific flight paths that serve traffic routeing through the Brisbane airspace system inbound to other destinations and may constrain Brisbane ATC's ability to extend the use of SODPROPS.

2.3	Modify specific SODPROPS flight paths and ATC procedures, where required, to maximise the potential improvements associated with recommendations 2.1 and 2.2	a) Examine options to reduce the track miles and aircraft emissions generated by the specific arrival and departure routes that flights use during SODPROPS, including the potential to incorporate arrival routes designed to advanced navigation standards. b) Examine options to amend the ATC procedures used to manage inbound traffic when SODPROPS is in use to enable pilots to optimise the descent to final approach. c) Examine short-term options to moderately increase the tactical use of over-the-water operations when the simultaneous parallel runway modes are in use, for example launching occasional departures in a 01 direction while the airport is configured for 19 operations when traffic conditions, met constraints and other operational factors confirm it is safe to do so.

PACKAGE THREE: REDUCE THE FREQUENCY & CONCENTRATION OF FLIGHTS OVER COMMUNITIES

TIMELINES: DEVELOPMENT DURING 2023 & IMPLEMENTATION IN 2024

Ref	Recommendation	Description
3.1	Develop and assess options for change proposals to reduce the frequency and concentration of flights over communities, and where they are feasible, engage with all affected stakeholders on the impacts and trade-offs	Proposals to modify the existing flight paths over communities in the city and outer suburbs should follow a transparent and coherent process to evaluate the impacts of different options and conduct meaningful engagement with all affected stakeholders about the trade-offs if change proposals to deliver improvements create new noise impacts or other negative outcomes. The options may build on a combination of the following suggestions arising from our analysis and/or include different options identified by ASA and other stakeholders: a) Options to redesign the two departure routes over the city from the new runway to the north so the flight paths are offset from the extended runway centreline and follow a different track over the ground to that overflown by inbound traffic on final approach to the new runway. b) Options to redesign the two departure routes over the city from the new runway so they diverge and the flight paths each follow different tracks over the ground. c) Options to redesign the two departure routes over the city from the existing runway used after 10 pm so the flight paths follow a different track over the ground to that overflown by the new runway departure routes used in the daytime.

		d) Options to introduce an ATC procedure to vector outbound flights using the two departure routes over the city from the new runway when a specific altitude has been reached (e.g. 4000ft) that would disperse the tracks over the ground because aircraft with higher climb rates would reach the specified altitude quicker and turn sooner. e) Options to redesign the three departure routes over the city from the existing runway to the south so they follow different tracks over the ground and potentially save track mileage, by turning sooner and/or tighter. f) Options to redesign two of the arrival routes over the city to the new runway from the north so the flight paths converge further to the west and the tracks over the ground are different to those overflown by outbound traffic heading north. g) Options to re-evaluate three of the standard compass headings that non-jet departures are instructed to follow after take-off (subject to the impacts on operational capacity) so that the tracks over the ground may be dispersed or repositioned over water. h) The development of a baseline option that describes the actual impacts created by the existing NPR flight paths over the city and outer suburbs in terms that are directly comparable to the options for any proposed modifications.

PACKAGE FOUR: OPTIMIZE THE PERFORMANCE OF THE WIDER BRISBANE AIRSPACE SYSTEM

TIMELINES: DEVELOPMENT IN 2023 & 2024, IMPLEMENTATION FROM 2025

Ref	Recommendation	Description
4.1	Develop and assess options for change proposals to introduce noise sharing through runway alternation using segregated and semi-mixed runway modes with an updated flight path design that deviates from compass operations, and if feasible engage with all affected stakeholders	a) The options included in work package four will take longer to develop than those in packages two and three because of the scale and complexity of the proposed changes, extending the expected timelines for implementation into 2025. b) The options to introduce new noise-sharing runway modes supported by an updated flight path design that deviates from compass operations should be configured to align with the modifications implemented as part of package three. c) It is important to emphasize that the areas that would benefit from temporary periods of relief through runway alternation would at other times experience comparatively more noise events when the alternation schedule is reversed.

		d) It is envisaged that the segregated and semi-mixed runway modes would be used alongside the simultaneous parallel modes and SODPROPS as part of a system to manage noise as traffic levels grow, designed with community and aviation stakeholders in a long-term Noise Action Plan. e) The options for a runway alternation schedule should consider the use of the semi-mixed modes, where departures use both runways and arrivals operate to one, or arrivals use both runways and departures operate from one, so that the airport's capacity can be allocated to accommodate peaks in traffic demand at different times. f) The options for the dimensions of the noise relief areas introduced as part of runway alternation should be informed by stakeholder engagement with the affected communities. Significant engagement with communities and aviation stakeholders should also be conducted to gather inputs on the proposed changes to the flight path design needed to ensure the noise relief areas are effective when in use and the airport can operate efficiently in all modes. g) Engagement with community and aviation stakeholders should influence how the noise relief areas are used if established, in particular the schedule of alternation. h) Dedicated safety assurance work, ATC simulations and aviation stakeholder engagement should be conducted to assess the risks associated with switching between the segregated modes and simultaneous parallel operations.
4.2	Develop and assess options for change proposals to introduce multiple arrival routes over the city that can be alternated to a planned schedule to deliver respite, and if feasible engage with all affected stakeholders	a) The NPR flight path design includes several arrival routes that use advanced navigation standards for more precise and flexible approaches and may be re-configured and supplemented with additional routes to deliver planned respite for some communities through alternation. b) The existing IT systems used by Brisbane ATC to support air navigation do not have the capacity to manage multiple alternating arrival routes. ASA is implementing a national programme of IT system upgrades that when complete is expected to enable options for respite routes on arrival to be developed and assessed for the Brisbane airspace system. c) Options to introduce respite routes on arrival should be incorporated into the proposed changes to the flight path design required to enable runway alternation.

d) If following the outcome of stakeholder engagement, options to implement runway alternation are not progressed, respite routes on arrival should be considered in isolation through a separate engagement exercise with community and aviation stakeholders for use with simultaneous parallel operations.

e) It is important to emphasize that the areas that would benefit from the use of respite routes on arrival would at other times experience comparatively more noise events when the alternation schedule is reversed and that the total population overflown would increase.

f) The introduction of respite routes would add significant complexity to the Brisbane airspace system, creating interactions with other arrival and departure routes and interdependencies with the airspace structures that integrate Brisbane traffic with the wider enroute network. The improvements expected from introducing respite routes should be assessed against the impacts on flight efficiency and aircraft emissions where longer tracks and sub-optimal climb and descent profiles are required to accommodate alternation.

Criteria for analysing potential improvement opportunities

9. The Trax team conducted a qualitative analysis of the potential improvement opportunities identified in the Interim Report. The analysis guided the scope of the work packages set out in Table 1, alongside the feedback gathered from the Community Focus Groups and industry engagement activities. A range of factors were considered in the analysis, including the positive and negative impacts that may arise from each opportunity, the inputs required to deliver them and the dependencies with other aspects of the NPR flight path design. The assessment approach was aligned to ASA's Flight Path Design Principles and tailored to our understanding of the local circumstances in Brisbane.[3] The positive and negative impacts that may arise following the implementation of a particular opportunity were analysed in five themes.

    - Safety risk and performance
    - Environmental impacts of overflight at lower altitudes, principally noise
    - Operational capacity and resilience
    - Flight efficiency, aircraft emissions and fuel burn
    - Integration with the wider airspace system

10. The overriding principle of airspace design and ATC operations is that safety is paramount. The Airservices Act 1995 requires that ASA treats safety as its primary consideration when exercising its functions, including flight path design. Aviation in Brisbane and Australia more generally has an excellent safety record. ATC keep aircraft safely separated by set distances. All potential interactions between traffic flows, for example where two routes cross or where faster aircraft begin to catch up with slower ones, are carefully managed. The more complex the interactions the more workload or capacity ATC must dedicate to ensuring safe separation is maintained. If there is a risk that an acceptable level of workload may be exceeded, the need to maintain safety will by necessity require ATC to limit the flow of traffic, sometimes resulting in delays. Any options for proposed changes that may introduce additional complexity to the NPR flight path design must be carefully managed to ensure there is no degradation in the established level of safety performance and that any new risks have effective mitigations. In addition, the availability of specialist resources and the rate and scale of change that Brisbane ATC can safely accommodate are important limiting factors on how the change proposals are developed and the timelines for their implementation.

11. Many of the opportunities identified in the Independent Review involve trade-off decisions where factors are affected positively at the expense of negative impacts elsewhere. Future work to develop and assess options for change proposals and engage with stakeholders must strike a careful balance across these competing factors, with a focus on optimising the performance of the overall Brisbane airspace system. While safety is the primary concern when considering proposed changes to flight paths or ATC procedures, operational capacity, resilience, flight efficiency and noise outcomes are also important considerations. Safety performance will never be the subject of a trade-off. However, the extent to which constraints on capacity, resilience, flight efficiency or noise outcomes may be required to maintain safety and mitigate the risks of implementing a potential opportunity could often be a factor in the decision to choose one improvement opportunity over another.

[3] ASA's Flight Path Design Principles (2020) are here

12. At lower altitudes, the most significant environmental concern associated with flight paths is the impact of aircraft overflight. The Independent Review is particularly focused on opportunities to limit and where possible reduce the environmental impacts of overflight at lower altitudes, primarily in terms of noise, but also considering air quality, tranquillity and biodiversity. The introduction of new flight paths designed to more advanced navigation standards (that are often accompanied by a reduction in ATC vectoring) can bring more intense levels of aircraft concentration and therefore noise. The average level of noise per flight has improved significantly in recent decades, driven by the introduction of quieter aircraft. For example, the Boeing 747, one of the noisiest aircraft in the fleet has been phased out and replaced by newer wide-body aircraft like the Boeing 787, Airbus A350 and the larger A380. Some older, noisier aircraft still operate at Brisbane Airport, but there is an expectation that the trend will continue, and comparatively noisier airframes will progressively be replaced. However, some communities experience more noise due to the growth in traffic levels and others from the redistribution of noise impacts between different areas.

13. The redistribution of noise impacts away from more sensitive areas with the objective of sharing assumes that there are adjacent areas that flight paths can be moved to, which are less sensitive to noise. The relative noise sensitivity of areas is difficult to estimate. There is a risk that improvements delivered in one area may lead to a redistribution of noise impacts to other areas, disrupting new communities. The effects of new, more frequent or more concentrated noise arising from the deployment of proposed changes that deliver improvements elsewhere must be carefully managed and guided by a coherent and transparent community engagement process that enables affected stakeholders to influence the trade-off decisions when noise redistribution may be the outcome.

14. The aviation sector as a whole is experiencing growing pressure to reduce the environmental impact of flights. Opportunities to improve the efficiency of the airspace are part of a broader approach to decarbonise aviation in a way that preserves the benefits of air travel. The industry expects a significant proportion of the required emissions reductions will come from improving the efficiency of aircraft, airports and airspace. As a result, the impact on flight efficiency of the options for change proposals is another important factor in the assessment. In this context, flight efficiency refers to aircraft following shorter flight paths and optimised climb and descent profiles. Flight efficiency is easily measured by comparing an actual flight path of an aircraft against the theoretical optimum – i.e. the shortest track distance and most efficient vertical profile.

1. Background

1.1. Brisbane Airport's New Parallel Runway

Brisbane Airport Overview

15. Aviation keeps Brisbane connected and provides the transport links that the city and broader State of Queensland need for business, tourism and economic growth. Brisbane Airport is a major commercial air transport hub that connects the Brisbane area with more than 50 towns and cities across Australia and over 30 international destinations. The airport is located on the coast, with Moreton Bay to the north and east. Brisbane City and most of its outer suburbs are situated to the west and southwest of the airport. BAC is responsible for the planning, development and operations of the airport under the provisions of the Airports Act 1996 that facilitated privatisation. ASA are responsible for providing ATC services, managing flights into and out of Brisbane Airport and across the wider Australian airspace system. ASA are also responsible for the development and implementation of flight path changes. Brisbane Airport served c.23 million passengers in 2019, travelling on c.195,000 flights. Domestic travel made up c.82% of the total flights, with c.18% serving international travellers. The airport also handled c.131,000 tonnes of freight.

Economic Drivers and Forecast Traffic Growth

16. The sustainable growth in aviation at Brisbane Airport benefits local communities and the wider Queensland economy given its unique geographical position and the needs of its residents, businesses, industrial sectors and tourists. Tourism is one of Queensland's leading industries, with millions of interstate and international visitors visiting the region each year, contributing c.AUD $23 billion to the local economy and both, directly and indirectly, employing c.207,000 Queenslanders in 2020.[4] Tourism consumption in Queensland from international travel enabled by Brisbane Airport totalled c.AUD $6.4 billion in 2020. Queensland has traditionally been considered a resource state with mining activity contributing c.12% of economic activity in 2020. A large proportion of the non-jet traffic operating to and from Brisbane airport provides essential connectivity for the mining sector.[5] Queensland's economy has also successfully diversified into professional and financial services, supported by an innovative and highly skilled workforce. The air transport connections enjoyed by Brisbane help it play an increasingly important financial role on the global stage.

17. The demand for aviation generally reflects the underlying growth in populations and economic activity of a particular region. Brisbane is home to c.1.3 million people and generated c.AUD $180 billion in Gross Regional Product during 2021.[6] The Queensland economy is growing at over 3% per year as the State recovers from the impacts of the Covid-19 pandemic. Over the long term, BAC expects flight numbers to grow to c.520,000 per year in 2054. Traffic levels were significantly lower than expected during 2020 and 2021 due to international and domestic travel restrictions. Passenger numbers dropped to c.7.7 million in 2020. The travel restrictions were largely removed in Q2-2022, and flight numbers are recovering rapidly.

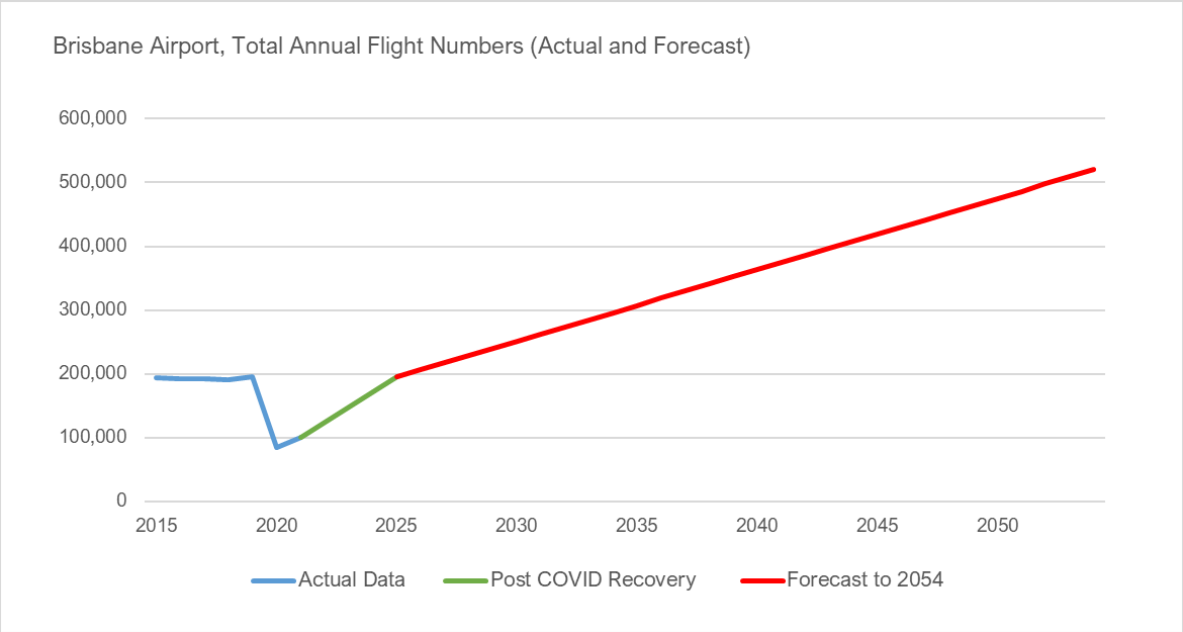
[4] Tourism Queensland - Economic Key Facts (2021)

[5] About the Queensland Economy - Queensland Treasury (2020)

[6] Brisbane City Council (2022)

18. Figure 2 illustrates the forecast growth in flights operating at Brisbane Airport; following the recovery in flight numbers to pre-pandemic levels in 2024/25, traffic is forecast to continue growing to reach c.520,000 flights per year in 2054.

Figure 2: Forecast growth in flights operating at Brisbane Airport to 2054



New Parallel Runway Development

19. The introduction of a parallel runway was a key feature of the long-term plan for Brisbane Airport since it opened in 1988. The NPR is a crucial piece of infrastructure required to meet the forecast growth in demand for aviation from the communities that the airport serves, now and for future generations. A proposal for the construction of the NPR was included in the Brisbane Airport Master Plan in 2003. The proposal was subject to two important pieces of legislation – the Airports Act, 1996 and the Environment Protection and Biodiversity Conservation (EPBC) Act 1999. To fulfil the requirements of both Acts, BAC developed a Major Development Plan (MDP) and an Environmental Impact Statement (EIS). The draft MDP and EIS were released for public comment between October 2006 and February 2007. Construction of the new runway was approved in 2007 by the government ministers for Environment and Transport. Ground improvement works for the NPR were delivered between 2012 and 2015. Runway construction started in 2016, and the NPR opened in July 2020, during the first phase of the pandemic.

NPR System Overview

20. The NPR system, illustrated in figure 3, features two wide-spaced parallel runways in a north-east/south-west alignment (at approximately 10/190 degrees) to take advantage of the prevailing winds and increase the number of flights operating over Morton Bay. The runways are situated 2km apart to maximise the number of flights that can land and depart when operated together in a dual mode. The new runway is displaced further north than the existing runway, closer to the water, so that new arrivals and departures overfly communities to the south at higher altitudes. The apron and taxiways also occupy the northern portion of the airport's sizeable 2,700-hectare estate, creating a buffer between aviation operations and the community. The new runway is 3,300 metres long, and the existing runway is 3560 metres. Brisbane has a subtropical climate with high

temperatures for much of the year. Aircraft require more runway distance to take off and land in hot weather. The number of hot days and the likelihood of temperature increases linked to climate change were important considerations when designing the length of the new runway.

Figure 3: Illustrative overview of the Brisbane Airport NPR system

21. The parallel runways have the same numerical designation (01 and 19) because they face in the same direction (010 degrees and 190 degrees). They are assigned left (L) and right (R) descriptions to distinguish the four runway ends that aircraft land to and take off from – 01L, 01R, 19L and 19R. The numerical designation is based on the direction the aircraft is travelling in, and the left and right descriptions translate to the view from the aircraft. For example, flights taking off over the water on the new runway depart from 01L, heading 10 degrees on the left runway, with the existing runway to the right. As a result, the new runway is known as 01L/19R and the existing runway is the reverse, 01R/19L.

22. Brisbane Airport currently has two main terminals: the International Terminal and the Domestic Terminal which are located 1.5 kilometres apart, with the International Terminal to the south. As part of the development of the 2020 Master Plan, BAC undertook a comprehensive review of the existing development strategy for the terminal areas. The review culminated in a flexible twenty-year terminal development plan that includes proposals for a Future Northern Terminal and a Future Western Terminal that are intended to provide integrated domestic and international operations. The impact of the terminal development plan on airport operations is an important factor in the long-term performance of the NPR system and the flight path design that supports it.

1.2. NPR Runway Modes of Operation and Flight Path Design

NPR Runway Modes of Operation

23. The introduction of the NPR system and associated flight path design changed how aircraft arrive and depart at Brisbane Airport. The EIS considered various concepts for potential flight path designs to support the NPR system and recommended a preferred option in 2007.[7] ASA produced the NPR flight path design several years later (between 2016 and 2019) under the regulatory oversight of CASA. The NPR flight path design introduced new routes and airspace structures incorporating more advanced air traffic management (ATM) concepts, changes in the approach to noise modelling and the evolution of the aircraft fleet mix operating at the airport. The flight path design is primarily intended to serve a compass operations model. In a compass operation, aircraft are allocated a runway based on the direction of travel to their destination (for departures) or from their point of origin (for arrivals). For example:

    - Outbound flights departing to destinations either south or east of Brisbane, such as Sydney, Melbourne and New Zealand, are allocated the existing (southernmost) runway. Similarly, inbound flights that originated from locations to the south or east are allocated the existing runway on arrival.
    - Outbound flights departing to destinations either north or west, such as Perth, Cairns and most of the international traffic that routes via Asia and the Middle East are allocated the new (northernmost) runway. Inbound flights arriving from the north and west are allocated to the new runway in the same way.

24. There are some exceptions when the compass operations model may not be applied. In poor weather conditions, ATC may re-allocate flights to the other runway for safety reasons. If one runway is over-allocated due to peaks in the schedule (for example, a large number of departures to the south in busy hours), ATC may re-allocate some flights to the other runway to reduce delays from aircraft holding in the air or queuing on the ground. In addition, as part of the project approval for the NPR, a Noise Abatement Procedure (NAP) applies to the southern end of the new runway that it should not be used during the night period (10 pm to 6 am)[8].

25. The airport typically operates using both runways at the same time, with flights arriving and departing simultaneously, in one of four main runway modes of operation. ATC decide which mode to use depending on the direction and strength of the prevailing winds, the volume of flights scheduled to land and depart in the coming hours and the impact of aircraft noise on communities. Aircraft operate safely and efficiently when landing and taking off into the wind. A limited number of flights can operate with a moderate tailwind in dry conditions when the visibility is good. A tailwind limit is applied at Brisbane Airport based on international standards of 5 knots.[9]

[7] Volume D of the EIS assesses changes to the airspace system to accommodate the new runway, including flight paths and community exposure to aircraft noise, as well as the potential impacts of aircraft emissions on the local and regional air quality.

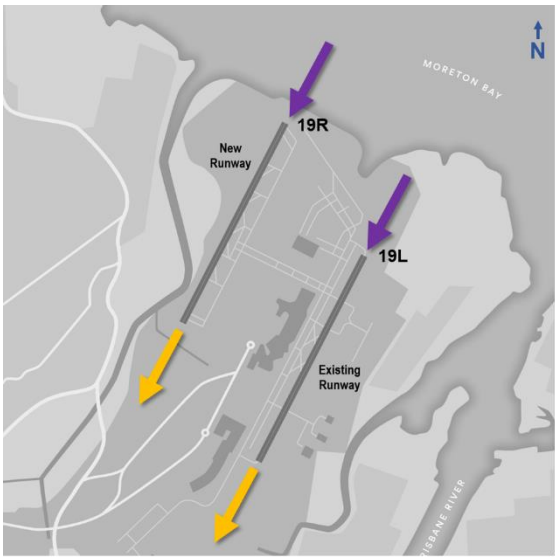
[8] The NAP does allow for a limited number of non-jet departures from 5 am onwards and may be temporarily paused in the event of an emergency or to meet specific requirements, such as runway maintenance works.

[9] The standard is set by the International Civil Aviation Organisation (ICAO) a specialized agency of the United Nations.

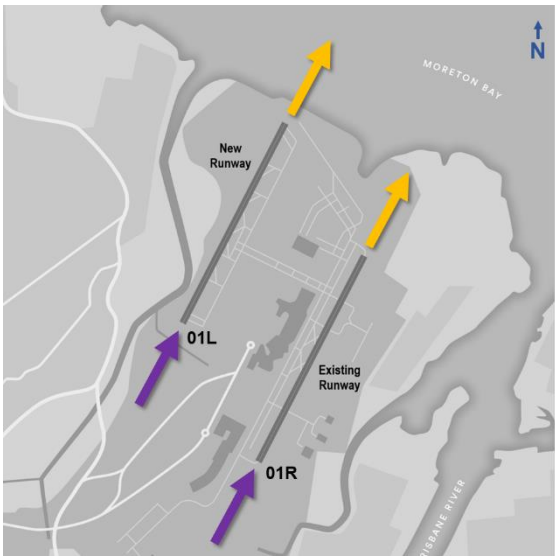
26. Figure 4 summarises some of the typical runway modes of operation that can be used at Brisbane Airport since the introduction of the NPR.

Figure 4: Typical NPR runway modes of operation in use at Brisbane Airport

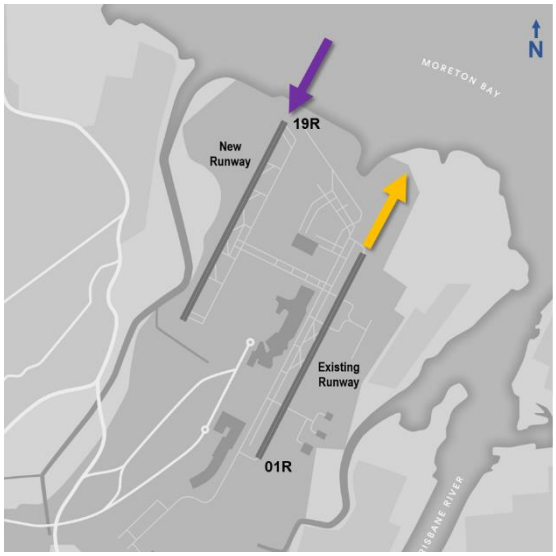
19 Simultaneous Parallel Operations



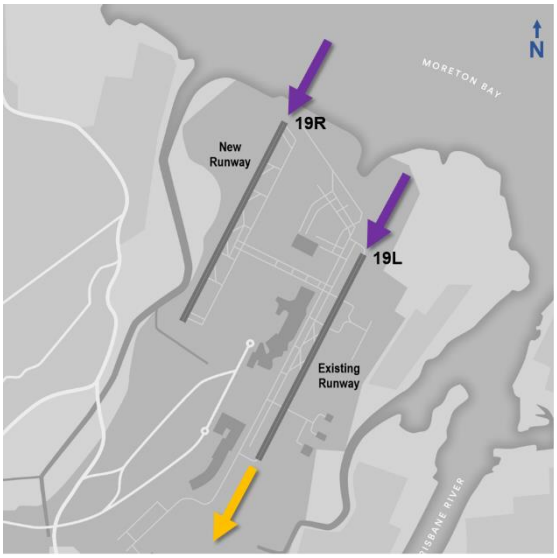
01 Simultaneous Parallel Operations



SODPROPS



Example of a 19 Semi-mixed Operation



- The top left panel illustrates 19 Simultaneous Parallel Runway Operations: Inbound flights arrive over the water, and outbound flights depart over the city. This high-capacity mode can accommodate a large number of flights and is used more often in the winter when the prevailing winds are from the south.
- The top right panel illustrates 01 Simultaneous Parallel Runway Operations: Inbound flights arrive over the city, and outbound flights depart over the water. This high-capacity mode can accommodate a large number of flights and is used more often in the summer when the prevailing winds are from the north.

- The bottom left panel illustrates Simultaneous Opposite Direction Parallel Runway Operations (SODPROPS): Inbound flights arrive over the water onto the new runway, and outbound flights depart over the water from the existing runway, leaving the city and most outer suburbs free from aircraft noise. A small number of non-jet aircraft may operate over the city during SODPROPS. This low to medium capacity mode can accommodate a limited number of flights when conditions are dry, visibility is good, and the tailwind component affecting either arrivals or departures does not exceed 5 knots. If visibility is less than 8km or the cloud base is lower than 2,500ft the airport can revert to a reciprocal mode (arrivals and departures operating in opposite directions over the bay, nose to nose, from a single runway), but the capacity is much lower (less than 12 flights per hour).
- The bottom right panel illustrates an example of one of the Semi-mixed modes of Operation in a 19 configuration: One runway is used exclusively for arrivals over the water and the other is used for a mixture of arrivals over the water and departures over the city. Alternatively one runway may be used solely for arrivals, and the other for a mix. In the segregated modes, one runway is used for departures only, and the other runway is used for arrivals only. The airport may also use a single runway mode of operation with arrivals and departures landing and taking off in the same direction (either 19 or 01) from the same runway (either the existing or the new).

27. Prior to the NPR, Brisbane Airport operated with a single main runway (now referred to as the existing runway) and a shorter cross runway, situated on a 140/320 degree axis. The cross runway 14/32 was decommissioned in April 2020 in preparation for the introduction of the NPR system. The airport used three main modes for jet traffic; 01 (arrivals over the city, departures over the water), 19 (departures over the city, arrivals over the water) and reciprocal mode, used for noise abatement during the night period. The cross runway was mainly used for light aircraft arriving from the northwest and departing to the southeast when the main runway was in a 19 configuration and occasionally during 01 and reciprocal operations.

NPR Flight Path Design

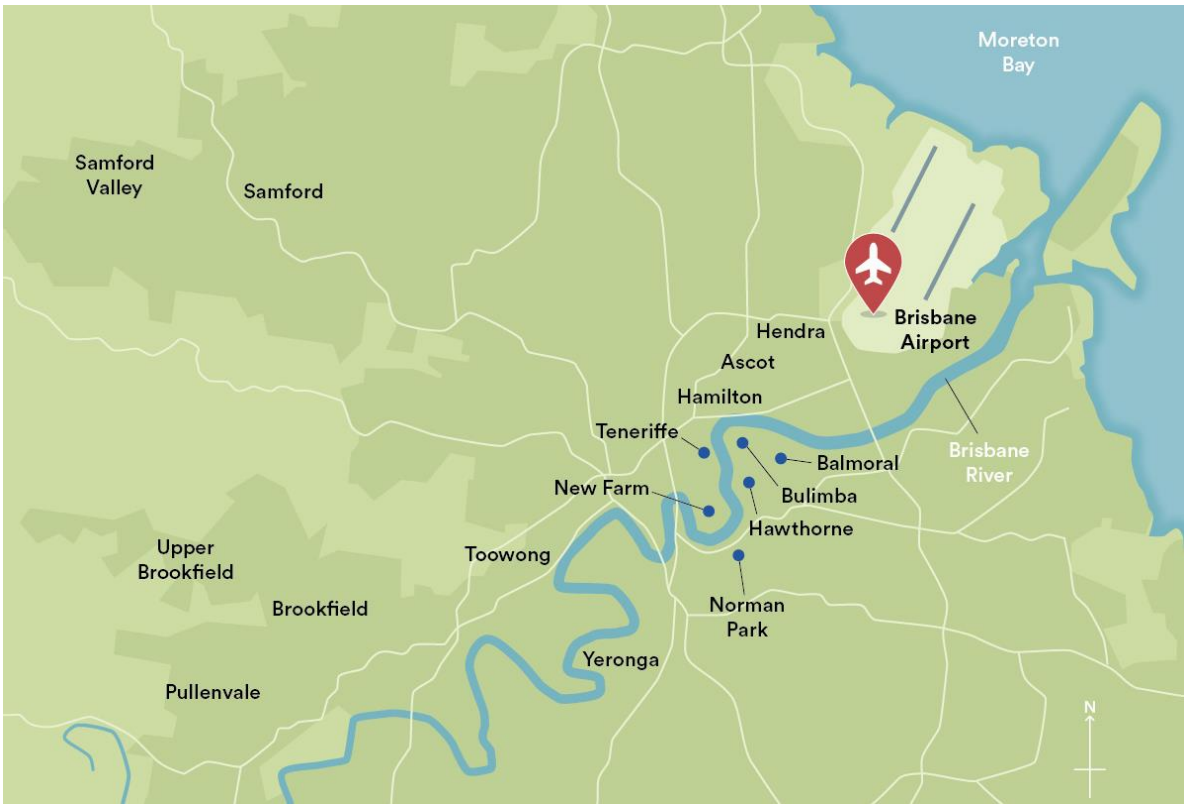
28. The EIS/MDP included a high-level airspace design that served as the concept of operations for the development of specific flight paths. ASA produced the final NPR flight path design using the EIS airspace design concept as an important guide, recognising that it formed the basis of the NPR project approval. The NPR flight path design provides a dedicated set of arrival and departure routes to and from the four runway ends. The flight paths are primarily configured to serve traffic in the directions required for a compass operations model and to deliver SODPROPS.

29. Flight path design is a complex task, involving technical analysis, environmental assessments, industry engagement, community participation, safety assurance and regulatory approvals. The design process requires high levels of coordination across the stakeholders involved. ASA incorporated a detailed set of air traffic control, aircraft operator and external stakeholder requirements into the design process, including, safety performance, runway and airspace capacity and flight efficiency. The EPBC Act requires ASA to assess the potential environmental significance of any changes to the flight path design. All proposed changes to the airspace structure and flight path design in Australia are developed and implemented following an airspace change process that is overseen by the CASA Office of Airspace Regulation. The ASA proposal for the changes needed to implement the NPR flight path design was submitted to CASA in 2018 for approval, along with a suite of supporting documentation regarding safety assurance, operational procedures and updated noise modelling.

1.3. Community concerns raised following the NPR opening

30. Despite lower-than-expected traffic levels, complaints from Brisbane residents regarding aircraft noise started to grow following the NPR opening. The Aircraft Noise Ombudsman (ANO) received 265 complaints up to June 30th 2021. Most of the complaints were raised during November and December 2020, including one from the Brisbane Flight Path Community Alliance (BFPCA) that included a survey of 2,075 residents. Most complaints originated from areas nearer to the NPR. A small but significant number related to areas considerably further away. When viewed collectively, the complaints highlight the community's general expectation that the NPR would lead to a larger share of Brisbane traffic arriving and departing over water and their concerns that the noise impacts in the city and surrounding suburbs are greater than expected. Figure 5 illustrates the areas where the majority of the complaints were raised.

Figure 5: Areas where the majority of complaints were raised following the NPR opening



Brisbane Flight Path Community Alliance

31. The Brisbane Flight Path Community Alliance (BFPCA) was formed to bring together the communities impacted by the NPR flight path design, in order to collaborate on, and advocate for, actions to mitigate the effects of aircraft noise, as well as other impacts. BFPCA's goal is that best practice design principles be applied to minimise the impacts of aircraft overflight while maintaining the economic benefits of the airport and the aviation industry in Queensland. Between December 2020 and January 2021 BFPCA conducted a Community Survey, releasing their findings in a report in February 2021 that provided a summary of the community experience since the NPR flight path design was introduced. The results of this survey were used to form the basis of the BFPCA's submission to the Australian Aircraft Noise Ombudsman's multiple complaints review in April 2021.

Australian Aircraft Noise Ombudsman's Multiple Complaints Review

32. The Australian Aircraft Noise Ombudsman (ANO) received 265 complaints up to June 2021, regarding the effects of aircraft noise following the introduction of the NPR flight path design. One complaint from the BFPCA incorporated a survey of 2,075 residents adversely affected by noise. In response the ANO conducted a review of ASA's environmental assessment of the impact of the flight paths developed for the NPR and its community engagement with potentially affected residents.[10] In particular, the ANO review recommended that the NPR flight paths PIR includes an engagement process that provides reasonable opportunities for community stakeholders to make contributions and suggest alternatives to the current flight paths.

Brisbane Airport Post Implementation Review Advisory Forum

33. The BAPAF was established by the Government in September 2021, in recognition of the significant community interest in the NPR flight path design and the need to have an independent view of the PIR. The BAPAF aim to provide ASA with a community-orientated forum that can be actively engaged throughout the PIR process. The forum received 385 submissions from residents across 47 Brisbane suburbs about the PIR that raise several concerns, including the volume of flights over populations, the management of noise and the engagement process. The first BAPAF quarterly report recommended several short-term noise improvement measures, specifically; a trial requiring all jet traffic to use the full length of the runway on departure (opportunity B1.1 in the Trax Independent Review Interim Report), a trial to extend the use of SODPROPS between 6 am and 8 am on weekends (linked to recommendation 2.1 of the Final Report) and the introduction of a noise abatement procedure requiring jet traffic to remain on the published departure route until 10,000-12,000ft. (opportunity B1.3 in the Interim Report. BAPAF also recommended the appointment of an independent specialist advisor to review and make improvement recommendations across all aspects of the PIR.

[10] The ANO's report on complaints about the NPR flight path design (August 2021) is here

2. Overview of the Community Focus Groups

34. An important element of the Independent Review involved direct engagement with local community stakeholders around Brisbane city and the outer suburbs. This engagement influenced our review, guiding the development of the work packages and recommendations in the Final Report. Community stakeholders have suggested that the change in aircraft operations following the introduction of the NPR has created a concentration of noise that is having a significant impact on those effected. The most common effect highlighted by community stakeholders is increased noise disruption, but other effects noted include loss of sleep, environmental impacts and disturbances to noise sensitive areas and buildings.

35. An important observation to note is that these impacts are subjective and vary significantly between individuals, even for those affected by the same flight paths. The geography, climate and culture within Brisbane influences the level of impact that aircraft operations have on some community stakeholders. Brisbane has a sub-tropical climate that allows residents to enjoy outdoor living for most of the year. House design accommodates this way of living with large outdoor spaces within many homes. House construction also supports this climate with many timber-built houses with single glazing windows that provide less mitigation to noise. The topography of Brisbane, with hills surrounding the city to the West also influences the noise impacts of flight paths in some areas, where noise energy is reflected by the hills extending the length of the noise events. The wider Brisbane area includes rural areas less than 30 km from the city centre. In these areas the ambient noise is lower, with residents choosing to live in locations that are prized for their tranquillity, exacerbating the disruption caused by aircraft noise.

Overview of the Community Focus Groups

36. The Trax team conducted a series of 12 Community Focus Groups in June 2022 at various locations around Brisbane city and the outer suburbs. Figure 6 illustrates the locations of the focus groups and the level of participation from surrounding suburbs across the wider Brisbane area. The objectives of the focus groups was to share information about the Independent Review and to listen and learn from people in the community affected by aircraft overflight. The number of attendees was limited to allow small group interactions, table-top discussions and one-to-one interviews. Participation varied between c.10 to c.30 people per event. The feedback obtained from these events has been summarised into generalised themes in Table 3. Feedback obtained that is relevant to the work package topics included in the final report have been summarised and specifically included in their relevant sections below.

37. Generalised feedback themes from the Community Focus Groups are as follows:

- Community feedback relating to airspace design
- Community feedback relating to governance, consultation, and engagement
- Other community feedback related to non-acoustic topics

Figure 6: Community Focus Group locations and participation across Brisbane City and the outer suburbs

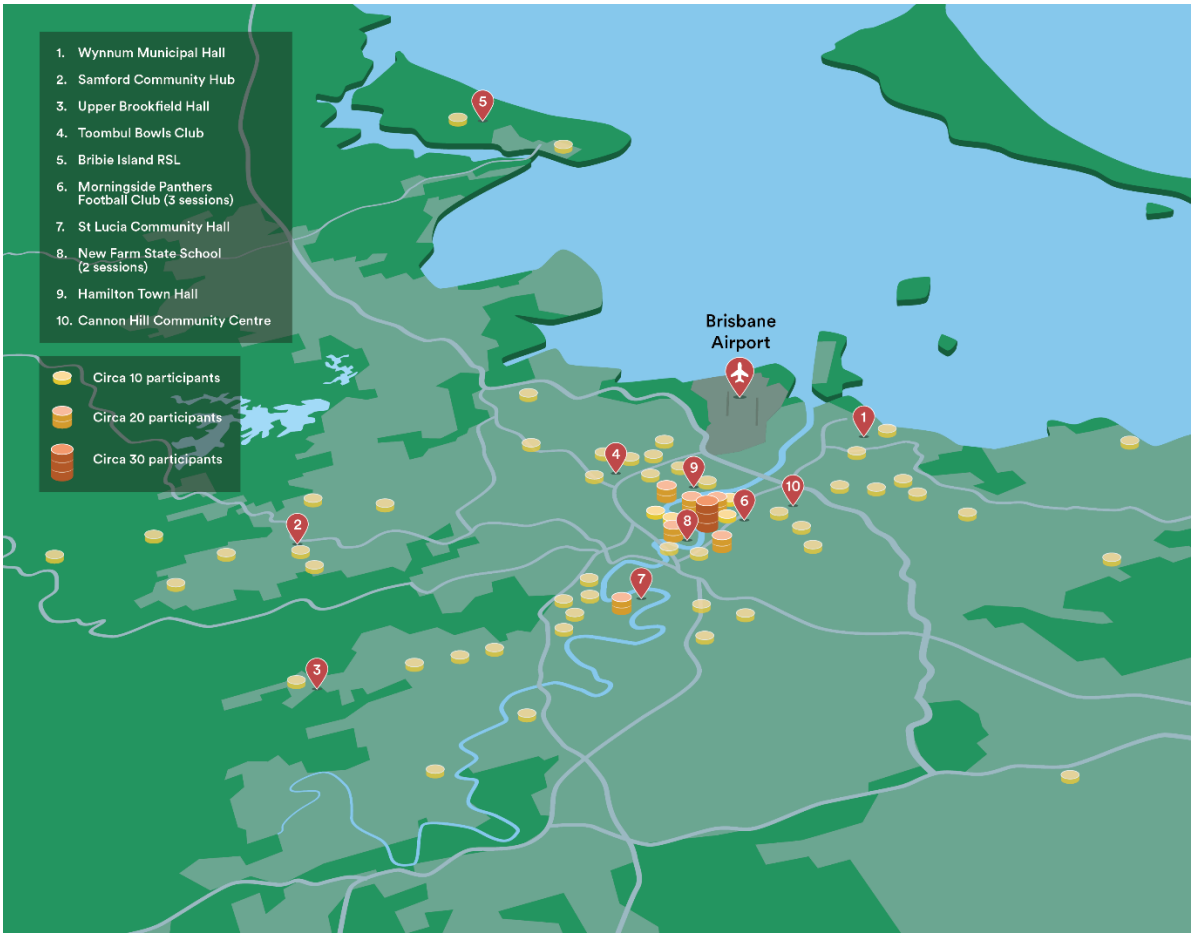


Table 3: Summary of feedback arising from the Community Focus Groups

Community feedback related to airspace design	
Frequency of flights	The frequency of flights and the concentration of tracks over the ground was raised as a concern across many Brisbane communities that were involved in the focus groups. A common theme is that there is little respite from arrival and departure operations as the inbound and outbound tracks often align over the same communities.
Length of Noise Exposure	Brisbane has areas with lower ambient noise. Residents who live to the West of Brisbane reported that the topography of the area also contributed to extended noise events as the noise energy is reflected off the hills.
Time of Day	The impacts of aircraft noise coinciding with early mornings and late evenings were raised as a concern by many stakeholders. The combination of events within the same location exacerbated the overall impact of noise.

Community feedback related to airspace design

Newly overflown communities	Many communities attending the focus groups highlighted the fact that prior to the NPR, aircraft noise was significantly less of an issue in their area.
Previously overflown communities	Residents previously overflown by flight paths supporting the legacy runway prior to the introduction of the NPR raised concerns that the options for proposed changes could return traffic over these areas.
Types of Aircraft	Jet aircraft noise was raised as concern by many residents. However, specific suburbs closer to the airport are impacted by a high-concentration over the same ground track from turbo-prop aircraft. Residents highlighted the low altitude and long duration of the overflights. The Airbus A380, Boeing B777 and the Rockwell Shrike Commander AC500 were frequently mentioned by residents as being particularly disruptive.
Totality of noise issues	The Brisbane area has several airports servicing commercial, military and general aviation airspace users. The impact of aircraft operations is predominantly from the commercial traffic arriving and departing from Brisbane Airport. However, the impact of public services (e.g., search and rescue or flying doctors), general aviation (small aircraft flights and helicopter operations) and military operations also contributes to the totality of aircraft noise impacts within the Brisbane area.
Predictability in aircraft operations	Creating predictability in aircraft operations and communicating that to communities was considered a significant noise mitigation action by most residents. Predictability was raised as a significant enabler to delivering sustainable noise outcomes.

Community feedback related to governance, communication and engagement

Engagement	Many residents raised significant concerns regarding their perception that there was a lack of adequate consultation and engagement processes during the development of the NPR flight path design.
Environmental Impact Assessment	Many residents raised significant concerns about the information included in the environmental impact assessments supporting the NPR flight path design.
Complaints Process	Some residents raised frustrations about the ASA complaints management process. Many residents reported making complaints and not receiving sufficient responses.
Access to trusted information	Some residents raised concern that they did not have access to trusted data from ASA and BAC relating to aircraft movements and noise information.

Community feedback related to non-acoustic topics

Aircraft Emissions	Some residents raised concerns relating to the environmental impacts of aircraft overflight in addition to noise. These issues covered impacts on climate change through emissions and air quality. There was particular concern raised by residents in Brookfield and Samford and adjacent suburbs that rely on Tank Water as the primary means of water regarding possible contamination.
Impact on Wildlife Habitats	In several rural locations residents raised concerns about the impact of aircraft operations on wildlife habitats. For example, at Bribie Island where a large population of bird species inhabits Buckley's Hole Conservation Park. Another example is the Moreton Bay Marine Park.

3. Work packages

38. In the second phase of the Independent Review the Trax team analysed the feasibility, benefits, impacts and dependencies of the potential improvements and consolidated the viable opportunities into four work packages. We used the feedback gathered from the Community Focus Groups and industry engagement activities to inform the scope of each package. This section describes the scope of the four work packages arising from our analysis in detail and sets out our specific recommendations regarding the approach to developing options for proposed changes to the NPR flight path design.

3.1. Package 1: Strong, transparent and representative governance

39. Work package 1 aims to establish a strong, transparent and representative governance mechanism to oversee the development and assessment of options for change proposals included in packages 2, 3 and 4. It is envisaged that the governance mechanism is established in 2022 to coordinate the stakeholders required to participate in the work packages as part of a single joined-up Programme. Work package 1 includes options for the creation of a programme oversight, management and assurance function, a communications and engagement process and a long-term Noise Action Plan.

40. A wide range of aviation and community stakeholders would be required to support the development of options for change proposals to the NPR flight path design and therefore participate in the governance mechanism in some form, including (but not limited) to:

- ASA, responsible for the provision of air traffic control services and the development of flight path designs and operational procedures.
- BAC, responsible for the operations and management of the airport infrastructure, including the terminals, runways and taxiways, and for capacity planning to meet forecast traffic demand.
- Aircraft operators that use Brisbane Airport, including scheduled passenger airlines, air freight, private charter, corporate jet, medical transfer and emergency services.
- Suitable representatives of the community stakeholders that may be affected by the impacts of aircraft overflight.
- Local, State and Federal Government authorities, including those responsible for aviation policy, land use planning and environmental affairs.
- The Department of Defence, Royal Australian Air Force (RAAF), and specifically RAAF Base Amberley that use volumes of segregated airspace to conduct Military operations and training.
- Other aerodromes in the region of Southeast Queensland that operate within the same enroute airspace system.

41. The governance mechanism should be established at the outset to coordinate the various contributions of these parties as part of a single joined-up Programme. It is important to recognise that the interests of the participating stakeholder groups may not always align. Conflicting views are likely to arise where the benefits of a particular change proposal fall to one group and the costs or negative external impacts fall to others. The governance mechanism will be required to clearly

identify the objectives of the proposed changes and the potential conflicts, understand the trade-offs associated with different options and strike efficient compromises across the stakeholder groups that seek to balance the benefits, costs and external negative impacts. For the governance to function effectively in this context, it must be conducted in an open, fair and transparent way, in the following terms:

- Open: Stakeholders should be assured that the options for specific change proposals are not a foregone conclusion. Engagement will be conducted at the formative stages of options development and throughout. Feedback will be conscientiously taken into account and stakeholders will have reasonable opportunities to influence the final proposed changes.
- Fair: Stakeholders should have advanced notice of the options under consideration for each package and the engagement process so they can plan their contribution and have adequate time and information to form meaningful inputs.
- Transparent: Stakeholder groups should be presented with accurate information about the impacts of different options for change proposals, tailored to their areas of concern. All information should be clear and accessible. Although the concepts included in the change proposals are often likely to be complex, the language used to communicate them should not be.

Programme oversight, management and assurance

42. The governance mechanism should be supported by robust programme management disciplines given the complexity of the options under consideration and the range of different stakeholders involved. We recommend the establishment of a Programme Oversight, Management and Assurance function that coordinates the development and assessment of options for change proposals to the NPR flight path design. For example the function may include:

    - A senior-level oversight group tasked with coordinating the various activities at a strategic level to ensure they are coherent, transparent and aligned to the achievement of a balanced set of objectives.
    - A programme management office that provides the disciplines required to ensure that roles and responsibilities are clear, stakeholders work to a common plan, activities are adequately resourced and the risks to delivering the proposed changes are well understood and managed.
    - A technical coordination group to support the development of options from a technical perspective, bringing together airport, ATC and aircraft operators to ensure the options under consideration are technically viable for all aviation stakeholders required to accommodate them.
    - An options development and assessment framework that ensures the criteria and methods used to evaluate the impacts of different options for change proposals are comprehensive, consistent and comparable.
    - An independent assurance process that coordinates the engagement of qualified third parties not directly involved in the development of the change proposals to challenge specific aspects of the Programme from a technical and process perspective and build trust with external stakeholders.

Communications and engagement process

44. Recent experiences in Australia, Europe and North America have shown that without an effective and well managed approach to community engagement, flight path changes may generate outcomes that are unacceptable to stakeholders and are vociferously challenged. The importance of an effective communications and community engagement process is based on the expectation that, when done well, it improves the social, environmental and economic outcomes of flight path changes and increases stakeholders' trust in the process for the future. Those who may be affected by options for change proposals should be encouraged to actively participate in the development and assessment process. To be effective, stakeholders should be offered the information, time and support to make meaningful contributions. The outputs of community engagement must be considered conscientiously by the proponents and have the potential to influence the final designs.

45. The communications and engagement process should confer legitimacy on the development and assessment of options for change proposals. When well-managed, the process may even bring a sense of shared ownership of the change proposals between the proponent and key stakeholders. Over time, fostering ownership may also create opportunities for some stakeholders to become advocates for specific benefits associated with flight path changes and participate proactively in future proposals.

46. Communications and engagement on flight path changes is not an easy undertaking. Information about the impacts are often technical in nature, can be hard to articulate and difficult for some stakeholders to understand. Environmental impacts in particular are dynamic in nature and change depending on the weather conditions, traffic levels or prevailing mode of air traffic operation. The level of sensitivity to a particular impact can vary across stakeholders within a community, and over time, making information about them difficult to quantify and share. Much of the research into the negative effects of aircraft overflight, and their mitigation, is relatively new and continues to evolve.

47. In Brisbane specifically, stakeholders suggest that the range of legislation, regulation and guidance that set the requirements for community engagement and flight path changes, combined with the many responsibilities held by different organisations, results in a fog of accountability. Insufficient or inconsistent transparency from the industry over a significant period of time has damaged trust for some stakeholders. The quality of the relationships between the industry and external stakeholders has begun to decline in some areas, generating a lack confidence in the process.

48. ASA's approach to community engagement has undergone significant changes over the last two years. A new Community Engagement Framework (CEF) was launched in 2020 that aims to provide a rigorous process for the delivery of community engagement associated with airspace changes. The CEF includes a public commitment on how communities will be engaged, supported by updated procedures and a range of online resources. A set of Flight Path Design Principles has also been developed to help guide the design and development of airspace changes and balance competing factors including noise, emissions and operational priorities.

49. In the context of the work packages to develop options for change proposals to the NPR flight path design we recommend:

    - Implementing a joined-up Communications Plan for the aviation organisations that are responsible for developing options to communicate effectively with community stakeholders.
    - Defining the engagement process that will be followed to gather meaningful inputs from community and aviation stakeholders to help shape the change proposals.

Long-term Noise Action Plan

50. In the Interim Report we highlighted that there is currently no long-term plan to optimise the performance of the Brisbane operation from a noise management perspective as traffic levels recover and continue to grow. Local communities and aviation stakeholders could be invited to participate in a coherent process to determine the noise relief and respite performance that the operation and airspace design should deliver over time and how noise should be shared as the demand for aviation in Brisbane grows.

51. We recommend that the governance mechanism should consider the development of a long-term Noise Action Plan that is developed in collaboration with representatives of the main stakeholder groups. The Noise Action Plan should clearly lay out how the options for change proposals to the NPR flight path design may combine with other measures to manage and where possible reduce the impacts of aircraft noise over the short, medium and longer term. In this capacity the Noise Action Plan could:

- Ensure that the specific noise mitigation measures included as part of the plan as it evolves (including trials, research projects and major changes) are scoped effectively, with agreed objectives, milestones, accountabilities and performance measures.
- Track the progress of options development, assessment, engagement and implementation plans linked to specific noise mitigation measures.
- Manage the dependencies associated with noise mitigation measures over time, including the rate and scale at which the ATC operation and aircraft operators can adapt to successive changes.
- Resolve issues that may impact the achievement of agreed milestones toward the development and implementation of noise mitigation measures.
- Maintain cross-industry and community stakeholder involvement and momentum behind the development and implementation of options to manage and where possible reduce the impacts of aircraft noise.

Work package one recommendations

PACKAGE ONE: STRONG, TRANSPARENT AND REPRESENTATIVE GOVERNANCE

TIMELINES: DEVELOPMENT & IMPLEMENTATION IN Q3-Q4 2022

Ref	Recommendation	Description
1.1	Establish a Programme Oversight, Management and Assurance function that coordinates the development and assessment of options for change proposals to the NPR flight path design	The function may include a variation of the following: a) A senior-level oversight group tasked with coordinating the various activities at a strategic level to ensure they are coherent, transparent and aligned to the achievement of a balanced set of objectives. b) A programme management office that provides the disciplines required to ensure that roles and responsibilities are clear, stakeholders work to a common plan, activities are adequately resourced and the risks to delivering the proposed changes are well understood and managed. c) A technical coordination group to support the development of options from a technical perspective. d) An options development and assessment framework that ensures the criteria and methods used to evaluate the impacts of different options for change proposals are comprehensive and consistent. e) An independent assurance process that coordinates the engagement of qualified third parties not directly involved in the development of the change proposals to challenge specific aspects of the Programme from a technical and process perspective and build trust with external stakeholders.
1.2	Implement a joined-up Communications Plan for the aviation organisations that are responsible for developing options to communicate effectively with community stakeholders	a) Without an effective and well managed approach to communications, flight path changes may generate outcomes that are unacceptable to stakeholders and vociferously challenged. b) The importance of an effective communications is based on the expectation that, when done well, it improves the social, environmental and economic outcomes of flight path changes and increases stakeholders' trust in the process for the future.
1.3	Define the engagement process that will be followed to gather	a) The engagement process should confer legitimacy on the development and assessment of options for change proposals.

	meaningful inputs from community and aviation stakeholders to help shape the change proposals	b) Those who may be affected by options for change proposals should be encouraged to actively participate in the development and assessment process. c) To be effective, stakeholders should be offered the information, time and support to make meaningful contributions. d) The outputs of community engagement must be considered conscientiously by the proponents and have the potential to influence the final designs.
1.4	Produce a long-term Noise Action Plan that clearly lays out how the change proposals and other measures not related to flight path design will contribute to limiting and where possible reducing noise over the short, medium and long-term as traffic levels grow	In this capacity the Noise Action Plan could: a) Ensure that the specific noise mitigation measures included as part of the plan as it evolves (including trials, research projects and major changes) are scoped effectively, with agreed objectives, milestones, accountabilities and performance measures. b) Track the progress of options development, assessment, engagement and implementation plans linked to specific noise mitigation measures. c) Manage the dependencies associated with noise mitigation measures over time, including the rate and scale at which the ATC operation and aircraft operators can adapt to successive changes. d) Resolve issues that may impact the achievement of agreed milestones toward the development and implementation of noise mitigation measures. e) Maintain cross-industry and community stakeholder involvement and momentum behind the development and implementation of options to manage and where possible reduce the impacts of aircraft noise.

Opportunities identified in the Interim Report incorporated in package one

52. Table 4 summarises the potential improvement opportunities in the Interim Report that have been incorporated into work package one.

Table 4: Interim Report potential improvement opportunities incorporated in package one

Ref	Interim Report potential improvement opportunity	Final Report Rec.
E1.1	Integrated planning, delivery and governance arrangements	Rec. 1.1
E1.2	Community Noise Management Board	Rec. 1.1
E1.3	Cross-industry airspace optimisation forum	Rec. 1.1
E2.1	Noise and other overflight data used to inform decision making	Rec. 1.3
E2.2	Operational data used to inform decisions and enhance performance	Rec. 1.3
E2.3	Mechanisms for sharing information with communities	Rec. 1.2
E3.1	Engagement approach for options development and assessment	Rec. 1.3
E3.2	An iterative approach to flight path design and impact assessment	Rec. 1.3

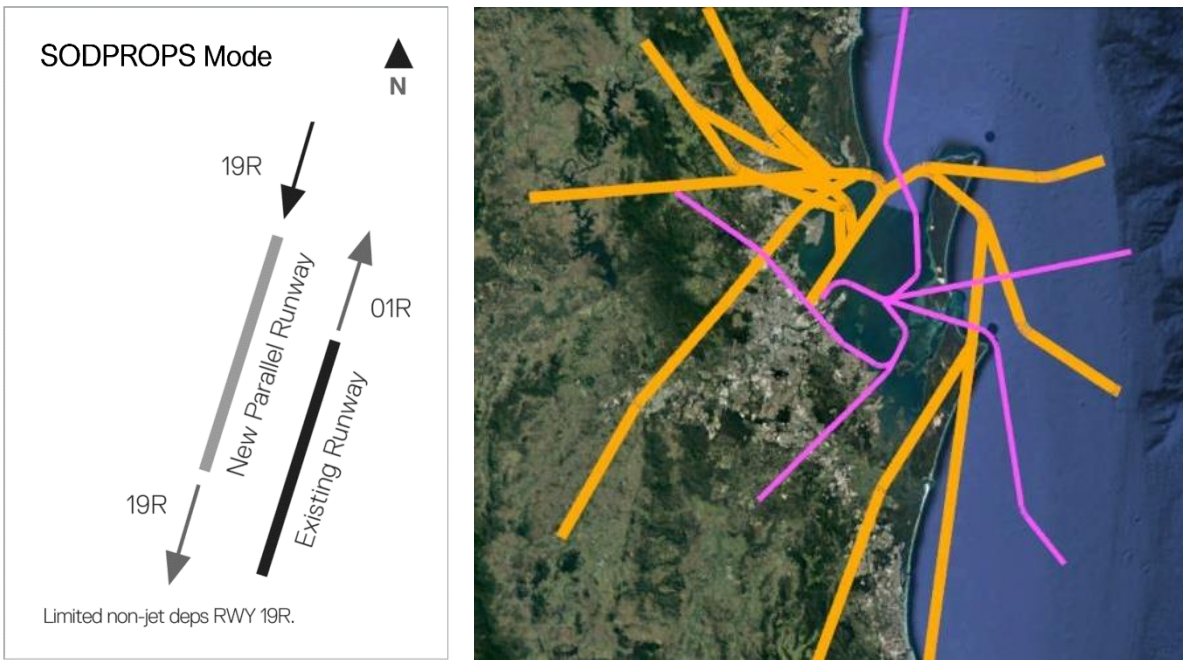
3.2. Package 2: Maximise flights over water

53. Work package 2 aims to maximise the total number of flights that operate over water, reducing the noise and other adverse effects of aircraft overflying communities. It includes options for the development of changes to ATC procedures and adjustments to the airspace structure that may be deployed relatively quickly to extend the use of SODPROPS when the met conditions and traffic levels permit. It is intended that most of the recommendations in package two can be delivered by the end of 2023.

SODPROPS overview

54. Maximising flights over the water when traffic levels are lower and the met conditions permit, is a fundamental principle of the NPR flight path design. The SODPROPS runway mode enables arriving and departing flights to operate simultaneously in opposite directions over the water, leaving the city and surrounding suburbs significantly less affected by aircraft overflight. SODPROPS is an innovative approach to noise abatement that is enabled by the wide spacing of Brisbane's parallel runways and is not commonly used at other large commercial air transport airports around the world[11]. When SODPROPS is in use, all arrivals land on the new runway set to 19R and all jet departures take off on the existing runway set to 01R, as illustrated in the left panel of figure 7.[12] In this manner, either the arriving or departing flights will operate with a tailwind component, depending on the prevailing wind direction, which is why such careful attention must be paid to the met conditions. The right panel of figure 7 illustrates the current SODPROPS flight paths. The pink tracks indicate the departures routes, and the orange tracks indicate the arrival routes.

Figure 7: Illustration of the SODPROPS runway mode of operation and flight paths



[11] The SODPROPS runway mode is currently used at Sydney Kingsford Smith Airport

[12] A small number of non-jet aircraft are permitted to depart over the city during SODPROPS, taking off on 19R (5am to 10pm).

55. In line with the EIS/MDP, SODPROPS is considered the preferred runway mode at Brisbane Airport, but to maintain an acceptable standard of safety, its use is subject to two important constraints; the volume of traffic that is scheduled to arrive and depart at the time the mode is initiated and over the coming hours, and the current and forecast met conditions. These constraints are explained in more detail below.

56. The total number of arriving aircraft that the airport can accept during SODPROPS (known as the Arrival Acceptance Rate) is currently 20 per hour. It may be possible to increase the number of arrivals slightly if operational procedures and the flight path design can be appropriately adjusted to assure there is no degradation in safety. However, accepting even a very small number of additional flights will create increasingly large delays as the maximum capacity threshold for SODPROPS is reached. At this point, to avoid operating with excessively high delays, the airport will change to a higher capacity mode.

57. Alongside the capacity constraints, SODPROPS can only be used under a strict set of met conditions, specifically:

- A 5-knot limit is currently applied to the tailwind component[13]
- Visibility must be 8km or greater
- The cloud base must not be lower than 2,500ft
- The runway surfaces must be dry
- The speed and direction of any crosswind is a constraint above 20 knots

58. There is a clear expectation in the EIS/MDP that this set of met conditions will mainly arise during the night period. If visibility is less than 8km or the cloud base is lower than 2,500ft. the airport can revert to a reciprocal runway mode (arrivals and departures operating in opposite directions over the bay from a single runway, nose to nose). However, the airport's capacity in a reciprocal runway mode is significantly lower (less than 12 flights in total per hour).

59. Industry feedback from key airline operators was received in relation to the use of SODPROPS. Airlines note that the preference for take-off and landing is into the wind and this mode should be used wherever possible. SODPROPS operations are considered acceptable provided other conditions such as a dry runway and limited crosswind are present. Airlines expect that that there is additional fuel burn and increased CO_2 emissions when operating in SODPROPS, however, the benefit in reduction of noise to community is prioritised.

[13] The 5-knot tailwind limit is currently the maximum threshold that complies with the international regulatory framework laid down by ICAO – International Civil Aviation Organisation sets the international air navigation standards for civil aviation.

Scope of work package two

60. SODPROPS is prioritized during the night period (10 pm to 6 am) when traffic levels are lower, and the met conditions are more often suitable. In the Interim Report, we identified that one of the keys to unlocking the full potential of SODPROPS is to tackle the obstacles and complications that may make it complex to initiate and operate the mode, especially outside of the night period. Of the total 49 potential improvement opportunities identified in the Interim Report, the first 11 relate directly to maximising flights over water. The opportunities include activities that could be delivered over the short, medium and long term (if they prove to be viable for the Brisbane operation). We grouped the opportunities into four themes, set out in Table 5.

Table 5: Themes identified in the Interim Report related to maximising flights over water

Theme (Reference in the Interim Report)	
Review metrological constraints (A1)	A review of the met constraints attached to the safe use of SODPROPS is intended to examine the opportunities that might exist to extend the range of met conditions that might be permitted if appropriate mitigations are in place.
ATC procedures and support tools (A2)	The ATC procedures and tools used in the Brisbane operation to initiate, deliver and exit SODPROPS are an important determinant of how often the preferred mode can be used when the met conditions permit.
Performance analysis for SODPROPS (A3)	Analysis of historic data about the met conditions in Brisbane, by time and type of day (weekday or weekend), and correlation with information about current and future traffic levels is intended to highlight potential opportunities to increase the use of the mode.
SODPROPS flight path design (A4)	A review of the existing NPR flight path design that considers the interdependencies with the wider route network, operations at adjacent airports and the treatment of segregated portions of Amberly airspace.

Review of met constraints

61. The first improvement opportunity in the Interim Report (referenced as A1.1) concentrated on the safety assurance to increase the tailwind limit applied to SODPROPS from 5-knots to 7-knots. ASA conducted a safety assessment of a 7-knot tailwind limit and submitted a Safety Case to CASA for review in April 2022, setting out the arguments, assurance and supporting evidence. A decision from CASA is expected shortly. Any wider review of the met constraints associated with the use of SODPROPS (opportunity A1.2 in the Interim Report) should be considered based on the outcome of CASA's review.

Analysis of traffic demand and met conditions

62. The third opportunity in the Interim Report (A2.1) is to set out a single, consolidated set of instructions, or an Operating Plan, that offers clear guidance on the approach to optimising the use of SODPROPS based on the latest understanding of the airport's capacity in this mode and future traffic levels. The decision-making criteria to initiate, maintain or exit SODPROPS (opportunity A2.2 in the Interim Report) in different scenarios could also form part of the Operating Plan. The development of the Operating Plan should be informed by analysis of historic data about the met

conditions in Brisbane, modelling of traffic demand across the day and forecast information about how traffic is expected to grow over time (related to opportunities A2.3 and A2.4 in the Interim Report).

63. A recent analysis conducted by ASA during 2022 that considered the met conditions affecting Brisbane operations between 2018 and 2021 indicates that conditions could be suitable for SODPROPS for approximately:

- c.40% of the time during the night period (10 pm to 6 am);
- c.30% to c.40% of the time during late afternoons and evenings (2 pm to 10 pm); and
- c.25% of the time in the mornings and early afternoons (6 am to 2 pm).[14]

64. The results of ASA's recent analysis are aligned with the conclusions of a comprehensive review conducted on behalf of BAC during the development of the EIS/MDP that examined ten years of wind data provided by the Australian Bureau of Meteorology. The review found, with a 5-knot tailwind limit, that the wind conditions would be suitable for SODPROPS c.30% to c.40% of the time during the night period, and c.20% to c.25% during the day when averaged over the year.

65. ASA's 2022 analysis also considered the traffic demand at different times of the day and how growth is expected to affect the schedule on weekdays and weekends. The analysis found that there are already times in the existing weekday schedule at Brisbane Airport that exceed the maximum capacity of the airport when SODPROPS is in use (assuming an arrival acceptance rate of c.20 flights per hour). Small periods of lower demand currently exist during the middle of the day on weekdays, but flight numbers are expected to increase above the SODPROPS capacity threshold in these periods by 2025 as traffic levels recover from the impacts of the pandemic. Traffic levels in the weekday evenings from 8 pm to 10 pm (when met conditions are more likely to be suitable) are often expected to remain within the SODPROPS capacity threshold as flight numbers grow out to 2025 and beyond. In addition, weekend mornings from 6 am to 8 am, Saturday afternoons and Sunday mornings are also time periods where SODPROPS would often have the capacity to accommodate forecast traffic demand out to 2025 and beyond.

66. In February 2022, ASA implemented a 12-month trial to extend SODPROPS operations to 8 am on Saturdays and Sundays, when the met conditions permit. The outcomes of the trial are being reviewed quarterly to understand the benefits to communities of extending SODPROPS hours and other environmental and operational impacts. The occasions when ATC are not able to use SODPROPS up to 8 am on the weekends will also be recorded as part of the trial.

67. We recommend that work package two should include the development and implementation of an ATC Operating Plan that builds on the current trial to extend the use of SODPROPS, with a particular focus on the time periods identified in the recent ASA analysis when traffic levels are forecast to remain within the SODPROPS capacity threshold as flight numbers grow out to 2025 and beyond and the met conditions are more likely to be suitable.

[14] Weather conditions derived from Automatic Terminal Information Service (ATIS) messages collated by ASA in 2022.

Tactical use of over-the-water operations

68. Each additional flight operating over the water results in a significant reduction in noise impacts over communities. Therefore, even small changes that may only result in a slight overall difference in the total number of flights over water should be considered where viable. One option is to consider an ATC procedure that enables the release of occasional departures in the opposite direction over the water while the airport is configured for simultaneous parallel operations. For example, if there is a northbound aircraft ready to taxi and depart in calm conditions during 19 operations at a time when there are no arrivals from the North, it could potentially be coordinated to tactically depart in a 01 direction over the water. There may be some similar opportunities to direct occasional arrivals over the water while 01 simultaneous parallel operations are in use (i.e. departures over the water from both runways and arrivals over the city to both). The appropriately accountable ATC supervisors would have ultimate sanction over the use of such tactical interventions and clearly, if there were any safety concerns or operational complexities such options would not be used.

SODPROPS constraints linked to the wider Brisbane airspace design

69. The traffic demand and met conditions analysis described above, excludes the effects of additional constraints to the use of SODPROPS in today's operation associated with the wider Brisbane airspace system. The configuration of the wider Brisbane airspace system, including the interactions between the NPR flight path design and the enroute network, constrain the use of SODPROPS, especially during the daytime when traffic levels are higher. Work package two should include developing options to amend the flight paths and/or ATC procedures for coordinating flights that route through the Brisbane airspace system inbound to other destinations and may constrain Brisbane ATC's ability to extend the use of SODPROPS.

Brisbane airspace interactions with the Amberly segregated airspace

70. A standard arrival route (known as the ENLIP STAR) that is intended for Brisbane traffic inbound from the West when SODPROPS is in use, is restricted during the daytime when the segregated airspace and transit corridors reserved for Military operations from Amberly airfield are activated. Operational feedback indicates that the constraints on the use of the ENLIP STAR may limit the ability to extend the use of SODPROPS. One option is to collaborate with the RAAF on the permanent release of targeted portions of Amberly airspace and redesign the Brisbane flight paths accordingly.

71. Another option is to further develop how the Flexible Use of Airspace (FUA) concept is applied in the Brisbane system. Rather than considering volumes of airspace as purely for Civil or Military operations, the FUA concept allows for some areas to be managed as a shared asset that is allocated based on demand. On this basis, the segregation of some portions of Amberly airspace may be activated and de-activated in close to real-time. New conditional flight paths for civil traffic could be deployed through portions of Military airspace that are currently segregated so that they can be planned and used when the airspace is not required for Military operations. The effectiveness of the FUA concept is dependent on the close collaboration of Civil and Military ATC and their ability to coordinate their operations dynamically. The new Flight Data Processing (FDP) system (known as CMATS) that is scheduled for deployment to both Civil and Military ATC units in the coming years is expected to strengthen Civil/Military planning and coordination because all controllers work with the same connected set of flight information and traffic management tools. Joint plans for the use of a shared volume of airspace with conditional civil routes could be developed strategically months ahead and refined in the weeks, days and even hours prior to use. Work package two should include further engagement with Defence on developing options for the targeted release and/or shared use of portions of segregated airspace to allow the extended use of SODPROPS.

Work package two recommendations

PACKAGE TWO: MAXIMISE FLIGHTS OVER THE WATER

TIMELINES: DEVELOPMENT & IMPLEMENTATION IN 2023

Ref	Recommendation	Description
2.1	Develop and implement an ATC Operating Plan to extend the use of SODPROPS	a) Develop and implement an ATC Operating Plan to extend the use of SODPROPS with a focus on weekday evenings, Saturday afternoons and Sunday mornings, when the met conditions and traffic levels permit. b) Examine the costs, benefits and operational impacts of extending the use of SODPROPS, including the provision for a moderate amount of flight delay to maintain the use of the mode when traffic demand approaches the maximum capacity for simultaneous opposite direction parallel operations.
2.2	Reduce the workload and complexity for Brisbane ATC associated with extending the use SODPROPS	a) Engage with Defence and RAAF Base Amberley to consider options for the targeted release and/or shared use of specific portions of Amberly segregated airspace to reduce the workload and complexity for Brisbane ATC associated with extending the use of SODPROPS. b) Examine options to amend the ATC procedures for coordinating flights that route through the Brisbane airspace system inbound to other destinations and may constrain Brisbane ATC's ability to extend the use of SODPROPS. c) Examine options to amend specific flight paths that serve traffic routeing through the Brisbane airspace system inbound to other destinations and may constrain Brisbane ATC's ability to extend the use of SODPROPS.
2.3	Modify specific SODPROPS flight paths and ATC procedures, where required, to maximise the potential improvements associated with recommendations 2.1 and 2.2	a) Examine options to reduce the track miles and aircraft emissions generated by the specific arrival and departure routes that flights use during SODPROPS, including the potential to incorporate arrival routes designed to advanced navigation standards. b) Examine options to amend the ATC procedures used to manage inbound traffic when SODPROPS is in use to enable pilots to optimise the descent to final approach. c) Examine short-term options to moderately increase the tactical use of over-the-water operations when the simultaneous parallel runway modes are in use, for example launching occasional departures in a 01 direction while the airport is configured for 19 operations when traffic conditions, met constraints and other operational factors confirm it is safe to do so.

Potential improvement opportunities identified in the Interim Report incorporated in package two

72. Table 6 summarises the potential improvement opportunities in the Interim Report that have been further developed and incorporated into package two.

Table 6: Interim Report potential improvement opportunities incorporated in work package two

Ref	Interim Report potential improvement opportunity	Final Report Rec.
A1.2	Wider review of the met constraints associated with SODPROPS	Rec. 2.1
A2.1	Clear & unambiguous instructions regarding the use of SODPROPS	Rec. 2.1
A2.2	Decision-making criteria for the use of SODPROPS	Rec. 2.1
A3.1	Post operational analysis to evaluate SODPROPS potential	Rec. 2.1
A3.2	Modelling & simulation of SODPROPS maximum capacity threshold	Rec. 2.1
A4.1	Re-positioning the routes that serve en-route traffic	Rec. 2.2
A4.2	Examine Amberly's impact on westerly arrivals during SODPROPS	Rec. 2.2
A4.3	Wider airspace redesign to enable the use of SODPROPS	Rec. 2.3

3.3. Package 3: Reduce the frequency & concentration of flights over communities

73. Work package three aims to reduce the frequency and concentration of aircraft overflying communities at lower altitudes through the development, assessment and engagement on options for small modifications to the NPR flight paths that remain aligned with the existing compass operations model. The options are intended to deliver short-term improvements in the management of noise, including targeted sharing where it is considered appropriate following engagement with all affected stakeholder groups. The activities required to develop and deploy the proposed changes should be led by ASA, with considerable input from the airline operators and BAC.

74. The scope of work package three includes:

- The development of options for small flight path modifications that could be deployed in the short term without changing the fundamental structure of the existing airspace design.
- Impact assessments to compare the options in terms of safety, noise outcomes, operational capacity and resilience, flight efficiency and network integration with the baseline option based on the performance of the existing NPR flight path design.
- The process for engagement with all affected communities and aviation stakeholders to gather feedback on the options and inform decisions about the proposed changes.
- The activities required to implement the approved changes, expected in 2024.

Technical features of the NPR flight path design

75. The existing NPR flight path design incorporates several advanced technical features that form the basis of many ATC projects worldwide to improve the way air traffic is managed in the future. These features are summarised in table 7, alongside a description of the outcomes they are intended to achieve. The development of options for flight path modifications proposed in work package three should carefully consider how the technical features of the existing design, and the related outcomes, may be affected by proposals for change.

Table 7: Technical features of the existing NPR flight path

Technical features	Outcomes
Safety by design	Safety by design through the strategic (rather than tactical) deconfliction of the flight paths: The conventional requirement for ATC to vector traffic tactically is minimised because the existing NPR flight paths are safely separated as part of the overall design. The principle of safety by design that is applied to the NPR flight paths is a fundamental part of the modern safety management systems used by ATC and the aviation sector in general.
Advanced navigation	The new flight paths are designed to advanced Performance-based Navigation (PBN) standards that are more precise and flexible than the conventional alternatives they have replaced. Aircraft fly PBN routes with greater accuracy, enabling strategic deconfliction of flight paths by design (see above). One of the outcomes is aircraft tracks over the ground are concentrated, which can limit the total population affected by aircraft noise but increase the frequency and intensity for those that are overflown.

Closed STARs	Advanced navigation facilitates the use of closed Standard Arrival Routes (STARs) that guide inbound aircraft along an accurate and repeatable flight path as they descend to land, without the need for ATC vectoring. Closed STARs are generally more efficient than Open STARs (see below) and create a more predictable operation for ATC and pilots. The accuracy and predictability offered by closed STARs can limit the total numbers of population overflown, but aircraft tracks over the ground and the associated noise impacts are concentrated.
Systemised SIDs	Systemised Standard Instrument Departures (SIDs) also rely on advanced navigation. Outbound jet aircraft follow precise departure routes that are flown with high levels of accuracy and limited ATC vectoring. The Brisbane SIDs are designed to serve a compass operations model by linking departing flights to key points in the airspace network at higher altitudes aligned to their onward destination. Concentrating outbound flights on a limited number of systemised SIDs is intended to limit the total population affected by noise, but similar to the closed STARs, aircraft tracks over the ground and the associated noise impacts are concentrated.
Continuous Climb Operations	The Brisbane SIDs are designed to optimise aircraft performance by enabling continuous climb operations (CCOs) so that outbound flights can manage their engine thrust and rate of climb to reach higher and more efficient cruising altitudes as quickly as possible without intermediate portions of level flight. The NPR flight path design prioritises the achievement of CCOs over continuous descent operations (CDO), meaning where arrival and departure routes cross, inbound flights sometimes descend lower and fly level for longer than they ideally would so that outbound flights can climb continuously.
Open STARs and RADAR SIDs for legacy aircraft	The design also incorporates conventional Open STARs and RADAR SIDs that accommodate some of the older non-jet aircraft in the fleet that are not all equipped to operate using advanced navigation. Open STARs guide inbound traffic to a point on the arrival route where ATC then vector the flights to the final approach for landing. In good conditions, pilots can fly a traditional visual approach from an Open STAR. Open STARs create a wider distribution of aircraft tracks over the ground for arriving flights when compared to closed STARs because of the reliance on ATC vectoring. RADAR SIDs are used by ATC to manage the non-jet traffic by directing the pilot to follow a standard compass heading immediately after take-off.

Frequency and concentration of noise

76. The use of advanced navigation, closed STARs and systemised SIDs creates an efficient and highly repeatable flight path design that is effective at limiting the total population affected by overflying aircraft. However, the increase in track-keeping accuracy linked to the use of advanced navigation and the reduction in ATC vectoring for most flights has created more frequent and more concentrated noise impacts in the areas that are overflown. These impacts arise in some areas that were not directly overflown previously because the NPR design is accommodating flights to two runways, with the new runway 2km to the north of the existing one. The frequency and concentration of noise is compounded in some areas, where the design places arrival and departure routes over the same locations, meaning communities on the ground are affected by noise during both 19 and 01 operations. This inevitably occurs more often in areas closer to the airport that are aligned to the extended runway centreline. Further from the airport, when flight paths begin to turn, there are options proposed in work package three to make small modifications to the existing design and reduce the frequency and concentration of overflights in some areas. The modifications in package three are primarily intended to redistribute the noise impacts. Noise reductions by aircraft climbing higher sooner on departure, staying higher for longer on arrival and applying CCO and CDO may also be achieved, depending on the nature of the proposed changes.

77. The redistribution of noise, with the objective of sharing the impacts, is a complex topic. In populated areas such as Brisbane, it is often likely that improvements delivered in one area will increase the disruption in other areas. The development and assessment of options to modify the existing flight paths must be carefully managed and guided by a coherent and transparent community engagement process that enables affected stakeholders to influence the trade-off decisions when noise redistribution is the intended outcome.

78. Questions and suggestions regarding the orientation of the flight path design were the most common topic raised by community stakeholders in the focus groups. In general, the main sentiment expressed was that the redesign of flightpaths for NPR operations has resulted in increased aircraft noise impacts in many of the areas represented at the meetings. Community stakeholders consistently emphasized that the pre-NPR flight paths were less intrusive in relation to their noise impact, in the areas they represented. A common observation was that some communities were now impacted by both arrivals and departures that follow the same track over the ground. Many stakeholders questioned whether departures could take a steeper gradient to reach higher altitudes quicker, reducing noise impacts on the ground. Other suggestions included the introduction of more distributed flight paths, to provide less concentration and share the noise across a larger population, providing relief for some of the more heavily impacted communities. Table 8 summarises some of the key issues raised by community stakeholders at the focus groups linked to the frequency and concentration of overflights.

Table 8: Summary of issues raised by community stakeholders about noise frequency and concentration

Technical features	Outcomes
Day-time arrival and departures outer-suburbs	Residents in Brookfield and Samford and adjacent suburbs raised significant issues associated with the concentration of noise impacts. These residents were previously not overflown, there are issues associated with low ambient noise and the topography in the area, with residents living at 1500ft.

Day-time arrival and departures – Bribie Island	Arrival routes to Brisbane that transit the southern part of Bribie Island provide noise disturbances to communities.
Day-time arrival and departures – Stradbroke Island	The arrival and departure traffic transiting Moreton Bay and Stradbroke Island cause noise concerns for residents on North Stradbroke Island. **A Community Focus Group was not held at Stradbroke Island. The engagement was conducted with a single representative of Stradbroke Island traditional owners.*
Departures in the evening and night period	Many residents raised significant concerns about the noise generated from the large jet departures travelling to Asia and the Middle East in the evenings and night period.
Turbo-prop aircraft operations	Residents in the vicinity of Brisbane, especially the suburbs to the immediate west and east of the airport are impacted by the high frequency of turbo prop aircraft operations.

Scope of work package three

79. Work package three concentrates on the development of proposals to modify the existing flight paths over the city and outer suburbs within the existing compass operations model, following a coherent and transparent process to evaluate the impacts of different options and conduct meaningful engagement with affected communities and aviation stakeholders, so they can understand and influence the changes. In the Interim Report we identified the opportunity (B3.3.) to make small flight path modifications that may offer different forms of noise mitigation without widespread changes. A related opportunity (B3.2) considered the proximity of the flight paths north and west of the airport to the segregated airspace that supports Military operations from Amberly airfield. The options for small modifications should be developed by ASA, working in collaboration with BAC and the airline operators. They may build on some of the suggestions made in the Independent Review and/or include different options identified by ASA and other stakeholders. At a minimum, it is envisaged that the options development will include a consideration of the:

- Departure routes from the new runway that route over the city and outer suburbs, serving outbound traffic to the north and west between 6 am and 10 pm (19R BIXAD & WACKO SIDs).
- Departure routes from the existing runway that route over the city and outer suburbs, serving outbound traffic to the north and west after 10 pm (19L BIXAD & WACKO SIDs).
- Departure routes from the existing runway that route over the city and outer suburbs, serving traffic to the south and east (19L GUMKI, SANEG & SCOTT SIDs).
- Arrival routes to the new runway that route over the outer suburbs and city, serving inbound traffic from the north and west between 6 am and 10 pm (01L MORBI, SCOTT & WOODY STARs).
- The treatment of non-jet traffic operating on RADAR SIDs.
- Development and assessment of a baseline option based on the performance of the existing NPR flight path design.

These considerations are described in greater detail in the sections below.

Departure routes from the new runway over the city and outer suburbs

80. Figure 8 illustrates the two departure routes used by jets departing from the new runway to the north and west, over the city and outer suburbs (19R). The routes are designated as the:

- 19R WACKO, which tracks straight ahead for several miles after departure, turns right and then shallow right again to head north and west.
- 19R BIXAD, which follows the same initial track over the ground as the 19R WACKO, with a tighter second right turn, wrapping around to the northeast, then tracking north.

In line with the compass operations model, all jet traffic with onward destinations to the north and west use one of these two routes between 6 am and 10 pm when the airport is configured for 19 operations (a noise abatement procedure prevents their use during the night period). Feedback from the Community Focus Groups highlight how some of the heavier aircraft using these routes are particularly disruptive and sometimes appear to operate at lower altitudes than expected.

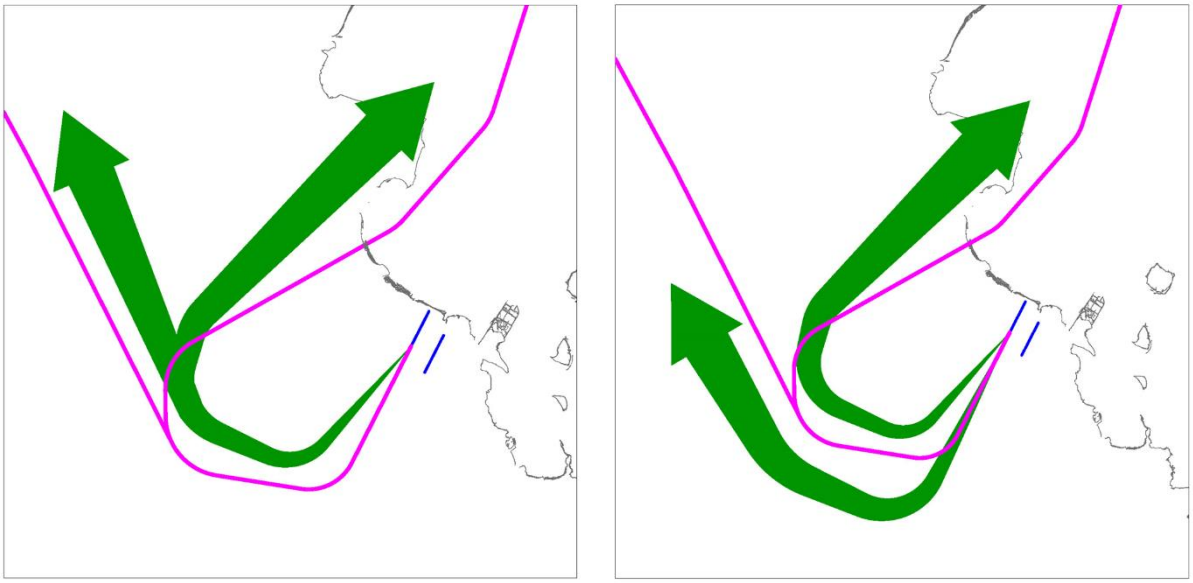
Figure 8: Illustration of northbound departure routes from the new runway (19R BIXAD & 19R WACKO)

81. The two routes follow the same initial track over the city and outer suburbs at lower altitudes, splitting when most flights are above 5000ft, to the north of Brookfield. The straight-ahead portion of the routes, immediately after departure, also overfly the same track as the arrivals on final approach to the new runway when the airport is in 01 operations (arrivals over the city, departures over water). One potential modification may be to change the angle of the straight-ahead portion of the routes immediately after departure by up to 15 degrees to the north[15], as illustrated in the left panel of figure 9, where the pink tracks denote the existing design, and the green arrows provide an indication of the type of modification. The actual location of the modified routes would be

[15] 15 degrees and the aircraft would begin to turn rather than fly straight ahead

determined by the outcomes of a detailed options assessment and stakeholder engagement exercise. The intention of this potential modification is to reduce the frequency and concentration of overflight created by the new runway departure routes over the city by moving the initial track moderately to the north, away from the extended runway centreline that is also overflown by the arrivals on final approach to 01L. The orientation of the two right turns would also change as a result of the offset, overflying different areas, as would the onward portion of the routes after the turns.

Figure 9: Illustration of types of proposals that might be developed for new runway departures over the city



82. The right panel of Figure 9 illustrates another option to modify the 19R departures by separating the tracks over the ground immediately after take-off. For example, the initial track of the 19R BIXAD might be offset to the north, and the 19R WACKO might continue along the extended runway centreline, turning later than the existing design to appropriately separate the routes and redistribute the impacts. The 19L BIXAD would overfly different areas immediately after departure and through the turns. Extending the straight-ahead portion of the 19R WACKO would position the first right turn further south and west, overflying new areas from that point onward. The extension south and west would also bring the route closer to the Amberly segregated airspace, potentially requiring engagement with Defence on a targeted release of airspace at lower altitudes (opportunity B3.2) in the Interim Report, or some form of shared access supported by the Flexible Use Airspace (FUA) concept (opportunity D3.2).

Northbound departure routes from the existing runway over the city used during the night

83. A Noise Abatement Procedure (NAP) prohibits the use of the new runway flight paths over the city during the night period (10 pm to 6 am)[16]. As a result, there are two departure routes that connect outbound traffic to the north from the existing runway, for use during the night period (if SODPROPS is not available). The routes are designated as the 19L BIXAD and 19L WACKO. The straight-ahead portion of both routes follows the extended runway centreline for several miles, parallel with the 19R departure routes. After the first right turn, the tracks over the ground converge so that aircraft route above the same areas during the night period as those affected during the daytime, increasing the frequency and concentration of overflight.

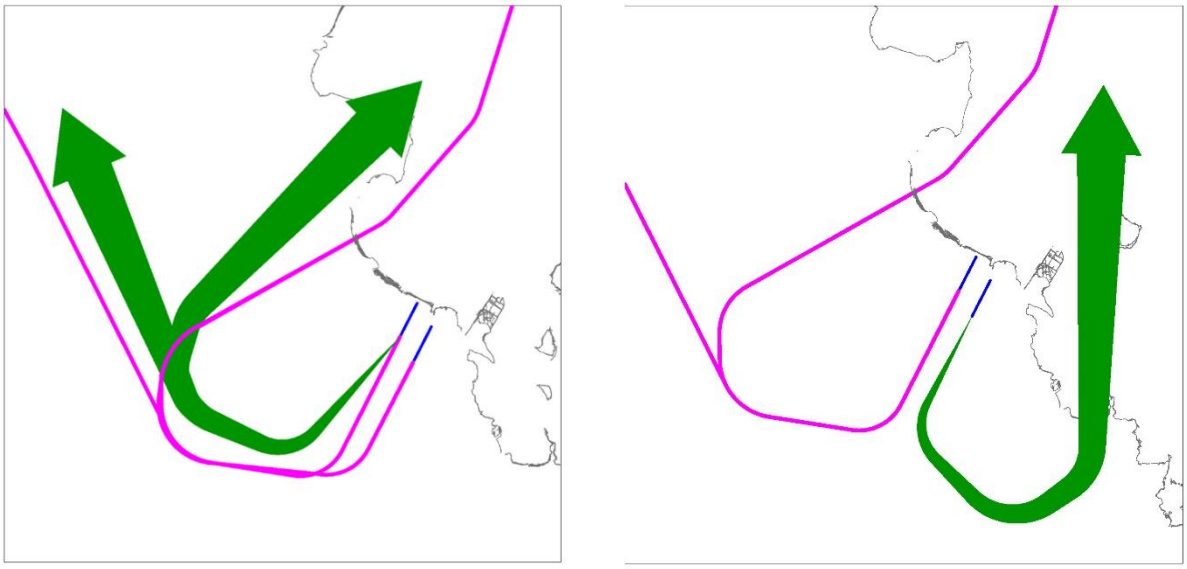
84. The left panel of Figure 11 illustrates how the options to modify the 19R departure routes from the new runway would also separate the tracks from the 19L routes used during the night. Another related option may be to modify the 19L departure routes in a manner similar to that illustrated in figure 11 for the 19R routes, but offset and/or extend the tracks to the south instead of the north.[17] A more extensive modification might be to redesign the 19L departure routes over the city to turn out left instead of right and wrap around to the north, overflying completely different areas at lower altitudes as illustrated in the right panel of figure 11. Again, the actual location of the modified routes would be determined by the outcomes of a detailed options assessment and stakeholder engagement exercise with all affect communities and aviation stakeholders.

Figure 10: Illustration of northbound departure routes from the new and existing runway (19R and 19L BIXAD & WACKO)

[16] The NAP does allow for a limited number of non-jet departures from 5 am onwards and may be temporarily paused in the event of an emergency or to meet specific requirements, such as runway maintenance works.

[17] The requirement for a targeted release or greater shared access to Amberly may be less of an issue for the routes used after 10 pm when the segregated airspace is not routinely activated.

Figure 11: Illustration of types of proposals that might be developed for existing runway departures after 10 pm

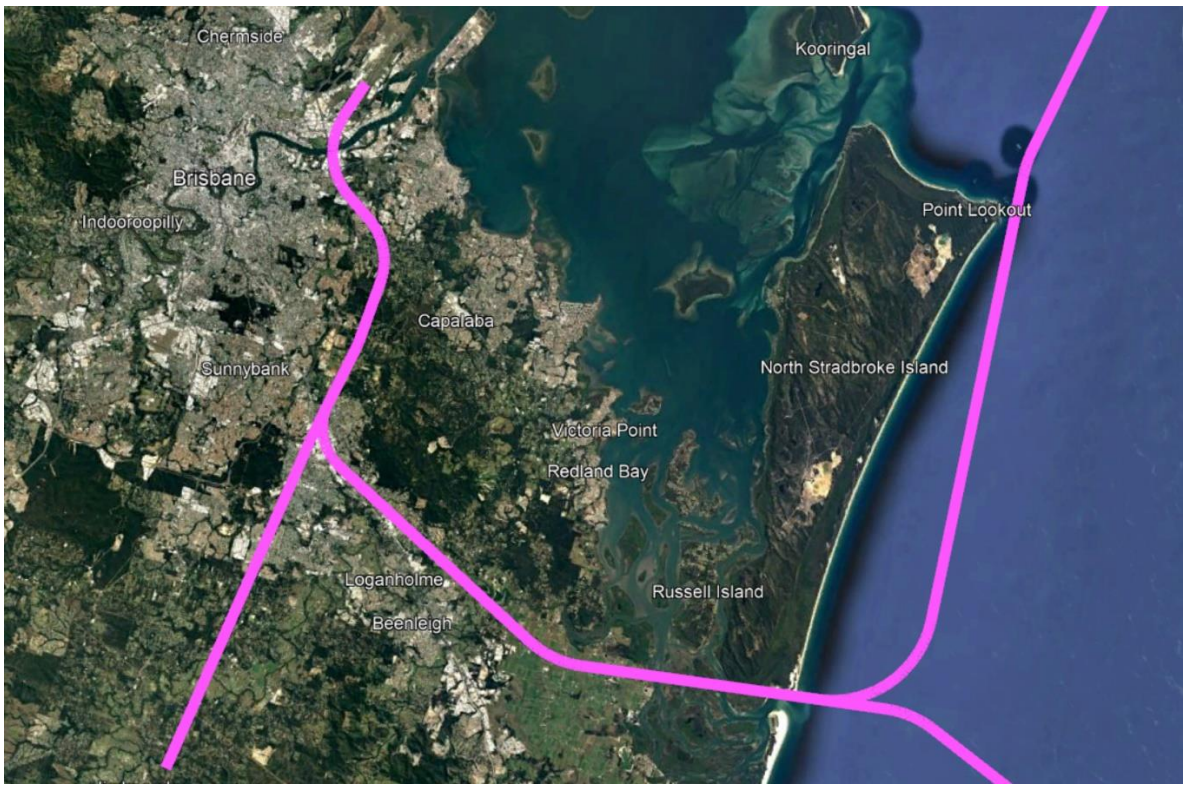


Southbound departure routes from the existing runway over the city and outer suburbs

85. Figure 12 illustrates the three departure routes used by jets departing from the existing runway to the south and east, over the city and outer suburbs (19L). The routes are designated as the:

- 19L GUMKI that turns out left, heading south initially, before turning to the east and then north
- 19L SANEG that follows the same initial track south as GUMKI before splitting to the southeast
- 19L SCOTT that turns out left and heads to the south on the same initial track as GUMKI & SANEG

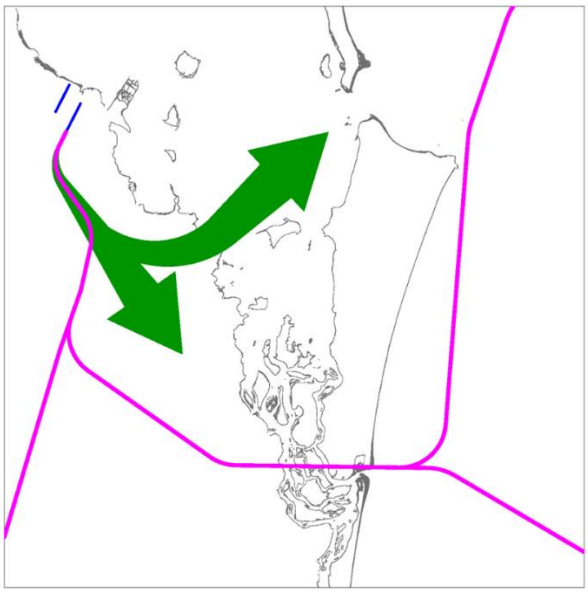
Figure 12: Illustration of southbound departure routes from the existing runway (19L GUMKI, SANEG & SCOTT)



In line with the compass operations model, all jet traffic with onward destinations to the south and east use one of these three routes. Feedback from the Community Focus Groups highlight how the frequency and concentration of overflights on the initial southbound track that is shared by all three routes increased significantly when the restrictions on domestic travel between States were lifted in Q1-2022. Feedback from the airline operators also highlighted that there may be opportunities to reduce the length of certain portions of the southbound departure routes, mitigating aircraft fuel burn and emissions.

One potential modification, in figure 13 may be to separate the three routes from the shared initial track sooner, by assessing options for either the SANEG, or the SANEG and the GUMKI to continue southeast after the first turn. Another set of options, illustrated in the right panel of figure 13 might be for either the SANEG or the SANEG and the GUMKI to continue the first turn, wrapping around tighter to track back in an easterly direction over water. One important issue that adds complexity to the development and assessment of these options, is the interaction with non-jet traffic also routeing south from the existing runway. The non-jet traffic follows a Radar SID (a standard compass heading) tight left at 110 degrees along the coastline, to separate them from the faster following jets, before turning south. Another important issue is the interaction with the arrival routes to the existing runway in 01 operations. Traffic on these arrival routes are descending northward along the coastline on their initial approach. Modifications to the 19L departure routes that wrap around to the east may lead to flight being held down beneath the arrival stream, interrupting the application of CCO. There may be a trade-off between climb performance and track miles, if the modifications reduced the overall length of the GUMKI SID. These interactions may constrain the extent of the modifications proposed for the 19L departure routes or generate a more extensive set of knock-on changes required to enable them. Again, the actual location of the modified routes would be determined by the outcomes of a detailed options assessment and stakeholder engagement exercise with all affected communities and aviation stakeholders.

Figure 13: Illustration of types of proposals that might be developed for existing runway departures south/east



Arrival routes to the new runway over the city and outer suburbs

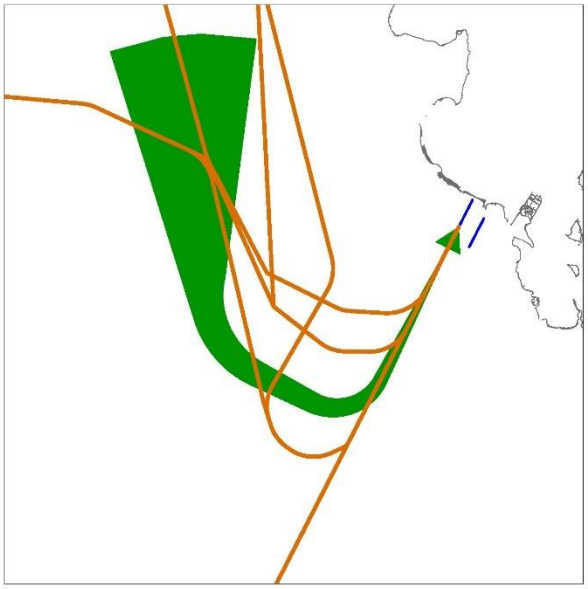
86. Figure 14 illustrates the three combinations of arrival routes used by inbound aircraft to the new runway from the north and west, over the city and outer suburbs (01L). The routes connect to the extended centreline at different distances from the runway for final approach, depending if the flights are following an Instrument Landing System procedure, an advanced navigation procedure (known as RNP-AR) or a visual approach. In line with the compass operations model, traffic arriving from the north and west use one of these routes between 6 am and 10 pm when the airport is configured for 01 operations. The same combination of routes also connects to the final approach to the existing runway, serving arrivals from the north and west after 10 pm during 01 operations. Feedback from the Community Focus Groups highlighted how the tracks of the two arrival routes that join the final approach closer to the runway overfly similar areas of the city and outer suburbs as the 19 departure routes from the new runway, increasing the frequency and concentration of overflight in these areas. Airline operators report issues with the efficiency of the 01 arrival routes (and some arrival routes to other runway ends) associated with descent profiles required to enable departure routes to climb continuously above the flows of inbound traffic. Aircraft are required to descent lower sooner and fly segments of level flight on some portions of the arrival routes to enable the application of CCO, leading to inefficient profiles and potentially additional noise. ATC also report that the constraint associated with Amberly airspace to the west, limits their ability to sequence the flow of inbound traffic efficiently and optimise the spacing between arrivals needed to maximise capacity.

Figure 14: Illustration of arrival routes from the north to the new runway in 01 operations

87. One potential modification is to redesign the combination of arrival routes, re-positioning the tracks further to the west, as illustrated in figure 15. This kind of modification could also consider removing the routes that currently join the final approach closer to the airport, turning in over the same areas

of the city that are also overflown by the 19R departure routes, to reduce the frequency and concentration of overflight. One of the main issues with repositioning the arrival routes further west is the interaction with Amberly airspace. A targeted release of airspace at lower altitudes or some form of shared access supported by FUA would be required for the options to modify the 01L arrival routes to be viable.

Figure 15: Illustration of the types of proposals that might be developed for 01 arrivals to the new runway



Arrival routes to the new runway over the water

88. Some of the arrival routes serving traffic from the north and west to the new runway when the airport is configured for 19 operations (arrivals over the water, departures over the city), create noise impacts for residents of Bribie Island. Specifically, the MORBI, SMOKA and WOODY STARS for traffic conducting an ILS approach to 19R overfly the southern shoreline at lower altitudes as they transition to the Final Approach. Feedback from the Community Focus Groups highlighted how noise impacts in this area tend to carry further over the water and beaches to the residential areas due to the low ambient noise levels. Residents of Bribie also emphasized the special significance of the Island from a biodiversity perspective drawing attention to the steps being taken to protect native fauna and flora. One option is to modify one, two or all three of the arrival routes, extending and re-orientating the turn so that they track over the north of Bribie Island at slightly higher altitudes and join the final approach further out over the water. This type of modification may add track miles to the arrival routes that are subject to the modification, creating a trade-off decision between noise impacts, fuel burn and emissions that should be evaluated as part of the options assessment and considered in the engagement with communities and aviation stakeholders.

Options for the management of non-jet aircraft noise linked to the RADAR SIDs

89. The Interim Report considered the treatment of non-jet traffic within the existing NPR flight path design from a noise management perspective. Approximately 30% of Brisbane traffic is non-jet, turboprop aircraft. One potential improvement opportunity was to engage with community stakeholders to build a better understanding of the size and nature of turboprop noise with the objective of identifying potential mitigations.

90. The Radar SID serving non-jet traffic departing over the water to the north from the new runway (01L) directs flights on a standard heading of 340° so that aircraft track over communities in Redcliff rather than over water. The Radar SID is orientated to separate the non-jet traffic from faster following jet aircraft departing on the 01L WACKO SID. One option is to transfer the non-jet traffic to a modified version of the 19L BIXAD SID that is currently used during SODPROPS to route traffic north from the existing runway, providing that safe separation from other routes can be maintained as part of a coherent set of flight path modifications. Another option may be to alternate the standard heading on the existing Radar SID so that it routes over water and concentrate on options to modify the existing 01L WACKO SID, which creates complex interactions for ATC in other areas of the NPR flight path design.

91. The Radar SID serving non-jet traffic departing over the city to the north from the new runway (19R) directs flights on a standard heading of 270°. The right turn after take-off is required to separate the non-jet traffic from faster following jets. Residents at the Community Focus Groups drew attention to the orientation of the turn that positions non-jet traffic at low altitudes over areas such as Northgate, Nundah and Wavell Heights that are only c.3 to 4km from the runway end. One option is to instruct non-jet traffic to turn tighter as soon as practicable after take-off and route back downwind, gaining altitude, before routeing north. Another option may be to alternate the standard heading by increments of 5° or 10° to disperse the tracks over the ground, providing safe separation from other routes can be maintained as part of a coherent set of flight path modifications.

Development and assessment of a baseline option

92. It is essential that a baseline option is developed that describes the actual impacts created by the existing NPR flight paths over the city and outer suburbs in terms that are directly comparable to the options for any of the proposed modifications.

Displaced runway thresholds

93. In the Interim Report, we considered a potential opportunity to assist with noise abatement for inbound traffic over the city by displacing the runway threshold. The runway threshold is the beginning of the portion of the runway that is usable for landing. It was envisaged that moving the approach profile of an aircraft closer to the airfield and the aircraft touchdown point further down the runway by displacing the threshold, might keep the lowest part of the approach within the airport perimeter, reducing the noise impacts over populations (albeit only moderately). The Interim Report highlighted guidance from ICAO that “the practice of using a displaced runway threshold as a noise abatement measure shall not be employed unless aircraft noise is significantly reduced by such use and the runway length remaining is safe and sufficient for all operational requirements.”

94. The length of the displacement that might be required for Brisbane’s runways to reduce aircraft noise over the city was not assessed as part of the Interim Report. For analytical purposes and to remain in line with ICAO’s guidance about maintaining safety and operational resilience (particularly in the context of the risk of runway excursions) it is assumed that a c.500m displacement is proposed.

Brisbane has a subtropical climate with high temperatures for much of the year and occasional heavy rainfall. Aircraft require more runway distance to land in hot weather and on wet runways. The number of hot days and heavy rainfall events are expected to increase in the coming years due to climate change, meaning a displacement of more than c.500m would not be recommended.

95. The key element of the ICAO criteria for using a displaced runway threshold is that aircraft noise must be significantly reduced. The loudness of noise is generally measured in terms of decibels (dB). A change of 3dB has been defined as the minimum that is perceptible under normal conditions, while a change of 10dB corresponds to roughly a doubling or halving of loudness. 'A-weighted decibels' (dBA) are often used in measurements of aviation noise. This adjusts decibel values to take account of the frequencies that people are most sensitive to, as the human ear is less sensitive to sounds at low and high frequencies. Analysis conducted by ASA, indicates that with a c.500m displacement, the altitude on arrival for a typical narrow-body jet increases by less than 100ft. when overflying the Noise Monitor located in Bulimba, approximately 5miles from the end of the new runway, generating an indicative noise reduction of 0.6dBA. If the length of the displacement was increased to 1000m, which is unlikely to be compatible with safe and resilient operations for all aircraft in all weather conditions, the indicative noise reduction increases to 1dBA. These reductions would not be considered significant in the context of ICAO's guidance, based on the general consensus amongst noise modellers that a change of 3dBA is the minimum that is perceptible.

96. ASA and BAC have reviewed the feasibility and costs of displacing the runway threshold for arrivals to 01L. The project would require significant infrastructure works, including the relocation of the Instrument Landing System, Approach Lighting and Rapid Exit Taxiways. The direct financial costs of implementing a displaced runway threshold are expected to exceed c.AUD $10 million. In addition, a number of specialist resources would be required to re-evaluate the taxi-way network, flight path design and the arrangements for protection against obstacles. Changes to these features may have an impact on runway capacity and efficiency. For example, moving the glide path protected area in line with a c.500m displacement may prevent the safe use of some existing taxiway holding points. The inclusion of a displaced threshold project in work package three would also draw investment, specialist resources and management attention away from the other potential flight path modifications described above that would be expected to yield greater benefits. For these reasons the option for a displaced runway threshold has been discounted in the Final Report.

Slightly steeper approaches

97. Alongside the displaced thresholds, the Interim Report also considered a related opportunity to deliver the same outcome, keeping flights higher on arrival, by increasing the glide path angle of the descent when aircraft are on the final approach. Flights arriving to Brisbane Airport currently follow a 2.9° glide path angle of descent. The Interim Report considered the opportunity to raise the glide path angle to 3.2°, highlighting that there would only be a small increase in altitudes on approach and consequently noise. We suggested that this opportunity may be combined with other related options to keep aircraft higher for longer on arrival, such as using a displaced runway threshold, to deliver incremental improvements. Analysis conducted by ASA, demonstrated that in isolation the implementation of a slightly steeper approach angle would increase the average altitude of inbound flights by less than 100ft, when overflying the Bulimba Noise Monitor and that the noise reduction per flight would be approximately 0.6dBA. One of the main challenges associated with a slightly steeper approach is the ability for aircraft to follow and Instrument Landing System approach safely in low visibility conditions with a glide path angle greater than 3.0°, leading to lower uptake of the change proposal. For these reasons the option for a slightly steeper approach has been discounted in the Final Report.

Work package three recommendations

PACKAGE THREE: REDUCE THE FREQUENCY & CONCENTRATION OF FLIGHTS OVER COMMUNITIES

TIMELINES: DEVELOPMENT DURING 2023 & IMPLEMENTATION IN 2024

Ref	Recommendation	Description
3.1	Develop and assess options for change proposals to reduce the frequency and concentration of flights over communities, and where they are feasible, engage with all affected stakeholders on the impacts and trade-offs	Proposals to modify the existing flight paths over communities in the city and outer suburbs should follow a transparent and coherent process to evaluate the impacts of different options and conduct meaningful engagement with all affected stakeholders about the trade-offs if change proposals to deliver improvements create new noise impacts or other negative outcomes. The options may build on a combination of the following suggestions arising from our analysis and/or include different options identified by ASA and other stakeholders: a) Options to redesign the two departure routes over the city from the new runway to the north so the flight paths are offset from the extended runway centreline and follow a different track over the ground to that overflown by inbound traffic on final approach to the new runway. b) Options to redesign the two departure routes over the city from the new runway so they diverge and the flight paths each follow different tracks over the ground. c) Options to redesign the two departure routes over the city from the existing runway used after 10 pm so the flight paths follow a different track over the ground to that overflown by the new runway departure routes used in the daytime. d) Options to introduce an ATC procedure to vector outbound flights using the two departure routes over the city from the new runway when a specific altitude has been reached (e.g. 4000ft) that would disperse the tracks over the ground because aircraft with higher climb rates would reach the specified altitude quicker and turn sooner. e) Options to redesign the three departure routes over the city from the existing runway to the south so they follow different tracks over the ground and potentially save track mileage, by turning sooner and/or tighter. f) Options to redesign two of the arrival routes over the city to the new runway from the north so the flight paths converge further to the west and the tracks over the ground are different to those overflown by outbound traffic heading north.

g) Options to re-evaluate three of the standard compass headings that non-jet departures are instructed to follow after take-off (subject to the impacts on operational capacity) so that the tracks over the ground may be dispersed or repositioned over water.

h) The development of a baseline option that describes the actual impacts created by the existing NPR flight paths over the city and outer suburbs in terms that are directly comparable to the options for any proposed modifications.

Potential improvement opportunities identified in the Interim Report incorporated in work package three

98. Table 9 summarises the potential improvement opportunities in the Interim Report that have been further developed and incorporated into work package three.

Table 9: Interim Report potential improvement opportunities incorporated in work package three

Ref	Interim Report potential improvement opportunity	Final Report Rec.
B3.2	Delegated use of Amberley at lower altitudes	Rec 3.1
B3.3	Small flight path changes to mitigate noise	Rec 3.1
B4.1	Examine the community perception of turboprop noise	Rec 3.1
B4.2	Re-evaluate the turboprop radar SIDs based on the outcome of B4.1	Rec 3.1
B4.3	Reintroduce a visual approach over the river	Rec 3.1

3.4. Package 4: Optimize the performance of the wider Brisbane airspace system

99. Work package four aims to optimize the environmental performance and operational capacity of the wider Brisbane airspace system through the development, assessment and engagement on a more expansive set of options for proposed changes to the airport's runway modes and flight paths that deviate from the compass operations model. It includes options for the introduction of noise sharing runway modes, the use of multiple routes for planned respite and how these broader changes to the NPR flight path design might be enabled by enhancements to the airspace structures that integrate Brisbane traffic with the wider enroute network.

100. The options included in work package four will take longer to develop than those in packages two and three because of the scale and complexity of the proposed changes, extending the likely timescales for implementation beyond 2025. The stakeholder engagement and consultation process for proposals to introduce new runway modes and flight paths that deviate from compass operations would be a lengthy exercise. So would the ATC simulation, procedure development and training activities needed to support their implementation. It is important that the options considered in work package four remain closely aligned with, and build on, the shorter-term changes developed in package three. The introduction of noise sharing runway modes and respite routes should be configured to further enhance the package three modifications that aim to reduce the frequency and concentration of overflight associated with the existing NPR flight path design. The scale and complexity of the airspace changes required to introduce respite routes, alongside runway alternation, or in isolation, would require significant interdependent changes to the airspace structures and route network that serve other airports and aircraft operations across the region. These interdependent changes to optimise the performance of the wider airspace system are also included within the scope of work package four.

101. A wide range of organisations are required to contribute to different aspects of work package four developing and assessing the options, supporting the consultation and working jointly to deliver the final changes. The organisations involved would include but are not limited to, ASA, BAC, other Airports and Aerodromes in Southeast Queensland, Airline Operators, General Aviation and Defence.

Options for the introduction of noise respite through runway alternation

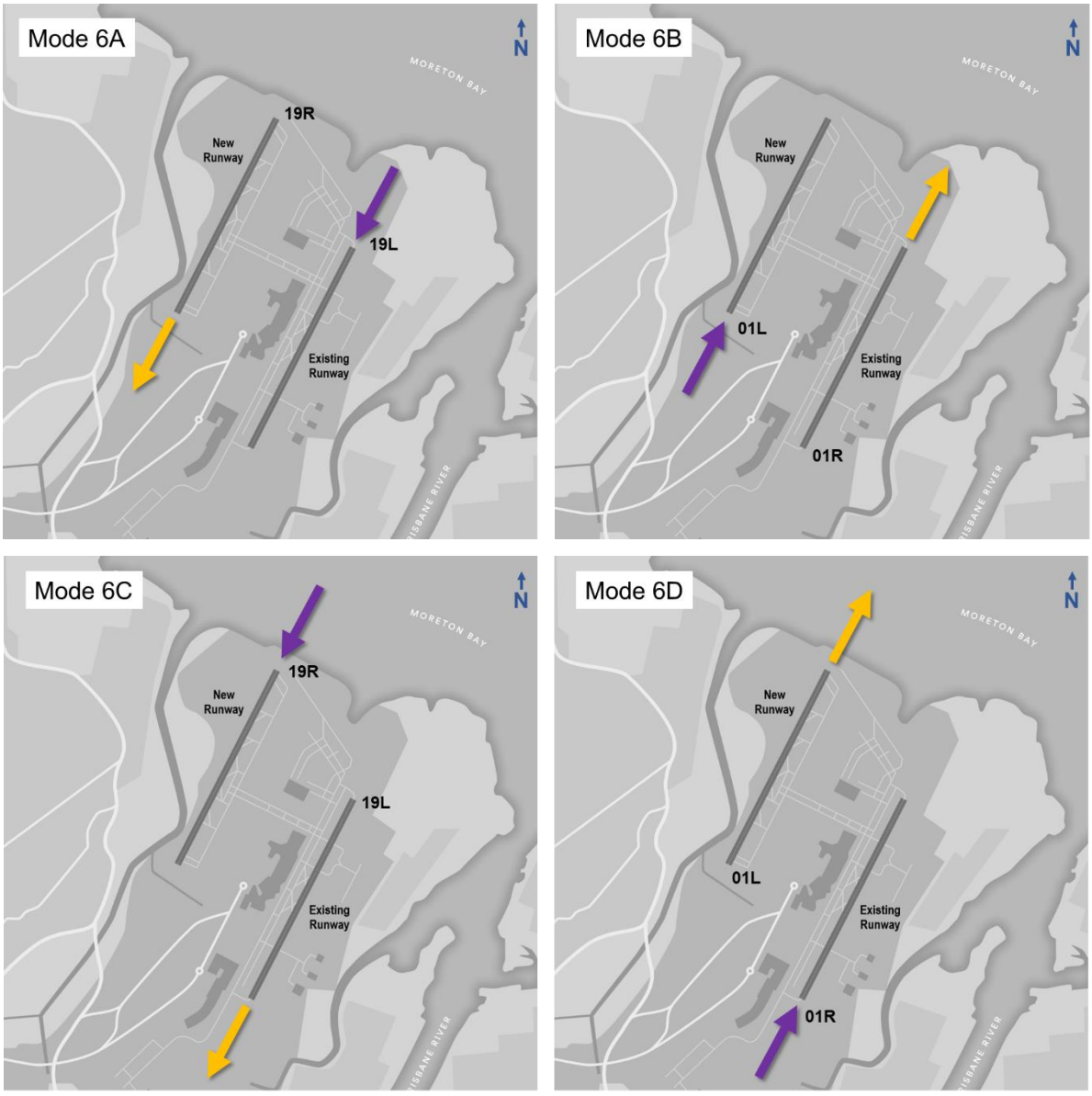
102. The provision of respite, or planned relief from aircraft noise, has become an important topic, especially for communities located closer to airports, where the other options to improve noise outcomes on the ground are limited. In the Interim Report we identified the potential improvement opportunities that may be developed to optimise noise sharing arrangements within the Brisbane operation. The introduction of a widely space parallel runway creates options to share the impacts of aircraft noise in different ways. The compass operations model that the NPR flight path design is configured for offers significant benefits in terms of capacity and predictability but limits the use of the parallel runways in other semi-mixed and segregated modes that may generate efficiency and noise management improvements.

103. Opportunity C1.1 in the Interim Report considered the introduction of noise respite through runway alternation by incorporating the use of segregated or semi-mixed modes that offer lower, but still significant, levels of capacity. It is envisaged that the segregated and semi-mixed modes would be used alongside the simultaneous parallel modes and SODPROPS as part of a longer-term plan for noise management over time as traffic levels grow (see work package one). Communities located

close to the airport, in alignment with the extended runway centreline may be offered periods of predictable relief from noise through a published schedule of runway alternation. It is important to emphasize that the areas benefiting from temporary periods of relief, would at other times experience comparatively more noise events when the alternation schedule is reversed.

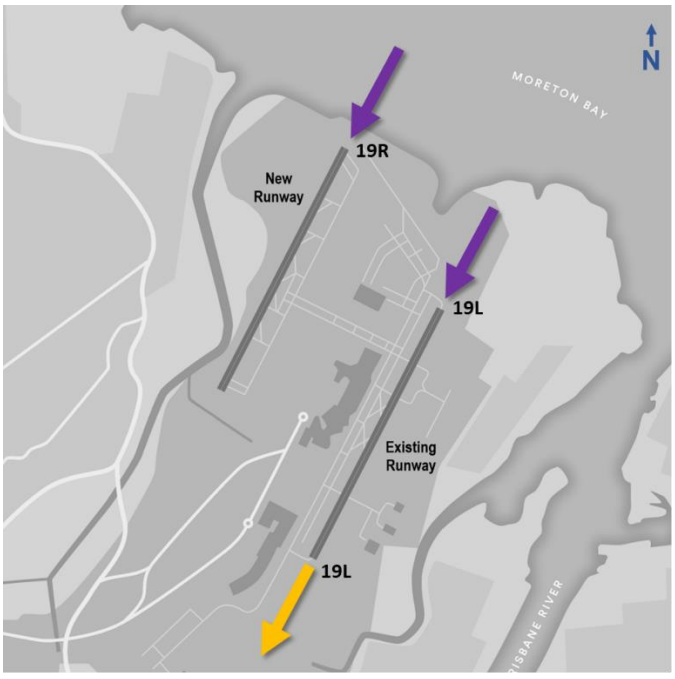
104. Two of the four segregated modes required for runway alternation, known as 6A and 6B, form part of the existing ATC procedures at Brisbane Airport. The introduction of two further modes, designated in this report as 6C and 6D, would allow for segregated arrivals and departures to each of the four runway ends, as illustrated in figure 16. Our observations and feedback gathered from ATC suggest that it should be possible to achieve a capacity of 30 arrivals and 30 departures per hour using segregated mode, with 5 miles spacing between the inbound aircraft and 2-minute separations between each take-off. Over time, as experience grows and operational procedures are refined, it is expected that the capacity in segregated mode will increase (to perhaps c.36 arrivals and c.36 departures per hour).

Figure 16: Illustration of the four segregated runway modes of operation required for runway alternation



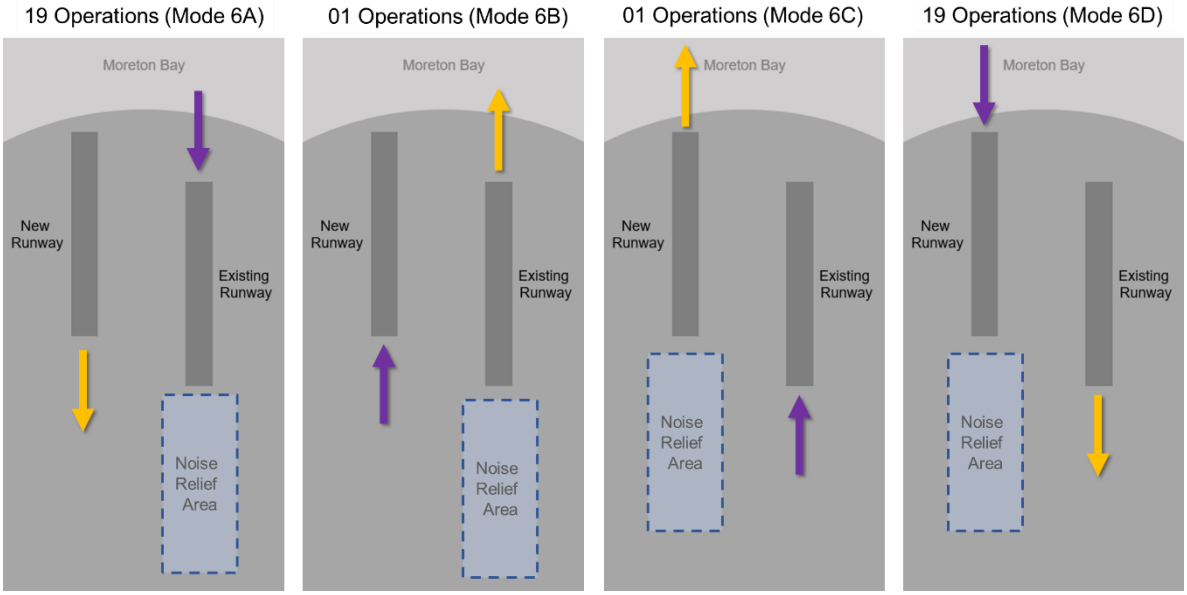
106. Opportunity C1.2 in the Interim Report refers to converting these segregated modes could to semi-mixed modes where departures use both runways and arrivals operate to one, or arrivals use both runways and departures operate from one. For example, figure 17 illustrates a semi-mixed mode variation of 6C, with arrivals using both runways and departures operating from one. The schedule allows for enhanced capacity for arrivals and departures in peak periods. Airlines need to be able to offer a competitive product when their passengers most want to travel. This involves scheduling more departures and arrivals in peak periods. The overall capacity of semi-mixed mode operations is similar to the segregated modes but instead of an equal split between arrivals and departures (e.g. 30 inbound and 30 outbound per hour) the capacity can be reapportioned to better meet the demands of the schedule (e.g. 42 arrivals and 18 departures during a busy inbound period), instead of reverting to one of the simultaneous parallel modes. It is expected that the use of a runway for these limited mixed mode operations (not full dual mixed mode) would only be utilised when capacity requirements, either through the schedule or due to unforeseen circumstances such as loss of a runway or thunderstorms, are exceeding the segregated capacity. This would be planned if as a result of scheduling and would be time limited and subject to review.

Figure 17: Illustration of the semi-mixed mode variation of mode 6C



108. Figure 18 illustrates how the creation of two noise relief areas in alignment to the extended runway centreline and the development of an alternating schedule for the use of segregated and semi-mixed modes can be used to deliver noise respite through runway alternation regardless of the runway direction.

Figure 18: Illustration of the noise relief areas with an alternating segregated runway mode schedule



109. The dimensions of the noise relief areas, should be informed by stakeholder engagement with the affected communities. Significant engagement and consultation with communities and aviation stakeholders would also be required to gather input on proposed flight path changes to ensure the noise relief areas are effective when in use and the airport can operate efficiently in either of the four segregated modes. For example, airline operators that predominately use the existing runway may be concerned with the impact on gate usage, scheduling and taxi times when required to use the new runway for either arrivals or departures during a segregated mode.

110. Input from community stakeholders should influence how the noise relief areas are used if established, in particular the schedule of alternation. For example the modes might be alternated daily at a prescribed time. A similar noise sharing arrangement used at Heathrow Airport in the UK requires the runways to alternate at 15.00 for the following 24 hours. Communities experiencing relief have a planned break from aircraft noise for the afternoon, night period and the next morning. The same communities then experience 24 hours of more concentrated noise and then the schedule repeats. The runway alternation that might be applied in Brisbane should be tailored based on the local circumstances of the affected communities. There may be a preference for longer periods of noise relief followed by concentration, or a more dynamic schedule. Community input is also required to determine the overall split between the use of the modes. For example communities that are newly affected by noise may expect a greater portion of the relief than those that have been overflown for many years. Whatever schedule of alternation is ultimately agreed, it should be published for stakeholders, followed predictably by ATC and subject to refinement through on-going community engagement (see work package one).[18]

[18] Heathrow Airport publishes its runway alternation schedule for the year ahead and supplies a downloadable app that automatically populates a phone or digital calendar.

111. The introduction of runway alternation would require significant changes to the existing NPR flight path design and the airspace structures that integrate Brisbane traffic with the wider enroute network because it deviates from the compass operations model. New arrival and departure routes would need to be incorporated into the design to ensure flights are connected to all directions from all runway ends. For example there is currently no departure route from the new runway over the city (19R) heading south. Options for a new route would need to be developed, assessed, consulted on and deployed to connect outbound traffic from the new runway, heading south over the city. Some of the existing NPR flight paths would also need to be redesigned to ensure they do not overfly the relevant noise relief area when used as part of the runway alternation scheme.

112. There are enough STARs in the existing NPR flight path design to support the arrivals in a segregated mode, but the use of closed STARs in the current operation may constrain capacity when only one runway is used for landing. To preserve a runway alternation schedule for any length of time, ATC may need to increase the use of open STARs that allow the spacing between arrivals to be fine-tuned with targeted vectoring. When inbound flights follow a closed STAR the track distance to landing is fixed and the spacing between arrivals can only be managed by controlling the aircrafts' speed. With an open STAR ATC can shorten or extend the track distance slightly by vectoring the flights to manage the arrival spacing with greater accuracy, thereby increasing the landing rate. A radar vectoring area would therefore need to be developed as part of the flight path redesign required to support the introduction of runway alternation. Options for the size and location of the area would need to be developed by ASA with inputs from the airline operators and communities. The dimensions may be similar to the radar vectoring area that served arrivals over the city to the main runway prior to the NPR opening. Although increasing the use of vectoring on arrival may be viewed as a backward step, following the introduction of closed STARs design to advanced navigation standards, some communities may perceive an improvement as arrival tracks over the ground are less concentrated and noise impacts are dispersed.

113. On departure, the introduction of additional routes for runway alternation would add complex new interactions to the overall flight path design. In particular, adding a departure route from the new runway heading south over the city, would create a new interaction with a route required to serve outbound traffic to the north when the existing runway is in use. Although the two routes would not be used at the same time in segregated mode, there would be a new risk introduced to the airspace system that adds complexity and must be managed appropriately.

114. Dedicated safety assurance work and ATC simulations would be required as part of the runway alternation development to understand the risks and complexity associated with switching between segregated modes, simultaneous parallel operations and SODPROPS. ATC simulations are resource intensive to conduct and require a mix of specialist ATC resources. They would also require participation from airline operators and possibly the regulator. The simulations that may be needed to support the development of options for runway alternation would take time to prepare, conduct and evaluate adding greater lead times to the development and implementation of options.

115. Opportunity B3.1 in the Interim Report considers a switch to the airport's current preference for simultaneous parallel operation in a 19 direction (departures over the city, arrivals over water), to a 01 direction. A switch to the preference would increase the amount of time during simultaneous parallel operations when arrivals overfly the city and departures take-off over water. Feedback from the Community Focus Groups about the differences between arrival and departure noise did not indicate a clear preference for one over the other. The application of continuous descent operations

and low noise approach measures (e.g. landing gear deployment, configuration of the flaps and the use of reverse thrust) may indicate that arrivals have the potential to be less impactful than departures in some circumstances. The current preference should be reviewed using the noise modelling data and incorporating feedback from communities and airline operators. If there is a decision to switch the preference, a short operational trial may be deployed to test the impacts. In the context of runway alternation there may be significant benefits to switching the preference and increasing the proportion of arrivals over the city. The noise relief areas are easier to define and protect for arrivals that are aligned to the runways on final approach several miles out.

116. It is important to emphasize that simultaneous parallel operations are the highest capacity and most overall efficient mode, enabling fully independent arrivals and departures. Although segregated operations are a powerful tool for use as part of an overall noise action plan, when peak traffic reaches a certain level and the runways become more heavily utilised, the noise concentration can become considerable. Through on-going engagement with communities, it may be considered more appropriate to switch back to simultaneous parallel operations in peak hours and focus noise mitigation measures built into the airspace design, for example through multiple respite routes.

Options for noise sharing through the deployment of multiple respite routes

117. The Interim Report considered the opportunities to introduce multiple arrival routes (C2.1) and/or departure routes (C2.2) that can be alternated as part of a schedule developed in collaboration with communities to offer noise respite. Like runway alternation, the objective of introducing respite routes is to improve the predictability of aircraft noise impacts and offer some communities with options for periods of relief that rotate with periods of more concentrated noise. Respite routes can be incorporated into the airspace system more easily with the use of advanced navigation standards because the flight paths can be designed with greater accuracy and flexibility.

118. The NPR flight path design includes arrival routes configured to use an advanced navigation standard known as RNP-AR (Required Navigation Performance – Authorisation Required). Aircraft must be equipped with RNP-compatible avionics, and authorisation is required from CASA for the specific pilot training needed to fly the routes. A large proportion of the jet fleet operating at Brisbane is RNP-AR equipped and approved. Much of the remaining jet fleet and some of the non-jet fleet is expected to become equipped and approved in the coming years. Arrival routes designed to an RNP-AR standard can be flown with high track-keeping accuracy, including the ability to conduct curved approaches closer into the runway.

119. Work package four includes the development and assessment of options for the introduction of multiple RNP-AR arrival routes to both runways when the airport is in 01 operations, and flights approach over the city and outer suburbs. Several RNP-AR routes are already in use as part of the existing NPR flight path design, but they are not configured for planned alternation from either an operational or noise relief perspective. In the short term, the database capacity of the IT system used in the Brisbane operation to process flight information may constrain the application of multiple RNP-AR arrival routes. ASA is currently developing a national programme of IT system upgrades that once deployed in the Brisbane operation, is expected to enable the use of multiple RNP-AR arrival routes.

120. The use of multiple RNP-AR arrival routes to create alternation of flight paths may be appropriate in some local circumstances, but it is also likely to increase the total population overflown (albeit in a more predictable manner). Respite routes would also add significant complexity to the overall

airspace system, creating interactions with other arrival and departure routes. In addition, new ATC tools may be required to support the use of respite routes because arrival spacing will be achieved only through streaming and time-based operations (the high-fidelity management of aircraft speed). The extensive use of ATC vectoring that distributes tracks over the ground would clearly undermine the noise relief offered by alternating the routes.

121. Another related option included for consideration in work package four is the development and assessment of different departure route configurations that include respite options. As with the arrivals, multiple departure route configurations will introduce significant additional complexity to the operation and interact with other features of the airspace design.

122. Respite routes may be considered as part of a flight path redesign that deviates from the compass operations model and is intended to support the introduction of runway alternation in segregated mode. Otherwise, if the outcome of consultation leads to a decision not to implement runway alternation, respite routes should be considered as part of work package four through a separate engagement with community and aviation stakeholders.

123. The scale and complexity of the airspace change required to introduce respite routes on arrival or departure, alongside runway alternation, or in isolation, would require significant interdependent changes to the airspace structures and route network that serve other airports and aircraft operations across the region. For example, the Amberly boundary to the west currently constrains the volume of airspace available to deploy multiple respite routes on arrivals from the north. The targeted release or shared access to portions of Amberly airspace may need to require, in close liaison with Defence, to develop credible options for noise respite in these areas.

Work package four recommendations

PACKAGE FOUR: OPTIMIZE THE PERFORMANCE OF THE WIDER BRISBANE AIRSPACE SYSTEM

TIMELINES: DEVELOPMENT IN 2023 & 2024, IMPLEMENTATION FROM 2025

Ref	Recommendation	Description
4.1	Develop and assess options for change proposals to introduce noise sharing through runway alternation using segregated and semi-mixed runway modes with an updated flight path design that deviates from compass operations, and if feasible engage with all affected stakeholders	a) The options included in work package four will take longer to develop than those in packages two and three because of the scale and complexity of the proposed changes, extending the expected timelines for implementation into 2025. b) The options to introduce new noise-sharing runway modes supported by an updated flight path design that deviates from compass operations should be configured to align with the modifications implemented as part of package three. c) It is important to emphasize that the areas that would benefit from temporary periods of relief through runway alternation would at other times experience comparatively more noise events when the alternation schedule is reversed. d) It is envisaged that the segregated and semi-mixed runway modes would be used alongside the simultaneous parallel modes and SODPROPS as part of a system to manage noise as traffic levels grow, designed with community and aviation stakeholders in a long-term Noise Action Plan. e) The options for a runway alternation schedule should consider the use of the semi-mixed modes, where departures use both runways and arrivals operate to one, or arrivals use both runways and departures operate from one, so that the airport's capacity can be allocated to accommodate peaks in traffic demand at different times. f) The options for the dimensions of the noise relief areas introduced as part of runway alternation should be informed by stakeholder engagement with the affected communities. Significant engagement with communities and aviation stakeholders should also be conducted to gather inputs on the proposed changes to the flight path design needed to ensure the noise relief areas are effective when in use and the airport can operate efficiently in all modes. g) Engagement with community and aviation stakeholders should influence how the noise relief areas are used if established, in particular the schedule of alternation. h) Dedicated safety assurance work, ATC simulations and aviation stakeholder engagement should be conducted to assess the risks associated with switching between the segregated modes and simultaneous parallel operations.

4.2	Develop and assess options for change proposals to introduce multiple arrival routes over the city that can be alternated to a planned schedule to deliver respite, and if feasible engage with all affected stakeholders	a) The NPR flight path design includes several arrival routes that use advanced navigation standards for more precise and flexible approaches and may be re-configured and supplemented with additional routes to deliver planned respite for some communities through alternation. b) The existing IT systems used by Brisbane ATC to support air navigation do not have the capacity to manage multiple alternating arrival routes. ASA is implementing a national programme of IT system upgrades that when complete is expected to enable options for respite routes on arrival to be developed and assessed for the Brisbane airspace system. c) Options to introduce respite routes on arrival should be incorporated into the proposed changes to the flight path design required to enable runway alternation. d) If following the outcome of stakeholder engagement, options to implement runway alternation are not progressed, respite routes on arrival should be considered in isolation through a separate engagement exercise with community and aviation stakeholders for use with simultaneous parallel operations. e) It is important to emphasize that the areas that would benefit from the use of respite routes on arrival would at other times experience comparatively more noise events when the alternation schedule is reversed and that the total population overflown would increase. f) The introduction of respite routes would add significant complexity to the Brisbane airspace system, creating interactions with other arrival and departure routes and interdependencies with the airspace structures that integrate Brisbane traffic with the wider enroute network. The improvements expected from introducing respite routes should be assessed against the impacts on flight efficiency and aircraft emissions where longer tracks and sub-optimal climb and descent profiles are required to accommodate alternation.

Potential improvement opportunities identified in the Interim Report incorporated in work package four

125. Table 10 summarises the potential improvement opportunities in the Interim Report that have been further developed and incorporated into work package four.

Table 10: Interim Report potential improvement opportunities incorporated in work package four

Ref	Interim Report potential improvement opportunity	Final Report Rec.
C1.2	Use of mixed-mode and tactical arrival and departure enhancements	Rec 4.1
C2.1	Multiple RNP-AR routes for noise respite on arrival	Rec 4.2
C2.2	Multiple departure route configurations for noise respite	Rec 4.3
D1.1	Airport/airspace capacity study for inbound and outbound aircraft	Rec 4.1
D1.2	Coordination of the arrival and departure sequencing	Rec 4.1

Appendix A: Opportunities mapped to Final Report Recommendations

#	Potential Improvement Opportunity	Status	Related Rec.
A1.1	Safety assurance for a 7-knot tailwind limit	In progress	-
A1.2	A wider review of the met constraints associated with SODPROPS	Pending A1.1	-
A2.1	Clear and unambiguous instructions regarding the use of SODPROPS	Package 2	Rec. 2.1
A2.2	Decision-making criteria for the use of SODPROPS	Package 2	Rec. 2.1
A2.3	Forecasting and decision-making support tools for SODPROPS	Include in Noise Action Plan	Rec 1.4
A2.4	System adaptations to support SODPROPS initiation and exit	Include in Noise Action Plan	Rec 1.4
A3.1	Post operational analysis to evaluate SODPROPS potential	Package 2	Rec. 2.1
A3.2	Modelling and simulation of SODPROPS maximum capacity threshold	Package 2	Rec. 2.1
A4.1	Re-positioning the routes that serve en route traffic	Package 2	Rec. 2.2
A4.2	Examine Big Amberly's impact on westerly arrivals during SODPROPS	Package 2	Rec. 2.2
A4.3	Wider airspace redesign to enable the use of SODPROPS	Package 2	Rec. 2.2
B1.1	Full-length departure trial that is now in progress	In progress	-
B1.2	Increasing the minimum climb gradient on the departure routes	Package 3	Rec. 3.1
B1.3	Reduce tactical intervention to maintain route compliance	In progress	-
B1.4	A best practice review of noise abatement departure procedures	Include in Noise Action Plan	Rec. 3.1
B2.1	Slightly steeper approaches for arrivals over the city	Discounted in package 3	-
B2.2	Displace the landing thresholds for arrivals over the city	Discounted in package 3	-
B2.3	Engage airlines to reduce the noise by flying quieter approaches	Include in Noise Action Plan	Rec. 1.4

B2.4	Review the potential for GBAS to improve noise management	Include in Noise Action Plan	Rec. 1.4
B3.1	Examine the runway mode preference for departures over arrivals	Package 4	Rec. 4.1
B3.2	Delegated use of Amberley at lower altitudes	Package 2	Rec 2.2
B3.3	Small flight path changes to mitigate noise	Package 3	Rec 3.1
B3.4	Larger flight path changes to mitigate noise and improve efficiency	Package 4	Rec 4.1
B4.1	Examine the community perception of turboprop noise	Package 3	Rec 3.1
B4.2	Re-evaluate the turboprop radar SIDs based on the outcome of B4.1	Package 3	Rec 3.1
B4.3	Reintroduce a visual approach over the river	Include in Noise Action Plan	Rec 1.4
C1.1	Noise relief by runway alternation in segregated mode	Package 4	Rec 4.1
C1.2	Use of mixed-mode and tactical arrival and departure enhancements	Package 4	Rec 4.1
C2.1	Multiple RNP-AR routes for noise respite on arrival	Package 4	Rec 4.2
C2.2	Multiple departure route configurations for noise respite	Package 4	Rec 4.2
C3.1	Brisbane Operating Plan	Package 1	Rec 1.4
D1.1	Airport/airspace capacity study for inbound and outbound aircraft	Package 4	Rec 4.1
D1.2	Coordination of the arrival and departure sequencing	Package 4	Rec 4.1
D1.3	Re-evaluate the delay threshold to relax compass operations	Package 2	Rec. 2.1
D1.4	Arrival sequencing with RNP and the use of targeted vectoring	Package 4	Rec 4.1
D1.5	Airspace redesign to enable independent operations	Package 2	Rec. 2.1
D2.1	Modelling and simulation to inform modifications to en-route sectors	Package 4	Rec 4.1/4.2
D2.2	Terminal-wide airspace re-design	Package 4	Rec 4.1/4.2
D2.3	Adaptations to manage other aerodromes/airspace users	Package 4	Rec 4.1/4.2
D3.1	Optimisation of new ATM systems and tools	Include in Noise Action Plan	Rec 1.4
D3.2	Greater Civil/Military integration to enable FUA	Include in Noise Action Plan	Rec 1.4

E1.1	Integrated planning, delivery and governance arrangements	Package 1	Rec. 1.1
E1.2	Community Noise Management Board	Package 1	Rec. 1.1
E1.3	Cross-industry airspace optimisation forum	Package 1	Rec. 1.1
E2.1	Noise and other overflight data used to inform decision making	Package 1	Rec. 1.1
E2.2	Operational data used to inform decisions and enhance performance	Package 1	Rec. 1.3
E2.3	Mechanisms for sharing information with communities	Package 1	Rec. 1.2
E3.1	Engagement approach for options development and assessment	Package 1	Rec. 1.3
E3.2	An iterative approach to flight path design and impact assessment	Package 1	Rec. 1.3