Perth Airport | New Runway Project

New Runway Project

FINAL
MAJOR DEVELOPMENT PLAN

VOLUME C: AIRSPACE MANAGEMENT PLAN

SECTIONS 19-26
FEBRUARY 2021

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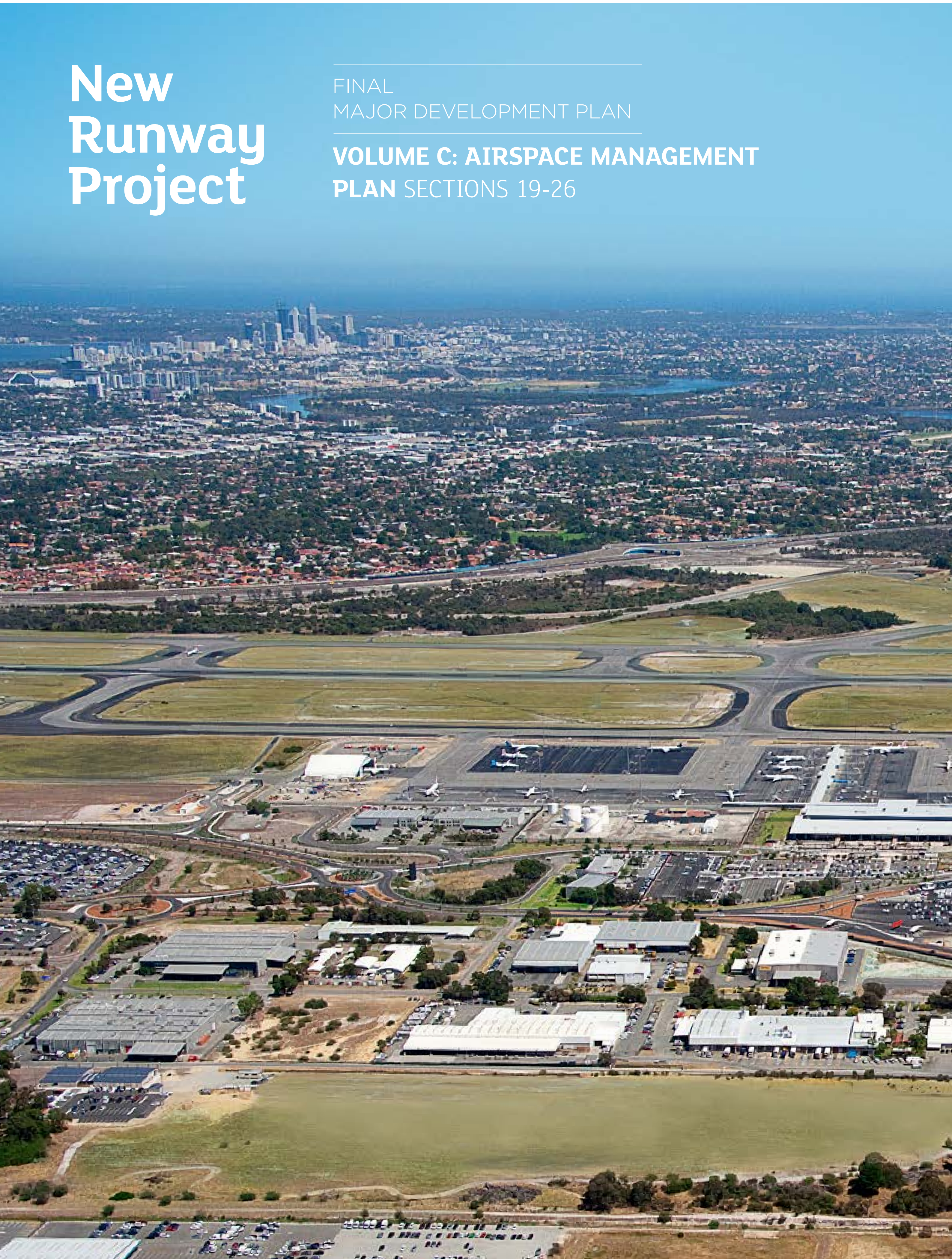

Volume C outlines the plan for airspace management. It also describes the impacts and mitigation strategies proposed as a result of the operation of the new runway as part of a parallel runway system.

The Final Major Development Plan for the New Runway Project is presented in four volumes:

- Executive Summary
- Volume A: Background and Need (Sections 1-7)
- Volume B: Environment, Heritage and Traffic Assessment (Sections 8-18)
- Volume C: Airspace Management Plan (Sections 19-26) – this volume

This volume should be read in conjunction with all other volumes.

This Final Major Development Plan for the New Runway Project has been prepared by Perth Airport Pty Ltd (Perth Airport) (ABN 24 077 153 130) to satisfy the requirements of the *Airports Act 1996* (Cth).

While all care has been taken in the preparation of this Final Major Development Plan for the New Runway Project:

- it is based on certain forecasts and assumptions, and Perth Airport makes no claim as to the accuracy or completeness of any of the information or the likelihood of any future matter,
- it should not be relied upon by any other party for any purpose,
- it does not commit Perth Airport to any particular development, and
- Perth Airport accepts no liability whatsoever to any person who in anyway relies on any information in this Final Major Development Plan for the New Runway Project (including making any decision about development or any other activity on or off Perth Airport).

ACKNOWLEDGEMENT OF COUNTRY

Hello, this is Whadjuk Country! Perth Airport operates on the traditional lands of the Whadjuk people of the Noongar Nation. We respect their ongoing cultural connection to this region. We value the insights and guidance of the Noongar signatories to the Perth Airport Partnership Agreement, as we work together to preserve and honour this connection.

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19 Airspace Management Plan Introduction

This section provides an overview of the process taken to develop and assess the Airspace Management Plan, noise and emissions and social impacts of the New Runway Project (NRP).

Detail is also provided on the following areas:

- What is the process for introducing new flight paths?
- How were the aircraft noise modelling and assessments undertaken?
- How was the air quality assessment undertaken?
- How was the social impact assessment undertaken?
- What is the major development plan process?
- What does the project involve?
- What assessments were undertaken?

19.1 Introduction

The New Runway Project (NRP) comprises the construction and operation of a new runway.

This volume presents the Airspace Management Plan for the operation of the new runway as part of a parallel runway system at Perth Airport. The Airspace Management Plan contains the proposed operating framework for airspace and flight paths, and the procedures that govern how aircraft could arrive and depart from a parallel runway system.

This Volume also outlines the assessment of aircraft noise, air-based air quality and greenhouse gas, health and social. An overview of hazards and risks to airport operations is also discussed.

19.2 Major Development Plan

The operation of a new runway, will result in changes to airspace and flight paths around Perth Airport.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires an airspace management plan to be referred to the Commonwealth Minister for the Environment, for advice on the change of airspace and flight paths associated with a new runway.

The *Airports Act 1996* (Airports Act) also requires an approved major development plan (MDP) for the construction and operation of a new runway. The contents of a major development plan, as outlined in Section 91 of the Airports Act, includes:

- if the development could affect noise-exposure levels at the airport, the effect that the development would be likely to have on those levels, and
- if the development could affect flight paths at the airport, the effect that the development would be likely to have on those flight paths.

This MDP has been prepared to address the various legislative approvals required for a new runway at Perth Airport and provides a combined approvals document to ensure a whole of project is represented.

The MDP is a detailed approvals document that has been structured and prepared to meet regulatory requirements of the Airports Act and the EPBC Act.

19.2.1 Approval Process

The legislative approvals process for the NRP is shown in Figure 19-1.

Further detail about the regulatory framework is provided in Section 1.

19.2.2 Major Development Plan Structure

The NRP MDP is presented in four volumes:

- Executive Summary,
- Volume A: Background and Need,
- Volume B: Environment Heritage and Ground Transport Assessment, and
- Volume C: Airspace Management Plan (this volume)

This volume should be read in conjunction with the Executive Summary, Volume A: Background and Need and Volume B: Environment Heritage and Ground Transport Assessment.

Table 19-1 provides details of the content and scope of each of the volumes and sections of the MDP.

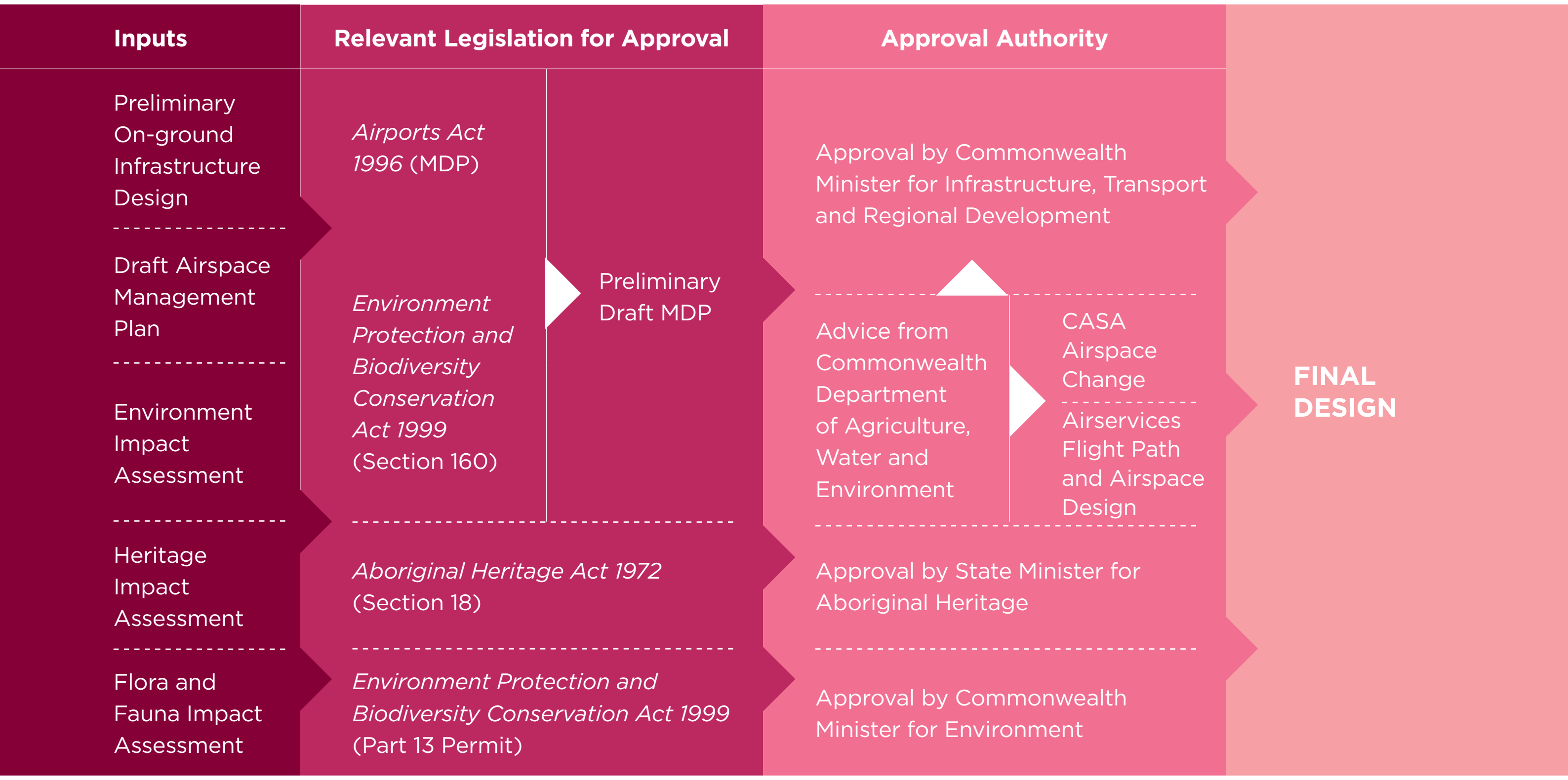


Figure 19-1 Legislative approvals process for the New Runway Project
Source: Perth Airport

Section	Description	Scope
Executive Summary		
Volume A: Background and Need		
01	Introduction	Volume A sets the scene for the project. It describes the background and need for the new runway, alternative options that have been considered, as well as provides a description of the NRP and how it will be constructed.
02	Need for additional capacity	
03	Options and alternatives	
04	Benefits of the New Runway Project at Perth Airport	
05	Consistency with State and Local government planning	
06	Project description and construction	
07	Consultation	
Volume B: Environment, Heritage and Traffic Assessment		
08	Environment, Heritage and Ground Transport Introduction	Volume B describes the initial conditions, impacts and mitigation strategies associated with the on-ground construction and operation activities of the NRP. It also provides details for environment, heritage and traffic management for the project.
09	Geology and soils	
10	Wetlands and hydrology	
11	Flora and vegetation	
12	Fauna	
13	Ground-based noise	
14	Air quality and greenhouse gas (ground)	
15	Landscape and visual	
16	Heritage	
17	Environment and heritage management	
18	Ground transport	
Volume C: Airspace Management Plan		
19	Airspace management plan introduction	Volume C outlines the plan for airspace management. It also describes the impacts and mitigation strategies proposed as a result of the operation of the new runway.
20	Background and existing airspace management	
21	Airspace management plan	
22	Aircraft noise	
23	Air quality and greenhouse gas (air based)	
24	Health	
25	Social	
26	Hazards and risks to airport operations	

Table 19-1 Content and scope of the New Runway Project Major Development Plan
Source: Perth Airport

19.2.3 Public Comment

In accordance with the requirements of a major development plan, under the Airports Act, Perth Airport released a Preliminary Draft MDP for 60 business days of public consultation. The public comment period ran from 31 May 2018 to 5pm (WST) 24 August 2018.

Further information on the consultation process is provided in Section 7.

19.3 Project Overview

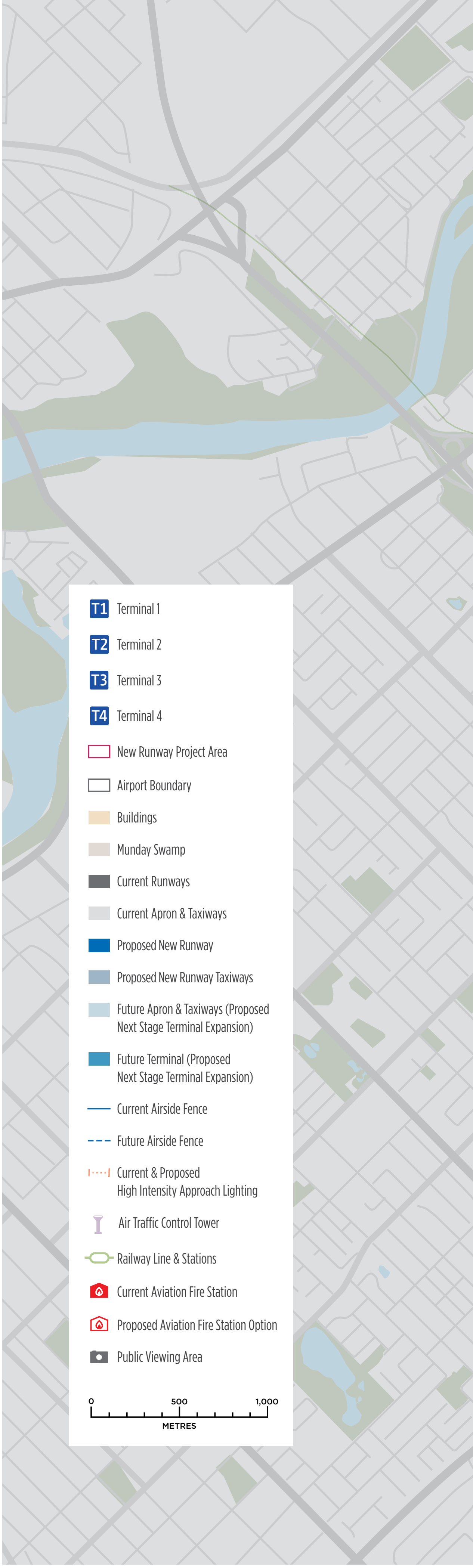
The NRP includes:

- construction, including clearing and site preparation, of a new runway up to 3,000 metres long with associated infrastructure, and
- development of an airspace management plan that will cater for the changes to current airspace and flight paths to accommodate operations of the new runway.

To meet future capacity demand, the new runway is expected to be operational between 2023 and 2028, subject to actual demand and a commercial agreement with airlines being reached. To meet this timeframe, Perth Airport is seeking to complete the approvals process for the new runway by 2021 to be ready for the construction and commissioning phase to begin.

The new runway will occupy 293-hectares and will be located parallel to the existing main runway with a two-kilometre separation so that both runways can be used independently. The location of the NRP is shown in Figure 19-2.

The location of the NRP is consistent with that identified in the Perth Airport Master Plan 2014 approved in January 2015, the subsequent Master Plan 2014 Minor Variation approved in June 2017, and the Perth Airport Master Plan 2020, approved in March 2020.



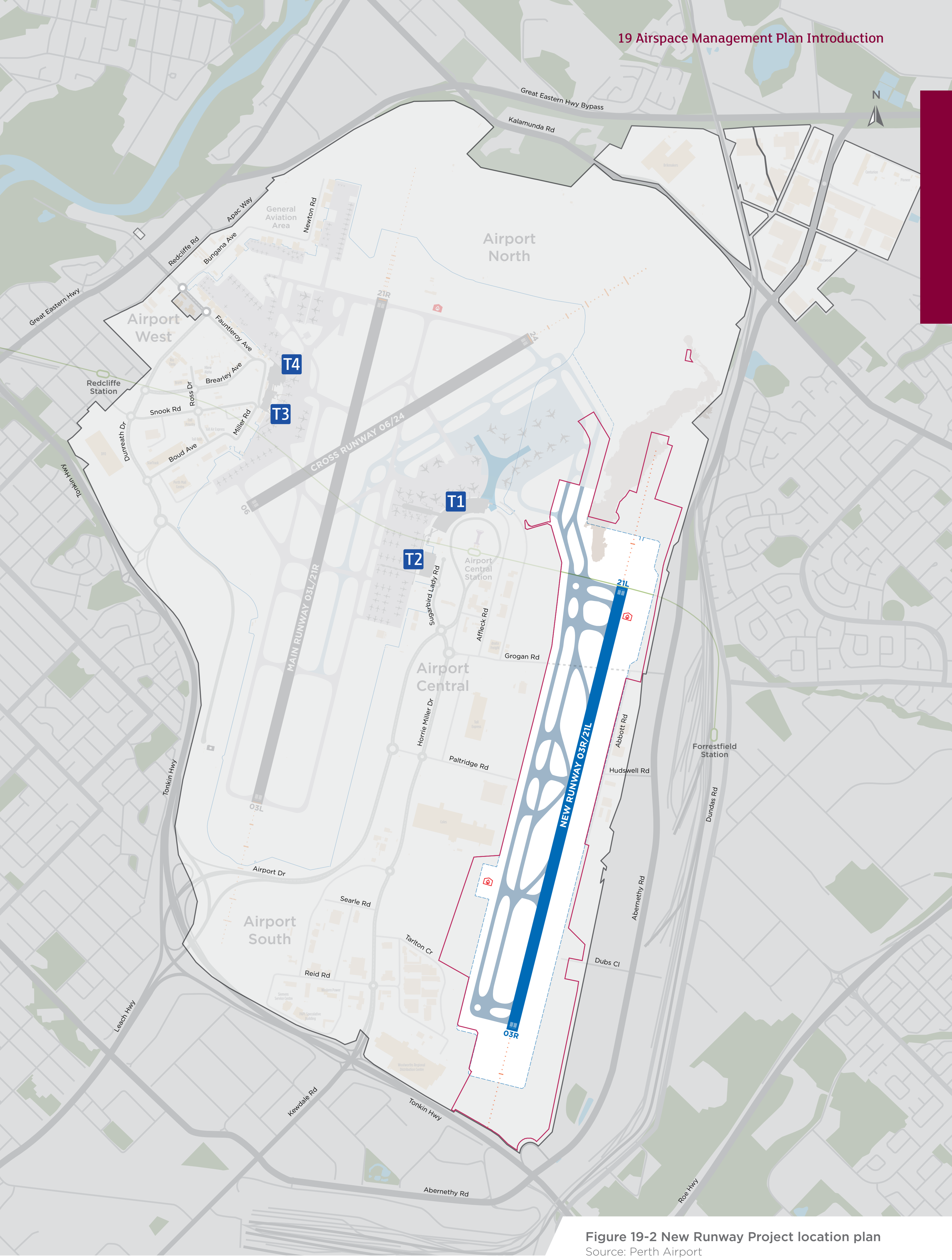


Figure 19-2 New Runway Project location plan
Source: Perth Airport

19.4 Airspace Management Plan Overview

This volume covers the following sections:

- Background and existing airspace management (Section 20),
- Airspace management plan (Section 21),
- Aircraft noise (Section 22),
- Air quality and greenhouse gas emissions (Section 23),
- Health (Section 24),
- Social (Section 25), and
- Hazards and risks to airport operations (Section 26).

Section 20 Background and Existing Airspace Management

This section provides background information to assist the reader to understand why aircraft fly where they do today. It details runway selection and the procedures that are used at Perth Airport to process arriving and departing aircraft.

Restrictions that dictate where aircraft can fly are explained along with the complexities of having three busy airports (Perth, RAAF Base Pearce and Jandakot) located close to each other.

Modes of operation where aircraft depart, either to the north or to the south, are detailed with information on the location of published flight paths and the flight tracks that are flown by aircraft today.

Section 21 Airspace Management Plan

The Airspace Management Plan details the process involved in developing flight corridors for operations of a parallel runway system at Perth Airport. The procedures for use of parallel runways consist of international standards and these standards have been applied in the drafting of the plan. Changes to airspace may be required when the final design of the flight paths commences approximately three years prior to the new runway becoming operational.

The indicative flight corridors shown in the Airspace Management Plan are restricted to those within approximately 70 kilometres of the airport. Outside of this, the aircraft are at a height where noise is not considered an issue and aircraft are flying over areas of much lower population or over the Indian ocean.

Section 22 Aircraft Noise

This section describes the anticipated changes to aircraft noise exposure resulting from operations of the new runway as part of a parallel runway system. Noise from aircraft approaching and departing Perth Airport and from their operations on the airfield is an unavoidable impact from the provision of critical and safe air services. From time to time, aircraft from Perth Airport – as well as Jandakot Airport and RAAF Base Pearce – will fly over most of the Perth Metropolitan Region. The NRP will change the distribution of aircraft noise exposure around Perth Airport and the Perth metropolitan area. This section also describes how aircraft noise is communicated, the methodology used to develop the various metrics presented, and the anticipated changes to aircraft noise once the new runway is operational.

Section 23 Air Quality and Greenhouse Gas Emissions

This section investigates the potential air quality impacts and greenhouse gas emissions associated with aircraft movements as a result of the NRP. Operations on the new runway will impact air quality and greenhouse gases as a result of emissions released by aircraft.

The purpose of this assessment was to quantify the emissions, identify the impact of the NRP and outline mitigations if required.

Section 24 Health

The health section focuses on the impact that aircraft noise exposure from the new runway could have on psychological effects, cognitive impairment, cardiovascular disease, sleep disturbance, and annoyance.

Section 25 Social

The social section focuses on identifying potential impacts of the NRP associated with people's way of life, their community, their environment, their health and wellbeing and their personal and property rights.

Section 26 Hazards and Risks to Airport Operations

This section assesses the hazards and risks to aviation activities as a result of aircraft operations on the new runway.

A review of the risks posed to aviation activity associated with the operation of the new runway was completed and considered including:

- airspace protection,
- aircraft crash,
- bird and animal strike,
- hazardous land use, and
- air traffic management.

Although a number of potential hazards and risks were identified, the majority are common to aircraft operations around the world, and therefore mitigated, to the highest level possible, through regulatory requirements and standards, and airport and aircraft operator's processes and procedures.

19.5 Consistency of Information

Based on recent aircraft movement forecasts, Perth Airport has adopted a 'plan for high' and anticipate to 'deliver at central' approach to additional runway capacity.

A likely opening range of 2023 to 2028 for the new runway allows industry to balance capital expenditure with appropriate levels of service and delays. Considering this range of dates, 2025 has been used as the day of opening of the new runway for all assessments throughout this volume.

Further information on the timing of the new runway is provided in Section 2.

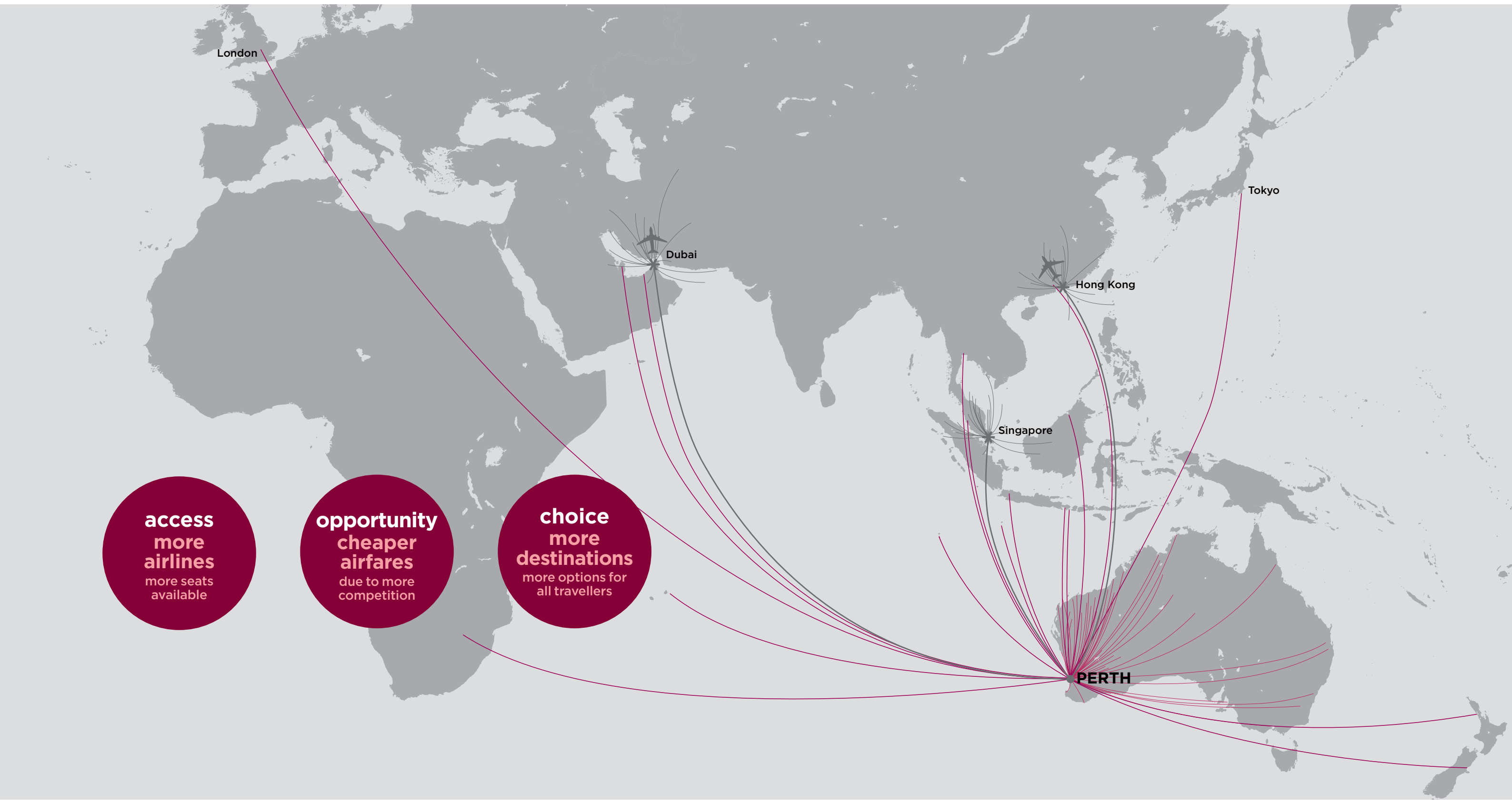

GB01

20 Background and Existing Airspace Management

This section provides background information to assist in understanding why aircraft fly where they do.

Detail is also provided on the following areas:

- How does weather affect airport operations?
- What are air traffic control operating procedures?
- How are flight paths designed?



20.1 Introduction

The New Runway Project (NRP) comprises the construction of a new runway up to 3,000 metres long parallel to the existing main runway (03L/21R).

This section provides background information on considerations and airspace operations to help understand the impacts of the NRP, including the various modes of operation, the considerations for determining which runway to use, and limitations that contribute to the design of where flight paths are located.

Additional information on the construction of the new runway and associated infrastructure can be found in Section 6.

20.2 Airport Operating Hours

Perth Airport operates 24 hours, seven days a week, providing an essential link for business and leisure travel, and meeting the needs of:

- regional communities and the resource sector,
- interstate domestic travel,
- international access to multiple global destinations, and
- freight, including express and time critical supplies.

Maintaining operational flexibility at Perth Airport are critical to supporting Western Australia's economy. Perth Airport is part of a national and global aviation network and, as such, flight times and schedules are not determined locally. The viability of many of Perth's international air services depend on linking with connecting networks through hub airports, such as Dubai and Singapore. Any restrictions on the operations of Perth Airport would lead to a significant loss of air services, which may result in a reduction of service levels and a likely increase in the cost of flying for community members and businesses.

International services are the lifeblood of the State's international tourism industry and the employment it supports. A reduced level of international air services that would arise from restrictions on Perth Airport would therefore have profound impacts on tourism and all those who depend on that industry.

The operational conditions at Perth Airport are also critical to maintaining and supporting an effective freight and logistics industry. A multitude of industries from minerals such as gold and diamonds, primary produce such as seafood and meat and a variety of specialist imports rely on the extensive dedicated freight and passenger plane 'belly freight' to support industry. Any operational restriction in these times would adversely and materially impact the industries which rely on overnight and well connected international routes.

A new growing market is that related to internet purchasing. Online retail is driven by its time critical responsiveness, and similar to other sectors, operational restrictions will directly and adversely impact providers and consumers.

20.3 Existing Airspace Considerations

The principal consideration in deciding where and how aircraft arrive and depart from an airport is safety. This takes precedence over all other matters. Following safety there are a wide range of other factors that influence the use of current and future runways, and the location and design of where aircraft fly, including:

- demand and volume of aircraft traffic,
- weather variations,
- departure and arrival procedures,
- modes of runway operations and capacity (the maximum number of aircraft which can be processed over a period of time),
- aircraft sequencing,
- efficiency including fuel burn and carbon emissions,
- managing exposure to surrounding communities through noise abatement procedures,
- local airspace coordination, and
- flight path design.

20.3.1 Demand and Volume of Aircraft Traffic

The number of aircraft wanting to fly, and the timing of when aircraft want to fly, influence the runway infrastructure required and the way in which aircraft use the airspace.

While schedules for airlines at Perth Airport remain consistent across the year, showing limited seasonal change, the daily and hourly aircraft movements can vary for a variety of reasons. Section 2 discusses the hourly, daily and weekly aircraft movement profiles of Perth Airport.

As detailed in Section 2, the total annual aircraft movements at Perth Airport are forecast to grow from 135,220 in 2016 to more than 241,000 movements in 2045.

20.3.2 Weather Variation

There are a number of ways in which weather affects aircraft operations, such as:

- wind direction and speed, which dictate the direction of the operating runways (i.e. the direction from which aircraft can land or take-off),
- different operating rules required when the runway is wet, and
- visibility due to fog or height of the cloud base determines which departure and arrival procedures and operating rules are used.

Weather conditions influence airport operations and have an impact on the capacity of the airport.

20.3.2.1 Wind

For flight operations, wind is most commonly described in terms of its crosswind and headwind or tailwind components. Crosswind is the wind that blows at right angles to the runway. The component of the wind that blows parallel with the runway, is called the headwind component if taking off in one direction and tailwind if taking off in the opposite direction.

Aircraft are designed to take-off and land into the wind. Therefore, the weather, and in particular wind speed and direction, is generally the main factor in determining which runway direction is used. Aircraft can operate safely on a runway that has a small tailwind component, typically less than five knots if the runway surface is dry.

Excessive crosswind components can impact an aircraft's ability to take-off or land safely. The strength of a crosswind component is a function of both the wind's strength and its direction. The closer the wind's direction is to being perpendicular to the runway, the greater its crosswind component.

Meteorological information for Perth Airport has been collected for many years by the Bureau of Meteorology and Airservices Australia. Wind speed and direction observations have been made by the Bureau of Meteorology at 9.00 am and 3.00 pm every day since 1 May 1944.

Wind patterns at Perth Airport can be characterised by a distinct daily pattern. As shown in Figure 20-1. In the mornings, winds are predominantly easterly or north-easterly while the afternoons are characterised by predominantly westerly or south-westerly winds.

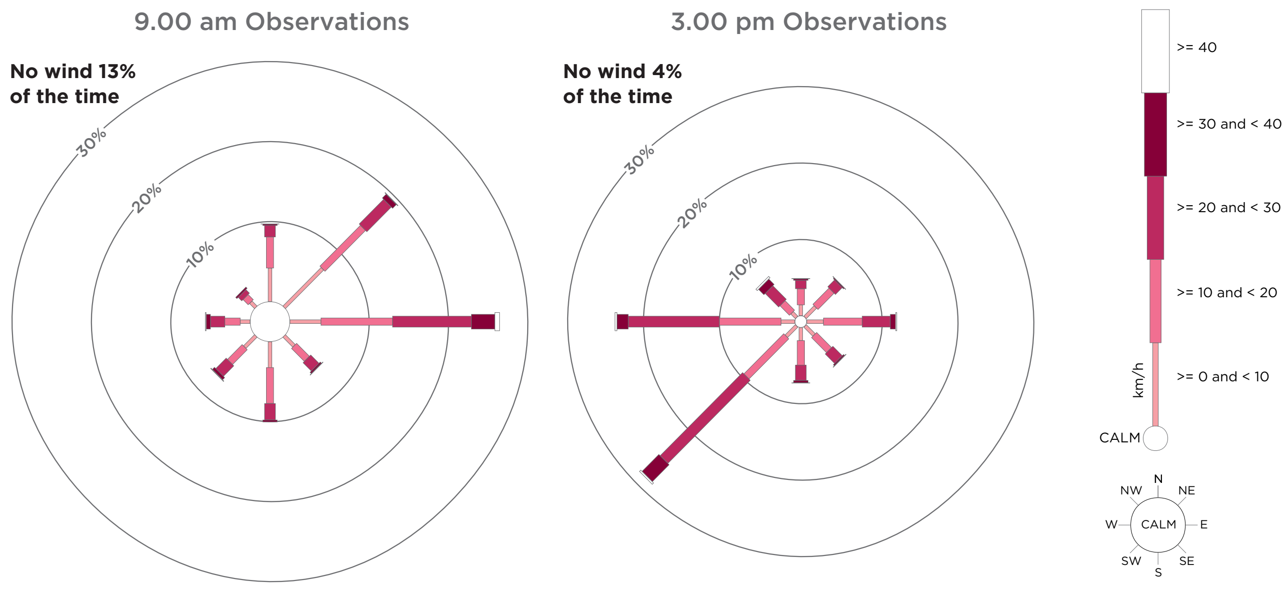


Figure 20-1 Breakdown by percentage of wind speed and direction
Source: Bureau of Metrology

The main runway (03L/21R) is used in runway 03 direction for a north-easterly wind and runway 21 direction for a south-westerly wind. The new runway (03R/21L) will be located parallel to the existing main runway (03L/21R) and will therefore have the same runway direction usage as the main runway.

Winds from the east or west will have crosswind components on the existing and new runways. Current air traffic control operating procedures dictate that if the crosswind exceeds 20 knots on a runway it should not be nominated for use if there is an available runway that is more into wind.

There are two descriptions of light winds in aviation: 'calm' is used to describe wind that may come from any direction but the speed is less than one knot, and 'variable' is used to describe a situation where it is not possible to describe a mean wind direction due to the variations, however the speed must be less than three knots. In these situations, air traffic control will nominate either the runway that the wind direction favours most or, if conditions are dry, the most appropriate runway for operational reasons.

20.3.2.2 Rain

The presence of water on the runway affects the performance of an aircraft by reducing the friction force between the tyres and the runway surface. Therefore, an aircraft needs a longer distance for take-off and landing during wet conditions. Safety considerations also generally dictate that no tailwind is allowed for operations on a wet runway. As a result, the operating rules for runway selection will change if it has been raining (even very lightly).

20.3.2.3 Visibility

Visibility is important in all phases of flight but particularly when the aircraft is close to the ground such as during take-off and initial climb out, and approach and landing.

When weather conditions do not provide sufficient visibility and pilots are unable to see the runway, terrain, obstacles and other aircraft, pilots are required to use instrument-flight rules and may operate on different flight paths. Air traffic control determines when instrument-flight conditions apply (i.e. when the pilot relies entirely on the information derived from cockpit navigation instruments) based on standards set by the International Civil Aviation Organization (ICAO).

The weather criteria used at Perth Airport, which determines whether an instrument or visual approach will be prescribed, are as follows:

- where the majority of cloud cover is below 3,000 feet above ground level and the visibility is eight kilometres or less – an instrument approach will be nominated. These conditions are known as Instrument Meteorological Conditions (IMC), or
- where the majority of cloud cover is above 3,000 feet above ground level and the visibility is more than eight kilometres – a visual approach may be nominated. These conditions are known as Visual Meteorological Conditions (VMC).

20.3.3 Departure and Arrival Procedures

There are procedures to follow when an aircraft departs or arrives at an airport. These procedures would be similar to directions from your house detailing the route you should drive to reach the highway. As there are a number of runways an aircraft can depart from or arrive to, there are a number of procedures for both departure and arrival, because they provide guidance from the runway to the point where the air route (highway) commences or ceases. To ensure safety, departure and arrival procedures are designed consistently and follow international guidelines.

For departures, the pilot follows a Standard Instrument Departure (SID). A SID will contain a number of points to track via to reach the air route. It may also contain an altitude that must be reached by a certain point (height requirement). A SID can be flown day and night in all weather conditions.

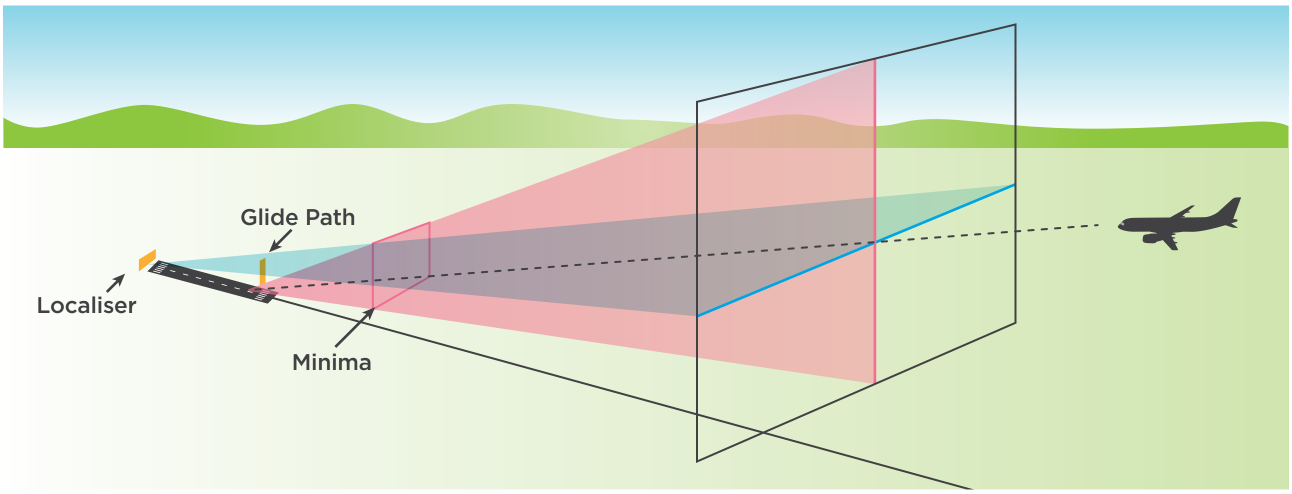


Figure 20-2 Instrument Landing System
Source: Airservices Australia

For arrivals, the pilot flies a Standard Arrival Route (STAR). These are similar to a SID in that they contain points to track by and may contain a height requirement. A STAR will position the aircraft close to the point of landing, where an approach will be made. The various approach options are detailed in Section 20.3.3.1.

SIDs and STARs are developed primarily to segregate inbound and outbound routes and, where these routes cross over to provide separation by use of height requirements. Due to aircraft performance, separate SIDs and STARs are developed for jet and turboprop aircraft (turbo propeller). All SIDs, where possible, from the one runway will be segregated from each other. Likewise, all STARs to the one runway will be segregated. However, due to the direction aircraft are departing to or arriving from, some tracks will need to cross each other. Height requirements are published on SIDs and STARs so height can be used to achieve aircraft separation where tracks cross. A height requirement to be at or below a certain altitude, may be on the STAR and this height must be met by a specified distance prior to the crossing point. The SID will then have a height requirement to be at, or above, an altitude that is 1,000 feet above the STAR height by a specified distance prior to the crossing point. This will ensure the aircraft are separated by at least 1,000 feet prior to crossing without any air traffic control intervention.

20.3.3.1 Approach Procedures

There are four types of approaches that can be made:

1. Visual approach by day

A visual approach is an approach to a runway conducted with reference to visual cues and clear of clouds. The pilot must have the runway in sight at all times. The pilot can descend the aircraft with visual reference to the ground.

2. Visual approach at night

A visual approach at night is similar to a visual approach by day. However, due to the difficulty of discerning the ground at night, a pilot requires assistance with the final descent to maintain clearance from terrain. Air traffic control can clear an aircraft to a safe altitude, which in Perth is 2,500 feet. For descent below this, the pilot requires the guidance of either, the Instrument Landing System (ILS) glide path or the Precision Approach Path Indicator system (PAPI). The PAPI is a set of lights at the runway edge that will show either white lights if the aircraft is too high, red lights if too low, or a combination of red and white when the aircraft is on the correct profile. The profile for arrival is a three-degree descent, which translates to commencing descent eight nautical miles from the runway from a height of 2,500 feet.

3. Instrument Landing System (ILS)

An instrument approach is required in poor weather conditions where the pilot cannot see the ground. In most cases an instrument approach will be conducted using an ILS. An ILS is a highly accurate navigation aid that uses radio signals to give the pilot vertical and horizontal guidance on a three-degree descent profile to the runway for landing. The ILS provides both lateral guidance (localiser) which will keep the aircraft on a heading direct to the runway; and descent guidance (glide path) which provides descent guidance to touch down on the runway. This system allows a pilot to descend to approximately 200 feet above ground level with a visibility of 800 metres before the runway must be in sight.

The localiser can be intercepted many miles out from the airport but the aircraft must be aligned with the runway centreline for this to occur. Intercepting the glide path will depend on the altitude of the aircraft and will occur when the aircraft intercepts the angled beam. At 2,500 feet this will occur at approximately eight nautical miles; and at 4,000 feet approximately 13 nautical miles. The ILS approach is shown in Figure 20-2.

4. Required Navigation Performance – Authorisation Required (RNP-AR)

Required Navigation Performance - Authorisation Required (RNP-AR) is a highly accurate procedure to approach and land on a runway. It does not provide guidance to the runway, but has minimum height and visibility requirements as to when a pilot must be able to see the runway similar to the ILS. RNP-AR uses highly accurate on-board computer systems to fly via a set of latitudes and longitudes while also providing descent guidance. RNP-AR is a STAR and an instrument approach combined. These approaches allow 'curved' approaches to be made and therefore are more flexible than an ILS which requires the approach to be made aligned with the runway.

RNP-AR is a reasonably new technology and requires the aircraft to be fitted with highly sophisticated equipment. New aircraft have this equipment installed but for older aircraft it is expensive to install and in some aircraft, it cannot be installed for technical reasons.

It will be many years until all aircraft at Perth are equipped to make these approaches. Currently approximately 30 per cent of aircraft operating at Perth are capable of flying these approaches.

One of the advantages for those that are equipped, is the ability to create routes that fly approaches closer to the airport. The result is that an aircraft will fly less miles than what is required by a traditional approach, resulting in reduced fuel burn and carbon emissions as well as potential noise management advantages.

20.3.4 Runway Modes

20.3.4.1 Operating Flows

Both ends of a runway can be used for arrivals and departures. The direction being used is referred to as the operating or duty runway.

An operating mode is the use of a certain runway or a combination of runways and the mode selected is based on a number of factors and selection criteria.

The main runway (03L/21R) is positioned in a north-south alignment and the cross runway (06/24) is positioned in a northeast-southwest alignment. Arriving aircraft from the north and departures to the south is referred to as the South Flow while arrivals from the south and departures to the north is referred to the North Flow as shown in Figure 20-3.

20.3.4.2 Mode Capacity

Departures

With each mode of operation there is a capacity limit. The mode capacity is heavily dependent on the number of arrivals and departures in an hour and whether meteorological conditions are IMC or VMC. With the need for more spacing between arriving aircraft (being at a slower speed and needing to be aligned with the runway) more departures can take off on a single runway than arrivals.

The current departures capacity is approximately 40 aircraft movements per hour for both North and South Flow. Due to the required spacing between aircraft and the design of the instrument-departure procedures, the departure capacity is the same whether on southerly operations using one runway for departures or northerly operations using two runways for departures. To achieve this departure rate there needs to be a low demand for arrivals.

In addition, air traffic control cannot provide visual separation of aircraft in poor weather with low cloud or poor visibility (IMC conditions). A lower departure rate occurs in these conditions, which can be as low as 30 departures per hour.

Arrivals

Rates for arriving aircraft are also dependent upon the weather conditions. If there is low cloud or low visibility, aircraft will be conducting instrument approaches. These are flown at a slower speed than a visual approach and require greater spacing between aircraft. The various landing rate capacities for arriving aircraft are:

- runway 21 and 24 in fine weather – 26 aircraft per hour,
- runway 21 only, 24 only or 03 only in fine weather – 24 aircraft per hour,
- runway 21 and 24 in poor weather – 22 aircraft per hour, and
- runway 21 only, 24 only or 03 only in poor weather – 20 aircraft per hour.

Use of runway 21 or 24 is therefore desirable during periods of peak arrival demand.

20.3.4.3 Preferred Runways

Runway directions may be defined as 'preferred' to enable air traffic to be managed efficiently or to reduce the noise impact over residential areas, refer to Section 20.3.6 for further information on noise abatement.

Currently at Perth Airport, all runways are equally preferred for arrivals and departures with the exception of runway 06 for landing and runway 24 for departures. These runway directions are the least preferred, due to the close proximity (approximately 970 metres) of residential housing to the south-western end of the cross runway (06/24). Although runways may be equally preferred (as is the case at Perth Airport), this does not mean that they are equally used.

Weather conditions and operational requirements influence the use of preferred runways at Perth Airport. Operational requirements include, when runway or taxiways are closed for aerodrome works, to maximise capacity during peak periods or efficient access to runways from the different terminal locations.

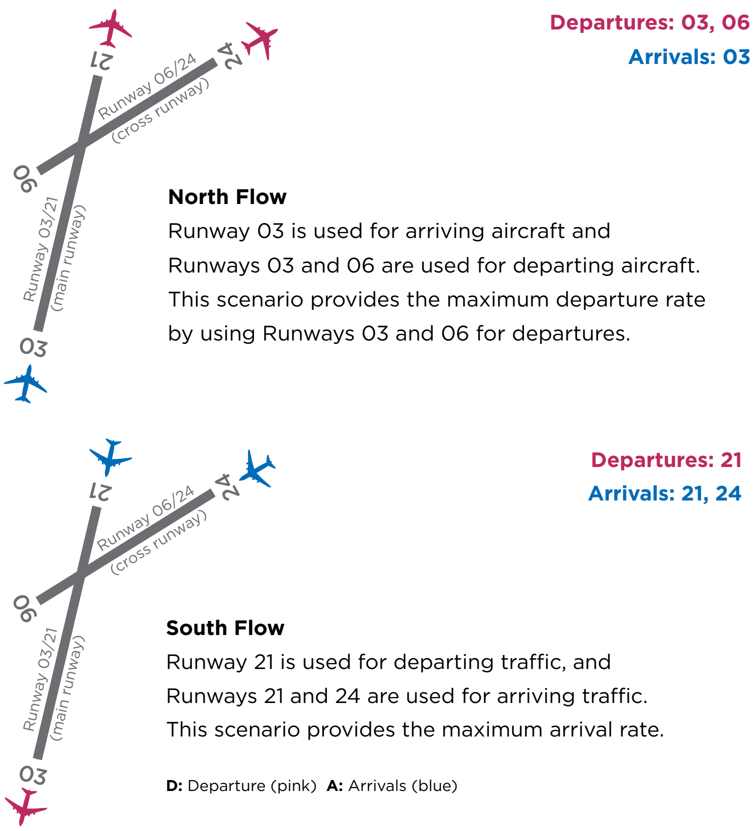


Figure 20-3 North and South Flow
Source: Perth Airport

20.3.4.4 Nominating Duty Runways

Specific weather, operational and noise-abatement provisions are considered when air traffic control nominate the duty runways.

When a runway is selected, it needs to be available for an extended period of time to allow air traffic control and pilots to plan for the descent, approach and landing.

Runway changes require a gap in the traffic, as an arriving aircraft must land prior to the next arriving aircraft commencing its approach in the opposite direction for the changed runway direction. This is because if the first aircraft made a missed approach and aborted its landing it could end up in a nose to nose conflict with an aircraft approaching to land in the opposite direction. For departing aircraft this is easier to achieve by not clearing aircraft for take-off for a short period of time, however when aircraft are arriving and tracking towards the airport, finding a sufficient gap is more difficult and needs to be well coordinated.

Air traffic control can manoeuvre aircraft to achieve a gap if arriving traffic levels are low or moderate. However, during peak arrival times, a runway change may result in the loss of two or three landings (referred to as slots) and result in aircraft holding in the air for up to ten minutes. If the wind changes to favour another runway and the conditions are completely dry, air traffic control may delay a runway change during peak arrival times and operate with up to five knots of downwind (as permitted by air traffic control operating procedures). This can result in less holding, fuel burn and carbon emissions for following aircraft. If the wind change results in criteria outside of the air traffic control operating procedures and there is a more favourable runway option, then for safety, air traffic control is required to make a runway change.

The criteria for selecting a runway is contained in the Airservices Aeronautical Information Publication (AIP) Enroute section which details certain conditions that must be considered when nominating a runway or runways for use, as shown in Figure 20-4.

Perth Airport operations are controlled by civilian air traffic controllers employed by Airservices. Royal Australian Air Force (RAAF) Base Pearce operations are controlled by RAAF air traffic controllers employed by the Department of Defence. Due to the proximity of the RAAF Base Pearce it is desirable to have Pearce and Perth operating on similar-direction runways. By coordinating the runway in use at both aerodromes, departures and arrivals will be heading in a similar direction and not be in a nose-to-nose situation. Due to this, a coordinated runway change plan is in place. Runway changes due to changing wind conditions may be delayed until the traffic disposition at both airports enables a change of runway direction. Perth and Pearce air traffic controllers have a unique situation in Australia: they are located in the same room and use the same equipment which enhances coordination of air traffic information.

AIP Australia | **25 MAY 2017** | **ENR 1.1 - 11**

2.3.5 **Nomination of Runways**

ATC will nominate the runway, preferred runway or take-off direction. Where noise abatement procedures are prescribed, and ATC traffic management permits, the provisions of DAP NAP will be applied, except that ATC will not nominate a particular runway for use if an alternative runway is available (unless required by Noise Abatement legislation), when:

a. the alternative runway would be preferred due to low cloud, thunderstorms and/or poor visibility;

b. for runways that are completely dry:
   - the crosswind component, including gusts, exceeds 20KT;
   - the tailwind component, including gusts, exceeds 5KT.

c. for runways that are not completely dry:
   - the crosswind component, including gusts, exceeds 20KT;
   - there is a tailwind component.

d. wind shear has been reported.

Note: Notwithstanding the limitations detailed above, location specific crosswind/tailwind limitations may be detailed in AIP DAP East/West NAP

Figure 20-4 Nomination of runways
Note: DAP = Departure and Approach Procedures, NAP = Noise Abatement Procedures.
Source: Airservices Australia

20.3.5 Aircraft Sequencing

Depending on their size and weight, different aircraft types will require varying separation between each other. This differential spacing is provided to allow for wake-turbulence effects from departing or arriving aircraft. For example, air traffic control may space two landing aircraft four nautical miles apart to allow the first aircraft to land and taxi clear of the runway before the second aircraft is cleared to land. If the first aircraft is a very large, Airbus A380, and the following was a medium sized Boeing 737, the wake-turbulence separation standard requires seven nautical miles spacing. This effectively reduces the hourly landing capacity by one aircraft. Although the distance in nautical miles between two aircraft may vary, the average for an hour can be represented by using a time measurement.

Additionally, airport infrastructure will have an impact on capacity as it contributes to the amount of time an aircraft takes to vacate the runway. For example, an aircraft will take less time on a runway if rapid exit taxiways (RETs) are available, as they can vacate at a higher speed rather than almost stopping on a runway to be able to make a 90-degree turn onto a taxiway.

The sequencing rates for the arriving and departing aircraft are determined by the capacity of the runway system. As such, the minimum time separation for sequencing (spacing) of arriving aircraft to a single runway at Perth Airport is shown in Table 20-1.

Table 20-1 shows how capacity is reduced as a result of bad weather conditions and poor visibility. This is due to aircraft flying at a slower speed on an instrument approach and therefore covering the distance of a separation standard (three nautical miles) will take longer than when flying faster on a visual approach. It also means visual separation standards, that allow either air traffic controllers or pilots to sight and visually separate with other aircraft, cannot be used.

To ensure a safe and efficient allocation of the airspace and airfield, departing aircraft typically depart between the arriving aircraft. The departing aircraft is held short of the runway, on the taxiway, until the arriving aircraft has crossed the runway threshold. Then the aircraft can be cleared to line up on the runway and wait while the landing aircraft vacates the runway. Once the landing aircraft is clear of the runway, the departing aircraft is cleared for take-off.

In the occurrence where there is one departure immediately after another, a number of factors dictate when the second aircraft is given clearance to take-off. The minimum standard is that the second aircraft can be cleared for take-off once the first aircraft is airborne and has reached a point at least 1,800 metres ahead of the following aircraft. However, this distance may be increased if the following aircraft is faster. This separation may also increase in the case of smaller aircraft following larger aircraft, due to wake turbulence, and the standard could be three minutes. Once again air traffic control can apply visual separation. Similar to arrivals, if there is poor weather and air traffic control cannot visually separate, departure capacity would be reduced.

Visual approaches, based on a two-and-a-half-minute minimum separation, enables a maximum of 24 arrivals per hour on a single runway. Where this is increased to a five-minute minimum separation, most likely in low visibility operations, a maximum of 12 arrivals per hour are enabled. This comparison demonstrates that low visibility conditions significantly reduce airport capacity.

20.3.6 Noise Abatement Procedures

Managing the noise impact on the surrounding community is considered when determining the runway selection. Noise abatement practices and procedures can provide noise relief to communities around airports from arriving and departing aircraft; however, the safety of aircraft remains the number one priority.

Noise abatement procedures are implemented by Airservices and published in the AIP in order to provide guidance on the selection of runways and flight paths around the airport.

Condition	Minutes
VMC – Visual approaches	2.5
IMC – Instrument approach due to the amount of cloud over or height above ground level then a visual approach	2.5
IMC – full ILS conditions where the visual criteria for visual flight cannot be met	3.0
Low visibility operations – where visibility is less than 1,200 metres	5.0

Table 20-1 Minimum current air traffic control time separation for sequencing of arrivals
Source: Perth Airport

There are certain constraints that prevent or hinder the implementation of noise abatement practices and procedures. Operational procedures must consider issues such as:

- the capacity requirements of the airport and airspace,
- the configuration of the airport and local community characteristics,
- the trade-off between noise and emissions, and
- whether aircraft are equipped with the necessary sophisticated instruments, including flight management systems.

Figure 20-5 shows the published noise abatement procedures for Perth Airport runway selection as of May 2018. It shows that the least preferred runway for landings is runway 06 and the least preferred for departures is runway 24. Although the noise abatement procedures state the other runways are equally preferred, this does not mean that they are equally used - rather that there is no preference in the use of the runways and the environmental conditions of the day (such as weather and operational requirements) will determine the preferred runway.

The noise levels experienced on the ground are directly impacted by the aircraft climb and descent profiles. It is accepted that where the aircraft climbs higher, there is a corresponding lowering of the noise impact at ground level. The climb can vary considerably, as it can be affected by a number of factors including:

- aircraft weight (which can fluctuate with passenger, cargo and fuel loads),
- air pressure, density and temperature,
- wind speed and direction,
- aircraft performance and configuration,
- aircraft speed and bank angle of turns, and
- climb gradient specified in the SID being flown (to achieve obstacle clearance).

Noise abatement procedures define the climb procedures at Perth Airport. Measures to minimise the noise exposure at ground include setting climb procedures. These refer to different combinations of engine power or thrust settings, and wing-flap retraction at specific altitudes.

At Perth Airport, during the later stages of descent and on final approach to land, aircraft generally maintain the worldwide standard constant descent rate of three degrees to the horizontal. This means an aircraft will descend about 50 metres for every 1,000 metres across the ground as it approaches the runway. A key element of the standard is that the height of the aircraft on approach will be fairly consistent over a given point.

Continuous descent procedures where the aircraft descends at idle power can produce benefits for both reduced noise and carbon emissions. However, power will generally need to be applied at lower levels close to the airport to intercept instrument landing systems or when air traffic control have to change the flight track to achieve the required separation with other aircraft. For this reason, continuous descent procedures may not provide any benefit during peak traffic times.

Noise abatement procedures are regularly reviewed and updated by Airservices. Further information on aircraft noise and noise management is contained in Section 22.

PERTH, WA

1 **PREFERRED RUNWAYS**

1.1 Runways be nominated by Air Traffic Control for noise abatement as follows:

Landing 1 – Runway 21 , Runway 03 and Runway 24 are equally preferred
2 – Runway 06

Departing I – Runway 21 , Runway 03 and Runway are equally preferred.
2 – Runway 24.

1.2 Due to a co—ordinated runway change plan for traffic management at Perth and Pearce, runway changes at Perth will generally be effected when the wind conditions listed in AIP NAP are met at both aerodromes.

Figure 20-5 Perth Airport current noise abatement-procedure runway selection
Source: Airservices Australia

20.3.7 Local Airspace Coordination

The airspace around an airport and the interaction with other airports plays a role in the use of runways and flight path design.

Perth Airport is located 20 kilometres inland from the coast, RAAF Pearce Airbase is located 30 kilometres to the north and Jandakot Airport is 16 kilometres to the south, as shown in Figure 20-6.

The proximity of other airports and their competing requirements have resulted in a complex airspace arrangement in the Perth Basin. The airspace arrangements that have evolved have done so in response to a unique situation within Australia, where the four major airspace users are located so close. These users are:

- navy – fleet base to the south of Perth,
- air force – Pearce is the major training base located to the north of Perth,
- army – specialised training and operational base located to the north of Perth, and
- civil – centred on Perth Airport and Jandakot Airport.

To facilitate the mix of airports and users, the airspace around Perth is a combination of controlled and uncontrolled airspace. Controlled airspace is designed to protect passenger-carrying aircraft by providing pilots with an air traffic control service. In uncontrolled airspace, the pilot is responsible for separation with other aircraft.

The impact of airspace associated with Pearce on civil operations is greater than experienced in other capital cities due to the proximity of RAAF Base Pearce and Perth Airport and associated airspace boundaries, large number and size of restricted areas; and the relative runway orientation of both aerodromes (both main runways are generally on a north/south alignment).

20.3.7.1 Restricted Airspace

Restricted areas are an area of Australian territory of defined dimensions (which may extend to a volume of airspace) over which the flight of aircraft is restricted in accordance with certain specified conditions. (Restricted areas are designated R and followed by a number for example R138).

Figure 20-7 shows the Restricted Areas in the Perth region in relation to the neighbouring aerodromes, including RAAF Base Pearce and Jandakot Airport.

During certain times, or for certain activities, restricted airspace is activated to accommodate military activities. Restricted airspace may be in uncontrolled airspace or controlled airspace, or cover a combination of both. When activated, the restricted areas are controlled by the relevant military authority: RAAF for flying training, Navy for warship firing practice, and Army for land-based firing practice. When these restricted areas are activated, Airservices must keep civil aircraft under the control of air traffic control, clear of the restricted airspace. The pilot of an aircraft not under air traffic control is the person responsible for remaining clear of active restricted areas. Navy and Army areas are generally activated when required, such as for a month at a time to accommodate a naval exercise. Restricted airspace for RAAF Base Pearce flying activities is generally activated 8.00 am to 5.00 pm Monday to Thursday, 8.00 am to 3.00 pm on Fridays for 48 weeks per year, and night flying training from 7.00 pm to 11.00 pm Monday to Thursday for 36 weeks per year.

Figure 20-6 Location of airports in the vicinity of Perth Airport
Source: Perth Airport

SID and STAR procedures are designed to keep aircraft clear of restricted airspace. Remaining clear of restricted areas means that the majority of aircraft arriving at Perth are funnelled to the east of Pearce airspace. (The exceptions are aircraft arriving from the Middle East and Africa, which are processed on an agreed route through the restricted airspace by arrangement with the Department of Defence.)

Outside the times when restricted airspace for RAAF Base Pearce is activated, Airservices controls the airspace that is coincident with controlled airspace boundaries. Parts of the restricted areas that are not contained within controlled airspace revert to uncontrolled airspace.

20.3.8 Flight Path Design

To ensure aircraft safety and efficient use of the airspace while ensuring equitable access for all airspace users where this is practicable, flight paths are designed to provide a three-dimensional route that aircraft use to arrive and depart from an airport. Flight paths are effectively corridors in the sky. Although they are often shown as a single line on a map, unlike a train on a railway line or a car on a highway, it is not always possible or desirable for aircraft to precisely follow along the line depicted. In practice, a flight path can vary by up to several kilometres or more. This occurs for a range of reasons, including weather conditions, the requirement to keep a safe distance between aircraft in the sky, and aircraft performance. If aircraft can be left on a published flight path, modern aircraft equipment means that they will fly that exact path time after time with accuracy of a few metres. As the flight paths for the new runway are yet to be fully designed (this occurs approximately three years before day of opening), this MDP includes flight corridors that show an area where aircraft may fly. These corridors are represented by a splay several kilometres wide.

Ideally, airlines would like aircraft to be flown by the most direct route and at the optimum altitude for reasons of efficiency of flight operations. However, it is not always possible for aircraft to fly the most direct route as the route design must provide separation between numerous flight paths. In the area around airports where the aircraft are at low level, there may also be rules to minimise impact to surrounding residential areas (referred to as noise abatement) that dictate where a flight path will go, such as areas of low population density.

The main criteria when designing flight paths is the safe segregation of aircraft. Efficiency, equity, and environment (not just aircraft noise related) impacts are also considered. During the design process, the impact of aircraft noise on the community is also taken into consideration once all other criteria have been satisfied. During the initial stages of departure, or the final stages of landing, the flight path is dictated by the alignment of the runway.

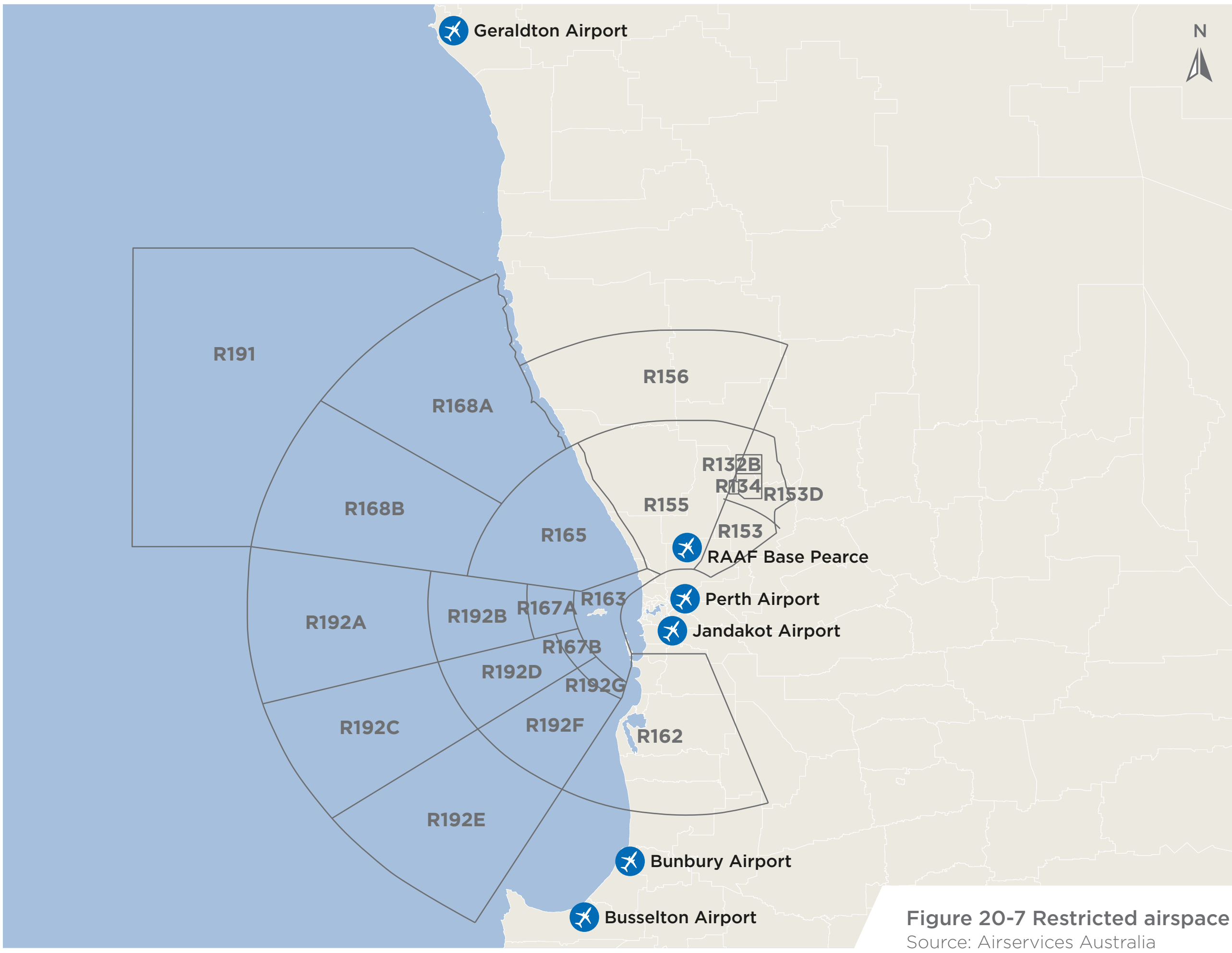


Figure 20-7 Restricted airspace
Source: Airservices Australia

20.4 Existing Operations

In 2003, Australia's aviation safety regulator, the Civil Aviation Safety Authority (CASA), conducted an audit of airspace use in Western Australia. Changes were identified to maintain safety and reduce complexity, and to effectively manage the increased demand for air travel, other aviation services and military flying. The Western Australia Route Review Project, widely known as WARRP, was conducted by Airservices between 2006 and 2008.

In November 2008, the project introduced two-way routes to the north-west. At the time of the project, air traffic control radar coverage was limited to a 350-kilometre radius of Perth. This meant that outside of areas covered by radar, 'procedural' separation standards were applied, which required much greater distances between aircraft. In 2012, Airservices installed a radar at Paraburdoo to help manage the growing traffic levels across Western Australia.

Automatic Dependent Surveillance Broadcast (ADS-B) is an air traffic surveillance technology that enables aircraft to be accurately tracked by air traffic controllers and other pilots without the need for conventional radar. ADS-B has now been installed around the country and air traffic control now has surveillance of all aircraft at cruising level across the entire Australian mainland, allowing consistent separation standards to be applied for all aircraft movement areas.

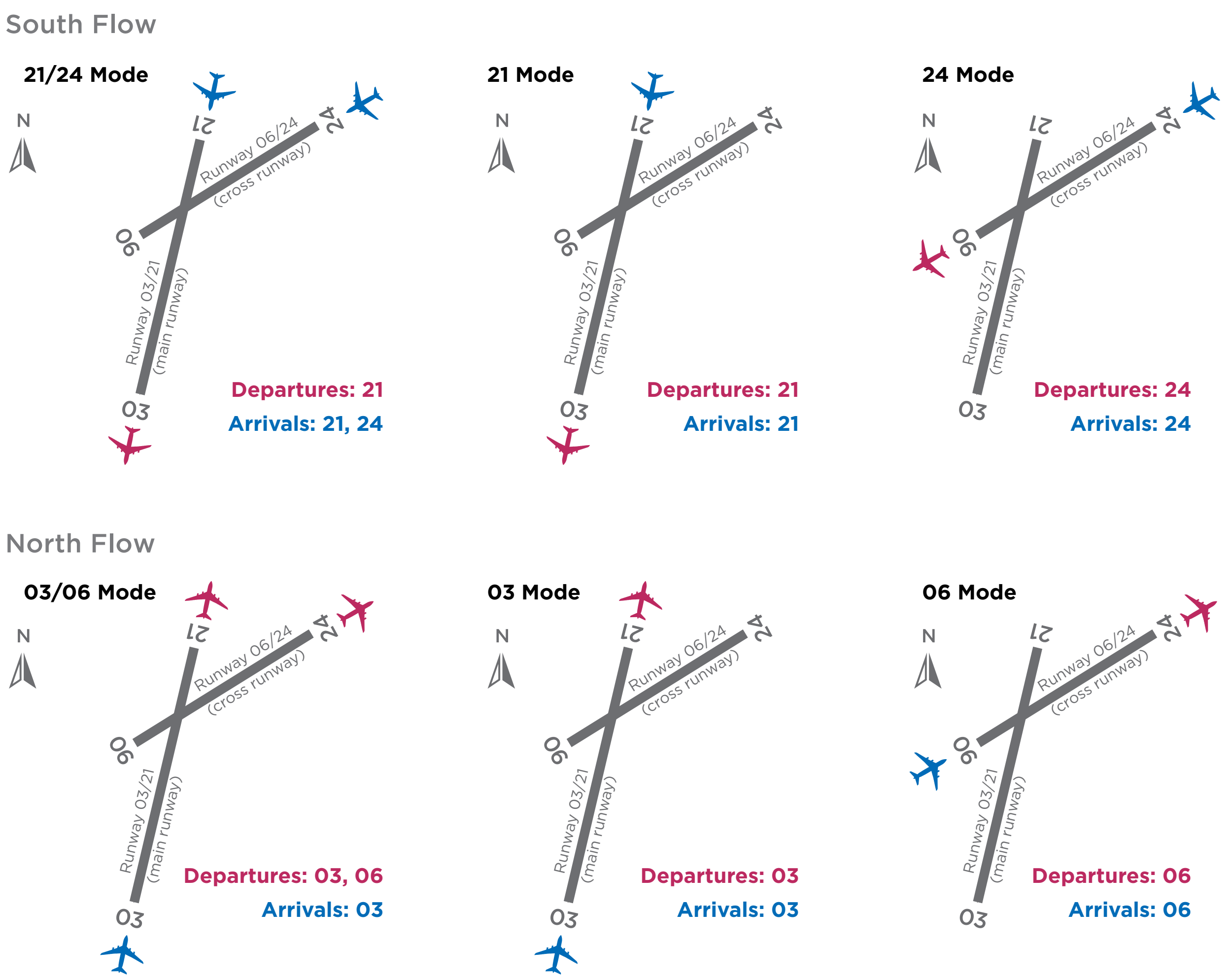


Figure 20-8 Existing runway system and modes
Source: Perth Airport

20.4.1 Modes of Operations

Within each operating flow (South Flow or North Flow), there are various modes of operation. These modes for the existing runways at Perth Airport are summarised and illustrated in Figure 20-8.

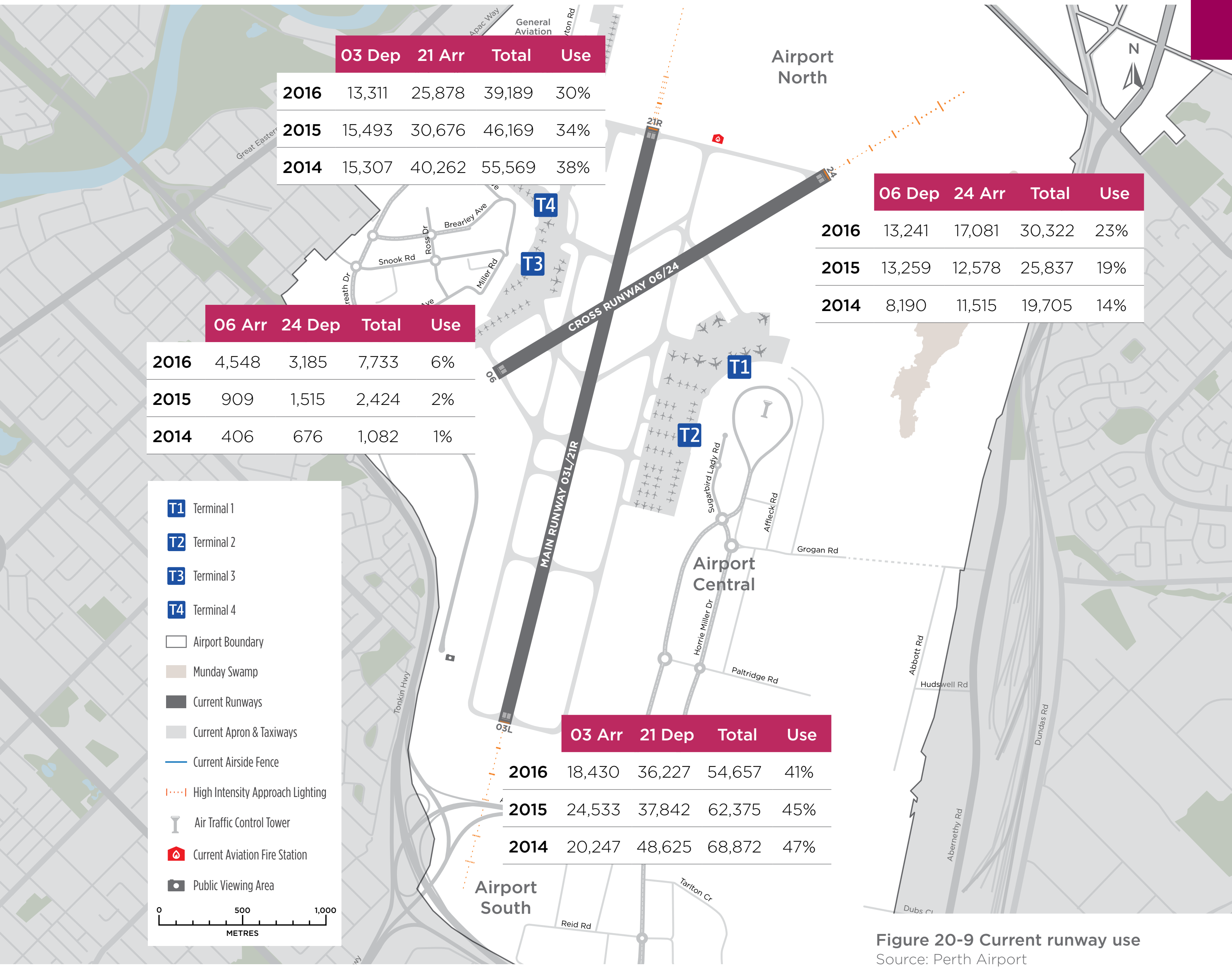
1. 21/24 mode – arrivals from the north for runway 21 and the north-east for runway 24 and all departures to the south off runway 21,
2. 21 mode – all arrivals from the north and all departures to the south,
3. 24 mode– all arrivals from the north-east and all departures to the south-west,
4. 03/06 mode – all arrivals from the south for runway 03 and departures to the north off runway 03 and to the north-east off runway 06,
5. 06 mode– all arrivals from the south-west and all departures to the north-east, and
6. 03 mode – all arrivals from the south and all departures to the north.

20.4.1.1 Current Runway Use

Weather and operational requirements favour the use of the main runway (03L/21R). This is reflected in Figure 20-9, which shows the runway use for 2014 to 2016.

Runway 21 tends to be used more frequently in the warmer months due to southerly winds, whereas runway 03 tends to be used more frequently in the cooler months when the predominant wind direction tends to be northerly.

Historical use of runway 06 for arrivals and runway 24 for departures averages two per cent of all movements as it is the least preferred runway. However, variations to the usage may occur in certain years. This can be seen in Figure 20-9 when in 2016 arrivals and departures accounted for six per cent of all movements due to extended closures of the main runway for infrastructure upgrades.



	03 Dep	21 Arr	Total	Use
2016	13,311	25,878	39,189	30%
2015	15,493	30,676	46,169	34%
2014	15,307	40,262	55,569	38%

	06 Dep	24 Arr	Total	Use
2016	13,241	17,081	30,322	23%
2015	13,259	12,578	25,837	19%
2014	8,190	11,515	19,705	14%

	06 Arr	24 Dep	Total	Use
2016	4,548	3,185	7,733	6%
2015	909	1,515	2,424	2%
2014	406	676	1,082	1%

	03 Arr	21 Dep	Total	Use
2016	18,430	36,227	54,657	41%
2015	24,533	37,842	62,375	45%
2014	20,247	48,625	68,872	47%

Figure 20-9 Current runway use
Source: Perth Airport

20.4.2 Flight Paths

20.4.2.1 Departures

For aircraft departing in a southerly direction to destinations to the east or north-east off runway 21, the SID requires a left turn to the east at 1,000 feet for turbo prop engine aircraft and at four nautical miles south for jet engine aircraft. The reason these turns are at different points is to segregate slower turbo prop aircraft from the faster jet aircraft. If a turbo prop aircraft continued on runway heading until four nautical miles there would be a delay in clearing a following jet aircraft for take-off due to its faster speed. This would reduce the departure capacity of the airport. For aircraft departing to the west, a right turn is made at four nautical miles. A small number of departures to destinations (such as Busselton and Albany) continue further than four nautical miles on runway heading as they need to proceed this way due to the geographic location of the destination being south.

For aircraft departing in a northerly direction to destinations to the west or north-west off runway 03, a turn is made to the west at four nautical miles. For departures to the east or north-east a turn is made to the east at 1000 feet for turbo prop aircraft and four nautical miles north for jet aircraft.

For departures from runway 06 most aircraft, turbo prop and jet, continue north-east on runway heading until approximately nine nautical miles.

Departures from runway 24 generally track on runway heading for eight nautical miles or turn to the east at 1,000 feet for turbo prop aircraft or 1,500 feet for jet aircraft.

Aircraft do not fly on the published departure procedures all the time. Reasons such as aircraft separation, adverse weather or for establishing a balanced arrival pattern, may result in an aircraft not flying on the published track. Additionally, the tracks are designed to avoid military restricted airspace, however, if the RAAF are not active there is no need to avoid this airspace and if there is no impact to safety or sequencing, aircraft can fly a more direct route saving fuel and reducing carbon emissions. When cleared by air traffic control to fly a more direct route there are rules applied such as they must be above a certain height prior to being taken off the published track.

Aircraft track by published waypoints which are defined as a latitude and longitude. In aviation, waypoints are given a five letter name. For example in Figure 20-10 there is a waypoint to the South-West of Perth Airport, named SWANN in reference to the fact it is located over the Swan River.

Existing departure procedures and flight tracks are shown in Figure 20-10, Figure 20-11, Figure 20-12 and Figure 20-13. These tracks are for a 12 month period (2016). The darker the colour the closer they are to the ground and the tracks extend to aircraft reaching 10,000 feet.

20.4.2.2 Arrivals

The majority of arriving traffic at Perth Airport tracks to the east of Pearce airspace. Arrivals from Africa and the Middle East track through restricted areas according to an agreed procedure with the RAAF and Navy. This arrival route from the west splits into two just prior to crossing the coast, with one arrival procedure for a landing on runway 03 and the other for a landing on runway 21.

On the southerly flow, all aircraft follow a similar track in the last stages of flight because this is the most efficient approach and due to restrictions from RAAF airspace. On the northerly flow to land on runway 03 or runway 06, there is the restriction of the Jandakot Airport control zone. In visual conditions, aircraft can track to the north of Jandakot and make a visual approach onto a five-mile final. This approach can be replicated at night using an RNP-AR approach for suitably equipped aircraft. In IMC conditions aircraft need to fly an ILS approach which must be commenced much further out than five miles. It can be seen in Figure 20-16 that when landing on runway 03 there are visual and RNP approaches, and the ILS approach, which track approximately 15 kilometres further south.

For aircraft arriving from the north-east there is one inbound air route for turbo prop aircraft and another for jet aircraft. These routes intersect and form a single inbound path approximately 25 kilometres north of the airport. For landings on runway 21 or 24, aircraft track from this point straight to the runway. For landings on runway 03 or 06, aircraft track from this point where they converge, to the east of Perth Airport and then turn back towards the airport at either the visual or RNP approach point, or fly further south before tracking in on the ILS approach route.

Aircraft arriving from the south east for runway 21 or 24 also have a separate inbound air route for turbo prop aircraft and one for jet aircraft, which converge at a point close to the airfield and then continue for a similar straight-in approach. For runway 03 and 06 there are two turbo prop aircraft inbound routes (one south-east and one east) and one jet aircraft arrival route. These three routes also converge at one of two points: one is to join the base leg of the visual or RNP approach, the other is to join the base leg for the ILS approach.

Aircraft arriving from the south have a published route for runway 03 and 06, where they also join at one of two base-leg positions for either the visual or ILS approach. There is no published route for these aircraft when landing on runway 21 or 24, they track direct to the airfield and are then processed by air traffic control to join the landing sequence.

The existing arrival routes and flight paths are shown in Figure 20-14, Figure 20-15, Figure 20-16 and Figure 20-17. These tracks are also for a 12 month period (2016).

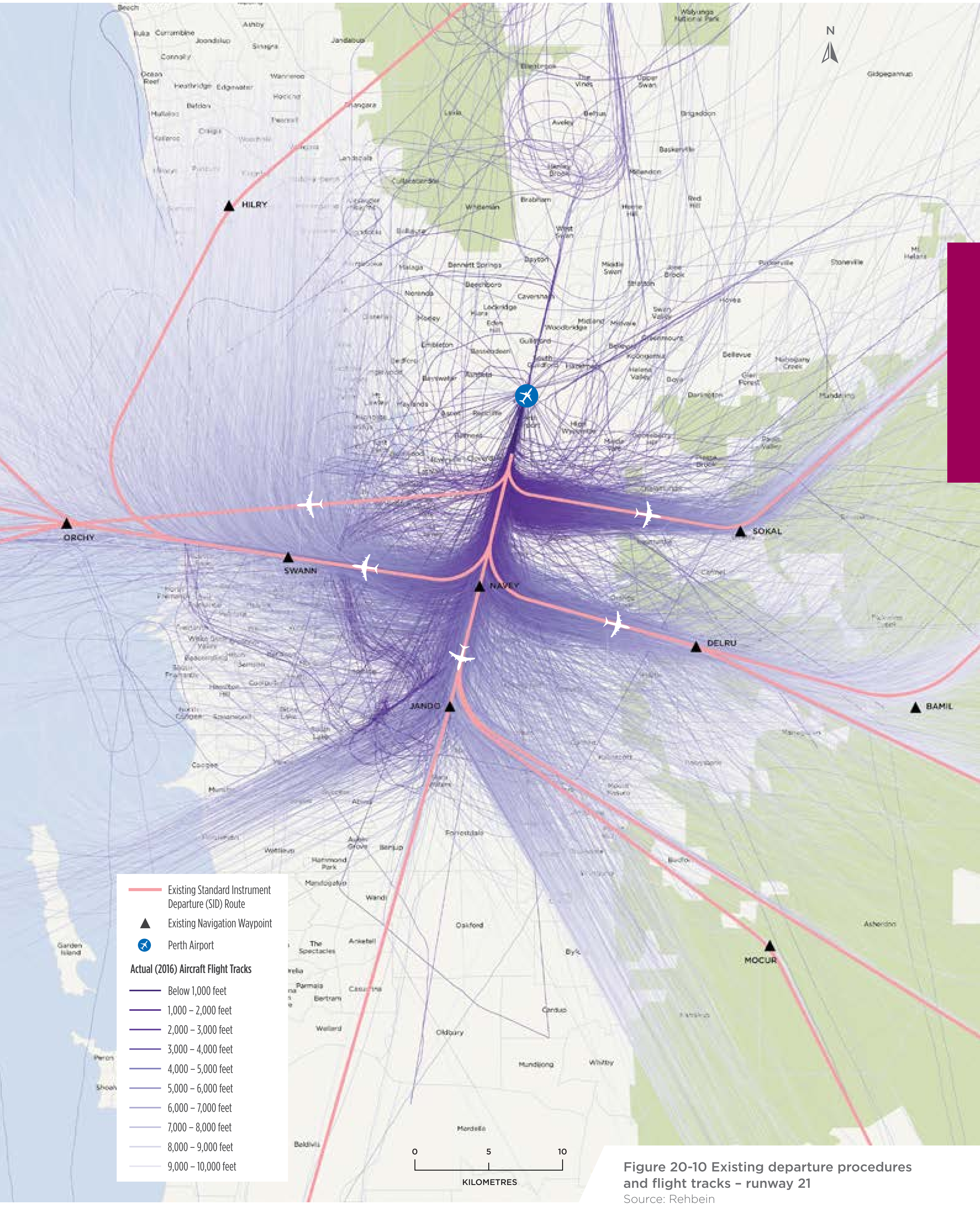


Figure 20-10 Existing departure procedures and flight tracks – runway 21

Source: Rehbein

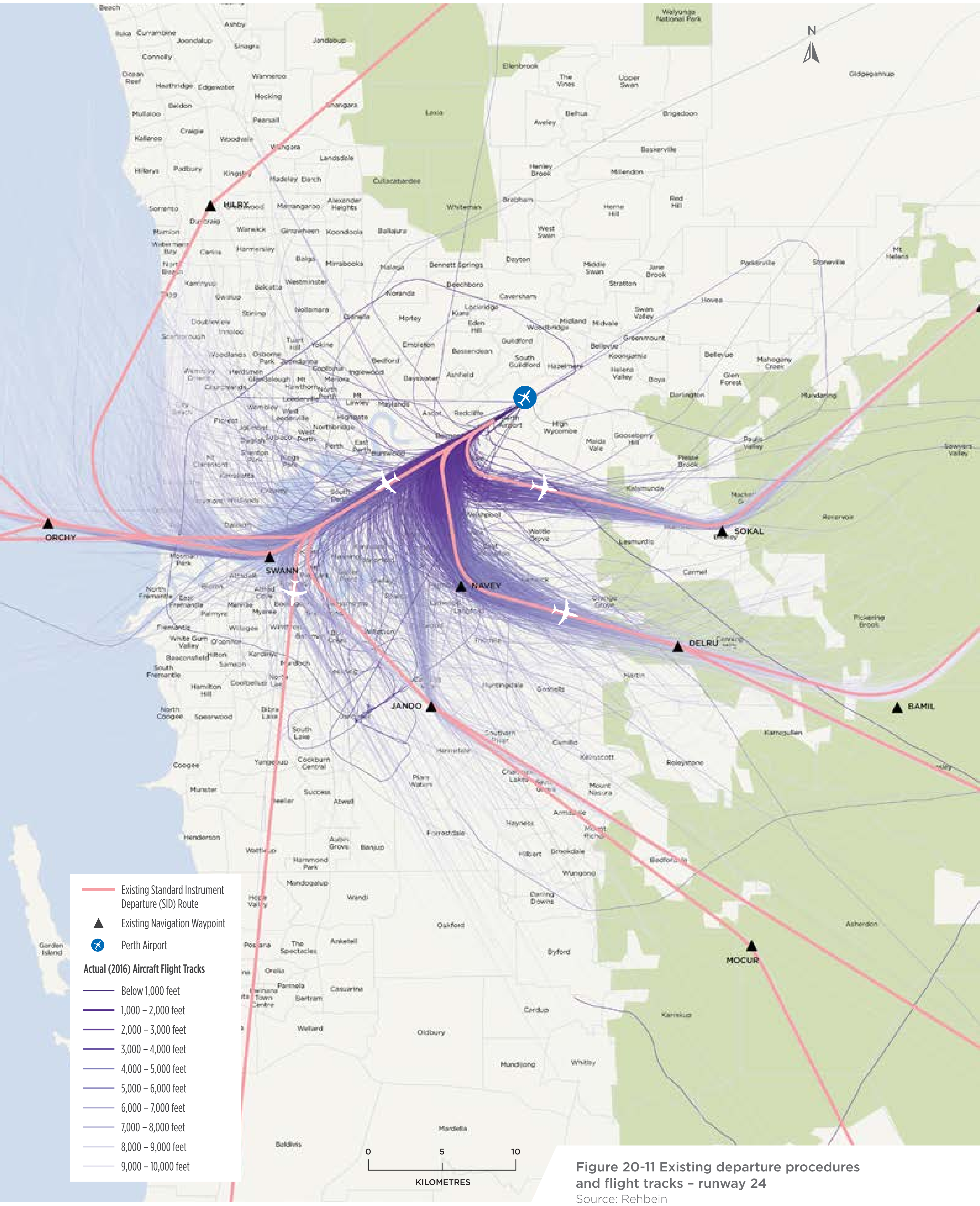


Figure 20-11 Existing departure procedures and flight tracks – runway 24
Source: Rehbein

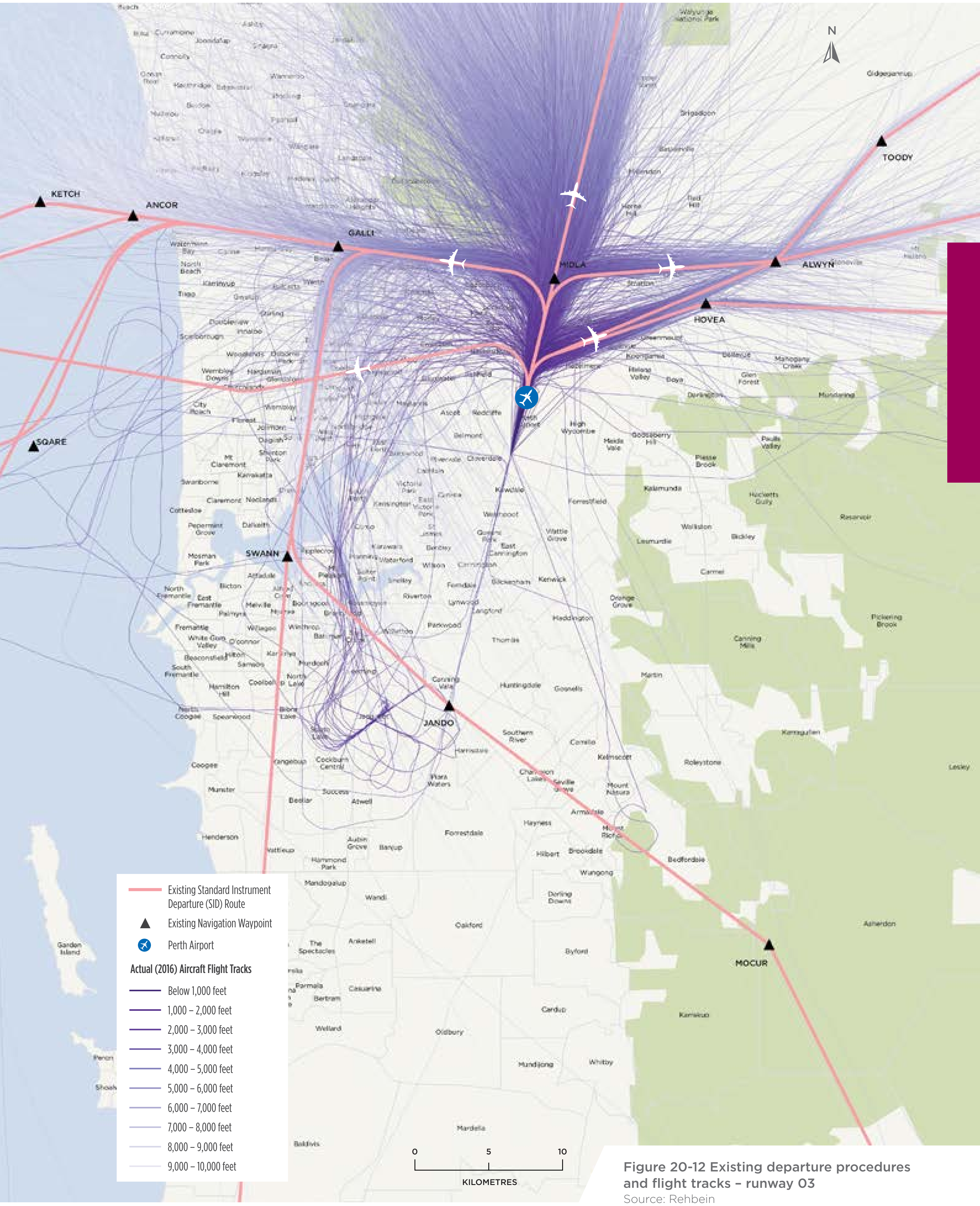


Figure 20-12 Existing departure procedures and flight tracks – runway 03

Source: Rehbein

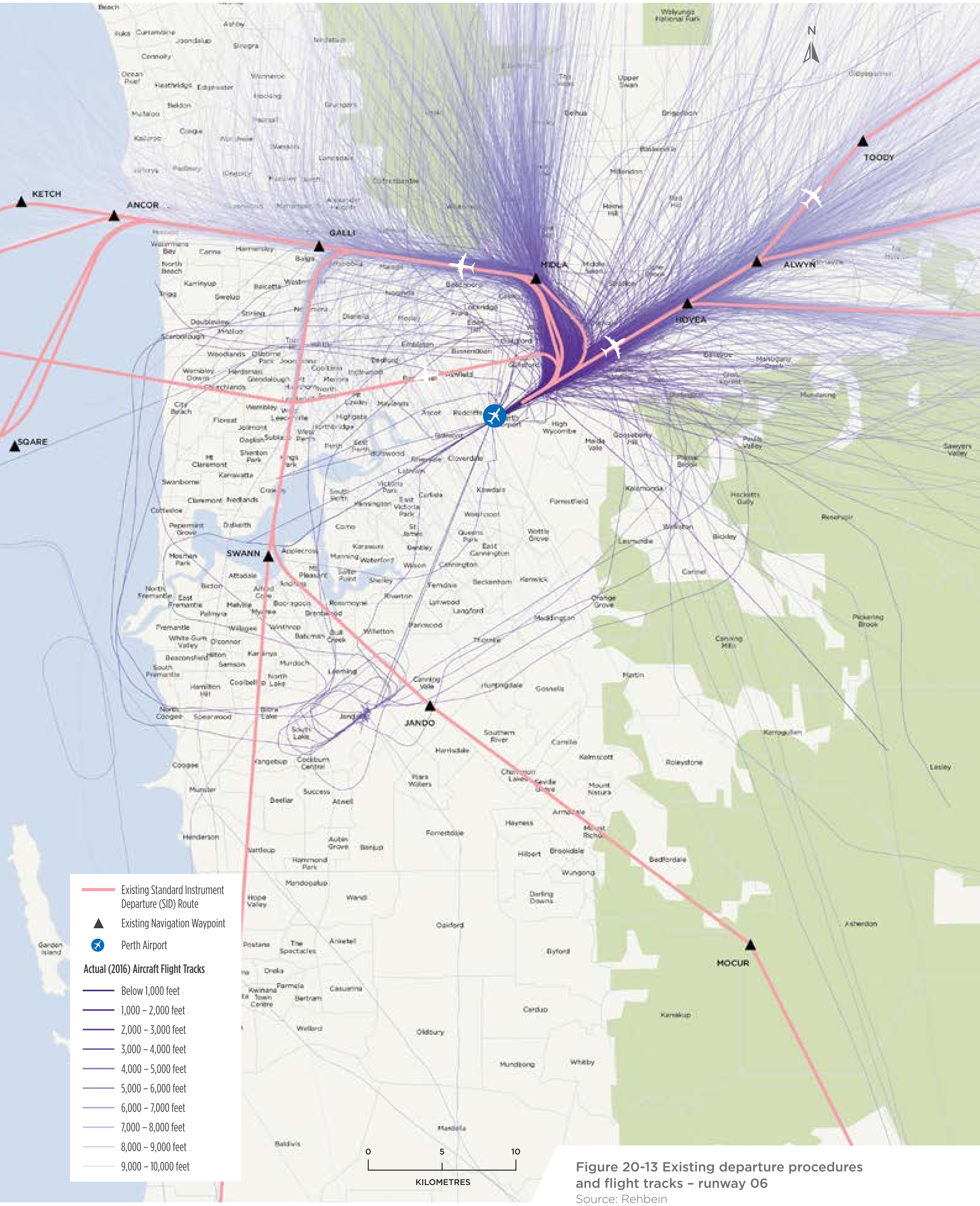


Figure 20-13 Existing departure procedures and flight tracks – runway 06

Source: Rehbein

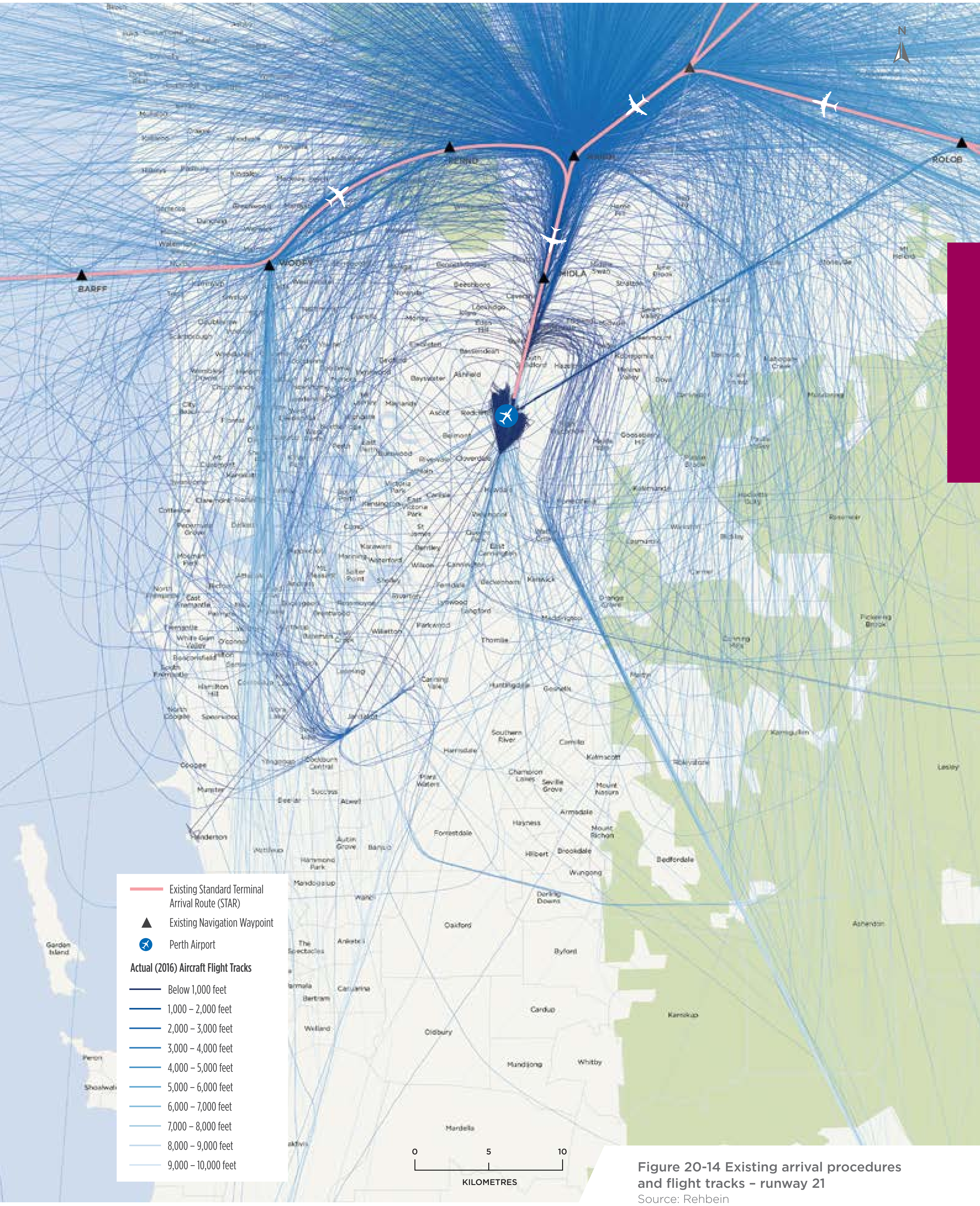


Figure 20-14 Existing arrival procedures and flight tracks – runway 21

Source: Rehbein

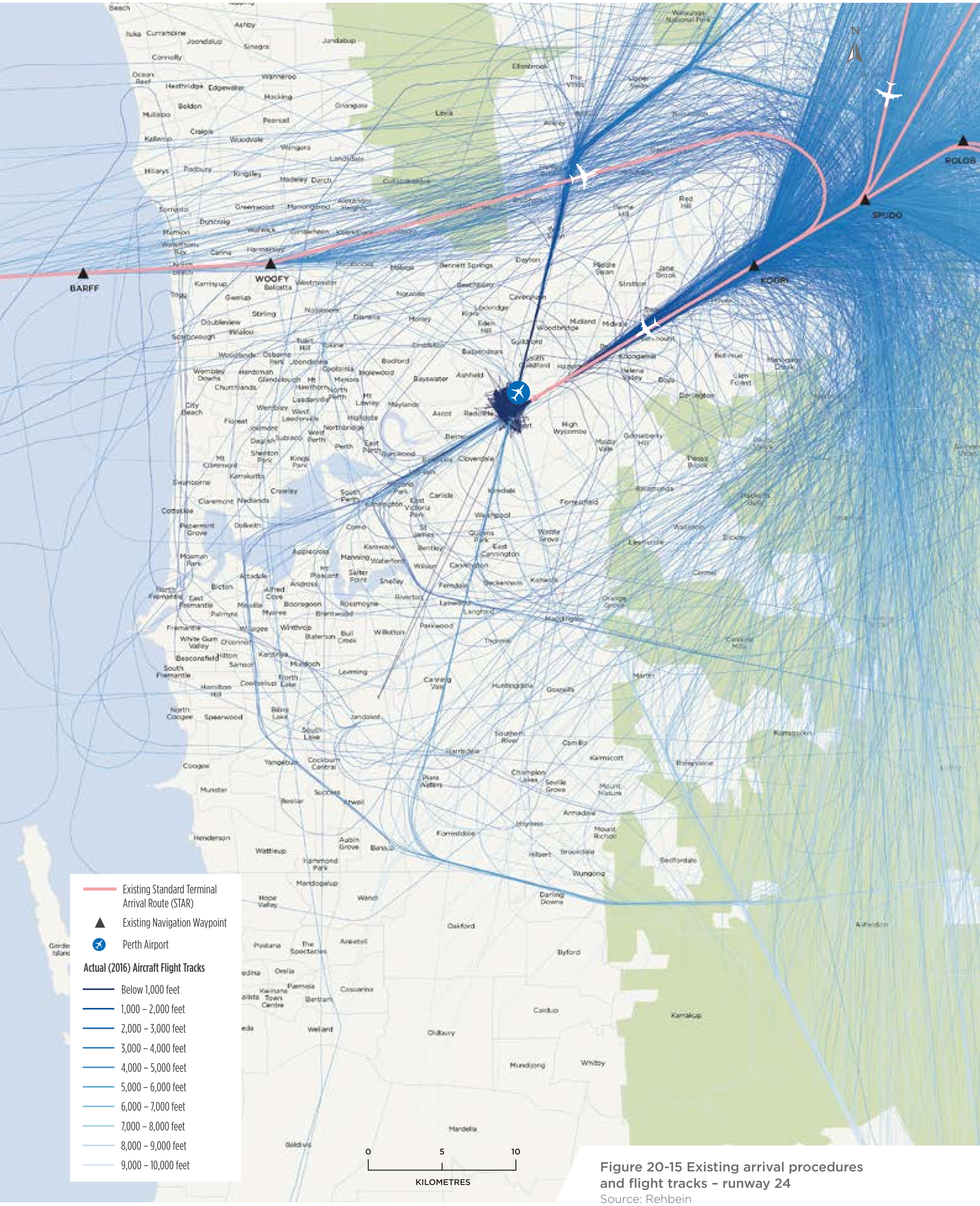


Figure 20-15 Existing arrival procedures and flight tracks – runway 24
Source: Rehbein

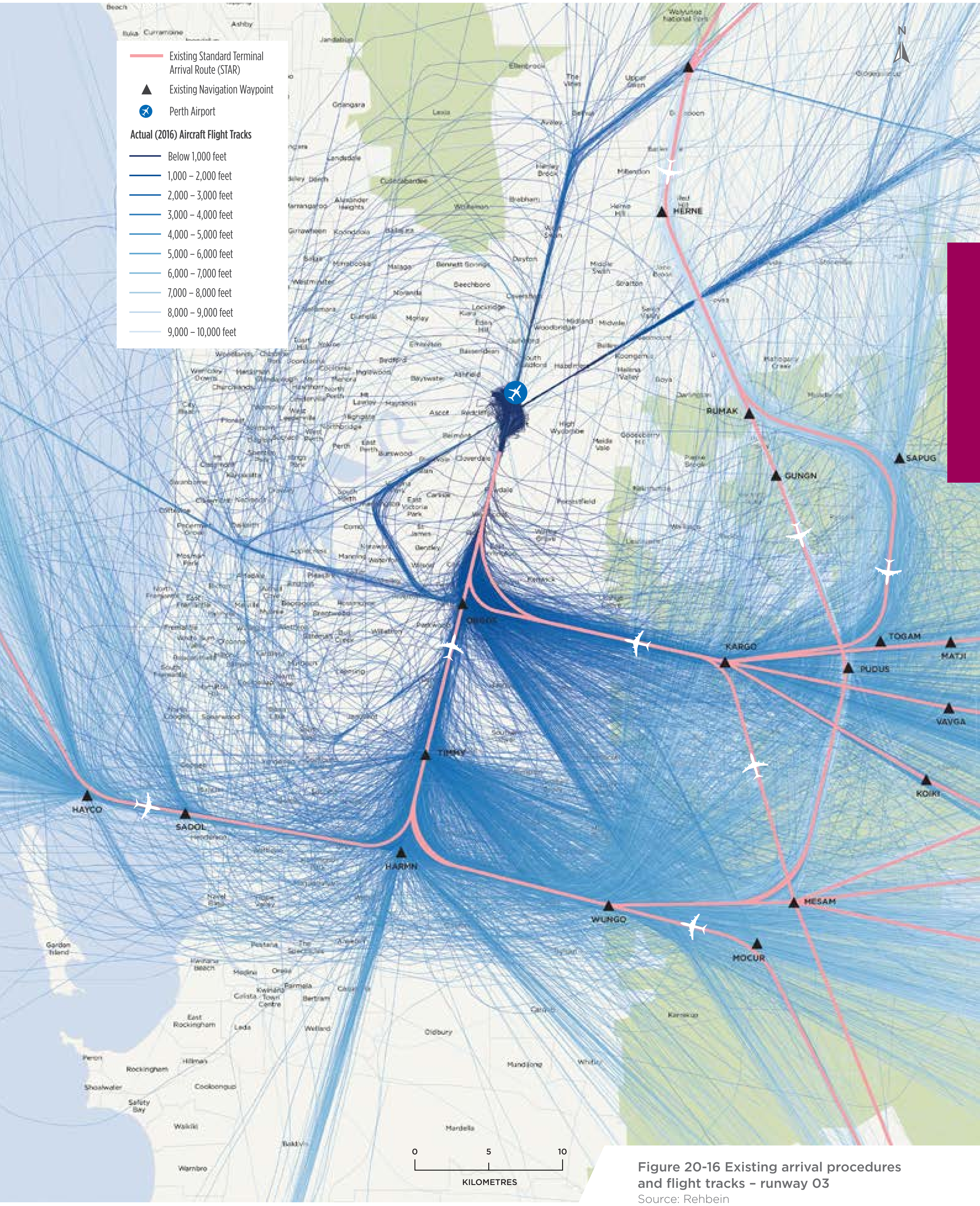


Figure 20-16 Existing arrival procedures and flight tracks – runway 03
Source: Rehbein

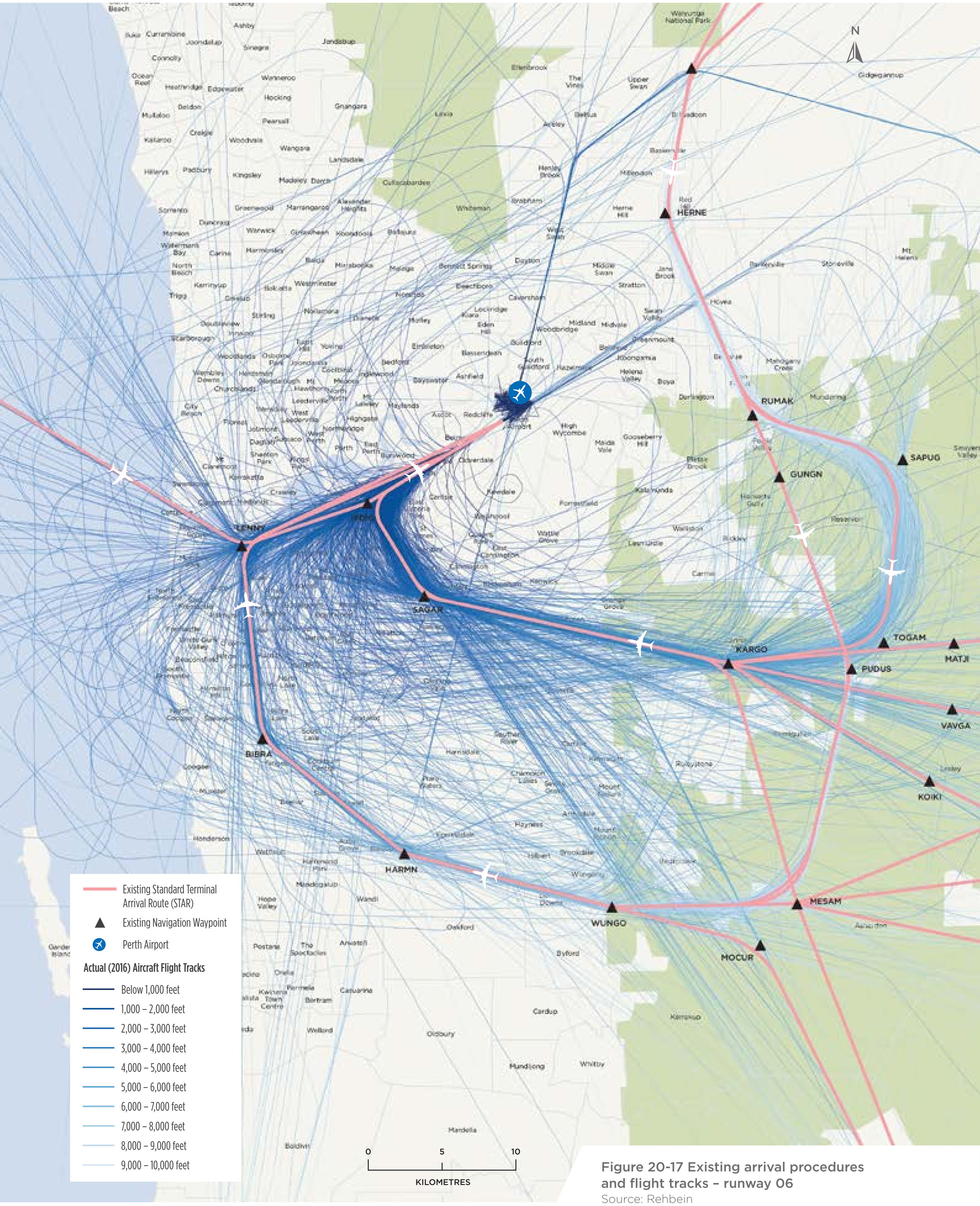


Figure 20-17 Existing arrival procedures and flight tracks – runway 06
Source: Rehbein

20.4.3 Interaction with Other Airports

20.4.3.1 RAAF Base Pearce

The close proximity of RAAF Base Pearce's restricted airspace to Perth Airport has necessitated development of specific air traffic procedures to ensure safety of civilian aircraft arriving and departing Perth with military operations in the adjoining restricted airspace.

The SIDs, STARs and other instrument approach procedures for Perth Airport are designed to provide a minimum distance of 1.5 nautical miles from military restricted airspace. To achieve this separation, aircraft departing from runway 03 must first track to the east or west and only turn north when clear of military airspace. Being clear of military airspace can be achieved either laterally or vertically when an aircraft has reached a height to fly above the restricted area.

Likewise, military procedures are designed so that the closest a military aircraft will fly near the boundary with civil airspace is 1.5 nautical miles. The 1.5 nautical mile distance on both sides of the civil and military airspace boundaries provides a minimum distance of three nautical miles between aircraft arriving or departing Perth Airport and aircraft operating within military airspace. Three nautical miles is the radar separation standard that air traffic control must achieve between aircraft.

20.4.3.2 Jandakot Airport

The majority of Jandakot Airport flights do not affect Perth Airport.

Some aircraft departing Jandakot in poor weather need to climb into Perth airspace to ensure safe flight above terrain. Depending on the runway available for use at Jandakot Airport, aircraft arriving at Perth may be delayed to facilitate an aircraft departing Jandakot. During southerly operations, the Royal Flying Doctor Service's medical priority flights can delay aircraft departing Perth, particularly when the weather is poor (low cloud and/or low visibility) as the priority aircraft need to climb into Perth airspace to ensure safe flight above terrain.

Whether an aircraft is arriving at Perth or Jandakot, during northerly operations in poor weather, aircraft which are descending until they achieve visual recognition with the runway use the same airspace. For air traffic control to maintain the minimum required radar separation of three nautical miles, aircraft arriving at Jandakot must be sequenced with aircraft arriving at Perth. Each Jandakot arrival therefore uses a 'slot' that could have been used by a Perth arrival, thus reducing the number of aircraft that can land at Perth in any given period.

20.4.4 Inactive Military Airspace

As described in Section 20.3.7, during certain times, or for certain activities, restricted airspace is activated to accommodate military activities.

When the restricted airspace is not active, Perth air traffic control can process aircraft on more direct routes which results in fewer miles flown, therefore saving fuel burn and carbon emissions. This can also provide noise improvements for the community. To avoid the possibility of issuing an incorrect departure procedure, there is not another set of SIDs and STARs for use when the Pearce airspace is inactive. This ensures there is no risk of accidentally issuing a SID which would clear an aircraft through RAAF airspace when restricted airspace is active.

Instead aircraft are processed though inactive restricted airspace via approved and published procedures. For example, rather than routing aircraft over the suburbs to the north-west of Perth as occurs during the day, the aircraft continue on the runway heading to fly over Pearce and less populated areas such as Whiteman Park.


Arrivals

21 Airspace Management Plan

This section provides an overview of the Airspace Management Plan for the New Runway Project (NRP).

Detail is also provided on the following areas:

- How was the concept for the plan developed?
- Where will aircraft fly when there is a new runway?
- Who uses which runway?
- What is a Airspace Management Plan?
- What is considered when developing flight paths?
- Where will aircraft fly when the new runway is operational?
- What is the Airspace Management Plan?

21.1 Introduction

The New Runway Project (NRP) will result in changes to the way the airport operates including runway operating modes, new and amended flight paths, and changes to the airspace architecture.

This section outlines the way the parallel runways could be used and how the Airspace Management Plan was developed. Parallel runway operations will involve a number of arrival and departure procedures to each runway and the actual procedures used may vary daily or even on an aircraft by aircraft basis. The rules that dictate how parallel operations are conducted are detailed along with proposed changes to airspace. Indicative flight corridors are shown to indicate the various routes that aircraft may fly. The final flight path design will occur in the three years prior to the runway opening. The indicative flight corridors shown allow for flexibility in the final design which will be completed by Airservices Australia. The final design will involve further consultation with airline operators and the community.

21.2 Development of Flight Paths and Airspace Architecture

This section outlines the Airspace Management Plan for the safe and efficient operation of a parallel runway system. The plan concentrates on operations within the terminal area. The terminal area (for the purposes of this document) is an area within 36 nautical miles (67 kilometres) of the airport. It does not include the en-route phases which are conducted at higher altitudes than terminal operations. The en-route phase is where the flight joins a published air route after flying a Standard Instrument Departure (SID) on departure or until the aircraft joins a Standard Terminal Arrival Route (STAR) for the arrival phase. The en-route phase is generally associated with level flight at the cruising altitude. The safety and efficiency of en-route operations will be a major consideration during the final design process and this may result in some changes to the Airspace Management Plan. It is expected that any changes will be for the purpose of evenly balancing traffic between the runways rather than a redesign of the airspace management plan presented in this MDP.

Development of the flight paths and airspace architecture for the NRP is undertaken in stages, as shown in Figure 21-1.

2013

Concept of Operations
Concept of Operations (CONOPS) developed to provide a high-level overview of how parallel runways at Perth Airport could operate.

2017

Preliminary design
Preliminary design of flight paths to determine flight corridors. The flight corridors inform the impact assessment and the Airspace Management Plan.

2018

Community consultation
Major Development Plan (MDP) released with detail on how the new runway will likely operate.

2019/2020

Approval
Target for Major Development Plan (MDP) to be approved by the Commonwealth Minister for Infrastructure, Transport and Regional Development was 2019, actual approval received November 2020.

Post 2020

Decision to build
Perth Airport and airlines reach a commercial agreement to commence construction of the new runway subject to actual demand. Construction of on-ground infrastructure commences.

Post 2020

Flight path and airspace detail design
Airservices Australia will lead the final detailed design of airspace and flight paths. This will take around three years and include extensive consultation with the Department of Defence, the Civil Aviation Safety Authority (CASA), airlines and Perth Airport.

Post 2022

Office of Airspace Regulation (OAR) approval
Civil Aviation Safety Authority (CASA) via their Office of Airspace Regulations (OAR) approves airspace changes.

Post 2022

Operational testing
Flight test and commissioning of the new runway undertaken.

2023-2028

Runway open
New runway will be opened between 2023-2028 subject to demand and a commercial airline agreement being reached.

As required

Post implementation review
Airservices Australia to review the operation of airspace and flight paths.

Figure 21-1 Stages of development of the flight paths and airspace architecture for the New Runway Project
Source: Perth Airport

21.3 Concept of Operations

In 2013, UK NATS was engaged by Perth Airport to support Perth Airport and Airservices in developing a Concept of Operations (CONOPS) for a parallel runway system. UK NATS is highly credentialed to complete the CONOPS following the detailed analysis they undertook during the Airport Capacity Enhancement Project (refer to Section 2 for further information), and their experience in worldwide planning for airport infrastructure upgrades.

The CONOPS provides a high level overview of how the runways could operate.

The CONOPS study provided a high-level view of the optimal operation of Perth Airport in terms of ground movements and airspace design, focusing on the handling of arrivals, departures, and missed-approach scenarios for parallel operations. The CONOPS considered the particulars of operations at Perth Airport (including airspace complexity with other airports, fleet mix, destinations, origins and apron locations) to maximise efficiency and capacity.

The CONOPS focused on 'day of opening' when airlines are located in both Airport Central and the existing Terminal 3 (T3) and Terminal 4 (T4) area, while also meeting the long-term needs of the airport after Qantas has relocated to Airport Central.

As outlined in the Perth Airport Master Plan 2014, the key points in relation to the technical studies completed as part of the CONOPS noted that:

- the optimal operation of the airport in terms of ground movements and airspace design was considered,
- Perth Airport and Airservices reached in-principle agreement on the CONOPS,
- planning and airspace modelling identifed a CONOPS which considered the complex airspace environment,
- the use of the cross runway (06/24) during peak periods would reduce the efficiency and the available runway capacity,
- parallel runways should operate in independent mixed mode when possible. This means each runway would cater for both arrivals and departures and operate independently of the other runway, and
- aircraft should be allocated to the runways based on terminal arrivals and compass departures as graphically shown in Figure 21-2.

The CONOPS will require further detailed work to develop full working procedures that satisfy the Safety Management System (SMS) and the national regulator. It is recognised that this work is likely to require adjustment of the CONOPS to ensure a safe, efficient and equitable use of airspace and parallel runway operations at Perth Airport.

21.3.1 Independent Mixed Mode

To maximise capacity, on day of opening and into the future, two operating modes were considered for parallel runway operations:

- segregated, and
- independent or dependent mixed mode.

Segregated mode operations involves having one runway allocated for departures and the other for arrivals. To maximise capacity, segregated mode operations require an even demand for arrivals and departures. As discussed in Section 2, the nature of the traffic demand at Perth is an early-morning wave of departures followed by a late-morning arrival demand. The same occurs in the afternoon, with a mid-afternoon departure burst and an early evening arrival demand. This makes the segregated mode unsuitable at Perth Airport.

Independent mixed mode is where both runways are used for both arrivals and departures, and the separation of aircraft is not dependent on each other. Although this mode can cater for traffic patterns at Perth Airport it does require sufficient airspace to process the aircraft onto two final flight 'legs' (the final approach to the airport).

Due to the location and operations of RAAF Base Pearce, in order to achieve independent mixed mode all of the time, more airspace would be required than is currently available for civil operations when Pearce restricted airspace is active.

When the airspace is not available, dependent mixed-mode operations would be required. This mixed mode operations require separation between aircraft on final approach for each runway and result in a significant decrease in capacity.

21.3.2 Runway Allocation

The development of the CONOPS considered current and future terminal locations and airline use, as well as taxiing distances, the number of runway crossings, and the air-track miles for departures and take-offs. The final flight path design will also consider any safety, economic penalty or runway balancing impacts.

Compass arrivals and departures are when aircraft arrive and depart from the runway nearest to their direction of flight. For example, arrivals from, and departures to, the west use the westerly runway (and vice-versa). This simplifies the airborne traffic management but can cause congestion and delay on the ground due to large numbers of aircraft taxiing long distances to and from their terminal aircraft-parking positions, and requires runway crossings.

Terminal arrivals and departures are defined as when aircraft arrive and depart from the runway nearest the terminal they operate from. The advantages on the ground are shortened taxi distances and reduced complexity for air traffic control. However, there is increased complexity in the air. Crossing aircraft in the air, particularly on departure, is more complex and requires a significant amount of airspace to allow vertical separation between the climbing aircraft. This can considerably increase airborne track miles.

To minimise the impact of additional airspace required for the parallel runway operation, the CONOPS recommended that, in peak periods, aircraft are allocated to the runways based on compass departures and terminal arrivals.

Terminal arrivals sees aircraft arriving on the runway proximate to the terminal that they operate from. For example, an aircraft operating at T3 or T4 will land on the existing main runway (03L/21R). There may be some variations to the terminal arrival concept where safety, economic penalty or runway balancing is required.

Compass departures sees the runway allocated according to the direction that the aircraft is going. The main runway (03L/21R) will generally cater for aircraft operating to destinations south, west and north-west. The new runway (03R/21L) will generally cater for aircraft operating to destinations north-east and east.

The CONOPS considered that, ideally in peak periods, runway allocations would provide a balance of near to equal numbers of arriving and departing aircraft using the existing and new runways. The combination of compass departures and terminal arrivals could achieve this.

To maximise capacity, and for efficient on-ground operations, all terminals would be located between the parallel runways. However this is currently not the case at Perth. Moving of the Qantas Group into Airport Central is planned by the end of 2025, based on commercial agreement. When this occurs, runway allocations will be revisited. However, modelling has shown that compass departures and terminal arrivals would still provide a safe and efficient runway-allocation model.

If departure runway use is imbalanced and impacts on the overall efficiency of airspace and ground operations, this can be corrected by requiring departures to certain northern ports to flight plan to depart either to the east or west to manage the imbalance. If terminal arrivals results in imbalance and impacts on the overall efficiency of airspace or ground operations either prior to Qantas relocation or after, this can be addressed by changing the allocation of runway for some flights. For example, if demand for the new runway (03R/21L) was lower than the existing main runway (03L/21R), then flights arriving from the east could land on the new runway (03R/21L). Although the taxi distance would be longer, it could reduce airborne track miles and fuel burn.

Departures concept

Arrivals concept

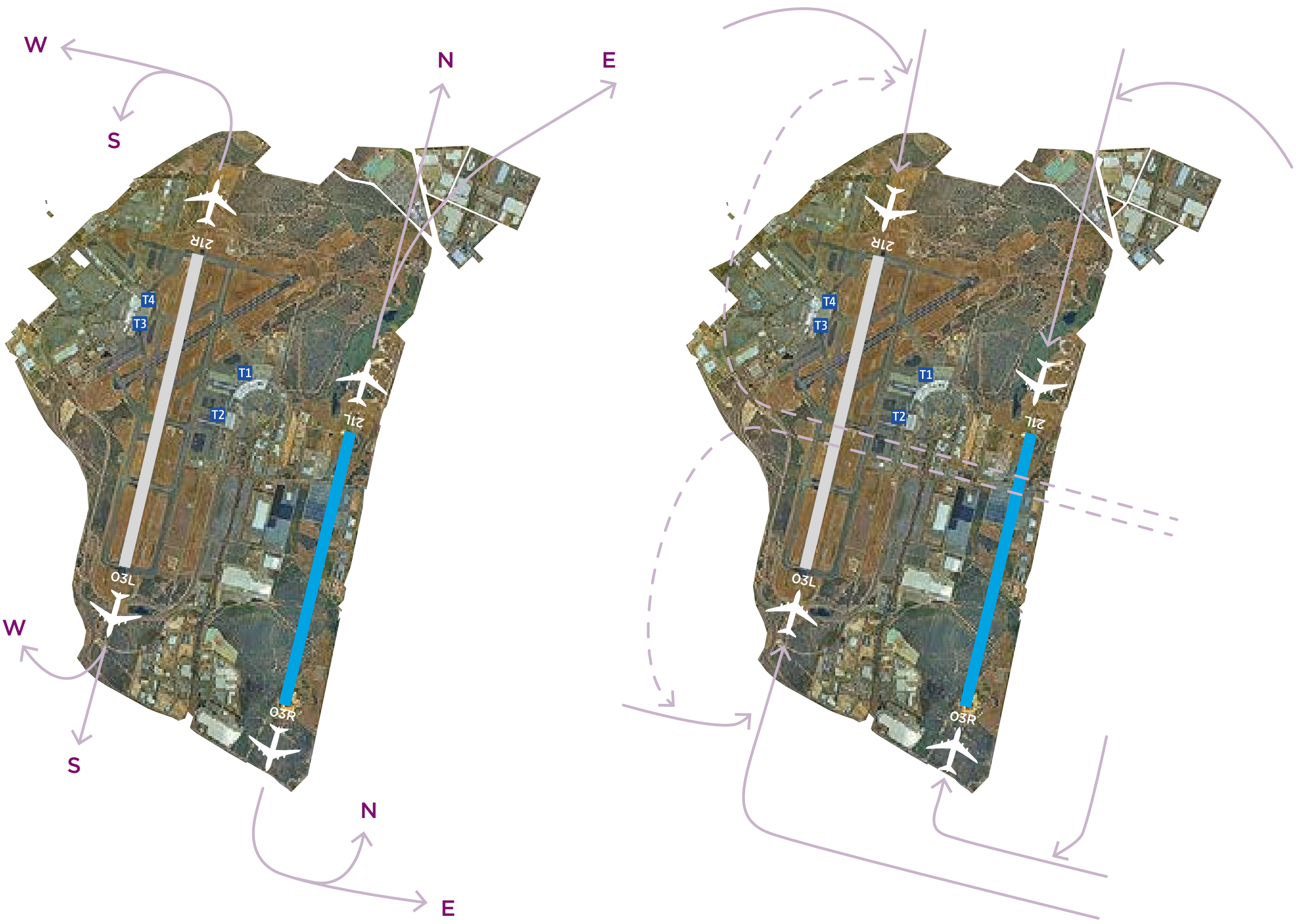


Figure 21-2 Compass departures and terminal arrivals concept of operation for parallel runway operations at Perth Airport
Source: Perth Airport

21.4 Airspace Management Plan

The Airspace Management Plan refines the CONOPS and outlines the expected airspace architecture and management framework for parallel runway operations at Perth Airport.

The process for developing the Airspace Management Plan has involved extensive consultation, including collaborative review and analysis of the airfield and airspace with Airservices and the Department of Defence. This process focused on achieving the most efficient airspace outcomes while prioritising safety and addressing the complex airspace environment.

A key complexity of the Perth airspace is the location of RAAF Base Pearce, which limits optimal flight path layouts for Perth Airport. The process to identify a suitable airspace arrangement on mutually acceptable and efficient air traffic management arrangements involved extensive dialogue between Perth Airport, Airservices and Department of Defence facilitated by the Department of Infrastructure, Transport, Regional Development and Communications (DITRDC). This dialogue will continue through to the final airspace design to be undertaken by Airservices. The aim is to achieve equitable access where this is practicable.

While noting the need to address safety and efficiency, extensive modelling and analysis has been undertaken to review potential flight paths and align these to create potential flight corridors.

The Airspace Management Plan is based on:

- the approved CONOPS as outlined in the Master Plan 2014,
- parallel runway operation,
- existing flight paths to and from Perth Airport, and the principle of maintaining as many of the current flight paths as possible and therefore minimising new over-fly areas,
- need to optimise airport capacity on day of opening and into the future,
- current preferred runway rules and Noise Abatement Procedures (NAP),
- the environmental conditions of Perth, including prevailing wind conditions,
- allowance for arrival procedures to ensure flexibility for design,
- ensuring that the airspace design and flight paths are simple and can be consistently applied to maximise safety and efficiency,
- collaboration to design procedures that cater for all airspace users; including working with the Department of Defence and Airservices to achieve an outcome that is mutually beneficial and does not impact safety and efficiency of both operations,
- ensuring flexibility for the final design to cater for improvements in operations, and
- current rule sets and known potential changes and the amalgamation of existing procedures with new procedural requirements for parallel operations.

As the NRP introduces a new runway during the final design, the preferred runway rules and Noise Abatement Procedures will require review in conjunction with Airservices.

21.4.1 Standards for Parallel Runway Operations

The use of parallel runways requires different safety standards than those for a single or cross runway operation.

Due to the closeness and complexity of parallel runway operations, a stringent rule set applies. These procedures are published by the International Civil Aviation Organization (ICAO) in the Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR or ICAO DOC 9643).

As detailed in Section 20, depending on weather conditions, an arrival to parallel runways can either be via:

- a visual approach, or
- an instrument approach.

A visual approach is an approach to a runway conducted with reference to visual cues and clear of clouds. The pilot must have the runway in sight at all time.

An instrument approach is an approach to a runway conducted in reference to navigation aids under instrument flight rules (IFR) to a point from which a landing may be made visually.

21.4.1.1 Visual Approaches on Parallel Runways by Day

Independent visual approaches (IVAs) are the most efficient way to process aircraft to parallel runways. It means two aircraft can be processed for an approach to each runway independent of each other. In other words, they can be side-by-side on approach. The IVA allows the aircraft to be established on final leg relatively close to the threshold (as close as four nautical miles or 7.4 kilometres) usually resulting in reduced track miles and therefore less aircraft fuel burn and carbon emissions than other options.

For these approaches, air traffic control will instruct the pilot to position the aircraft on a minimum four-nautical-mile final approach. While air traffic control are processing the aircraft, there will be variations to the flight path flown. Although the variations will be in the vicinity of each other, the result will be a splay of flight tracks. One reason for a splay is that if a preceding aircraft is slower than a following aircraft for the same runway, the controller may then instruct the following aircraft to intercept final at five or six nautical miles. This would allow enough spacing for the first aircraft to land and vacate the runway before the following aircraft received its landing clearance.

21.4.1.2 Visual Approaches on Parallel Runways at Night

Visual approaches at night require the pilot to descend with reference to the glide path component of the Instrument Landing System (ILS) or via the guidance lights of the Precision Approach Path Indicator (PAPI). While the day visual-approach procedure allows for a minimum four-nautical mile final leg, due to the requirement for guidance on descent at night, a minimum final leg of eight nautical miles is required when descending from 2,500 feet. As is the case with day visual approaches, the independent parallel runway approach ruleset requires air traffic control to provide instructions to establish the aircraft on final. As a result, a splay of flight tracks will be evident.

To facilitate night operations on the South Flow where aircraft are landing from the north, there is an impact on Pearce airspace if it is conducting night flying. If access to Pearce airspace is not available, then independent approaches are not possible and dependent approach procedures can be applied with a resultant decrease in Perth Airport's capacity.

21.4.1.3 Instrument Approaches on Parallel Runways

Instrument approaches to parallel runways can achieve similar arrival rates to visual approaches. However, as they occur in poor weather, where the aircraft may be in cloud, the ruleset is more stringent.

The rules for instrument approaches mean that there must be 1,000 feet separation between aircraft until each aircraft is established on the ILS, and they must be established at least two nautical miles prior to commencing descent that is guided by the glide-path component of the ILS. Once they are established, they may both descend as required and land simultaneously. These approaches are closely monitored on radar by air traffic control.

Each pair of parallel approaches has a 'high side', and a 'low side' for vectoring. This provides vertical separation until aircraft are established inbound on their respective localiser course. The low-side altitude should be such that the aircraft will be established on the ILS localiser course well before ILS glide path interception. The high side altitude should be 1,000 feet above the low side.

Descent on an ILS glide path is carried out on a three-degree slope. This equates to approximately 320 feet of descent for each nautical mile an aircraft flies across the ground. To descend from 4,000 feet will involve flight for 13 nautical miles established on the ILS. Another two nautical miles is required to allow for the level flight requirement stated previously. Additional miles will be required for the air traffic controller to radar vector the aircraft onto the ILS as required in the procedure ruleset, and the base leg for this arrival will be approximately 20 nautical miles (37 kilometres) from the airport.

Current modelling has considered both South and North flows to have a high side at 4,000 feet and a low side at 3,000 feet. As described, a final approach leg of approximately 20 nautical miles (37 kilometres) will be required. Lateral separation must also be provided, with adjacent uncontrolled airspace where aircraft can fly without air traffic control intervention.

Again, due to air traffic control instructions, there will be a splay of flight tracks which will also impact Pearce airspace when arriving from the north.

21.4.1.4 Required Navigation Procedures Approaches on Parallel Runways

The ruleset for parallel runway operations was revised to include Required Navigation Performance-Authorisation Required (RNP-AR) approaches in late 2018. The updated ruleset allows for independent RNP-AR approaches to parallel runways. These will allow aircraft to track from downwind on a curved approach to the relevant runway. Independent RNP-AR approaches have the ability to reduce the impact on RAAF Base Pearce and Jandakot Airport operations, and are available day and night in all weather conditions. However, the fitment of the appropriate navigational equipment to all aircraft operating at Perth would be required to achieve maximum runway capacity.

Final determination on RNP-AR use on the parallel runway system will be determined during the final flight path design.

21.4.1.5 Dependent Approaches on Parallel Runways

If access to RAAF Base Pearce airspace is not available at night (the hours of darkness) or in instrument conditions when on the South Flow, dependent operations must be implemented. Dependent operations require the aircraft to be flown to intercept the ILS at least eight nautical miles from the runway to allow descent, except when an RNP-AR approach can be accommodated by air traffic control. This results in an approach to the new runway the same as the approach for the night time approach. From the west, today's procedure would be adopted (i.e flying a nine-nautical mile arc to intercept the ILS). These approaches for dependent mode and RNP-AR approaches have been included in the Airspace Management Plan.

When demand is below a level requiring independent approaches to parallel runways, dependent approach procedures could be applied. This means that a combination of ILS approaches, and RNP approaches, for suitably equipped aircraft, would be feasible, with no impact on capacity. In this mode, independent approaches could be used for two RNP-AR aircraft or an RNP-AR and an aircraft on an ILS approach. Two aircraft on ILS approaches would require a dependant approach reducing the runway capacity. The higher the RNP-AR equipage of the Perth fleet, the less impact on runway capacity.

21.4.1.6 Weather Criteria for Parallel Runway (Instrument or Visual)

Weather criteria determines whether an instrument or visual approach is used. The criteria currently used at Perth for existing operations are described in Section 20 and will likely be the same for parallel runway operations.

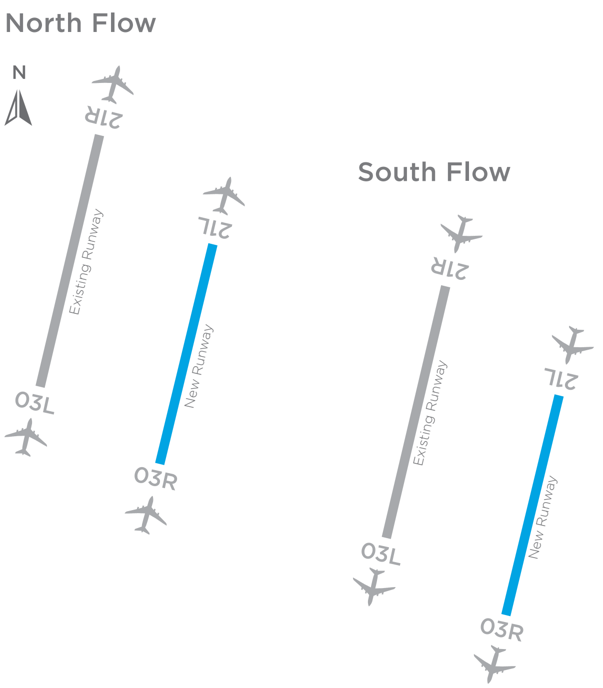


Figure 21-3 Operating flows for new parallel runway
Source: Perth Airport

21.4.1.7 Parallel Runway Departures (Instrument or Visual)

For departures on parallel runways, departure procedures must diverge by at least 15 degrees immediately after take-off. Currently there is no requirement at Perth for an immediate turn after take-off for existing procedures (as detailed in Section 20). The 15 degrees may be applied to a turn off one runway or could apply to both runways. 15 degrees is the minimum divergence required by the standards, and it can be greater. Limiting factors to the size of the turn would be aircraft performance capabilities, and physical barriers such as turning to head towards high terrain. The method to achieve the 15-degree divergence requirement is detailed in Section 21.4.3.2.

There is no definition of 'immediate' in relation to when the turn must be made. Most SIDs in Sydney (the only major Australian airport with parallel runways currently in operation) use a turn at 500 feet.

21.4.2 Proposed Flows of Operation

Perth has two operating flows; South Flow and North Flow. The flow is generally selected as the most into wind runway. Parallel runway operations will continue to use the south and north flows, as shown in Figure 21-3. Key considerations for the selection of the operating flow will continue to be safety, wind and capacity.

The Airspace Management Plan considers southerly and northerly operating flows for parallel runway use only. It does not consider options such as single runway use of either the existing main runway or new runway, or use of the existing cross runway, although in some circumstances these may be possible, such as when one runway is out of service for maintenance.

21.4.2.1 South Flow

This flow will be used when the runways nominated for use are runway 21 right (21R) and runway 21 left (21L), which is when aircraft depart to the south over suburbs such as Cannington and Beckenham, and arrive from the north over suburbs such as Midland and Guildford.

21.4.2.2 North Flow

This flow will be used when the runways nominated for use are runway 03 left (03L) and runway 03 right (03R), which is when aircraft depart to the north and arrive from the south. All arrivals and departures on the North Flow have no impact on Pearce operations.

21.4.3 Proposed Flight Corridors

Perth Airport, in consultation with Airservices, developed proposed flight corridors to guide the assessment of impacts and the final airspace and flight path design. This is not a full detailed design of the airspace and flight paths, and should be considered as the guiding principles that will inform the airspace and flight path detailed design process (refer to Section 21.6).

These proposed flight corridors have been developed in conjunction with Airservices to ensure the design is a workable solution addressing safety as the number one consideration. As the actual flight paths are subject to Airservices final design prior to opening of the runway, the actual location of flight paths has not been finalised.

The proposed flight corridors were established considering the following guiding principles:

- continuation of south and north flows of operation,
- establishment of an arrival route from the north-west to allow arriving aircraft to be processed to the existing main runway (03L/21R),
- provision for arrivals from the east to cross overhead the airport to access the existing main runway (03L/21R). This is a fundamental requirement for the terminal arrivals concept. Most other arriving traffic can be processed for either runway by routing aircraft outside terminal airspace to the appropriate feeder point. Due to geographic configuration, this is not feasible with arrivals from the east and so the additional arrival routes are required to position the aircraft to the west of the airport for a landing on the existing main runway,
- allowance for independent instrument approaches and dependent approaches on runway 21R and 21L (if access to RAAF Base Pearce airspace is unavailable at night or in instrument conditions),
- allowance for separate arrival routes for independent visual approaches by day and by night where possible, to limit the number of track miles required to be flown, when conditions permit this to be done safely and without restriction on capacity,
- provision of RNP-AR approaches to be made available to suitably equipped aircraft when traffic conditions permit. It is also expected that over time, the majority of the Perth fleet will consist of RNP-AR equipped aircraft and these approaches will become the norm,
- aircraft operations should be concentrated, as much as possible, over non-noise sensitive areas and premises, and
- maintain existing flight corridors as much as possible.

A flight corridor will not be a constant track displayed as a line on a map that all aircraft will fly directly over. Instead flight corridors are shown as a splay which is a horizontal representation of where aircraft may track for a variety of reasons. The splay may be on both sides of a track or mainly on one side. For example, a procedure that requires an aircraft to intercept a minimum four-nautical-mile-final would have the splay further out than four nautical miles and not closer, (closer would mean the procedure is not complying with the ruleset).

Departure and arrival procedures are published procedures that pilots are required to follow. They will usually be published as a set of tracking points that are described by a Global Positioning System (GPS) latitude and longitude. These are entered into the aircrafts flight-management system, and the pilot or autopilot will fly the route. Some departure procedures may specify a height to turn rather than latitude and longitude.

For example, at Perth, the turbopropeller (turboprop) aircraft SID to the east makes a turn at 1,000 feet. The distance from the airport at which aircraft reaches 1,000 feet will vary according to many factors and, as a result, this departure procedure will have a wide splay of possible flight tracks, and not be a line on a map.

Flight paths to the west, once an aircraft has crossed the coastline, have not been finalised. The actual flight paths will be subject to the location of the corridor that will be agreed by Airservices and the Department of Defence. As these flight paths will be over water, they have not been included in the noise-modelling.

The current, and any proposed departure and arrival procedure does not mean that the airspace use is prohibited to other flying activities. For example, operations by emergency response aircraft will always take priority over normal operations on a flight corridor if the two conflict. This is managed by air traffic control, as required, to ensure safety is not compromised. An example of this situation would be to stop aircraft departures on a particular flight corridor if firefighting aircraft required the airspace to fight a bushfire.

The following assumptions have been made on how arrivals and departures would operate for the parallel runway system. These assumptions will form the basis of the final airspace and flight path design.

21.4.3.1 Arrivals

For each mode, there are various approach options for aircraft landing, as detailed in Section 21.4.1. These are required because the approach used is dependent on a number of factors including weather conditions, military activity and whether it is day or night.

The Airspace Management Plan includes the establishment of a single arrival route to complement the existing departure route to the north-west of Perth through existing military restricted airspace. These routes will facilitate arrivals and departures to and from the existing main runway (03L/21R). Workshops involving Perth Airport, Airservices and the Department of Defence investigated various options to facilitate this arrival route. The details will be agreed following a comprehensive route review and design process with agreed outcomes and changes subject to approval of an Airspace Change Proposal (ACP). Air routes may vary during this design process but it's anticipated that any variations will occur over water and have no impact on completed noise modelling as presented in Section 22.

South Flow

This flow will be used when the runways nominated for use are runway 21 right (21R) and runway 21 left (21L), which is when aircraft depart to the south of the airport and arrive from the north. With terminal arrivals, aircraft that are landing on the existing main runway and arriving from eastern ports, will be required to overfly the airport to establish them for an approach from the west. The aircraft would be at a height of approximately 10,000 feet over the airport when making a visual approach. This will be similar to some of the current arrival STARs used in Melbourne for Perth flights. However these aircraft may land on the new runway if required for runway balancing negating the need to overfly the airport. Arrivals to the new runway from the east will fly to the north of Perth Airport, and then make a left turn on to the final leg.

Proposed arrival corridors for the South Flow are illustrated in Figure 21-4.

Once the aircraft are established either east or west of the airport (depending on the runway they are landing on), there are various approach paths:

- minimum four-nautical-miles-final for independent visual approaches by day,
- minimum eight-nautical-miles-final for independent visual approaches at night,
- up to 20-nautical-miles-final for independent instrument approaches,
- minimum eight-nautical-miles-final for dependent approaches day or night, or
- curved approach for an RNP procedure.

North Flow

A North Flow will be used when the runways nominated for use are runway 03 left (03L) and runway 03 right (03R), which is when aircraft depart to the north and arrive from the south.

Proposed arrival corridors for the North Flow are illustrated in Figure 21-6.

With terminal arrivals, aircraft that are landing on the existing main runway and arriving from eastern ports will be required to overfly the aerodrome. However, with the North Flow this is only required for instrument approaches as there are no constraints from Pearce airspace. If required, runway balancing may result in these aircraft landing on the new runway negating the need to overfly. Visual approaches to the existing runway can be accommodated by making an approach parallel to, and south of the new runway approaches on both visual and night-visual procedures. There is adequate controlled airspace to run the approaches parallel, and at a suitable distance apart, to allow air traffic control separation while maximising capacity.

This flow will also use the visual approaches to parallel runways. However, when aircraft are approaching to land on the existing main runway from the west it is not possible for them to track for a four nautical mile final leg due to proximity of the Jandakot Control Zone (a parcel of airspace that extends three nautical miles around Jandakot Airport; and extends from the ground up to 1,500 feet). The northern edge of the three nautical mile zone is approximately seven-and-a-half nautical miles south of Perth Airport. This distance is insufficient to allow air traffic control to process the aircraft on the final approach track by a minimum of four nautical miles, as they would require descent through the Jandakot Control Zone. To remain clear of this zone, aircraft must be 1,000 feet clear, which means overflying Jandakot at 2,500 feet until established on the ILS, which is similar to the current approach procedure. A curved RNP approach, onto a four-nautical mile or less final leg, may be achievable and is included in the Airspace Management Plan.

The northerly flow uses parallel arrival flight paths for aircraft arriving from the east during day and night VMC operations. These aircraft will overfly the aerodrome during IMC operations. When overflying the aerodrome they are estimated to be at 12,000 feet.

Once aircraft are established either east or west of the airport (depending on the runway they are landing on) there are various approach paths.

- minimum four-nautical-miles-final for independent visual approaches by day on runway 03R and eight nautical miles final for runway 03L when arriving from either the east or west,
- minimum eight nautical miles final for independent visual approaches at night, or 12 miles if approaching from the east for the existing main runway 03L (to be parallel and to the south of the 03R approach from the east),
- up to 20-nautical-miles-final for independent instrument approaches, or
- curved approach for an RNP-AR procedure.

21.4.3.2 Departures

The key considerations for the departures include:

South Flow

- the departure procedures from the existing main runway will remain the same, either with a right turn to the west or departing straight ahead to the south,
- new departure procedures will be required from the new runway to process the aircraft departing to the east or north-east to join the existing flight path structure,
- at least 15 degree divergence will be applied to the new runway – the exact departure procedure will be subject to the procedure design requirements and be finalised in the final design phase,
- the design principle will be to initially overfly industrial areas on runway heading until approximately one-and-a-half nautical miles upwind then turning onto a heading to fly over the intersection of the Roe Highway and Welshpool Road, and then over areas of least population as far as possible when heading towards the escarpment, and
- a departure route for turbo prop aircraft from the new runway will be similar to the procedure used off the existing runway where aircraft turn left approximately 90 degrees shortly after take-off to clear the path for faster following jet aircraft. This departure will be for aircraft such as the DHC8 (Dash 8), Beech 200, Beech 1900 and the Embraer 120 Brasilia.

Proposed departure corridors for the South Flow are illustrated in Figure 21-5.

North Flow

- departing off the existing main runway will fly the same departure procedure as with a left turn to the west,
- at least 15 degree divergence will be applied to the new runway,
- the design principle has applied an approximately 46-degree turn to replicate the current departure flight tracks for aircraft departing from the current cross runway 06. This is a long-established departure path. The exact departure procedure will be subject to the procedure design requirements and be finalised as part of the final design, and
- a departure route for turbo prop aircraft from the new runway will be implemented where aircraft turn right approximately 90 degrees shortly after take-off to clear the path for faster following aircraft. This departure will be for aircraft such as the DHC8 (Dash 8), Beech 200, Beech 1900 and the Embraer 120 Brasilia.

Proposed departure corridors for the North Flow are illustrated in Figure 21-7.

21.4.3.3 RAAF Base Pearce Airspace

If access to RAAF Base Pearce airspace is unavailable in IMC or at night, independent approaches to parallel runways are not available. In this situation, dependent approaches are required, and a minimum of three nautical miles' separation is required between all aircraft regardless of which runway they are landing on. Dependent approaches result in a significant drop in the arrival capacity at Perth Airport.

RAAF Base Pearce airspace, including night flying, is activated for approximately 29 per cent of the year. As the airspace is active during the day and on weekdays, the active times coincide with Perth Airports peak traffic periods and so the impact is significant.

Pearce is generally active in daylight hours. Due to Perth's weather patterns, IMC conditions, when on South Flow, would expect to be encountered less than three per cent of the time. Impacts on capacity will only be experienced at times when demand exceeds the capacity achievable for dependent arrivals. Therefore, capacity constraints will only occur when the demand exceeds the dependent capacity (i.e. estimated to be less than three per cent of the time) but this will increase with time as traffic levels increase.

Perth Airport is committed to working with both Airservices and the Department of Defence to determine appropriate flexible use of airspace arrangements. Workshops have already been held, and all parties have reached in-principle agreement that arrivals from the west will be feasible and that further work will be undertaken to investigate flexible use of airspace, where airspace is shared between civil and military aircraft according to user requirements.

Airservices will continue to jointly work with the Department of Defence to facilitate flexible use of airspace arrangements, however the flight paths will be designed to maximise capacity for when access is available.

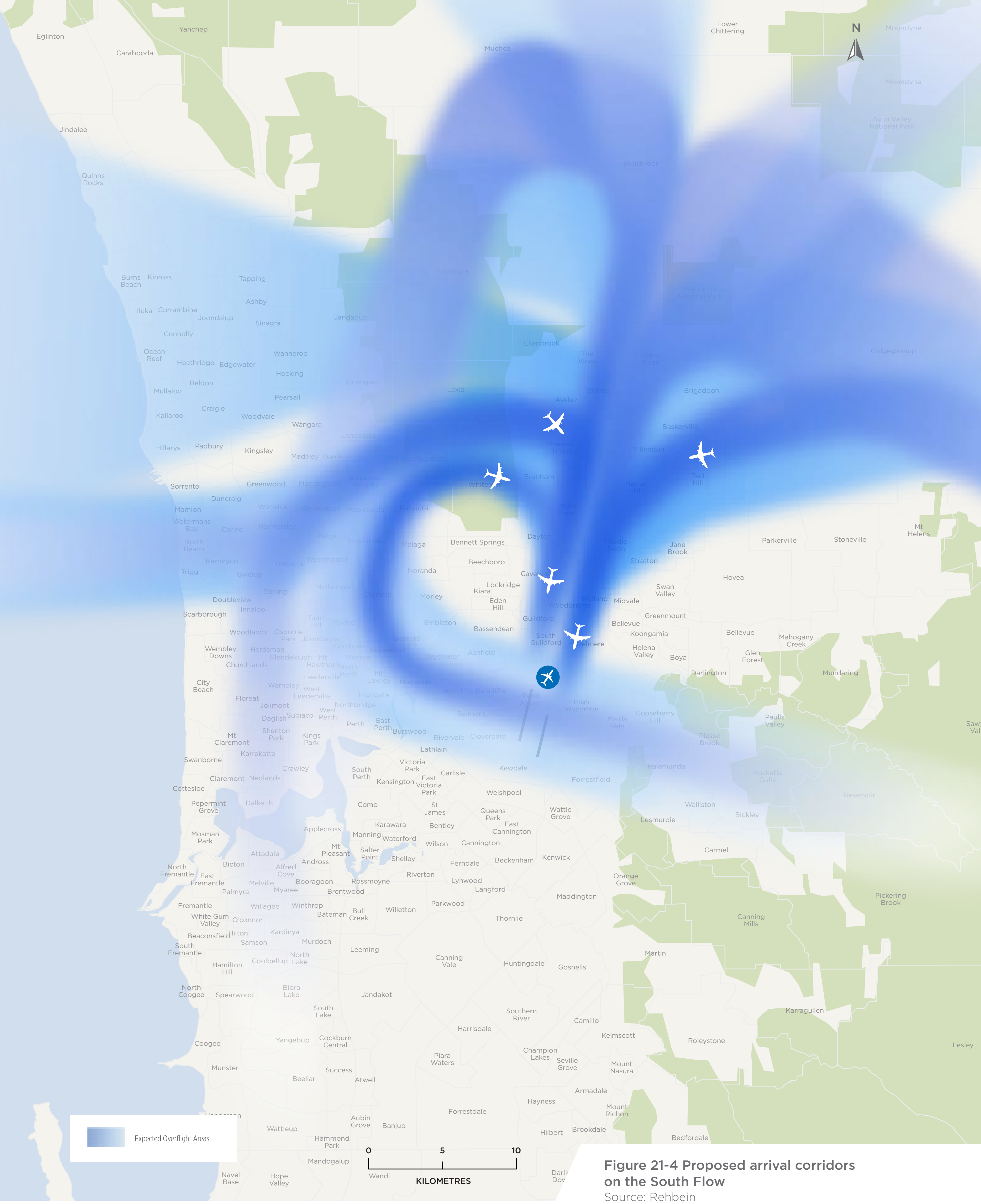


Figure 21-4 Proposed arrival corridors on the South Flow
Source: Rehbein

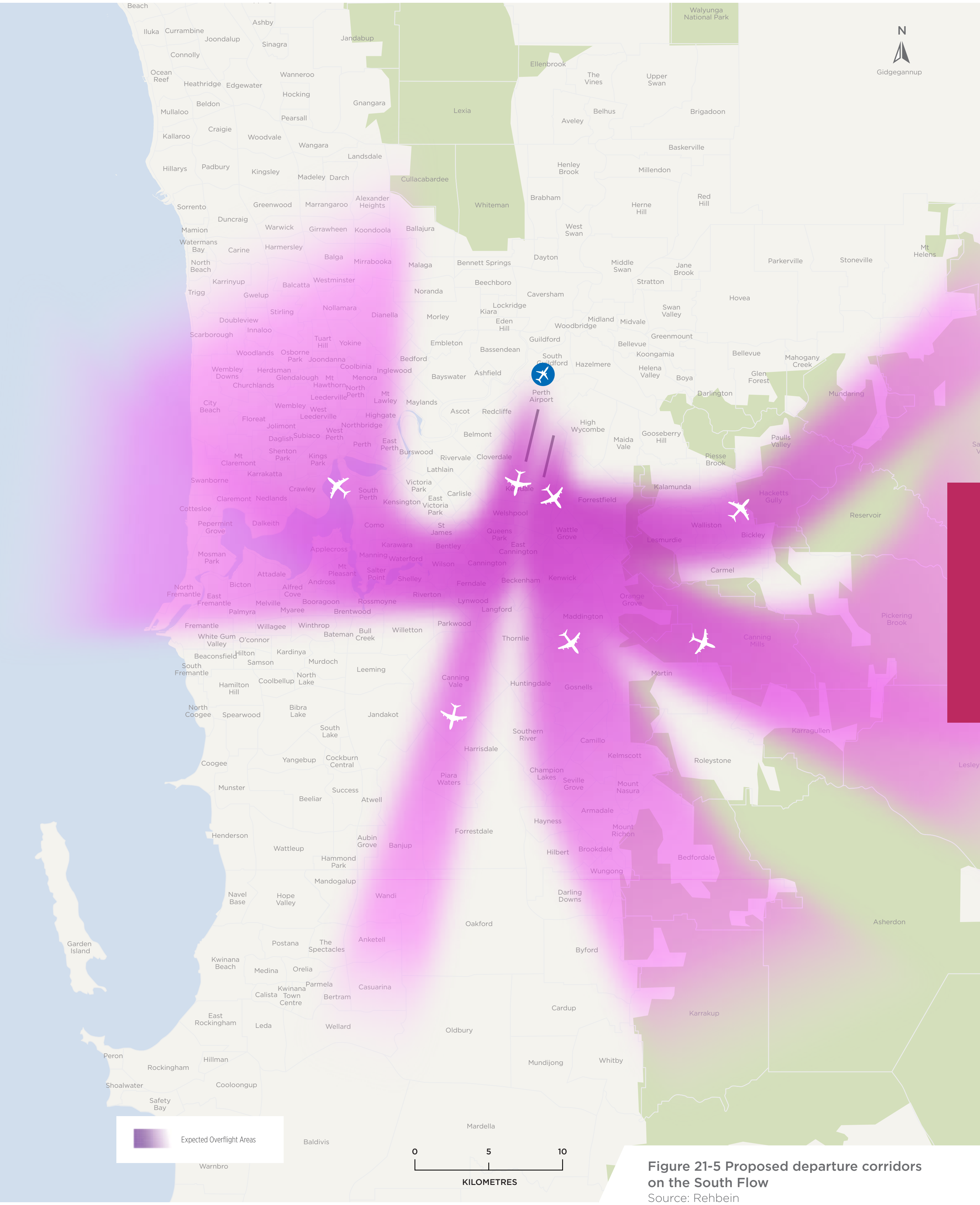


Figure 21-5 Proposed departure corridors on the South Flow
Source: Rehbein

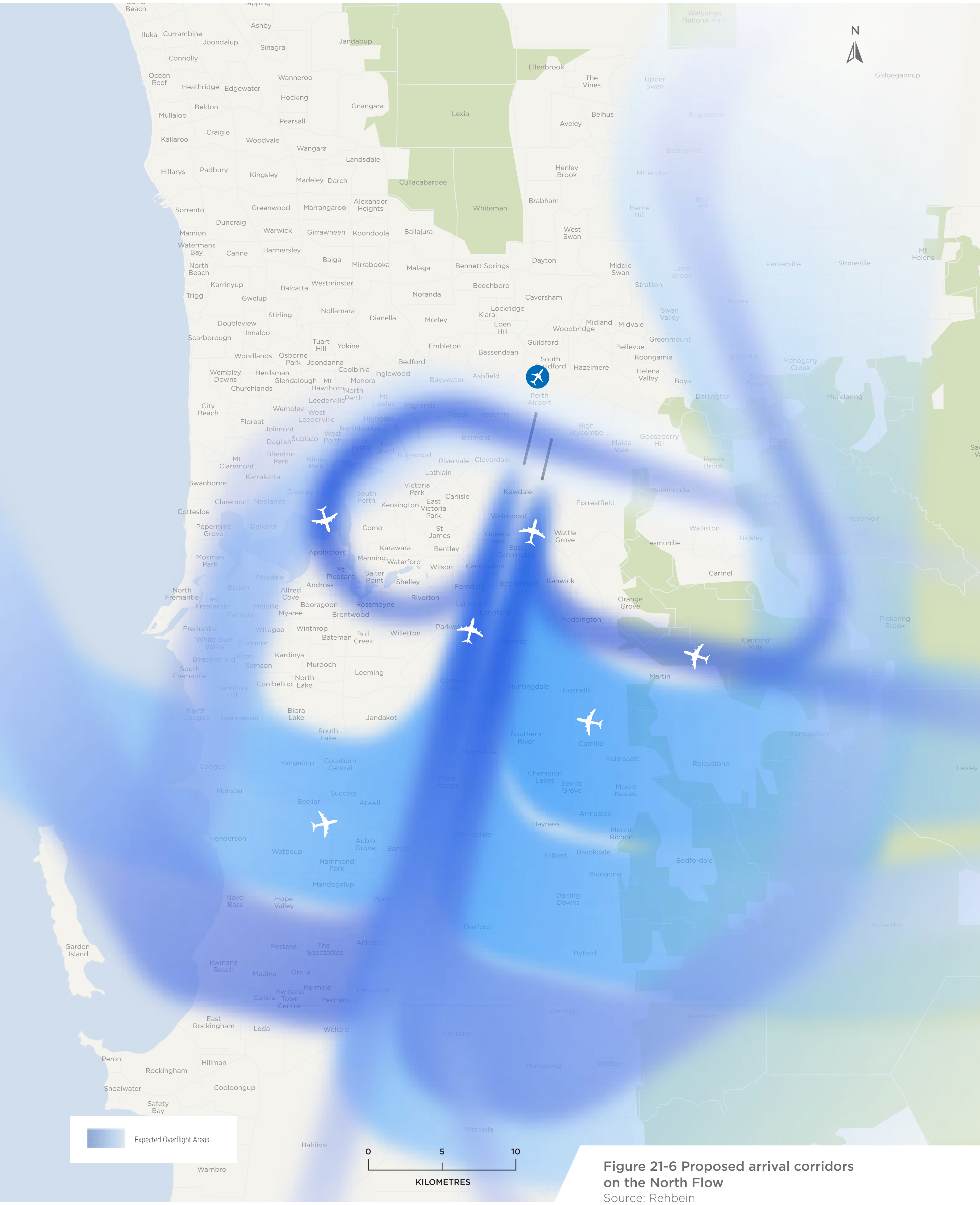


Figure 21-6 Proposed arrival corridors on the North Flow
Source: Rehbein

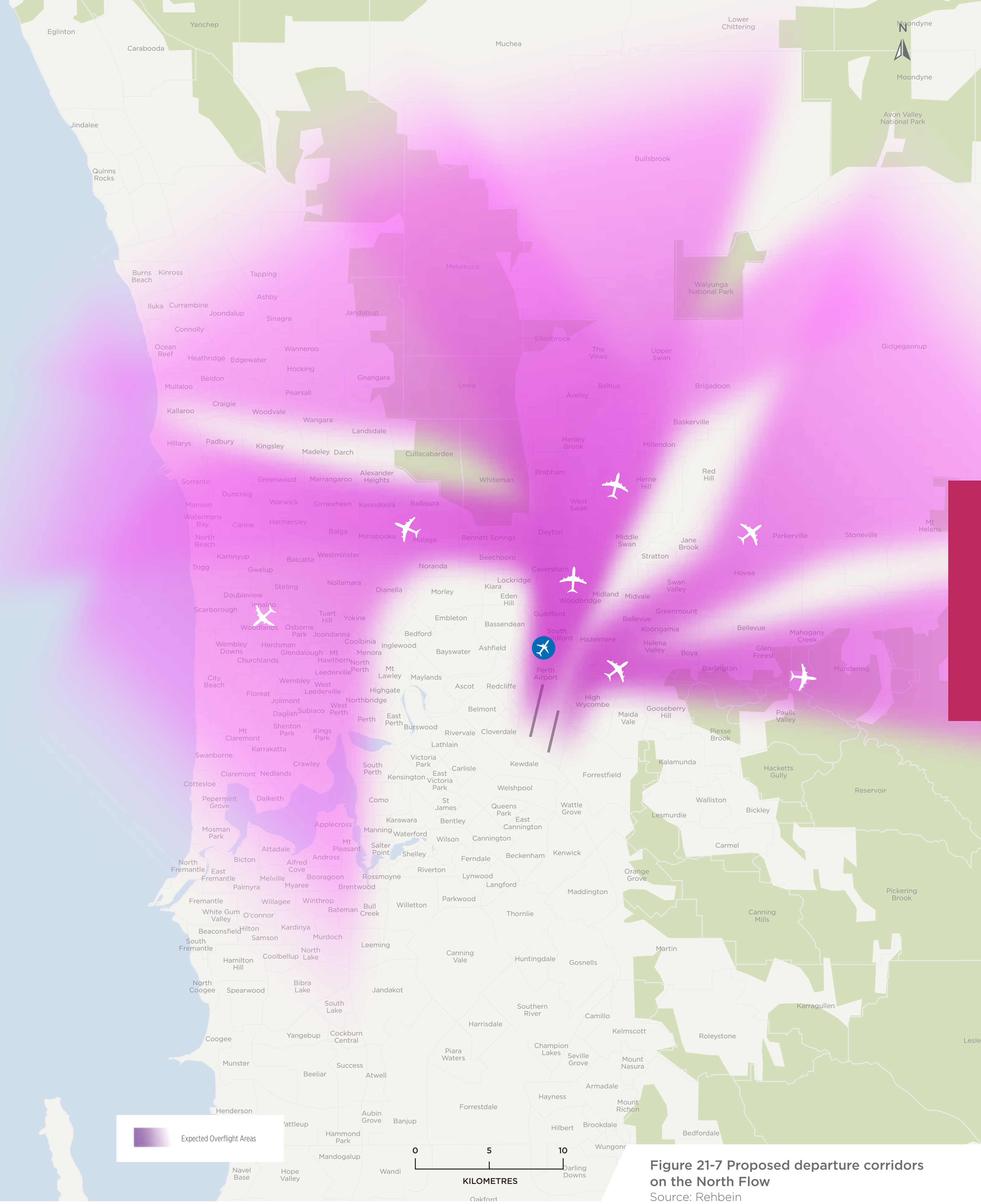


Figure 21-7 Proposed departure corridors on the North Flow

Source: Rehbein

21.4.4 Proposed Airspace Changes

To accommodate parallel runway operations at Perth Airport an application to change controlled airspace may be required. This would maximise capacity in all conditions and in all modes of operation. While additional airspace may not be required during visual approach weather conditions, it is anticipated that a change may be required to operate simultaneous instrument approaches that comply with the current ruleset for parallel runway operations. Controlled airspace cannot be 'turned on and off' when required (unlike military restricted areas). This section outlines the worst-case scenario of new controlled airspace that may be required. The amount needed, if any, will be refined during the detailed flight path design stage and if changes are required, Perth Airport will submit an airspace change proposal (ACP) to CASA for assessment and final decision.

As detailed in Section 21.4.1.3, independent parallel approaches in instrument conditions requires 1,000-feet vertical separation, or three-nautical-mile horizontal radar separation, to exist between aircraft on adjacent final approach paths.

Therefore, an aircraft intercepting final leg at 20 nautical miles will need up to three nautical miles' separation from the potential closest aircraft operating in uncontrolled airspace. An allowance is also applied for a longer final leg (due to air traffic control vectoring) and so the proposed controlled airspace boundary could extend to 25 nautical miles. In addition to lateral separation, vertical separation from uncontrolled airspace is required. This requires an aircraft to be a minimum of 500 feet above the base of controlled airspace. For an aircraft to fly at 3,000 feet, the base of controlled airspace must therefore, be no higher than 2,500 feet.

The end result may require both the extension and lowering of controlled airspace, both to the north and south of Perth Airport, to allow independent instrument approaches thus maximising the capacity of Perth Airport.

21.4.4.1 Airspace North of Perth

To the north of Perth Airport changes to airspace may be required to allow aircraft to be processed via the long final leg required for independent parallel instrument approaches. The current controlled airspace has a base of 2,000 feet out to an 18 nautical mile arc from Perth. Between 18 and 22 nautical miles, the base is 3,500 feet. The next step out at 22 nautical miles is a base of 4,500 feet. To facilitate the flight at 3,000 feet the base of controlled airspace will need to be lowered to 2,500 feet out to 25 nautical miles and to a lateral extent which will ensure that it contains the low aircraft at least three nautical miles from the other parallel runway's localiser, plus a safety tolerance.

Any proposed change to the north, changes uncontrolled airspace to controlled airspace. Aircraft flying in uncontrolled airspace are required to avoid flying into controlled airspace unless they receive an airways clearance from air traffic control. When RAAF Base Pearce is operational the RAAF activate their restricted airspace which stretches from ground level up to 16,000 feet. This restricted airspace contains both controlled and uncontrolled airspace. The proposed increase in the size of controlled airspace to the north of Perth will have no impact to Pearce operations. Pilots are notified when the military airspace is active by an information system called Notice To Airmen (NOTAM). Aircraft without an airways clearance from RAAF controllers must avoid the airspace.

21.4.4.2 Airspace South of Perth

The same principle of aircraft arriving in instrument conditions on the low side at 3,000 feet would need to apply to the airspace south of Perth. A similar reduction may be proposed to the base of controlled airspace to 2,500 feet out to 25 nautical miles; and to the same lateral extent as applied to the north. This will require lowering airspace in the 3,500 feet steps to 2,500 feet. This proposed area is south of Jandakot Airport and will impact on some general aviation activities.

To the south of Jandakot is a training area that abuts the Jandakot Control Zone from ground level up to 6,000 feet. This area is designated as a Danger Zone, to alert pilots that high numbers of aircraft can be operating in the area. Any proposed change to controlled airspace would result in aircraft tracking to the south of Jandakot restricted from flying above 2,500 feet until up to 25 nautical miles south of Perth. This is approximately eight nautical miles (15 kilometres) further south from where they can currently climb up to a maximum height of 6,000 feet. Any proposal would also reduce the size of the training area, and safety mitigations would need to be considered and determined by Airservices and CASA after consultation with the general aviation community. There would also be an impact for aircraft departing to the east of Jandakot, as they would be restricted to 2,500 feet rather than the current 3,500 feet.

These restrictions would only apply to aircraft remaining outside Perth controlled airspace. If an aircraft has a flight plan to climb into controlled airspace, air traffic control will issue an airways clearance and provide further climb above these levels.

The RAAF has a restricted area located above 6,000 feet overhead the training area. It would not be known until the detailed airspace design stage if the arriving aircraft landing on the North Flow will require access to above 6,000 feet while on descent. If they do, negotiations with the Department of Defence will be required to seek an airspace solution.

Procedure design will be required to determine the exact volume of airspace that may be required; and there is the possibility that less than 25 nautical miles may be required, which will lessen the impact to the training area and RAAF restricted area. It may also be possible to reduce the lateral extent of the changes.

21.4.4.3 Need for Additional Airspace

There are a number of factors that need to be considered when deciding if additional controlled airspace will be required. Additional airspace would be required for Independent Instrument Approaches in IMC conditions as detailed in 21.4.1.3. Instrument approach conditions are experienced for approximately five percent of the time in Perth meaning that additional airspace would not be required for the other 95 percent of the time.

Technological advances and changes to the operating regulations as detailed in 21.4.1.4, will have progressed to a stage where alternative options are available with less demanding requirements for additional controlled airspace to support optimal operations. This would allow for independent approaches in IMC conditions between two RNP-AR equipped aircraft, or one RNP-AR equipped and one non RNP-AR equipped aircraft. Two non-equipped RNP-AR aircraft would need to be processed for dependent approaches as detailed in 21.4.1.5. Whilst this would not maximise the potential capacity at Perth Airport, it may be sufficient to process the traffic demand on day of opening with minimal delays. As the RNP-AR equipage rates rise with replacement aircraft, the airport capacity in Instrument Approach conditions will also rise.

Consultation with the Commonwealth, Jandakot Airport and users of the airspace to reach an agreed outcome for all parties will be undertaken should airspace changes be required. Any proposal for an airspace change must be submitted to CASA including a safety assessment and evidence of industry consultation as well as consideration of equity of access to airspace users.

As the airspace regulator, CASA will need to take into consideration amongst other things, safety, efficiency and equitable access, in assessing the final airspace change proposal supporting Perth Airport’s runway development plan. In deciding final airspace requirements in the Perth Basin, consideration of all operational requirements at civil and military airports in the Basin including Perth, Jandakot and Pearce will be required.

21.5 Cross Runway

The CONOPS showed that the continued use of the cross runway (06/24) once a parallel runway is operational would reduce the efficiency and overall runway capacity at Perth Airport, therefore negating the benefits of the new runway.

Consistent with the Master Plan 2014, Perth Airport is considering closing the cross runway (06/24) when the parallel runway is constructed and operational. An assessment of whether the cross runway will be required to accommodate aircraft operations, post commissioning of the parallel runway system, was completed. Among numerous other factors, this study principally looked at the impact on safety and usability of the parallel runway system if the cross runway was decommissioned. A large part of this assessment comprised analysis of weather including wind speed and direction, and the resulting crosswinds that could be expected on the parallel runways if no cross runway was available.

The internationally adopted standards are published in the ICAO Annex 14 – Aerodromes Volume 1 Aerodrome Design and Operations. Annex 14 states that the usability factor of a runway of an aerodrome is not less than 95 per cent for the aircraft that the aerodrome is intended to serve. (Usability factor is the percentage of time during which the use of a runway or system of runways is not restricted because of the crosswind component).

Usability of the main runway 03/21 and cross runway 06/24 direction in Perth was calculated for aircraft with maximum crosswind components of 10, 13 and 20 knots respectively. This was done by taking historical wind observation data from the Bureau of Meteorology since 01 May 1944 and calculating how many of these observations had a crosswind component (that is, a component perpendicular to the runway in excess of 20 knots). A key output from this process was that the cross wind on the parallel system is less than 20 knots for 98.9 per cent of the time. The majority of the aircraft fleet operating at Perth Airport have documented maximum crosswind limitations well above 20 knots. Therefore, per the ICAO standards, the cross runway is not required when the new runway (03R/21L) comes into operation.

The cross runway cannot be closed prior to the day of opening of the new runway and commencement of parallel operations. If the cross runway (06/24) remains open, it will only be used when the crosswind of the parallel runway system exceeds 20 knots.

The cross runway was closed for aerodrome works for a period of seven months in 2013-14, and for significant periods of time in 2016 and 2017 for runway works. During these closures, no diversions to alternate airports were required because of excessive crosswind.

Several factors will influence the decision to decommission the cross runway, including operating costs and consultation with aircraft operators and regulators. The final decision on the future of the cross runway is yet to be made and will require further consultation with airlines and Airservices.

21.6 Final Design

Airservices is the airspace and navigation service provider responsible for the final design and publication of air routes, and arrival and departure procedures, at Perth Airport. The final design is required to meet Airservices As Low As Reasonably Practicable (ALARP) risk principles for safety, traffic management and the environment and will need to be approved by CASA as Australia's airspace regulator.

The final airspace design generally commences three years prior to the introduction of any proposed flight path procedure or modes of operation for the parallel runway system, and will require extensive industry and community engagement by Airservices supported by Perth Airport. Prior to the final design an agreed operational plan will be developed by Airservices in consultation with the Department of Defence. It is expected that this will commence following the introduction of Pilatus PC-21 training aircraft at RAAF Base Pearce in 2019 and approval of this MDP.

To ensure that, as far as practical, the future detailed assessment does not present any unforeseen operational requirements or environment impacts, the design of the Airspace Management Plan has involved consultation with Airservices, the relevant regulators and the Department of Defence.

Changes to existing airspace architecture associated with the future operation of the NRP will require an airspace change approval under the *Airspace Act 2007* and Airspace Regulations 2007. The approval for this airspace change is required prior to the operation of the new runway, most likely a few years in advance of the planned runway opening date.

The final design is to be in accordance with applicable aviation safety standards under the *Civil Aviation Act 1988* and airspace management regulations under the *Airspace Act 2007*. Instrument flight Procedures are to be designed by a Civil Aviation Safety Regulation Part 173 certificated design organisation (of which Airservices is one). Procedures must be verified by CASA to ensure they are compliant with Part 173 prior to publication in the Aeronautical Information Publication (AIP).

Future developments, particularly in aircraft technology and navigation systems, may also necessitate changes to the proposed airspace operations. Any airspace changes would be addressed as part of the ongoing approval process. Increases in traffic levels may also impact aircraft operations and procedures, and may result in changes to the procedures used on the day of opening of the new runway. The MDP contains various approach procedures that may be used. Prior to day of opening, an assessment of factors, such as aircraft fitment of new technology, will be made and an analysis of the capacity versus demand will be undertaken. Even dependent approaches will provide more capacity than the current runways. However, if demand can be met by using a combination of dependent and independent procedures, there may be changes to the extent of new controlled airspace required.

As part of the airspace change-approval process, it is anticipated that a compliance report will be required to demonstrate that the design is in line with the Airspace Management Plan and that there is no material change to the impact assessment, as described in Section 22.

21.7 Future Change to Airspace

This MDP details the proposed, flight corridors and airspace changes anticipated for the day of opening of the NRP based on current procedures. After opening there may be changes that may impact flight paths and airspace just as there are changes made now to the current flight paths and procedures. There may also be changes required after opening due to changes in technology or in air traffic management rules.

The airspace change process is an existing process that is required to make changes to flight paths, airspace or procedures that involves widespread consultation and approval from the Office of Airspace Regulation within CASA. This process will continue to be applied, and will be used for any changes made to procedures at Perth Airport after the new runway opens.

22 Aircraft Noise

This section describes the changes to aircraft noise exposure resulting from operation of the New Runway Project (NRP).

Detail is also provided on the following areas:

- How is aircraft noise described and what are the methods used to communicate aircraft noise exposure to the public?
- What methodology was used to develop predicted aircraft noise exposure around the Perth metropolitan area?
- What is the expected change in levels of exposure to aircraft noise around the Perth metropolitan area with the new runway operational?

22.1 Introduction

Noise from aircraft approaching and departing Perth Airport and from their operations on the airfield is an unavoidable impact from the provision of critical and safe air services. From time to time, aircraft from Perth Airport – as well as Jandakot Airport and the Royal Australian Air Force's (RAAF) Base Pearce – will fly over most of the Perth metropolitan region.

The New Runway Project (NRP) will change the distribution of aircraft noise around Perth Airport and cater for future aircraft traffic growth.

Perth Airport works with Airservices Australia, government and industries to manage the impact of aircraft noise on surrounding communities. This section provides an assessment of the aircraft noise changes resulting from the operation of the new runway as part of a parallel runway system.

22.2 Key Findings

Key findings from the assessment of aircraft noise resulting from operations on the new runway include:

- The changes to flight paths and airspace will result in a reduction in the number of noise events for some areas, an increase in noise events for other areas, and some newly impacted areas.
- On opening, operation of the new runway will improve the noise environment for many people exposed to aircraft noise, especially in the evening and night time periods, due to the spreading of aircraft movements across the parallel runway system.
- Areas to the east and south/south-east of the airport are the most likely to experience an increase in aircraft noise events or be newly affected by aircraft noise events. Areas to the west and south-west are the most likely to experience a decrease in aircraft noise events, on day of opening, but this is expected to grow again as traffic grows.
- The levels of vibration due to the highest expected aircraft noise levels are well below those which may cause structural damage to buildings. However, they may result in secondary sound generation from loose windows and other building elements in areas close to the airport boundary.

22.3 Policy and Legislative Framework

The NRP is a major airport development that will change the distribution or volume of aircraft noise, therefore the *Airports Act 1996* (Airports Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) require a Major Development Plan (MDP) to be prepared for approval.

The requirements for a MDP are contained in Section 91 of the Airports Act and those specific to aircraft noise exposure include:

(1) A major development plan or a draft of such a plan, must set out:

(e) if the development could affect noise exposure levels at the airport—the effect that the development would be likely to have on those levels; and

(ea) if the development could affect flight paths at the airport—the effect that the development would be likely to have on those flight paths; and

(f) the airport-lessee company's plans, developed following consultation with the airlines that use the airport, local government bodies in the vicinity of the airport and—if the airport is a joint user airport—the Defence Department, for managing aircraft noise intrusion in areas forecast to be subject to exposure above the significant ANEF levels; and

(h) the airport-lessee company's assessment of the environmental impacts that might reasonably be expected to be associated with the development; and

(j) the airport-lessee company's plans for dealing with the environmental impacts mentioned in paragraph (h) (including plans for ameliorating or preventing environmental impacts)

(6) In developing plans referred to in paragraph (l)(f), an airport-lessee company must have regard to Australian Standard AS 2021—2000 ("Acoustics—Aircraft noise intrusion—Building siting and construction") as in force or existing at that time.

Figure 22-1 Indicative A-weighted decibel noise levels in typical situations
Source: Wilkinson Murray

22.4 Aircraft Noise Descriptors

22.4.1 Noise Levels

The volume (loudness) of a sound depends on its sound-pressure level, which is expressed in decibels (dB). For measurement purposes, A-weighted decibels (dBA) are generally used because they take into account varying sensitivity of the human ear to different frequencies of sound.

Most sounds we hear in our daily lives have sound-pressure levels in the range of 30 dBA and 90 dBA. The daytime sound level in a typical home is about 40 dBA and the average noise level of conversation is about 60-65 dBA.

The typical levels for listening to music at home are about 70-75 dBA, and in a public hotel 80-90 dBA. A loud rock concert would produce noise levels of about 110 dBA.

Figure 22-1 shows indicative A-weighted decibel (dBA) noise levels for a range of typical situations that many would be familiar with. For noise sources where distance is relevant, such as a jet aircraft arrival, it shows how far away the measurement was taken from.

Two to three decibels is the minimum change in sound level that most people can detect, while every ten dBA increase in sound level is perceived as a doubling of loudness as highlighted in Figure 22-2.

Additionally, individuals may perceive the same sound differently and may be more or less affected by a particular sound. Experience has shown that many factors can influence an individual's response to aircraft noise, including:

- the specific characteristics of the noise (e.g. the frequency, intensity and duration of noise events) and the time of day noise events occur,
- background noise levels, and whether background noise is natural, industrial, desirable (eg. bird song) or undesirable (eg. road traffic),
- their personal circumstances and expectations about the number, frequency, loudness and timing of noise events,
- their individual sensitivities and lifestyle (e.g. whether they spend a lot of time outdoors or sleep with a window open),
- their reaction to a new noise source (in the case of a new airport or new runway) or to changed airport operational procedures,
- their understanding of whether the noise is avoidable and their notions of fairness, and
- their attitudes towards the source of the noise (e.g. general views about aviation activities and airports).

22.4.2 Descriptors of Aircraft Noise

A range of metrics are available to describe the level of aircraft noise in an area, each being useful for a different purpose. Those relevant for an assessment of aircraft noise associated with airport infrastructure and airspace change, are described in the sections below.

22.4.2.1 Australian Noise Exposure Forecast

For land-use planning in Australia, the accepted metric for aircraft noise exposure is the Australian Noise Exposure Forecast (ANEF). The ANEF is a forecast of future aircraft noise exposure and shows the concentration of noise around a particular airport. The ANEF is endorsed by Airservices and based on the:

- expected aircraft movement numbers,
- types of aircraft,
- daily distribution by time period of arrivals and departures,
- configuration of the runways, and
- arrival and departure tracks flown, along with ascent and decent profiles.

An ANEF chart is a set of land-use planning contours for a specific airport which has been formally endorsed for technical accuracy by Airservices. The production of an ANEF chart for all major airports is a requirement of the Airports Act. The 2014 ANEF, which was endorsed as part of Master Plan 2014, was the current ANEF at the time this MDP was developed. Since that time a new ANEF has been developed which can be found within Master Plan 2020. Further information on both the 2014 and 2020 ANEF and consistency of the NRP with these contours is provided in Section 22.5.4.4.

The ANEF contours do not refer to normal decibel levels. ANEF contours are calculated from the effective perceived noise level in decibels (EPNdB) for each operation occurring at an airport. The EPNdB accounts for characteristics which affect the noise of aircraft. ANEF contours also consider the cumulative nature of noise exposure in addition to weighting night-time operations to account for people's increased sensitivity to noise at night.

The ANEF unit was developed on the basis of social survey data and is correlated with the proportion of people who would describe

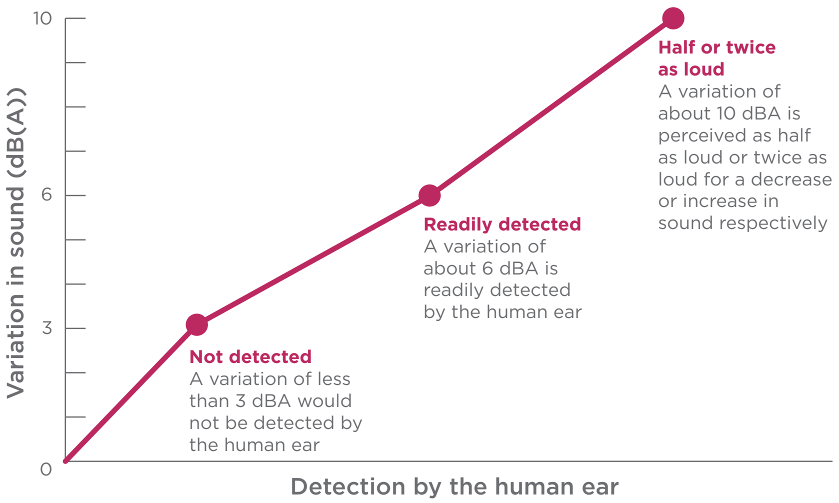


Figure 22-2 Perception of variation in sound levels
Source: Perth Airport

themselves as 'seriously affected' by the noise. The relationship between ANEF values and the proportion of people seriously affected by the noise is shown in Figure 22-3.

The ANEF was developed from a study of reactions in areas with long-established aircraft noise. Previous assessments of aircraft noise in Australia have demonstrated that the ANEF and the response function presented in Figure 22-3 do not adequately describe peoples' reactions to a change in aircraft noise, such as that associated with a new runway or airspace design.

The ANEF definition is complex and, as a single-number index, it does not provide the level of information generally sought by interested members of the public.

For these reasons, the ANEF is limited in its applicability to an assessment of changing aircraft noise levels and is thus used primarily to assess land-use planning implications of the NRP.

Australian Standard 2021:2015 Acoustics – Aircraft noise intrusion – Building siting and construction (AS2021) provides guidance on the acceptability of various areas near airports for certain types of development, based on the ANEF level in the area. For example, residential development is considered 'acceptable' in areas with ANEF lower than 20, 'conditionally acceptable' in areas with ANEF between 20 and 25 and 'unacceptable' in areas with ANEF greater than 25. In conditionally acceptable areas, AS2021 recommends that new buildings should incorporate acoustic treatment to achieve specified internal noise levels. The building-type acceptability for ANEF zones is shown in Table 22-1.

The relationship between ANEF values and the proportion of people seriously affected by aircraft noise is useful as one of a number of tools for assessing the impact of noise exposure.

Contours which are calculated using the same methods as ANEF contours, but which have not been formally endorsed by Airservices, are known as Australian Noise Exposure Concept (ANEC) contours. Contours which are prepared for a previous year, based on actual usage data (rather than forecasts), are known as Australian Noise Exposure Index (ANEI) contours.

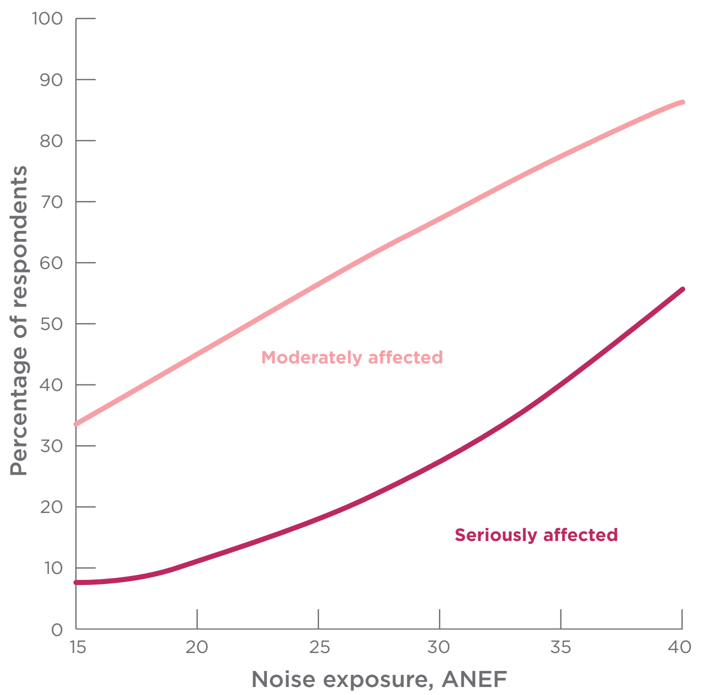


Figure 22-3 Relationship between Australian Noise Exposure Forecast and proportion of people affected by aircraft noise
Source: Australian Standard 2021:2015

Note: This graph was derived from the National Acoustic Laboratories Report No. 88

The assessment of future aircraft noise associated with the NRP presents ANEI contours for existing movements and ANEC contours for various future airport options.

22.4.2.2 Single event maximum noise levels (L_{Amax})

Single-event maximum noise-level (L_{Amax}) contours indicate the maximum noise level resulting from a single operation on a specific flight track. This type of assessment presents composite single event contours, indicating the outer envelope of L_{Amax} noise-level contours for aircraft operation on all possible tracks.

Internationally, aircraft noise is measured using slow (S) time-weighting. This means that the sound is measured over one second intervals, rather than a fast time-weighting that measured sound over 0.125 second intervals. Time-weighting is an international standard developed to ensure sound level meters are calibrated to a consistent measurement. Data based on S time-weighted measurements is used by the extensive databases and programming algorithms to determine aircraft noise exposure levels. Aircraft noise measurements and assessments in Australia use S time-weighting.

L_{Amax} noise levels using S time-weighting are used in the calculation of N-above metrics, described below.

22.4.2.3 N-above contours

Aircraft noise exposure can be described by the number of noise events above a threshold level. These metrics are referred to as Number Above contours, or N-above, contours, and describe the nature of aircraft noise exposure at any point.

They show the number of times that a sound level, e.g. 65 dBA, is exceeded. Figures in this section show these as colour-coded contours so that the distribution of aircraft noise can easily be seen. The level of detail is intended to allow communities and individuals to better understand the likely impact of the noise.

The N-above system of describing aircraft noise was developed through industry and community consultation by the then Commonwealth Department of Infrastructure and Regional Development now Commonwealth Department of Infrastructure, Regional Development and Cities (DIRDC). It is described in the discussion paper Expanding Ways to Describe and Assess Aircraft Noise (DoIRD, 2000).

The use of N-above contours to communicate and assess aircraft noise exposure is outlined by the National Airports Safeguarding Framework (NASF) Guideline A prepared by the National Airports Safeguarding Advisory Group (NASAG) in 2016 and Standards Australia Handbook SB HB 149:2016 Acoustics—Guidance on producing information on aircraft noise.

The most commonly-used noise descriptor in this system is N70, i.e the number (N) of aircraft noise events per day exceeding 70 dBA.

A noise level of 70 dBA outside a building will generally result in an internal noise level of approximately 60 dBA, if windows are open to a normal extent. This noise level is sufficient to disturb conversation, in that a person speaking will generally need to raise their voice to be understood. An internal aircraft noise level of 60 dBA (i.e. an external level of 70 dBA) is likely to cause some words to be missed in speech from a television or radio. N70 values therefore indicate the average number of times per day when such events would occur.

If external windows are closed (providing greater noise attenuation through the façade) an internal noise level of 60 dBA would be experienced when the external noise level is approximately 80 dBA. For a listener outside, who is receiving no noise attenuation from a building, the described effects would be experienced with an external aircraft noise level of approximately 80 dBA.

Perth Airport recognises that Perth residents enjoy an outdoor lifestyle, supported by a mild climate, and an abundance of warm weather and sunshine during the summer months. As a result, Perth Airport has historically adopted N65 contours (i.e. the number of aircraft noise events exceeding 65 dBA per day) in preference of N70. This is a conservative approach compared to other Australian airports to account for the anticipated prevalence of outdoor living.

For assessment of night-time noise impacts, it is customary to consider N60 values.

The N60 describes the number of events exceeding 60 dBA external to a building, which would typically result in a maximum noise level of 50 dBA within a building having windows open to a normal extent. If this were the case in a room where a person is sleeping, a 50 dBA maximum noise level is considered to be close to the point at which noise may cause awakening. At 50 dBA L_{Amax} (or equivalent noise level in an alternate metric) approximately three per cent of aircraft noise events have been found to cause awakenings in field trials. Therefore, N60 is considered to reasonably describe the number of events which may in some circumstances cause sleep disturbance.

N-above contours can be calculated for different periods, indicating the average number of events experienced per day in that period.

For the assessment of aircraft noise from the new runway, N65 and N60 contours have been calculated.

N-above contours are presented for five or more events per period. This threshold is adopted because it represents a level above which aircraft noise would be considered a regular feature of the noise environment (i.e. five events per day). N-above values of five or more are considered appropriate for describing aircraft noise in areas that currently experience aircraft noise, as well as areas which would be newly affected. Furthermore, they provide sufficient resolution to describe the change in aircraft noise for both existing and newly exposed areas.

It is acknowledged that the adopted thresholds are lower than those suggested for describing existing aircraft noise by National Airports Safeguarding Framework Guideline A, which is

- N70 24hr=20 events per day,
- N65 24hr=50 events per day,
- N60 24hr=100 events per day, and
- N60 night=6 events per night.

Building type	Forecast noise exposure level (ANEF)		
	Acceptable	Conditionally acceptable	Unacceptable
House, home, unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF	20 to 25 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 30 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF zones		

Table 22-1 Building site acceptability table based on Australian Noise Exposure Forecast zones
Source: Australian Standard 2021:2015

Notwithstanding this, the purpose of this assessment differs from those guidelines and ultimately benefits from the greater resolution with which aircraft noise exposure is described.

N-above values for future scenarios have been calculated based on application of 'busy' weekday and 'busy' weekend schedules (90th percentile weekday and weekend day), described further in Section 22.4.2.4

22.4.2.4 Typical busy day N-above contours

Like many noise metrics, one disadvantage of N-above contours is that some information is obscured by the use of averages, e.g. annual and seasonal averages. This is apparent when airport infrastructure and operating modes dictate that some areas are overflown only occasionally.

The concept of a 'typical busy day' is therefore used to describe a busy day from the perspective of a receiver on the ground.

The production of a typical busy day N-above diagram is achieved by calculating the 90th percentile of the N-above values across the assessment period. That is, the typical busy day N-above describes the N-above value exceeded on ten per cent of days (or one in ten days).

The percentile N-above metric is designated with the form $NX_{(90)}65$, where 90 refers to the percentile (i.e. the highest ten per cent of days or about 36 days a year) and the 65 refers to the noise level threshold (in dBA).

Typical busy day N65 and N60 contours are shown on all future N-above drawings within this section.

22.4.2.5 Summary of aircraft noise metrics

The impact of aircraft noise is dependent on a number of factors, four of the most important are:

- aircraft noise levels,
- frequency of occurrence of aircraft noise events/number of events,
- duration of aircraft noise events, and
- the character of aircraft noise (e.g. low frequency noise).

Table 22-2 demonstrates which of these factors are incorporated into the aircraft noise metrics used in this assessment.

The ANEF and ANEC metrics consider each of the four factors and were developed from social surveys of annoyance around airfields. However, none of these key factors can be derived from the ANEF itself. As such it fails to effectively communicate the real-world experience of aircraft noise.

N-above charts describe the number of events exceeding the nominated noise-level threshold, e.g. 60 dBA. This threshold represents a level above which impacts would be expected (e.g. conversation interrupted) and therefore may more effectively communicate the real-world impacts of aircraft noise. However, N65 and N60 metrics do not necessarily describe the extent of emergence above the threshold noise level. They can therefore be ineffective in communicating high noise levels such as those experienced in close proximity to airfields. A limitation of N-above contours relates to the averaging across extended periods (seasonally or annually).

Typical busy day N-above charts are useful in communicating the number of events above a threshold during periods of aircraft activity in an area. When combined with respite diagrams, which show the percentage of days when little or no aircraft noise events are expected, they provide the most informative combination of metrics for non-technical audiences.

The equivalent continuous sound level (L_{Aeq}) measure is sometimes used to describe aircraft noise, in which case it refers to the noise level that is due to aircraft only, excluding other noise. This has little benefit in communicating aircraft noise as it does not include surrounding noise levels. L_{Aeq} is generally used to describe continuous ambient sound levels.

Although L_{Amax} is effective in communicating the noise level of aircraft events, it does not communicate any other information about aircraft noise. It is only useful when combined with supplementary information such as N-above or flight zone.

Furthermore, for most airfields L_{Amax} for many operations, tracks and aircraft would be needed. Summation of all this information is difficult, making L_{Amax} impractical as a means of wholly describing aircraft noise.

Based on the above, the assessment of impacts should consider a variety of these metrics.

All the above indicators of noise impact are therefore included in this assessment. However, due to the number of scenarios and time periods involved, some indicators are presented only for the more important or relevant cases.

22.4.3 Time Periods

The ANEF system defines two periods: 7.00 am to 7.00 pm and 7.00 pm to 7.00 am.

Noise during the 7.00 pm to 7.00 am period is weighted by a penalty of six decibels to account for increased sensitivity during the ANEF 'evening/night' period. These standard time periods for the calculation of ANEF related metrics ANEI and ANEC are adopted here. However, it is common practice to communicate aircraft noise in different time periods to the ANEF system.

For the purpose of this assessment, N-above contours and flight paths are presented for the:

- full 24-hour period,
- day period (6.00 am to 7.00 pm),
- evening period (7.00 pm to 11.00 pm), and
- night period (11.00 pm to 6.00 am).

Factor described by Noise Metric? Noise Metric:	Aircraft noise levels	Number of events	Duration of events	Aircraft noise character
ANEF / ANEC / ANEI	*Yes* ANEF is dependent on the noise level of aircraft though the noise level of aircraft cannot be deduced from the ANEF itself.	*Yes* ANEF is dependent on the number of aircraft noise events though the number of events cannot be deduced from the ANEF itself.	*Yes* ANEF is dependent on the duration of aircraft noise events though the duration of events cannot be deduced from the ANEF itself.	*Yes* ANEF is based on the effective perceived noise level which includes adjustments for annoying characteristics of aircraft noise.
N-above	*Partially* N-above charts consider events over a threshold level (e.g. 65 dBA) but do not consider the actual noise level of these events (i.e. the intrusion above 65 dBA is ignored). The inclusion of multiple thresholds, makes the consideration of level more comprehensive.	*Yes* N-above charts consider the number of events over a threshold level, but are averaged over a season or year.	*No*	*No*
Typical Busy Day N-above	*Partially* N-above charts consider events over a threshold level (e.g. 65 dBA) but do not consider the actual noise level of these events (i.e. the intrusion above 65 dBA is ignored).	*Yes* Typical busy day N-above charts communicate the N-above exceeded by a small percentage of days (in this assessment ten per cent of days).	*No*	*No*
L_{Aeq} (Equivalent continuous sound level)	*Yes* L_{Aeq} is dependent on the noise level of aircraft though the noise level of aircraft cannot be deduced from the L_{Aeq} itself.	*Yes* L_{Aeq} is dependent on the number of aircraft noise events though the number of events cannot be deduced from the L_{Aeq} itself.	*Yes* L_{Aeq} is dependent on the duration of aircraft noise events though the duration of events cannot be deduced from the L_{Aeq} itself.	*No*
Single Event Maximum Noise Level (L_{Amax})	*Yes* The L_{Amax} represents the maximum noise level from a single aircraft operation.	*No*	*No*	*No*
'Flight zone' diagrams	*No*	*Yes*	*No*	*No*

Table 22-2 Comparison of aircraft noise metrics
Source: Wilkinson Murray

22.5 Aircraft Noise Management at Perth Airport

22.5.1 Aircraft Noise Management

Perth Airport works to actively manage aircraft noise exposure and its effect on the community while balancing the need for critical and safe air services. This has the benefits of:

- enabling the community to make informed decisions about aircraft noise exposure on their lives,
- providing guidance to achieving appropriate land-use outcomes around the airport,
- managing, mitigating and, where possible, working towards reducing the impacts of aircraft noise, and
- protecting Perth Airport's 24-hour seven-days-a-week operations.

Perth Airport has adopted the International Civil Aviation Organization's (ICAO) 'balanced approach' to aircraft noise management for managing noise in the vicinity of the airport. This involves identifying an airport's noise issue and then analysing the various measures available to reduce noise. The four principal elements of the ICAO balanced approach are:

- reduction of noise at source,
- land-use planning and management,
- noise-abatement operational procedures, and
- operating restrictions.

22.5.1.1 Roles and responsibilities

Perth Airport only has some control over the management of ground-based aircraft noise.

Airservices is responsible for managing the airspace around Perth Airport, including designing flight paths that are safe, efficient and minimise noise impacts on the community as far as is possible. The Civil Aviation Safety Authority (CASA) is responsible for the administration and regulation of Australian-administered airspace under the *Airspace Act 2007*

The management of aircraft noise is the responsibility of several organisations. Perth Airport is committed to working with Airservices, airlines, Commonwealth, State and Local Governments to identify opportunities for improvement.

The range of organisations and groups with roles and responsibilities in relation to aircraft noise management is provided in Table 22-3.

22.5.1.2 Aircraft Noise Management Strategy

The framework includes community consultation and engagement, and appropriate infrastructure planning as principal elements.

Perth Airport's commitment to managing aircraft noise is guided by the Aircraft Noise Management Framework (ANMF) as shown in Figure 22-4. This framework takes into account aircraft taking off, departing, approaching, landing and manoeuvring on the airfield, including engine testing, within the airport site.

This framework includes six key themes that guides Perth Airport's effective management of the impacts of aircraft noise on surrounding communities.

Theme 1 - Identify Opportunities

Work with Airservices, aircraft operators, industry stakeholders and the community to identify opportunities for improvement and achieve better outcomes where possible.

Between 2010-2015, Airservices considered more than 30 proposed noise improvement opportunities for the greater Perth area. These proposals came from a variety of sources, such as Airservices internal analysis, the Aircraft Noise Ombudsman, aviation industry and community feedback. As a result, ten changes have been implemented, including two pertaining to Jandakot Airport. The remaining proposals were either not found to be noise improvements or were unable to be safely implemented.

Each initiative is assessed first and foremost for its impact on safety. If there are no safety implications, further assessment determines whether it provides an overall benefit to the Perth community. For example, a change may be considered if it exposes a smaller number of people to noise but not if it merely moves the noise from one group to another of a similar size.

A proposal may also be unworkable because of airspace constraints. An example of this is the proximity of RAAF Base Pearce's restricted areas preventing a route to be moved further north.

Where an initiative is deemed to provide an improvement for the community, a trial of the procedure may be conducted to verify the initial findings. This involves advertising and widespread consultation with all stakeholders, including the community.

The results of the trial, including community feedback, are assessed and a decision made on whether to permanently implement the procedure or discard it.

If implemented, a post-implementation review is usually conducted to verify the success of the change.

An example of an introduced improvement was for departures to the west of Perth (to destinations such as Africa and the Middle-East).

When departing to the north, in order to avoid RAAF Base Pearce airspace, aircraft turn to the west, tracking over populated suburbs such as Beechboro and Noranda. But when RAAF Base Pearce is inactive (generally during the hours of darkness) there is no requirement to turn left.

A procedure to allow aircraft to fly further north over less populated areas such as Whiteman Park was trialled; following a post-implementation review the procedure became permanent. The noise improvement to the community was assessed to be the higher priority even though the procedure involves aircraft flying additional miles with extra fuel costs.

Organisation / Groups	Roles and Responsibilities
International Civil Aviation Organization (ICAO)	• establishes strict noise-certification standards for new aircraft • provides guidance on noise-management strategy • Australia is a member state of ICAO
Civil Aviation Safety Authority (CASA)	• independent statutory authority with responsibility for regulation of civil aviation operations in Australia • provides overriding consideration to air safety • responsible for airspace regulation through the Office of Airspace Regulation
Department of Infrastructure, Transport, Regional Development and Communications (DITRDC)	• advises the Commonwealth Government on the policy and regulatory framework for Australian airports and the aviation industry • provides policy advice to the Minister on the management of aircraft noise • provides regulatory oversight of the Air Navigation (Aircraft Noise) Regulations 1984, including their applications to aircraft which do not meet Australian aircraft noise standards
Airservices Australia	• provides air traffic control services • manages and maintains aircraft navigation, surveillance, and noise monitoring infrastructure • establishes flight paths, including at Perth Airport • manages noise complaints and enquiries through the Noise Complaints and Information Service • provides information on aircraft movements, runway and flight path usage and noise impacts using a range of noise descriptors • conducts noise monitoring in communities surrounding Perth Airport • reviews and endorses the Perth Airport ANEF for technical accuracy • implements Noise Abatement Procedures • considers environmental impacts (including noise) of air traffic management
Airlines and aircraft operators	• operate and maintain aircraft that meet the ICAO noise certification requirements • implement Noise Abatement Procedures principles for flight operations
Aircraft Noise Ombudsman (ANO)	• oversees the handling of aircraft noise issues by Airservices and the Department of Defence • conducts independent reviews of noise complainants and complaint handling • makes recommendations for improvements and changes where necessary and feasible
State and Local government	• State Government develops land use planning frameworks to prevent developments that are inappropriate, having regard to aircraft noise • Local governments implement State Government land use planning frameworks
Perth Airport	• manages operations at the airport • develops and maintains infrastructure to support aircraft operations • publishes a Master Plan with an associated ANEF at least every five years • develops a management plan for managing aircraft noise intrusion in areas forecast to be subject to exposure above significant ANEF levels • applies an engine ground run management plan • engages with the Perth Airport Community Forum (PACF), Planning Coordination Forum (PCF), and the Perth Airport Aircraft Noise Technical Working Group (PAANTWG) and the broader community
Perth Airport Community Forum (PACF)	• works collaboratively to consider issues of importance to the community and airport in the context of recognising and enhancing: – the long-term sustainability and growth of Perth Airport – Perth Airport's role as a responsible corporate citizen within the local and broader community, and – Perth Airport's role as a major economic contributor for Western Australia
Planning Coordination Forum (PCF)	• supports effective engagement between Perth Airport and Commonwealth, State and Local government agencies on strategic planning issues, including land use and aircraft noise impacts
Perth Airport Aircraft Noise Technical Working Group (PAANTWG)	• enables industry to initiate and evaluate operational changes while ensuring that the noise impact of those changes is considered and opportunities to improve noise outcomes are explored

Table 22-3 Organisations responsible for aircraft noise management
Source: Perth Airport

Theme 2 - Land Use Planning

Facilitate change to land-use planning and a policy that directs inappropriate land uses away from the airport, while encouraging compatible land uses in the intervening areas to protect operational flexibility and 24/7 operations.

Perth Airport works with Airservices, CASA and Commonwealth, State and Local governments to coordinate land-use planning and management.

Perth Airport supports a 'push-pull' strategy. This means incompatible land uses - such as residential development - are directed away from areas that are, or will be, exposed to significant aircraft noise; while land uses that are less sensitive to aircraft noise, such as industrial developments - are encouraged in areas surrounding the airport estate.

Local government guidance regarding development in the vicinity of Perth Airport is provided by the State Planning Policy 5.1 Land Use Planning in the Vicinity of Perth Airport (detailed in Section 5). It adopts Perth Airport's ANEF contours to determine the acceptability of various development types within each of the ANEF contours. The intention is to restrict, or require building treatment, for noise-sensitive developments in areas forecast to be impacted by aircraft noise.

Perth Airport developed its first ANEF as part of the 1985 Master Plan, more than 30 years ago. Since that initial noise forecast which included the three runway system, the overall footprint of the noise exposure forecast is relatively the same.

An important point to recognise is that, since 1983, there has been considerable development and infill in and around Perth Airport. During that time the published ANEF referred to in each subsequent Master Plan every five years has not changed significantly as shown in Figure 22-5.

New or increased density residential development close to the airport, and in particular those areas located within an aircraft noise exposure level of greater than 20 ANEF, should not occur.

Theme 3 - Engage and Communicate

Engage and communicate with the community to ensure the community is informed, and that concerns and priorities are considered in guiding aircraft-noise-management outcomes.

Perth Airport is committed to ensuring the community is fully informed and that their concerns and priorities are considered in guiding aircraft-noise-management outcomes.

A key focus of this engagement is to communicate aircraft-noise information in an uncomplicated and easy-to-understand manner.

Perth Airport therefore provides a range of material to inform and engage the community about noise implications and flight paths. This includes the ANEF contours, Noise-above contours, published books on aircraft noise, and the online Aircraft Noise Informational Portal available at **perthairport.com.au/aircraftnoise**.

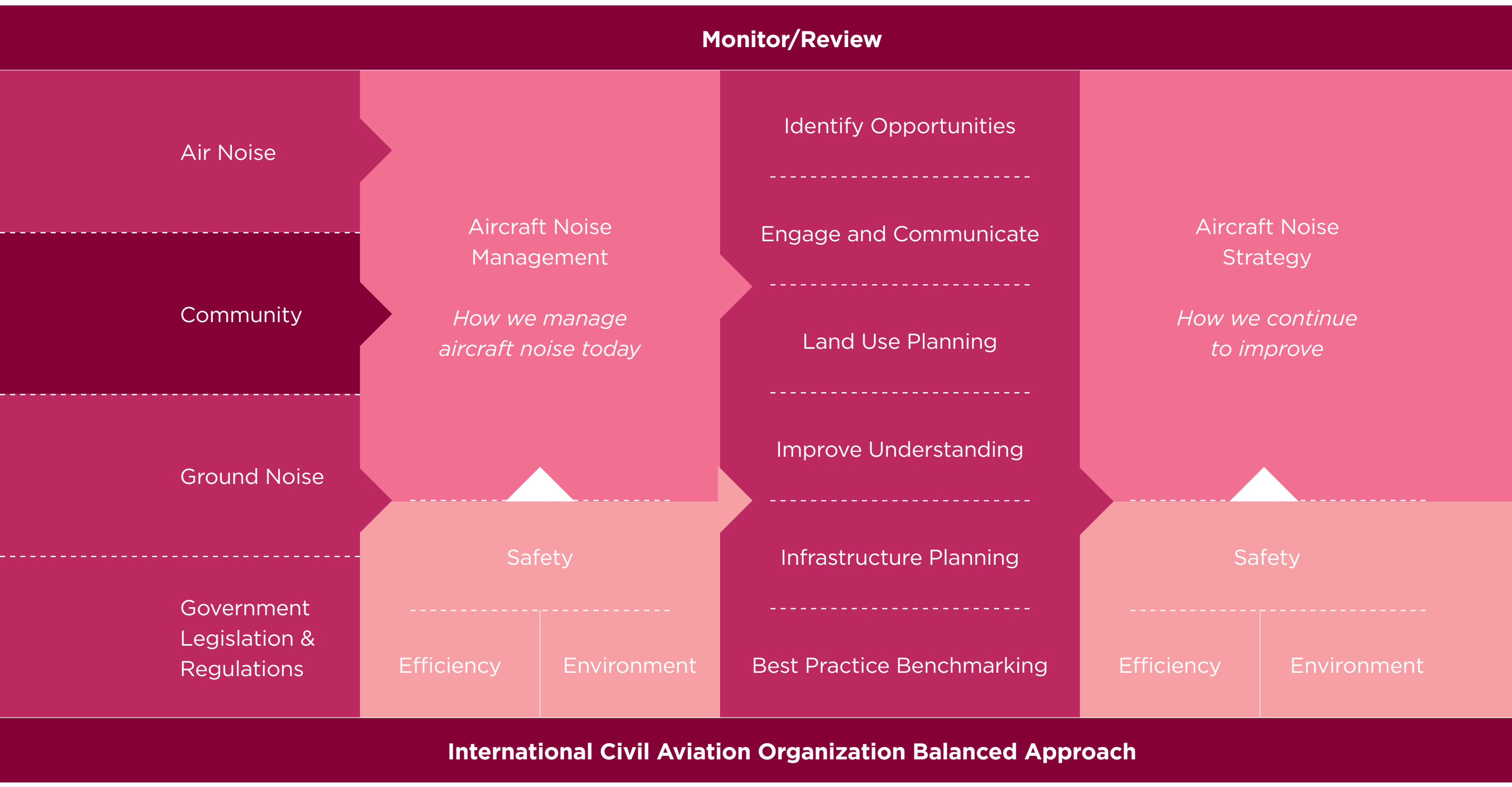


Figure 22-4 Perth Airport Aircraft Noise Management Framework
Source: Perth Airport

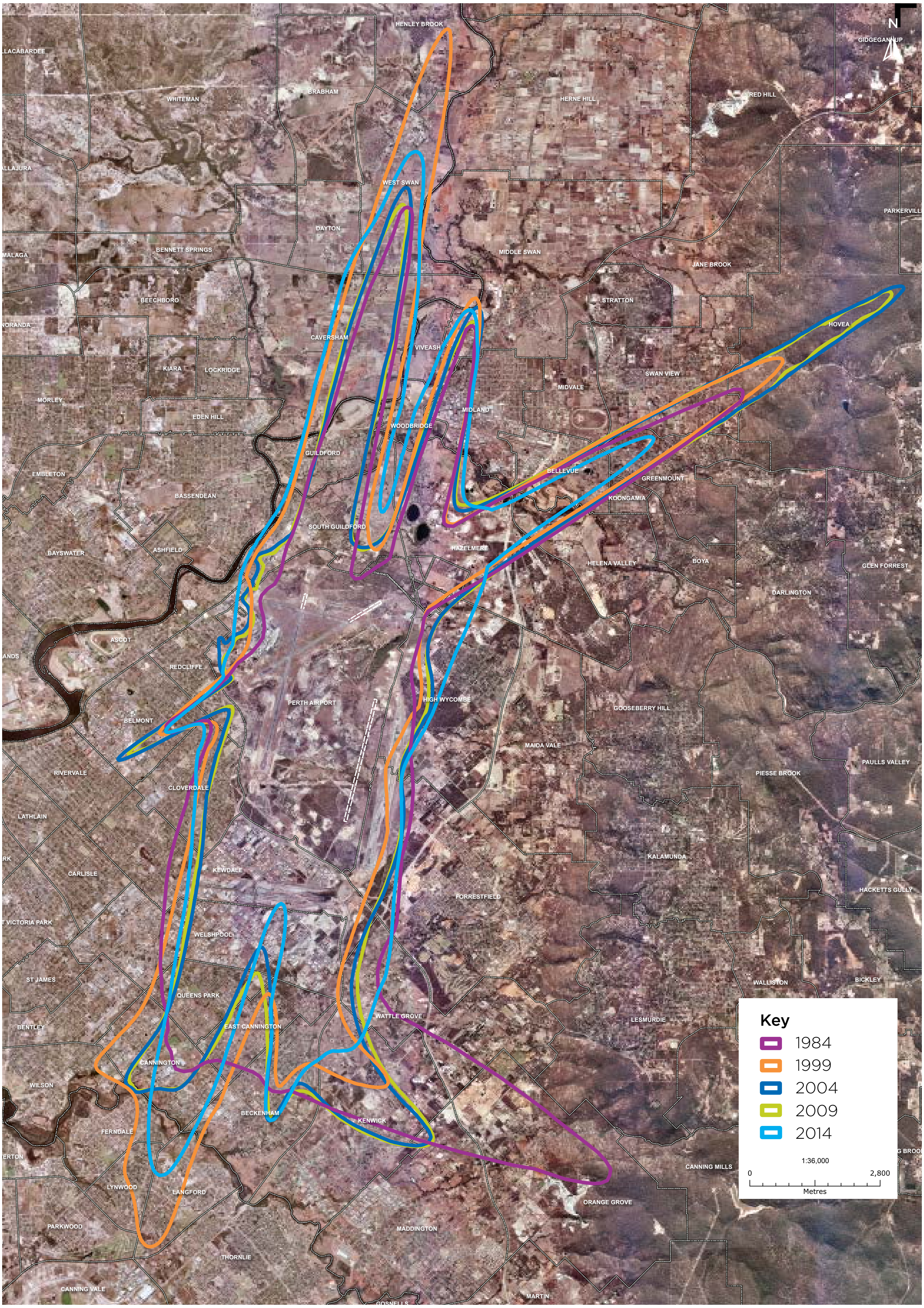


Figure 22-5 Comparison of Australian Noise Exposure Forecast 20 - 25 zone contours overlaid on 1983 Aerial Image
Source: Perth Airport

Since 2015, the Perth Airport ANEF and N65 Noise Above contours have been made available through State Landgate Property Interest Reports.

Section 7 of this MDP details Perth Airport's ongoing consultation and education mechanisms. They include:

- Planning Coordination Forum (PCF) to foster planning discussions with Commonwealth, State and Local governments
- Perth Airport Community Forum (PACF) which gives members of the public the opportunity to meet with representatives from Perth Airport
- guests such as Airservices and the Aircraft Noise Ombudsman.

In mid-2017, Perth Airport invited community members to participate in a number of focus groups to improve how information on flight paths and aircraft noise is presented. This has assisted Perth Airport to provide clear, concise and meaningful information which assists the community to make informed decisions. The information and illustrations presented in this MDP were prepared following this feedback.

Theme 4 - Improve Understanding

Continually seek to improve our understanding of aircraft noise and its impacts to ensure effective noise management.

Perth Airport continues to invest in understanding aircraft noise innovation, impacts and ways to engage and communicate. The development of this MDP has required a number of technical studies to assess the impact of the NRP. In addition to the noise modelling presented in this section, assessments have been undertaken for ground-based noise (Section 13), the impact of aircraft emissions on air quality and greenhouse gas (Sections 14 and 23) and the impact of aircraft noise on the social environment (Section 25).

Perth Airport also participates in a number of national forums and working groups focussed on aircraft noise.

Theme 5 - Infrastructure Planning

Apply best practice aircraft-noise-management practices where relevant in the development of new airport infrastructure, including through design and community consultation.

The design of the airport infrastructure, including runways, taxiways and engine run up facilities can impact on the aircraft exposure footprints around an airport. The design of the new runway and associated infrastructure has considered best practice aircraft noise management practices.

Designing flight paths for new infrastructure is a complicated process. Airservices designs flight paths through extensive consultation - often over many years - with airports, aircraft operators, government, CASA, and the local community.

The final flight paths for the parallel runway system will be designed by Airservices during the detailed design phase before the new runway opens. This phase also includes the development of air-traffic management procedures and noise abatement procedures. Opportunities to minimise noise impacts on communities will be considered in developing the final flight paths.

The *Airservices Act 1995* states that Airservices must make safety of air navigation its most important consideration. Subject to this, Airservices must perform its functions so that, as far as practicable, the environment is protected from the effects associated with the operation and use of aircraft. Consideration is given to approach and departure paths that minimise noise over residential areas, fuel consumption and emissions.

As outlined in Section 20 and 21, flight paths for Perth Airport are constrained by military airspace to the north, west and south, and Jandakot Airport airspace to the south. These constraints increase with the introduction of a new runway as new procedures are developed and existing procedures modified to facilitate parallel runway operations.

An Airspace Management Plan based on a preliminary airspace design has been completed by Perth Airport in consultation with Airservices and the Department of Defence. This is detailed in Section 21. In determining the proposed flight corridors for parallel runway operations, this review has considered current and emerging technologies to explore if there can be improved outcomes for implementation in the detailed design stage.

Theme 6 - Best Practice Benchmarking

Understand what best practice is, and learn lessons from other airports and industries on how to manage the impacts of aircraft noise and community engagement.

By participating in forums such as the PAANTWG and the National Industry Noise Forum, Perth Airport can discuss and consider aircraft noise-management initiatives both in Australia and at airports around the world.

A recent Australian initiative was led by Perth Airport and resulted in the publication of a booklet called 'Reducing Aircraft Noise in Existing Homes'. This provides information about practical modifications that can reduce noise levels and is available from **perthairport.com.au/aircraftnoise**.

22.5.1.3 Managing Aircraft Noise in Areas of Significant Australian Noise Exposure Forecast Levels

The Airports Act requires an MDP to provide plans (developed in consultation with airlines and local government bodies within the vicinity of the airport) for managing aircraft noise intrusion in areas forecast to be above the significant ANEF (30 ANEF) levels.

The Perth Airport Master Plan 2014 identifies that there are 107 houses in the South Guildford and Guildford area and six houses in the High

Wycombe area that sit within the 30 ANEF contour. The specific measures focused on areas within the 30 ANEF contour include land use control, described in Section 5, and noise abatement procedures, described in Section 20.

As the final flight path design for the new runway is undertaken, consideration will be given to the impacts on houses within the 30 ANEF contour.

22.5.2 Ambient Noise Environment Surrounding Perth Airport

The ambient noise environments surrounding Perth Airport range from urban environments (such as the Perth CBD) to rural environments that are largely removed from man-made noise.

The information below is useful in understanding aircraft noise levels, especially metrics like N60 and N65 which describe the number of daily events above 60 dBA and 65 dBA thresholds respectively.

Table 22-4 adapts Appendix A of Australian Standard AS 1055.2-1997 Acoustics-Description and measurement of environmental noise.

22.5.3 Describing How Aircraft Noise is Experienced

The subjective prominence of aircraft noise events is partly dependent on how much louder the aircraft noise sounds (emergence) than the previous level of background noise environment.

Table 22-5 provides descriptions of the subjective noise level for 60 dBA and 65 dBA aircraft noise events with reference to many of the ambient noise environments described in Table 22-4.

Description of Area	Description of Typical Noise Sources	Average Background A-weighted Noise Level, $L_{A90,T}$ (Indicative Ambient L_{Aeq} in brackets)		
		7am – 6pm	6pm – 10pm	10pm – 7am
Areas with negligible transportation or industry. Likely described as rural.	Natural sound such as wind in trees and wildlife.	40 (45)	35 (40)	30 (35)
Areas with low density transportation and negligible commerce or industry. Likely described as rural, perhaps with rural residential areas. May be representative of quiet suburban areas with limited exposure to transportation noise.	Natural sounds, distant or occasional transportation noise.	45 (50)	40 (45)	35 (40)
Areas with medium density transportation or some commerce or industry. Representative of many suburban areas.	Nearby and regular transportation noise.	50 (55)	45 (50)	40 (45)
Areas with dense transportation or some commerce or industry. Representative of many urban centres.	Nearby and constant transportation noise. Possible mechanical plant noise from urban centres of industry. Generic urban hum.	55 (60)	50 (55)	45 (50)
Areas with very dense transportation or in commercial districts or bordering industrial districts.	Nearby busy transportation infrastructure such as a freeway or urban rail line.	60 (65)	55 (60)	50 (55)
Areas with extremely dense transportation or within predominantly industrial districts.	Noise from adjoining busy transportation infrastructure. Industrial sources.	65 (70)	60 (65)	55 (60)

Table 22-4 Estimated average background and ambient noise levels
Source: Wilkinson Murray

Notes: 1. Adapted from Appendix A of Australian Standard AS 1055.2-1997 Acoustics-Description and measurement of environmental noise.
2. Much lower noise levels are possible in rural areas when natural sounds are low, such as periods with little wind and infrequent wildlife noise.

Ambient Noise Level (L_{Aeq} dBA)	Likely Environment(s)	Aircraft Noise Level (L_{Amax} dBA)	Emergence (dBA)	Description
45 or less	Areas with negligible transportation or industry. Likely described as rural.	60	20 or more	Finite aircraft noise events of 60 dBA would be prominent above the ambient noise level. Subjectively it is likely to be perceived as more than twice as loud as ambient noise.
		65	25 or more	Finite aircraft noise events of 65 dBA would be prominent above the ambient noise level. Subjectively it is likely to be perceived as more than twice as loud as ambient noise.
50	Areas with low density transportation and negligible commerce or industry. Likely described as rural, perhaps with rural residential areas. May be representative of quiet suburban areas with limited exposure to transportation noise.	60	10	Finite aircraft noise events of 60 dBA would be prominent above the ambient noise level. Subjectively it is likely to be perceived as twice as loud as ambient noise of 50 dBA.
		65	15	Finite aircraft noise events of 65 dBA would be prominent above the ambient noise level. Subjectively it is likely to be perceived as more than twice as loud as ambient noise.
60	Areas with dense transportation or some commerce or industry. Representative of many urban centres. Examples: Around 200 metres to Great Eastern Highway, Roe Highway or Kwinana Freeway Near (approximately 100 metres) to sub-arterial roads.	60	Nil	Finite aircraft noise events of 60 dBA would be heard at a similar level to ambient noise and is likely to be audible.
		65	5	Finite aircraft noise events of 65 dBA would be prominent above the ambient noise level. Subjectively it is likely to be perceived as noticeably louder than ambient noise of 60 dBA.
65	Areas with very dense transportation or in commercial districts or bordering industrial districts. Examples: Near (approximately 100 metres) to freeways Very near (approximately 50 metres) to sub-arterial roads	60	-5	Finite aircraft noise events of 60 dBA would be partially masked by the ambient but is likely to be audible to an attentive listener.
		65	Nil	Finite aircraft noise events of 65 dBA would be heard at a slightly louder level than ambient noise.
70	Areas with extremely dense transportation or within predominantly industrial districts. Examples: Very near approximately 50 metres to freeways	60	-10	Finite aircraft noise events of 60 dBA would be largely masked by the ambient and is likely to be inaudible.
		65	-5	Finite aircraft noise events of 65 dBA would be heard at a similar level to ambient noise and is likely to be audible.

Table 22-5 Subjective description of aircraft noise levels relative to the ambient noise level
Source: Wilkinson Murray

22.5.4 Existing Aircraft Operations and Noise Emissions

This section presents an overview of existing aircraft operations and noise emissions at Perth Airport. Existing operations have been modelled based on the data for calendar year 2016.

22.5.4.1 Runway Usage

Figure 22-6 presents a summary of the runway usage based on 2016 data. The data shows minimal use of runway 06 (western end of cross runway) for arrivals and runway 24 (eastern end of cross runway) for departures.

22.5.4.2 Flight Paths

Section 20 outlines the current flight paths that are used at Perth Airport.

Although aircraft differ in operation, type, altitude, noise level and frequency, most areas of the greater Perth Basin are overflown at some stage.

22.5.4.3 2016 N-Above Noise Contours

N60 and N65 noise contours have been produced for 2016 and are useful in describing current aircraft noise. These plans are based on the 2016 data and are useful in describing the current aircraft noise exposure from Perth Airport.

These represent the predicted annual average number of movements per day with maximum noise levels (L_{Amax}) exceeding the threshold (60 or 65 dBA). Because the numbers are over a year, the number on a particular day can be much higher or lower than the average. To allow lower level exposure to be better understood, N-above contours show five events per day (e.g. N65=5). This is consistent with previous similar assessments in Australia and exceeds some contemporary guidelines for communicating aircraft noise (e.g. NASF Guideline A).

In general, the noise contours follow the tracks of the aircraft when they are landing and taking off. The prevalence of arrivals onto runway 24 (south-westerly direction) is evident in the contours, with the N65=5 extending more than 30 kilometres from the runway in this direction. Arrivals onto runway 03 (northerly direction) from the east are quite prevalent (the N65=5 extending over 25 kilometres from the runway in this direction, 20 kilometres direct).

Separated contours (or apparent islands) are possible in N-above contours and usually a consequence of elevated terrain. In Figure 22-7 one example exists north-east of the airport about the 20-kilometre radius.

Figure 22-7 presents the 2016 weekday N65 for a 24-hour period, Figure 22-8 presents the 2016 weekend N65 for a 24-hour period and Figure 22-9 shows a 2016 average 24-hour period.

Figure 22-10, Figure 22-11 and Figure 22-12 present the 2016 night (11.00 pm to 6.00 am) N60 for an average night, weekday night and weekend night respectively.

The night time N-above contours extend along the flight tracks in each direction. The contours reflect the minimal use of arrivals onto runway 06 and departures off runway 24.

Fewer flights occur on weekends, which is evident in both the 24-hour N65 and night N60 contours. However, the general pattern is similar between weekday and weekend.

The most notable difference occurs in the N60=5 night contours; the weekend N60=5 contour does not extend east toward the Swan River over Shelley and Salter Point and surrounds.

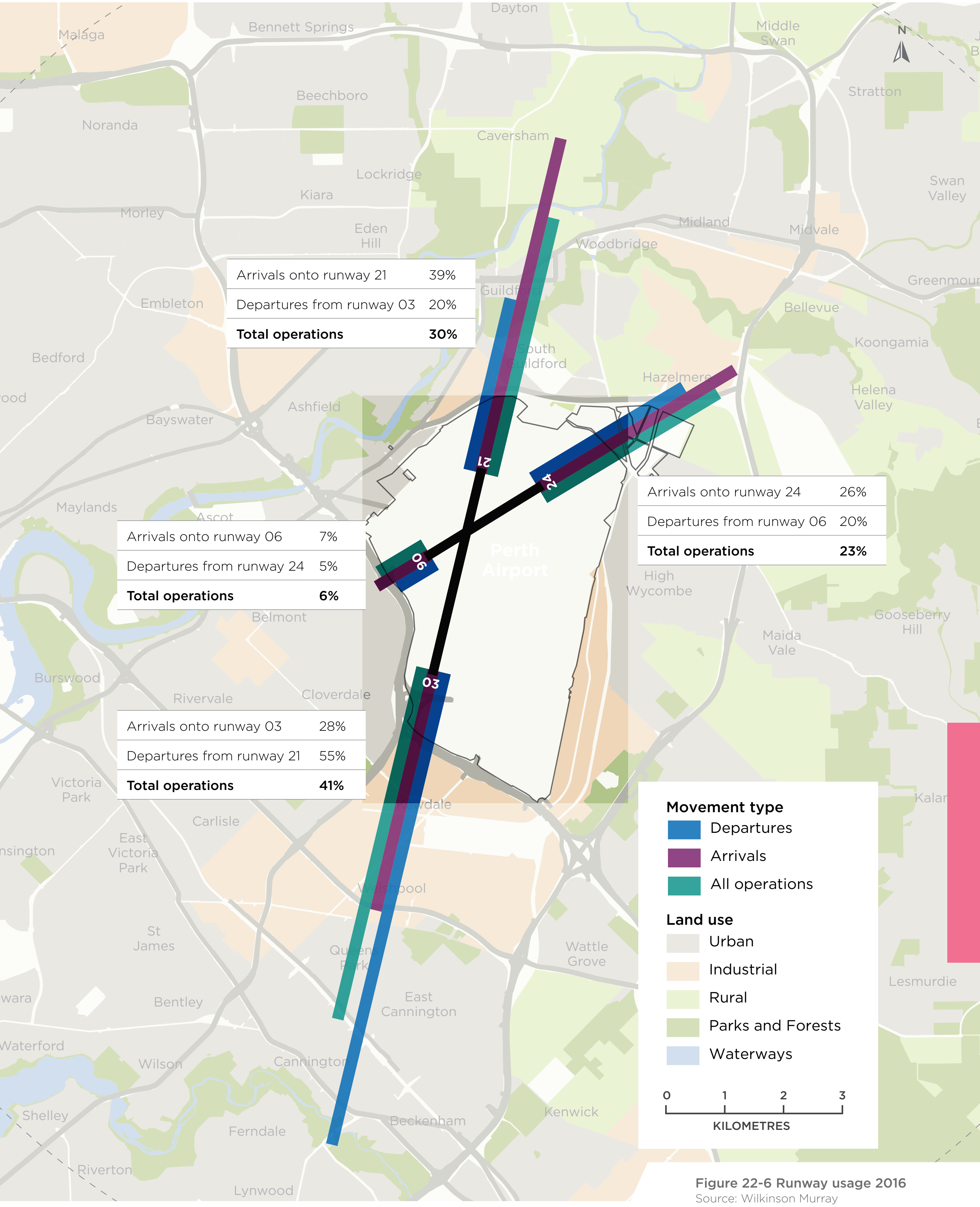


Figure 22-6 Runway usage 2016
Source: Wilkinson Murray

Figure 22-7 2016 N65 average weekday 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

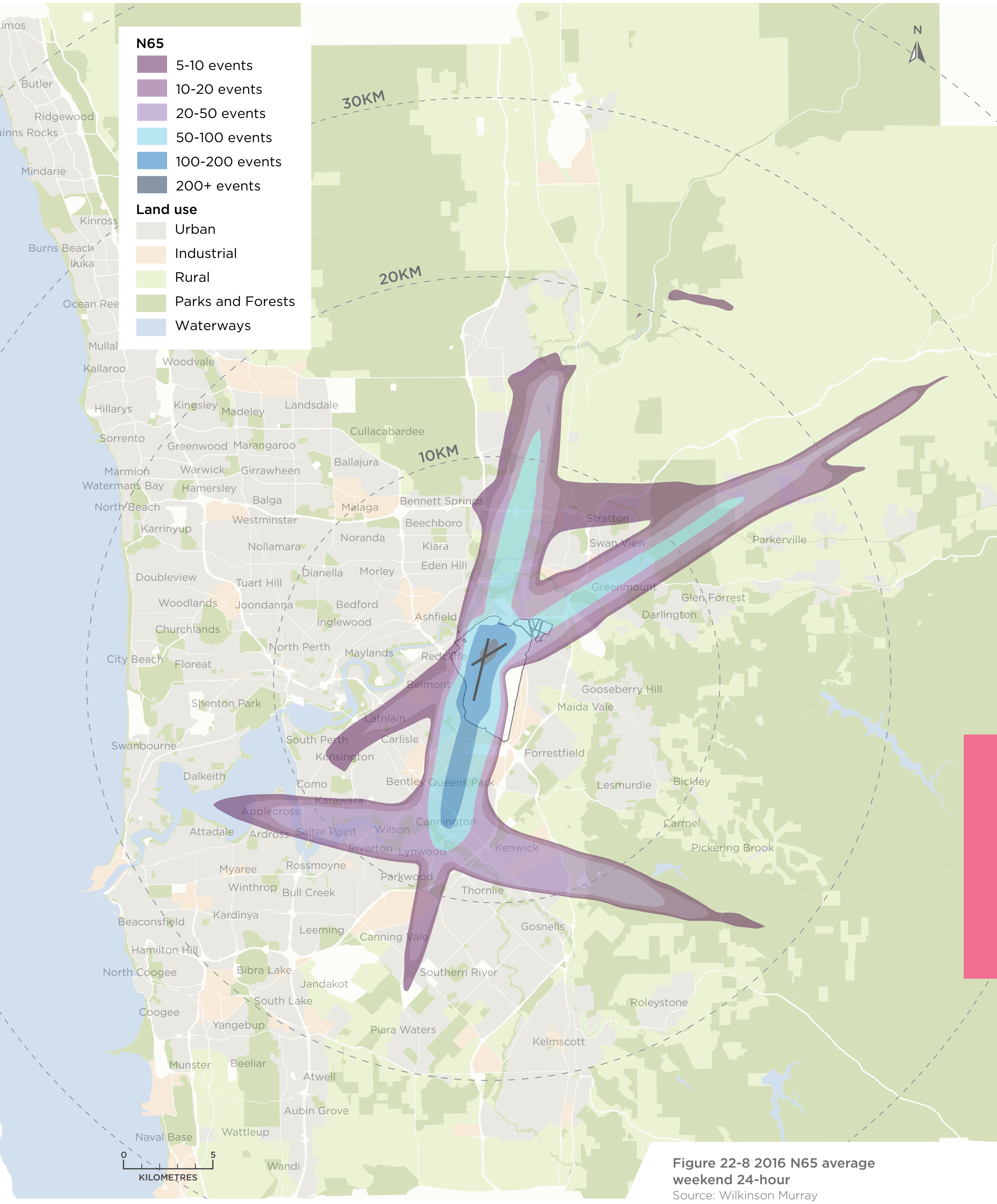


Figure 22-8 2016 N65 average weekend 24-hour

Source: Wilkinson Murray

This N65 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-9 2016 N65 average day 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

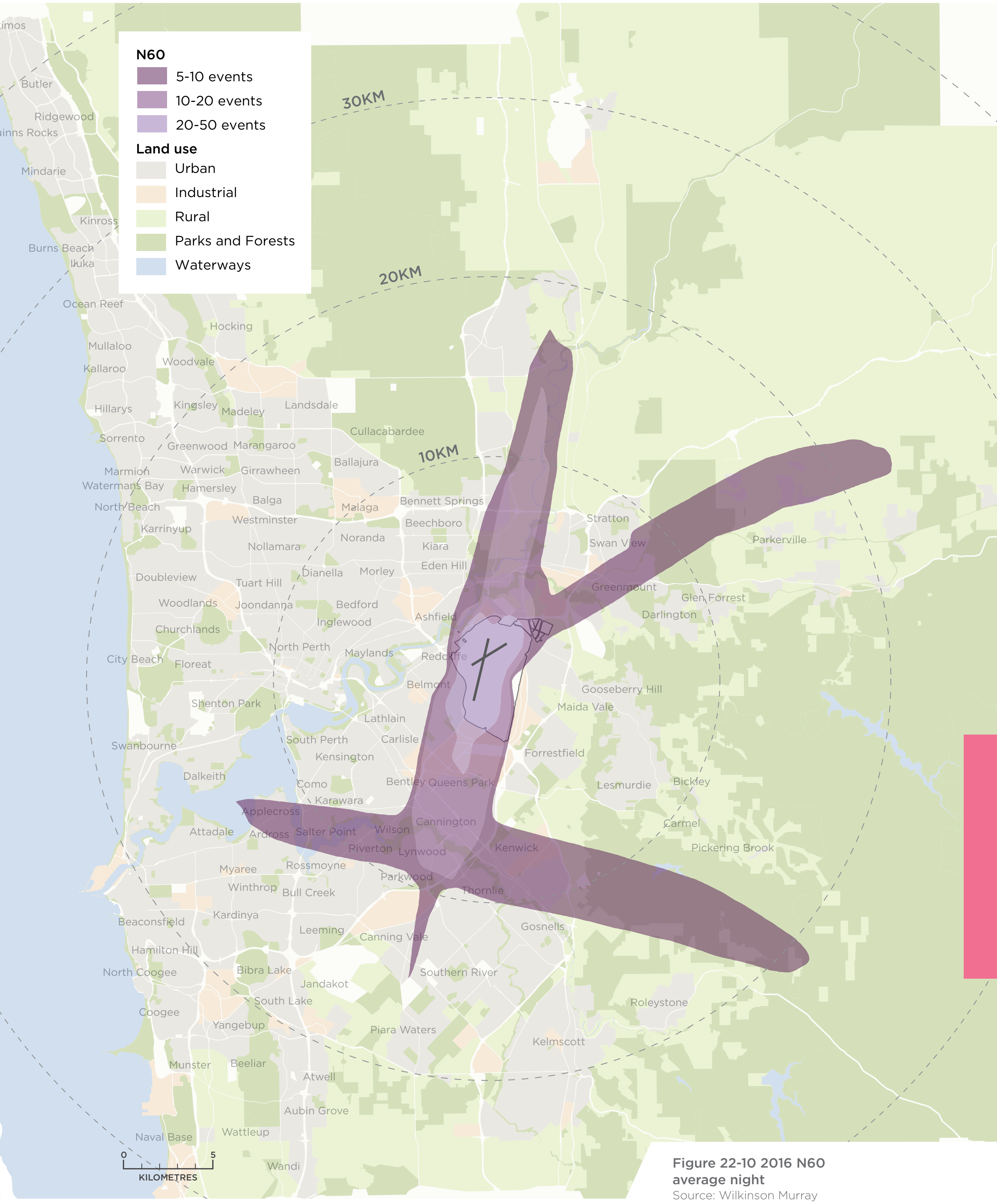


Figure 22-10 2016 N60 average night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

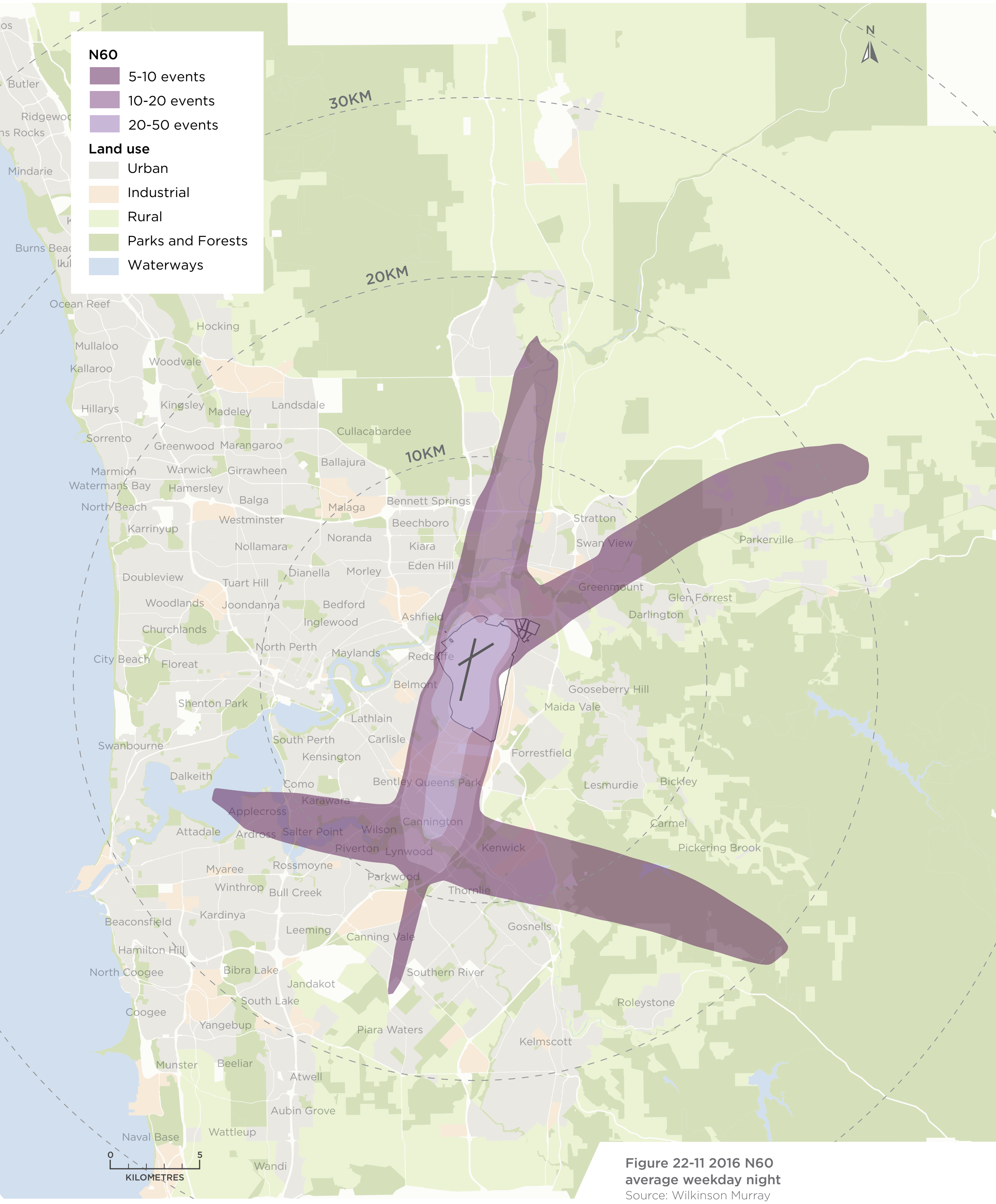


Figure 22-11 2016 N60 average weekday night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

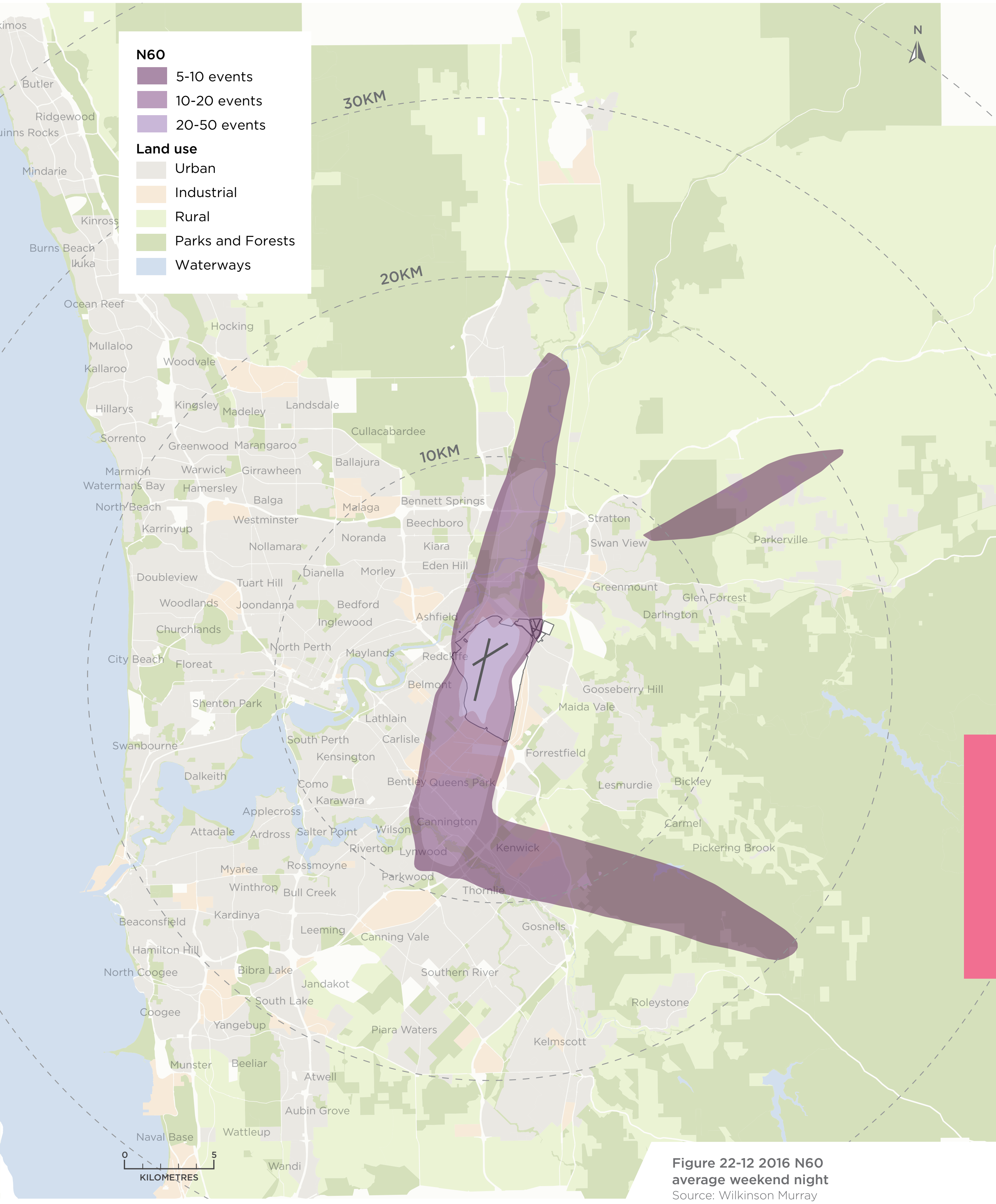


Figure 22-12 2016 N60 average weekend night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft fly, however all areas of Perth have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

22.5.4.4 Australian Noise Exposure Forecast and Australian Noise Exposure Index

The Perth Airport ANEF was produced as part of the Master Plan 2014 and features a composite of ANEC contours for the existing and proposed future runways. The ANEF was prepared for the forecast ultimate practical capacity of the airport with the new parallel runway; at the time considered to be 350,000 annual aircraft movements.

Development of the Australian Noise Exposure Forecast

The projected timeframes an ANEF can cover is outlined in the 'Manner of Endorsement for Australian Noise Exposure Forecasts' from the DIRDC:

- a standard ANEF that forecasts noise exposure levels up to a maximum of 20 years,
- a long-range ANEF with a specified year (i.e. a forecast of noise exposure levels beyond 20 years), or
- an ultimate practical capacity ANEF that forecasts the noise exposure level likely if an airport was operating at its ultimate practical capacity.

If land-use planning around Perth Airport was based on a 20-year ANEF (that is, with a smaller contour) rather than the ultimate ANEF, this could result in inappropriate development. In the long term, it could result in aircraft noise exposure over a wider area and restrict the ultimate capacity of the airport.

Since 2004, in consultation with State and Local governments, an ultimate ANEF based on 350,000 annual aircraft movements has therefore been developed.

This is consistent with anticipated levels of activity once the airport starts to reach capacity during peak periods with the airfield fully developed (including extensions to existing runways and construction of the new runway (03R/21L) having been undertaken).

The 2009 ANEF was developed as a 'point in time' ANEF, where aircraft movements were proportioned across the proposed runway infrastructure for the year that 350,000 movements would occur. This is an acceptable method when the timing of infrastructure developments is outside the planning period. However, allocation of movements in this way resulted in 20 per cent of aircraft traffic being allocated to the cross runway (06/24), which equated to around 70,000 aircraft movements per year.

In 2012, around 18,000 movements operated from the cross runway (06/24). It is unlikely that 70,000 movements would operate on the cross runway (06/24) either now or in the future. However, it is likely that more than 280,000 movements (the remaining 80 per cent) would operate on the parallel runway system. Therefore, in essence, the parallel runways (that is, the existing main runway 03L/21R and new the runway 03R/21L) were under-protected in the 2009 ANEF and the cross runway (06/24) was overprotected.

Perth Airport therefore adopted a 'composite' ANEF for the Master Plan 2014. This reflects a combination of three ANECs that are based on the existing and potential future runway operating modes, as shown in Figure 22-13.

2018 ANEC

The first ANEC (2018 ANEC) is based on approximately 179,000 aircraft movements a year and reflects the existing runway system at capacity.

After this, additional runway infrastructure is required to meet demand, either by an extension of the cross runway (06/24) or the construction of the new runway (03R/21L).

2022 ANEC

The second ANEC (2022 ANEC) considers the extension of the cross runway (06/24) and when this operating mode would reach capacity.

This ANEC provides a capacity of approximately 190,000 aircraft movements per annum and is expected to be reached in 2022, also when the maximum movements on the cross runway (06/24) is reached. In 2023, additional runway infrastructure is again required, leading to the third ANEC.

2059 ANEC

The third ANEC (2059 ANEC) is based on the long-term airfield layout including the extension to the main runway (03L/21R) and construction of the new runway (03R/21L). This scenario considered 350,000 annual aircraft movements and is consistent with the anticipated level of activity once the airport is reaching capacity.

The 'composite' ANEF is created by taking the outer contour lines of the three ANECs. The Perth Airport 2014 Ultimate ANEF was endorsed by Airservices for technical accuracy and is shown in Figure 22-14.

In late 2018, Perth Airport undertook a review of the ANEF as part of the Master Plan 2020 process. The 2020 Ultimate Capacity ANEF was generally similar to the 2014 Ultimate Capacity ANEF described within this MDP. While a review of the airport's ultimate capacity increased the total number of annual aircraft movements from 350,000 to 360,000, this did not result in significant overall changes to new ANEF contours. Further detail on the 2020 Ultimate Capacity ANEF can be found in Master Plan 2020.

The 2016 Australian Noise Exposure Index (ANEI, produced from actual radar data for 129,756 flights in 2016), is presented in Figure 22-15. Perth Airport's online Aircraft Noise Interactive Noise Portal provides the ANEI for previous years.

The ANEI is calculated using the same noise metric and time weighting as an ANEF but prepared for a previous year, based on actual movement data.

22.6 New Runway Aircraft Noise Modelling Methodology

A wide range of factors affect the potential noise exposure from future aircraft operations at Perth Airport. A complex modelling process is therefore required to take them into account. The objective of the noise modelling process is to calculate values of the noise descriptors listed in Section 22.4.2 for current operations, and to predict values for future scenarios, such as the operation of the new runway.

22.6.1 Scenarios

The following key scenarios for aircraft noise impacts were undertaken as part of the assessment of the new runway:

- existing airport operations 2016 – baseline scenarios with existing operations represented based on data for the year 2016 (being the most recently available calendar year prior to the assessment's commencement).
- without the new runway 2025 - future scenario using the existing runways are to allow comparison of the impacts of the NRP. Predictions for the 'without new runway' scenario have been undertaken for the NRP's nominal year of opening (i.e. 2025).
- with the new runway 2025 - represents aircraft operations immediately after the opening of the NRP. Consequently, a significant redistribution of aircraft operations to the new runway is expected. (This scenario is assumed to occur prior to Qantas moving from T4 to Airport Central), and
- with the new runway 2045 - represents aircraft-noise impacts 20 years after the opening of the new runway (taking account of projected growth in air traffic in this period).

The above scenarios considered the parallel runway operations as outlined in Section 21 without the cross runway being available.

Sensitivity testing was undertaken that considered impacts of:

- Qantas Group moving from T4 to Airport Central and the potential change to the distribution of traffic,
- changing the Concept of Operations (CONOPS) developed for NRP (see Section 21), and
- either closure of, or operations on, the cross runway.

22.6.1.1 Integrated Noise Model (INM)

The Integrated Noise Modelling (INM) program is a computer model that calculates aircraft noise exposure in the vicinity of airports, and is used extensively across Australian airports to model future noise impacts.

It was developed by the US Federal Aviation Administration, based on the algorithm and framework from the Society of Automotive Engineers SAE-AIR-1845 Procedure for the Calculation of Airplane Noise in the Vicinity of Airports. This uses noise-power-distance (NPD) data to estimate noise accounting for specific operation modes, thrust settings, source-receiver geometry, acoustic directivity and other environmental factors.

The INM can produce noise contours for an area or noise levels at pre-selected locations. The noise output can be exposure based, maximum-level based or time based.

Although the INM focusses mainly on aircraft overflight noise it also includes departure noise and landing noise including reverse thrust when the aircraft is on the runway.

The US Federal Aviation Administration only recently superseded the INM program with the Aviation Environmental Design Tool (AEDT). The INM program (Version 7.0d) has therefore been used for the aircraft noise predictions for this assessment. (The calculation and prediction algorithms relating to aircraft noise are understood to be similar in both calculation programs).

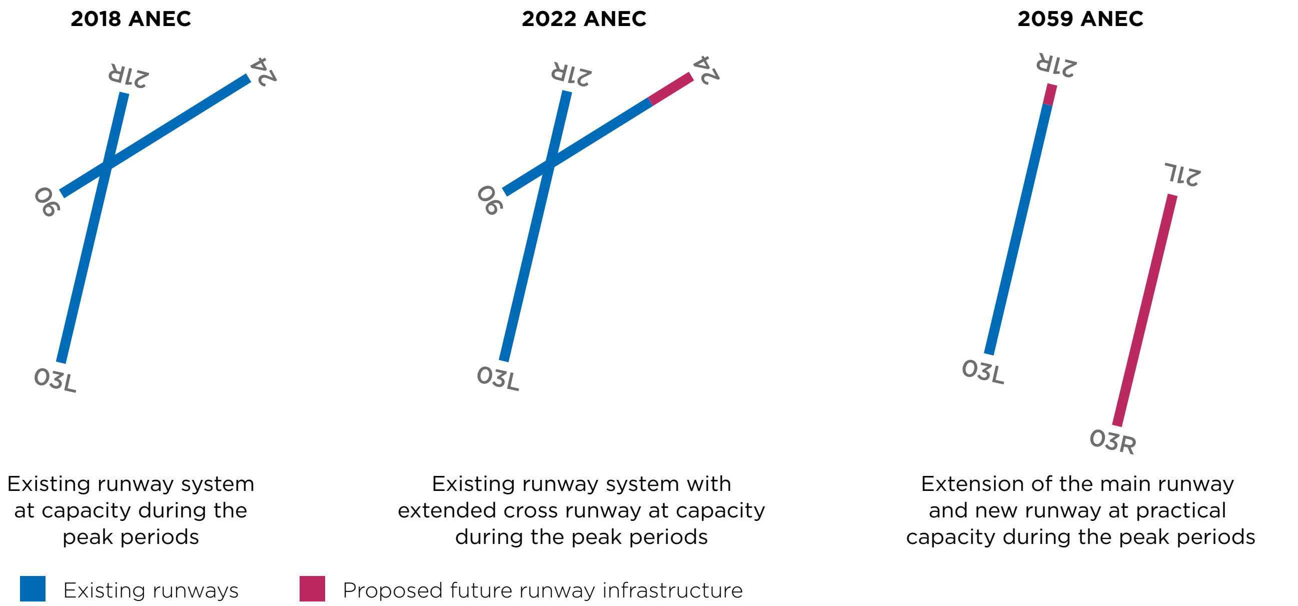


Figure 22-13 2018, 2022 and 2059 Australian Noise Exposure Concept runway scenarios for the Perth Airport Australian Noise Exposure Forecast
Source: Perth Airport Master Plan 2014

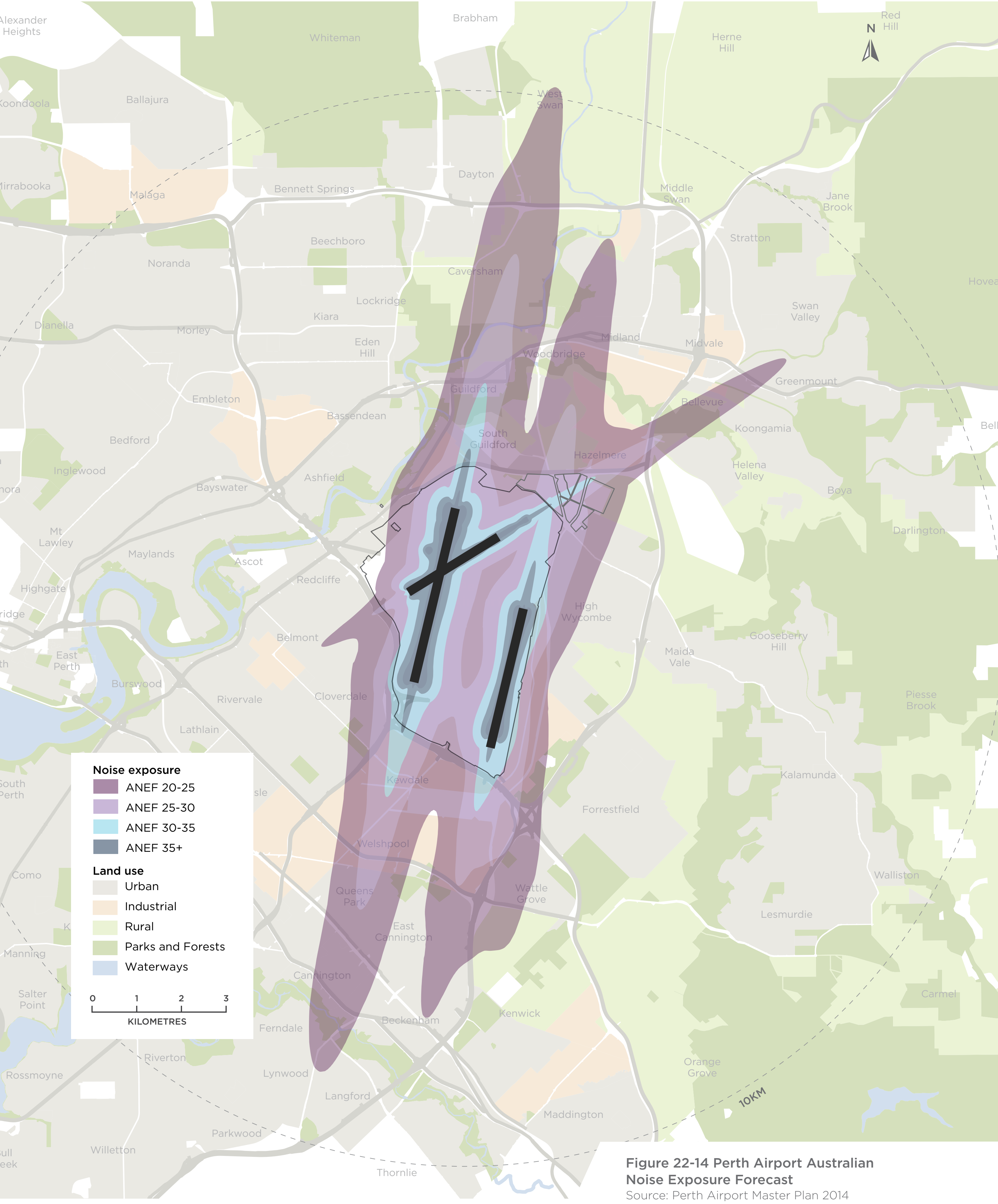


Figure 22-14 Perth Airport Australian Noise Exposure Forecast
Source: Perth Airport Master Plan 2014

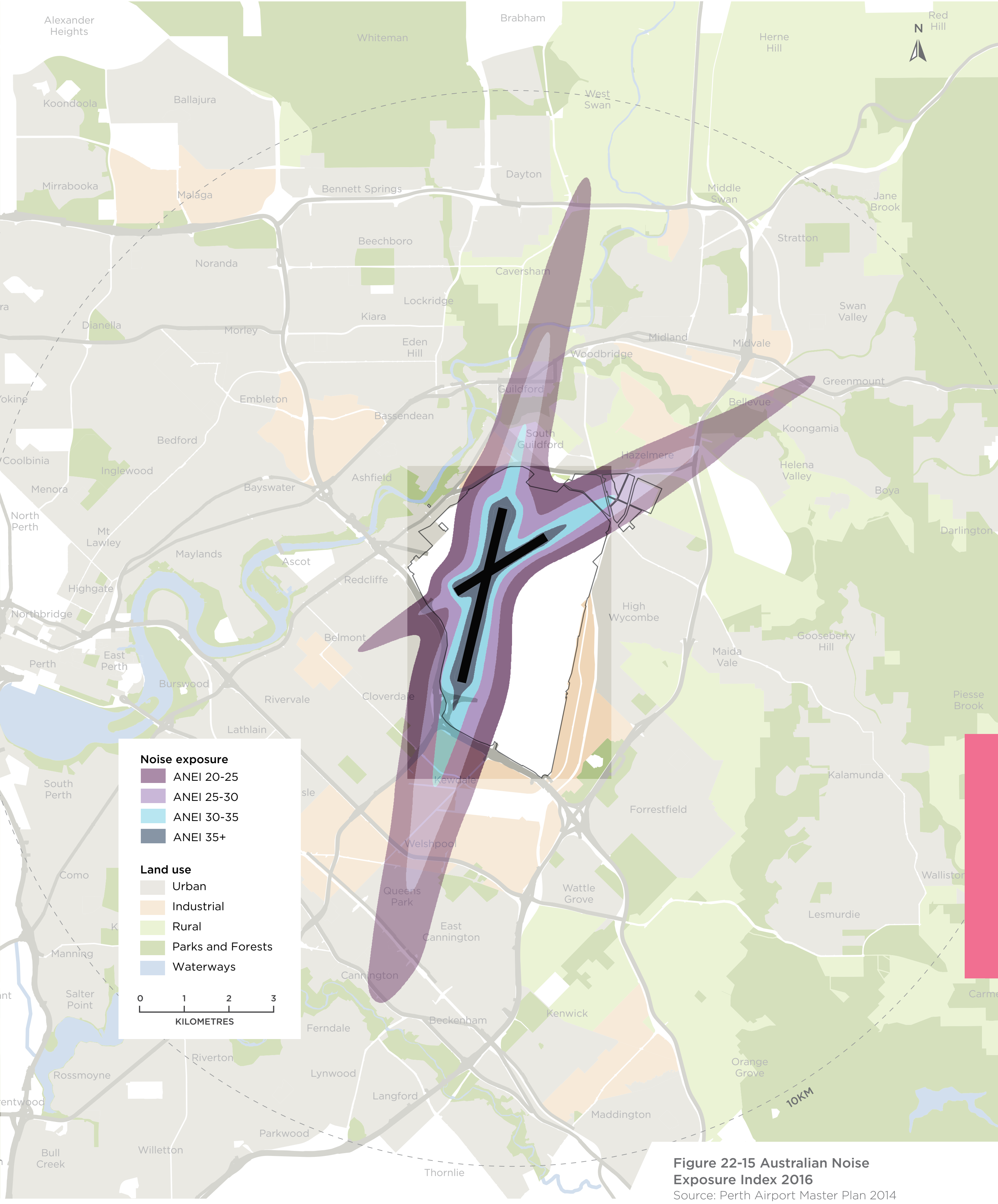


Figure 22-15 Australian Noise Exposure Index 2016
Source: Perth Airport Master Plan 2014

This ANEI represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

22.6.2 Validation of the Aircraft Noise Model

Airservices undertakes regular monitoring of aircraft noise in various suburbs around Perth. Current aircraft-noise monitoring locations are shown in Table 22-6 and listed in Figure 22-16.

Noise-measurement data for calendar year 2016 from four noise monitoring locations (East Cannington, Queens Park, Swan View and Guildford) was obtained from Airservices' Noise and Flight Path Monitoring System (NFPMS). This data was then correlated with radar flight track information and used to validate the INM data with over 25,000 recordings used for flights verification and calibration analysis.

Predictions of sound exposure level (SEL) and L_{Amax} for each of the correlated flights were conducted using INM. Radar data was used to precisely model the track flown by each operation. Initially INM standard approach and departure procedures were used for the calculations. These procedures allow the model to determine the vertical profile and assumed aircraft settings for each stage of the operation.

Following initial calculations, the predicted noise level for each operation was compared to the measured noise level from the NFPMS data. Similarly, the actual profiles were compared to the profiles produced by the model using the standard procedures.

The operations modelled considered various approaches, departures and stage lengths. A stage length is the distance an aircraft flies to its next destination and is relevant as aircraft are generally heavier if they are flying further and may have a lower departure profile. Nominated stage lengths are shown at Section 22.6.9.

Many aircraft and operations demonstrated discrepancies between the measured and modelled noise levels and profiles.

In many instances, these discrepancies warranted adjustment of the predicted noise levels. This was achieved through changing the departure stage length, substitution of the aircraft type or both. An iterative approach was taken, whereby a change was made and then the measured and predicted noise levels and profiles were compared, until the model was considered to be adequately calibrated.

The general approach to selecting a calibration adjustment was to match the aircraft noise levels as closely as practical and also consider the profile (though this was secondary). The decision hierarchy adopted is defined as follows.

- any discrepancies less than two decibels were considered to be within the accepted accuracy of the model,
- the same aircraft type was maintained wherever possible,
- if necessary, an alternate aircraft type was selected. Wherever possible the substitute aircraft was of the same class (e.g. narrow body jet, medium turboprop). Occasionally, if the same aircraft class was not suitable, an aircraft of similar class with similar dimensions was selected, and
- the departure stage length that results in the most correct noise levels and is consistent with the radar data median profile was selected.

The verification process was undertaken for each runway separately and noise monitoring location. The verification results demonstrate that the calibrated noise model is consistent with the measured noise data. In the majority of instances, the resulting discrepancy is less than two decibels.

Aircraft with insufficient data to draw conclusions were not calibrated. Some of these aircraft show discrepancies greater than two decibels. Typically, they were smaller aircraft with lower noise levels or are aircraft which are rarely operated at Perth Airport; the impact of these aircraft on the overall noise assessment is minimal.

22.6.3 Modelling Inputs

Input data for the INM noise model includes the following variables:

- selection of aircraft types (aircraft fleet mix),
- numbers of aircraft operations (including departures, arrivals and circuit operations and day/night split),
- runway dimensions and allocation to respective operations,
- flight-track descriptions and flight-track dispersal (to take into account the spread on the track by aircraft operations),
- aircraft destinations or origins (stage lengths) to take into consideration track allocation,
- day/night split of operations,
- terrain data, and
- normalised wind velocity and temperature information.

The key inputs are explained in more detail below.

ID	Type	Suburb
1	permanent noise monitoring location	East Cannington
2	permanent noise monitoring location	Queens Park
4	permanent noise monitoring location	Swan View
5	permanent noise monitoring location	Guildford
37	permanent noise monitoring location	Bennett Springs
40	permanent noise monitoring location	Carlisle

Table 22-6 Noise monitoring locations
Source: Airservices Australia

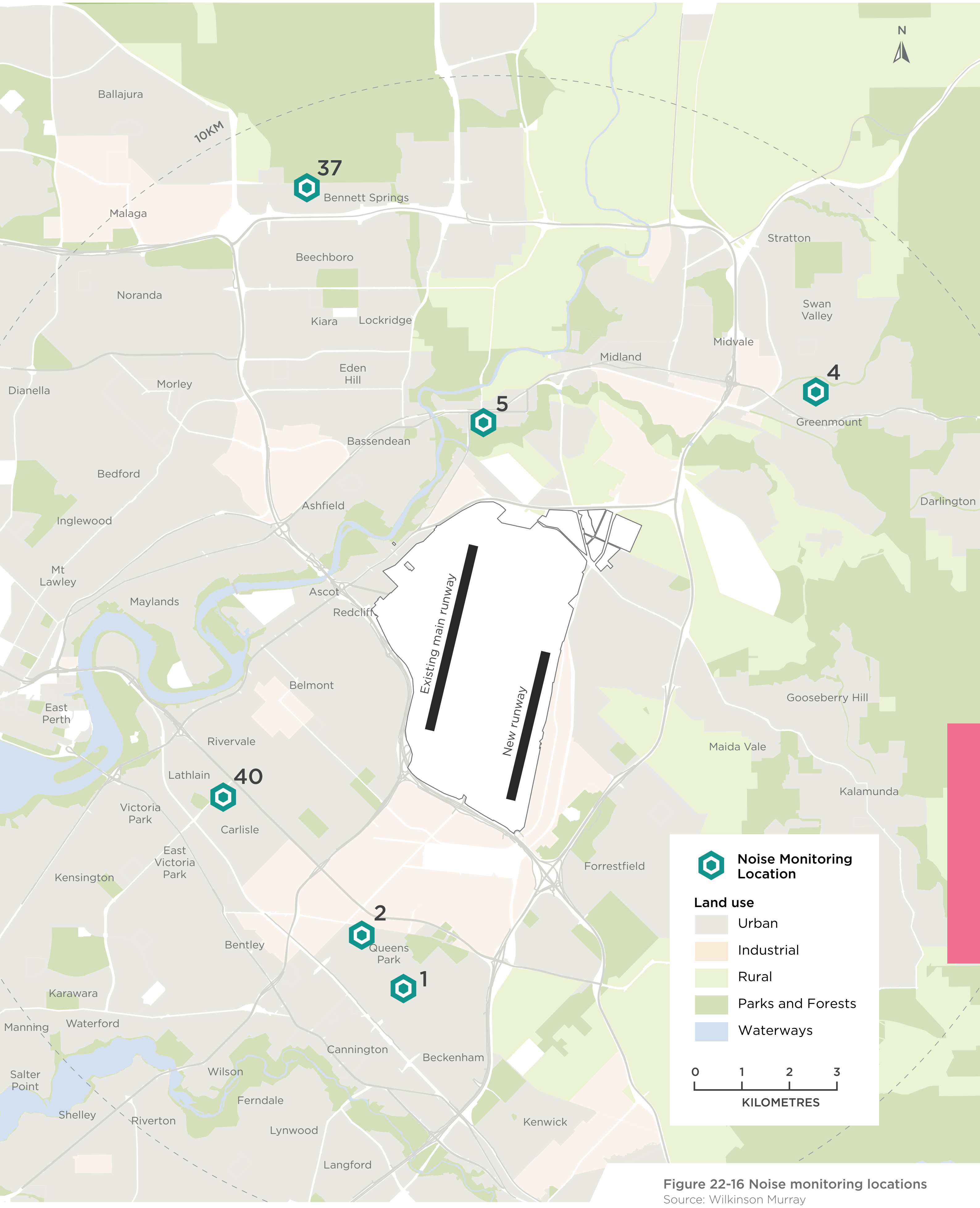


Figure 22-16 Noise monitoring locations
Source: Wilkinson Murray

22.6.4 Selection of Aircraft Types

To facilitate noise modelling, forecast schedules, which are a set of schedules developed using aircraft movement forecasts, for future scenarios were developed based on forecasts outlined in Section 2.

All forecast schedules were developed as accurately as possible, given the available data. Any foreseeable error is not considered to significantly impact the noise-modelling outcomes. The forecast schedules are considered sufficient for the purpose of this assessment.

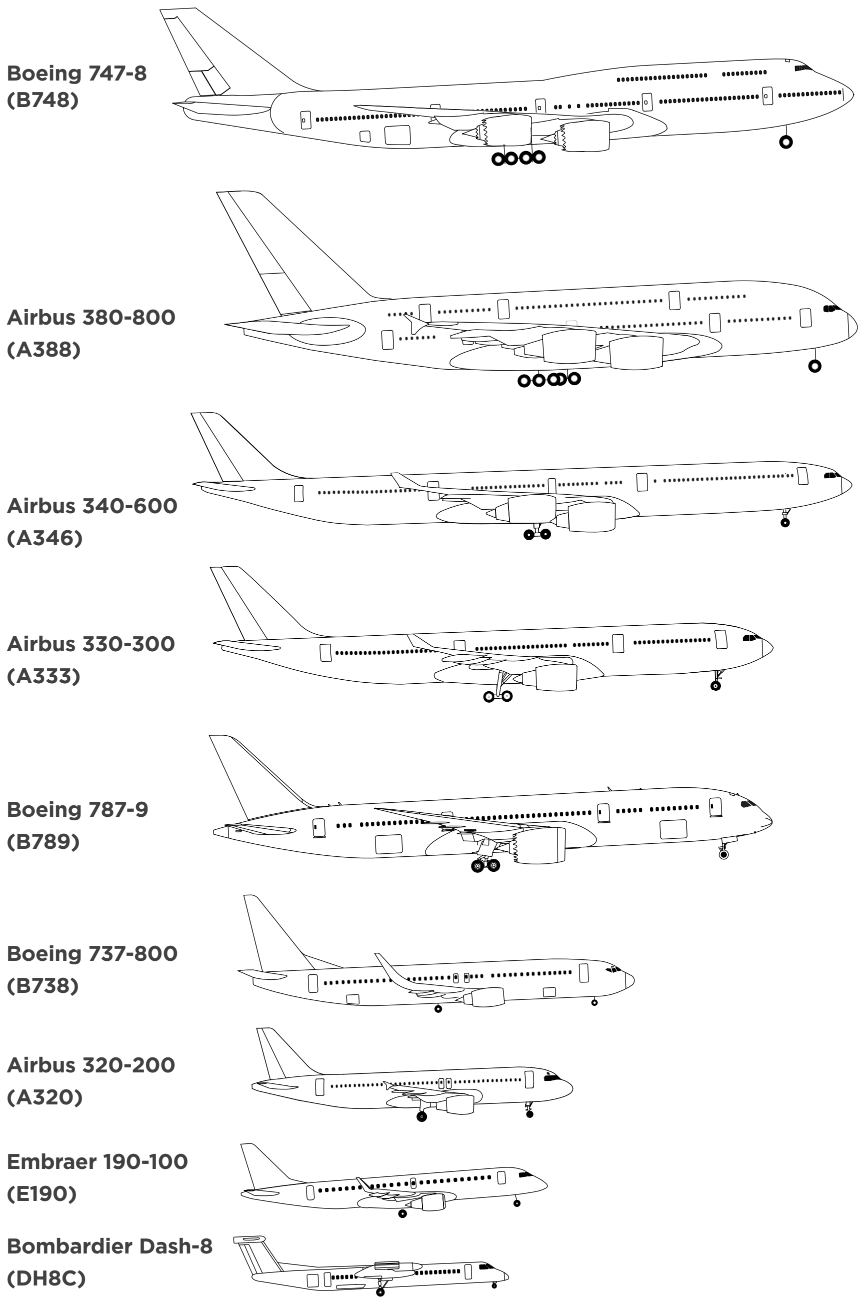


Figure 22-17 Aircraft size comparison
Source: Wilkinson Murray

22.6.4.1 Standard Aircraft Types Used in Calculations

Table 22-7 summarises the primary aircraft types projected, the corresponding aircraft class and the standard aircraft types used to represent the aircraft noise in the INM program.

Figure 22-17 provides a comparison of various commercial aircraft, providing some scale for the various aircraft classes described in Table 22-7.

22.6.4.2 Substitution of Current Aircraft (Calibration)

Following a verification process, some of the standard aircraft types were substituted to better correlate with the actual noise levels recorded at the noise-monitoring locations.

Table 22-8 shows the aircraft substitutions determined by the model-calibration process.

22.6.4.3 Substitution of Future Aircraft

Because the noise profile is taken from actual flights (not predicted noise levels) the INM model includes only those aircraft currently operational. When modelling future aircraft, the existing aircraft that is most equivalent must therefore be used.

This means the expected reduction in noise levels due to the introduction of quieter aircraft is not incorporated in the model. The substitutions are shown in Table 22-9.

22.6.5 Number of Aircraft Operations

The predicted future number of aircraft movements are based on the forecasts outlined in Section 2.

Forecast schedules for a typical busy-weekday and a typical busy-weekend were prepared, for both the with and without new runway scenarios. This included future aircraft type, operation type (arrival or departure), time of operation and port of origin or destination for each operation.

Because the busy-day schedules represent the forecast 90th percentile weekday and weekend day, annualising these schedules results in more annual movements than actually forecast. Because all noise metrics have been based on the busy-day schedules they are considered slightly conservative. However, they are consistent with the effective communication of aircraft noise without obscuring their impacts by using averages.

Table 22-10 shows predicted total aircraft movements per day for each assessment year.

Aircraft Type (Scheduled)	Manufacturer	Aircraft Class	Default INM Aircraft Type
A319	Airbus	Small narrow-body jet	A319-131
A320	Airbus	Large narrow-body jet	A320-232
A332	Airbus	Medium wide-body jet	A330-343
A333	Airbus	Medium wide-body jet	A330-343
A346	Airbus	Medium wide-body jet	A340-642
A388	Airbus	Very large wide-body jet	A380-861
AT43	ATR	Large turbo-prop	DHC830
B190	Beechcraft	Small turbo-prop	DHC6
B350	Beechcraft	Small turbo-prop	CNA441
B463	British Aerospace	Small narrow-body jet	BAE300
B734	Boeing	Large narrow-body jet	737400
B737	Boeing	Large narrow-body jet	737700
B738	Boeing	Large narrow-body jet	737800
B748	Boeing	Very large wide-body jet	7478
B772	Boeing	Medium wide-body jet	777200
B788	Boeing	Medium wide-body jet	7878R
B789	Boeing	Medium wide-body jet	7878R
DH8A	Bombardier	Small turbo-prop	DHC830
DH8B	Bombardier	Medium turbo-prop	DHC830
DH8C	Bombardier	Large turbo-prop	DHC830
E120	Embraer	Small turbo-prop	EMB120
E190	Embraer	Medium narrow-body jet	EMB190
F70	Fokker	Small narrow-body jet	F10062
F100	Fokker	Small narrow-body jet	F10062
PC12	Pilatus	Small turbo-prop	CNA441
RJ1H	Avro	Small narrow-body jet	BAE300
RJ85	Avro	Small narrow-body jet	BAE146
SF34	Saab	Medium turbo-prop	SF340

Table 22-7 Default current aircraft types modelled
Source: Wilkinson Murray

Aircraft Type (Scheduled)	Operation (Arrival or Departure)	INM Aircraft Type (Substituted)
B772	Arrival	7773ER
B789	Arrival	777200
B734	Arrival	737
B73Y	Arrival	737D17
A320	Departure	737700
B712	Arrival	MD9025
	Departure	EMB195
DH8C	Arrival	CVR580
	Departure	CVR580
DH8B	Arrival	CVR580
	Departure	CVR580
DH8A	Arrival	CVR580
	Departure	CVR580
SF34	Departure	CVR580

Table 22-8 Current aircraft substitutions used for new runway assessment
Source: Wilkinson Murray

Aircraft Type (Scheduled)	INM Aircraft Type (Substituted)
B779	7773ER
B778	777200
A351	777300
A359	777200
A330neo	A330-343
A321neo	A321-232
A320neo	A320-232
B737 MAX9	737800
B737 MAX8	737800

Table 22-9 Future aircraft substitutions for new runway assessment
Source: Wilkinson Murray

Assessment Year	Movements per Weekday	Movements per Weekend Day	Annual Movements
2025	590	330	188,234
2045	798	486	258,732

Table 22-10 Predicted aircraft movements for new runway assessment years
Source: Wilkinson Murray

22.6.5.1 Aircraft operations forecasts

Noise predictions are sensitive to the forecast aircraft operations. The following example will help show the impact that changing the forecast will have on the ANEC.

If the total number of operations at the airport were to increase or decrease from that predicted (while retaining the same aircraft types, tracks and other features), the impact would be as follows:

- doubling (or halving) the forecast aircraft movements would change the ANEC value by three at any point and be noticeable by most residents,
- a change of ten per cent in the forecast aircraft movements would result in a change of less than 0.5 in the ANEC value at any point. If it occurred suddenly, the long-term impact of such a change is considered negligible,
- doubling aircraft numbers would slightly expand the N-above contours, and the N-above value at any point would double. For low values of N-above (such as N65 = 5) the extent of the contours is limited by the loudest aircraft type, so may not extend greatly, and
- for a listener on the ground, they would be aware of a change in the number of operations by the frequency of overflights or the time between them. A doubling or halving of the number of flights would probably be very noticeable; a change of ten per cent may or may not be noticeable.

Figure 22-18 presents the average number of operations in each hour, based on the busy day schedules. The typical morning and evening peaks are evident, as is the lower number of flights during the night period (11.00 pm to 4.00 am) especially between 2.00 am and 4.00 am.

Time scheduling has an impact. N-above and ANEC metrics are related to the allocation of flights to the following time periods:

- day,
- evening, and
- night.

Altering the scheduling within a time period would not significantly alter the noise predictions. But altering the scheduling between the time periods is likely to have an effect (ie. moving a flight from 8.00 am to 9.00 am would have a minimal effect on the noise predictions because the flight remains in the 'day' period. But moving a flight from 11.00 am to 11.00 pm would have a far greater effect).

Table 22-11 shows a breakdown by aircraft family (see Table 22-7 for aircraft-family classifications assumed in this assessment). The fleet mix is predicted to remain fairly steady for the forecast period. Narrow-body jets account for the majority of operations (approximately 60 per cent). Medium wide-body jets account for a further 20 to 25 per cent of forecast movements. The data shows no difference in the movements per day in the 2025 without new runway and with new runway percentages as there is not expected to be a significant increase in operations as soon as the runway is opened.

22.6.6 Runway Dimensions and Allocation to Respective Operations

Runway dimensions used in the model are consistent with the NRP description as outlined in Section 6.

The allocation of runways and operating modes for existing scenarios and scenarios without the new runway were consistent with the modes outlined in Section 20.

Future modes of operations were modelled as outlined in Section 21.

22.6.6.1 Rules for Mode Selection – Existing

Because aircraft noise metrics for the existing (current day based on 2016) scenario were calculated directly from radar data, the selection of modes (runway selection) was not necessary for this scenario. However, the rules below represent current practice by air traffic control as far as is practicable within the constraints of the model.

At all times, where more than one operating mode is available on the basis of meteorological constraints, the mode to be used is selected in order of the preferences defined by the noise abatement procedures (NAPs, which are described in Section 20).

To avoid conflicts in the mode-allocation model, distinct mode priorities are assigned to each mode as shown in Table 22-12. These were selected to mimic the existing trends of runway use observed in the historical radar data. In addition to the mode priorities, the following rules relating to changes between these modes have been applied.

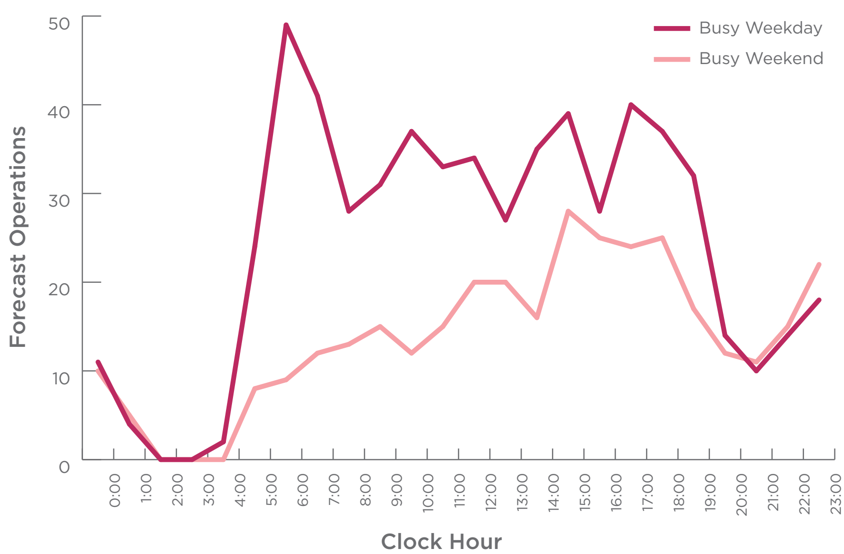


Figure 22-18 Busy weekday and weekend forecast operations by hour, new runway 2025
Source: Wilkinson Murray

Changes to a higher priority mode occur if:

- the new mode is forecast to remain available (based on meteorological conditions) for two hours, and
- the new mode meets the currently scheduled demand.

Changes to a lower priority mode occur if:

- the current mode is unavailable at the current time,
- the new mode is available with regard to meteorological conditions, and
- the new mode meets the currently scheduled demand.

22.6.6.2 Rules for Mode Selection – Future

The future modes for scenarios that include the new runway were allocated as per the Concept of Operations and the Airspace Management Plan (see Section 21). The Airspace Management Plan for parallel runway operations has been developed by Perth Airport through extensive collaboration with Airservices and airlines. The Airspace Management Plan applies a compass departure and terminal arrival concept:

- compass departures means that the runway for departures is selected based on the destination, i.e. flights for destinations east of the airport would typically depart off the new runway (03R/21L), and
- terminal arrivals means that the runway for arrivals is selected based on the terminal that the aircraft will use.

22.6.6.3 Overall Calculation Procedures for Future Scenarios

For each scenario considered, an operating mode was assigned for each 30 minutes over a 14-year period, taking account of:

- the set of possible operating modes and their priority,
- whether each mode is available under the current meteorological conditions, using the meteorological data set described in Section 22.6.11, and
- whether a change to a higher-priority mode would be undertaken under the assumed rules for mode selection, as described in Section 22.6.6.2.

Aircraft Family	Movements per Day – Without New Runway (per cent)	Movements per Day – With new runway (per cent)	
	2025	2025	2045
Very large wide-body jet	0.8	0.8	1.4
Large wide-body jet	0.8	0.8	2.0
Medium wide-body jet	20	20	25
Large narrow-body jet	27	27	27
Small narrow-body jet	34	34	31
Large turbo-prop	2.3	2.3	1.9
Medium turbo-prop	0.9	0.9	0.6
Small turbo-prop	12	12	9.6
Freight	0.6	0.6	0.6
Business jet	0.8	0.8	0.8
General aviation	0.9	0.9	0.9

Table 22-11 Predicted daily aircraft movements by aircraft family by year
Source: Wilkinson Murray

Departure Runway(s)	Arrival Runway(s)	Mode Allocation Model Priority
Runway 21	Runway 21 and Runway 24	1
Runway 03 and Runway 06	Runway 03	1
Runway 21	Runway 21	3
Runway 03	Runway 03	3
Runway 24	Runway 24	5
Runway 06	Runway 06	5

Table 22-12 Mode priorities
Source: Wilkinson Murray

Notes: 1. Where equal priority modes are available the most into wind direction is selected.

Aircraft operations occurring in each 30-minute period were then assigned to tracks according to the direction of the port of origin or destination and the airline. Operations on each track are then used to determine measures of overall noise exposure, using the calculated noise levels described in Section 22.4.

22.6.6.4 Runway Nomination / Availability Rules

Rules for the selection of runway to use were taken from the Civil Aviation Safety Regulations 1998 Manual of Standards Part 172 – Air Traffic Services. The application of these rules to the meteorological data was determined to match, as much as possible, the historical data describing the selection of runways at Perth Airport. See Section 20 for further details of these rules and their application.

Should these rules or their application be altered in the future, this has the potential to alter the availability of runways and consequently the noise footprint.

22.6.7 Adoption of Future Procedures by Air Traffic Control

Assessment of noise exposure for future scenarios has been undertaken using an iterative process to minimise noise exposure while maximising the operability of the airport.

Small changes to how the runways would operate, which may be necessary for practical reasons currently not identified, would have minimal impact on the assessment outcomes. However, significant deviation from the proposed procedures would alter the noise footprint and potentially the outcomes and conclusions of this assessment.

New technologies may permit the detailed airspace design to deviate from the modelling assumptions because they often present the opportunity to reduce aircraft-noise emissions. Regardless, airspace changes are subject to assessment and aircraft noise will be considered at the detailed airspace design stage.

22.6.8 Flight Track and Flight Track Dispersal

An aircraft flight path represents a three-dimensional trace of an aircraft's position while performing an operation; a flight track represents a two-dimensional projection of the flight path onto the ground surface.

This section considers flight tracks. The height-vs-distance profile of aircraft performing these operations is considered separately in Section 21.

As outlined in Section 20, aircraft arriving at and departing from an airport nominally follow one of a number of standard arrival routes (STARs) or standard instrument departure routes (SIDs).

Actual tracks diverge from these nominal tracks due to meteorological conditions, requirements for aircraft separation and other variable factors.

Modelling inputs have been developed to replicate as accurately as possible the anticipated future movements of aircraft, based on the current spread of tracks around the nominal published flight paths (SIDs and STARs). SIDs and STARs for the existing airspace along with proposed SIDs and STARs for the NRP are detailed in Section 21.

This is a best-fit approximation only for future movements. While this approach is considered reasonable and current best-practice, the actual distribution of aircraft around a nominal track will vary from day to day, week to week and month to month.

Aircraft noise metrics for the existing scenario were calculated directly from historical radar data for the calendar year 2016. Thus, each operation was individually modelled on the track described by the radar data.

Existing aircraft flight tracks were analysed to determine tracks for the scenario without the new runway. This dispersion of existing tracks was also used to inform the dispersions applied to new tracks. (Representative existing tracks were determined by analysis of all flight tracks recorded by Airservices over the 2016 calendar year).

The data contained approximately 130,000 flights matched to flight plans by Airservices. The data contained information such as the port of origin/destination, aircraft type, operation and runway.

It was checked for consistency with geometric filters used to confirm the operation and runway.

The purpose of this flight track analysis was to identify the tracks associated with specific types of aircraft operations, thereby allowing the noise emissions to be predicted for future years.

Aircraft operations were classified by:

- aircraft category (jet or non-jet),
- operation (arrival or departure), and
- visual meteorological conditions (VMC) or instrument meteorological conditions (IMC) (determined from the meteorology data visibility and cloud records at the time).

A selection of the analysis is provided in order to demonstrate the process. Figure 22-19 and Figure 22-20 demonstrate the analysis of all arrival and departure flight densities. This permits the identification of typical flight tracks surrounding the airport. The density is expressed as a percentage of the total operations in the dataset. The dataset is filtered to include only one type of operation, e.g. jet arrivals on runway 03 as shown in Figure 22-21, to make prominent tracks more apparent.

Prominent concentrations of tracks are later represented as track groups to facilitate further analysis.

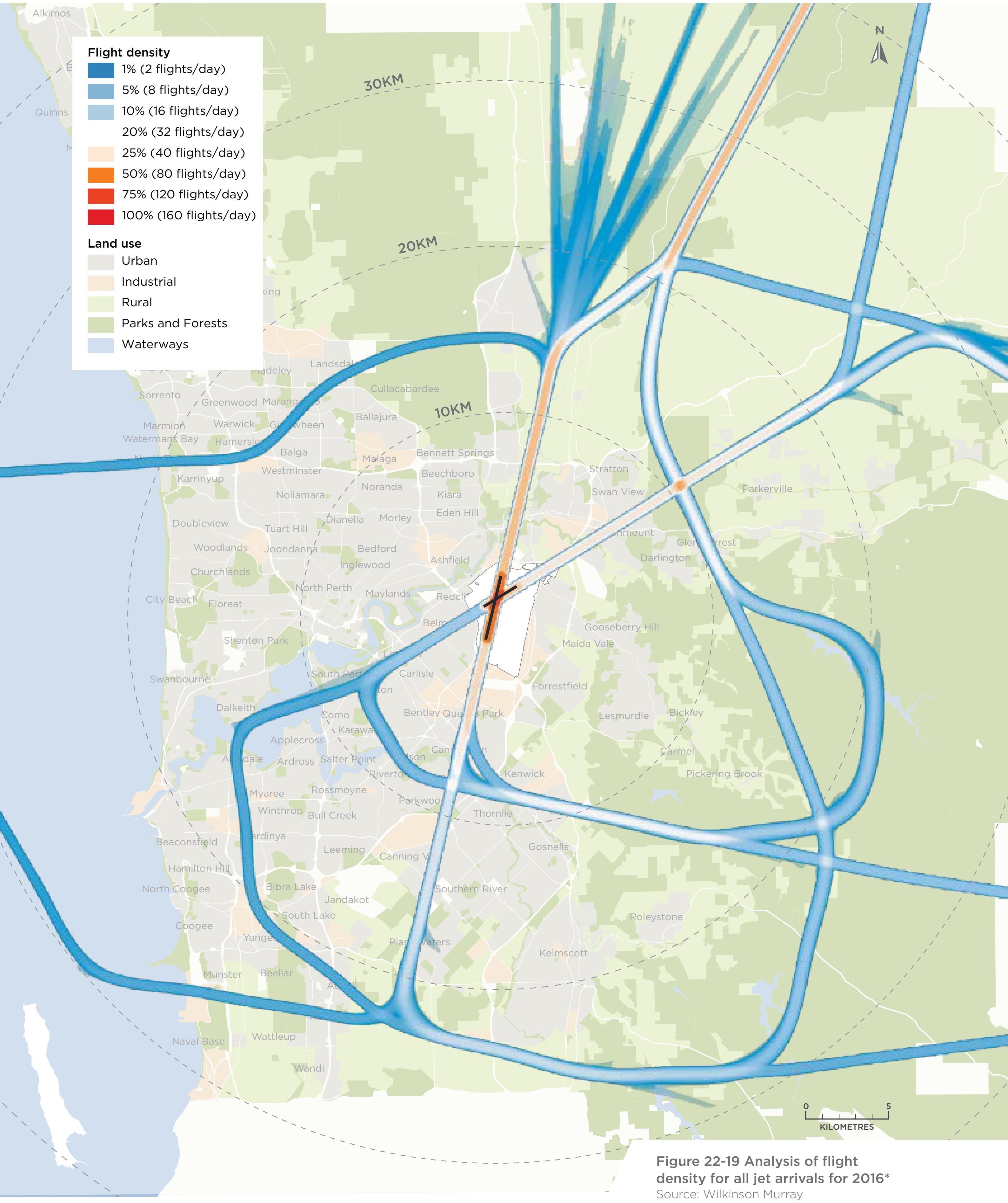


Figure 22-19 Analysis of flight density for all jet arrivals for 2016*
Source: Wilkinson Murray

*The 2016 dataset analysed included a total of 129,756 aircraft operations. The total number of operations involving jet aircraft was 115,712. On average, 158 jet departures and 158 jet arrivals per day were included in the density analysis.

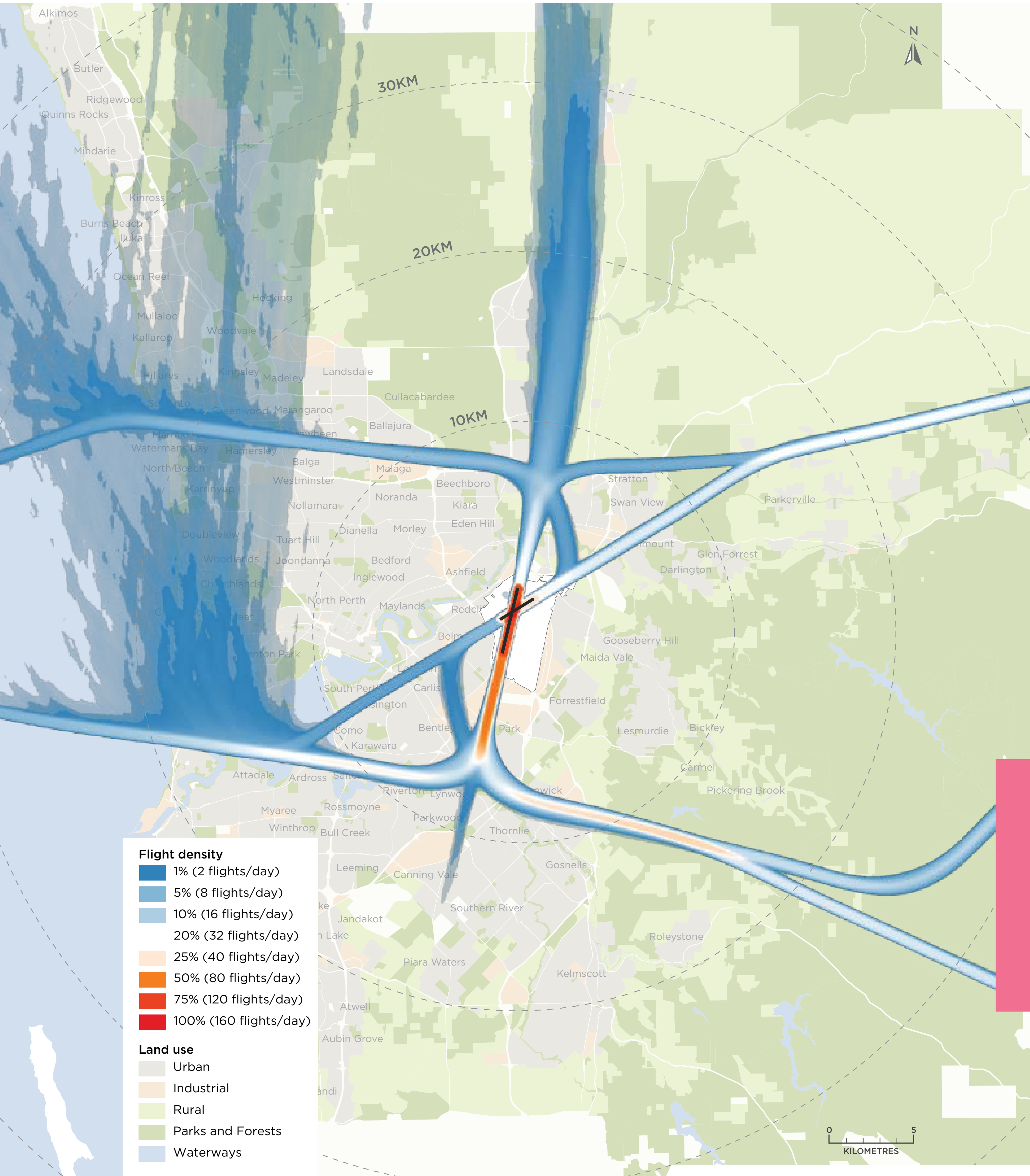


Figure 22-20 Analysis of flight density for all jet departures for 2016*
Source: Wilkinson Murray

*The 2016 dataset analysed included a total of 129,756 aircraft operations. The total number of operations involving jet aircraft was 115,712. On average, 158 jet departures and 158 jet arrivals per day were included in the density analysis.

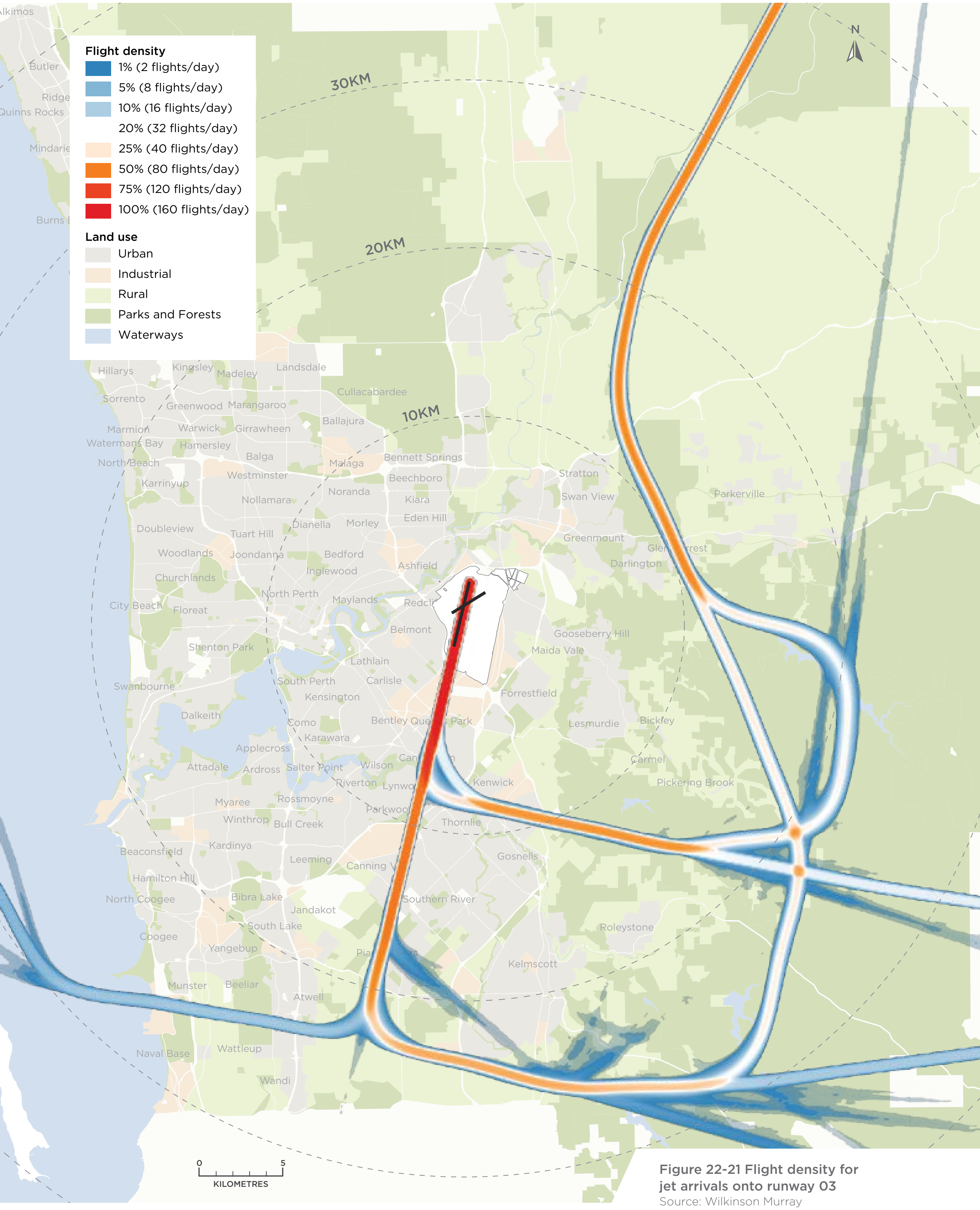


Figure 22-21 Flight density for jet arrivals onto runway 03
Source: Wilkinson Murray

Figure 22-22 presents the allocation of flight records into track groups, a grouping based on the direction from which they arrived, for jet arrivals onto runway 03. (Different track groups are represented by different colours.)

For each group, a set of tracks comprising median tracks and sub-tracks was then determined, representing the centre of each group and the dispersion of tracks within the group. Generally, between five and nine tracks were assigned for each group.

The locations of these tracks were determined directly from the recorded tracks, using custom-developed software.

Figure 22-23 demonstrates the construction of discrete flight tracks to represent the spread of tracks in the existing dataset. These tracks can then be modelled. Unlike standard sub-track distributions in INM which are symmetric, sub-tracks determined in this manner may be asymmetric (i.e. if there is a bias for aircraft to fly farther to one side of the median than the other, this is reflected by the sub-tracks).

In this way, if aircraft operations are categorised as described above they can be assigned on a proportional basis first to a track group, using the proportion of actual operations in each group and then to median or sub-tracks.

22.6.8.1 Flight Tracks and Airspace Design

The assessment is sensitive to the location of flight tracks and the distribution of operations to these tracks.

The design of flight corridors and airspace architecture for the new runway is discussed in Section 21.

Tracks used in the existing and without new runway scenarios were determined from existing operations. Analysis was undertaken to determine and model the distribution of operations across currently flown tracks for these scenarios.

Considering the normal deviation of individual aircraft from standard tracks (both instrument and visual), modelling includes a number of sub-tracks which are distributed either side of the median track (middle or main track). The locations of sub-tracks for tracks not currently flown are based on existing dispersions of similar tracks. Operations are assigned to the median and sub-tracks using a normal distribution profile. This ensures that the noise modelling is more aligned with reality.

If tracks are altered, then the noise footprint would alter accordingly. Therefore, though the predictions are sensitive to flight tracks, care has been taken to ensure the model closely represents reality and significant variation from the modelling assumptions in this regard is considered unlikely.

A significant change to the airspace surrounding Perth Airport, such as the introduction of new air traffic management procedures, would alter the noise footprint.

22.6.8.2 Flight Profiles

The assessment generally assumed standard ascent and descent profiles that are contained in the INM modelling software.

Departures considered the forecast destination and consequently determined an ascent profile based on the INM stage length (and consequent fuel load). Calibration of stage lengths to match existing profiles was undertaken to the extent practical. These are considered likely to closely align with actual flight profiles as significantly greater or lesser ascents require more fuel and/or are not permitted.

Departure procedures are typically specific to aircraft and airlines. Different procedures may dictate different climb rates and thrusts used. These will alter the noise level on the ground.

Ascent profiles also depend on wind and other meteorological conditions influencing aircraft performance e.g. departures with a stronger headwind will follow a steeper profile than those with less headwind. Modelling used a headwind of zero knots which was determined by the calibration process to best correlate with measured noise levels.

It is possible that some operations could adopt alternative profiles and/or procedures, if appropriate procedures are developed. This may alter the noise footprint for these operations.

22.6.9 Aircraft Destinations or Origins

Generally, longer flights require aircraft to carry more fuel on departure, which results in higher thrust settings and lower climb profiles. The combination of these factors means that departures of longer flights typically produce higher noise levels than shorter ones. The noise emissions of arriving aircraft are generally independent of the distance flown because minimal thrust is required and much of the noise on arrival is generated by the airframe interacting with the air.

In the INM modelling program, departures are defined for several stage lengths, representing different distances to the destination. Noise levels on departure can be calculated for various stage lengths for each aircraft type. Table 22-13 presents the various INM departure stage lengths.

INM Stage Length	Distance to Destination Airport (nautical miles)	
	From	To
1	0	500
2	501	1000
3	1001	1500
4	1501	2500
5	2501	3500
6	3501	4500
7	4501	5500
8	5501	6500
9	over 6500	

Table 22-13 Integrated Noise Model aircraft departure stage lengths
Source: Wilkinson Murray

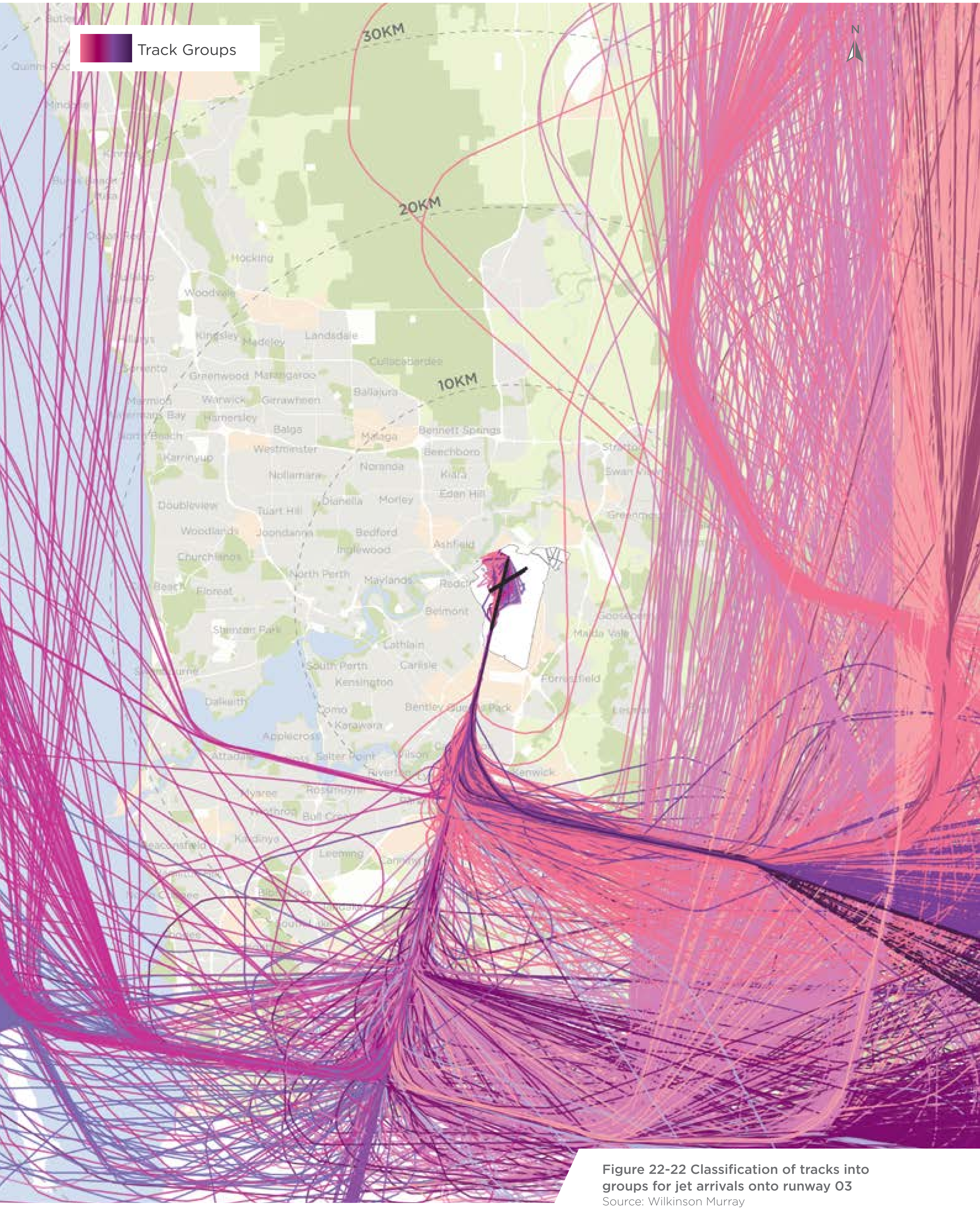


Figure 22-22 Classification of tracks into groups for jet arrivals onto runway 03
Source: Wilkinson Murray

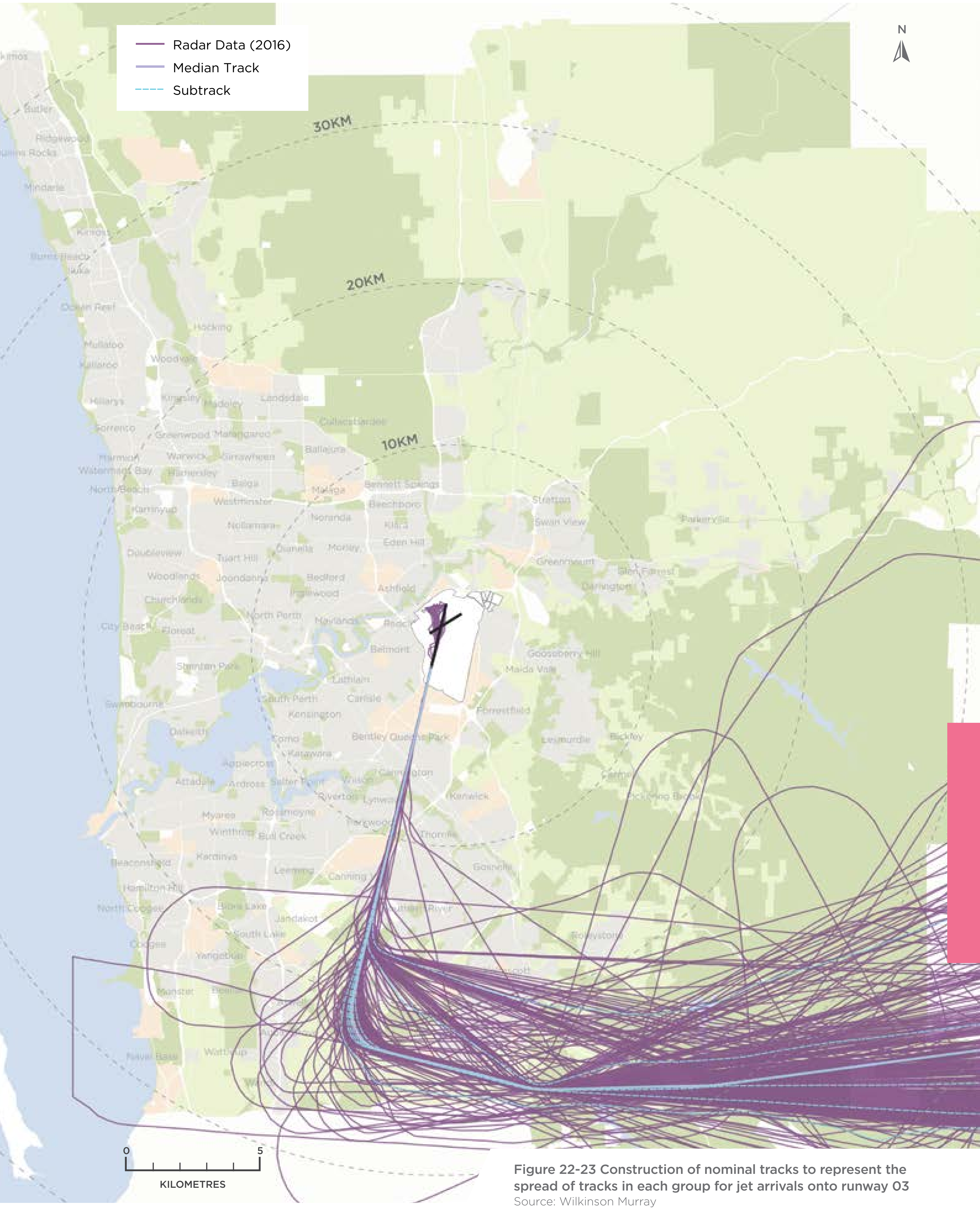


Figure 22-23 Construction of nominal tracks to represent the spread of tracks in each group for jet arrivals onto runway 03
Source: Wilkinson Murray

Departures by most aircraft types are defined for several stage lengths, representing different distances to the destination and hence different assumed fuel loads. Noise levels on departure were calculated for all possible stage lengths for each aircraft type and were allocated to operations based on the port of destination assigned to each departure in the forecast schedule for the relevant scenario.

22.6.10 Terrain Data

Terrain was considered in the noise model. Terrain was obtained from the National Aeronautics Space Administration (NASA) shuttle radar topography mission three arc second global dataset.

22.6.11 Meteorological Data

The mode of operation of the airport is largely dependent on meteorological conditions.

Meteorological data from the Perth Airport weather station was acquired from the Bureau of Meteorology for the period 1 January 2002 to 13 March 2017. This data was recorded every 30 minutes (excluding a small percentage of missing data). The data includes:

- mean wind speed,
- maximum three second gust wind speed,
- mean wind direction,
- visibility, and
- cloud cover for three layers including height and amount (oktas).

The influence of these prevailing winds is evident in the proportional availability of the existing main runway (03R/21L) presented in Figure 22-24. The prevailing sea breeze from the south-west, limits availability of runway 03 (i.e. departing to the north and arriving from the south) in the afternoon and evening. Conversely, the prevailing land-to-sea breeze limits availability of runway 21 during the night and morning. This phenomenon is most pronounced during the warmer months of October through March. However, it can be observed to a lesser degree throughout the remainder of the year.

The availability for the parallel runway system (new runway 03R/21L and main runway 03L/21R) is predicted, using historical meteorological data, in Figure 22-24.

22.6.11.1 Noise Levels from Individual Aircraft Operations

Parameters used in the INM calculations were:

- temperature of 20 °C,
- atmospheric pressure of 1017 hectopascals, and
- headwind of zero knots.

Each of these parameters was selected to be a conservative representation of reality, with each parameter equivalent to or resulting in slightly reduced aircraft performance (i.e. reduced climb for departures, higher thrust settings and higher noise levels on the ground) as compared to the mean values determined in the analysis. These values were used in the verification and calibration processes detailed in Section 22.6.2 and a general tendency for the model to slightly under-predict was observed despite the apparent conservatism of these parameters.

Predicted noise levels are not very sensitive to any of the above parameters – for example, increasing the temperature by 5 °C would increase the noise level on the ground by less than one decibel.

The assessment is sensitive to the prevailing meteorological conditions, the impact of which would be to alter the airport operating mode. The impact of these conditions was accounted for by the analysis of over 15 years of meteorological data and incorporation of this data into the modelling methodology. Consequently, over time, actual conditions are unlikely to dictate significantly different operations from those determined by the assessment. It is recognised that there may be periods of time when different meteorological conditions prevail and for these periods there may be more or fewer operations of a particular type.

22.6.12 Aircraft Noise Assessment Methodology

This assessment has adopted a best-practice aircraft noise assessment to comply with, and generally exceed, the requirements of the Airports Act. The adopted methodology is consistent with Standards Australia Handbook 149:2016 Acoustics—Guidance on producing information on aircraft noise. The prediction and assessment methodology has been developed following a review of contemporary assessments of similar projects in Australia and internationally, and in consultation with Airservices.

22.6.13 Assessment Considerations

22.6.13.1 Potentially Affected Receivers

Noise-sensitive receivers in the area around Perth Airport include residences, schools and other educational facilities, hospitals and other health care facilities, nursing homes, places of worship and childcare centres. The potential impact on these receivers is assessed in terms of a number of descriptors of noise exposure, as set out in Section 22.4. Benefits and impacts of the new runway are assessed in terms of changes in noise exposure at these locations, and in terms of the number of receivers experiencing a given level of noise exposure.

The assessment considers the new runway as part of parallel runway operations. Therefore some impacts would already exist.

22.6.14 Description of Significance Criteria

Evaluating aircraft noise exposure quantitatively is complex because significance is influenced by numerous factors. These factors include aircraft noise levels, the number of events, the duration of events and the number of receivers impacted. In addition, the potential impact of each of these factors is not solely based on the absolute value and it is also relevant to consider the degree of change of each.

There are no legislated quantitative criteria for the evaluation of aircraft noise in Australia. Instead, the assessment of aircraft noise is necessarily made by considering the impacts in a fair and equitable way.

What is fair and equitable cannot be determined simply from the number of receivers affected or noise levels alone. Changes in the noise environment should be considered. A reduction of aircraft noise in one area does not necessarily offset the introduction of new aircraft noise to another community, even though the total number of receivers above a particular noise metric threshold may be reduced. The benefits of periods with little or no aircraft noise (respite) or the negative impacts of reducing or removing respite are difficult to consider in the same quantitative framework as, for example, counting dwellings within noise modelling contours.

Section 22.4 outlined a set of metrics that describe aircraft noise and, to the degree possible, peoples' reaction to that noise. It is proposed that with this suite of metrics, all stakeholders are able to consider the various benefits and detriments of each option. These benefits and detriments are able to be compared against a defined impact significance framework so that the evaluation of impacts is as transparent and consistent as possible. The significance framework is qualitative and reflects the goals of the NRP for managing aircraft noise:

- to the extent permitted without compromising the operability of the airport,
- to minimise impacts resulting from aircraft noise, and
- to be fair and equitable to the various communities surrounding the airport with regards to aircraft noise exposure.

The qualitative significance criteria developed to assist in evaluating aircraft noise impacts are detailed in Section 25 which considers the social impacts of aircraft noise on the community.

Figure 22-24 Proportional availability of runway 03/21 by clock hour
Source: Wilkinson Murray

*The y-axis denotes the availability, by time, of the runway based on the entire meteorological dataset (14 years). The x-axis denotes the period starting with the indicated clock hour. VMC and IMC refer to visual and instrument meteorological conditions. ILS, in this context, refers to a subset of IMC with low visibility and/or low-level cloud whereby instrument landing systems would typically be required.

22.7 Aircraft Noise Assessment

22.7.1 Without New Runway 2025

This section presents predicted aircraft operations and noise emissions at Perth Airport with the continuation of the existing runway infrastructure. This without new runway scenario includes natural growth in operations not related to the NRP.

22.7.1.1 Runway Usage

Figure 22-25 presents the predicted runway usage in 2025 for the without new runway scenario. The data shows a continuation of the existing trend with regard to limited use of runway 06 for arrivals and runway 24 for departures, and use of the other runways.

22.7.1.2 N-Above Noise Contours

N60 and N65 noise contours were produced for the scenario without the new runway.

Figure 22-26, Figure 22-27 and Figure 22-28 present the without new runway average 24-hour N65 for a weekday, weekend and a typical day in 2025.

In all cases the minimal use of departures off runway 24 (south-westerly direction) and arrivals onto runway 06 (north-easterly direction) is evident. The typical busy day N65 ($NX_{(90)}$65, dotted line) in this area (Belmont and surrounds) is larger than the average, indicating that on days when this area is overflown, the number of noise events is understated by the average N-above.

Figure 22-29, Figure 22-30 and Figure 22-31 present the predicted without new runway annual night N60 for a typical night, weekday night and weekend night in 2025 respectively.

The typical busy day N60 ($NX_{(90)}$60, dotted line) contours are larger than the average. It is likely that this is due to the runway direction being maintained throughout the night period on at least ten per cent of nights. Hence the typical busy day N60 contours extend farther in all directions along arrival and departure tracks.

22.7.1.3 ANEC Noise Levels

The ANEC without the new runway for 2025 is presented in Figure 22-32.

The ANEC shows noise exposure is predicted in all directions, to a less extent off the southwest end of the cross runway (06/24), with no clear bias towards the other directions.

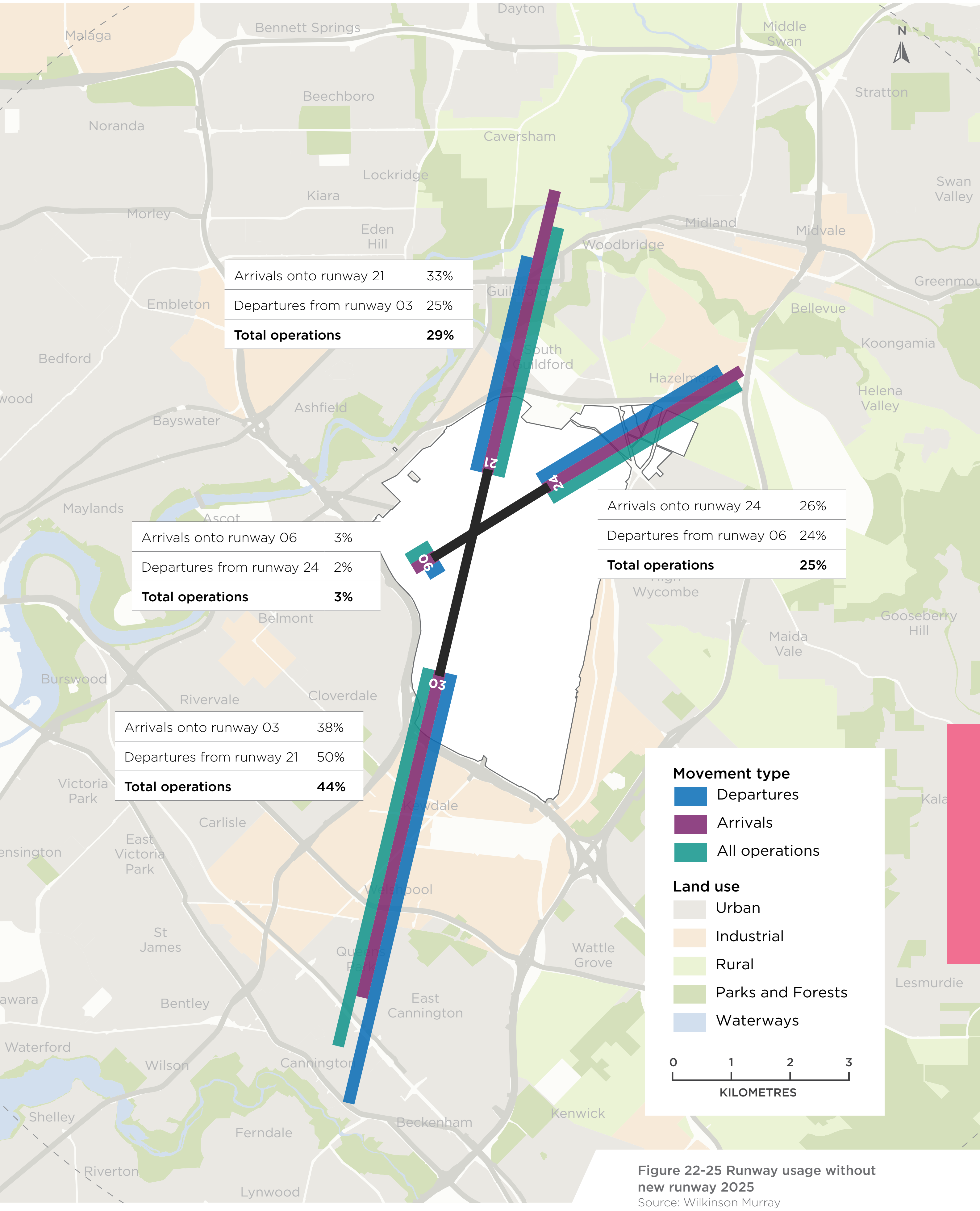


Figure 22-25 Runway usage without new runway 2025
Source: Wilkinson Murray

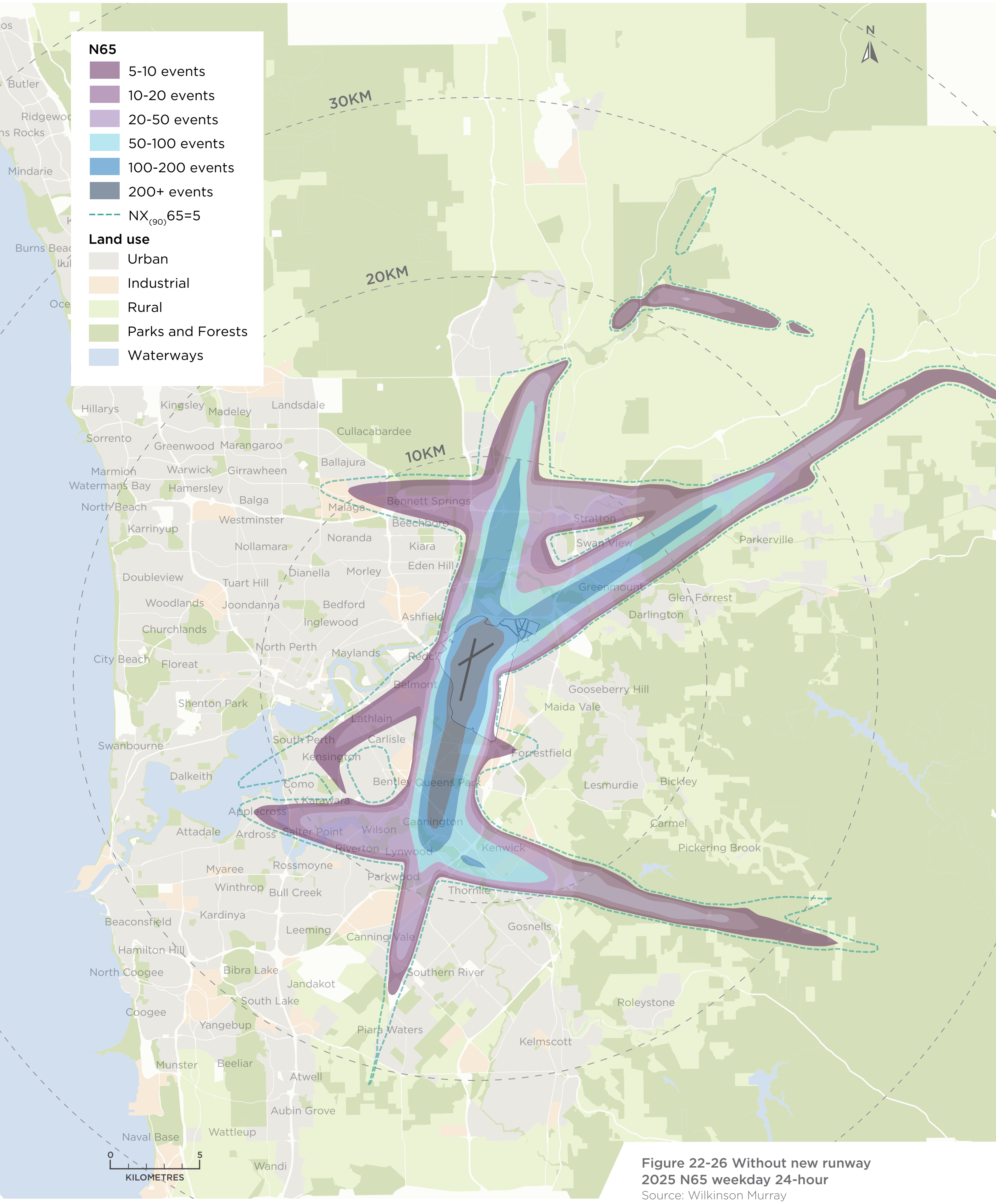


Figure 22-26 Without new runway 2025 N65 weekday 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

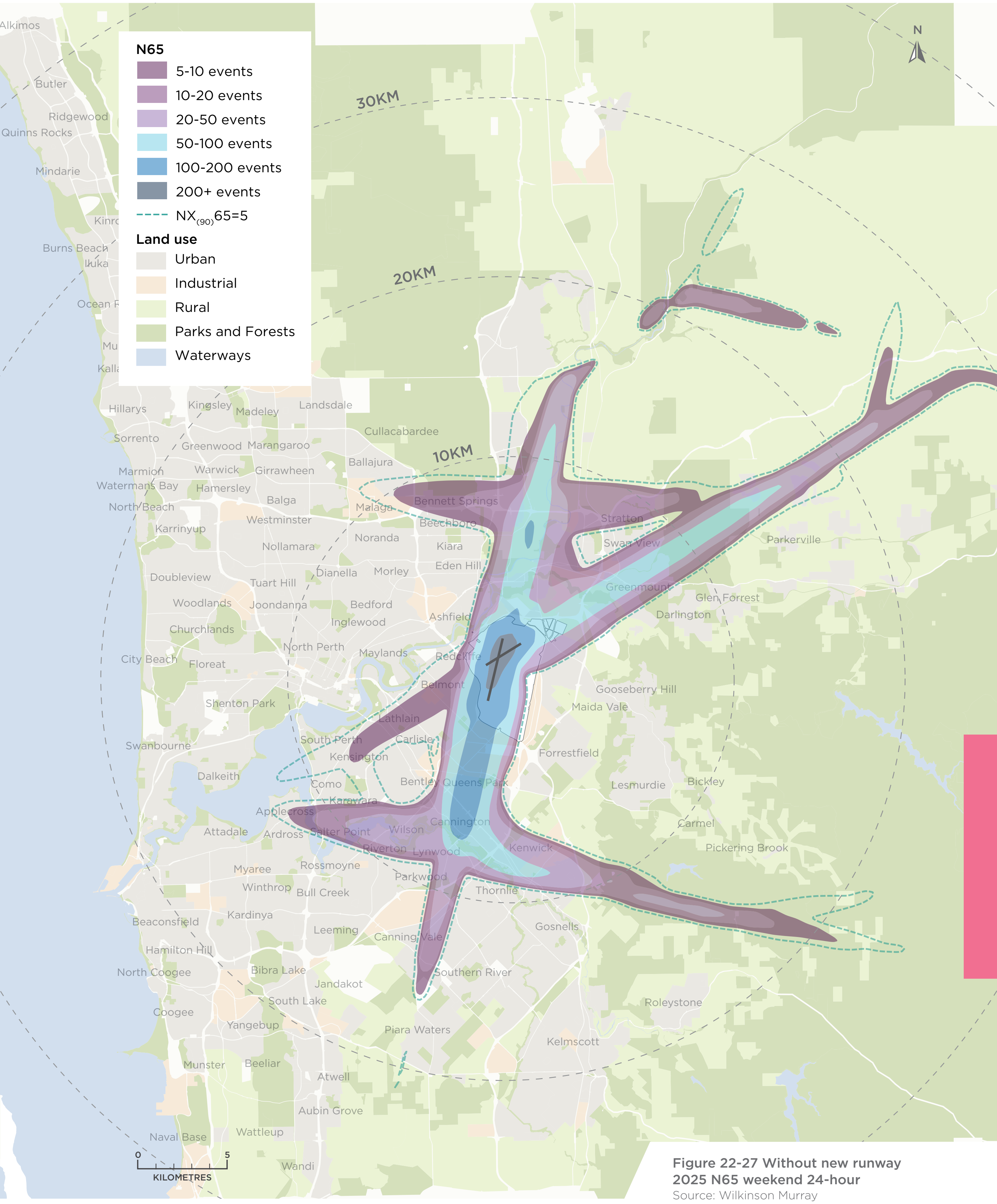


Figure 22-27 Without new runway 2025 N65 weekend 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-28 Without new runway 2025 N65 day 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

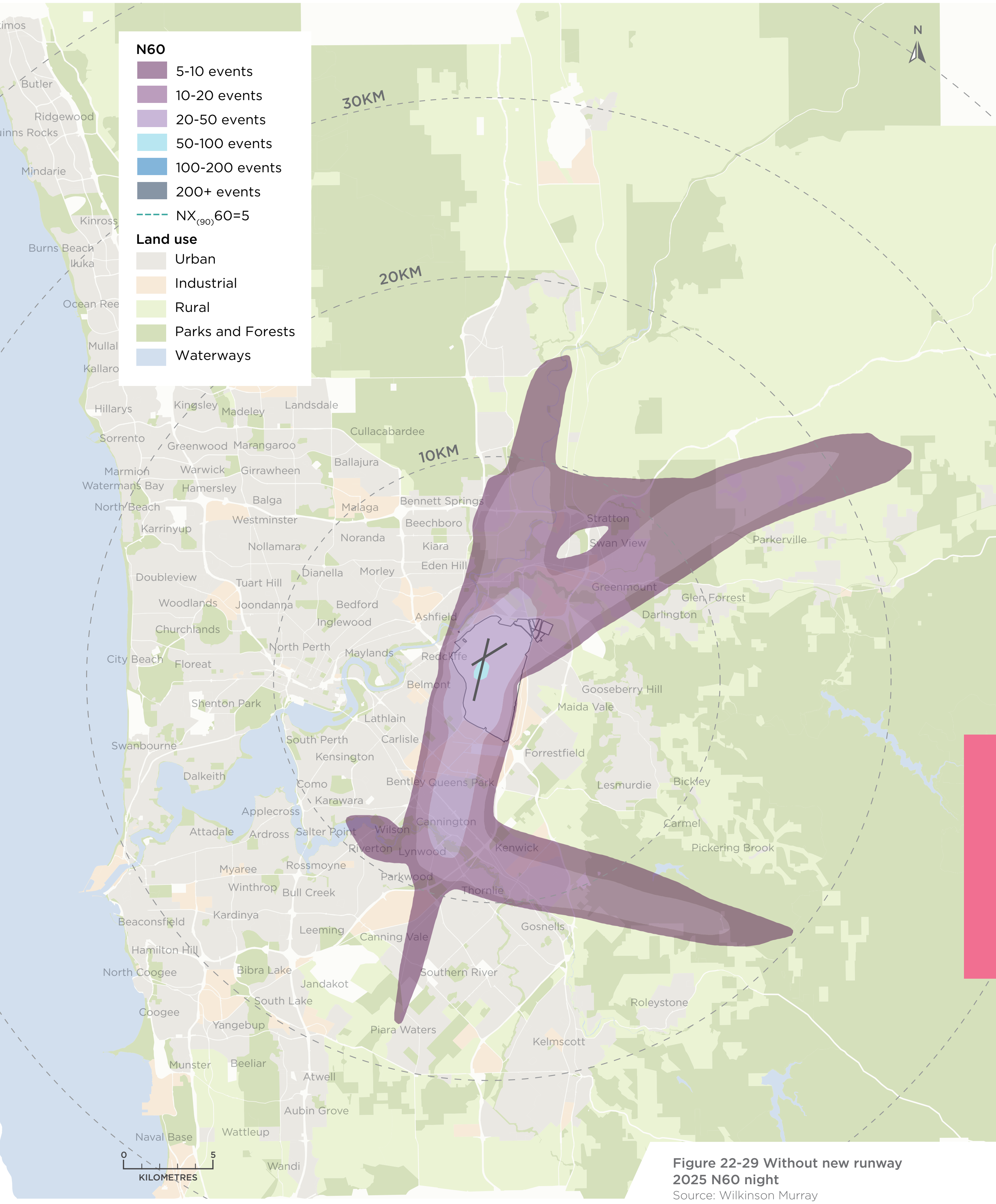


Figure 22-29 Without new runway 2025 N60 night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-30 Without new runway 2025 N60 weekday night

Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

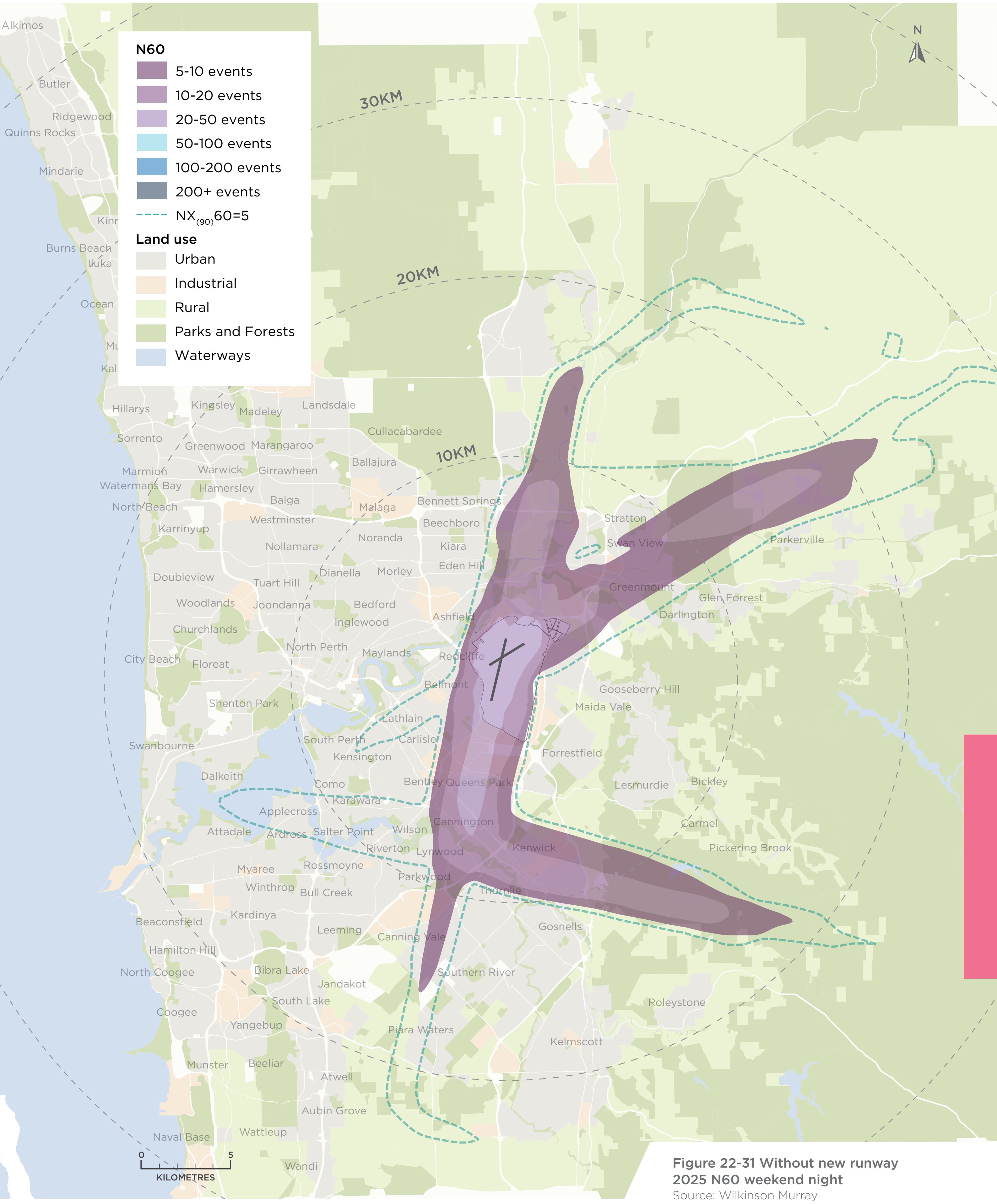


Figure 22-31 Without new runway 2025 N60 weekend night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

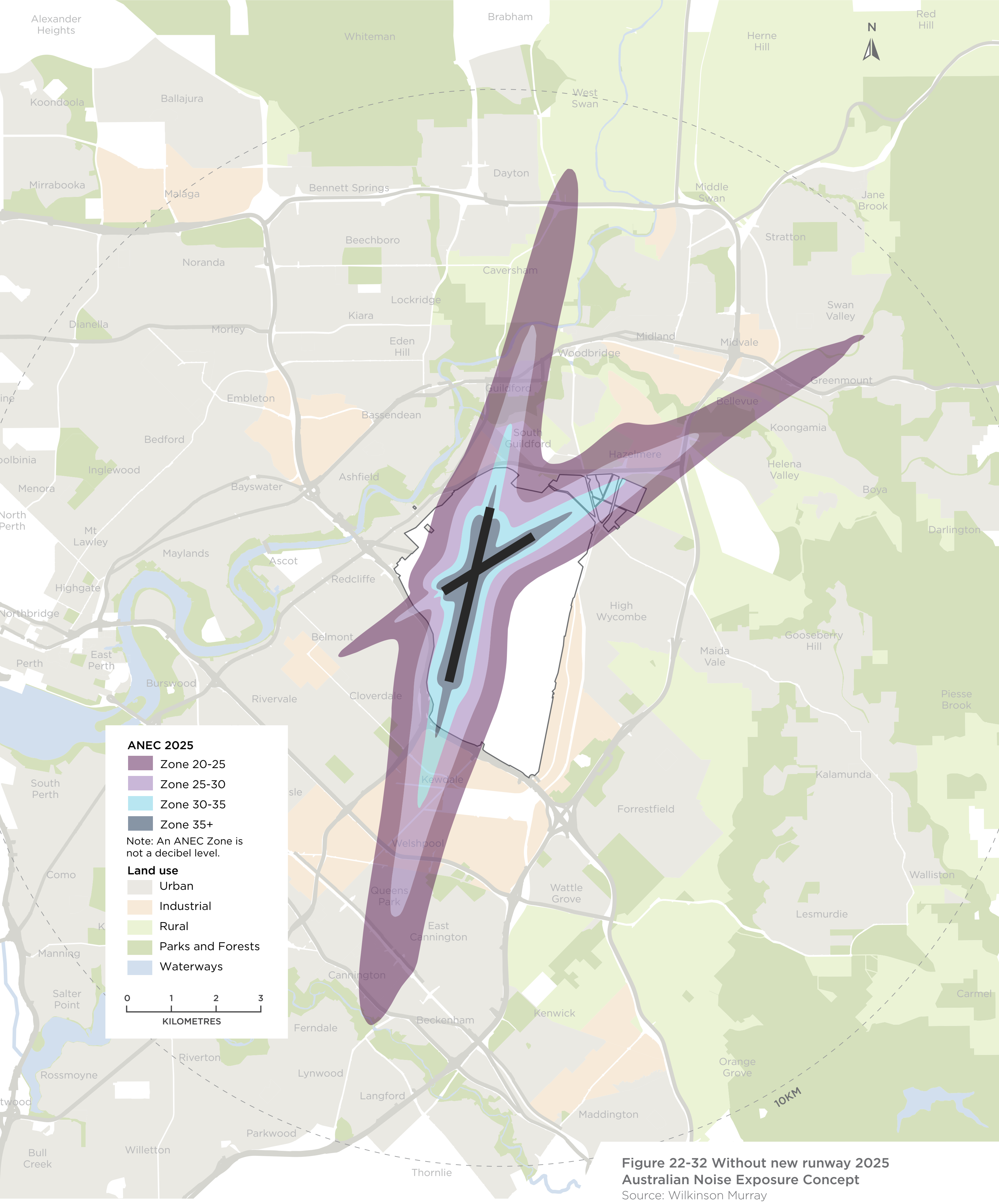


Figure 22-32 Without new runway 2025 Australian Noise Exposure Concept
Source: Wilkinson Murray

22.7.2 With New Runway 2025 and 2045

This section presents predicted aircraft operations and noise emissions at Perth Airport with the new runway. Many of the impacts of the new runway can be evaluated by comparing the metrics presented in this section with the corresponding without new runway metrics as previously described.

22.7.2.1 Parallel Runway Usage

Figure 22-33 and Figure 22-34 present summaries of the predicted runway usage with the NRP for 2025 and 2045.

22.7.2.2 Parallel Runway N-Above Noise Contours

N60 and N65 noise contours have been produced for the parallel runway operations. Predictions have been undertaken for 2025 and 2045.

Figure 22-35, Figure 22-36 and Figure 22-37 present the predicted NRP annual 24-hour N65 for a weekday, weekend and typical day in 2025. Figure 22-38, Figure 22-39 and Figure 22-40 present the predicted NRP N6O for a weekday, weekend and typical night in 2025.

The 24-hour N65 reflects the anticipated use of the new parallel runways. As compared with the equivalent without new runway scenario (shown previously in Figure 22-27, Figure 22-28 and Figure 22-29), the contours extend similarly along the extended centreline of the existing main runway (03L/21R), coinciding with the majority of proposed arrival tracks. The NRP contours are also similar to the scenario without the new runway along prominent departure tracks turning west off the existing main runway (03L/21R) centreline at approximately seven kilometres north and south of the airport.

Areas along the new runway (03R/21L) centreline are captured within the N65 contours for the NRP annual 24-hour scenario. Some of these areas are not captured by the corresponding without new runway contours.

Departures to the east with the NRP are predicted to generally use the new runway under the compass departures concept. Therefore, the without new runway N65 contours are not mirrored by the NRP N65 contours in this regard.

South of the airport, departures off runway 21L turn left soon after they cross the end of the runway. This is far sooner than the scenario without the new runway, which turn approximately seven kilometres south of the existing runway (03L/21R). The left turn soon after the runway end is a requirement of independent parallel runways, to provide adequate separation between the procedures for each runway. Noise contours in this area (Beckenham, Wattle Grove, Kenwick, Orange Grove and surrounds) differ from the without new runway scenario, impacting some areas that would be regarded as newly affected. More detailed analysis in the detailed design stage will be conducted to determine optimal routes.

Proposed departure procedures off runway 03R (northerly direction) consider using the corridor along the existing cross runway (06/24) centreline, northeast of the airport. The with new runway N65 contours for 2025 in this area are generally within the corresponding without new runway contours, with the N65=5 extending less than 20 kilometres in the with new runway scenario compared with over 30 kilometres in the without new runway scenario.

The area around Stratton, north east of the airport, is predicted to experience fewer noise events (as described by the N65) with the new runway. This is due to departures heading east using the new runway, along the tracks described above. In the without new runway scenarios those departures are expected to continue using the current departure tracks, which turn east approximately seven kilometres north of the airport.

Figure 22-41 to Figure 22-46 present this same information for 2045.

The N65=5 contour for the 2025 and 2045 with the new runway are similar because these are ultimately determined by the noise footprint of the louder aircraft. The forecast growth in operations is most evident in the remaining N65 contours. The progression of the 10, 20, 50 and 100 event N65 contours away from the airport is apparent across the three assessed years.

In both the 2025 and 2045 scenarios, the typical busy day N65 (dotted line, $NX_{(90)}65$) is generally only slightly larger than the average N65, indicating consistent operations and runway use. Where arrival and departure tracks diverge, the typical busy day N65 and average N65 differ. The typical busy day N65 indicates that for areas such as Huntingdale and Southern River to the south of runway 03R/21L, on at least ten per cent of days in 2025 five or more events exceeding 65 dBA are predicted.

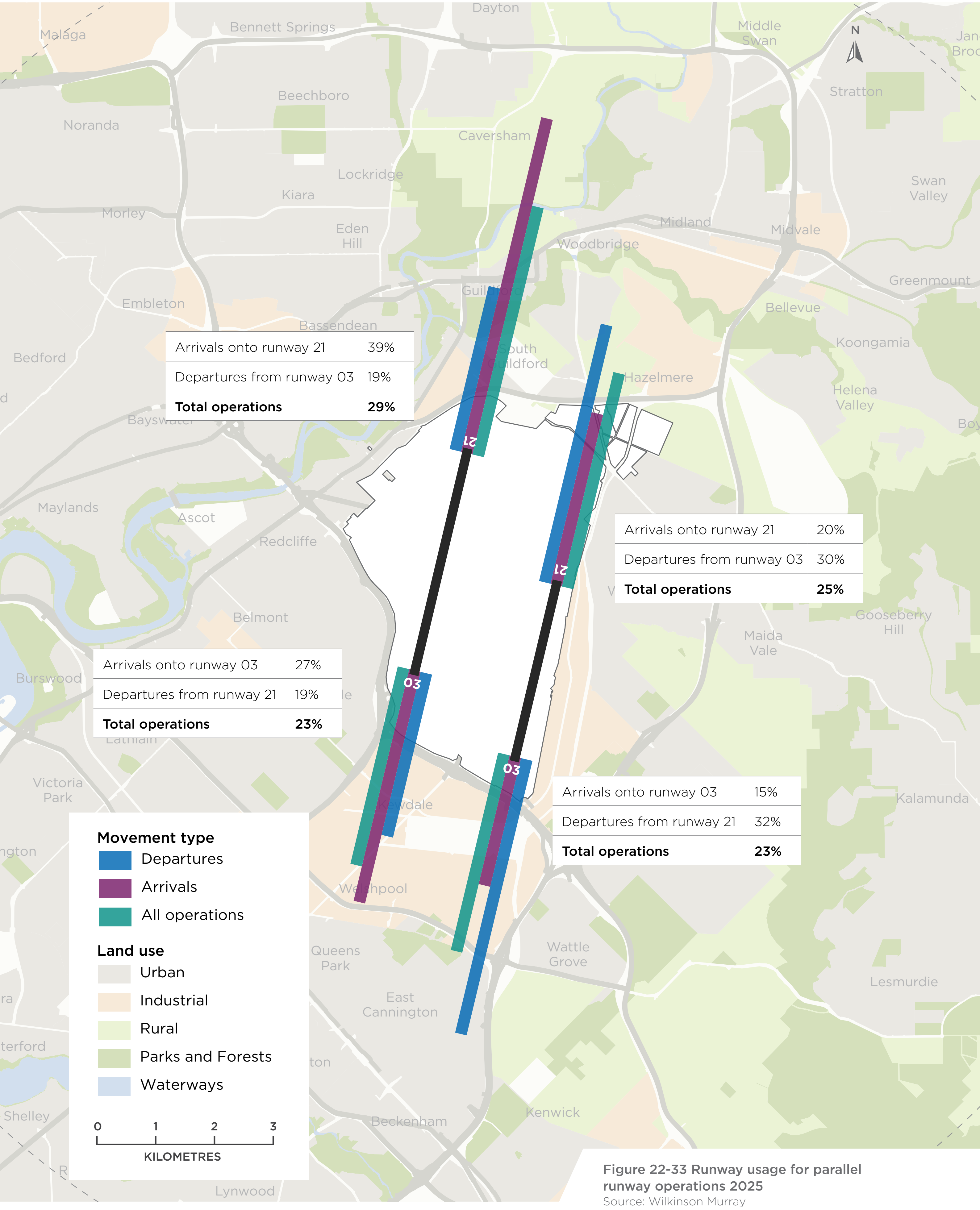


Figure 22-33 Runway usage for parallel runway operations 2025

Source: Wilkinson Murray

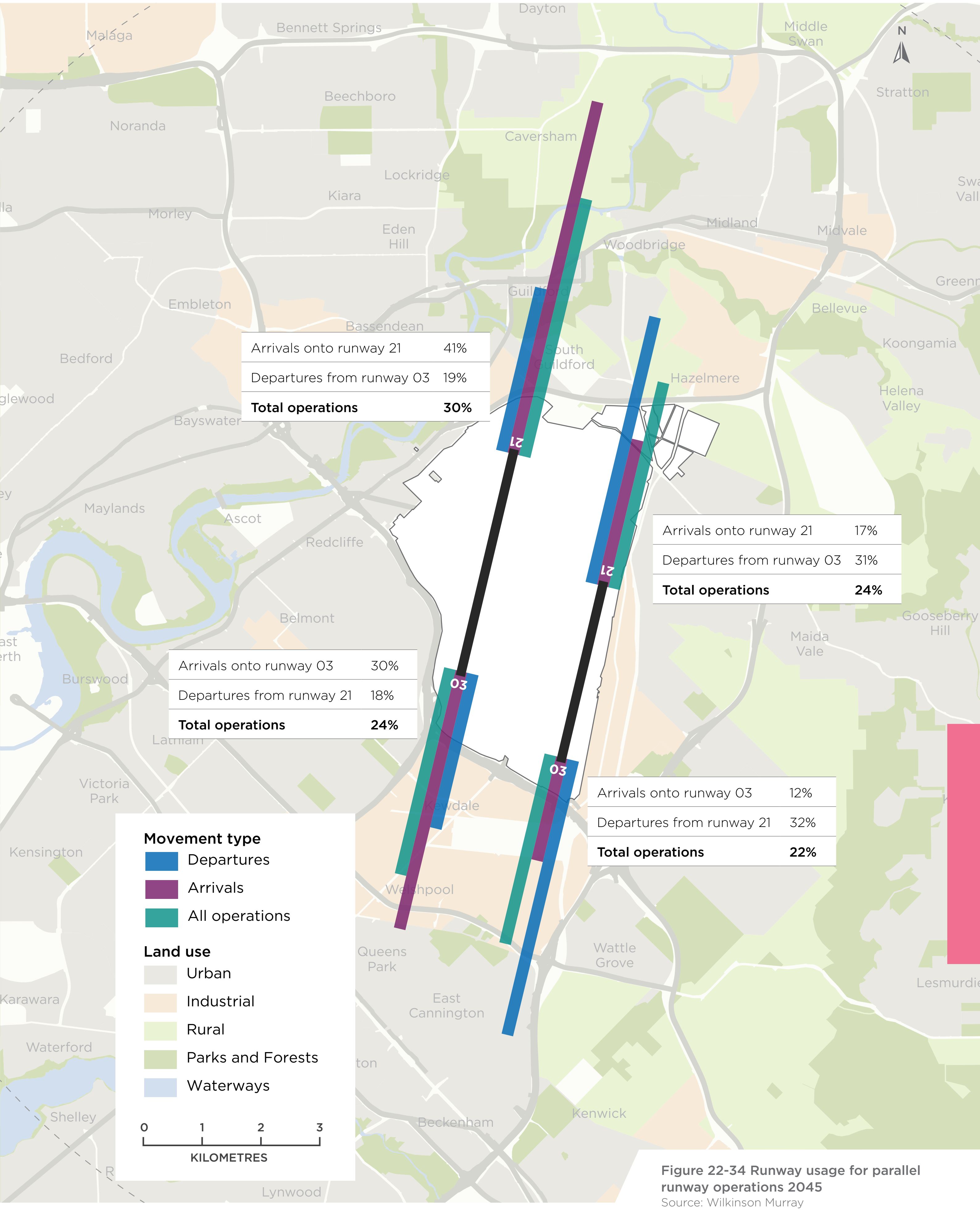


Figure 22-34 Runway usage for parallel runway operations 2045
Source: Wilkinson Murray

Figure 22-35 With new runway 2025 N65 weekday 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

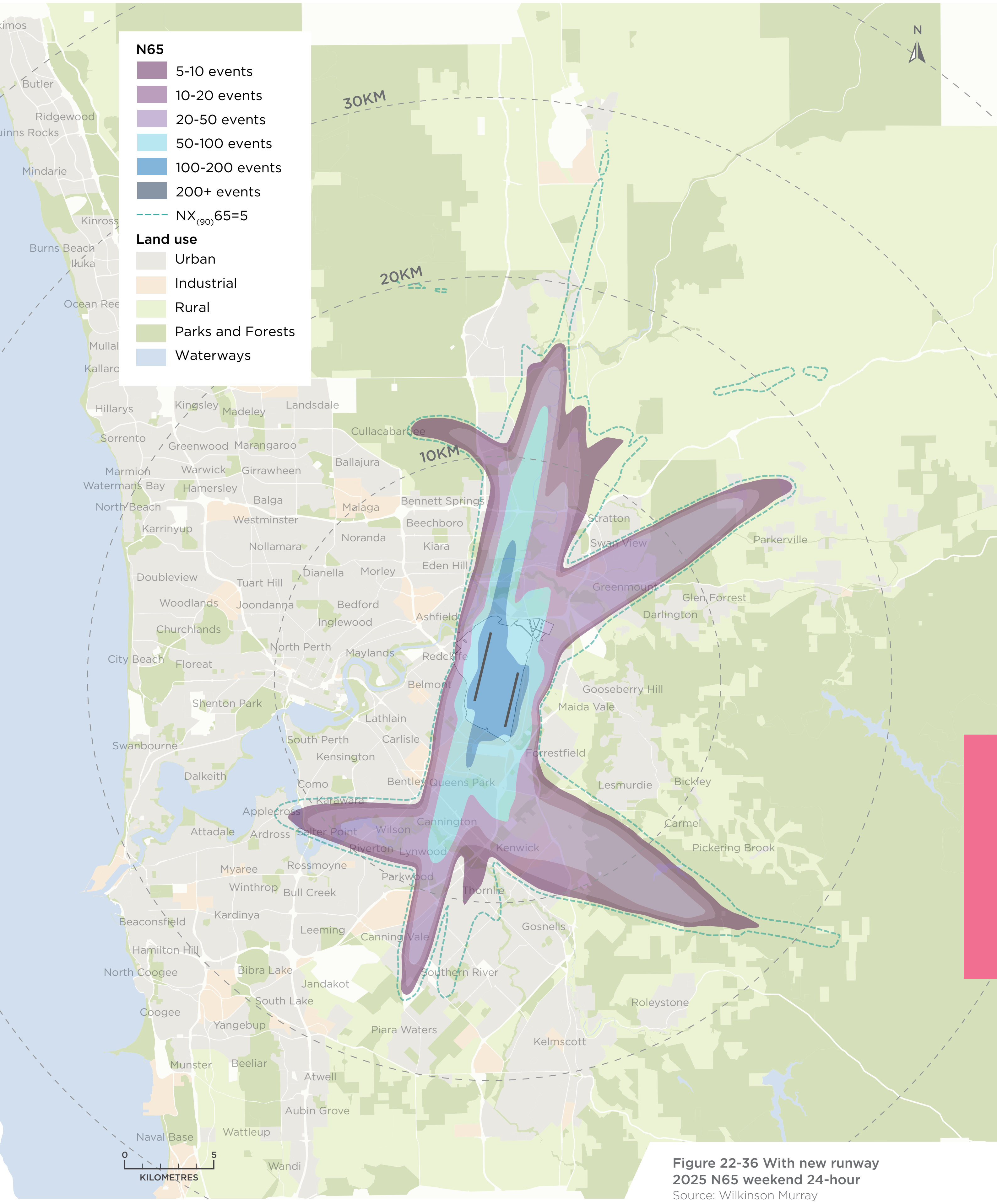


Figure 22-36 With new runway 2025 N65 weekend 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-37 With new runway 2025 N65 day 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

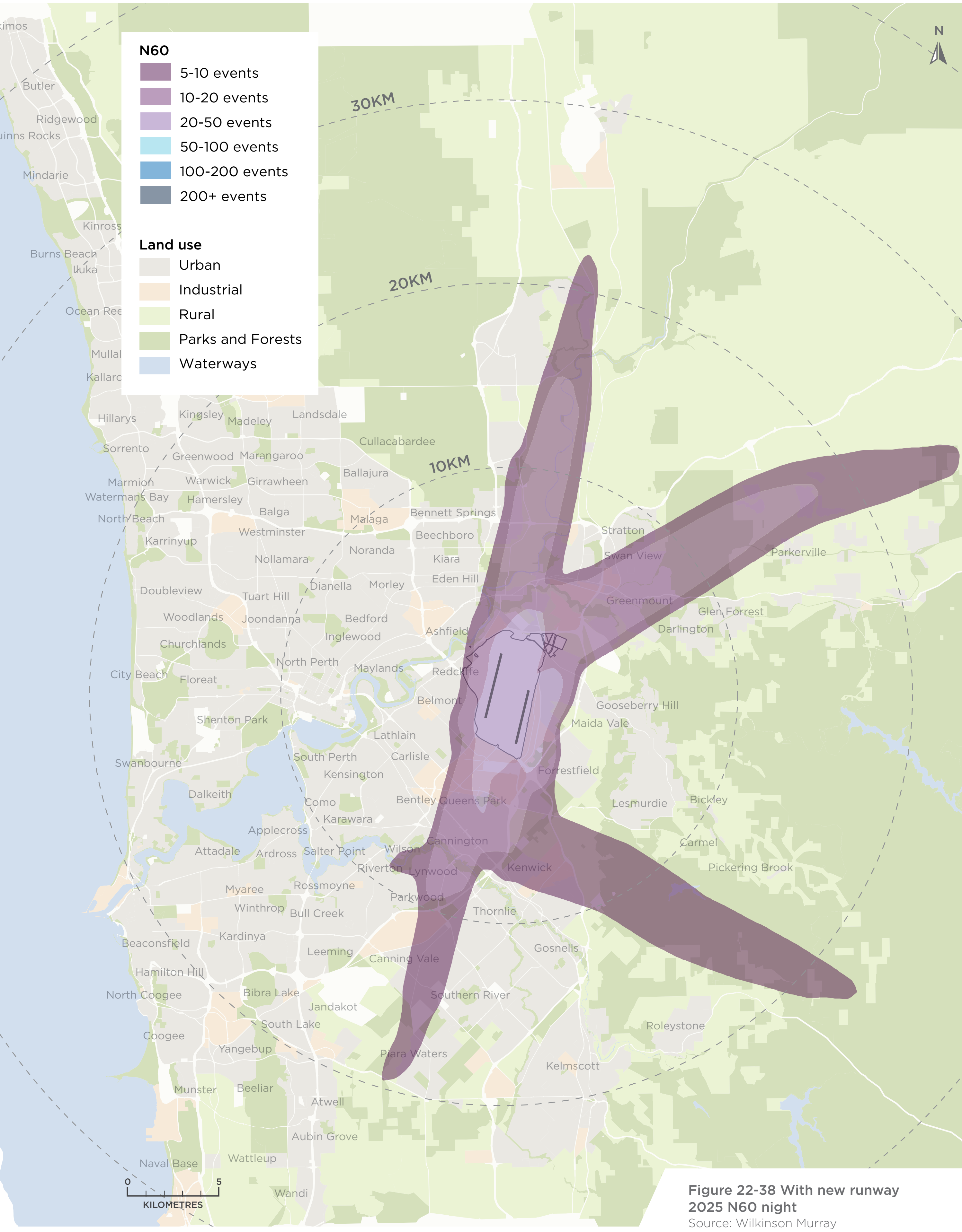


Figure 22-38 With new runway 2025 N60 night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

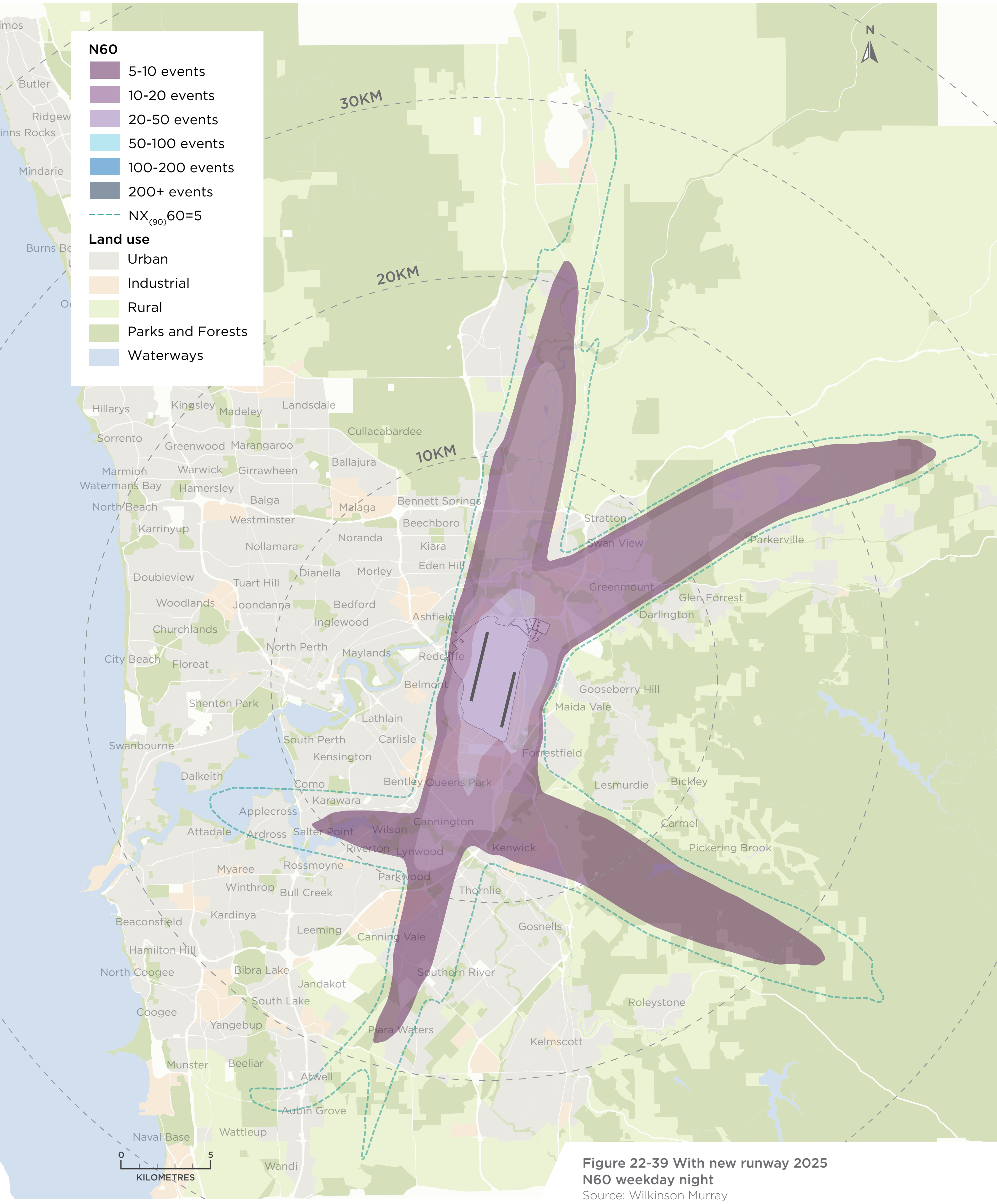


Figure 22-39 With new runway 2025 N60 weekday night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

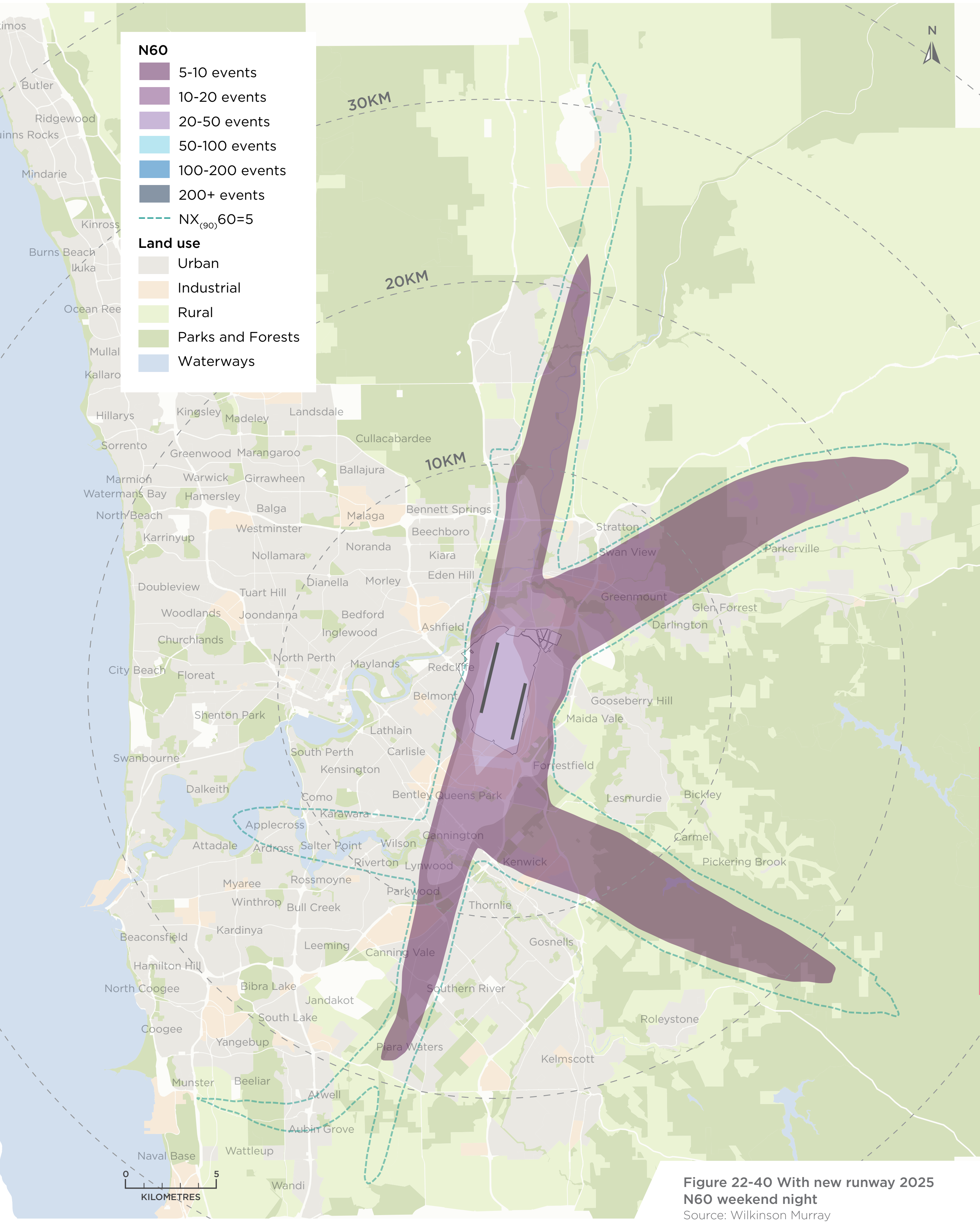


Figure 22-40 With new runway 2025 N60 weekend night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-41 With new runway 2045 N65 weekday 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-42 With new runway 2045 N65 weekend 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

Figure 22-43 With new runway 2045 N65 day 24-hour
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

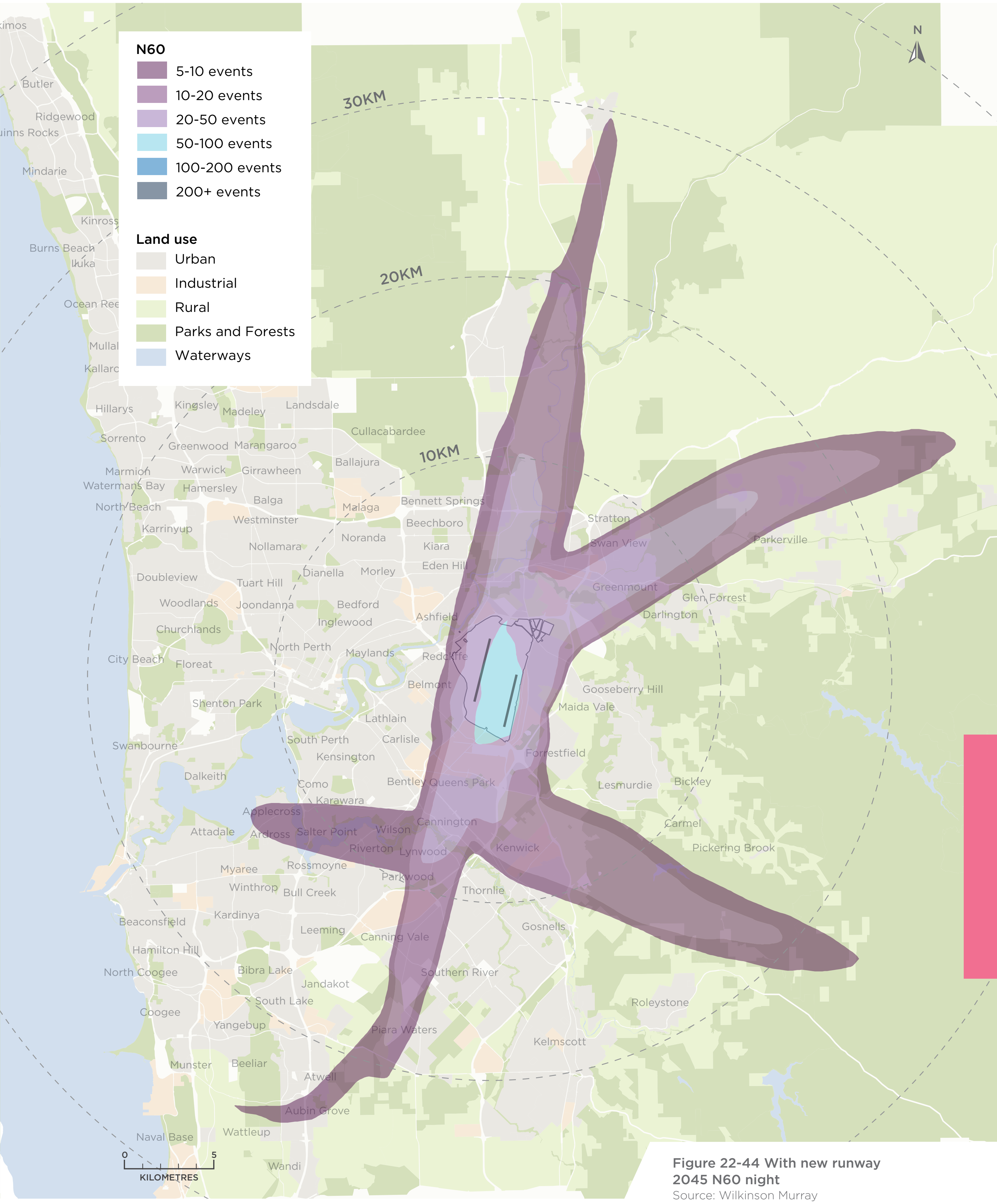


Figure 22-44 With new runway 2045 N60 night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

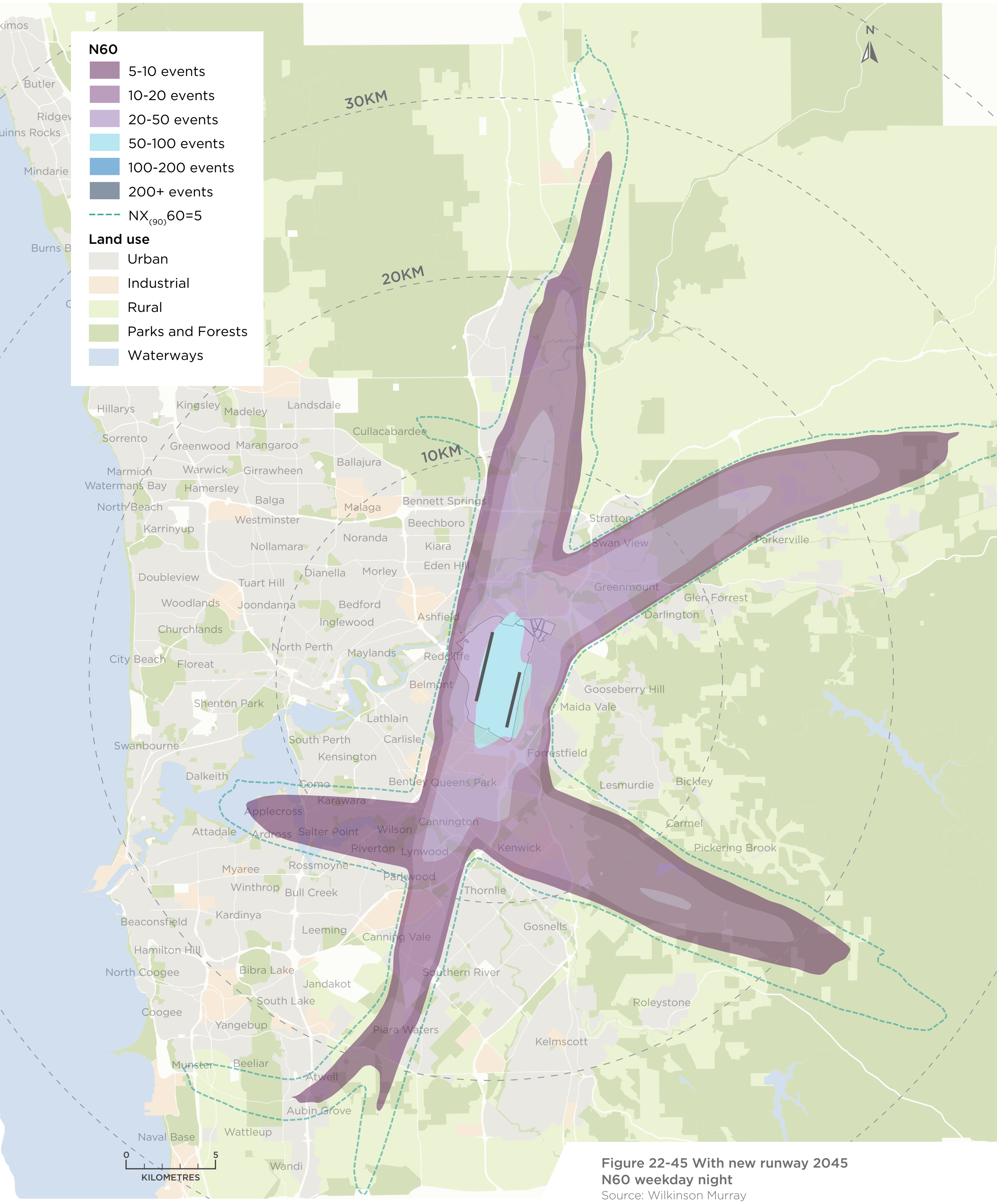


Figure 22-45 With new runway 2045 N60 weekday night

Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

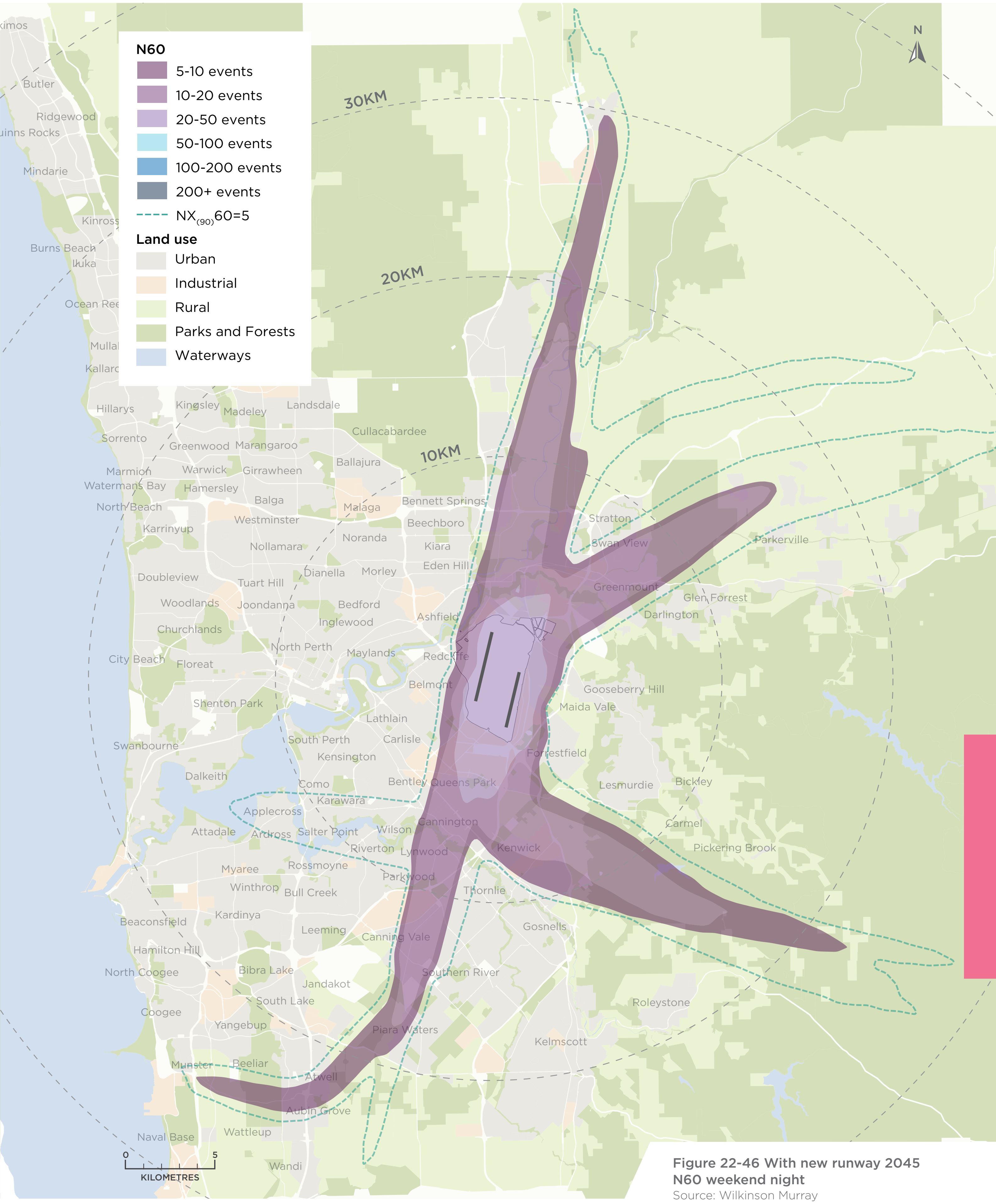


Figure 22-46 With new runway 2045 N60 weekend night
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

22.7.2.3 Seasonal Variations

Seasonal variations in meteorological conditions and schedules can result in changes in noise exposure.

Schedule changes are commonly associated with varying schedules at other airports, such as differences due to daylight saving in other states. For the assessment, the seasonal variation in the schedule was examined but not considered significant enough to warrant production of difference schedules. Thus, the assessment has been undertaken based on a single set of busy day schedules.

Seasonal variations due to meteorological conditions with reference to the prevailing winds for each season was considered. N-above contours have been produced for summer and winter for the with new runway scenario in 2025. In the case of summer and winter N-above charts, summer is defined as October to April, and winter as May to September. These periods were selected because they represent the most distinct shift in prevailing winds historically. Seasons referred to in the wind roses are conventionally defined seasons.

Figure 22-47 and Figure 22-48 presents summer and winter N-above contours for the with new runway weekday 24-hour and weekday night 2025 scenario.

A review of the results indicates that seasonal differences in the N-above contours are insignificant for the most part.

Because seasonal variations generally have a limited impact on the resulting operations, and consequently aircraft noise metrics, showing separate summer and winter contours for each scenario is not warranted. The ninetieth percentile, or typical busy day, N-above contours adequately communicates the potential variation in aircraft noise exposure.

22.7.2.4 Consistency with Australian Noise Exposure Forecast

Several particulars of the current assessment differ from the noise predictions used in developing the ANEF, specifically:

- a newer model of INM has been used, with updated aircraft noise profiles,
- significant analysis of historical data has been undertaken to determine the tracks flown for existing and with the new runway future scenarios,
- further refinement of the CONOPS has been undertaken in consultation with airlines, Airservices and the Civil Aviation Safety Authority (CASA),
- analysis of the existing track dispersions (i.e. the lateral deviation of actual operations from the SID or STAR route) has been applied to more accurately predict the dispersion of the future airspace design,
- analysis of over 14 years of meteorological data and consideration of air traffic control procedures has been used to predict future operations, including the proportional split of operations between runways, and
- the noise model used to calculate and predict aircraft noise at Perth Airport has undergone a significant validation and calibration exercise as part of this MDP assessment.

Figure 22-49 shows that the planning for the NRP is consistent with the 2014 ANEF.

The respective ANECs, from the 2045 scenario, are generally within the existing ANEF. It is difficult to meaningfully compare these ANECs against the existing ANEF because the ANEF is an ultimate capacity ANEF nominally forecast to occur in 2059. Therefore, a comparison against the ANEF and the 2059 ANEC is also provided in Figure 22-49.

As the produced ANECs are generally within the ANEF, this confirms the NRP is consistent with the endorsed ANEF and the existing land-use planning protection offered by the ANEF system includes the forecast use of the NRP.

Since the submission of the draft MDP, Perth Airport has developed a new ANEF as part of Master Plan 2020.

The new Ultimate Capacity ANEF continues to demonstrate consistency with the noise modelling contained within this MDP.

The new Ultimate Capacity ANEF and detail regarding it's composition can be found in Master Plan 2020.

22.7.3 Flight Zone Diagrams

The flight track movement charts that summarise the modelling undertaken for 2025 are presented in Figure 22-50 and Figure 22-51.

In the flight zone diagrams over page, the typical daily range is defined as the 20th percentile to the 90th percentile (i.e. excluding the lowest 20 per cent and highest 10 per cent of predicted days).

The flight zone diagrams provide a breakdown of the assumptions used in the aircraft noise modelling. Therefore, the flight zone diagrams provide an estimate on how often, on average, an aircraft is expected to use a given flight corridor in a given period.

The diagrams also show an estimate of respite for each corridor. Respite indicates the percentage of days when no flights are predicted (from the modelling) for the nominated period. For example, a respite of 35 per cent for 24 hours, would mean that for around 10 days per year it is expected that aircraft will not fly on the indicated corridor.

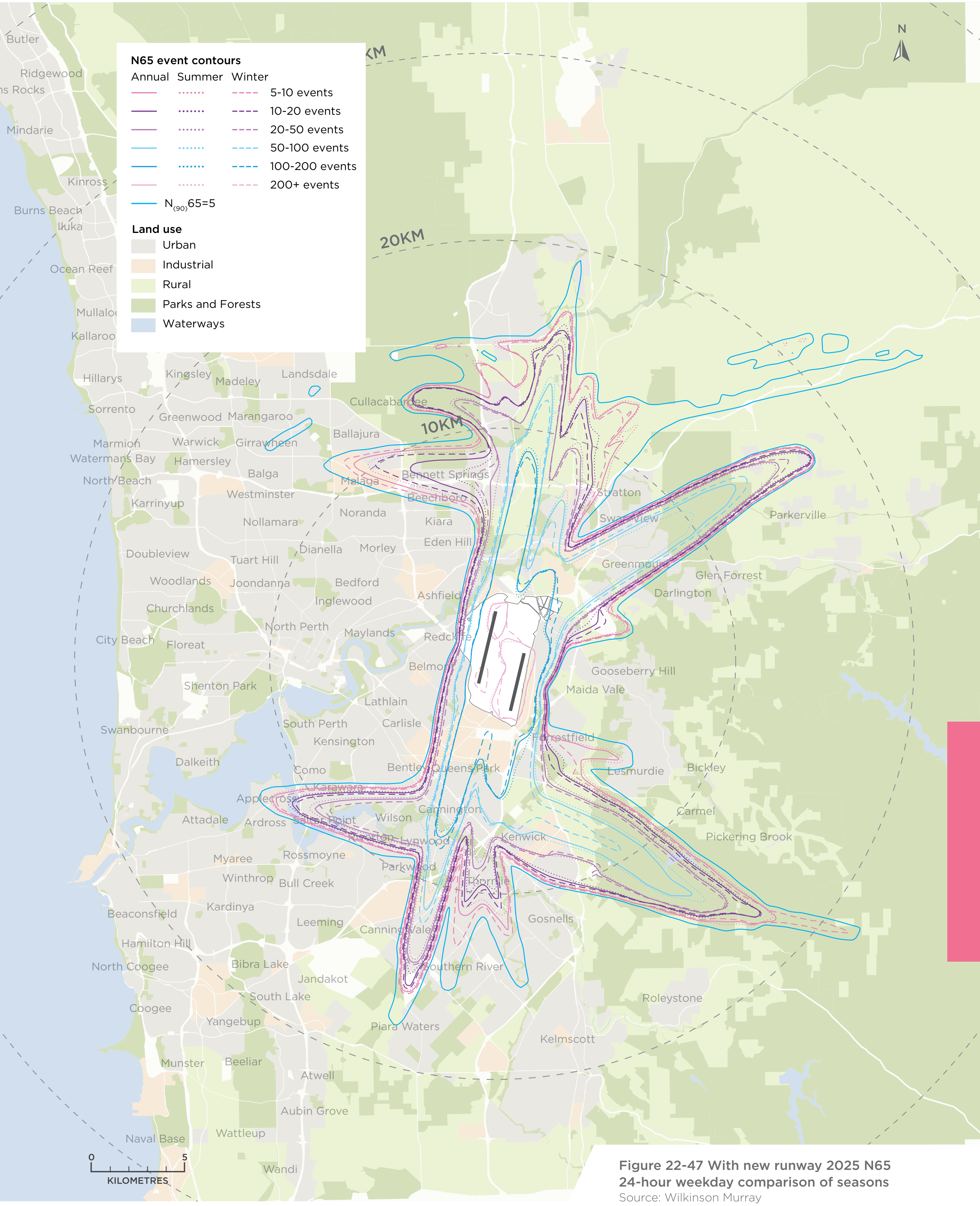


Figure 22-47 With new runway 2025 N65 24-hour weekday comparison of seasons

Source: Wilkinson Murray

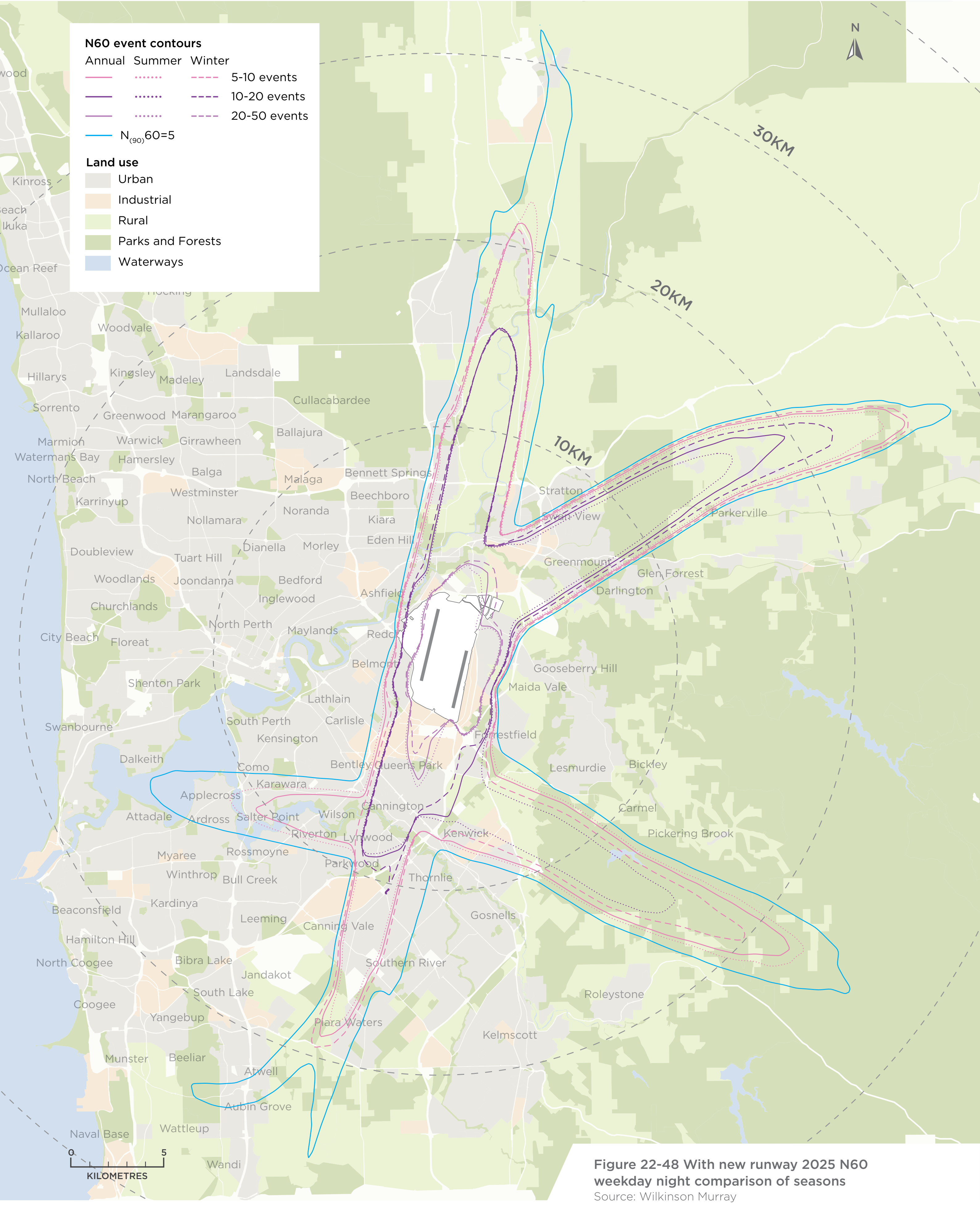


Figure 22-48 With new runway 2025 N60 weekday night comparison of seasons
Source: Wilkinson Murray

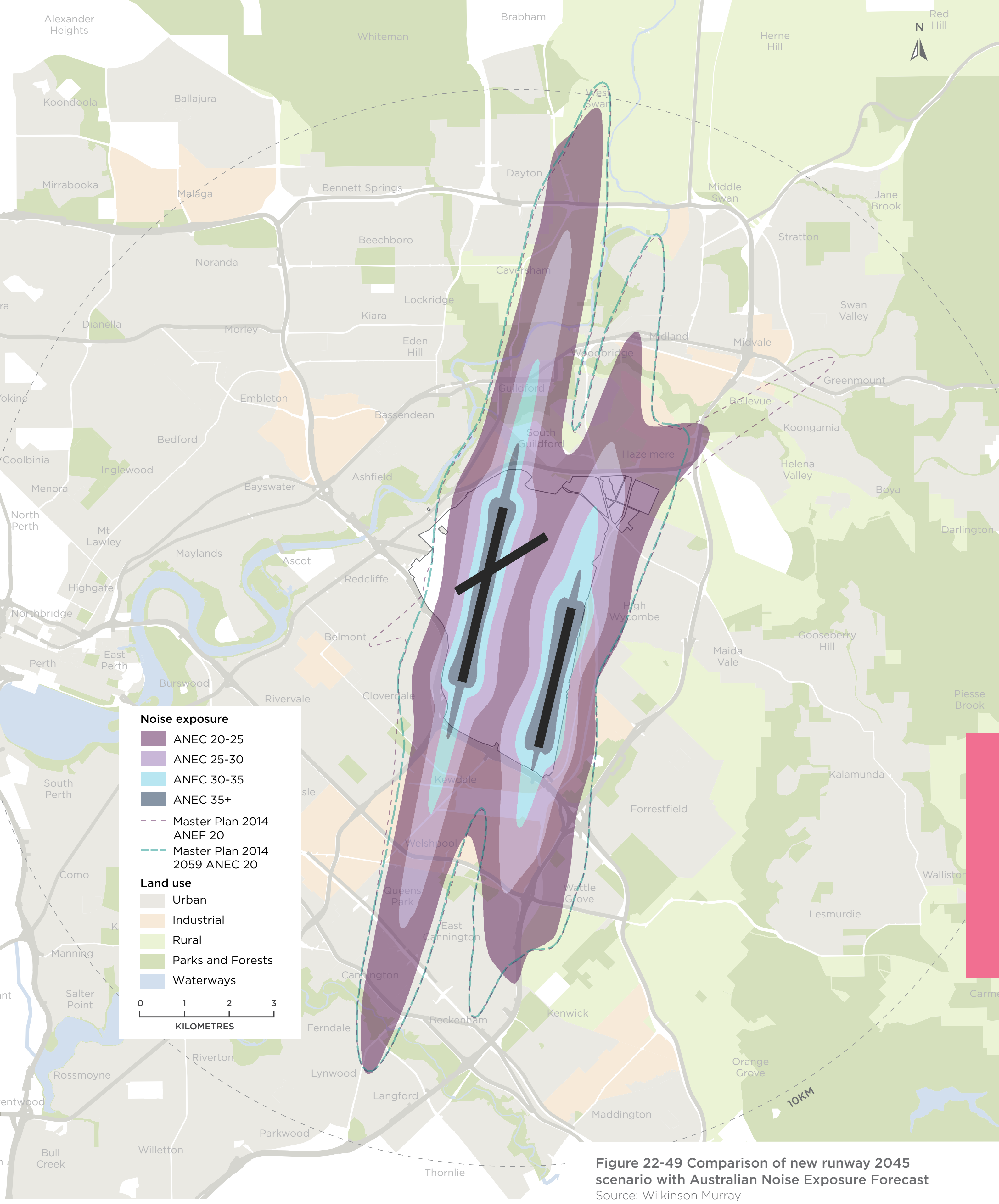
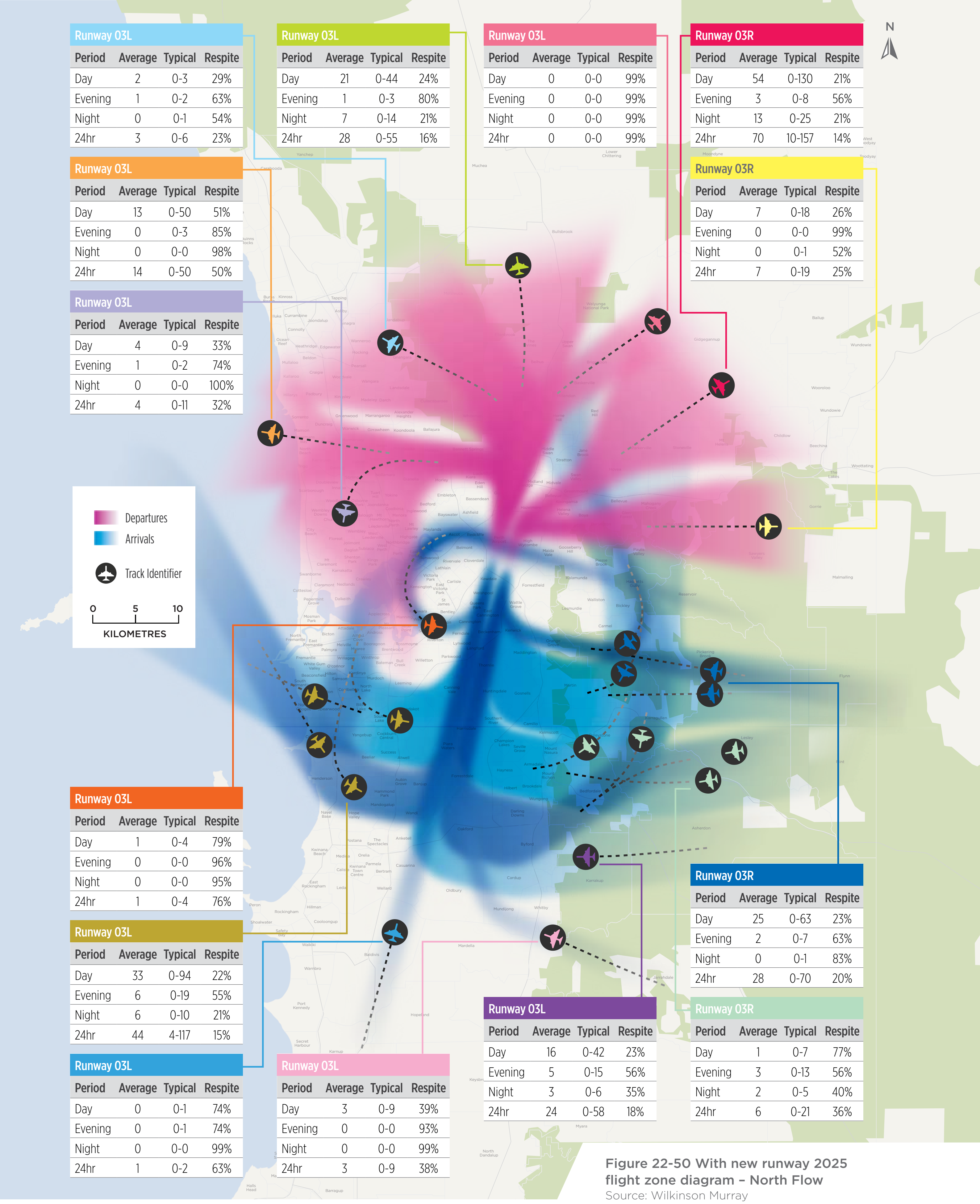


Figure 22-49 Comparison of new runway 2045 scenario with Australian Noise Exposure Forecast
Source: Wilkinson Murray

This ANEF represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.



Runway 03L

Period	Average	Typical	Respite
Day	2	0-3	29%
Evening	1	0-2	63%
Night	0	0-1	54%
24hr	3	0-6	23%

Runway 03L

Period	Average	Typical	Respite
Day	21	0-44	24%
Evening	1	0-3	80%
Night	7	0-14	21%
24hr	28	0-55	16%

Runway 03L

Period	Average	Typical	Respite
Day	0	0-0	99%
Evening	0	0-0	99%
Night	0	0-0	99%
24hr	0	0-0	99%

Runway 03R

Period	Average	Typical	Respite
Day	54	0-130	21%
Evening	3	0-8	56%
Night	13	0-25	21%
24hr	70	10-157	14%

Runway 03L

Period	Average	Typical	Respite
Day	13	0-50	51%
Evening	0	0-3	85%
Night	0	0-0	98%
24hr	14	0-50	50%

Runway 03R

Period	Average	Typical	Respite
Day	7	0-18	26%
Evening	0	0-0	99%
Night	0	0-1	52%
24hr	7	0-19	25%

Runway 03L

Period	Average	Typical	Respite
Day	4	0-9	33%
Evening	1	0-2	74%
Night	0	0-0	100%
24hr	4	0-11	32%

Runway 03L

Period	Average	Typical	Respite
Day	1	0-4	79%
Evening	0	0-0	96%
Night	0	0-0	95%
24hr	1	0-4	76%

Runway 03R

Period	Average	Typical	Respite
Day	25	0-63	23%
Evening	2	0-7	63%
Night	0	0-1	83%
24hr	28	0-70	20%

Runway 03L

Period	Average	Typical	Respite
Day	33	0-94	22%
Evening	6	0-19	55%
Night	6	0-10	21%
24hr	44	4-117	15%

Runway 03L

Period	Average	Typical	Respite
Day	16	0-42	23%
Evening	5	0-15	56%
Night	3	0-6	35%
24hr	24	0-58	18%

Runway 03R

Period	Average	Typical	Respite
Day	1	0-7	77%
Evening	3	0-13	56%
Night	2	0-5	40%
24hr	6	0-21	36%

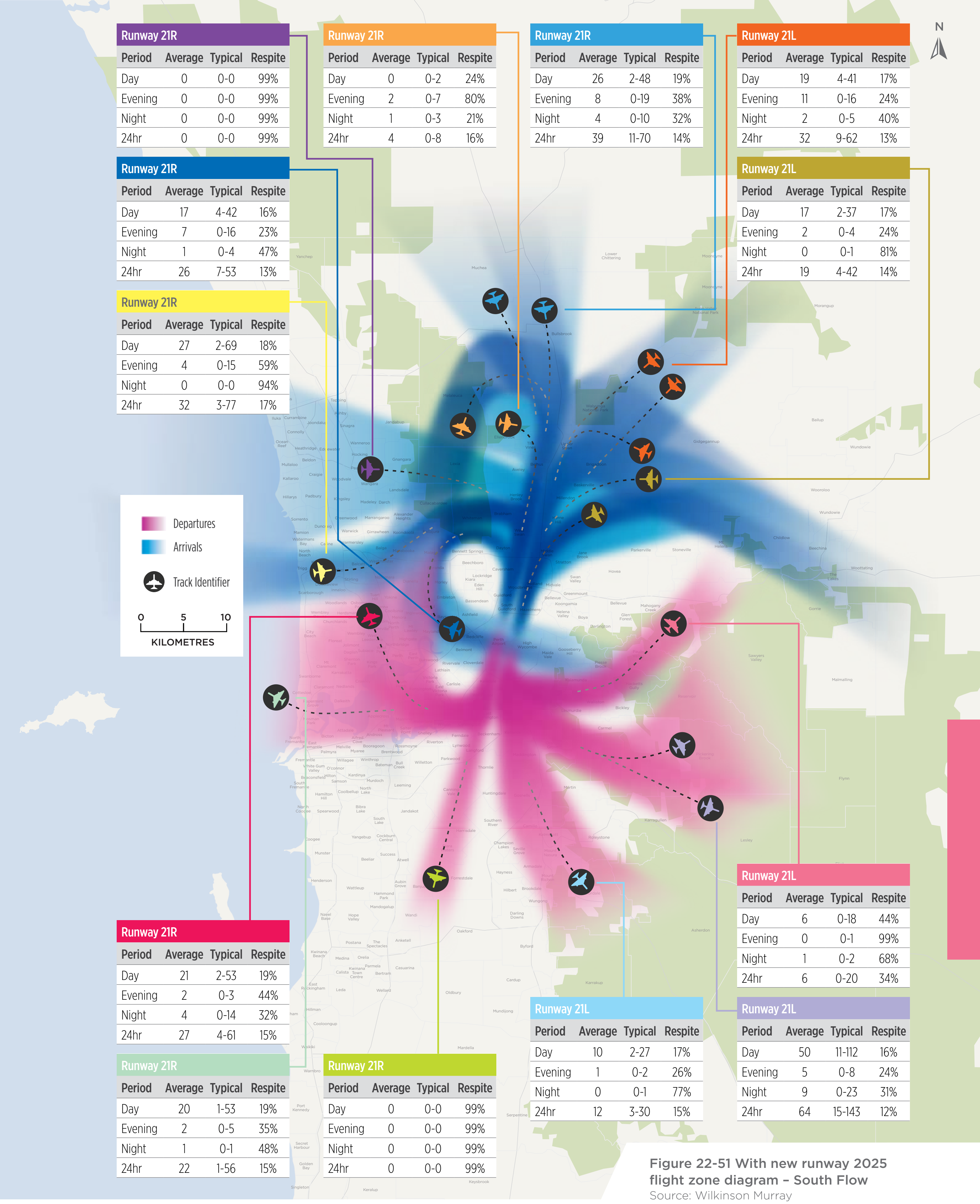
Runway 03L

Period	Average	Typical	Respite
Day	0	0-1	74%
Evening	0	0-1	74%
Night	0	0-0	99%
24hr	1	0-2	63%

Runway 03L

Period	Average	Typical	Respite
Day	3	0-9	39%
Evening	0	0-0	93%
Night	0	0-0	99%
24hr	3	0-9	38%

Figure 22-50 With new runway 2025 flight zone diagram – North Flow
Source: Wilkinson Murray



Runway 21R

Period	Average	Typical	Respite
Day	0	0-0	99%
Evening	0	0-0	99%
Night	0	0-0	99%
24hr	0	0-0	99%

Runway 21R

Period	Average	Typical	Respite
Day	0	0-2	24%
Evening	2	0-7	80%
Night	1	0-3	21%
24hr	4	0-8	16%

Runway 21R

Period	Average	Typical	Respite
Day	26	2-48	19%
Evening	8	0-19	38%
Night	4	0-10	32%
24hr	39	11-70	14%

Runway 21L

Period	Average	Typical	Respite
Day	19	4-41	17%
Evening	11	0-16	24%
Night	2	0-5	40%
24hr	32	9-62	13%

Runway 21R

Period	Average	Typical	Respite
Day	17	4-42	16%
Evening	7	0-16	23%
Night	1	0-4	47%
24hr	26	7-53	13%

Runway 21L

Period	Average	Typical	Respite
Day	17	2-37	17%
Evening	2	0-4	24%
Night	0	0-1	81%
24hr	19	4-42	14%

Runway 21R

Period	Average	Typical	Respite
Day	27	2-69	18%
Evening	4	0-15	59%
Night	0	0-0	94%
24hr	32	3-77	17%

Runway 21L

Period	Average	Typical	Respite
Day	6	0-18	44%
Evening	0	0-1	99%
Night	1	0-2	68%
24hr	6	0-20	34%

Runway 21R

Period	Average	Typical	Respite
Day	21	2-53	19%
Evening	2	0-3	44%
Night	4	0-14	32%
24hr	27	4-61	15%

Runway 21L

Period	Average	Typical	Respite
Day	10	2-27	17%
Evening	1	0-2	26%
Night	0	0-1	77%
24hr	12	3-30	15%

Runway 21L

Period	Average	Typical	Respite
Day	50	11-112	16%
Evening	5	0-8	24%
Night	9	0-23	31%
24hr	64	15-143	12%

Runway 21R

Period	Average	Typical	Respite
Day	20	1-53	19%
Evening	2	0-5	35%
Night	1	0-1	48%
24hr	22	1-56	15%

Runway 21R

Period	Average	Typical	Respite
Day	0	0-0	99%
Evening	0	0-0	99%
Night	0	0-0	99%
24hr	0	0-0	99%

Figure 22-51 With new runway 2025 flight zone diagram – South Flow
Source: Wilkinson Murray

22.7.4 Estimated Number of Affected Dwellings

For the purpose of this assessment, the number of identified dwellings within N-above contours has been counted. Furthermore, the change in N-above value has been evaluated for each of the dwellings in the data, and this is presented for each of the with new runway N-above contours – that is, the N65=5 row provides counts of the number of dwellings that are within the with new runway N65=5 events contour and would experience an increase or decrease in N65 corresponding to the relevant column.

For the purpose of estimating dwellings that would be newly affected by aircraft noise, a threshold of N-above equals one was assumed – meaning that on average less than one event would exceed the noise level threshold per day without the new runway. Therefore, the estimated number of newly affected dwellings in the N65=5 events row presents the number of dwellings predicted to experience N65 of 5-10 events daily with the new runway, but N65 less than one without the new runway.

Dwellings that would be exposed to N-above greater than the assumed threshold without the new runway, are not discounted. Predicted N-above increases at such dwellings are reported in the corresponding count of dwellings predicted to receive increased N-above events. For example, a dwelling exposed to four N65 events without the new runway, but nine N65 events with the new runway, would be represented by the increase of 1 in the +5 to 10 events column of the N65=5 event row. However, such a receiver would not be considered to be newly affected by aircraft noise. An example of how to read the table is shown in Figure 22-52.

This analysis has also been undertaken for each suburb separately and the results are presented in Section 25.

22.7.4.1 Dwelling Data and Analysis

Locations of dwellings were obtained from the State Department of Planning, Lands and Heritage.

The data was verified against aerial photography in the area of interest (i.e. within ANEC and N-above contours).

An analysis using GIS software was undertaken to determine the noise metric value at each dwelling for each scenario. Analysis of these values facilitated classification of dwellings within ranges of interest (i.e. dwelling counts within a contour) and also the change in noise between various scenarios for each dwelling (i.e. the number of dwellings predicted to experience a change of ten or more N65 events). The analysis considered the centroid of each polygon representing the land-use.

22.7.4.2 Estimated Number of Affected Dwellings NRP 2025

The estimated number of dwellings for the with new runway 2025 scenario is provided in Table 22-14 and Table 22-15, showing N65 annual 24-hour 7-day and N60 annual night respectively.

Table 22-14 shows that the number of dwellings predicted to experience N65 of five or more, considering the full 24-hour period, is expected to decrease by seven per cent in 2025 with the operation of the new runway (compared to without the new runway in 2025). There are predicted to be 8,175 newly affected dwellings in 2025, based on the N65 metric. The majority of these are north and south of the new runway, including parts of Canning Vale, East Cannington, Forrestfield, Herne Hill, High Wycombe, Thornlie and Wattle Grove.

Table 22-15 demonstrates that the number of dwellings impacted by night time noise, described by N60 of five or more, is predicted to be reduced by the opening of the new runway. The total number of dwellings within N60=5 events (or more) is predicted to reduce from more than approximately 65,000, to 56,000; a 14 per cent decrease. Approximately 13,600 dwellings are predicted to average at least five fewer events above 60 dBA (N60). Approximately 6,800 dwellings are predicted to experience an increase in average N60 events by five or more night noise events.

Section 25 details affected dwellings in 2045.

Dwellings within the N65=10-20 contour

The number of dwellings in the N65=10-20 contour for the 2025 with new runway scenario

The number of dwellings in the N65=10-20 contour that will have a decrease of 10-20 daily events with the operation of the new runway

The number of dwellings in the N65=10-20 contour that will not change with the operation of the new runway

Estimated number of affected dwellings – NRP 2025 N65 annual 24hr

	Estimated number of dwellings		Number of dwellings by increase in daily noise events with NRP opening					Number of dwellings by decrease in daily noise events with NRP opening						
N65 Noise Event Contour	2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events	Dwellings Unchanged	Newly Affected Dwellings
N65=5-10	20,191	17,204	3,372	318	-	-	-	635	906	1,077	437	-	10,459	3,676
N65=10-20	19,838	16,433	2,384	1,067	-	-	-	678	1,183	3,055	988	-	7,078	978
N65=20-50	22,707	22,898	3,040	4,340	2,090	1	-	899	1,136	2,477	2,686	34	6,195	1,107
N65=50-100	12,921	16,335	458	1,370	2,942	2,733	101	639	1,404	2,563	2,908	568	649	1,853
N65=100+	7,994	5,108	215	8	179	285	768	77	176	44	1,933	964	459	561
Total	**83,651**	**77,978**	**9,469**	**7,103**	**5,211**	**3,019**	**869**	**2,928**	**4,805**	**9,216**	**8,952**	**1,566**	**24,840**	**8,175**

The number of dwellings in the N65=10-20 contour for the 2025 without the new runway scenario

The number of dwellings in the N65=10-20 contour that will have an increase of 5-10 daily events with the operation of the new runway

The number of dwellings in the N65=10-20 contour that will be newly affected with the operation of the new runway

Figure 22-52 Example of estimated number of affected dwellings
Source: Wilkinson Murray

	Estimated number of dwellings		Number of dwellings by increase in daily noise events with NRP opening					Number of dwellings by decrease in daily noise events with NRP opening						
N65 Noise Event Contour	2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events	Dwellings Unchanged	Newly Affected Dwellings
N65=5-10	20,191	17,204	3,372	318	-	-	-	635	906	1,077	437	-	10,459	3,676
N65=10-20	19,838	16,433	2,384	1,067	-	-	-	678	1,183	3,055	988	-	7,078	978
N65=20-50	22,707	22,898	3,040	4,340	2,090	1	-	899	1,136	2,477	2,686	34	6,195	1,107
N65=50-100	12,921	16,335	458	1,370	2,942	2,733	101	639	1,404	2,563	2,908	568	649	1,853
N65=100+	7,994	5,108	215	8	179	285	768	77	176	44	1,933	964	459	561
Total	**83,651**	**77,978**	**9,469**	**7,103**	**5,211**	**3,019**	**869**	**2,928**	**4,805**	**9,216**	**8,952**	**1,566**	**24,840**	**8,175**

Table 22-14 Estimated number of affected dwellings – New Runway Project 2025 N65 24-hour
Source: Wilkinson Murray

	Estimated number of dwellings		Number of dwellings by increase in daily night noise events with NRP opening					Number of dwellings by decrease in daily night noise events with NRP opening						
N60 Noise Event Contour	2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events	Dwellings Unchanged	Newly Affected Dwellings
N60=5-10	28,057	28,230	2,618	1	-	-	-	2,740	1,968	71	-	-	20,832	2,684
N60=10-20	27,349	25,786	1,793	900	1	-	-	4,674	3,702	469	-	-	14,247	1,484
N60=20-50	9,660	2,072	152	905	443	-	-	1	-	18	-	-	553	414
Total	**65,066**	**56,088**	**4,563**	**1,806**	**444**	**0**	**0**	**7,415**	**5,670**	**558**	**0**	**0**	**35,632**	**4,582**

Table 22-15 Estimated number of affected dwellings – New Runway Project 2025 N60 night
Source: Wilkinson Murray

22.7.5 N-above Difference Charts

The differences in N-above values between with and without the new runway scenarios are presented graphically in Figure 22-53 to Figure 22-56.

These figures can be considered to represent the change in N-above values between the with new runway and without new runway scenarios. The purple areas indicate a reduction in N-above events and the blue areas indicate an increase in N-above events.

The N65 24-hour difference charts for 2025 indicate that there will be an increase in N65 values along the tracks associated with the new runway, with the exception of the area northeast of the airport, which coincides with the existing arrival route onto runway 24 (departures off runway 03R have been designed to use this corridor). Reductions are indicated elsewhere, in most areas overflown by existing operations.

The N60 night difference charts reveal similar trends, though with fewer operations at night, the magnitude of differences is reduced.

22.7.6 Cross Runway

Section 21 outlines the potential future uses of the cross runway. As no decision has been made on whether the cross runway will remain or close, a sensitivity assessment was undertaken.

In the scenario including the cross runway, approximately five per cent of arrivals and departures are forecast to use the cross runway (06/24) during periods when crosswinds on the parallel runways exceed 20 knots.

Figure 22-57 and Figure 22-58 present day N-above contours for the 2025 scenario with and without the cross runway while Figure 21-59 and Figure 21-60 present night N-above contours for the 2025 scenario with and without the cross runway.

The influence of cross runway is clear in the area southwest of this runway. Differences in the N-above contours elsewhere, however, are negligible. This is expected with only five per cent of flights predicted to use the cross runway.

Noting that the inclusion of the cross runway has little impact on the resulting operations and consequently aircraft noise metrics, presentation of separate contours for each scenario is not warranted.

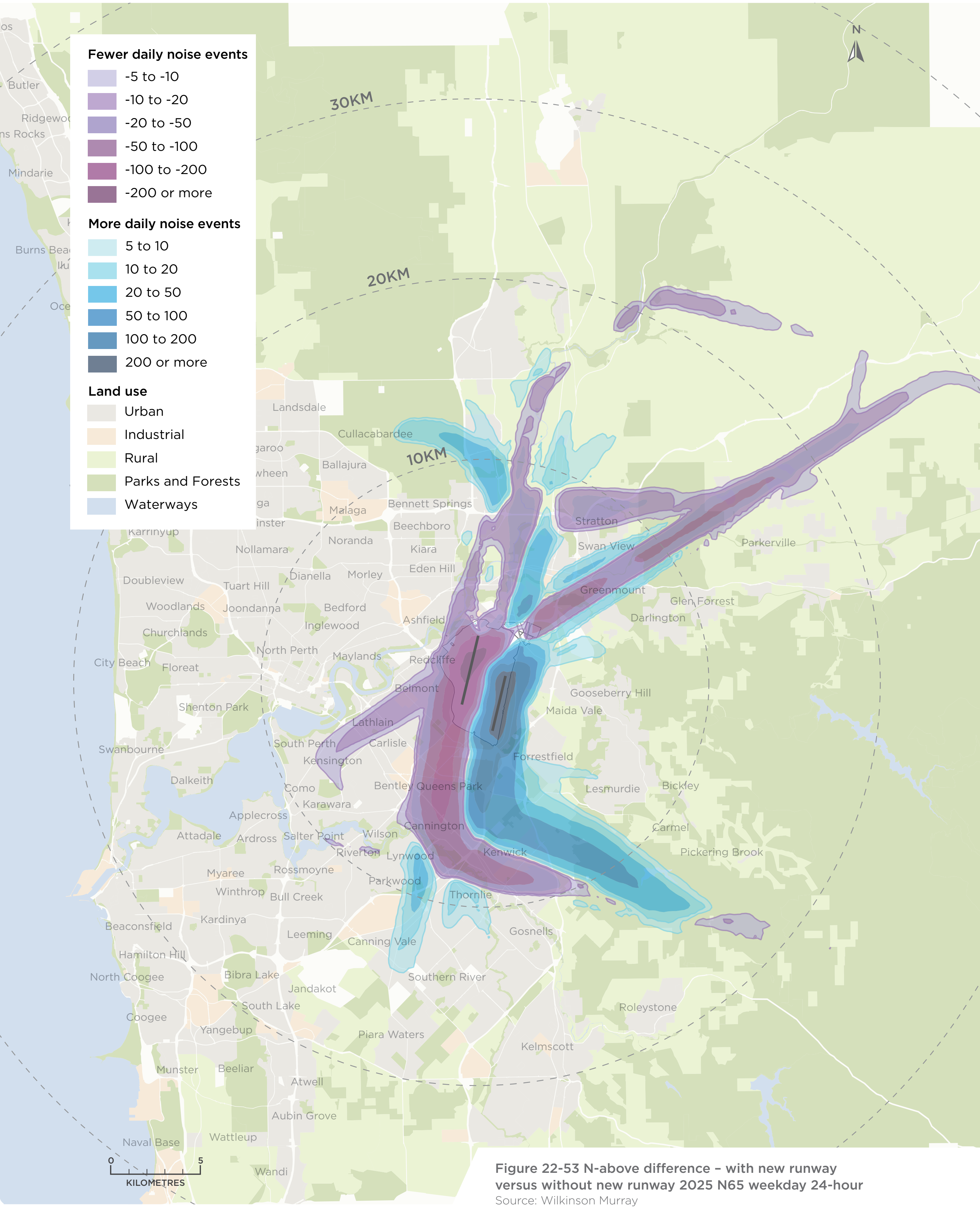


Figure 22-53 N-above difference – with new runway versus without new runway 2025 N65 weekday 24-hour
Source: Wilkinson Murray

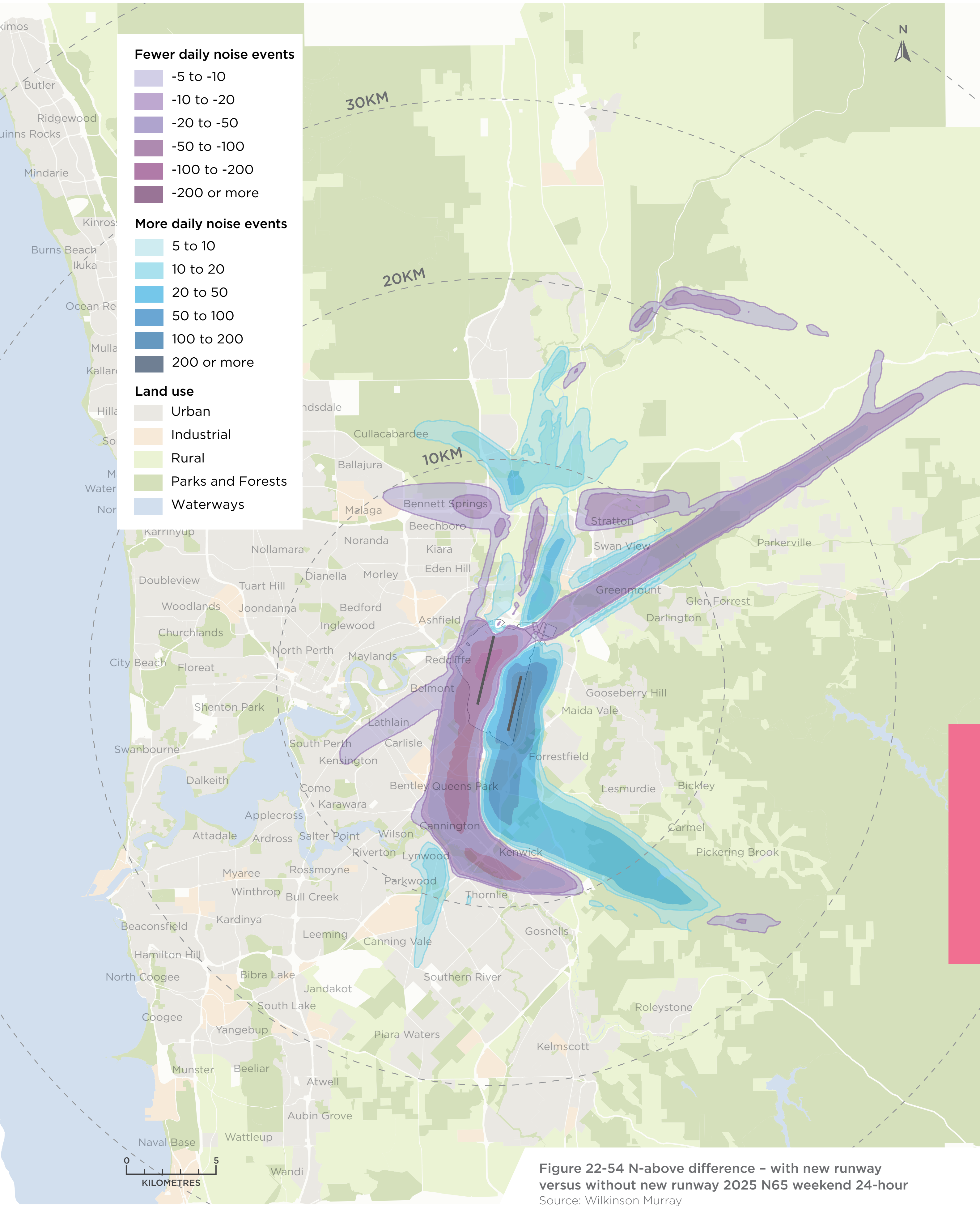


Figure 22-54 N-above difference – with new runway versus without new runway 2025 N65 weekend 24-hour
Source: Wilkinson Murray

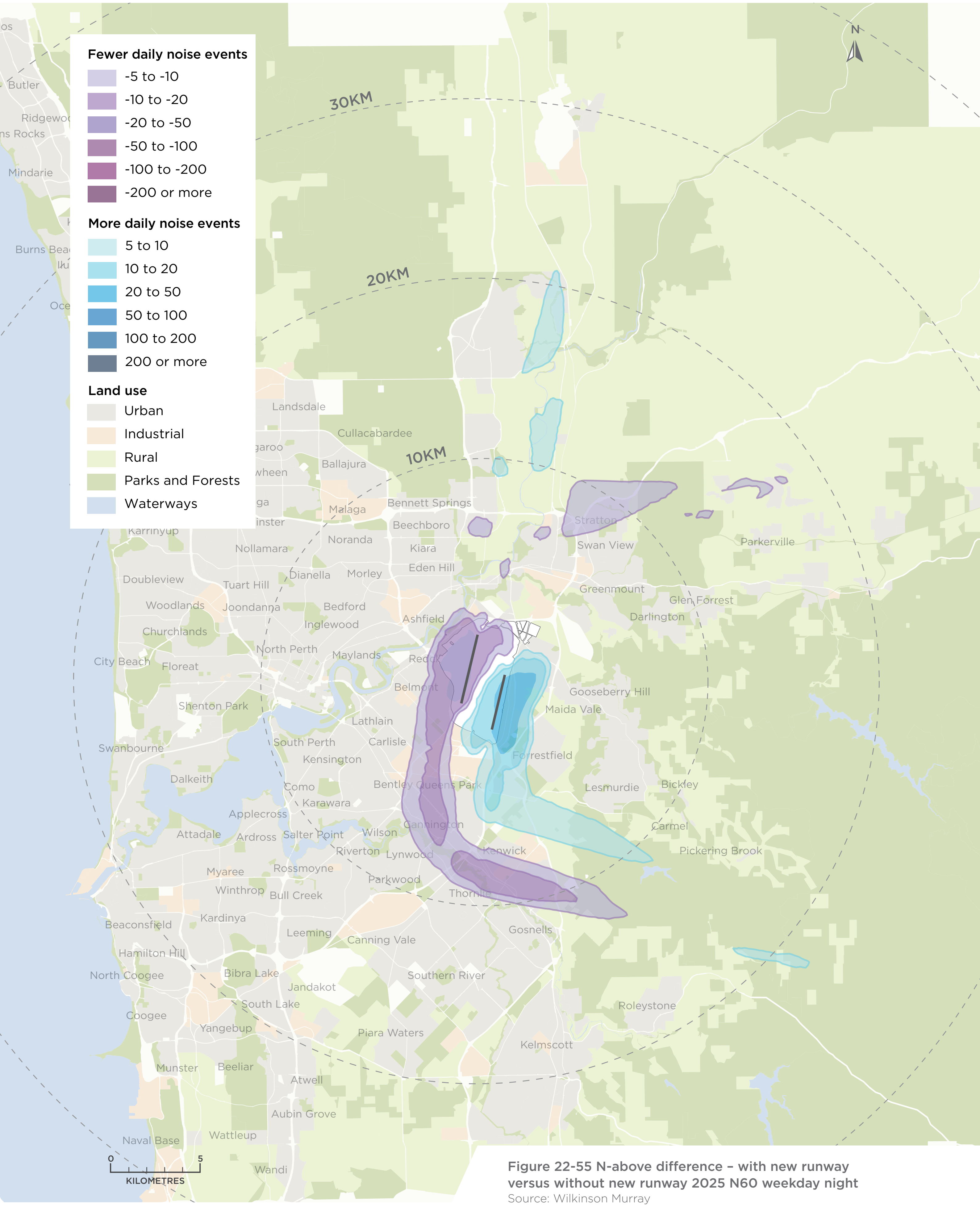


Figure 22-55 N-above difference – with new runway versus without new runway 2025 N60 weekday night
Source: Wilkinson Murray

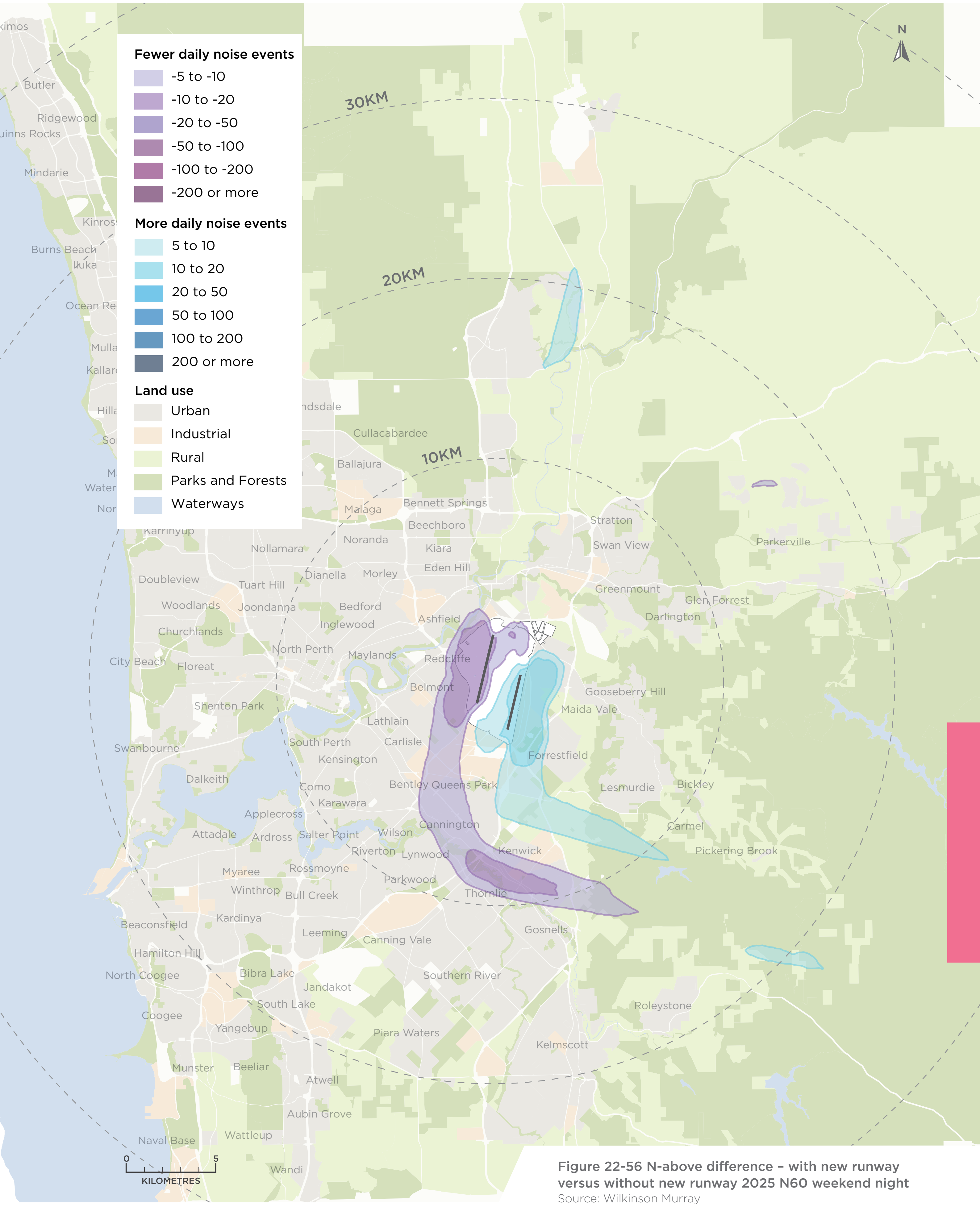


Figure 22-56 N-above difference – with new runway versus without new runway 2025 N60 weekend night
Source: Wilkinson Murray

Figure 22-57 With new runway 2025 N65 weekday 24-hour without cross runway
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

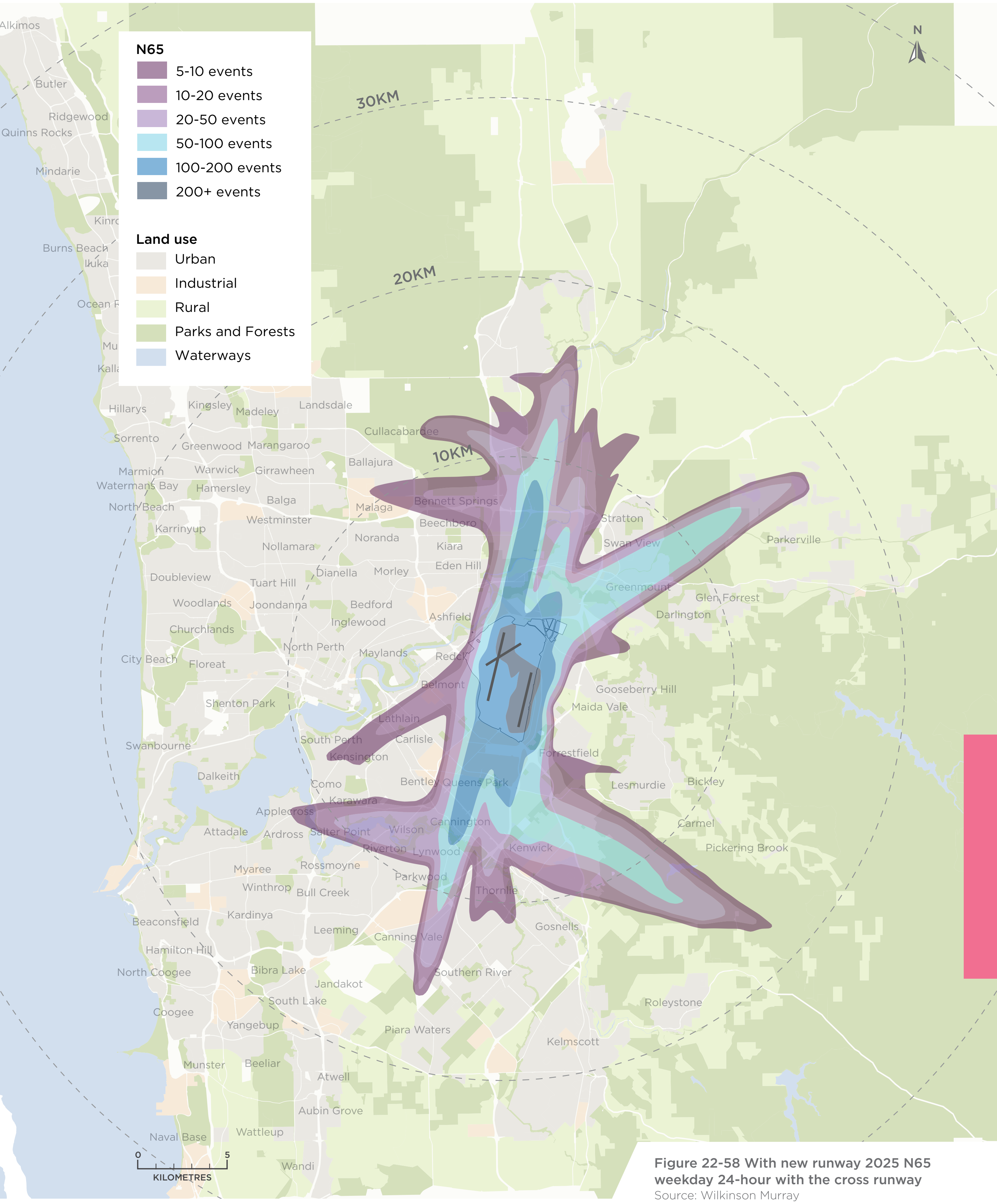


Figure 22-58 With new runway 2025 N65 weekday 24-hour with the cross runway
Source: Wilkinson Murray

This N65 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

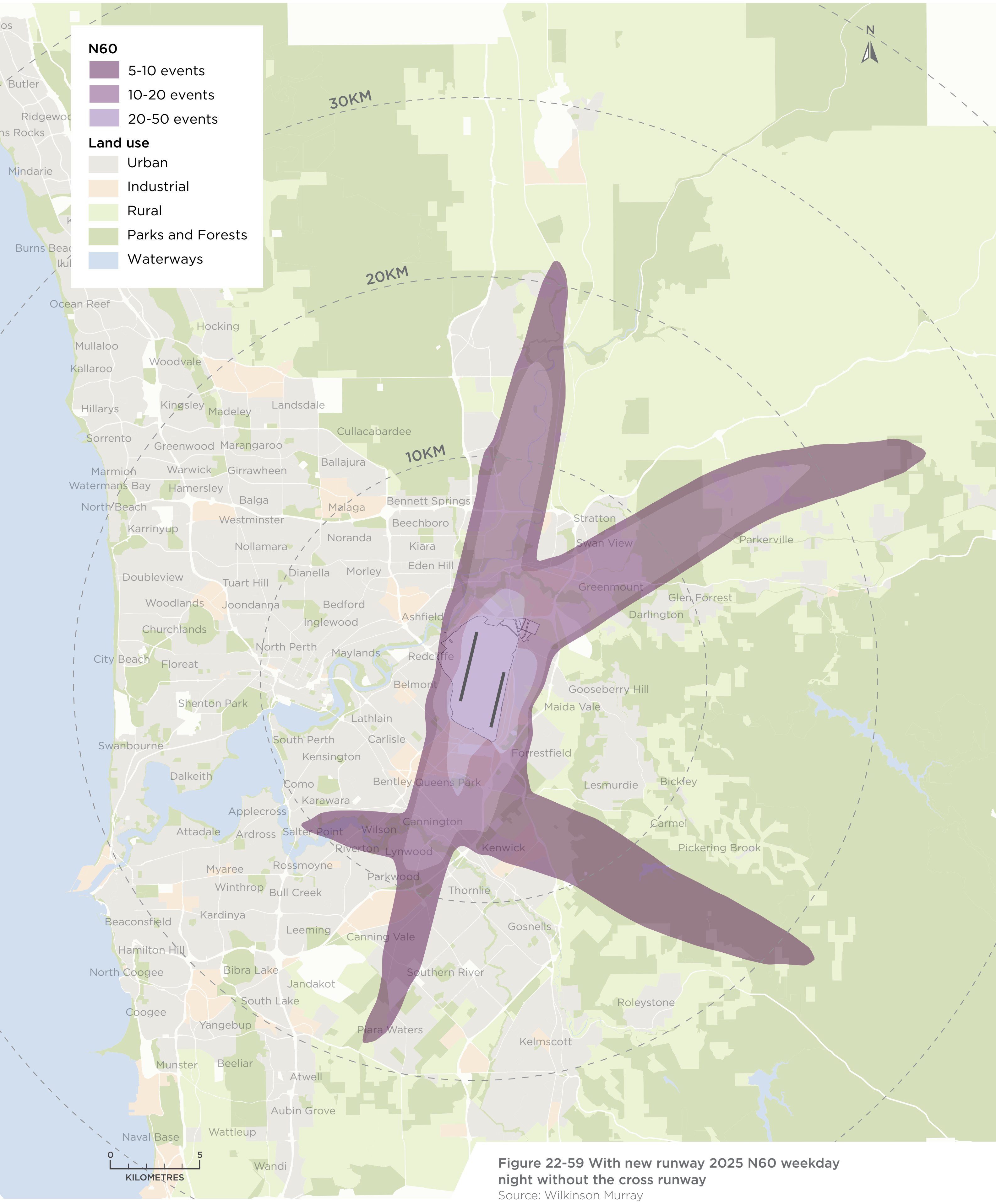


Figure 22-59 With new runway 2025 N60 weekday night without the cross runway
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

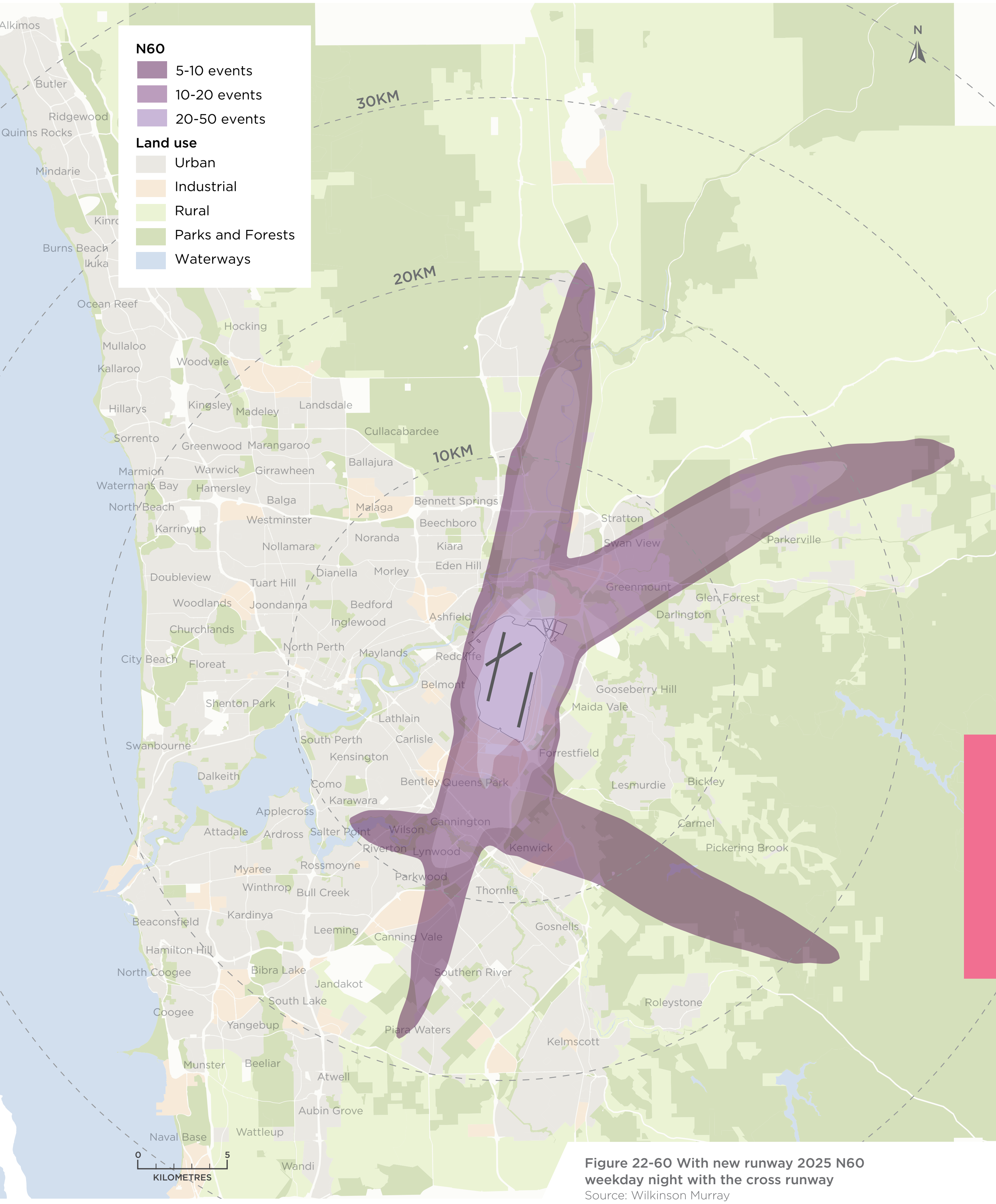


Figure 22-60 With new runway 2025 N60 weekday night with the cross runway
Source: Wilkinson Murray

This N60 represent where the majority of aircraft will fly, however all areas of Perth will have aircraft from Perth Airport, Jandakot Airport or RAAF Base Pearce flying overhead from time to time.

22.7.7 Terminal Consolidation

As outlined in Section 21, the CONOPS for the NRP has been developed by Perth Airport in consultation with Airservices and airlines.

Perth Airport has been working with Qantas on plans to relocate their operations to Airport Central. Assuming commercial agreement is reached, this is expected to occur by December 2025. While it is expected that the terminal arrivals CONOPS will be used, it is possible that airlines, Airservices and Perth Airport will adopt an alternate compass arrivals concept. The potential impacts of this alternative concept on aircraft noise was considered.

Terminal arrivals and compass arrivals show slight differences in the N-above contours; the compass arrivals concept results in more arrivals onto the new runway (03R/21L) and consequently contours associated with these tracks are larger while contours associated with arrival tracks onto the existing main runway (03L/21R) are slightly smaller. It is noted that the N65=5-10 24-hour and N60=5-10 night contours for the compass arrival concept fit within the corresponding typical busy day N-above contours for the terminal arrival CONOPS.

Although it is likely that terminal arrivals will remain, following a decision for Qantas to relocate to Airport Central, Airservices will work with Perth Airport and airlines to determine an operating plan that provides safe and efficient allocation of runway usage.

22.7.8 Noise Induced Vibration

Vibration generated by sound-pressure waves and potential damage generated by wake vortices are effects that can occur in buildings very close to the end of a runway. These effects are rare in Australia, as buildings tend not to be situated close to runways where these effects typically occur, and modern engine and airframe design also significantly reduces wake-vortex production.

An assessment of the potential for vibration induced by noise and by aircraft vortices associated with the NRP was undertaken.

The issue of vibration from sound-pressure waves can be considered by identifying the level of (low frequency) sound energy predicted at the nearest buildings to the proposed runway, and comparing this with standard thresholds for potential damage and for secondary noise generation (i.e. rattling).

At high noise levels, the low frequency components of aircraft noise can result in vibration of loose elements in buildings, notably windows. Even at the highest expected noise levels, the levels of vibration due to low frequency noise are well below those which may cause structural damage to buildings. However, they can result in secondary sound generation from loose windows and other building elements.

With typical light building structures, noise-induced vibration may begin to occur where the maximum external noise level reaches approximately 90 dBA. This level is generally consistent with Hubbard's Sound Pressure Level Threshold Criteria (Partnership for Air Transportation Noise and Emissions Reduction: An FAA/NASA/Transport Canada sponsored Center of Excellence, Report No. Partner-COE-2007-001 Low-frequency Noise Study, 2007) for a typical large-aircraft operation. The effect is more common on departures than arrivals, since the noise spectrum for a departure close to the airport has stronger low frequency components.

Figure 22-61 shows 90 dBA noise level contours for an Airbus A380 aircraft departure with a stage length of seven (e.g. Dubai) on both the existing main runway (03L/21R) and new runway (03R/21L), together with a Boeing 777-200 aircraft departure with a stage length of four (e.g. Singapore) on runway 24 and 06. These operations are the loudest that are forecast to occur at Perth Airport.

Based on the above analysis the likelihood of noise-induced vibration associated with the NRP is predicted to be low, as the 90 dBA contour is contained within the airport boundary or close to.

The above findings are based on building constructions that are in reasonable condition. Normal windows in poor condition or lightweight lead light windows may be more susceptible to some vibration.

In summary, future operations forecast to occur at Perth Airport on the NRP will have low potential to cause rattling at the dwellings closest to the new runway.

Based on the above analysis, the likelihood of noise-induced vibration associated with the NRP is low, as the 90 dBA contour is contained within the airport environs.

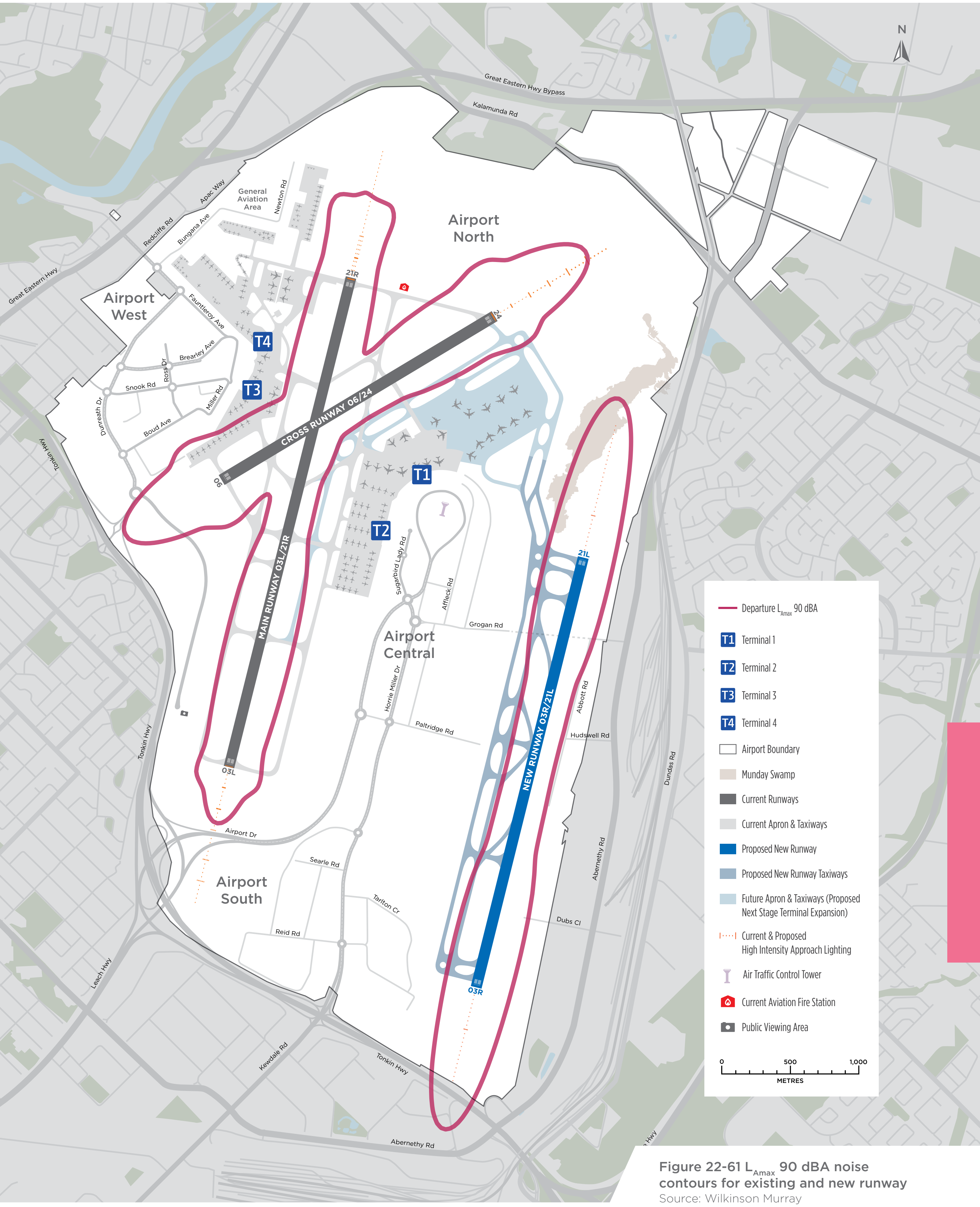


Figure 22-61 L_{Amax} 90 dBA noise contours for existing and new runway
Source: Wilkinson Murray

22.8 Mitigation of Aircraft Noise Impacts

Aircraft noise is an unavoidable consequence of an operating airport and regulations and standards that ensure the safe and efficient operation of the airport may limit the availability of potential noise mitigation options.

Effective mitigation of aircraft noise often requires a number of small, incremental improvements to result in a noticeable reduction in aircraft noise.

Three fundamental options for mitigation of aircraft noise are:

- reduce noise emissions from the aircraft,
- plan infrastructure, flight paths and airport operating strategies to achieve lower exposure over noise-sensitive areas, and
- develop land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

Aircraft noise emissions have reduced substantially over the past 40 years, and improvements are expected to continue. As such, some reduction in aircraft noise emissions over time has been incorporated into the predictions in this assessment, through the progressive evolution of the fleet mix in the forecast schedules.

However, all aircraft types used in modelling are currently in use, and hence the assumed reduction is considered to be conservative – future noise levels are likely to be, if anything, lower than assumed.

In addition to the three fundamental mitigation options detailed above, the provision of information to both existing and potential residents in areas likely to be exposed to noise is vitally important.

Perth Airport has developed an Interactive Aircraft Noise Information Portal that provides further detail on why aircraft fly where they do, current and future aircraft noise exposure information and various details on ways to reduce noise in homes.

22.8.1 Aircraft Noise Mitigation in the New Runway Infrastructure and Airspace Design

Aircraft noise-mitigation measures have been incorporated into the design, and have been developed over the various previous stages of the NRP through the MDP assessment process.

In order to reduce the impacts of aircraft noise on communities, the NRP has considered a number of mitigation elements already into airspace design.

Airspace design at a large airport such as Perth is complex, and safety is paramount.

Constraints increase with the introduction of a new runway, as additional procedures must be developed and existing ones modified to use the new and existing runways. As a consequence, it can be difficult to mitigate aircraft noise emissions through airspace design, because procedures are often dictated by standards to ensure the safe operation of the airspace. Nonetheless, so far as is possible, aircraft noise has been considered in the airspace design work which has been undertaken for this MDP.

The following features of the Airspace Management Plan are noteworthy:

- establishment of flight path corridors which replicate existing arrival and departure routes wherever possible, in particular use of the existing runway 06 departure flight paths for proposed runway 03R departures,
- consideration has been given to closing runway 06/24. In the event that it is maintained for use, runway 06/24 would be used only when this is operationally necessary (e.g. when cross winds are in excess of 20 knots). The closure or reduced use of runway 06/24 means areas to the south-west of the airport will be overflown much less than the existing situation,
- jet arrivals to the existing runway 03L from the east in visual conditions will pass to the south-east of the Perth metropolitan area to join a final approach consistent with the Instrument Landing System (ILS) final approach to this runway, via a right base. This avoids the need for many aircraft to overfly the airport and join the western circuit, reducing track miles flown and minimising noise impacts over densely populated areas to the west and south-west of the airport. Only non-jet arrivals (in VMC and IMC) and jet arrivals in IMC conditions would need to overfly the airport and areas east, and
- for departures to the east and north from the proposed runway 21L, the detailed airspace design may use expected changes to the rules for simultaneous independent departures from parallel runways to enable aircraft to remain over the existing industrial land uses as much as possible, minimising the noise exposure on residential areas to the south of the airport.

22.8.2 Managing Aircraft Noise in Areas of Significance

As discussed in Section 22.5.1.3 the Airports Act requires a management plan for areas forecast to be above significant as 30 ANEF levels. In 2045 with new runway, it is predicted that no residents or public buildings would be within the 30 ANEC or 25 ANEC respectively due to new runway operation.

22.8.3 Aircraft Noise Insulation Schemes

Whether or not noise insulation schemes are introduced or extended in relation to Australian capital city airports is a Commonwealth Government public policy decision. Perth Airport has considered the likely impacts of the scheme being implemented.

At two airports in Australia (Adelaide and Sydney), the Commonwealth Government mandated a noise-amelioration program for residential homes within the Australian Noise Exposure Index (ANEI) noise modelling 30 contour; and for public buildings (such as schools, churches, day care centres and hospitals) located in the ANEI 25 contour.

The Sydney Airport Noise Amelioration Program (SANAP) was introduced around 1995 and ran for six years, with a total cost in excess of $470 million. The SANAP provided insulation to a total of 4,083 residential dwellings and 99 public buildings. In addition, 151 residences and one public building in the most noise-sensitive areas were voluntarily acquired and used to create a public park.

The Adelaide Airport Noise Abatement Program (AANAP) began in 2000 and is estimated to have cost $63 million. The AANAP provided 648 residential dwellings and eight public buildings with noise insulation over its ten-year operation.

If the Commonwealth policy was to be applied to Perth Airport for buildings and residents near the new runway, this would see only six houses in the 30 contour and one aged care facility and one church within the 25 contour at 2025.

Insulation schemes are not without their challenges. Insulation programs are administered by the Commonwealth Government with strict metrics applied as to eligibility for the scheme. In the case of Adelaide, the scheme applied to one side of a street that fell within the requisite ANEI contour, while other noise-exposed residents that were on the opposite side of the street did not qualify. Programs like this are complex to administer with the costs and building works undertaken over multiple years. Insulation schemes also impact the passengers, as the cost of any scheme is passed on to the travelling public by way of higher airfare ticket prices.

There are also questions about the effectiveness of insulation schemes. Often, they target properties where owners have purchased them knowing the exposure to aircraft noise. Residents with aircraft noise exposure, but further from the airport, are generally not eligible. The schemes do not allow for the lifestyle of residents, for instance providing no relief for those whose concern is outdoor living areas, or who wish to sleep with windows open. Perhaps for such reasons the history of similar schemes around the world has shown they do not reduce annoyance to the degree expected, despite very high costs.

22.8.4 Peak Charging

Similar to peak charging for aircraft wanting to use the airport in peak times (as discussed in Section 3), peak charging could be used to manage aircraft noise exposure during night periods. In theory, this would act as a price signal to airlines to move flights to a time of day when it is cheaper for them to operate. Again, as outlined in Section 3, Perth Airport introduced peak pricing in 2013 to manage the number of aircraft wanting to operate in the morning peak periods. Despite its introduction it had little impact on the behaviour of airlines as the extent of the peak price premium was an insufficient incentive to fly outside of times that customers preferred or to facilitate effective network scheduling. Any further peak pricing would need to be substantial to change the timing that aircraft operate at Perth Airport. Therefore, any change would not only impact the Perth market but also the wider airline networks and add additional cost to passengers across all segments. Perth Airport will continue to work with Airservices, Commonwealth, State and Local governments and industry to explore options to manage the exposure and potential impact of aircraft noise to residents surrounding Perth Airport, particularly during sensitive hours.

22.9 Conclusion

An assessment of changes to aircraft noise exposure with operation of the NRP as part of a parallel runway system was undertaken.

The assessment adopted a comprehensive methodology for the prediction, assessment and communication of aircraft noise, which represents industry best-practice. Existing flight data were analysed to determine existing aircraft noise exposure, flight tracks, statistical geometric dispersion about those tracks, as well as air traffic control behaviour. This analysis was applied to forecast schedules for two assessment years, along with over 14 years of historical meteorological data to predict, to the extent possible, future operations and their associated aircraft noise exposure. A scenario without the new runway, whereby the airport continues to operate with the existing infrastructure, was used to evaluate the impact of the NRP.

The noise model used in the assessment was validated extensively using historical measured noise levels for over 25,000 flights in 2016. Calibration was found to be necessary for some operations, and this calibration was undertaken.

A suite of aircraft noise metrics and supplementary information is included in the report. The information includes ANEC/ANEF, N-above, typical busy day N-above, indicative noise-altitude-distance charts and flight path diagrams. With this information stakeholders are able to consider land-use planning implications, the level and occurrence of aircraft noise events, and the potential variation in the number of events between days.

The aircraft noise exposure is predicted to increase in areas north and south of the new runway, as well as areas near new flight paths associated with the new runway. Some areas that are presently impacted by aircraft noise can expect a reduction in this noise with the new runway.

In 2025, upon opening of the new runway, approximately 5,600 fewer dwellings are predicted to be affected by aircraft noise, described by N65 of five or more; a reduction of approximately seven per cent. There are predicted to be approximately 8,000 newly affected dwellings, based on the N65 metric in 2025. The majority of these are north and south of the new runway, including parts of Canning Vale, East Cannington, Forrestfield, Herne Hill, High Wycombe, Thornlie and Wattle Grove.

Further discussion of aircraft noise exposure is included in the Social Impact Assessment outline in Section 25.

23 Air Quality and Greenhouse Gas (Air-Based)

This section describes the impacts on air quality and greenhouse gas emissions from air-based activities resulting from the construction and operation of the New Runway Project (NRP).

Detail is also provided on the following areas:

- What are the existing air quality, odour and greenhouse gas emission conditions around Perth Airport and its surrounds?
- What are the expected impacts to air quality, odour and greenhouse gases from the NRP in the future?
- How will any potential impacts to air quality, odour and greenhouses gases be mitigated?

23.1 Introduction

This section describes the impacts to air quality, odour and greenhouse gases resulting from aircraft operations following construction and commissioning of the New Runway Project (NRP).

For this assessment, emissions resulting from aircraft operations were defined as all emissions from an aircraft's main engines. The significant aircraft-based activities considered are:

- engine start-up,
- aircraft taxiing on the airfield,
- aircraft take-off and climb out, and
- aircraft approach and landing.

Operations on the new runway will impact air quality and greenhouse gases as a result of emissions released by aircraft.

An assessment to quantify the emissions, identify the impact of the NRP, and determine whether mitigation would be required, was undertaken.

The ground-based air quality and greenhouse gas assessment is detailed in Section 14, with a similar legislative context. This assessment also used the same sensitive receptors.

Information on how aircraft will operate using new runway is provided in Section 21.

23.2 Key Findings

Key findings from investigations into air quality and greenhouse gas from air-based sources include:

- The potential impact of NRP aircraft operations on air quality impacts and greenhouse gas emissions is determined to be low, with the predicted concentrations of all criteria pollutants and air toxics complying with the established impact assessment criteria.
- Emissions from newer aircraft are anticipated to reduce in the future as aircraft engine technologies improve, and it is likely that the impact of the NRP operations on air quality concentrations will reduce in years to come.
- The increased volatile organic compounds emissions associated with aircraft operating on the NRP are considered unlikely to result in significant nuisance odour impacts.

23.2.1 Policy Context and Legislative Framework

As with the ground-based assessment, air pollutant emissions, ambient air quality and greenhouse gas emissions are governed by legislation, guidelines and standards which have been introduced at the Commonwealth and State government levels. Perth Airport is subject to Commonwealth legislation. However, State legislation and guidance documents have been referenced where relevant to the assessment.

Regulated air pollutants are considered as 'ambient' pollutants and 'air toxics'. Ambient pollutants are typically emitted from a variety of common emission sources in large quantities. Air toxics are pollutants that are present in the air in low concentrations and have hazardous characteristics. Excessive amounts of any regulated pollutant can cause health impacts.

A summary of applicable legislation and guidelines is provided in Table 23-1.

The air quality criteria adopted for this impact assessment, as summarised in Table 23-2, are the most stringent of those detailed in the Airports (Environment Protection) Regulations 1997 (AEPR), the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) and the National Environment Protection (Air Toxics) Measure (Air Toxics NEPM).

Under the *National Greenhouse and Energy Reporting Act 2007 (NGER Act)*, corporations in Australia which exceed thresholds for greenhouse gas emissions or energy production or consumption are required to measure and report data to the Clean Energy Regulator on an annual basis. Greenhouse gas emissions must be reported for Scope 1 and Scope 2 sources.

Aircraft greenhouse gas emissions are categorised as Scope 3 emissions and are therefore not reportable under the NGER. Emissions associated with aircraft movements fall under the reporting responsibility of the respective airlines. However, decisions made by Perth Airport regarding the design and operation of the airport can influence some Scope 3 emissions from aircraft, particularly those related to aircraft taxiing. To identify the Scope 3 emissions that are influenced by airport decisions, the Airports Council International (ACI) Guidance Manual: Airports Greenhouse Gas Emissions Management (ACI, 2009) divides Scope 3 emissions into "Scope 3A" and "Scope 3B" emissions. Scope 3A emissions are those Scope 3 greenhouse gas emissions that the airport operator can influence, whereas Scope 3B emissions are the Scope 3 greenhouse gas emissions that the airport operator cannot influence to any reasonable extent. In the context of this assessment, aircraft greenhouse gas emissions during the "taxi-out" and "taxi-in" modes of the landing take-off cycle comprise the Scope 3A emissions. All other greenhouse gas emissions during the landing take-off cycles are considered Scope 3B emissions.

Legislation/Measure	Legislating Body	Understanding
Airports Act 1996 (Airports Act)	Commonwealth Government	The Airports Act provides a legal framework for the operation of civilian and joint-user airports in Australia, and promotes environmental management of activities conducted at airports. A number of offences and corresponding penalties are described for air pollution. No objective criteria to limit air emissions from airport operations are specified.
Airports (Environment Protection) Regulations 1997 (AEPR)	Commonwealth Government	The objective of the AEPR is to provide regulation and accountability for activities conducted at airports and promote improved environmental management. This regulation: • does not apply to aircraft emissions, • requires prevention or minimisation of air pollution (including odour), • sets out monitoring and reporting requirements and corresponding penalties, • sets out contamination limits for emissions from specific sources (mainly stationary sources such as generators), and • sets out ambient air limits (applicable to air within the airport site).
National Greenhouse and Energy Reporting Act 2007 (NGER Act)	Commonwealth Government	National framework for corporations to report on emissions. Annual threshold values are specified for both facilities and corporations – emissions must be reported if estimated emissions exceed any of the thresholds. The airport is defined as a 'facility' by this Act during the operational phase of the NRP.
Air Navigation (Aircraft Engine Emissions) Regulation 1995	Commonwealth Government	Specifies that it is an offence for an aircraft to fly if it does not satisfy engine emissions requirements of Annex 16 and operators which contravene this legislation will be penalised.
National Environment Protection (National Pollutant Inventory) Measure (NEPM)	Commonwealth Government	Aims to improve ambient air quality and minimise environmental impacts via emissions reporting by facilities which exceed the specified threshold. A reporting threshold is provided for 93 substances (including NEPM substances). This legislation affects Perth Airport's annual reporting obligations.
National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM)	Commonwealth Government	Establishes air quality standards, monitoring and reporting protocols for seven listed pollutants (which have been included in this assessment). Air quality standards set out by this legislation have been considered in combination with those specified by the AEPR, as AEPR standards are only relevant for locations within the estate, whereas these standards are applicable at all locations nationally. The State Government does not have its own limits. AAQ NEPM standards were developed for assessment of whole of airshed impacts, rather than a local area.
National Environment Protection (Air Toxics) Measure (Air Toxics NEPM)	Commonwealth Government	Sets out procedures to collect information regarding five hazardous air pollutants based on investigation limits (for reporting only).
Air Quality and Air Pollution Modelling Guidance Notes 2006	State Government	Provides general guidance for air dispersion modelling including meteorological data preparation, model acceptability and reporting.

Table 23-1 Summary of applicable legislation and guidelines
Source: Perth Airport

23.2.2 Significance Criteria

Significance criteria used in the assessment of potential impacts of emissions to air, from air-based activities, associated with the NRP are described in Table 23-3.

The State Department of Water and Environmental Regulation (DWER) uses the parameter of 'Air Quality Index' (AQI) to describe air quality within Western Australia. AQIs describe the percentage of the AAQ NEPM Standard reached for each pollutant (i.e. if levels of $PM_{2.5}$ are equal to the AAQ NEPM for that averaging period, the AQI will be a value of 100). The AQI is determined for each pollutant and averaging period, and the AQI for the assessment is taken as the maximum of each pollutant. The key used by DWER is presented in Table 23-4.

The criteria detailed within Table 23-4 are based upon the difference in AQI between the two options of with new runway and without new runway in the assessment scenarios and distinguish between "short term" and "long term" impacts. Short term AQI are based on ten-minute, one-hour and 24-hour averaging periods, and "long term" AQI are based on annual average.

As greenhouse gas emissions from aircraft are not directly under the control and reporting responsibilities for Perth Airport, significance criteria have not been established for this assessment.

Likelihood of impacts for this assessment were classified in accordance with the process discussed in Section 8. The highest-rated impact for a single pollutant for each scenario, was used as the impact significance for that scenario and combined with the relevant likelihood of the impact to determine the resulting risk level.

Pollutant	Criterion	Averaging Period	Legislation
Carbon Monoxide (CO)	9 ppm[1] or 10,000 µg/m³	8 hours	AAQ NEPM
Nitrogen Dioxide (NO_2)	0.12 ppm[1] or 328 µg/m³	1 hour	AAQ NEPM
	0.03 ppm or 62 µg/m³	1 year	AAQ NEPM
Particulate matter less than 10 µm diameter (PM_{10})	50 µg/m³	1 day	AAQ NEPM
	25 µg/m³	1 year	AAQ NEPM
Particulate matter less than 2.5 µm diameter ($PM_{2.5}$)	25 µg/m³	1 day	AAQ NEPM
	8 µg/m³	1 year	AAQ NEPM
Sulfur dioxide (SO_2)	0.25 ppm or 712 µg/m³	10 minutes	AEPR
	0.20 ppm[1] or 570 µg/m³	1 hour	AAQ NEPM/AEPR
	0.08 ppm[1] or 228 µg/m³	1 day	AAQ NEPM
	0.02 ppm or 60 µg/m³	1 year	AAQ NEPM
Benzene	0.003 ppm or 9.7 µg/m³	1 year	Air Toxics NEPM
Formaldehyde	0.04 ppm or 44 µg/m³	1 day	Air Toxics NEPM
Toluene	1 ppm or 4,000 µg/m³	1 day	Air Toxics NEPM
	0.1 ppm or 400 µg/m³	1 year	Air Toxics NEPM
Xylene	0.25 ppm or 1,188 µg/m³	1 day	Air Toxics NEPM
	0.2 ppm or 950 µg/m³	1 year	Air Toxics NEPM
Odour	2 OU/m³, 99.5th percentile	3 minute	EPA Guidance Statement No. 47
	4 OU/m³, 99.9th percentile	3 minute	EPA Guidance Statement No. 47

Table 23-2 Air quality criteria relevant to the assessment of the New Runway Project
Source: AEPR, AAQ NEPM and the Air Toxics NEPM

[1] one day of exceedances per year allowed by AAQ NEPM

Magnitude Description	Example Criteria	Specialist Criteria
Major Adverse	Impacts considered critical to the decision-making process. They tend to be permanent, or irreversible, or otherwise long term, and/or can occur over large scale areas. Environmental receptors are extremely sensitive, and/or the impacts are of national significance. Typically, mitigation measures are unlikely to remove such effects.	$AQI_{\text{with new runway}}$ > 100, where $AQI_{\text{with new runway}}$ is at least one classification higher than that for $AQI_{\text{without new runway}}$ (i.e. $AQI_{\text{with new runway}}$ is poor but $AQI_{\text{without new runway}}$ is fair). Many sensitive receptors (i.e. residential, child-care centre) are affected for long term averaging periods (one year), and repeatedly for short term averaging periods (less than one year).
High Adverse	Impacts likely to be of importance in the decision-making process. They tend to be permanent, or otherwise long to medium term, and/or can occur over large or medium scale areas. Environmental receptors are high to moderately sensitive, and/or the impacts are of State significance.	$AQI_{\text{with new runway}}$ > 100, where $AQI_{\text{with new runway}}$ is at least one classification higher than that for $AQI_{\text{without new runway}}$ (i.e. $AQI_{\text{with new runway}}$ is poor but $AQI_{\text{without new runway}}$ is fair). A few sensitive receptors are affected for long term averaging periods, and repeatedly for short term averaging periods.
Moderate Adverse	Impacts relevant to decision-making, particularly for determination of environmental management requirements. These impacts tend to range from long to short term, and/or occur over medium scale areas or are focused within a localised area. Environmental receptors are moderately sensitive, and/or the impacts are of regional or local significance.	$AQI_{\text{with new runway}}$ > 100, where $AQI_{\text{without new runway}}$ is at least one classification higher than that for $AQI_{\text{without new runway}}$ (i.e. $AQI_{\text{with new runway}}$ is poor but $AQI_{\text{without new runway}}$ is fair). A few non-sensitive receptors (i.e. industrial areas, roads, car parks) are affected for long term averaging periods, and/or repeatedly for short term averaging periods.
Minor Adverse	Impacts recognisable, but acceptable within the decision-making process. They are still important in the determination of environmental management requirements. These impacts tend to be short term, or temporary and at the local scale.	$AQI_{\text{with new runway}}$ > 100, where $AQI_{\text{with new runway}}$ is at least one classification higher than that for $AQI_{\text{without new runway}}$ (i.e. $AQI_{\text{with new runway}}$ is poor but $AQI_{\text{without new runway}}$ is fair). A few receptors are affected for short-term averaging periods only.
Negligible	Minimal change to the existing situation. This could include for example impacts which are beneath levels of detection, impacts that are within the normal bounds of variation or impacts within the margin of forecasting error.	$AQI_{\text{with new runway}}$ > $AQI_{\text{without new runway}}$, but $AQI_{\text{with new runway}}$ < 100.
Beneficial	The project results in an improvement in the baseline situation, for example, improved air quality.	$AQI_{\text{with new runway}}$ < $AQI_{\text{without new runway}}$

Table 23-3 Significance criteria – air quality and greenhouse gas (air-based)
Source: Wilkinson Murray

Air Quality Description	AQI Range
Extreme	200 +
Very poor	150 – 200
Poor	100 – 149
Fair	67 – 99
Good	34 – 66
Very good	0 – 33

Table 23-4 Key developed by State Department of Environment Regulation to describe regional air quality by the measured Air Quality Index (AQI)
Source: State Department of Environment and Regulation

23.3 Air Quality

While Perth enjoys relatively good air quality compared to many countries around the world, it can still impact susceptible people and ground level concentrations can still exceed current air quality standards. Both short-term and long-term exposure to air pollutants can cause health problems. Therefore, it is important to consider impacts from air-based activities associated with the new runway to air quality.

23.3.1 Methodology

Four operational scenarios were assessed:

- baseline - reflective of current operations (based on 2016 data),
- opening - reflective of operations in 2025 with the new runway,
- opening - reflective of operations in 2025 without the new runway, and
- 20 years - reflective of operations 20 years after opening the new runway (2045).

The baseline assessment establishes air quality and greenhouse gas impacts caused by current aircraft operations at the airport, enabling assessment of future impacts of the NRP.

Scenarios with and without the new runway for the opening year have the same projected number of annual and daily landing take-off cycles.

Scenarios with and without the new runway for 20 years post-opening have different projected annual and daily landing take-off cycles. The current runway system is expected to reach capacity during peak periods prior to 2045, and therefore the scenario with the new runway will have a greater number of annual and daily landing take-off cycles.

23.3.1.1 Operational Emissions

Potential sources of air pollutant emissions associated with aircraft operations comprise the main aircraft engines and auxiliary power units. This assessment considers emissions from an aircraft's main engines, while auxiliary power unit emissions are included in the ground-based air quality and greenhouse gas assessment detailed in Section 14.

The modelling system used, calculates aircraft engine emissions below 915 metres, based on emission and performance data for the particular engine(s) fitted to each aircraft. Engine emissions factors in the modelling system are adopted from the Engine Exhaust Emissions Data Bank developed by the International Civil Aviation Organization (ICAO).

23.3.1.2 Modelling

To ensure consistency with the ground-based assessment, the same air dispersion model, AERMOD, was used. Refer to Section 14 for more detail on the AERMOD model.

23.3.1.3 Sensitive Receptors

To ensure consistency with the ground-based assessment, this assessment has also used the same sensitive receptors. Refer to Section 14 for more detail on sensitive receptor selection.

A total of 57 receptors were used. Receptor locations are described in Table 23-5 and shown in Figure 23-1 and are categorised as community (considered sensitive), residential (considered sensitive), industry (considered less sensitive) or off-site (places of worship, schools, child care, aged care facilities, considered sensitive) and on-site (locations within the estate which are accessible but persons are not expected to spend more than one hour, considered non sensitive).

23.3.1.4 Modelling Inputs and Assumptions

Key assumptions adopted to complete air emission calculations for each emission source are detailed below.

Aircraft Operating Modes

In AERMOD, the landing take-off cycle is divided into six separate aircraft operating modes:

- start-up,
- taxi-out,
- take-off,
- climb-out,
- approach, and
- taxi-in.

A departure consists of the start-up (of engines), taxi-out (from apron (aircraft parking area) to runway), take-off (from runway) and climb-out modes. The approach (to the runway) and taxi-in (from runway to parking area) modes comprise a landing.

Operating Modes, Schedules and Allocations

For each scenario modelled, a set of airport operating modes is defined, together with selection rules defining the conditions under which each operating mode would be selected by air traffic control.

The selection rules take account of weather conditions, the number of departures and arrivals occurring at the time, and the priority assigned to each mode (which is generally a reflection of the desirability of that mode).

Detailed schedules of predicted busy weekday and weekend operations are used, together with historical weather data, to allocate each aircraft movement to the appropriate runway. The schedule also identifies the aircraft type, airline and origin/destination for each aircraft movement.

Airfield Layout and Operation

The airfield layout is modelled in AERMOD, identifying aircraft parking positions (apron) at a terminal, taxiways and runways. A taxi-path is defined for each of the taxiway routes used by an aircraft to taxi between the apron and runway.

The modelled taxiways are a simplification of the actual network of taxiways at Perth Airport and the subsequent taxi-paths are a conservative representation of airport operations. For instance, the model assumes that all departing aircraft would taxi to the end of the runway for departure, and that arriving aircraft would taxi to the end of the runway before exiting via a taxiway. In reality, the network of taxiways at Perth Airport provides multiple points of entry and exit for each runway, allowing the aircraft to use short taxiing distances.

For each aircraft movement in the schedule, the airline is used to identify the apron, which along with the runway, determines the taxi-path for the movement. Table 23-6 presents the terminals modelled in AERMOD and which airlines are assigned to that terminal for each assessment scenario. Figure 23-2 provides an overview of the terminal locations, as detailed within Table 23-6, in relation to the airfield.

Based on the terminal allocations shown in Table 23-6 and the airport layout shown in Figure 23-2, aircraft operating out of Terminal 3 (T3) and Terminal 4 (T4) during the 2025 with new runway scenario would have to taxi considerable distances to access the new runway. In the 2045 with new runway scenario, a considerable number of aircraft previously operating out of T3 and T4 would move to the new terminals, located centrally between the two main runways. This configuration would considerably reduce the taxiing distances for these aircraft.

ID	Description	Type	ID	Description	Type
R1	Ngala Early Learning Centre	On-site (S)	R30	Whiteside Street	Residential (S)
R2	Terminal 1 Short Term Car Park	On-site (NS)	R31	Love Street	Residential (S)
R3	Terminal 2 Short Term Car Park	On-site (NS)	R32	Guilfoyle Green	Residential (S)
R4	Terminal 3 and Terminal 4 Short Term Car Park	On-site (NS)	R33	Forster Park	Community (S)
R5	Mulberry Tree Child Care	Off-site (S)	R34	Mack Place	Residential (S)
R6	Belmay East Pre-School Centre	Off-site (S)	R35	Pioneer Park	Community (S)
R7	Redcliffe Park	Community (S)	R36	Maida Vale Road	Residential (S)
R8	Ollie Worrell Reserve	Community (S)	R37	Sultana Road West	Residential (S)
R9	Kids HQ Child Care	Off-site (S)	R38	Nardine Close	Residential (S)
R10	Great Eastern Highway Site 1	Residential (S)	R39	Belgravia Street	Residential (S)
R11	National Lifestyle Villages Hillview	Off-site (S)	R40	Abernethy Road Site 1	Industry (NS)
R12	Aurora Entrance	Residential (S)	R41	Hudswell Road	Industry (NS)
R13	Waterhall Road	Residential (S)	R42	Abernethy Road Site 2	Industry (NS)
R14	Queens Road Arboretum	Community (S)	R43	Abernethy Road Site 3	Industry (NS)
R15	Fleming Reserve	Community (S)	R44	Glassford Road	Industry (NS)
R16	Koel Court	Residential (S)	R45	Onsite industry	On-site (NS)
R17	Palmer Court	Residential (S)	R46	Casella Place	Industry (NS)
R18	Central Avenue	Residential (S)	R47	Abernethy Road Site 4	Industry (NS)
R19	Coolgardie Avenue	Residential (S)	R48	Mustang Court	Residential (S)
R20	Middleton Park	Community (S)	R49	Worrell Avenue	Residential (S)
R21	Coolbarro Lane	Residential (S)	R50	Great Eastern Highway Site 2	Industry (NS)
R22	Hoskin Street	Residential (S)	R51	Reid Street	Residential (S)
R23	Pindi Court	Residential (S)	R52	Hyland Street	Residential (S)
R24	Hatch Court	Residential (S)	R53	Peter Road	Residential (S)
R25	Upwood Circuit	Residential (S)	R54	Citrus Grove	Residential (S)
R26	St Maria Goretti's Catholic School	Off-site (S)	R55	Gregory Street	Residential (S)
R27	Redcliffe Primary School	Off-site (S)	R56	Newburn Road	Residential (S)
R28	Bulong Avenue	Residential (S)	R57	General Aviation	On-site (NS)
R29	Anglican Church of Australia	Off-site (S)			

Table 23-5 Summary of receptors assessed in this assessment
Source: Perth Airport
Note: (S) = sensitive and (NS) = non sensitive

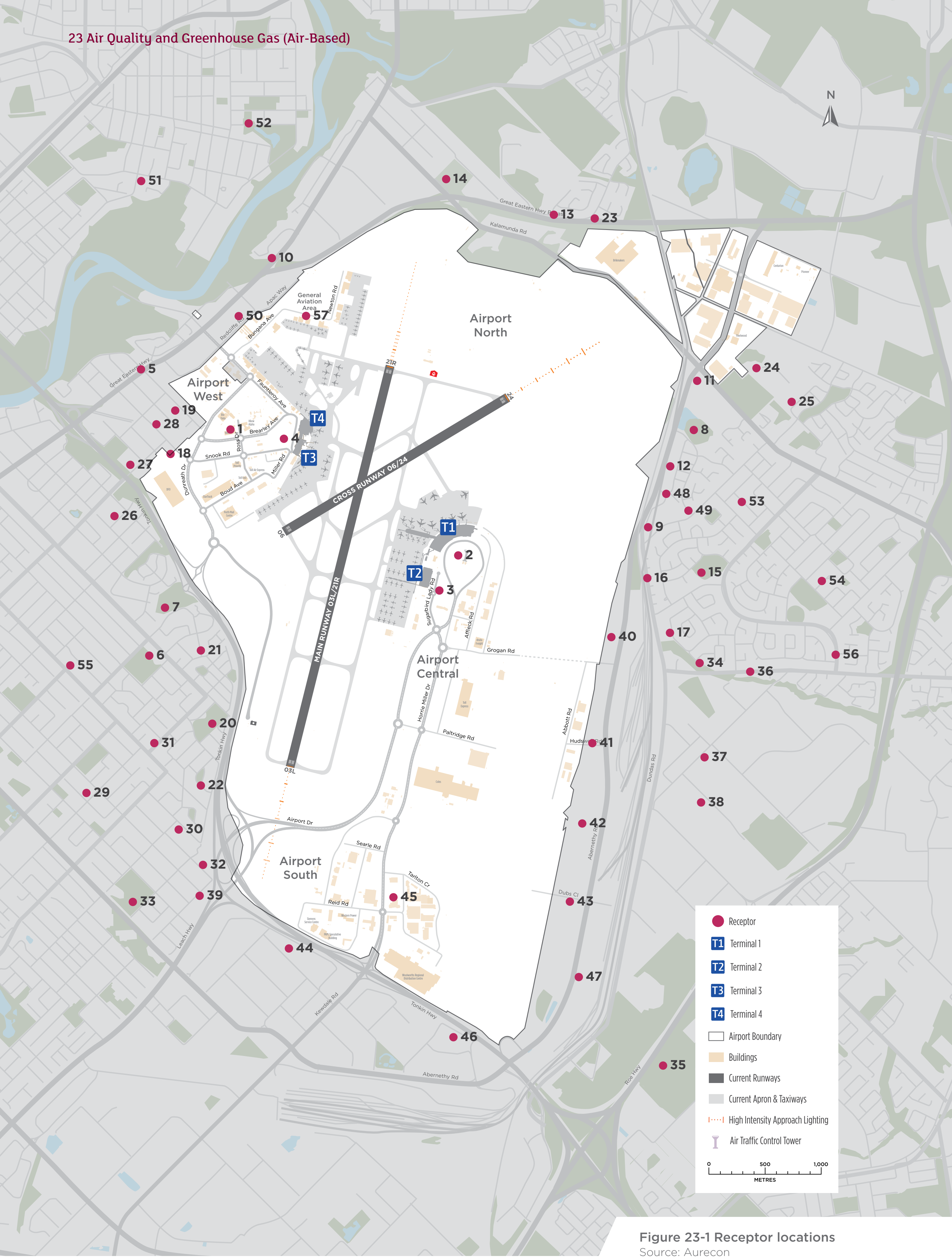


Figure 23-1 Receptor locations
Source: Aurecon

Aircraft

The forecast schedule included projections of some of the newer aircraft types expected to be used in the future, such as the Boeing 737 MAX and Airbus A330neo currently under development. For these future aircraft types a substitute existing aircraft type was used, which is likely to be conservative since newer aircraft tend to be more fuel efficient.

NO_x Conversion

To ensure consistency, the same NO_x conversion method used in the ground-based assessment, the United States Environmental Protection Authority's Ozone Limiting Method to predict ground level concentration of NO_2, was used. Refer to Section 14 for more detail.

Volatile Organic Compound Speciation

Ground level concentrations of air toxics were calculated based on the predicted ground level concentrations of Volatile Organic Compound (VOC) and incorporating the speciation percentages for aircraft exhaust implemented by the US Environment Protection Agency (EPA). The speciation rates for relevant air toxics are summarised in Table 23-7.

Sulfur Dioxide

Dispersion models typically predict ground level concentrations at time intervals of one hour or more. The power-law recommended by EPA Victoria has been used to predict ten minute concentrations of SO_2.

Fuel Dumping

Fuel dumping from aircraft is an extremely rare occurrence, and typically only occurs in emergency situations when an aircraft needs to return to an airport shortly after take-off and the abnormal (heavy) landing weight may impact the safe landing of the aircraft. Generally, if an aircraft needs to burn-off fuel prior to landing, it will continue to fly until sufficient fuel load has been used up.

All instances of fuel dumping due to an emergency must be reported to the Australian Transport Safety Bureau. There are no instances of fuel dumping in the vicinity of Perth Airport recorded in the Bureau's National Aviation Occurrence Database.

In the extremely rare event that fuel dumping is required, all efforts are taken to ensure that it is done in a location away from populated areas and at a sufficient altitude to allow the fuel to vaporise before reaching the ground.

Odour

The VOCs in aircraft exhaust emissions are the most likely cause of nuisance odour associated with aircraft movements. Perth Airport has recorded one odour complaint associated with aircraft operations since 2012.

Potential nuisance odour impacts associated with the NRP have been assessed qualitatively, based on the changes in annual VOC emissions.

Airline Group	Assigned Terminal			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
International	T1	T1	T1	Future International Terminal (Proposed Next Stage Terminal Expansion)
Qantas (International)	T1	T3/4	T3/4	Future International Terminal (Proposed Next Stage Terminal Expansion)
Qantas (Domestic)	T3/4	T3/4	T3/4	Future Domestic Terminal (Proposed Next Stage Terminal Expansion)
QantasLink	T3/4	T3/4	T3/4	Future Domestic Terminal (Proposed Next Stage Terminal Expansion)
Jetstar	T3/4	T3/4	T3/4	Future Domestic Terminal (Proposed Next Stage Terminal Expansion)
Network Aviation	T3/4	T3/4	T3/4	Future Domestic Terminal (Proposed Next Stage Terminal Expansion)
Freight	T3/4	T3/4	T3/4	T3/4
Virgin Domestic	T1	T1	T1	T1
Virgin Australia Regional Airlines	T2	T2	T2	T2
Tigerair	T2	T2	T2	T2
Regional Express	T2	T2	T2	T2
Alliance	T2	T2	T2	T2
General Aviation	General Aviation Area			

Table 23-6 Airlines and terminals
Source: Wilkinson Murray

Air Toxic	Percentage of Volatile Organic Compound
Benzene	1.681
Polycyclic aromatic hydrocarbons	Not applicable (not a significant component of aircraft exhaust emissions)
Formaldehyde	12.31
Toluene	0.642
Xylenes	0.448

Table 23-7 Volatile organic compound speciation (air toxics)
Source: Wilkinson Murray

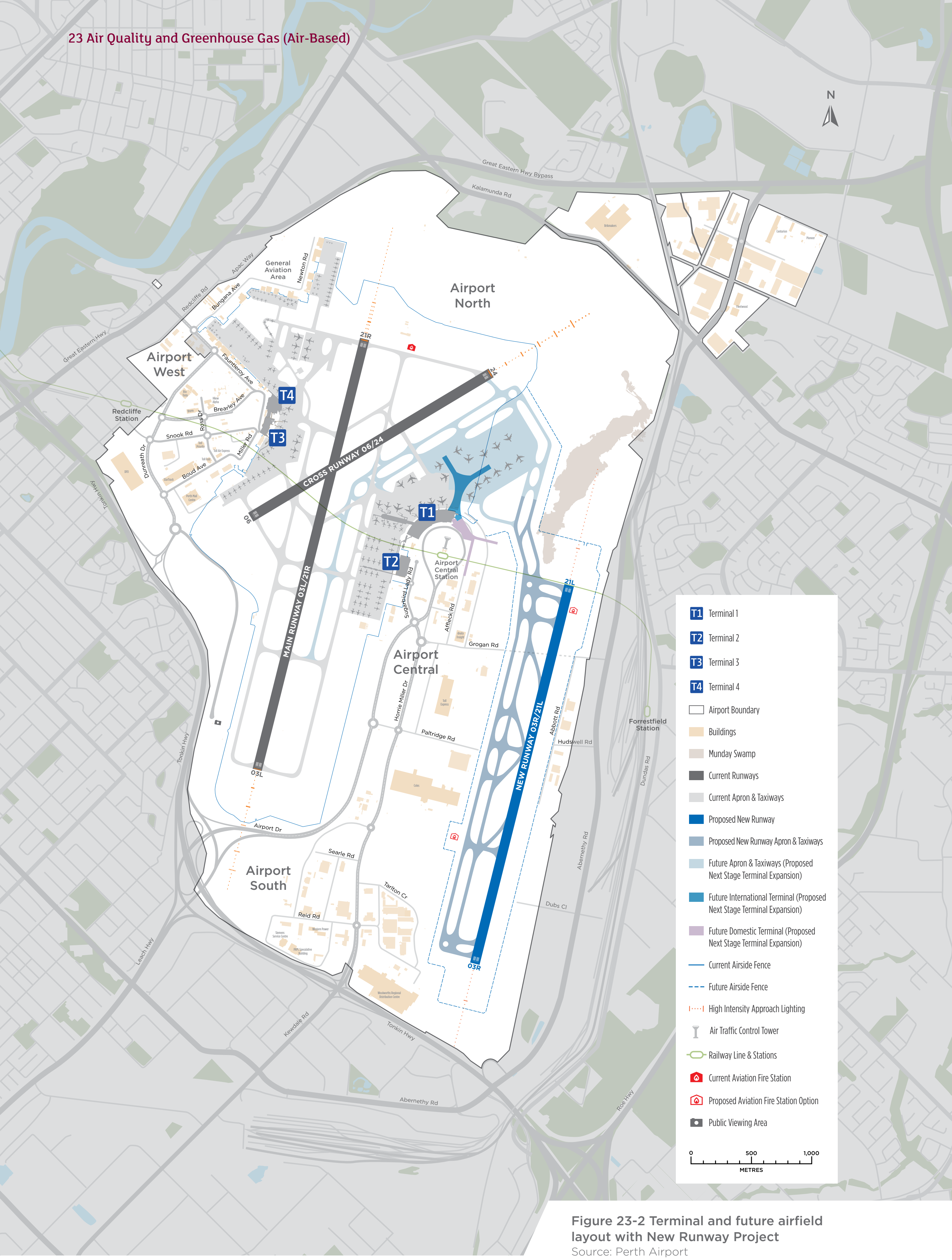


Figure 23-2 Terminal and future airfield layout with New Runway Project
Source: Perth Airport

23.3.2 Existing Condition

Terrain, ambient air quality and sensitive receptor locations influence air quality at sensitive receptor locations at Perth Airport and surrounding areas.

23.3.2.1 Terrain

Perth Airport is located approximately 20 kilometres inland from the coast and approximately one kilometre south of the Swan River. The proximity of the coast to the estate may influence the local climate.

Located just over six kilometres to the east is mountainous terrain of the Kalamunda National Park. Terrain in all other directions is relatively flat. Presence of the mountains has the potential to limit dispersion of air pollutants in the flat region surrounding the estate.

23.3.2.2 Sensitive Receptors

In Western Australia, sensitive receivers with respect to air quality impacts are defined as per the DWER's 'A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities' published in January 2011.

Sensitive receivers are defined as the following premises (the premises may exist now or in the future):

- residential dwellings,
- schools,
- hospitals,
- nursing homes,
- child care facilities,
- offices,
- public recreation areas, and
- protected wetlands.

Sensitive receivers located closest to a significant emission source are most likely to be exposed to adverse air quality. Aerial imagery and land use zoning maps were used to identify relevant sensitive receptors.

Land use zoning for Perth Airport and its surrounds is discussed in Section 5. Much of the land surrounding the estate is classified as urban and contains sensitive receptors.

The following observations were made from inspection of land use zoning and aerial imagery:

- sensitive receptors are located in high density within urban zones, predominantly residential properties,
- sensitive receptors exist in medium to low density within rural zones, and
- many public properties are located near the airport, including schools, halls and nursing homes.

Some receptors may have a heightened sensitivity to air quality, particularly the elderly and young.

Several industrial zones are located near the airport. Properties within these industrial zones are likely to contain emission sources which affect local air quality. A map which shows emissions reported to the National Pollutant Inventory (NPI) in areas surrounding Perth Airport is provided in Figure 23-3. This map shows a high density of NPI reported emissions within the southern industrial zone. Emissions from these sources are mainly VOCs and are likely to impact sensitive receptors located to the south west of the estate.

Additionally, an abundance of vegetation and forestry is located to the east of the estate at Kalamunda National Park and surroundings. This vegetation generates biogenic VOCs, the amount of which is expected to exceed industrial sources. Biogenic VOC species are not NPI listed pollutants.

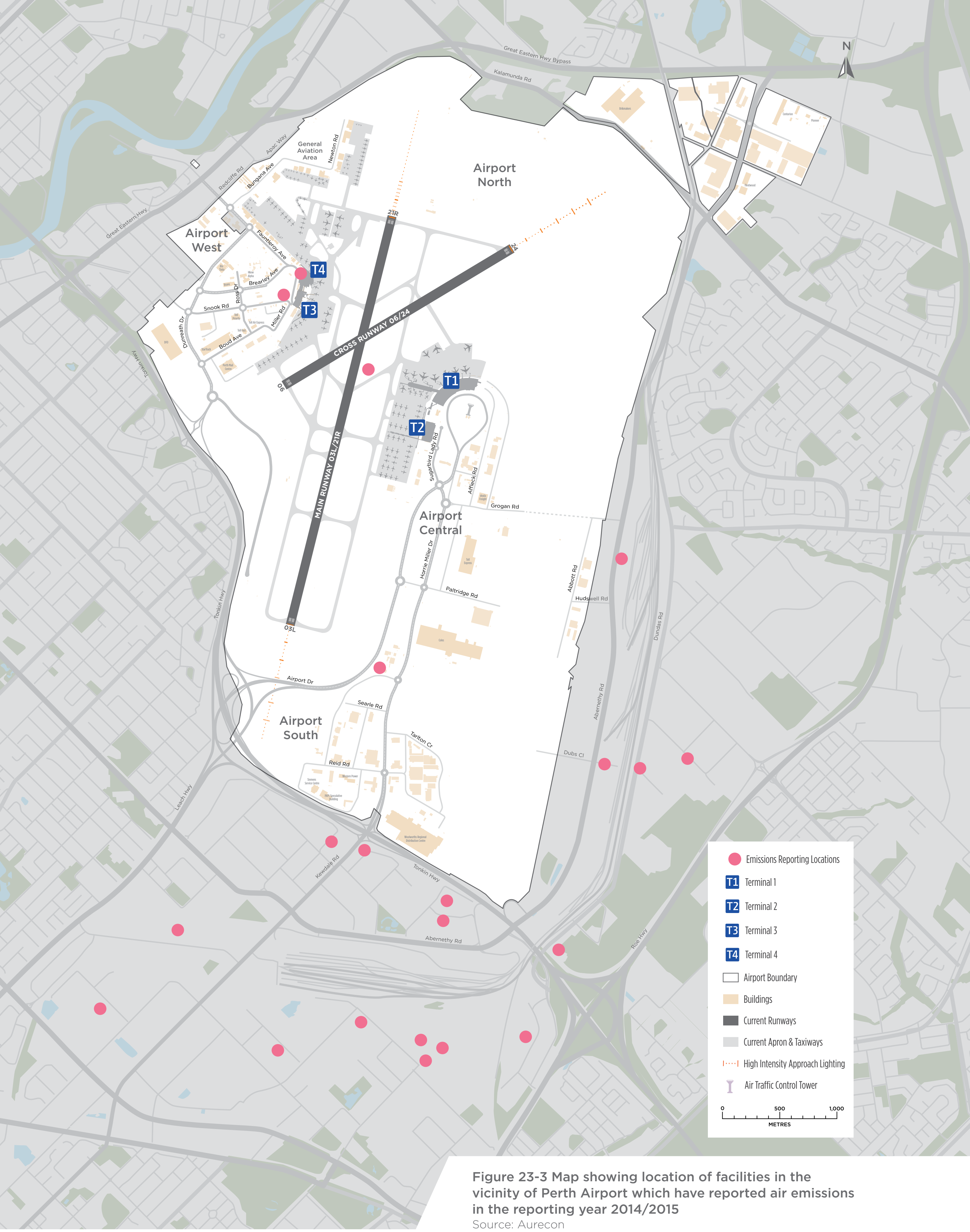


Figure 23-3 Map showing location of facilities in the vicinity of Perth Airport which have reported air emissions in the reporting year 2014/2015
Source: Aurecon

23.3.2.3 Ambient Air Quality

To enable assessment of potential impacts of the NRP against the relevant air quality assessment criteria it is necessary to establish background concentrations of pollutants so that the cumulative impact (emissions from the airport plus ambient concentrations) can be assessed.

The DWER operates an air pollutant monitoring network throughout Western Australia consisting of 13 stations. Eight of these sites are within the Perth Metropolitan area with the three closest locations to Perth Airport shown in Figure 23-4. Caversham (CA) monitoring station is located closest to estate, thus air quality monitoring data for all pollutants (other than SO_2) collected from the CA monitoring station between 2012 and 2016 were used to establish existing air quality at Perth Airport and compared against relevant air quality criteria. SO_2 is not monitored at CA, and so SO_2 levels collected at the South Lake (SL) monitoring station were used as SL is the closest monitoring station which records SO_2.

The air-based air quality assessment was completed more recently than the ground-based assessment and it has therefore used more recent historical data (2012 to 2016).

A summary of the comparison between collated air quality data and relevant criteria is provided in Table 23-8.

Pollutant and Averaging Time	2012	2013	2014	2015	2016	Criteria	Notes
CO, 8 hour max. (ppm)	0.9	0.9	0.7	1.2	0.9	9	No exceedances
NO_2, 1 hour max. (ppm)	0.037	0.043	0.033	0.041	0.036	0.12	No exceedances
NO_2, annual ave. (ppm)	Met[1]	Met[1]	Met[1]	0.006	0.006	0.03	No exceedances
PM_{10}, 24 hour max.(µg/m³)	**68.7 (4)**	**62.4 (1)**	**52.6 (1)**	46.8	38.1	50	Exceedances due to: 2014 - bushfire 2013 - smoke haze 2012 - multiple events of smoke haze and one crustal event 2011 smoke haze
PM_{10}, annual ave. (µg/m³)	16.8	15.4	17.4	16.7	15.0	25	No exceedances
$PM_{2.5}$, 24 hour max. (µg/m³)	**45.9 (3)**	22.6	**39.3 (1)**	**30 (5)**	24.1	25	Exceedances due to: 2015 – bush fires and prescribed burning (excluded from assessment) 2014 - bushfire 2012 - multiple events of smoke haze
$PM_{2.5}$, annual ave. (µg/m³)	7.8	7.9	8.1	8.5	7.7	8	No sites in Perth met criteria in 2015
SO_2, 1 hour max. (ppm)	0.039	0.044	0.051	0.037	0.034	0.2	SO_2 isn't monitored at Caversham. South Lake data was used as this station is most representative and closest No exceedances
SO_2, 24 hour max. (ppm)	0.006	0.014	0.01	0.007	0.010	0.08	
SO_2, annual ave. (ppm)	0.001	0.001	0.001	0.002	0.003	0.02	
O_3, 1 hour max. (ppm)	0.098	**0.101 (1)**	0.091	**0.103 (1)**	0.096	0.1	Exceedances due to: 2015 – no exceptional circumstances 2013 inland event/wind conditions/ assessable
O_3, 4 hour max. (ppm)	**0.086 (2)**	0.075	0.073	**0.084 (1)**	**0.085 (1)**	0.08	Exceedances due to: 2016 - inland event/wind conditions/ assessable 2015 – no exceptional circumstances 2012 – smoke induced

Table 23-8 Summary of air quality monitoring area for the New Runway Project area
Source: Aurecon

[1] – No concentration value was available. The report only detailed that the limit had been met
Note: exceedances are shown in bold and number of exceedances shown in brackets

Air quality from CA monitoring station (and, therefore, the NRP area) is typically good with the exception of some isolated events and high pollution periods. Atmospheric levels of NO_2, CO and SO_2 remained well below the criteria, and satisfied the relevant criteria for the assessment period (2012-2016).

Atmospheric levels of PM_{10} and $PM_{2.5}$ typically satisfy criteria except for days where a smoke haze over the Perth metropolitan area was observed due to bushfires and prescribed burning events.

Exceedances recorded during the assessment period occurred during summer months, with no exceedances recorded during winter months. No exceedances of the annual averaging period criterion for PM_{10} were recorded. In 2012, 2015 and 2016 the $PM_{2.5}$ annual averaging period criterion was exceeded at CA monitoring station.

Ozone is the product of chemical reactions between reactive organic gases and oxides of nitrogen (NO_x) in the presence of sunlight, whereby the reactive organic gases are predominantly biogenic VOCs. Ozone concentrations close to the ground vary based on several factors including time of day, year and availability of nitrogen oxides and tend to be highest during summer months when more sunlight is available.

Ozone levels typically satisfy criteria with only several exceedances recorded during the assessment period. All exceedances occurred during summer.

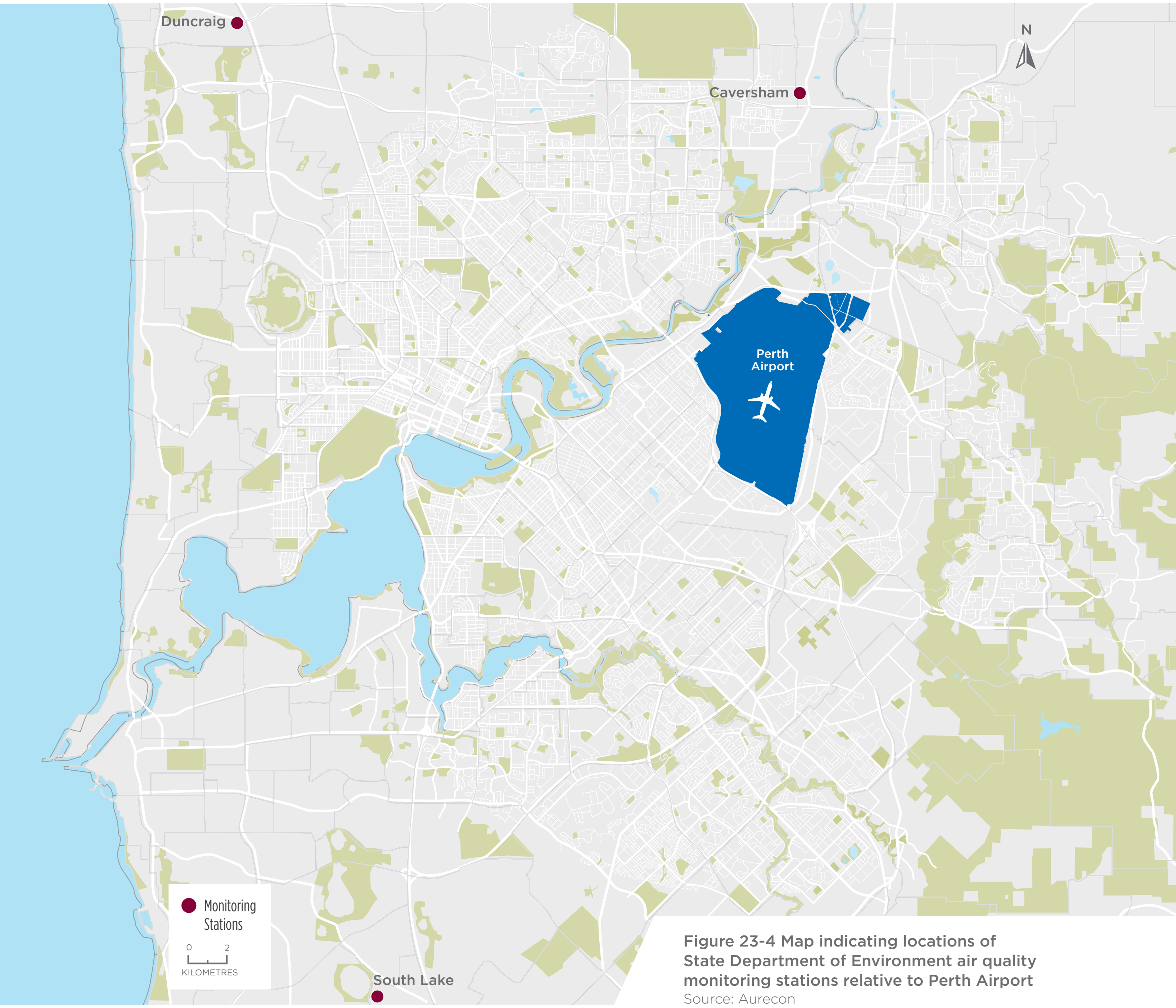


Figure 23-4 Map indicating locations of State Department of Environment air quality monitoring stations relative to Perth Airport
Source: Aurecon

During the assessment period, maximum values for PM_{10} and $PM_{2.5}$ 24-hour average concentrations have decreased. This is likely due to implementation of more stringent emissions legislation and improved technology. Despite this, negligible change in annual average concentrations is observed. Maximum values of ozone one hour average and four-hour average concentrations have shown a slight increase over the assessment period. Negligible difference in maximum concentrations was observed for pollutants SO_2, CO and NO_2.

Individual Toxic Air Pollutants

Continuous monitoring of air toxics is not currently conducted anywhere in Western Australia. The most recent monitoring of air toxics in the Perth Metropolitan Region is documented in the Background Air Quality Monitoring in Kwinana, 2005-2010 Technical Report, prepared in 2011 by the then Department of Environment and Conservation (now the DWER). The Report presents a summary of several background air quality monitoring studies conducted in Perth during 2005 to 2010. Table 23-9 presents the highest measured background levels for each air toxic and indicates that all measured concentrations of air toxics were well below the relevant NEMP standards.

Air Quality Adopted for Assessment

Table 23-10 summarises the existing background air pollutant concentrations that have been adopted to assess the impacts of the NRP. For the criteria pollutants, hourly observations during 2016 from the AQMS at Caversham and South Lake have been incorporated in this assessment.

Pollutant	Averaging Period	Existing Ambient Concentration	NEPM Standard
Benzene	Annual	0.88 µg/m³	9.6 µg/m³
Formaldehyde	24 hours	5.1 µg/m³	49 µg/m³
Toluene	24 hours	8.7 µg/m³	3,760 µg/m³
	Annual	3.4 µg/m³	376 µg/m³
Xylenes	24 hours	10.1 µg/m³	1085 µg/m³
	Annual	3.2 µg/m³	868 µg/m³

Table 23-9 Air toxics ambient levels
Source: Wilkinson Murray

Pollutant	Averaging period	Background Concentration
Carbon monoxide	8 hours	Hourly data used (Caversham AQMS)
Nitrogen dioxide	1 hour	Hourly data used (Caversham AQMS)
	Annual	
Sulfur dioxide	10 minutes	Hourly data used (South Lake AQMS)
	1 hour	
	24 hours	
	Annual	
Particles as PM_{10}	24 hours	Hourly data used (Caversham AQMS)
	Annual	
Particles as $PM_{2.5}$	24 hours	Hourly data used (Caversham AQMS)
	Annual	
Benzene	Annual	0.88 µg/m³
Formaldehyde	24 hours	5.1 µg/m³
Toluene	24 hours	8.7 µg/m³
	Annual	3.4 µg/m³
Xylenes	24 hours	10.1 µg/m³
	Annual	3.2 µg/m³

Table 23-10 Adopted background concentrations for air quality assessment
Source: Wilkinson Murray

23.3.3 Impact Assessment

The following sections discusses the potential air quality impacts associated with the NRP. The section also presents the dispersion modelling results where an exceedance in the established criteria is predicted to occur.

23.3.3.1 Criteria Pollutants

Carbon Monoxide

Table 23-11 presents a summary of the annual CO emissions in the landing take-off cycle during each assessment scenario. The results in Table 23-11 show that CO emissions from aircraft are dominated by taxiing, which typically accounts for approximately 90 per cent of total CO emissions. The modelling of aircraft taxiing is very conservative, particularly in the 2025 with new runway scenario. Despite aircraft movements in 2045 increasing by more than 20 per cent over those in 2025, CO emissions only increase by approximately four per cent. This is most likely due to fewer movements by some older aircraft. Future improvements in aircraft engine emissions are likely to reduce CO emissions from new aircraft. Therefore, since newer aircraft have not been modelled in AERMOD, future CO emissions from aircraft are expected to be lower than those presented herein.

The total ground level concentrations of CO are well below the adopted criterion at all sensitive receptors during each assessment scenario. Comparison of the incremental and total concentrations show that aircraft activities have a small to moderate effect on total CO concentrations. For on-site receptors, and other receptors located in close proximity to the airport, eight-hour CO concentrations tend to be lower when runway compared to the without runway scenario. At receptors further away from the airport, the difference between the with runway and without runway options is small. At some receptors, eight-hour CO concentrations are predicted to increase under the with runway options.

The worst-case air quality index for eight-hour average CO is predicted to be very good during all assessment scenarios. Aircraft operations associated with the NRP are predicted to have a negligible impact on ambient CO concentrations.

Nitrogen Dioxide

Table 23-12 presents a summary of the annual NO_x emissions, calculated in AERMOD, for the landing take-off cycle during each assessment scenario. The data in Table 23-12 show that NO_x emissions are dominated by the take-off and climb out modes of the landing take-off cycle, where aircraft engines are being operated at or close to full power. It is calculated that the take-off and climb out modes typically account for approximately 80 per cent of total NO_x emissions from aircraft movements. Future improvements in aircraft engine emissions are likely to reduce NO_x emissions from new aircraft. Therefore, since newer aircraft have not been modelled in AERMOD, future NO_x emissions from aircraft are expected to be lower than those presented.

The maximum predicted incremental and total one-hour average ground level NO_2 concentrations at sensitive receptors for all assessment scenarios are presented in Table 23-13.

Table 23-14 indicates that the maximum one-hour average NO_2 concentration is predicted to exceed the established impact assessment criterion of 246 µg/m³ at several sensitive receivers in the 2045 with new runway scenarios.

Mode	Annual CO Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	140.31	182.93	368.92	382.50
Take-off	11.91	12.25	12.21	10.41
Climb Out	7.92	4.93	4.93	5.83
Approach	48.14	51.68	51.69	75.26
Taxi In	174.45	210.38	330.13	325.39
Total	**382.73**	**462.16**	**767.88**	**799.38**

Table 23-11 Emissions and dispersion modelling system calculated emissions – Carbon Monoxide
Source: Wilkinson Murray

Mode	Annual NO_x Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	17.3	26.1	52.3	71.7
Take-off	475.3	672.6	670.7	865.2
Climb Out	147.7	213.2	213.3	406.8
Approach	75.8	98.2	98.2	186.6
Taxi In	39.1	53.6	68.3	94.7
Total	**755.1**	**1,063.7**	**1,102.7**	**1,625.1**

Table 23-12 Emissions and dispersion modelling system calculated emissions – Nitrogen Dioxide
Source: Wilkinson Murray

The NEPM goal for one-hour NO_2 requires that the standard of 246 µg/m³ is not exceeded on more than one day per year. To investigate the potential for one-hour NO_2 to exceed the NEPM standard on more than one day per year, the second highest predicted one-hour NO_2 concentration, at each receptor where the maximum predicted one-hour NO_2 concentration exceeds the impact assessment criterion, has been extracted from the dispersion modelling results. These results are also shown in Table 23-14. In each instance, the second highest predicted one-hour NO_2 concentration complies with the impact assessment criterion, indicating that the NEPM goal of no more than one exceedance of the one-hour NO_2 standard per year would be met.

The worst-case AQI for one-hour average NO_2 concentrations during the Baseline and 2025 without new runway assessment scenarios range from very good to fair at nearby sensitive receptors. During the 2025 with new runway scenario, the worst-case one-hour NO_2 AQI ranges from very good to fair and there are a number of receptors where the worst-case AQI for one-hour NO_2 has degraded by one category. In the 2045 with new runway scenario, the worst-case one-hour NO_2 AQI ranges from very good to poor. There are many receptors where the AQI has degraded by one category, and at one receptor, the worst-case one-hour NO_2 AQI has degraded by two. There is no predicted change to the AQI for annual average NO_2 under any assessment scenario.

The predicted incremental and total annual average ground level NO_2 concentrations at sensitive receptors for all assessment scenarios indicate no exceedances of the impact assessment criterion for annual average NO_2.

For aircraft operations associated with the NRP, based on the predicted impacts as described above, are considered to have a minor adverse effect on ambient NO_2 concentrations.

Receptor		Maximum Predicted one-hour NO_2 (criterion = 246 µg/m³)							
		Baseline		2025 Without New Runway		2025 With New Runway		2045 With New Runway	
ID	Category	Incremental	Total one-hour	Incremental	Total one-hour	Incremental	Total one-hour	Incremental	Total one-hour
R4	On-site	127	144	180	224	124	168	216	260
R6	Sensitive	107	141	91	125	147	181	237	271
R7	Community	106	134	118	129	129	161	241	274
R16	Residential	49	70	69	90	170	196	226	252
R20	Community	162	196	136	171	198	232	328	362
R21	Residential	76	110	91	123	121	153	227	260
R22	Residential	92	109	113	131	121	148	226	252
R40	Industry	46	71	67	77	209	235	274	300
R55	Residential	101	136	86	120	157	192	246	280
R57	On-site	83	119	172	216	116	160	204	248
AQI Key		Very Good		Good		Fair		Poor	

Table 23-13 Predicted incremental and total one-hour Nitrogen Dioxide concentrations
Source: Wilkinson Murray

Scenario	Receptor		Highest Predicted Concentration (ug/m³)	Second Highest Predicted Concentration (ug/m³)	
	ID	Category		Value	< ug/m³
2045 with new runway	R4	On-site	260	175	Yes
	R6	Sensitive	271	129	Yes
	R7	Community	274	190	Yes
	R16	Residential	252	127	Yes
	R20	Community	362	171	Yes
	R21	Residential	260	214	Yes
	R22	Residential	252	243	Yes
	R40	Industry	300	132	Yes
	R55	Residential	280	91	Yes
	R57	On-site	248	145	Yes

Table 23-14 Nitrogen Dioxide one-hour exceedances and next highest values
Source: Wilkinson Murray

Sulfur Dioxide

Table 23-15 presents a summary of the annual SO_x emissions for each mode in the landing take-off cycle during each assessment scenario.

Table 23-16 shows the compliance of all SO_2 concentrations, for each of the averaging periods, in all assessment scenarios against the nominated assessment criterion.

During the Baseline, 2025 without new runway and 2025 with new runway scenarios the SO_2 AQI, for all averaging periods, is very good at all sensitive receptors, and the difference between the with new runway and without new runway scenarios is very small.

Based on the predicted impacts, aircraft operations associated with the NRP are predicted to have a beneficial impact on ten-minute and one-hour ambient SO_2 concentrations and a negligible impact on 24-hour and annual ambient SO_2 concentrations. Overall, this impact is regarded as negligible.

Particulate Matter (PM_{10})

Table 23-17 presents a summary of the annual PM_{10} emissions for each mode in the landing take-off cycle during each assessment scenario.

Table 23-18 shows the compliance of all PM_{10} concentrations, for each of the averaging periods, in all assessment scenarios against the nominated assessment criterion.

During all assessment scenarios, the AQI for 24-hour average and annual average PM_{10} is fair and good respectively, and aircraft operations associated with the NRP have a negligible impact on ambient PM_{10} concentrations.

Particulate Matter ($PM_{2.5}$)

Table 23-19 presents a summary of the annual $PM_{2.5}$ emissions for each mode in the landing take-off cycle during each assessment scenario.

Table 23-20 shows the compliance of all $PM_{2.5}$ concentrations, for each of the averaging periods, in all assessment scenarios against the nominated assessment criterion.

The total 24-hour average $PM_{2.5}$ concentrations showed very little variation across the assessment scenarios. These results are dominated by the maximum existing ambient 24-hour average $PM_{2.5}$ concentration, as observed at the CA monitoring station. Analysis of the incremental 24-hour $PM_{2.5}$ concentrations shows that aircraft movements under the with new runway scenario contribute very little to ambient 24-hour average $PM_{2.5}$ concentrations.

The predicted total annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion of 7μg/m³ at all sensitive receptors, during all assessment scenarios. The 2016 annual average $PM_{2.5}$ concentration observed at the CA monitoring station was 7.7 μg/m³, which exceeds the NEPM goal proposed to be implemented from 2025. The results indicate that the contribution of aircraft movements under the NRP to annual average $PM_{2.5}$ concentrations is negligible.

During all assessment scenarios, the AQI for $PM_{2.5}$ is poor for both 24-hour and annual averages. However analysis indicates aircraft operations associated with the NRP have a negligible impact on ambient $PM_{2.5}$ concentrations.

Mode	Annual SO_x Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	5.32	7.43	14.88	19.00
Take-off	18.30	25.95	25.87	38.02
Climb Out	7.17	10.46	10.45	22.44
Approach	10.16	12.91	12.90	21.29
Taxi In	7.93	10.26	15.00	19.40
Total	**48.88**	**67.01**	**79.11**	**120.14**

Table 23-15 Emissions and dispersion modelling system calculated emissions – Sulfur Dioxide
Source: Wilkinson Murray

Pollutant	Averaging Period	Assessment Criterion (μg/m³)	Complies
Sulfur dioxide	Ten minutes	700	Yes
	One hour	570	Yes
	24 hours	228	Yes
	Annual	60	Yes

Table 23-16 Compliance of Sulfur Dioxide concentrations against assessment criterion
Source: Wilkinson Murray

Mode	Annual PM_{10} Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	0.434	0.538	1.111	1.133
Takeoff	2.615	2.815	2.807	2.941
Climb Out	0.978	1.067	1.068	1.577
Approach	0.851	0.877	0.876	1.090
Taxi In	0.632	0.741	1.087	1.158
Total	**5.510**	**6.038**	**6.949**	**7.899**

Table 23-17 Emissions and dispersion modelling system calculated emissions – Particulate $Matter_{10}$
Source: Wilkinson Murray

Pollutant	Averaging period	Assessment Criterion (μg/m³)	Complies
Particles as PM_{10}	One hour	50	Yes
	24 hours	25	Yes

Table 23-18 Compliance of Particulate $Matter_{10}$ concentrations against assessment criterion
Source: Wilkinson Murray

Mode	Annual $PM_{2.5}$ Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	0.434	0.538	1.111	1.133
Take-off	2.615	2.815	2.807	2.941
Climb Out	0.978	1.067	1.068	1.577
Approach	0.851	0.877	0.876	1.090
Taxi In	0.632	0.741	1.087	1.158
Total	**5.510**	**6.038**	**6.949**	**7.899**

Table 23-19 Emissions and dispersion modelling system calculated emissions – Particulate $Matter_{2.5}$
Source: Wilkinson Murray

Pollutant	Averaging period	Assessment Criterion (μg/m³)	Complies
Particles as $PM_{2.5}$	One hour	20	No
	24 hours	7	No

Table 23-20 Compliance of Particulate $Matter_{2.5}$ concentrations against assessment criterion
Source: Wilkinson Murray

23.3.3.2 Toxics

Table 23-21 presents a summary of the annual VOC emissions, calculated in AERMOD, for each mode in the landing take-off cycle during each assessment scenario. Ground level concentrations of each individual air toxic have been predicted using the VOC speciation profile.

The predicted incremental and total ground level concentrations of air toxics comply with their respective impact assessment criteria, at all sensitive receptors, in all assessment scenarios.

During all assessment scenarios, the AQI for each air toxic is very good, and aircraft operations associated with the NRP have a negligible impact on ambient air toxic concentrations.

23.3.3.3 Odour

Potential odour impacts associated with the NRP have been assessed qualitatively, based on the changes in annual VOC emissions, as calculated in AERMOD.

Table 23-21 indicates that total VOC emissions from aircraft would increase in future years, over that of the baseline conditions, by eight to 65 per cent. Total aircraft movements in the Baseline scenario are based on actual aircraft movements in 2016, whereas aircraft movements in all future scenarios are based on schedules for typical busy weekdays and busy weekends. This methodology results in total annual aircraft movements being overestimated by approximately five to ten per cent.

The results in Table 23-21 also indicates that total VOC emissions are dominated by taxiing, which typically accounts for over 60 per cent of VOC emissions. The modelling of aircraft taxiing is extremely conservative and, therefore, the estimated VOC emissions for assessment scenarios where taxiing distances are increased are likely to be disproportionately high.

As calculated by AERMOD, the highest annual VOC emissions would occur in the 2025 with new runway assessment scenario. During this scenario, it is assumed that several airlines are yet to relocate from terminals T3 and T4 to the terminals located in Airport Central. Aircraft associated with these airlines may taxi between terminals T3 and T4 and the new runway, resulting in significantly more taxiing.

Under the 2025 with new runway scenario, representing the second highest annual VOC emissions, the new runway results in increased taxiing distances for aircraft located in terminals T3 and T4, compared to the 2025 without new runway scenario. As outlined above, the modelling methodology results in additional VOC emissions from increased taxiing to be overestimated. Notwithstanding, the 2025 with new runway assessment scenario represents an airport configuration that could eventuate if the new runway is commissioned prior to the new terminals.

Following the initial increase in VOC emissions in the 2025 with new runway scenario, the 2045 with new runway scenario shows a decrease in overall VOC emissions. This is due to a decrease in the use of older aircraft. Future improvements in aircraft engine emissions are likely to put further downward pressure on VOC emissions. Therefore, since newer aircraft have not been modelled in AERMOD, future VOC emissions from aircraft are expected to be lower than those presented.

The existing odour impacts associated with aircraft operations at Perth Airport are very low, as evidenced by only one odour complaint being received in the past five years. On this basis, the increased VOC emissions associated with the NRP are considered unlikely to result in significant nuisance odour impacts from aircraft operations at Perth Airport.

23.3.4 Mitigation

The preceding air quality assessment has demonstrated that aircraft operations associated with the NRP would have a low impact on ambient air quality in the vicinity of Perth Airport.

Nevertheless, the AERMOD emissions estimates demonstrate that aircraft emissions during taxiing are significant. This is particularly the case for VOC where, notwithstanding the conservative nature of the modelling, taxiing typically accounts for more than 60 per cent of total VOC emissions from aircraft in the landing take-off cycle. Unnecessary taxiing reduces the overall efficiency of the airport and increases the amount of fuel used by aircraft. Accordingly, Perth Airport places considerable emphasis on the layout of the taxiway network to reduce the amount of taxiing required. It also highlights the importance of consolidation of all commercial air

Mode	Annual VOC Emissions (tonnes)			
	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Startup	20.955	29.532	29.554	42.407
Taxi Out	32.467	33.834	71.598	48.738
Takeoff	2.877	2.786	2.775	2.12
Climb Out	1.249	1.144	1.142	1.5
Approach	7.856	7.855	7.853	7.335
Taxi In	39.969	38.756	60.723	38.334
Total	**105.373**	**113.907**	**173.645**	**140.434**

Table 23-21 Emissions and dispersion modelling system calculated emissions – Volatile Organic Compound
Source: Wilkinson Murray

services into Airport Central Precinct, between the parallel runways, for long-term efficiency and associated environmental benefits.

23.3.5 Summary of Impacts

A summary of the air quality impacts against the significance criteria is shown in Table 23-22 and has been used to inform a risk assessment for the air-based air quality impacts associated with the NRP.

The risk assessment is summarised in Table 23-23. This risk assessment considers the impacts of greatest significance across all assessment scenarios at the most affected sensitive receptors. Specifically, this corresponds to one-hour NO_2 which was assessed as being subject to a minor adverse impact at the most affected receptor locations. As shown in Table 23-23, the risk rating of adverse impacts to local air quality is determined to be low.

23.4 Greenhouse Gas

23.4.1 Methodology

CO_2 emissions from aircraft exhausts comprise the potential greenhouse gas emissions associated with aircraft movements from the NRP, and have been calculated using AERMOD. Greenhouse gas emissions from auxiliary power units have been considered in the ground air quality and greenhouse gas impact assessment detailed in Section 14.

23.4.2 Impact Assessment

Greenhouse gas emissions from aircraft are categorised as Scope 3 emissions and are therefore not reportable under the NGER. Nevertheless, it is prudent to investigate the effect of the NRP on aircraft greenhouse gas emissions.

Table 23-24 presents the greenhouse gas emissions from aircraft for the landing take-off cycle. Take-off produces more greenhouse gas emissions than any other single landing take-off mode, typically accounting for approximately one-third of aircraft greenhouse gas emissions during the landing take-off cycle. Table 23-24 also presents the breakdown of Scope 3 greenhouse gas emissions into Scope 3A and Scope 3B emissions.

23.4.3 Summary of Impacts

The results show that the greenhouse gas emissions from taxiing are significant. In most assessment scenarios, the combined greenhouse gas emissions from the taxi-out and taxi-in modes are greater than those from the take-off mode alone. The modelling of aircraft taxiing is conservative, and these results are therefore considered an overestimate of greenhouse gas emissions from taxiing.

Pollutant	Averaging Period	Limit (µg/m³)	Baseline AQI	2025 Without New Runway		2025 With New Runway		2045 With New Runway	
				AQI	Impact	AQI	Impact	AQI	Impact
CO	Eight hours	10,000	10	10	Negligible	10	Negligible	10	Negligible
NO_2	One hour	246	80	96	Negligible	96	Negligible	147	Minor Adverse
	One year	62	20	24	Negligible	25	Negligible	27	Negligible
PM_{10}	One day	50	76	76	Negligible	76	Negligible	77	Negligible
	One year	25	60	60	Negligible	60	Negligible	60	Negligible
$PM_{2.5}$	One day	20	121	121	Negligible	121	Negligible	121	Negligible
	One year	7	111	111	Negligible	111	Negligible	111	Negligible
SO_2	Ten minutes	712	21	24	Negligible	27	Negligible	44	Negligible
	One hour	570	18	21	Negligible	23	Negligible	38	Negligible
	One day	228	12	12	Negligible	12	Negligible	13	Negligible
	One year	60	15	16	Negligible	16	Negligible	16	Negligible
Benzene	One year	9.6	10	9	Negligible	9	Negligible	9	Negligible
Formaldehyde	One day	49	28	12	Negligible	12	Negligible	13	Negligible
Toluene	One day	3,760	0.2	0.2	Negligible	0.2	Negligible	0.2	Negligible
	One year	376	0.9	0.9	Negligible	0.9	Negligible	0.9	Negligible
Xylene	One day	1,085	1	0.9	Negligible	0.9	Negligible	0.9	Negligible
	One year	868	0.4	0.4	Negligible	0.4	Negligible	0.4	Negligible
Significance of impacts (the worst rating was selected, making the risk conservative given that most are negligible)				Minor Adverse		Minor Adverse		Minor Adverse	
Overall likelihood of impacts for the scenario				Possible		Possible		Possible	
Risk rating				Low		Low		Low	

Table 23-22 Summary of impact significance classifications for each pollutant
Source: Wilkinson Murray

23.5 Conclusion

This assessment has investigated the potential air quality impacts and greenhouse gas emissions associated with aircraft movements as a result of the NRP. Establishment of baseline conditions was necessary to allow quantitative assessment of air-based air quality and greenhouse gas impacts due to operation of the NRP.

The maximum one-hour average NO_2 concentration is predicted to exceed the established impact assessment criterion of 246 µg/m^3 at several sensitive receivers in the 2045 with new runway scenarios. In each of these instances, the second highest predicted one-hour NO_2 concentration complies with the impact assessment criterion, indicating that the NEPM goal of no more than one exceedance of the one-hour NO_2 standard per year would be met.

The predicted concentrations of all other criteria pollutants and air toxics investigated in this air quality assessment comply with the established impact assessment criteria.

Potential nuisance odour impacts associated with the NRP have been assessed qualitatively, based on the changes in annual VOC emissions. The existing odour impacts associated with aircraft operations at Perth Airport are very low, as evidenced by only one odour complaint being received in the past five years. On this basis, the increased VOC emissions associated with the NRP are considered unlikely to result in significant nuisance odour impacts.

A risk assessment for local air quality impacts associated with aircraft movements under the NRP has been conducted, considering the impacts of greatest significance across all assessment scenarios at the most affected sensitive receptors. Specifically, this corresponds to one-hour NO_2 which was assessed as being subject to a minor adverse impact at the most affected receptor locations. The risk rating of adverse impacts to local air quality is determined to be low. No specific measures to mitigate

			Initial Assessment				Residual Assessment			
Impacting Process	Impact Detail	Project Phase	Standard Mitigation	Significance/ Consequence	Likelihood	Initial Risk	Additional Mitigation	Significance	Likelihood	Residual Risk
Aircraft movements	Adverse impacts to local air quality, specifically one-hour NO_2 concentrations, near Perth Airport	Operation	Taxiway design to reduce taxiing distances as much as practicable	Minor Adverse	Possible	Low	No additional mitigation measures identified	Minor Adverse	Possible	Low
Air-based operations (including aircraft taxiing) (all scenarios)	Air-based Volatile Organic Compound emissions result in odour complaints registered by the public	Operation	Taxiway design to reduce taxiing distances as much as practicable	Negligible	Unlikely	Very low	No additional mitigation measures identified	Negligible	Highly Unlikely	Very low

Table 23-23 Air quality and greenhouse gas (air-based) – summary
Source: Wilkinson Murray

		Greenhouse Gas Emissions (tonnes CO_2-e)			
Landing Take-off Mode	Scope	Baseline	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Taxi Out	3A	14,357	19,999	40,095	51,184
Take-off	3B	49,299	69,908	69,683	102,426
Climb Out	3B	19,337	28,180	28,156	60,442
Approach	3B	27,374	34,786	34,752	57,344
Taxi In	3A	21,372	27,630	40,424	52,247
Sub-total 3A		35,729	47,629	80,519	103,431
Sub-total 3B		96,010	132,874	132,591	220,212
Total		**131,739**	**180,504**	**213,111**	**323,643**

Table 23-24 Aircraft greenhouse gas emissions – by landing take-off mode
Source: Wilkinson Murray

the impacts of the NRP on ambient NO_2 concentrations have been identified. However, NO_x emissions from newer aircraft are anticipated to reduce in the future as aircraft engine technologies improve, and it is likely that the significance of the impact of the NRP on ambient NO_2 concentrations will reduce in years to come. Notwithstanding, the residual risk of adverse impacts to local air quality due to aircraft movements under the NRP is assessed as being low.

Aircraft greenhouse gas emissions are categorised as Scope 3 emissions for Perth Airport, and are therefore not reportable under the NGER.

While there are limitations to what Perth Airport can do to reduce air-based air quality and greenhouse gas emissions, there are several strategies and initiatives, implemented by industry, which attempt to reduce their impact.

In October 2016, the International Civil Aviation Organisation reached an agreement on a scheme to reduce greenhouse gas emissions from international aviation activities. The strategy, known as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), involves technical and operational improvements and advances in the production and use of sustainable alternative fuels for aviation. CORSIA involves voluntary pilot and initial phases from 2021-2023 and 2024-2026 respectively, followed by a mandatory phase for all participants from 2027-2035. Australia is intending to participate in CORSIA from the outset of the pilot phases.

The overarching aim of the CORSIA strategy is to work towards the global aspirational goal of carbon-neutral growth of international aviation emissions from 2020 onwards. The agreement is relevant to the NRP, though domestic aviation emissions are not subject to CORSIA.

The Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) is a joint initiative which comprises Airservices, Airways New Zealand, Japan Air Navigation Services, Civil Aviation Authority of Singapore and the Federal Aviation Administration. The goals of ASPIRE is to:

- accelerate the development and implementation of operational procedures to reduce the environmental footprint for all phases of flight, from gate to gate,
- facilitate the use of environmentally friendly procedures and standards world-wide,
- capitalise on existing technology and best practices,
- develop shared performance metrics to measure improvements in the environmental performance of the air transport system,
- provide a systematic approach to ensure appropriate mitigation actions with short, medium and long-term results, and
- communicate and publicise ASPIRE environmental initiatives, goals, progress and performance to the global aviation community and the general public.

The ASPIRE agreement, which commenced in 2008, is expected to provide the means to measure the environmental performance of current air transport systems in the South Pacific and guide the development of long term actions to minimise the aviation industry's impact on the region.

Perth Airport has a degree of control over aircraft taxiing, to the extent that the design and operation of the airport can seek to reduce taxiing as much as possible. The new runway and associated taxiways being constructed as part of the NRP have been designed to ensure efficient aircraft operations, as far as possible, while maintaining compliance with airport safety standards.


Arrivals

24 Health

This section provides an assessment of the impact to health from the operations of the New Runway Project (NRP).

Detail is also provided on the following areas:

- What research has been undertaken on the health impacts of aircraft noise exposure?
- How relevant is the research to the NRP?
- How will the NRP impact on the health of the surrounding communities?
- What mitigation measures will be undertaken to manage the impact to health?

24.1 Introduction

In 1948, the World Health Organization (WHO) defined health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. Based on this definition, it is accepted that health is a broad concept. Factors such as stress and annoyance are health concerns in their own right and not just pathways to physiological illnesses such as heart disease and hypertension.

The section describes the potential impacts on health resulting from the operation of the NRP.

A study was undertaken to examine the potential health impact from aircraft noise exposure from the operations of the NRP. The study focussed on five main health consequences:

- psychological effects,
- cognitive impairment,
- cardiovascular disease,
- sleep disturbance, and
- annoyance.

The potential health impacts associated with aircraft air emissions have also been considered.

Impacts associated with construction noise have not been assessed as construction noise is a short-term activity and the anticipated noise exposure is much lower than for that expected for aircraft operations. The construction process for the NRP is detailed in Section 6.

Information on the changes to airspace and flights paths and aircraft noise impact assessments are outlined in Section 20, 21 and 22.

24.2 Key Findings

The key findings from investigations into health include:

- Research into the health impacts of aircraft noise exposure has generally been conducted at airports much busier than Perth Airport, with no specific research completed for the Perth area.
- Generally, and not specific to the NRP, the research found that:
  - the most adverse health effect from aircraft noise exposure is considered to be sleep disturbance, due to the knock-on effects of sleep deprivation that includes an increased risk, in the long term, of obesity, diabetes and cardiovascular outcomes. Some groups, such as children and the elderly, are considered to generally be more susceptible to sleep disturbance,
  - some research has shown that aircraft noise exposure can impact on some cognitive outcomes and some areas of learning in primary age school children, with the most evidence existing for reading comprehension and some types of memory,
  - with regards to the increased risks of hypertension and the linked increased risks of ischaemic heart disease, research identifies that this risk is higher for long-term (10-15 years) exposure to aircraft noise and more prevalent in older people (over 65 years),
  - perceived and real health consequences of aircraft noise contribute to the annoyance that the noise provokes, and annoyance can result in increased stress which can lead to health consequences. The health consequences of annoyance are generally a mediator for other health issues such as stress, which is in turn linked to cardiovascular disease. Annoyance can be reduced through information, engagement to improve understanding of aircraft noise, and for those affected, manage the noise in the least intrusive way reasonably possible, and
  - the health consequences associated with air pollution include stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma, with particulate matter being the major contributor.
- With careful planning, and thorough engagement with affected populations, any potential health impacts resulting from NRP operations are likely to be small, or restricted to relatively few people.
- The NRP is unlikely to cause adverse psychological impacts on the surrounding communities.
- Noise induced hearing impairment is highly unlikely to result from community exposure to aircraft noise from NRP operations, as hearing impairment occurs only at prolonged exposure to high levels of noise well beyond the levels from NRP flight operations.
- The operation of the NRP will impact on a small number of kindergartens, pre-schools and schools that may be sensitive to cognitive and learning impacts related to noise.
- The NRP and operation of a parallel runway system will result in changes and flight paths around Perth Airport at night time. The opening of the new runway will alter the pattern of aircraft noise exposure and result in reduced aircraft noise exposure in some areas, and new or higher aircraft noise exposure in other areas.
- Operation of the NRP will eventually result in a greater number of annual aircraft movements than what could operate at Perth Airport without the NRP, and the increased aircraft capacity will result in small increases in pollution levels. However, increased efficiency in operations due to the parallel runway system will also have some impact in reducing emissions by reducing airborne delays for incoming aircraft and ground running for aircraft queued for departure. This, in turn, will reduce engine run times (and emissions) from arriving aircraft, as well as aircraft with engines running awaiting departure.
- Strategies to minimise noise impact can assist in reducing the health consequences of aircraft noise exposure. These include appropriate land use planning around airports, careful route planning, noise abatement procedures, provision of clear and comprehensible information about the likely exposure to aircraft noise, as well as information to assist those affected by the noise to undertake amelioration measures that can reduce noise penetration into homes.
- Further research is required into the effect of aircraft noise and potential health impacts, with nearly every study suggesting further research is required.

24.3 Policy Context and Legislative Framework

The literature and research examining the health impacts of aircraft noise and emissions is extensive and diverse and draws on a range of Australian and international guidelines, including:

- Airports (Environment Protection) Regulations 1997 (Commonwealth),
- Guidelines for Community Noise (WHO 1999),
- Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide (WHO 2003)
- The Health Effects of Environmental Noise Other Than Hearing Loss (enHealth 2004),
- Night Noise Guidelines for Europe (WHO 2009),
- Burden of Disease from Environmental Noise (WHO 2011),
- Health Effects from Particulate Matter (WHO 2013), and
- National Environment Protection Measures (NEPC 2017).

24.4 Methodology

A desk top review of relevant literature relating to the health impacts of aircraft noise, including research, reviews and guidelines was undertaken to assess health impacts.

Over the past 15 years, a number of Australian and international guidelines have been developed and large research projects undertaken in areas close to the some of the major international airports, such as Heathrow and Munich airports.

The assessment considered 168 articles that have been published between 1993 and 2017. Each article was assessed in terms of its research methodology, strength of findings, and relevance to Perth Airport operations.

24.5 Research Considerations and Limitations

24.5.1 Location and Environs

The tools and techniques for assessing the health effects of aviation vary from epidemiological population-level studies (of the patterns, causes and effects of health and disease conditions in a specific population) to detailed monitoring and assessment of the impact of specific levels of noise on individuals. The population studies vary widely in many characteristics, as does the aircraft noise to which they are exposed. The application of research findings to Perth should be considered in the context of variable social, environmental, housing, employment and geographic circumstances.

Housing can have a significant impact on the intrusion of noise. In addition, physical environment and geography can affect both the propagation of aircraft noise and emissions, and the levels of background noise and emissions. Many of the studies highlight the importance of seemingly minor circumstances such as room orientation and window openings (Babisch 2006; Jones and Rhodes 2013; Miedema and Vos 2007), which can be improved through amelioration measures.

The assessment of health impacts considers evidence from both laboratory-based studies and epidemiological studies. There are inherent challenges of drawing solid and 'generalisable' conclusions from research on aircraft noise. Laboratory studies are able to objectively measure certain health effects such as sleep disturbance and cardiovascular outcomes. However, research participants in the laboratory may be more sensitive to sleep disturbance, making it difficult to extrapolate laboratory findings to 'the real world' (enHealth 2004; Ising and Kruppa 2004). Most major reviews of aircraft noise and health consider the best evidence to come from epidemiological studies conducted in the field. Yet epidemiology carries associated risks and may not provide clear-cut answers (enHealth 2004).

Confounding, or 'mixing of effects' can occur when an association between a health outcome and aircraft noise is identified, although might also be explained by another factor which has an independent effect on the health outcome. For example, people living in high noise areas may be more likely to have a lower socio-economic status, which in turn increases their risk for certain health impacts (Huss et al 2010). Likewise, some ethnicities have a strong association for cardiovascular disease (Hansell et al 2013). Well-designed studies take confounding factors into consideration and adjust the analysis accordingly. However, in some cases – especially population-level studies that use census data or medical records – data is not always available on individual confounding factors, like family history of cardiovascular disease, or smoking. In these cases, data is estimated. Consequently, some of the strongest evidence comes from individual-level studies because they can control more confounding factors (enHealth 2004).

In some studies, noise levels must also be estimated if not available or assessed by researchers (Miedema and Vos 2007; Ohrstrom et al 2006). This can result in misclassification if the noise levels are incorrect for some participants (Clark 2015).

Another variable that limits 'generalisability' is time. Cross-sectional studies capture a snapshot at a given time and cannot account for the possible difference between long and short-term effects (Hansell et al 2013). The most valuable evidence comes from longitudinal studies, where data is gathered for the same subjects repeatedly over a period of time. There is also a distinction between acute and chronic noise exposure, which longitudinal studies are able to delineate. The body's response to acute noise exposure might be short-term, for example a temporary increase in heart rate, which will be different from the body's response to being exposed to noise over a long period of time.

Further complications come from trying to measure subjective responses (Stansfeld and Matheson 2003). This is particularly the case for sleep disturbance and annoyance, most commonly assessed through subjective responses. Objective and subjective assessments of sleep disturbance have produced different results. This is compounded by the different methods used to assess health effects, including survey techniques (Fields et al 2001), sampling and noise exposure measurements (WHO 2011). Although other effects like cardiovascular impacts may be easier to measure objectively, determining causality from aircraft noise requires very large samples (Clark 2015).

Some of the most useful evidence comes from meta-analysis which systematically compares and summarises evidence from a range of relevant studies. While this approach has its own limits based on the comparability of disparate study designs and methodologies (Maurice et al 2009), meta-analyses provides a systematic review of evidence to take into account trends over time.

In some cases, research also relies on indirect evidence of the association between aircraft noise and health effects (WHO 2009).

For example, there is evidence that environmental noise can cause sleep disturbance, and there is evidence that sleep deprivation has a number of adverse health effects. Therefore, the causal link between noise and those health effects is indirect (Swift 2010; WHO 2009). This is reflected in researchers' consistent calls for further research into the health effects of aircraft noise. In fact, nearly every study suggests further research is needed.

24.5.2 Pattern of Aircraft Noise

Many studies are based on aircraft traffic volume and noise levels that are very different from current operations at Perth Airport or from what is expected as a result of the NRP operations.

Perth Airport currently has just over 130,000 aircraft movements per year. This is below the peak year of 2013 that experienced 151,000 aircraft movements. The number of annual flights at Perth Airport is forecast to reach 172,000 by 2025 and 241,00 by 2045 as outlined in Section 2.

In contrast, London's Heathrow Airport had over 474,000 aircraft movements in 2017. Many of the studies undertaken have been at airports with traffic levels at the sorts of levels that occur at Heathrow Airport. This does not make the results of health studies at busier airports irrelevant, but it does require caution when translating studies undertaken at one airport to the circumstances of another.

Over the past 45 years, aircraft have become quieter but this does not mean that aircraft noise exposure has reduced. The growth in the number of aircraft flying and the average size of those aircraft has counterbalanced some of the substantial noise improvements of newer aircraft, such as the Boeing 787 and the Airbus A380.

Over time, fleet renewal will see changes to the aircraft mix, replacing the noisiest, oldest aircraft flying with the newest, quietest models available. However, the growth forecasts for Perth Airport (detailed in Section 2) demonstrate that any noise improvements through increasing use of quieter aircraft types may be offset by the growth in the average size and the number of aircraft flying.

24.5.3 Aircraft Noise Metrics

In general, a particular challenge in assessing the health impact of aircraft noise exposure is how the studies rely on the measurement of aircraft noise to which a population is exposed. Various noise metrics are available and can result in varying conclusions. Section 22 provides further information on relevant aircraft noise metrics.

Measuring Noise

Noise is measured in decibels. Decibels are logarithmic scales that provide ratios of pressure, from which the power of a sound wave and its perceived loudness can be calculated. The measurement of sound for the purposes of most research on the health effects of aircraft noise exposure is based on the A-weighted scale, referred to as dBA. An increase of one dBA is considered just discernible by a person with good, undamaged hearing in isolation from background noise. A three dBA change is considered to be a level of increase just discernible for the average person in an outdoor environment. A variation in sound of ten dBA is perceived as either doubling in volume, or reducing by half as shown in Figure 24-1.

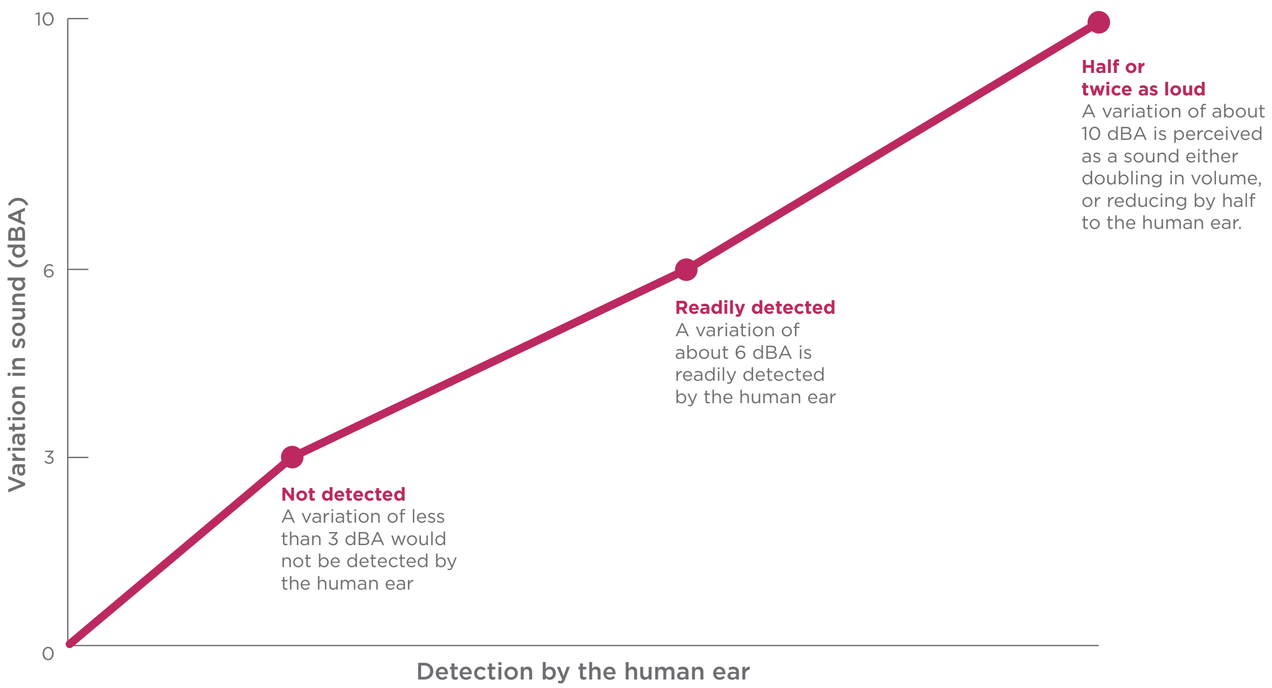


Figure 24-1 Perception of variation in sound levels
Source: Perth Airport

Composite Noise Metrics

A particular challenge in researching the health impacts of aircraft noise exposure is identifying comparable levels of noise from different sources. An aircraft passing overhead will generate noise over a relatively short duration but will exceed the level of background noise if the aircraft is loud enough, close enough and the level of background noise is low enough. There will then be no aircraft noise until the next aircraft passes. Road traffic noise tends to be less episodic (depending on the type of road). The source of the road noise is also fixed (to the road) whereas an aircraft can vary significantly in both height and lateral position, creating greater variation in noise impact.

Much analysis of aircraft noise uses metrics that seek to provide a standard, single value for noise over a given period, which might be a day, or part of a day (such as evening, day or night), and is averaged over a longer period. Alternatively, some metrics are calculated from composite data from a longer period. This seeks to calculate a 'continuous noise equivalent level' for the specified period of time (e.g. 24 hours, evenings, or night-time), although this continuous level is derived from episodic noises. Continuous noise equivalent measures include the Australian Noise Exposure Forecast (ANEF), the US Noise Exposure Forecast (NEF), and L_{dn}/L_{den} (day night average sound level / day evening night sound level) measures commonly used in Europe.

Formulas for calculating the continuous noise equivalent level vary, with a key difference being the weightings for day, evening and night noise. In the case of L_{dn} (day night average sound level) and ANEF formulas, evenings are not given a separate weighting but instead a widening definition of night (in the case of the ANEF 'night' is 7.00 pm to 7.00 am) which reduces the penalty for night noise, whereas L_{den} (day evening night sound level) and the NEF separate day, evening and night.

Accordingly, there are no precise conversions from one scale to another. This can complicate the comparison of different studies using different metrics. It can also inhibit the ready application of the results of a study undertaken in one location to the circumstances of another location (Correia et al 2013; Maurice et al 2009; Paunovic et al 2011; WHO 2011).

The common use of composite noise indices can also obscure important distinctions in the nature of the aircraft noise exposure. The impact of aircraft noise can be from a relatively few very loud events, a great many quieter events, or anything in between. The noise can be almost entirely during daylight hours, largely at night, in the evenings or early morning, or any of these in varying combinations.

Some continuous equivalent noise measures adjust for day, night and possibly evening, but they do not allow for varying patterns within those bands. Night noise in a burst at 10.00 pm is likely to have very different effects from noise evenly spread across the whole night. The absolute numbers of events and their loudness will further affect that variation. All of these distinctions may well have a significant effect on the impact of that noise (Stansfeld and Clark 2015).

Alternative Noise Metrics

Some health impacts of aircraft noise relate to the specific types of aircraft noise events. Aircraft noise may disturb sleep when a single event is loud enough. Disturbance not only takes the form of awakenings but also the subtler disturbance of the different sleep stages. In this context, it is important to identify the number and frequency of events above a specified level. There is limited research on the use of different metrics for measuring aircraft noise such as the number of events above a specified level (say 65 dBA) in a specified time period (such as night, perhaps defined as 10.00 pm to 6.00 am). These measures, known as the Number Above or N-contours, are not always available. Some studies have highlighted the possible benefits of using N-contours and other metrics (Maurice et al 2009; Sharp et al 2014). The N-contours for NRP operations are detailed in Section 22.

Measuring Annoyance

While annoyance is seen as a health issue in its own right, it is also implicated in other health concerns as a result of the stress related impacts it has. Accordingly, it is important to be able to measure the level of annoyance that occurs at a specified level of noise. Currently the relationship of annoyance to aircraft noise exposure is assessed by measures such as L_{den}, ANEF or the NEF. Those measures are based on 'dose/response' surveys that plot communities' responses to aircraft noise and relate these to a formula that gives a composite index for the total noise in those locations. The actual noise events in those communities can vary significantly in loudness, duration, frequency of events and distribution over time of day.

Recent commentary has questioned the validity of the dose/response relationship and the capacity of these formulas to provide an accurate representation of the noise level as perceived by those who are annoyed. This raises questions about the capacity to relate annoyance to identified levels of aircraft noise. Research shows that annoyance is frequently driven by factors other than the level of aircraft noise, such as fear of crashes, unmet expectations about the level of peace and quiet, changes in noise levels, and lack of understanding about why the aircraft have to fly where they do (Guski 1999; Civil Aviation Authority 2017; ICAO 2016; Southgate 2007). It appears that the noise level people are exposed to only plays a small part in predicting or explaining their level of annoyance.

Complaint Data

Traditionally, consumer service and supply industries draw heavily on complaint data to assess dissatisfaction. While not all people who are dissatisfied will lodge complaints, a high level of complaints, at aggregated levels, can provide important insights into consumer reactions. In the field of aircraft noise, some papers highlight the need to disaggregate complaints and annoyance (enHealth 2004; ICAO 2016) based in part on the substantial distortion of complaint data by a very few chronic complainers. Arguably, with better complaint data that does not count repeat contacts as separate complaints, aircraft noise complaints could provide at least supplementary data on the level of annoyance. They could also provide insights into levels of self-reported sleep disturbance, and some other health indicators such as self-reporting of stress in response to aircraft noise. At the non-aggregated level, complaints can provide important information about specifics of annoyance drivers, if treated with appropriate discernment.

In practice, complaint data is not used in this way (enHealth 2004; ICAO 2016) and is generally regarded as unreliable. This is a reasonable assessment in view of the poor collection and reporting of aircraft noise complaint data across the aviation industry worldwide. The standard practice of designating every contact made by a complainant as a separate complaint allows very few complainants to confound the data. Over time improved data collection and analysis, focusing on the number of distinct individuals who complain and the specific issues that provoke those complaints, may provide valuable insights beyond those currently available. Airservices has changed its approach to collection of complaints data to align with this thinking.

24.5.4 Interdependent Health Impacts

Although the various health consequences of aircraft noise exposure are generally considered under separate headings, they in fact are intricately linked, as shown in Figure 24-2. For example, sleep disturbance is linked to cardiovascular health (Basner et al 2014) and annoyance. Similarly, annoyance can affect sleep disturbance (Pirrera, De Valck and Cluydts 2010), self-reported health and cardiovascular outcomes. In reality, the health effects of noise are often intertwined and interdependent.

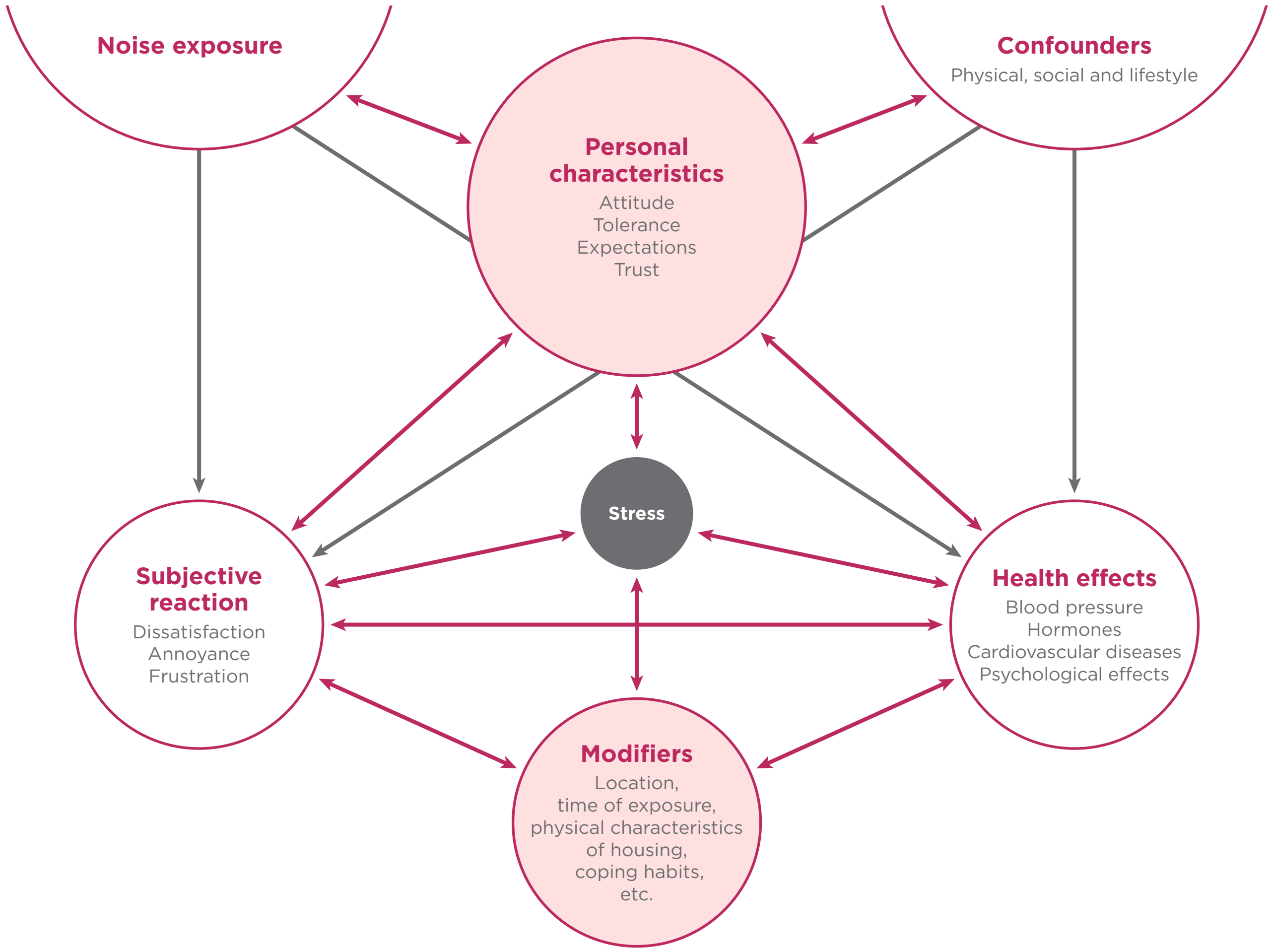


Figure 24-2 Interdependent health impacts

Source: Berry and Sanchez, The Economic and Social Value of Aircraft Noise Effects: A Critical review of the State of the Art (2014)

24.6 Impact Assessment

The NRP will result in the operation of a parallel runway system that will see changes to flight paths around Perth Airport. These changes, as well as the projected future growth in air traffic, will alter the pattern of aircraft noise exposure and result in reduced aircraft noise exposure in some areas and new or higher aircraft noise exposure in other areas.

The operations of a parallel runway system will therefore alter the distribution of the potential health impacts, rather than deliver any net increase.

A health impact assessment has considered the potential health impact from aircraft noise on five main health consequences:

- psychological effects,
- cognitive impairment,
- cardiovascular disease,
- sleep disturbance, and
- annoyance.

The potential health impacts associated with aircraft air emissions has also been considered.

24.6.1 Psychological Effects

A range of health outcomes are relevant in considering the possible psychological effects of aircraft noise. At the most serious end is mental illness, defined by Australia's National Mental Health Plan (Department of Health 2003) as 'a clinically diagnosable disorder that significantly interferes with an individual's cognitive, emotional or social abilities'.

Research has also considered a range of other conditions that impact mental health, consistent with the definition of mental health as 'a state of emotional and social wellbeing in which the individual can cope with the normal stresses of life and achieve his or her potential'. Under this definition conditions such as stress and annoyance are valid mental health concerns but are not clinically defined mental illnesses.

While reliable research into mental health effects from aircraft noise exposure is limited, a consistent finding is that aircraft noise exposure has not been shown to cause psychiatric disorders (Jones 2010a; Jones and Rhodes 2013; Stansfeld and Matheson 2003; WHO 1999). It is accepted that aircraft noise exposure can result in psychological effects such as annoyance and stress (EnHealth 2004) and anxiety (Clark 2015), but it is unclear whether psychological health affects the aircraft noise response by making some people more susceptible to the mental health effects of aircraft noise exposure, or whether the aircraft noise response causes the psychological effect (Babisch 2014).

There is limited evidence of mental health concerns due to aircraft noise exposure. The data is unclear and any impact would appear to be short term. Studies identifying such impacts have generally been based on much higher levels of aircraft noise exposure than are forecast for Perth Airport. The potential impact of the new runway operations on psychological health has been assessed as negligible.

24.6.2 Cognitive Impairment

Cognitive impairment is a term generally used to refer to any form of impairment that affects the mind or the brain. In relation to aircraft noise exposure, the focus has been on the capacity of individuals to process information, most frequently in the context of learning.

A number of studies have identified links between high levels of exposure to noise and children's learning (Hygge, Evans and Bullinger 2002; Stansfeld et al 2005). The studies do not point to a clearly definable level of impact from aircraft noise and some have considered other environmental noise.

The principal impacts identified relate to reading comprehension, some types of memory, and inconsistent findings for attention (Matheson, Stansfeld and Haines 2003; Stansfeld et al 2005; Stansfeld and Matheson 2003; WHO Europe 2011). Studies have pointed to a delay in reading ability of between two and eight months (Clark et al 2006; Klatte et al 2016). Although not unanimous in their findings, some studies suggest that this effect is reversible (Hygge, Evans and Bullinger 2002; Sharp et al 2014). Two studies found that night-time noise did not have an additional cognitive effect on children over and above the effect of daytime exposure (Clark et al 2006; Stansfeld et al 2010).

Despite the uncertainties in this area of research, there is evidence to conclude that aircraft noise exposure can have a detrimental effect on some cognitive outcomes and some areas of learning in primary age school children. The most evidence exists for reading comprehension and some types of memory. The major studies that provide the primary source of data for this area of research have been undertaken in Europe and the US, often at airports with much higher levels of aircraft activity than will occur at Perth Airport.

Research on cognition effects in adults is limited but does point to there being no significant impact (WHO 2009).

The operation of the new runway will result in a number of education facilities being overflown by aircraft as outlined further in Section 25. The analysis shows a slight reduction in 2025 with the opening of the new runway, due to the spread of aircraft traffic across the parallel runways. By 2045 the number of impacted facilities will increase to pre-NRP numbers.

Research also suggests that further work is required in this area. The potential impact of the new runway operations on cognitive and learning impairment has been assessed as minor adverse as there are no schools within the significant noise effected contours as identified in the Airports Act. Perth Airport supports further research to be undertaken at an international and national level.

24.6.3 Cardiovascular Effects

The Australian Institute of Health and Welfare defines cardiovascular disease as 'all diseases and conditions involving the heart and blood vessels', of which the main types in Australia are coronary heart disease, stroke and heart failure/cardiomyopathy.

Research in this field takes a broader view, and includes related conditions that may link to cardiovascular disease, such as hypertension (persistent long-term high blood pressure).

Studies vary significantly in the noise levels assessed and many seek to determine whether there are thresholds at which the effects are evident.

A highly-cited review of pre-2006 studies identified the threshold for evidence of ischaemic heart disease at an average sound pressure of 65 to 70 dBA (Babisch 2006). In 2009, the WHO Europe identified 55 dBA as a threshold at which there was 'limited evidence' for greater risk of myocardial infarction and hypertension, while in a 2010 publication the European Environment Agency identified 60 dBA as a threshold for higher risk of myocardial infarction. A 2014, meta-analysis suggested that earlier suggestions of a threshold were correct, but presented 55 to 60 dBA as the level at which there is a relatively small increased risk of ischaemic heart disease (Babisch 2006). Some recent studies suggest there is no threshold, but an increased risk as noise levels get higher, with the risk rising by seven to 17 per cent per ten decibel increase in noise level (Basner et al 2014).

Some studies identify effects greater in older people (Rosenlund et al 2001) or have focussed on older people such as those over 64 years old (Correia et al 2013; Sorensen et al 2011). Others suggest effects require long-term exposure of up to 20 years (Huss et al 2010; Swift 2010). Certain groups are more at risk of cardiovascular illnesses including men (Australian Institute of Health and Welfare 2011) and specific ethnic backgrounds (Hansell et al 2013).

There is some evidence for an association between environmental noise and increased risks of hypertension (Babisch 2006; Jarup et al 2008; Maurice et al 2009; Rosenlund 2001), with a general view that this also links to increased risks of ischaemic heart disease. Much of the research on which this conclusion is based has considered levels of exposure above those that are forecast for Perth Airport. The potential impact of the new runway operations on cardiovascular health has been assessed as minor adverse.

24.6.4 Sleep Disturbance

From the research, the most commonly agreed health consequence of noise is sleep disturbance. It has also been cited as the most adverse health effect (WHO 2011) due to the knock-on effects of sleep deprivation. These include an increased risk, in the long term, of obesity, diabetes and cardiovascular concerns (Swift 2010).

There are two ways of studying sleep disturbance, with different results produced from the two approaches.

Typically, laboratory-based studies assess objective sleep disturbance through polysomnography – a method of sleep study that records physiological responses during sleep such as brain waves and heart rate. Sleep disturbance can also be assessed subjectively by asking participants to fill in questionnaires.

Ultimately, knowledge about sleep disturbance and aircraft noise is incomplete. There remains disagreement over which noise measurements to use to best assess sleep disturbance and there is no single agreed dose/response relationship for sleep disturbance and aircraft noise.

Most research focuses on indoor sound levels as more accurate predictors of sleep disturbance than outside. The extent to which noise can penetrate a dwelling varies greatly, and is dependent not just on house construction and insulation, but also on factors that are difficult to isolate in research such as open windows or the orientation of bedroom windows (Jones and Rhodes 2013; Miedema and Vos 2007; Ohrstrom et al 2006).

Some groups are more susceptible to sleep disturbance, like children and the elderly, but there is little research into these specific groups. Factors other than environmental noise can cause sleep disturbance, and some studies conclude that other factors like needing the bathroom or having young children are far more likely to disturb sleep than aircraft noise (Jones and Rhodes 2013).

Research into sleep disturbance and aircraft noise exposure has sometimes produced inconsistent findings. People are generally better able to adapt to continuous noise levels like traffic (enHealth 2004) than aircraft noise, which is punctuated by events (Clark 2015; Denison 2016). However, one study using polysomnography found that road noise had the most effect on objective sleep disturbance, even though participants' self-reported sleep disturbance identified aircraft noise as more disturbing (Basner et al 2011). The uneven patterns of air traffic at night in many airports, including Perth, provide a very real confounding factor for the research and its translatability.

The noise levels at which sleep disturbance occurs varies across studies. Sleep disturbance can also occur in subtler ways than awakenings, such as altered sleep structure, cardiovascular responses and changes in the amount of time spent in different sleep stages (Basner et al 2011; enHealth 2004; Jones and Rhodes 2013).

The NRP and operation of a parallel runway system will result in changes to flight paths around Perth Airport at night time. Section 22 outlines the changes that will occur. The opening of the new runway will alter the pattern of aircraft noise exposure and result in reduced aircraft noise exposure in some areas and new or higher aircraft noise exposure in other areas.

The opening of the NRP will also impact on community facilities that may be sensitive to sleep disturbance such as child care or kindergarten facilities as outlined in further detail in Section 25.

The analysis shows a reduction in 2025 with the opening of the new runway, with 24 of the 72 facilities no longer impacted by five or more daily noise events. By 2045, the number of facilities will reach the pre-NRP counts, with an increase shown for aged care and retirement facilities.

The potential impact of the new runway operations on sleep disturbance has been assessed as moderate adverse. Perth Airport supports further research to be undertaken at international and national level.

24.6.5 Annoyance

The health effects of aircraft noise contribute to annoyance, and are contributed to by annoyance (Passchier-Vermeer and Passchier 2000). In other words, annoyance at aircraft noise is not just a response to the noise itself but also a response to what the noise represents. Perceived and real health consequences of aircraft noise contribute to the annoyance that the noise provokes, and annoyance can result in increased stress which can lead to health consequences.

At roughly similar constant equivalent noise levels, aircraft noise has been found to be more annoying than road traffic noise (Airports Commission 2013; Miedema and Vos 2007). This suggests that the pattern of the noise is a relevant factor in determining annoyance. It is likely that the episodic nature of aircraft noise makes it more annoying (ICAO 2016; Stansfeld et al 2005).

The annoyance literature also focuses on non-acoustic factors that are identified as perhaps the most important variable in explaining annoyance. Numerous sources cite non-acoustic factors as more significant than actual noise levels in predicting or explaining annoyance, and some identify acoustic factors as accounting for only a third of the cause of the annoyance (Ising and Kruppa 2004). Non-acoustic factors are described in varying ways but can be summarised as:

- unmet expectations (e.g. that there would be less, or no aircraft noise),
- change (linked to expectations that there would be no change, and a failure of communication about change),
- lack of understanding (e.g. why aircraft fly where they do),
- fear (e.g. aircraft noise prompting an associated fear of aircraft crashing),
- individual sensitivity to noise (individual responses to noise vary greatly), and
- value placed on the cause of noise (the greater the value placed on the source of the noise, i.e. aviation services and sector, the less likely an individual will be annoyed).

A change in the noise can be a driver of annoyance (ICAO 2016, enHealth 2004). However, the annoyance of the noise can also be attributed to a change in an individual's situation, such as changed hours of work or change in stress from other sources.

Another finding is that children are less annoyed by aircraft noise than adults (Stansfeld and Clark 2015). This may relate to the acoustic drivers of annoyance, such as interference with conversation, TV viewing and peace and quiet which may be more significant to adults. It is also likely to relate to the non-acoustic factors discussed previously.

The Perth Airport Master Plan 1999 reports a telephone survey of 300 residents, within a ten kilometre radius of Perth Airport, that was undertaken by Patterson Research Group to identify perceptions of noise. This survey identified that 71 per cent of respondents considered vehicle traffic as the main cause of annoyance, compared with 17 per cent that considered aircraft as the main cause of annoyance. For those survey respondents living within the Australian Noise Exposure Forecast (ANEF) contours (current at that time), 65 per cent identified aircraft as the main cause of annoyance, however only ten per cent of the respondents within the ANEF contours said that noise had a major effect on their family. The study noted that very small proportions of respondents were worried or concerned about aircraft noise.

During the period of December 2017 to February 2018, Patterson Research Group undertook a more detailed survey of community attitudes towards infrastructure development in and around Perth. More than 2,600 people within a 30-kilometre radius from Perth Airport were randomly selected to take part in a survey about noise in their neighbourhood and their level of annoyance towards the noise sources. The survey identified:

- in terms of the extent to which aircraft noise is an irritation, four per cent of all respondents reported aircraft noise as a major irritation, five per cent as quite irritating, 25 per cent as a minor irritation and 65 per cent as hardly noticed,
- the main sources of noise issues were attributed to road traffic, barking dogs, general anti-social behaviour, and particular neighbours. Aircraft noise was reported as an issue for nine per cent of respondents, with this proportion increasing with proximity to the airport – 12 per cent of respondents within ten kilometres of the airport reported aircraft noise as an issue, nine per cent within 10-20 kilometres, and six per cent for respondents within 20-30 kilometres of the airport,
- when considering different time periods and whether aircraft noise was noticeable and an issue, the time periods that caused the most irritation were 11.00 pm to 3.00 am (5.3 per cent of all respondents), 7.00 pm to 11.00 pm (4.8 per cent), 6.00 am to 8.00 am (4.5 per cent), and 3.00 am to 6.00 am (3.7 per cent), and
- for respondents that indicated aircraft noise was a major issue or something of an issue, the main ways in which noise affected them was disturbed sleep, disruption to activities, and annoyance/irritation. The volume of noise events, as well as changes to the frequency and timing of flights, were noted as specific causes of annoyance/irritation. A few respondents also reported anxiety/stress from low flying planes.

The potential impact of the new runway operations on annoyance has been assessed as minor adverse.

24.6.6 Emissions

There is substantial literature on the health effects of emissions from road and air traffic that identifies various pollutants from the burning of fuels as responsible for adverse health effects. In 2013, the WHO undertook a major review of evidence on health aspects of air pollution and confirmed the significance of air pollution as a risk to health.

The health consequences associated with air pollution include stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma (WHO 2013), with particulate matter being the major culprit. One study identified an impact on both increased mortality and increased hospital admissions (Hanninen et al 2014). Both the WHO and the US Environmental Protection Agency have also reported on studies linking long-term exposures to a range of other adverse health outcomes such as atherosclerosis, childhood respiratory disease and adverse birth outcomes (Denison 2016).

Airport related activities that contribute to air emissions include ground service equipment used to service aircraft, auxiliary power units used to power parked aircraft, stationary aircraft engines, road traffic, energy generation (cogeneration), fuel storage, and flight operations. The assessment of emissions as a result of the NRP are detailed in Section 14 (ground-based sources) and Section 23 (airborne operations).

Operation of the new runway will eventually result in a greater number of annual aircraft movements than what could operate at Perth Airport without the new runway. The increased aircraft capacity will result in small increases in pollution levels. However, increased efficiency in operations due to the parallel runway system will also have some impact in reducing emissions by reducing airborne delays for incoming aircraft, and ground running for aircraft queued for departure. This, in turn, will reduce engine run times (and emissions) from both arriving aircraft and aircraft with engines running and awaiting departure.

The potential impact of emissions from new runway operations affecting health has been assessed as minor adverse. Nitrogen oxide emissions from newer aircraft are anticipated to reduce in the future as aircraft engine technologies improve, and it is therefore likely that the impact of the new runway operations on ambient nitrogen oxide concentrations will reduce in years to come also.

24.6.7 Auditory Health

There is consistent evidence to show that hearing impairment occurs only at prolonged exposure to high levels of noise well beyond the levels from aircraft over-flights.

Studies indicate that sustained noise exposure above at least 75 dBA is necessary for auditory damage to occur (Airports Commission 2013; Basner et al 2014). Aircraft noise is by nature intermittent - albeit in extreme situations it can be intermittent at relatively high levels - and for only short periods does it exceed 75 dBA. Noise induced hearing impairment is thus highly unlikely to result from community exposure to aircraft noise (WHO 2011) and the potential impact has been assessed as negligible.

24.6.8 Impact of the New Runway Project

The NRP will not, of itself, increase the total aircraft noise load over Perth in the short term. It will allow better management of the growth in air traffic that has already occurred at the airport, and improve efficiency, customer service and effectiveness of operations. There will come a stage at which the additional runway will allow a greater total volume of air traffic than the current runway system can accommodate, which is detailed in Section 2 and Section 3.

Studies that relate health effects to total aircraft noise loads (through the use of continuous equivalent noise levels) would suggest that, as a result of the parallel runway operations, the impact of a new runway would be to alter the distribution of the health impacts, rather than to deliver any net increase in these effects. Nevertheless, a better view of the literature is that the health impact of aircraft noise is a more complex equation than a direct relationship with total noise loads.

The significance of the patterns of air traffic, the importance of non-acoustic factors, and the variability in the dose/response relationships that drive evaluations of total noise load suggest that effective, noise sensitive management of air traffic can moderate the health consequences that flow from that traffic. There is potential to use the options created by an additional runway, and subsequent parallel runway system, to reduce the negative health outcomes from air traffic though the greater flexibility in design of air traffic routes and the management of air traffic on those routes.

It is also important to consider the interrelationships between the different health concerns to understand the potential for reducing the negative health outcomes from aircraft noise exposure. Given that annoyance can lead to stress, which can cause hypertension, which can in turn lead to heart disease, there are opportunities to alter the health outcomes for heart disease through better management of the non-acoustic factors that affect annoyance due to aircraft noise.

The evidence on the health impacts of aircraft noise is sometimes unclear and often contradictory, but there is evidence to show a range of health issues exist. This is applicable to the NRP even though many of the studies undertaken have considered noise levels significantly higher than will occur at Perth Airport. Importantly, the evidence not only points to the potential negative impact of increased noise but also the benefits of reduced noise. In the case of the NRP, there will be reductions in aircraft noise for some populations under existing air routes, and increased or new noise events for others.

24.7 Mitigation

24.7.1 Standard Mitigation

Strategies to minimise aircraft noise impact can assist in reducing the health impacts associated with aircraft noise. These strategies are detailed in Section 22 and include:

- appropriate land planning around airports through State and Local government policy and decision making to ensure that future noise-sensitive uses are not located in noise impacted areas,
- operational procedures that include noise abatement procedures,
- direct engagement with populations and community facilities under flight corridors,
- provision of clear and comprehensible information about the likely aircraft noise exposure, including published Number-above contours and the Interactive Aircraft Noise Information Portal,
- provision of clear information to assist those affected by the noise to undertake amelioration measures that can reduce noise penetration into homes, such as the 'Reducing noise in existing homes brochure',
- comprehensive Perth Airport Aircraft Noise Management Plan, and
- the Perth Airport Aircraft Noise Technical Working Group, which enables the aviation industry to initiate and evaluate operational changes while ensuring that the noise impact of those changes is considered and opportunities to improve noise outcomes are explored.

24.7.2 Additional Mitigation

Additional mitigation measures to be applied throughout the design of the airspace and operations of the new runway, include:

- careful route planning and incorporating existing arrival and departure routes into the airspace design wherever possible,
- improved use of new navigation technology,
- review of noise abatement procedures for NRP and parallel runway operations,
- provision of timely information, and
- direct engagement with newly impacted education facilities.

24.8 Summary of Impacts

Table 24-1 presents a summary of the impacts assessed as part of health assessment as well as standard and additional mitigation measures and associated risk rankings.

<table>
<tr><th></th><th></th><th></th><th colspan="4">Initial Assessment</th><th colspan="4">Residual Assessment</th></tr>
<tr><th>Impacting Process</th><th>Impact Detail</th><th>Project Phase</th><th>Standard Mitigation</th><th>Significance/ Consequence</th><th>Likelihood</th><th>Initial Risk</th><th>Additional Mitigation</th><th>Significance</th><th>Likelihood</th><th>Residual Risk</th></tr>
<tr><td rowspan="6">Aircraft noise exposure</td><td>Increased risk of mental health</td><td>Operation</td><td rowspan="6">Appropriate land use planning, State Planning Policy 5.1 and inclusion of new runway in Perth Airport ANEF since 1983
Published-Above noise contours
Aircraft Noise Management Framework
Published noise abatement procedures
Perth Airport Aircraft Noise Technical Working Group
Engagement with populations and community facilities under flight corridors
Interactive Aircraft Noise Information Portal
Reducing noise in existing homes brochure</td><td>Negligible</td><td>Highly Unlikely</td><td>Very Low</td><td rowspan="6">Careful route planning during final airspace design
Noise abatement procedures reviewed for NRP/ parallel runway operations
Improved use of new navigation technology
Provision of timely information
Engagement with newly impacted education facilities</td><td>Negligible</td><td>Highly Unlikely</td><td>Very Low</td></tr>
<tr><td>Cognitive and learning impairment</td><td>Operation</td><td>Minor Adverse</td><td>Possible</td><td>Low</td><td>Minor Adverse</td><td>Unlikely</td><td>Low</td></tr>
<tr><td>Increased risk of cardiovascular disease</td><td>Operation</td><td>Minor Adverse</td><td>Possible</td><td>Low</td><td>Minor Adverse</td><td>Unlikely</td><td>Low</td></tr>
<tr><td>Annoyance</td><td>Operation</td><td>Minor Adverse</td><td>Possible</td><td>Low</td><td>Minor Adverse</td><td>Unlikely</td><td>Low</td></tr>
<tr><td>Hearing impairment</td><td>Operation</td><td>Negligible</td><td>Highly Unlikely</td><td>Very Low</td><td>Negligible</td><td>Highly Unlikely</td><td>Very Low</td></tr>
<tr><td>Sleep disturbance</td><td>Operation</td><td>Moderate Adverse</td><td>Possible</td><td>Medium</td><td>Minor Adverse</td><td>Possible</td><td>Low</td></tr>
<tr><td>Emissions</td><td>Increased pollutants</td><td>Operation</td><td>Decreased airborne holding and associated fuel burn</td><td>Minor Adverse</td><td>Possible</td><td>Low</td><td>No additional mitigation measures identified</td><td>Minor Adverse</td><td>Possible</td><td>Low</td></tr>
</table>

Table 24-1 Summary of impacts, risks and mitigation measures
Source: Perth Airport, 2017

24.9 Conclusion

There have been many studies dating back decades on the health impacts of environmental noise and specifically aircraft noise exposure.

Most of these health impact studies have relied on research undertaken in environments very different from Perth Airport. Some have been premised on noise and traffic levels that far exceed those that are expected at Perth Airport in the foreseeable future. Others have relied on peak noise levels that will not be generated by the traffic using the new runway. However, the research does provide conclusions that can be applied more widely and considered for the NRP.

The key conclusions that can be drawn about the impact of the NRP are:

- the noise levels associated with the new runway are well below those in many of the major studies on health impacts of aviation,
- the key health issues are likely to be:
  - cognition in learning for schools overflown,
  - sleep disturbance, and
  - annoyance,
- depending on the usage of the new runway, the noise levels generated might be below key levels for identifiable cardiovascular health impacts, and
- the key health concerns are amenable to a range of measures to ameliorate their impact.

Some individuals will find impacts, in the form of sleep disturbance and annoyance from the new runway as significant. Through careful and sensible long-term planning and engagement with affected populations and schools, these impacts are likely to be small, or restricted to relatively few people.

25 Social

This section provides as assessment of the social impacts from the construction and operations of the New Runway Project (NRP).

Detail is provided on the following areas:

- How are social impacts assessed for the new runway?
- What are the social impacts of the new runway?
- How will social impacts be mitigated?

25.1 Introduction

This section describes the impacts of the New Runway Project (NRP) on the social environment as a result of:

- construction of the new runway and associated infrastructure,
- aircraft operations on the new runway and taxiways as part of a parallel runway system, and
- changes to the airspace and flight paths surrounding the airport.

The social impact assessment considers the social changes and impacts on community that have been determined through the assessments undertaken and described throughout Volume A, B and C of this MDP. Section 19 provided detail regarding existing aircraft operations around Perth Airport. Section 20 provides an overview of the Airspace Management Plan which outlines where aircraft are likely to fly when the new runway opens as part of a parallel runway system. Section 22 provides an assessment of the aircraft noise exposure associated with parallel runway operation. These sections form the basis of much of the social impact assessment. The social impacts should therefore be considered in the context of information provided in other Sections of this MDP.

25.2 Key Findings

- The NRP will not, of itself, increase the total aircraft noise load over Perth in the short term. It will allow better management of air traffic at the airport, and improve efficiency and effectiveness of operations. In the longer term the new runway will allow a greater total number of aircraft movements per year than the existing runways can accommodate,
- over an average day (24-hour period) at day of opening (2025), it is estimated that:
  - the number of existing dwellings to experience five or more aircraft noise events above 65 decibels (dBA) is expected to decrease from approximately 83,600 to 78,000,
  - of these, approximately 27,500 dwellings will average at least five fewer daily noise events,
  - 25,600 dwellings will average at least five additional daily noise events,
  - nearly 8,200 dwellings will be newly affected, and
  - by 2045, due to the growth in aircraft movements, the number of dwellings exposed to increase to approximately 83,000.
- during the daytime period (6.00 am to 7.00 pm) at day of opening (2025), it is predicted that:
  - the number of existing dwellings to experience five or more aircraft noise events above 65 dBA is expected to decrease from approximately 69,300 to 68,000, and
  - by 2045, the number of dwellings exposed will increase to 71,400,
- during the evening period (7.00 pm to 11.00 pm) at day of opening (2025), it is expected that:
  - the number of existing dwellings to experience five or more aircraft noise events above 65 dBA is expected to decrease from approximately 20,200 to 16,900, and
  - by 2045, the number of dwellings exposed will increase to 24,300.
- during the night-time period (11.00 pm to 6.00 am) at day of opening (2025), it is estimated that:
  - the number of existing dwellings to experience five or more aircraft noise events above 60 dBA is expected to decrease from approximately 61,200 to 54,900, and
  - by 2045, the number of dwellings exposed will increase to 86,383.
- areas to the east and south/south-east of the airport are the most likely to experience an increase in aircraft noise events or be newly affected by aircraft noise events. Areas to the west and south-west are the most likely to experience a decrease in aircraft noise events,
- the majority of the dwellings with a reduced impact are located in the southern suburbs of Beckenham, Kenwick, Langford, Maddington and Thornlie, and to the north and north-west, the suburbs of Bassendean, Belmont, and Cloverdale,
- the areas with an increased impact are mainly located to the south of the airport in the suburbs of Canning Vale, Ferndale and Thornlie, Midland, High Wycombe and Swan View to the north, and Forrestfield and Wattle Grove to the east,
- the majority of newly impacted dwellings are located north and south of the airport, including the suburbs of High Wycombe, Thornlie, Wattle Grove and Forrestfield,
- suburbs to the south and south-west, such as Wilson, Waterford, Riverton, and Manning, will not experience a significant change in impacted dwellings at day of opening of the new runway, and
- the number of community facilities impacted by aircraft noise events, including aged care and retirement facilities, hospitals, childcare, education facilities, and prisons and detention centres, will decrease on day of opening of the new runway.

25.3 Methodology

25.3.1 Approach

The International principles for social impact Assessment are widely used. The principles state that an assessment:

"...includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, or planned interventions (policies, programs, plans, and projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment" (Vanclay, 2003).

According to Vanclay, social impacts are associated with changes to one or more of the following:

- **people's way of life** – how they live, work, play and interact with one another on a day-to-day basis,
- **culture** – shared beliefs, customs, values and language or dialect,
- **community** – its cohesion, stability, character, services and facilities,
- **political systems** – the extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place, and the resources provided for this purpose,
- **environment** – the quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust and noise they are exposed to; the adequacy of sanitation, their physical safety, and their access to and control over resources,
- **health and wellbeing** – health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity,
- **personal and property rights** – particularly whether people are economically affected, or experience personal disadvantage which may include a violation of their civil liberties,
- **fears and aspirations** – their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children.

This assessment focuses on identifying potential impacts of the NRP associated with people's way of life, their community, their environment, their health and wellbeing and their personal and property rights.

The assessment of social impacts has many variables and can become quite complex. To simplify this as much as possible while maintaining important details, the following parameters were set to enable comparison between existing social environment and the social environment that would occur as a result of the NRP.

To identify impacts, the assessment considers the following scenarios:

- 2025 without the new runway compared to the 2025 with the new runway, to identify where social impacts and benefits may be expected at day of opening,
- 2045 with the new runway scenario, to show how Perth Airport is predicted to grow with the new runway over time.

The social impact assessment relies on a dwellings dataset to identify the number of dwellings, and therefore people, who are likely to experience impacts from the NRP. Dwelling data was obtained from the State Department of Planning, Lands and Heritage (DPLH). Where the number of people has been described, Western Australia's average household size of 2.55 people per dwelling has been used.

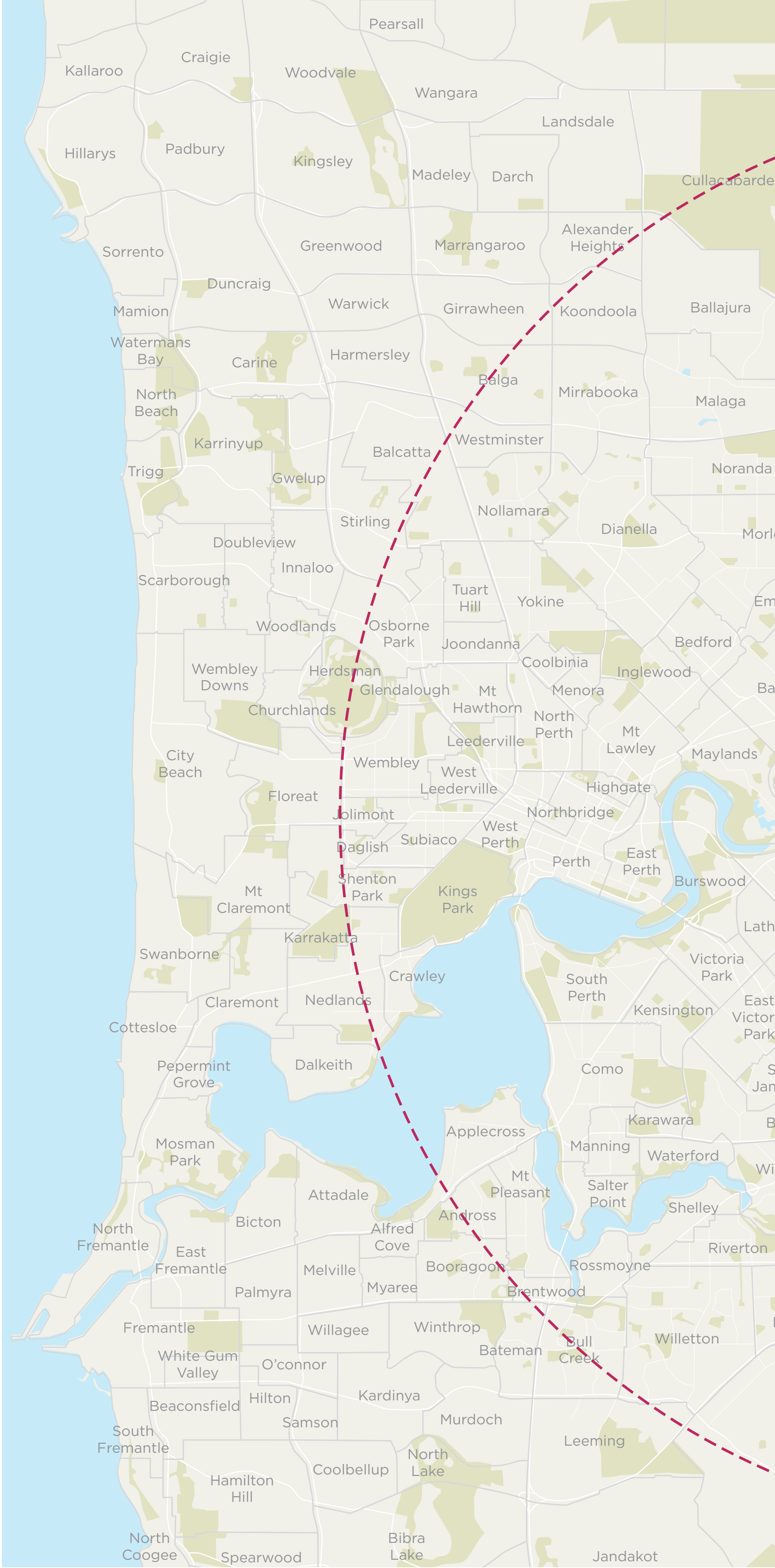
While high level strategic planning has identified likely areas where dwelling density is planned to increase in the years leading up to 2025 and to 2045, it is not possible to identify the exact locations or the density of the future dwellings.

As such, to enable comparison between the with and without new runway scenarios, analysis of the dwelling count dataset was undertaken to determine the number of existing dwellings within specific areas and noise contours. This dataset contains 2016 dwelling numbers and does not project any growth in dwelling numbers. Where relevant, qualitative discussion about potential impacts on future growth areas is included in the assessment to address this limitation.

25.3.2 Study Area

The assessment of the social impacts considered areas within a 15-kilometre radius of Perth Airport, as shown in Figure 25-1. The 15-kilometre radius was chosen as this takes in areas that are most likely to experience a direct impact of the construction and operation of the NRP, such as aircraft noise at a level and frequency that some may consider to be disruptive. Any areas that sit outside of the 15-kilometre boundary that are impacted by similar noise levels have also been considered.

Areas that sit under the proposed flight corridors as part of the parallel runway system are areas where the social environment is most likely to change. Areas close to the airport may also be impacted by ground based activities on and around the airport.



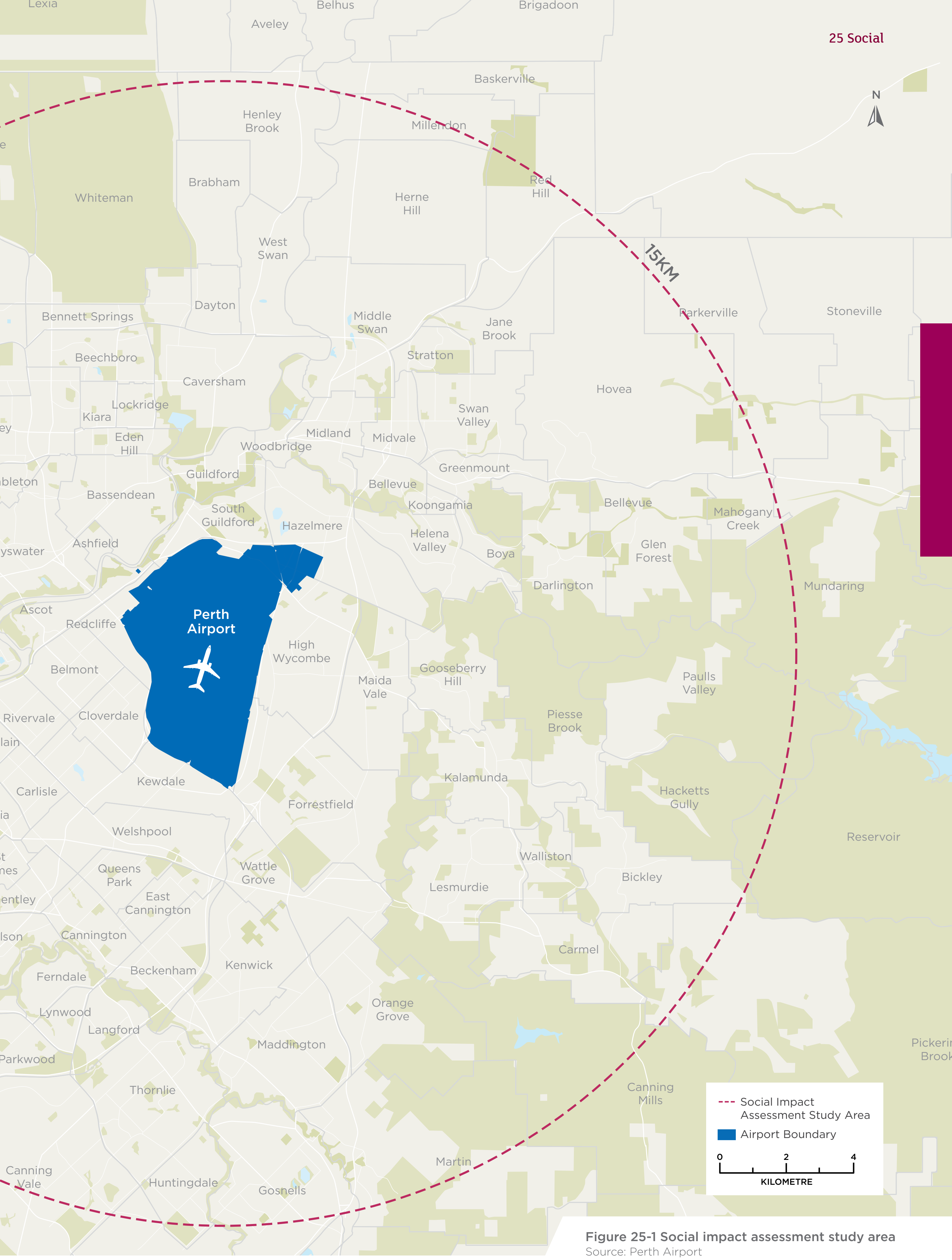


Figure 25-1 Social impact assessment study area
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

25.3.3 Significance Criteria

There are no recognised standards for assessing social impacts and it is not common practice to describe social impacts in terms of significance criteria. The significance of social impacts is largely a matter of judgement. For the purposes of this assessment, significance criteria have been established to allow consideration of impacts in relation to the other environmental, social and economic impacts that have been identified.

The assessment of the social impacts of the NRP has been undertaken using the impact categories shown in Table 25-1.

Magnitude Description	Significance Criteria
Major Adverse	The impact is considered critical to the decision-making process. Impacts tend to be permanent or irreversible or otherwise long term and can occur over large scale areas. People can no longer safely live, work, learn or recreate within an area because of impacts associated with operation of the airport. The social environment is irrevocably damaged because people no longer use the impacted area.
High Adverse	The impact is considered likely to be important to decision-making. Impacts tend to be permanent or irreversible or otherwise long to medium term. Impacts can occur over large or medium scale areas. People can continue to live, work, learn or recreate within the area but many are severely impacted by the operation of the airport. The social environment is damaged because some people will choose to no longer use the impacted area.
Moderate Adverse	The effects of the impact are relevant to decision-making including the development of environmental mitigation measures. Impacts can range from long term to short term in duration. Impacts can occur over medium scale areas or otherwise represents a significant impact at the local scale. People can continue to live, work, learn or recreate within the area but some are severely or moderately impacted by the operation of the airport.
Minor Adverse	Impacts are recognisable or detectable but acceptable. They are still important in the determination of environmental management requirements. These impacts tend to be short term, or temporary and at the local scale. People can continue to live, work, learn or recreate within the area are sometimes impacted by the operation of the airport.
Negligible	Minimal change to the existing situation. This could include for example impacts which are beneath levels of detection, impacts that are within the normal bounds of variation or impacts that are within the margin of forecasting error.
Beneficial	Effects of the impact are beneficial to the social environment.

Table 25-1 Significance criteria – social
Source: Arup

25.4 Social Baseline

A social baseline is a record of a study area as it stands at a point in time. It provides information on demographics, employment levels and community values. A social baseline is important as it provides a point from which changes over time can be understood and examined. It also provides context for the social impacts that have been identified throughout this assessment.

This section summarises the existing social conditions within the study area that may be directly or indirectly impacted by the NRP. The investigations undertaken used a range of data, sourced from the Australian Bureau of Statistics (ABS) and DPLH, to describe the existing social conditions within the study area. Table 25-2 provides an overview of the areas considered and baseline information.

Area	Study Outcome
Population	In 2016, the estimated residential population of Greater Perth was 2,066,564. (Greater Perth is a term used to describe the geographical area that represents the functional extent of Western Australia's capital city, and includes the City of Mandurah, Pinjarra (Statistical Area Level 2) and the Shire of Murray). Population density generally increases towards the Central Business District (CBD), with the bulk of the city's population living to the west and south of Perth Airport. Areas close to the airport, especially north, south and north-east of the airport, generally have lower population densities. A number of areas to the north and the east of Perth Airport are sparsely populated. This is due in part to a combination of state forests, the undulating terrain of the Darling Scarp, and current farming and agriculture land uses. Around 260,000 dwellings are located within 15 kilometres of Perth Airport. Using Western Australia's average household size of 2.55 people per dwelling, this equates to around 650,000 people living within 15 kilometres of the airport, or around 32 per cent of the total Greater Perth population.
Age structure	The median age of the Greater Perth population in 2016 was 36. This is slightly younger than the median age of persons in Australia of 38. Average ages tend to be lower closer to the CBD area. Families with children under the age of 15 are fairly evenly spread across Perth, although there are higher proportions on children in areas outside of the city centre, especially north and south of the city. The proportion of the population aged over 65 years is generally higher away from the CBD and in areas to the east of the city. Close to the airport, the suburbs of Hazelmere and Whiteman have a higher proportion of people aged over 65 years.
Cultural and ethnic characteristics	Almost half (42.7 per cent) of Greater Perth's residents were born overseas. The top five places of birth outside Australia for Perth's residents are: • England (8.6 per cent), • New Zealand (3.2 per cent), • India (2.4 per cent), • South Africa (1.8 per cent), and • Malaysia (1.5 per cent). Language and linguistic diversity can influence social cohesion in a community. Those with lower levels of English can suffer from poor communication, exclusion and reduced socio-economic opportunities. They can be a high risk, vulnerable group with poor literacy, comprehension and slower response rates to acute and chronic impacts. On average, 26.5 per cent of the Greater Perth residents speak a language other than English at home. Generally, the outer suburbs north and south of the airport contain a higher proportion of people who are not fluent in English.
Need for assistance	The need for assistance is used as an indicator to show areas that may have higher proportions of people with disabilities. The areas to the north-east of the airport have high proportions of people who require assistance. This is consistent with higher median ages and the proportion of people aged more than 65 years in these areas.
Workforce participation	Employment participation rates have been assessed by identifying the proportion of persons in the labour force. The participation rate encompasses a measure of the active part of an economy's labour force. High participation is generally illustrative of lower unemployment and improved economic opportunities and conditions for households. Those not involved in the labour force may include the retired, students, home workers and/or those with long term health conditions or disabilities. Greater Perth had a labour force participation rate of 67.6 per cent and an unemployment rate of 6.2 per cent at the time of the 2016 Census. Data released by the State Department of Employment for the first quarter of 2017 showed an unemployment rate of 6.4 per cent for Western Australia and 7.6 per cent for the Perth Local Government Area. Labour force participation is fairly consistent across the city. Close to the airport, areas to the north-east of the airport showed the highest percentage of unemployment.

Table 25-2 Social baseline characteristics
Source: Arup

Area	Study Outcome
Shift work	In November 2012, the ABS undertook a Working Time Arrangements survey which included questions related to shift work. This survey found that 16 per cent of Australia's working population regularly worked shifts, usually on rotating rosters. Using this statistic, it is estimated that around 100,000 people who currently live within 15 kilometres of Perth Airport could be shift workers.
Income	Economic wellbeing is largely determined by economic resources and weekly household income is widely adopted to indicate poverty, inequalities, social capital and relative wealth. The median weekly personal and household income in Greater Perth was $728 and $1,643 respectively. This is slightly higher than the State medians of $724 and $1,595. The average personal income is also higher than the national minimum weekly personal wage which is currently $672.70. Areas further away from the Perth CBD, especially those north and south of the city, have median personal incomes that are lower than the national minimum wage. Within 15 kilometres of Perth Airport, the median weekly household income was $1,554, which was consistent with, but slightly higher than, the State average of $1,415.
Socio economic status	The Socio-Economic Indexes for Areas (SEIFA) index is a dataset provided by the ABS that summarises different aspects of the socio-economic environment for an area, based on a range of socio-economic data from the Census such as income, educational attainment, unemployment and dwellings without motor vehicles. It provides a more general measure of socio-economic status than using indicators on their own. SEIFA has a number of indexes; this assessment considers the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD). The IRSAD summarises information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage measures. A low score indicates relatively greater disadvantage and a lack of advantage in general. For example, an area could have a low score if there are (among other things) many households with low incomes, or many people in unskilled occupations and few households with high incomes, or few people in skilled occupations. A high score indicates a relative lack of disadvantage and greater advantage in general. For example, an area may have a high score if there are (among other things) many households with high incomes, or many people in skilled occupations and few households with low incomes, or few people in unskilled occupations. For ease of use, SEIFA scores are divided into ten equal groups, termed deciles. Some areas cannot be assigned a SEIFA score because the population is too small or the quality of the data is not good enough. Areas of lower SEIFA IRSAD deciles extend in a linear north-south pattern from the airport. Close to the airport, areas to the north-east recorded the highest levels of disadvantage.
Housing and property	**Number of dwellings** Around 260,000 dwellings are located within 15 kilometres of Perth Airport. A number of areas to the north and the east of Perth Airport that are sparsely populated. As noted previously, these areas are largely a combination of state forests, the undulating terrain of the Darling Scarp, and current farming and agriculture land uses. **Dwelling types** The majority (76.9 per cent) of private dwellings in Greater Perth are in the form of separate houses, while 16 per cent are semi-detached, row terrace or town houses, and 6.6 per cent are flats or apartments. 70 per cent of private dwellings are owned either outright (28 per cent) or with a mortgage (42 per cent). Within the study area, there are higher proportions of home ownership to the east of the airport. **Housing value and costs** The median weekly rent in Greater Perth is $360 while the median monthly mortgage repayment is $2,000. These are slightly higher than the State average rent of $347 and mortgage repayment of $1,993. 9.9 per cent of households renting have rent payments that are greater than 30 per cent of their household income, and 9.3 per cent of houses owned with a mortgage have mortgage repayments that are greater than 30 per cent of their household incomes. Based on Real Estate Institute of Western Australia data, the median house price in Greater Perth in March 2017 was $515,000 and the median price for a unit was $419,500. **Social housing** Of the rented dwellings within the 15-kilometre study area, 11 per cent are owned by the State government. Clusters of State owned houses are located to the east, south and north-west of the airport.

Table 25-2 Social baseline characteristics (Continued)

25.4.1 Measuring Aircraft Noise Exposure

Number-above contours (N-contours) are used to show locations that will experience noise events of a certain decibel level or more during set time periods.

To undertake the social impact assessment, and based on the noise modelling undertaken and described in Section 22, N65 contours, which describe 65 dBA noise events, have been prepared for the day (6.00 am to 7.00 pm) and evening (7.00 pm to 11.00 pm) periods. A noise level of 65 dBA outside a building will generally result in an internal level of approximately 55 dBA if windows are open. This is the approximate sound level at which conversation and other indoor activities can generally be disturbed.

N60 contours have been used to consider night (11.00 pm to 6.00 am) periods. N60 describes the number of events exceeding 60 dBA external to the building which would typically result in a noise level of 50 dBA within the building, having windows open to a normal extent. A 50 dBA noise level is considered to be close to the point which may cause awakening.

N-contours represent an average day and not a typical day. On a typical day, more events than the N-contours suggest may be experienced. Traffic at Perth Airport varies significantly between the different days of the week and also depending on the runway direction that is being used at a particular time.

Further information about N-contours, as well as the influence of weather and other operational conditions on runway modes, is detailed in Section 20, 21 and 22.

To consider the baseline condition for aircraft noise exposure without the new runway, N65 and N60 noise forecasts were developed for 2025 with existing runway infrastructure (2025 without new runway) considering the growth forecasts outlined in Section 2.

Table 25-3 provides the number of current dwellings within the day, evening and night N-contours for the 2025 without new runway scenario.

As shown in Table 25-4, there are a wide range of community facilities that will experience five or more average daily noise events prior to the new runway being in operation. Facilities that are used predominantly during the day time, such as schools and child care centres, are not included in the night counts as they are generally not used during these hours. Information about the individual facilities is provided in Section 25.9.

This information in also shown in Figure 25-2, Figure 25-3 and Figure 25-4.

2025 without new runway	Dwelling count by number of average daily aircraft noise events						
	5-10 Daily Events	10-20 Daily Event	20-50 Daily Events	50-100 Daily Events	100-200 Daily Events	200+ Daily Events	Total Dwellings
N65 day (6.00 am to 7.00 pm)	17,668	17,552	18,102	10,263	5,670	5	**69,260**
N65 evening (7.00 pm to 11.00 pm)	10,413	6,708	3,052	0	0	0	**20,173**
N60 night (11.00 pm to 6.00 am)	26,383	26,464	8,278	3	0	0	**61,125**

Table 25-3 Number of dwellings within N65 and N60 contours - 2025 without new runway
Source: Arup

Number of community facilities within N-contours for 2025 without new runway			
Facility type	N65 Day (6.00 am - 7.00 pm)	N65 Evening (7.00 pm - 11.00 pm)	N60 Night (11.00 pm - 6.00 am)
Aged care and retirement	30	3	20
Childcare	33	10	
Community centre	23	8	
Hospital	6	0	5
Kindergarten or pre-school	11	6	
Place of worship	73	29	65
Prison or detention centre	2	1	3
School	66	23	
Tertiary education	1	1	
Total	**245**	**81**	**93**

Table 25-4 Summary of community facilities within N65 and N60 contours - 2025 without new runway
Source: Arup

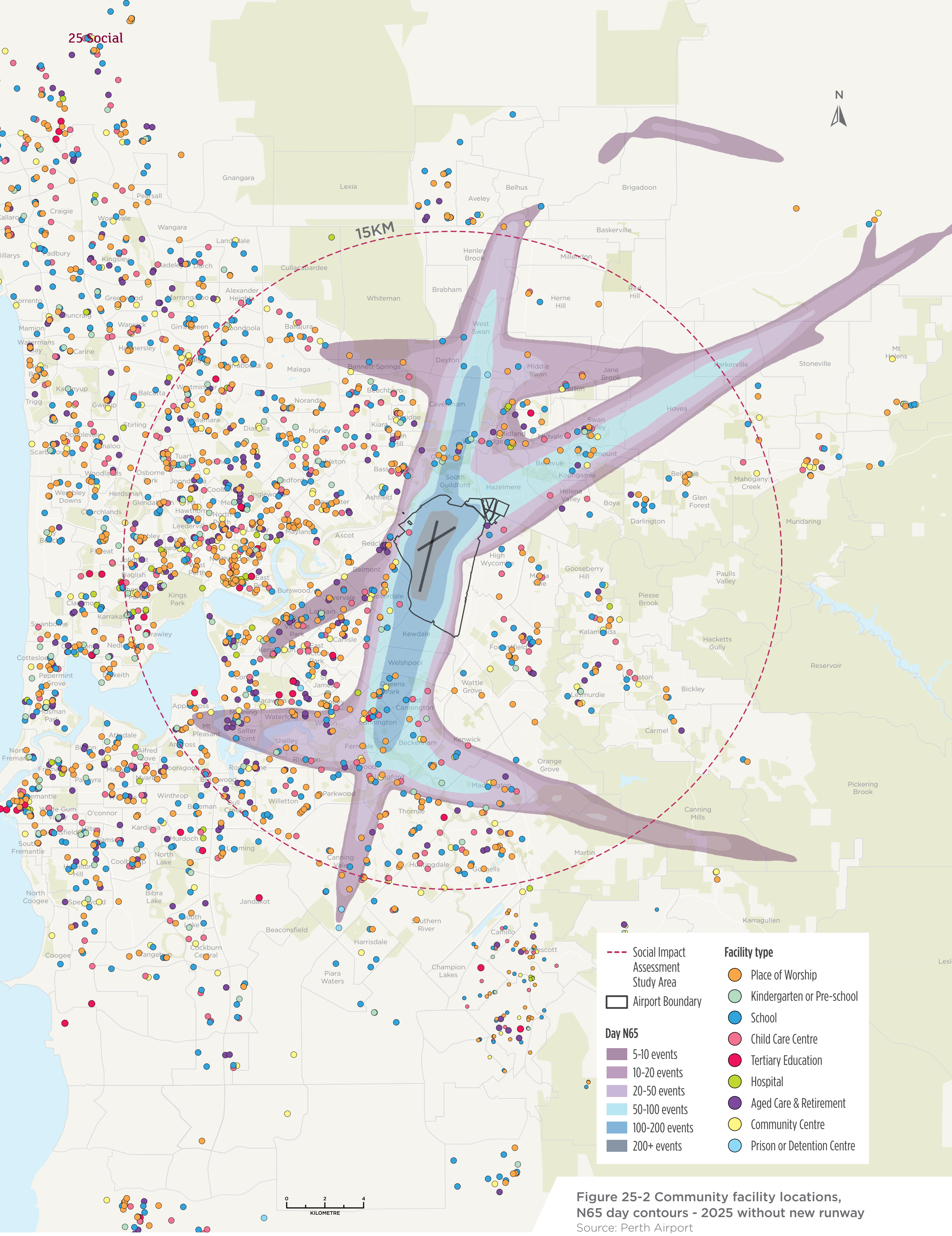


Figure 25-2 Community facility locations, N65 day contours - 2025 without new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

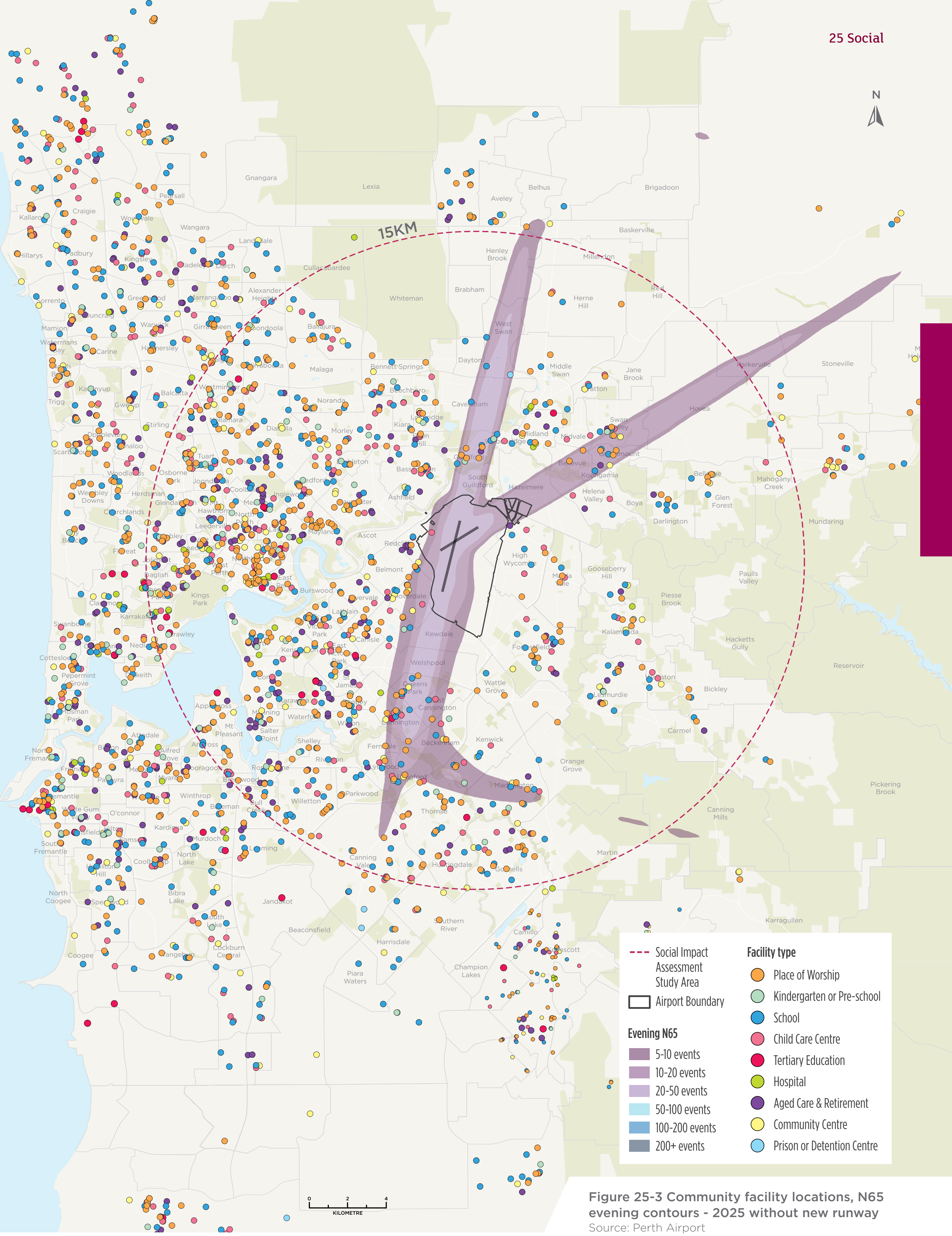


Figure 25-3 Community facility locations, N65 evening contours - 2025 without new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

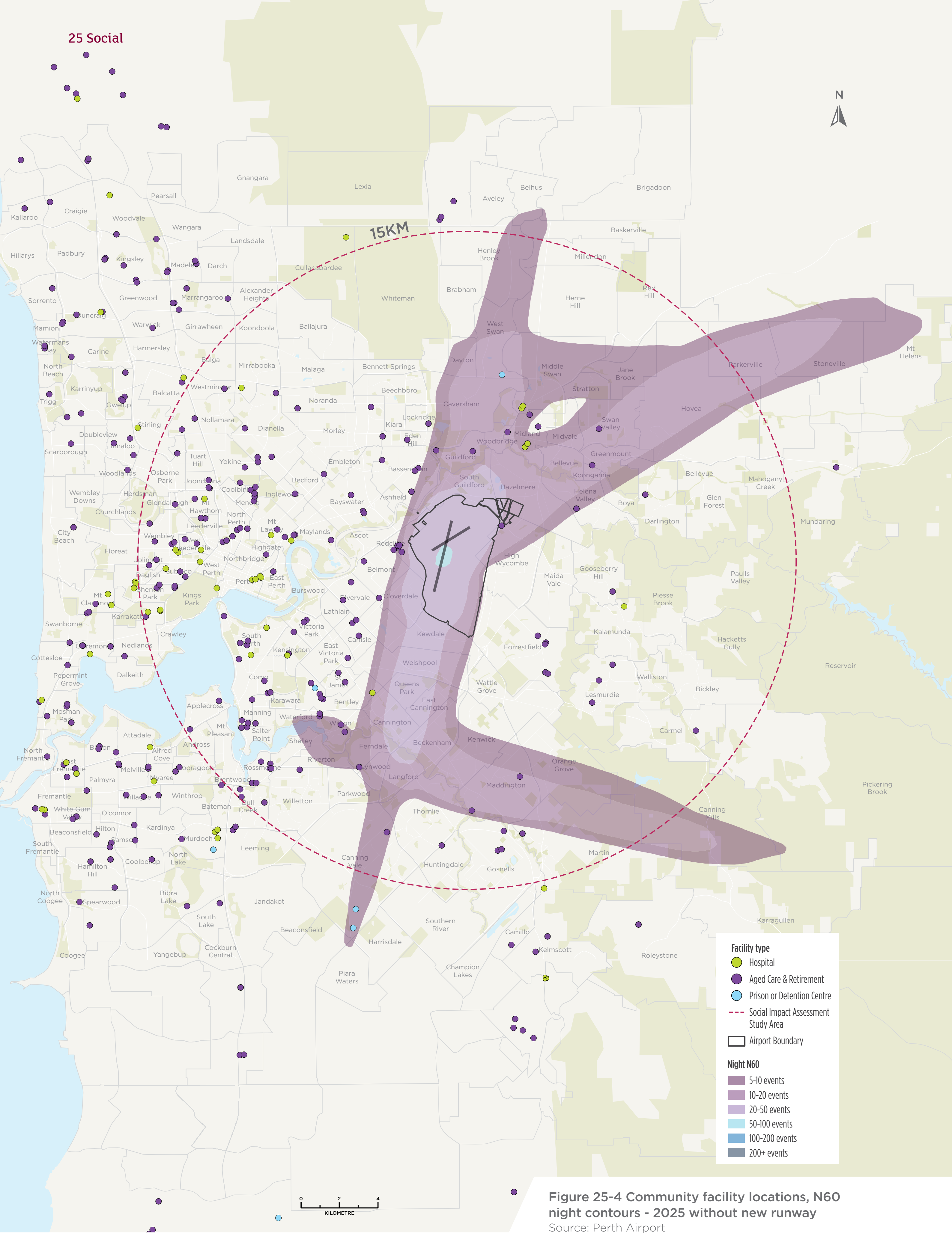


Figure 25-4 Community facility locations, N60 night contours - 2025 without new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

25.4.2 Community Survey

The Perth Airport Master Plan 1999 highlights the outcomes of a telephone survey of 300 residents, within a 10-kilometre radius of Perth Airport, that was undertaken by Patterson Research Group to identify perceptions of noise. This survey identified that ten per cent of the respondents living within the Australian Noise Exposure Forecast (ANEF) contours (current at that time) said that noise had a major effect on their family. The ANEF is a forecast of future aircraft noise exposure and shows the concentration of noise around a particular airport. The study noted that very small proportions of respondents were worried or concerned about aircraft noise.

During the period of December 2017 to February 2018, Patterson Research Group undertook a survey of community attitudes towards infrastructure development in and around Perth. More than 2,600 people in a 30-kilometre radius from Perth Airport were randomly selected to take part in a survey about their neighbourhood, the choices they made when selecting their residence and support for the construction of a new runway. The questions were based on the community survey that was undertaken for the Master Plan 1999.

Key findings from the survey include:

- 90 per cent of people surveyed had been to Perth Airport within the last 12 months,
- when asked about the drawbacks of living in their suburb, 1.8 per cent of people surveyed highlighted aircraft noise as an issue,
- aircraft noise was an irritation for 34 per cent of the respondents, with 25 per cent considering it a minor irritation, five per cent quite irritating, and four per cent reporting aircraft noise as a major irritation,
- aircraft noise was reported to have a negative impact on quality of life for ten per cent of respondents (four per cent as a major issue and six per cent as something of an issue), with 40 per cent indicating aircraft noise was noticeable but not really an issue, and 49 per cent reporting aircraft noise did not impact on quality of life at all, and
- when given the options about which infrastructure upgrades would be needed to effectively cope with Perth's future growth, 44 per cent of people ranked increasing Perth Airport's runway capacity of high importance when compared against other State transport needs.

25.5 Assessment

This section describes the potential impacts of the NRP in relation to the social environment. It compares the 2025 without new runway scenario (baseline) to the 2025 with new runway scenario to identify where social impacts and benefits may be expected. The 2045 with new runway scenario is also used in the impact assessment where relevant to show how Perth Airport is predicted to grow over time.

The NRP will have both beneficial and adverse impacts on regional and local communities and social services and facilities.

The following sections provide details of predicted changes to the social environment as a result of construction and operation of the NRP. The impact assessment addresses:

- demographics,
- housing and property, and
- aircraft noise exposure.

25.5.1 Demographics

The NRP is not expected to have a direct impact on Perth's demographic profile in relation to population, age structure, cultural and ethnic characteristics, workforce participation, income or overall socio-economic status.

Although the NRP is not considered to have a direct impact on the demographics of surrounding communities, the improved access to Perth enabled by the NRP may have some role in growth and demographic change over time, including increased migration and visitor numbers. With the anticipated growth in Perth's population, the NRP will be key to supporting the growing city and its surrounding regions. Impacts to Perth's demographic structure could be experienced if the NRP did not proceed, due to the capacity constraints that would occur at Perth Airport.

The impact to the population's demographic profile as a result of the NRP is considered to be negligible.

25.5.2 Housing and Property

Construction and operation of the NRP would not have a direct impact on the cost or type of public or private housing as there is no additional land requirements for the project.

Indirect impacts to housing and property may occur as a result of noise exposure associated with aircraft operations in the vicinity of Perth Airport. These indirect impacts would come about through restrictions to land use due to the ANEF and amenity related impacts associated with the noise environment. The ANEF is used for land-use planning purposes, and is applied in conjunction with Australian Standard 2021:2015 (Acoustics – Aircraft noise intrusion – Building siting and construction) to provide guidance on the acceptability of certain types of development within the ANEF zones. As described in Section 22, the ANEF for Perth Airport has included the operation of a parallel runway system since the early 1980s.

In relation to property values, analysis of 212,210 property sales transactions between 1995 and 2015 identified that over the past 20 years the house price growth within the current Perth Airport N65 noise contours has been slightly faster than in the areas within five kilometres of the N65 contours.

This indicates that other factors may dominate considerations when purchasing a house, such as proximity to the Perth CBD, traffic infrastructure, local investment in amenity and urban regeneration, changes in local school performance in national rankings, changes in the location of employment and the workforce mix, along with other local developments. Within the Perth context, the expansion of the fly-in fly-out workforce over the past decade may also be a factor that has increased the relative attractiveness of properties close to Perth Airport.

These observations were largely confirmed by the community survey undertaken, on behalf of Perth Airport, by Patterson Research Group in early 2018. People surveyed were asked to what extent infrastructure assets were considered when selecting their current home. Access to shops and services was the most important reason identified, followed by proximity to the CBD and access to public transport. More than 48 per cent of people reported that they did not consider aircraft traffic at all when selecting their current home.

In relation to areas that will be newly included in the N65 contours due to the operation of the new runway, the assessment predicts no difference in the growth of property values for those properties within new areas of the N65 contours and those outside these contours (in the study's control area).

The impact to housing and property as a result of the NRP is considered to be negligible.

25.5.3 Aircraft Noise Exposure

The NRP will result in changes to airspace and flight paths around Perth Airport. These changes, as well as the projected future growth in air traffic, will alter the pattern of aircraft noise exposure and result in reduced noise exposure in some areas and new or higher noise exposure in other areas.

The new runway will not, of itself, increase the total aircraft noise load over Perth in the short term. It will allow better management of the growth that has already occurred in air traffic at the airport, and improve efficiency and effectiveness of operations. There will come a time when the new runway will allow a greater total number of aircraft movements than the current runway system can accommodate, which is detailed in Section 2.

The opening of the new runway requires new flight paths for aircraft using the new runway, as well as changed flight paths on the existing main runway to accommodate parallel runway operations.

The assessment considers the forecast growth in aircraft movements between 2025 and 2045, increasing from 172,000 to 241,000 annual aircraft movements. This growth in air traffic will result in dwellings being exposed to an increasing number of noise events, as well as more dwellings being exposed to noise events.

Consistent with the baseline, the assessment of the aircraft noise exposure as a result of the new runway has been undertaken using N65 contours for day (6.00 am to 7.00pm) and evening (7.00 pm to 11.00 pm) periods, and N60 contours for night noise impacts (11.00 pm to 6.00 am).

25.5.3.1 Day Time (6.00 am to 7.00 pm)

Figure 25-5 shows the daytime period for the 2025 with the new runway.

Suburbs closer to the airport and closer to the future flight corridors are more likely to receive higher frequencies of 65 dBA noise events than those further away from the airport and flight corridors. Figure 25-6 shows the 2045 N65 daytime contours, which when compared to the N65 for 2025, the contours spread slightly, with the main increase to the north-east and the number of average daily events also increasing.

As shown in Table 25-5, the opening of the new runway will result in an overall reduction of 1,268 dwellings that will experience five or more 65 dBA noise events during the day. While there is a reduction in dwellings that experience more than 100 or less than 20 average daily noise events, the number of dwellings that will experience between 20 and 50 daily noise events will increase from 18,102 to 23,816.

By 2045, due to the growth in aircraft movements at Perth Airport, 71,346 dwellings would experience five or more 65 dBA noise events during the day time period.

Table 25-6 shows that the overall number of community facilities located within N65 daytime contours decreases by nearly 11 per cent on day opening of the new runway. This is most noticeable for aged care and retirement facilities, which decrease from 30 to 20. By 2045, the total number of existing community facilities exposed to N65 daytime noise events will increase to 233, which is a reduction from the 245 existing facilities impacted in 2025 without the new runway.

While there is an overall decrease, the changes in the distribution of these contours mean that some facilities would no longer be affected, some would experience a decrease or increase in noise event frequency, and some would be newly affected by five or more N65 daytime noise events. The expected range of average daily noise events above 65 dBA for each impacted community facility is shown in Section 25.9, Table 25-15.

Number of dwellings within N65 day contours				
Average daily noise events	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
5-10	17,668	15,948	-1,720	15,202
10-20	17,552	16,331	-1,221	11,589
20-50	18,102	23,816	5,714	22,489
50-100	10,263	10,703	440	15,726
100-200	5,670	1,194	- 4,476	6,332
200+	5	0	-5	8
Total dwellings	**69,260**	**67,992**	**-1,268**	**71,346**

Table 25-5 Number of dwellings within N65 day contours
Source: Arup

Number of community facilities within N65 day contours				
Facility type	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
Aged care and retirement	30	20	-10	22
Childcare	33	26	-7	30
Community centre	23	19	-4	19
Hospital	6	5	-1	5
Kindergarten or pre-school	11	11	0	11
Place of worship	73	73	0	77
Prison or detention centre	2	2	0	1
School	66	60	-6	67
Tertiary education	1	2	1	1
Total	**245**	**218**	**-27**	**233**

Table 25-6 Summary of community facilities within N65 day contours
Source: Arup

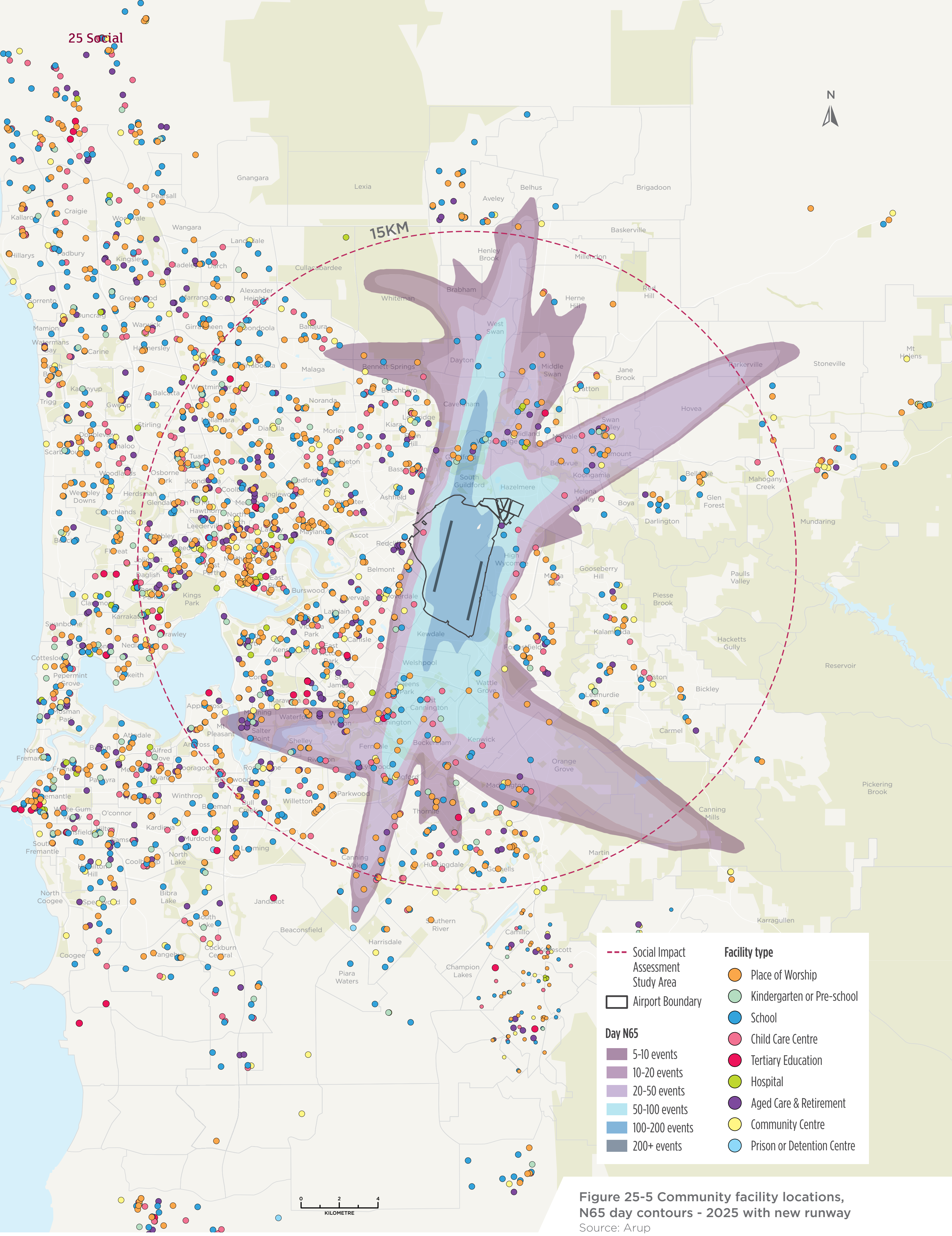


Figure 25-5 Community facility locations, N65 day contours - 2025 with new runway
Source: Arup

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

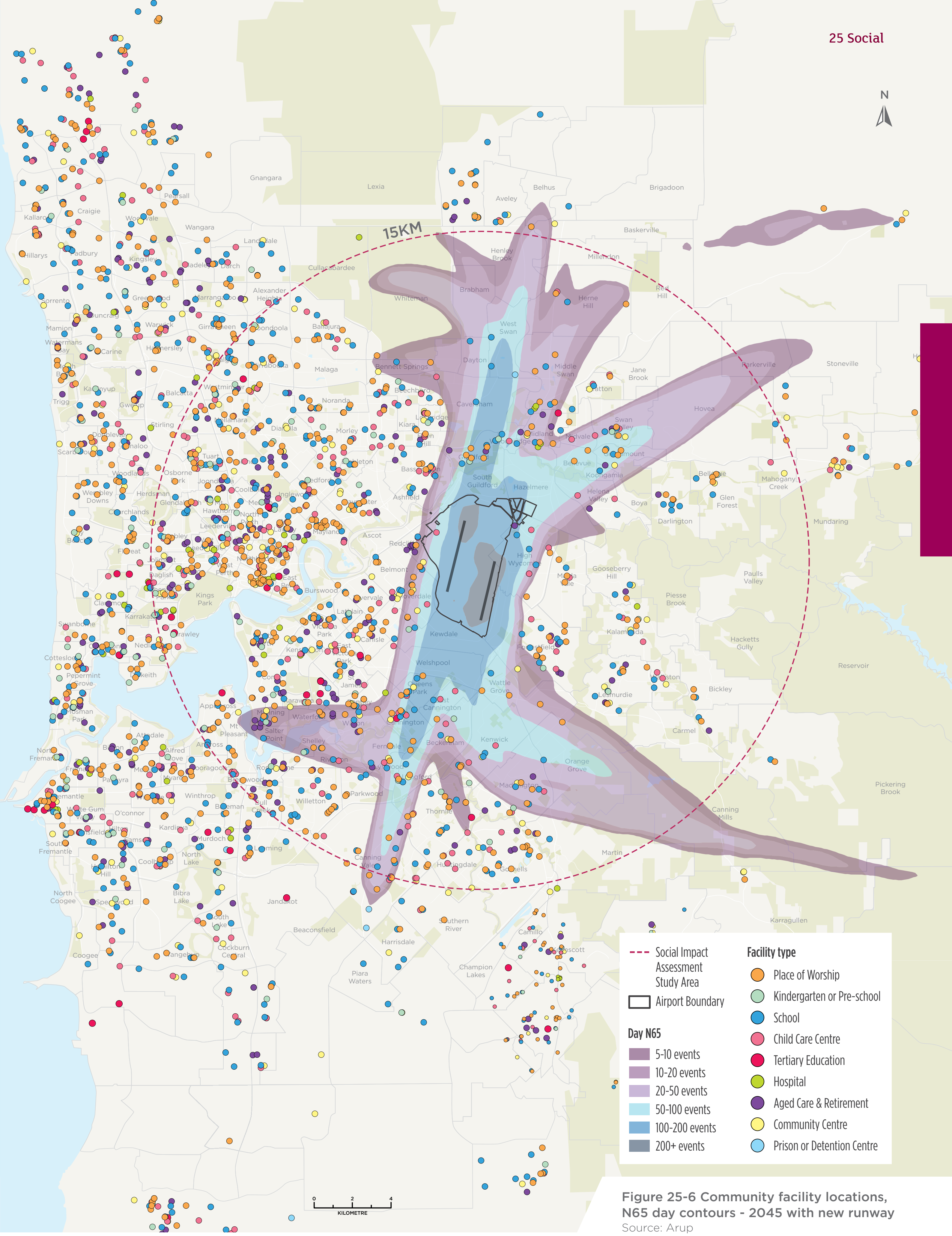


Figure 25-6 Community facility locations, N65 day contours - 2045 with new runway
Source: Arup

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

25.5.3.2 Evening (6.00 pm to 11.00 pm)

During the evening period, the N65 contours for the 2025 with new runway scenario is shown in Figure 25-7.

Suburbs closer to the airport and closer to flight corridors are more likely to receive higher frequencies of 65 dBA noise events than those further away from the airport and flight corridors.

The most obvious change to the N65 evening contours with the opening of the new runway (in comparison to the 2025 without new runway scenario) is that the contours no longer include the suburbs of Hazelmere, Helena Valley, Greenmount, Swan View, Hovea, Parkerville, Stoneville, Gidgegannup, Beckenham, Kenwick and Maddington. This does not imply that these areas will no longer experience aircraft noise, rather that these areas no longer experience a daily average of five or more evening noise events above 65 dBA.

Figure 25-8 shows that by 2045 the N65 evening contours will extend further to the south-east and into the suburbs of Orange Grove, Maddington and Canning Mills.

Table 25-7 shows the estimated number of dwellings within each of the N65 evening contours. At 2025, day of opening there is an overall reduction of 16 per cent in the number of dwellings within the N65 evening contours, with the main change being the decrease in dwellings forecast to receive between 20 and 50 daily noise events above 65 dBA.

By 2045, due to the growth in aircraft movements, 24,241 dwellings would experience an average of five or more 65 dBA noise events during the evening.

Table 25-8 identifies that the number of existing community facilities located within N65 evening contours reduces from 81 to 67. While there is a small decrease, the distribution

Number of dwellings within N65 evening contours				
Average daily noise events	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
5-10	10,413	9,273	-1,140	11,897
10-20	6,708	6,824	116	11,098
20-50	3,052	807	-2,245	1,246
50-100	0	0	0	0
100-200	0	0	0	0
200+	0	0	0	0
Total dwellings	**20,173**	**16,904**	**-3,269**	**24,241**

Table 25-7 Number of dwellings within N65 evening contours
Source: Arup

Number of community facilities within N65 evening contours				
Facility type	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
Aged care and retirement	3	4	1	5
Childcare	10	6	-4	8
Community centre	8	5	-3	7
Hospital	0	4	4	4
Kindergarten or pre-school	6	4	-2	4
Place of worship	29	21	-8	25
Prison or detention centre	1	1	0	1
School	23	21	-2	31
Tertiary education	1	1	0	1
Total	**81**	**67**	**-14**	**86**

Table 25-8 Summary of community facilities within N65 evening contours
Source: Arup

of these contours results in some facilities that will no longer be included, some that will experience a decrease or increase in noise event frequency, and some that are newly exposed to more than five 65 dBA evening noise events. By 2045, the number of existing community facilities exposed to N65 evening noise events will be similar to the pre-NRP counts.

The list of the impacted community facilities within each suburb is shown in Section 25.9, Table 25-16.

25.5.3.3 Night (11.00 pm to 6.00 am)

N60 is the metric used to describe night time noise impacts. At day of opening of the new runway, Figure 25-9 shows the N60 night contours with the new runway.

Figure 25-10 shows that by 2045, the main change to the N60 night contours is not a spread of the contours, but rather an increase in the density of number of daily noise events.

Table 25-9 shows the estimated number of dwellings within each of the N60 night contours. At 2025 day of opening there is an overall reduction of 6,256 dwellings within the night contours, with the main change being the decrease in dwellings forecast to receive between 20 and 50 daily noise events.

By 2045, due to the growth in aircraft movements at Perth Airport, nearly 87,000 dwellings would experience five or more noise events above 60 dBA during the night time period. The main increase is to the number of dwellings forecast to experience between 20 and 50 night time noise events.

As shown in Table 25-10, the number of existing community facilities located within N60 night noise contours decreases by 12. While there is an overall decrease, the distribution of these contours results in some facilities in Redcliffe and Bentley that are no longer included, some that experience a decrease or increase in frequency, and a retirement facility in Ferndale that is newly impacted.

By 2045, the number of existing community facilities impacted by N60 night noise events will have increased, with newly included facilities in Applecross, Bassendean, Como, Manning and Salter Point.

The list of the impacted community facilities within each suburb is shown in Section 25.9, Table 25-17.

Number of dwellings within N60 night contours				
Average daily noise events	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
5-10	26,383	27,765	1,382	36,222
10-20	26,464	24,692	-1,772	29,919
20-50	8,278	2,415	-5,863	20,800
50-100	3	0	-3	0
100-200	0	0	0	0
200+	0	0	0	0
Total dwellings	**61,128**	**54,872**	**-6,256**	**86,941**

Table 25-9 Number of dwellings within N60 night contours
Source: Arup

Number of community facilities within N60 night contours				
Facility type	2025 Without New Runway	2025 With New Runway	Change at Day of Opening	2045 With New Runway
Aged care and retirement	20	11	-9	25
Hospital	5	2	-3	4
Prison or detention centre	3	3	0	3
Total	**28**	**16**	**-12**	**32**

Table 25-10 Summary of community facilities within N60 night contours
Source: Arup

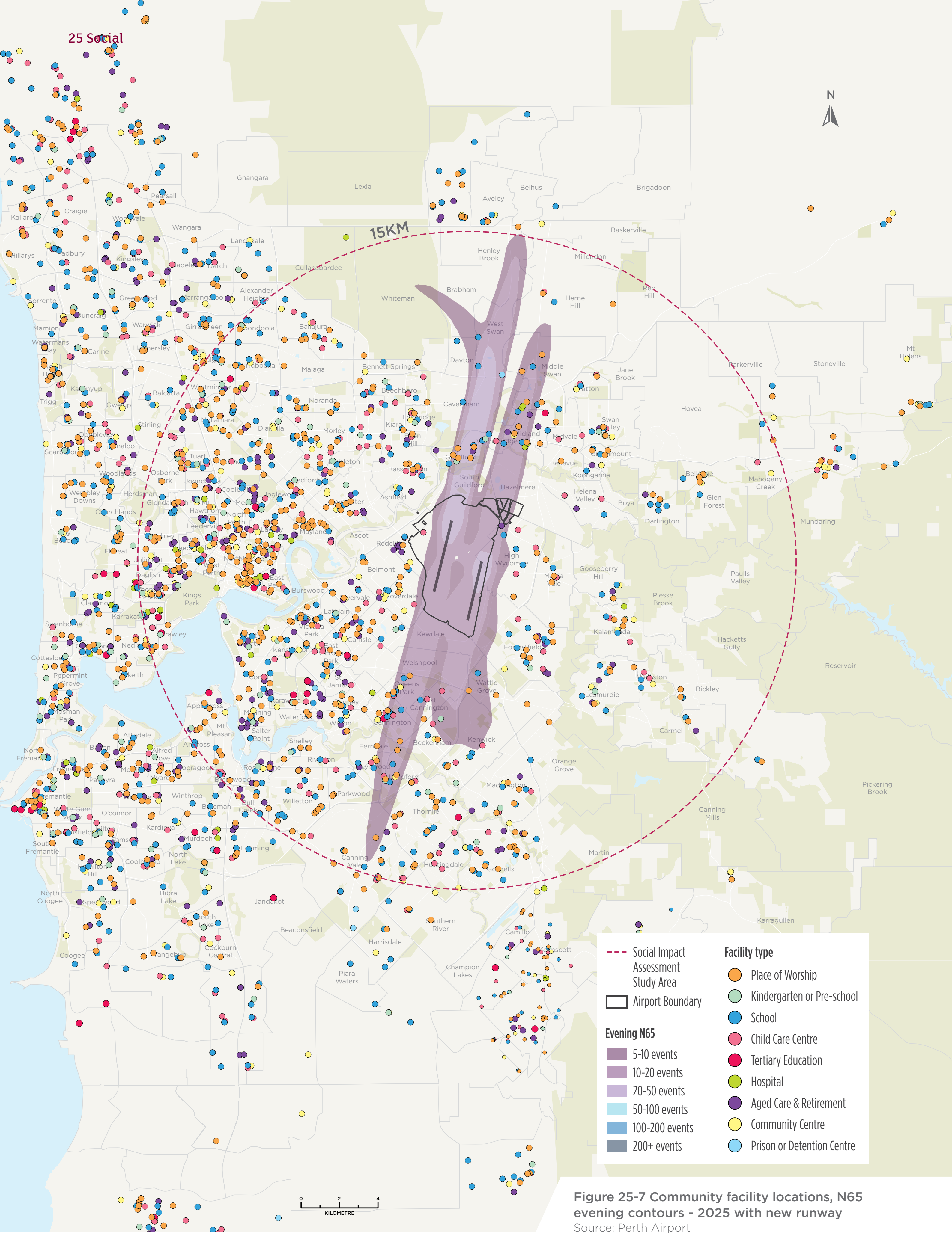


Figure 25-7 Community facility locations, N65 evening contours - 2025 with new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

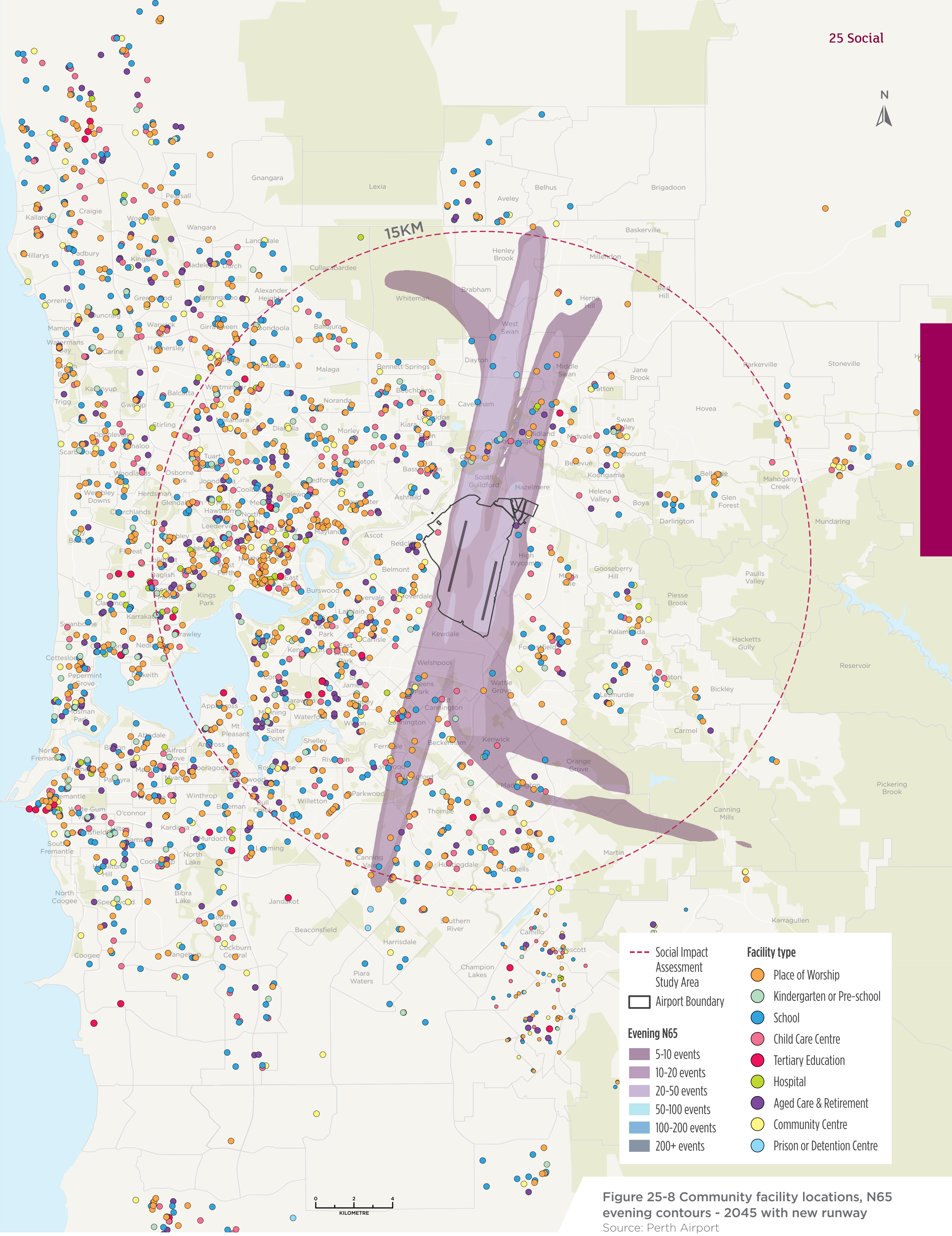


Figure 25-8 Community facility locations, N65 evening contours - 2045 with new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

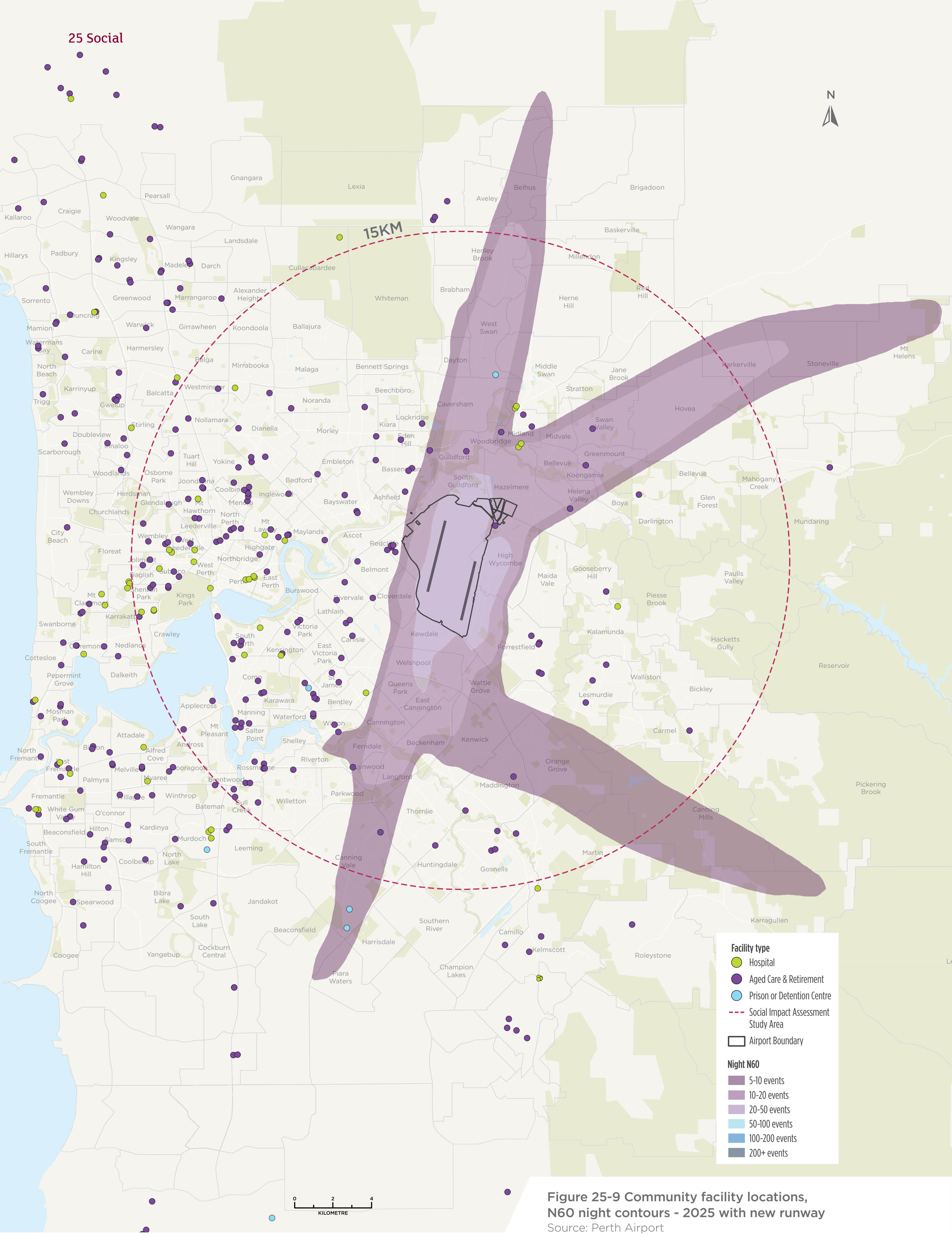


Figure 25-9 Community facility locations, N60 night contours - 2025 with new runway
Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

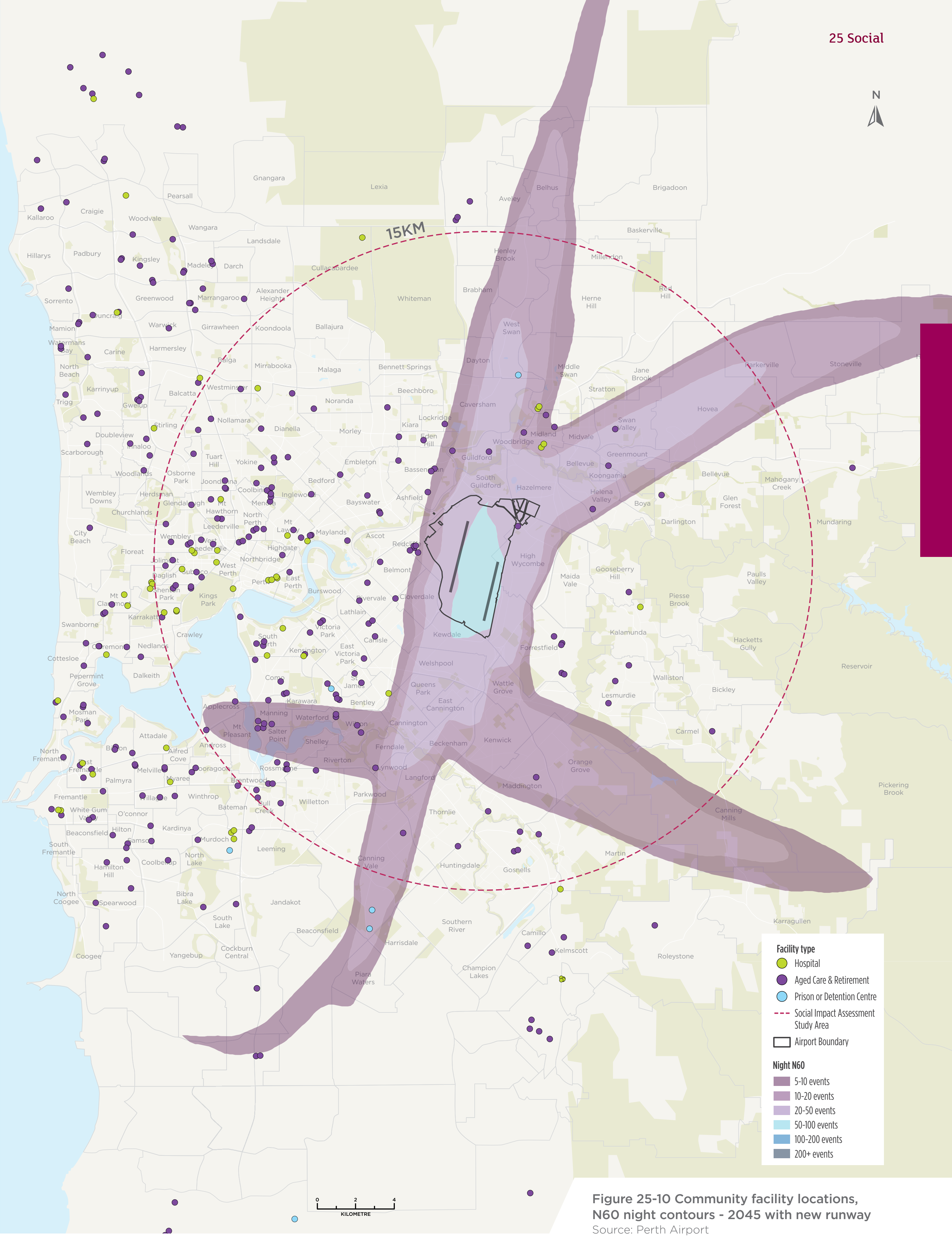


Figure 25-10 Community facility locations, N60 night contours - 2045 with new runway

Source: Perth Airport

15km study area boundary may vary slightly from actual study area due to altered terrain in graphic design process.

25.5.3.4 Affected Dwellings

To provide an overall summary of the affected dwellings, a 24-hour comparison is provided in Table 25-11.

Table 25-11 shows that with the opening of the new runway, the number of existing dwellings predicted to experience five or more events above 65 dBA, over an average daily 24-hour period, is expected to decrease from 83,651 to 77,978. The number of dwellings within each suburb that are within N65 contours for the 2025 without new runway and 2025 with new runway scenarios is provided in Section 25.9.

Approximately 27,500 dwellings are predicted to average at least five fewer daily noise events. Of these, 27 per cent will experience between ten and 20 fewer daily noise events and 20 per cent will experience between 50 and 100 fewer daily noise events. The majority of the dwellings with a reduced impact are located in the southern suburbs of Beckenham, Kenwick, Langford, Maddington and Thornlie, and to the north and north-west, the suburbs of Bassendean, Belmont, and Cloverdale.

Approximately 25,700 dwellings are predicted to experience an increase of five or more daily noise events above 65 dBA. Of these, 37 per cent will experience between five and ten additional daily noise events and 28 per cent will experience between ten and 20 additional daily noise events.

These dwellings are mainly located in the southern suburbs of Canning Vale, Ferndale and Thornlie, northern suburbs of Midland, High Wycombe and Swan View, and Forrestfield and Wattle Grove to the east.

Nearly 25,000 existing dwellings will not experience a change in average daily noise events at day of NRP opening. Suburbs to the south and south-west, such as Wilson, Waterford, Riverton, and Manning, will not experience a significant change in impacted dwellings at day of NRP opening.

There are predicted to be nearly 8,200 newly affected dwellings. The majority of these are north and south of the new runway, including High Wycombe (1,864), Thornlie (1,794), Wattle Grove (1,740) and Forrestfield (897).

N65 Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with NRP opening					Number of dwellings by decrease in daily noise events with NRP opening					Dwellings Unchanged	Newly Affected Dwellings
	2025 Without NRP	2025 With NRP	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
5-10	20,191	17,204	3,372	318				635	906	1,077	437		10,459	3,676
10-20	19,838	16,433	2,384	1,067				678	1,183	3,055	988		7,078	978
20-50	22,707	22,898	3,040	4,340	2,090	1		899	1,136	2,477	2,686	34	6,195	1,107
50-100	12,921	16,335	458	1,370	2,942	2,733	101	639	1,404	2,563	2,908	568	649	1,853
100+	7,994	5,108	215	8	179	285	768	77	176	44	1,933	964	459	561
Total	**83,651**	**77,978**	**9,469**	**7,103**	**5,211**	**3,019**	**869**	**2,928**	**4,805**	**9,216**	**8,952**	**1,566**	**24,840**	**8,175**

Table 25-11 Number of dwellings by change in N65 (24-hour) noise events
Source: Wilkinson Murray

N60 Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily night noise events with NRP opening					Number of dwellings by decrease in daily night noise events with NRP opening					Dwellings Unchanged	Newly Affected Dwellings
	2025 without NRP	2025 with NRP	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
5-10	28,057	28,230	2,618	1				2,740	1,968	71			20,832	2,684
10-20	27,349	25,786	1,793	900	1			4,674	3,702	469			14,247	1,484
20-50	9,660	2,072	152	905	443			1		18			553	414
Total	**65,066**	**56,088**	**4,563**	**1,806**	**444**			**7,415**	**5,670**	**558**			**35,632**	**4,582**

Table 25-12 Number of dwellings by change in N60 night noise events
Source: Wilkinson Murray

Table 25-12 demonstrates that the number of existing dwellings impacted by five or more noise events above 60 dBA at night is predicted to be reduced by the opening of the NRP. The total number of dwellings within N60 night time noise contours will reduce from approximately 65,000, to 56,000; a 14 per cent decrease.

Approximately 27,700 dwellings are predicted to average at least five fewer night time noise events. Of these, 60 per cent will experience between five and ten less night time noise events and 38 per cent will experience between ten and 20 less night time noise events.

Approximately 6,800 dwellings are predicted to experience an increase of five of more night time noise events. Of these, 67 per cent will experience between five and ten additional night time noise events and 27 per cent will experience between ten and 20 additional night time noise events. The main suburbs impacted are High Wycombe, Wattle Grove, Forrestfield and The Vines.

Nearly 4,600 dwellings are predicted to be newly affected by five or more noise events. These dwellings are predominantly located in Forrestfield, High Wycombe and Wattle Grove.

25.5.3.5 Growth to 2045

The assessments predicts a growth in annual aircraft movements from 172,000 in 2025 to 241,000 in 2045.

This growth in air traffic over time will result in dwellings being exposed to an increasing number of noise events, as well as an increased number of dwellings being exposed to aircraft noise events.

The projected number of dwellings within each of the noise event contours for 2045 day (24-hour) and night (11.00 pm to 6.00 am) is shown in Table 25-13.

Average Daily Noise Events	Number of dwellings within N65 day (24-hour) contours, 2045 With New Runway	Number of dwellings within N60 night (11.00 pm to 6.00 am) contours, 2045 With New Runway
5-10	18,850	36,222
10-20	13,414	29,919
20-50	19,331	20,800
50-100	20,041	0
100-200	10,646	0
200+	849	0
Total dwellings	**83,131**	**86,941**

Table 25-13 Number of dwellings within day and night noise contours – 2045 with new runway
Source: Wilkinson Murray

25.6 Social Impacts of the New Runway Project

25.6.1 Non-Airspace Related Impacts

Construction of the new runway would result in changes at the airport which include the removal of vegetation, landform changes and the presence of construction related activity on the NRP site. These works would result in some temporary amenity impacts (such as ground based noise, dust and visual intrusion in areas very close to the new runway area which may have an impact on people in surrounding areas. These impacts are considered to be manageable and would be addressed via mitigation and management actions outlined in the Construction Environmental Management Plan (CEMP).

In relation to local roads, construction is expected to add around 1,000 vehicles per day to roads in the vicinity of the airport. Grogan Road would be permanently closed at the start of construction. This closure may add minor delays to the local road network, but would have minimal impact on the wider road network.

Construction activities associated with the NRP are expected to add to the real economic output of the Perth Region (as measured by Gross Regional Product) by $329 million and create 487 jobs. This economic input would have a positive benefit to the region's socio-economic environment.

Once operational, the new runway will increase the size of Perth Airport's visible infrastructure from on and off airport view points, but given the current scale of the airport, this change is considered to be negligible.

It is forecast that the cumulative impact of the operation of the new runway is $1.03 billion in 2017 dollars.

25.6.2 Airspace Related Impacts

The social impacts of the NRP are discussed in the context of vulnerable populations, people's way of life, people's environment and their interaction within the community.

25.6.2.1 Community Facilities and Vulnerable Populations

Individuals respond to sound and noise differently and there can be large variation in their response. While the average or majority response by a population is used to determine aircraft noise thresholds, certain groups within the population are particularly noise sensitive or vulnerable to new or increased aircraft noise exposure levels. The World Health Organization's Guidelines for Community Noise (1999) suggest that some groups are often underrepresented in socio-acoustic studies on noise exposure, including:

- infants and children,
- older adults,
- people with mental or physical medical conditions,
- people with hearing or speech challenges, and
- shift workers.

These people may be more vulnerable to noise exposure depending on the nature of their condition or circumstance. For example, people with hearing impairments may be vulnerable to speech interference. People with depression or anxiety issues may experience increased effects due to fear of accidents from overflying planes. Shift workers may be more sensitive to daytime and evening noise events.

In relation to N65 noise events, in the short term, operation of the NRP would reduce the number of aircraft noise events in some areas, but over time, aircraft noise exposure in an area will grow to similar pre-NRP levels. Vulnerable people may be less able to cope with changes to aircraft noise exposure and therefore may be at greater risk of harmful effects. This is especially relevant to disadvantaged segments of the population that would receive new aircraft noise exposure as a result of the NRP.

Sensitive community facilities such as schools, child care centres, hospitals and aged care facilities are also more likely to be used by population groups that are more noise sensitive.

The overall number of community facilities located within N65 contours in the day time decreases by 11 per cent with the opening of the NRP. In the evening, the number of exposed community facilities reduces by 17 per cent. At night, the number of facilities within the N60 contours decreases by 43 per cent. While there is an overall decrease, the distribution of these contours changes, with some facilities no longer affected, some that experience a decrease in noise event frequency, some would experience an increase in noise event frequency, and some would be newly affected by more than five 65 dBA noise events.

By 2045, due to the growth in aircraft movements, there are increases in the number of community facilities located in the noise event contours and increases in the density of daily noise events. Facilities exposed to N65 daytime noise events will increase by seven per cent (an additional 15 facilities) from the 2025 with runway scenario, while for evening noise events the increase is from 67 to 86 facilities (28 per cent). The number of existing community facilities impacted by N60 night noise events will increase from 16 to 32, with newly exposed facilities located in Applecross, Bassendean, Como, Manning and Salter Point.

25.6.2.2 People's Way of Life and Environment

Exposure to aircraft noise has the potential to adversely impact people's way of life including "how they live, work, play and interact with one another on a day-to-day basis" (Vanclay, Esteves, Aucamp, & Franks, 2015). According to the WHO Guidelines (1999), the effects of community noise (such as aircraft and road transportation) depends on the extent to which it interferes with different activities.

The guidelines state that in the context of aircraft noise, interference with rest, recreation and watching television are the most important issues for people. The N65 noise contour is used as the threshold for interference with speech communication and can be used as a proxy for determining the number of dwellings, and thus the number of people, that may be affected by noise related disturbance.

While the NRP is not likely to have any direct physical impacts on the way that people live their lives, the indirect impact of exposure to aircraft noise could adversely affect some people, particularly those who live within areas that are predicted to experience frequent noise events of more than 65 dBA.

Opening of the new runway would improve the noise environment for some people currently exposed to aircraft noise, especially in the evening and night time periods. In the following years, the forecast growth in flights at Perth Airport would mean this noise exposure would grow over time in line with aviation traffic growth. By 2045, more dwellings would be exposed to N65 noise event (day and evening) and N60 noise events (night) than at 2025. During the day, this would result in a five per cent increase in dwellings within the N65 contours. In the evening, this would result in more than 40 per cent increase in dwellings within the N65 contours. At night, this would result in a 50 per cent increase in dwellings within the N65 noise contours.

The impacts associated with new or additional exposure to aircraft noise and people's way of life might include:

- **use of dwellings and buildings** – people who experience frequent noise events may change the way they use their dwelling, such as keeping windows closed or not using outdoor living spaces. This may result in loss of amenity, higher use of air conditioning and less frequent interactions with neighbours and their community,

- **television watching and radio** – people who are watching television or listening to the radio may need to turn these devices up to hear them during noise events or may miss sections of the program they are watching or listening to as an aircraft flies overhead,
- **speech disturbance** – conversations may be interrupted by noise events. People may have to talk louder or cease talking / listening until the aircraft has passed overhead. The WHO Guidelines on Community Noise (1999) state that sectors of the community who are particularly vulnerable to impacts created by speech disturbance are the hearing impaired, the elderly, children in the process of language and reading acquisition and individuals who are not familiar with the spoken language,
- **annoyance** – people who are exposed to aircraft noise may be annoyed by these events. This annoyance has the potential to change their way of life due to psychological and or physiological manifestations of this annoyance, and
- **sleep disturbance** – sleep disturbance may impact the way people go about their daily lives.
- **visual impact of aircraft** – the proposed flight corridors may mean that people begin to see aircraft in locations that they may not have been in the past.

25.6.2.3 Community Interactions

Exposure to aircraft noise has the potential to impact people's community including its cohesion, stability, character, services and facilities.

People's connection to their community comes from their interaction with neighbours and other people in their local environment. This can occur at home or at local facilities such as shopping areas, schools or other community facilities. The impact of excessive noise on certain sections of the community has the potential to change the way that people use their outdoor living spaces, reducing incidental interactions with neighbours where people aren't outside as frequently. It may also impact their use of community facilities in their local area. This may result in some people being or feeling less connected to their local community.

25.7 Mitigation

25.7.1 Standard Mitigation

As discussed in Section 21, the design of preliminary flight corridors for the NRP has been undertaken to consider and avoid noise exposure on populated areas as much as possible. However, the impact of increased or new aircraft noise exposure will be unavoidable in some areas, largely due to the increasing number of flights to and from Perth Airport over time.

Perth Airport actively manages aircraft noise exposure and its effect on the community. Strategies to minimise aircraft noise exposure are detailed in Section 22 and include:

- appropriate land use planning around Perth Airport through State and Local government policy and decision making, dating back to the early 1980s, to ensure that future noise-sensitive uses are not located in noise impacted areas associated with the new runway,
- operational procedures that include noise abatement procedures,
- timely provision and engagement with populations and community facilities under flight corridors,
- provision of clear and comprehensible information about the likely aircraft noise exposure, including published 'Number-above' contours and the Perth Airport Interactive Aircraft Noise Information Portal,
- provision of clear information to assist those affected by the aircraft noise to undertake amelioration measures that can reduce noise penetration into homes, such as the 'Reducing noise in existing homes brochure',
- comprehensive Perth Airport Aircraft Noise Management Plan, and
- the Perth Airport Aircraft Noise Technical Working Group, which enables the aviation industry to initiate and evaluate operational changes while ensuring that the noise impact of those changes is considered and opportunities to improve aircraft noise outcomes are explored.

25.7.2 Additional Mitigation

Additional mitigation measures to be applied throughout the design of the airspace and operations of the new runway, include:

- careful route planning and incorporating existing arrival and departure routes into the airspace design wherever possible,
- improved use of new navigation technology,
- review of noise abatement procedures for the new runway and parallel runway operations,
- provision of timely information to residents, and
- timely provision and engagement with newly exposed education facilities.

It is acknowledged that new and additional aircraft noise exposure will be experienced by some people who live, work and recreate in areas near Perth Airport and its associated flight paths or corridors.

These impacts will be considered through the final design of flight paths and operational procedures.

This residual impact is an unavoidable outcome of operating a major airport that services the travels needs of the city, and state, and provides significant economic outcomes for the people of Perth and Western Australia.

25.7.4 Summary of Impacts

Table 25-14 presents a summary of the social impacts and summary of the residual impacts assessed as well as standard and additional mitigation measures and associated risk rankings.

			Initial Assessment				Residual Assessment			
Impacting Process	Impact Detail	Project Phase	Standard Mitigation	Significance/ Consequence	Likelihood	Initial Risk	Additional Mitigation	Significance	Likelihood	Residual Risk
Runway facilitates additional traffic	Additional traffic facilitates growth in population leading to changes demographics of surrounding communities	Construction, Operations	None identified	Negligible	Highly Unlikely	Very Low				
Increased or new aircraft noise exposure	Reduced housing or property value	Planning, Operations	NRP operations included in ANEF contours since 1985	Negligible	Unlikely	Very Low				
	Vulnerable populations particularly sensitive to new or changed noise exposure	Operations	Appropriate land use planning (State Planning Policy 5.1 and inclusion of NRP in Perth Airport ANEF since 1983) Published Number-above noise contours Aircraft Noise Management Plan Published noise abatement procedures Perth Airport Aircraft Noise Technical Working Group Timely engagement with populations and community facilities under flight corridors Interactive Aircraft Noise Information Portal Reducing noise in existing homes brochure	Moderate Adverse	Possible	Medium	Careful route planning during final airspace design Noise abatement procedures reviewed for NRP/ parallel runway operations Improved use of new navigation technology Provision of timely information Engagement with newly impacted education facilities	Minor Adverse	Possible	Low
	Use of community facilities	Operations		Moderate Adverse	Possible	Medium		Moderate Adverse	Possible	Medium
	People's way of life – day	Operations		Minor Adverse	Possible	Low		Minor Adverse	Possible	Low
	People's way of life – evening	Operations		Minor Adverse	Possible	Low		Minor Adverse	Possible	Low
	People's way of life - night	Operations	As above	Moderate Adverse	Possible	Medium	As above	Moderate Adverse	Possible	Medium
	Community Interactions	Operations		Minor Adverse	Possible	Low		Minor Adverse	Possible	Low
Altered visual landscape	Clearing of site and construction of the NRP	Construction	CEMP	Negligible	Almost Certain	Low				

Table 25-14 Summary of impacts, risks and mitigation measures
Source: Perth Airport

25.8 Conclusion

The requirement for a future parallel runway system at Perth Airport has been identified and planned for since the 1970's.

The relative isolation of Perth as an Australian capital city and the vast distances between major population centres makes air travel and Perth Airport indispensable to the people of Western Australia and to the State's economic, social and cultural development. Perth Airport is both the primary airport in Western Australia and the hub through which nearly all regional aviation is serviced.

Perth residents rely on air transport more than most other Australians in that they travel by air more frequently and over longer distances for work, education, recreation, health and to visit friends and relatives.

Perth's forecast population growth will also result in an increased demand for aviation services for both passenger and freight transport purposes.

Aircraft movements at Perth Airport are expected to increase reaching 172,000 annual aircraft movements by 2025 and 241,000 by 2045. Without the new runway, by 2025, delays would regularly occur at Perth Airport as the runway capacity is exceeded. By 2045, approximately 140 aircraft movements would be foregone each day, resulting in significant constraints to the community and State development.

Construction of the NRP will result in changes at the airport which include the removal of vegetation, landform changes and the presence of construction related activity on the airport. These works would result in some temporary amenity impacts (such as ground based noise, dust, visual) in areas very close to the NRP which may have an impact on people in these areas. These impacts are considered to be manageable and would be addressed via mitigation and management actions outlined in the CEMP which will be developed before site works commence.

In relation to local roads, construction is expected to add around 1,000 vehicles per day to roads in the vicinity of the airport. Grogan Road will be permanently closed at the start of construction which will have minimal impact on the wider road network.

Once operational, the new runway will increase the size of Perth Airport's visible infrastructure from on and off airport viewpoints, but given the current scale of the airport, the infrastructure that is already in place and the activities it facilitates, this change is considered to be negligible.

In relation to the social impact of aviation related noise, on opening in 2025, the NRP would change the community's exposure to aircraft noise due to aircraft traffic being distributed across the parallel runway system. This will result in a reduction in the number of noise events for some areas, an increase in noise events for other areas, and some new noise events for other areas.

During the day, some areas to the north-east and west of the airport would receive less frequent and lower decibel noise, while areas to the north and south of the new runway would receive new aircraft noise. While there are changes to where noise will be experienced, overall the number of dwellings and community facilities impacted by noise events during the day remains fairly consistent. On opening, in the evening and the night time, there will be an overall decrease in the number of dwellings and community facilities located with the noise event contours. Due to the growth in aircraft movements over time and the increased capacity enabled by the new runway, by 2045 the areas exposed to aircraft noise events will increase.

Measures to manage social impacts or improve social benefits have been identified based on the social benefits and impacts that have been discussed throughout this MDP. Measures were identified based on standard statutory mitigation measures as well as industry best practice. Measures recommended will be adapted based on detailed design work.

To address the impacts of new or changed exposure to aircraft noise, Perth Airport will continue to work with State and Local governments, airlines and Airservices to implement Perth Airport's Aircraft Noise Management Framework. This includes advocating for appropriate land use planning in the vicinity of the airport, using appropriate metrics to identify noise sensitive areas and actively discouraging development in noise sensitive areas. The ANEF system has its limitations, and as such, Perth Airport will advocate for the N-contours to be considered when updating planning provisions associated with the airport.

Perth Airport will continue to engage with stakeholders and the community about the growth of Perth Airport and the impacts and benefits this growth brings. Perth Airport will continue to provide information on aircraft noise and its exposure to assist the community manage and even lessen the impacts where possible.

25.9 Suburb Overview

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Baskerville	Community centre	Baskerville Hall	5-10		
Bassendean	School	Bassendean Primary School	5-10		5-10
Beckenham	Childcare centre	Buggles Child Care	50-100	20-50	20-50
	Place of worship	Beckenham Community Church	50-100	20-50	10-20
		Beckenham Community Church of Christ	50-100	20-50	20-50
		City Lighthouse Church of Christ	50-100	20-50	20-50
	Kindergarten or pre-school	Beckenham Kindergarten	20-50	50-100	50-100
	School	Beckenham Primary School	50-100	20-50	20-50
Beechboro	Kindergarten or pre-school	Meerlinga Family Centre			5-10
	School	Beechboro Christian School	5-10	5-10	5-10
Bellevue	Place of worship	Bellevue Baptist Church	50-100	20-50	50-100
		Swan Christian Fellowship	50-100	20-50	50-100
Belmont	Childcare centre	Belmont Oasis OSHC	5-10		
	Community centre	Belmont Senior Citizens Centre	5-10		
	Place of worship	Airport City Church	20-50	10-20	20-50
		Ascot Christadelphians	20-50	10-20	20-50
	School	Belmont City College	5-10		
Bennett Springs	Community centre	Bosnian-Herzegovinian Cultural and Recreation Centre	5-10	5-10	5-10
	Place of worship	Shree Swaminarayan Temple Perth	5-10	5-10	10-20
Bentley	Childcare centre	Bentley Child Care Centre	5-10	5-10	5-10
	Hospital	Bentley Hospital	10-20	5-10	5-10
	Place of worship	Salvation Army Bentley Corps			5-10
		Bentley Islamic Community centre			5-10
	School	Bentley Primary School		5-10	5-10
Boya	Community centre	Boya Community centre	20-50	20-50	50-100
Canning Vale	Aged care and retirement	Joseph Banks Aged Care	5-10	10-20	20-50
	Childcare centre	Bounce OSHC - Campbell			5-10
		Goodstart Early Learning Centre-Promenades			5-10
	Place of worship	Eternal Life Ministries at Campbell Primary School			5-10
		Livingston Seventh-Day Adventist Church	10-20	10-20	20-50
		St Emilie's Parish		5-10	10-20
		The Billabong Church	5-10	10-20	10-20
		Gurdwara Sahib	10-20	20-50	50-100
	Prison or detention centre	Hakea Prison	5-10	5-10	
	School	Caladenia Primary Independent School	5-10	10-20	10-20
		Campbell Primary School			5-10
		Canning Vale College	10-20	20-50	20-50
		St Emilies Catholic Primary School			5-10

Table 25-15 Community facilities within N65 day contours, by suburb
Source: Arup

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Cannington	Childcare centre	Treasure Island Child Care Centre	100-200	50-100	100-200
		Tumbleweed Child Care Centre	50-100	20-50	50-100
	Community centre	Cannington Civic Centre	20-50	20-50	20-50
		Communicare Employment & Training Services	100-200	50-100	100-200
	Place of worship	Cannington Seventh-Day Adventist Church	50-100	20-50	50-100
		Cannington Uniting Church	100-200	50-100	100-200
		St Michael and All Angels Church	20-50	20-50	20-50
		The Rocks Ministry	10-20	5-10	10-20
		True Jesus Church Cannington	50-100	20-50	50-100
	School	Cannington Community College	50-100	50-100	50-100
		Sevenoaks Senior College	100-200	50-100	100-200
	Tertiary education	Technical College of Western Australia	50-100	20-50	50-100
Caversham	Childcare centre	Little Leprechauns Childcare	5-10	5-10	10-20
	School	Caversham Primary School	50-100	50-100	100-200
		Caversham Training and Education Centre	20-50	20-50	50-100
Cloverdale	Aged care and retirement	Faulkner Park Retirement Estate	5-10		
		St Ives Faulkner Park Retirement Estate	5-10		
	Childcare centre	Cloverdale Child Care Centre	100-200	50-100	50-100
	Community centre	Belmont Youth Services Centre	5-10		
		Forster Park Hall	50-100	20-50	50-100
		Miles Park (Belmont Junior Soccer Club Park)	20-50	10-20	20-50
	Place of worship	All Saints Anglican Church	20-50	10-20	20-50
		Belmont Church of Jesus Christ of Latter-Day Saints	20-50	5-10	10-20
		Notre Dame Parish	20-50	10-20	10-20
		Perth Alliance Church	20-50	10-20	20-50
	School	Belmay Primary School	50-100	20-50	20-50
		Cloverdale Primary School	5-10		
		Notre Dame Primary School	20-50	5-10	10-20
Como	Place of worship	St Pius X Church	10-20	10-20	5-10
	School	Saint Pius X Catholic Primary School	10-20	10-20	5-10
Dayton	School	Riverlands School		10-20	20-50
East Cannington	Childcare centre	Happy Tots Childcare centre	50-100	20-50	50-100
		YMCA Early Learning Centre	20-50	50-100	50-100
	Place of worship	St Francis of Assisi Church	50-100	20-50	20-50
	School	Gibbs Street Primary School	100-200	50-100	100-200
Ferndale	Aged care and retirement	Howard Solomon Residential Aged Care Facility	5-10	10-20	10-20
	Place of worship	Lynwood Christian Church	20-50	20-50	50-100
	School	Damla College	10-20	10-20	20-50
Forrestfield	Community centre	Hartfield Park Recreation Centre		10-20	10-20

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Facility Name	Number of average daily N65 daytime noise events: 2025 Without New Runway	2025 With New Runway	2045 With New Runway
Greenmount	Aged care and retirement	Regis Cypress Gardens	50-100	20-50	50-100
	Place of worship	Greenmount Church of Jesus Christ of Latter-Day Saints	50-100	20-50	50-100
		Greenmount Kingdom Hall	50-100	20-50	50-100
		St Anthony's Church	50-100	20-50	50-100
	School	Greenmount Primary School	50-100	20-50	50-100
		St Anthony's Catholic Primary School Greenmount	50-100	20-50	50-100
Guildford	Aged Care	Guildford Village	100-200	100-200	100-200
		St Vincents Aged Care	10-20	10-20	20-50
	Kindergarten or pre-school	Guildford Grammar Kindergarten	50-100	50-100	100-200
		Guildford Kindergarten	50-100	50-100	100-200
	Place of worship	Chapel of St Mary and St George Guildford Grammar	100-200	100-200	100-200
		Guildford Wesley Chapel	50-100	100-200	100-200
		St Charles Seminary	50-100	50-100	100-200
		St Mary's Church	100-200	100-200	100-200
		St Matthew Church	50-100	50-100	50-100
	School	Guildford Grammar School	100-200	100-200	100-200
		Guildford Grammar Prep School	50-100	50-100	100-200
		Guildford Primary School	20-50	20-50	50-100
Helena Valley	Childcare centre	A Step Ahead Early Learning and Care Centre	20-50	20-50	20-50
Henley Brook	Place of worship	All Saints Church	5-10	10-20	10-20
Herne Hill	Childcare centre	Swan Valley Child Care Centre			5-10
	Place of worship	St Michael's the Archangel			5-10
	School	Herne Hill Primary School			5-10
High Wycombe	Aged care and retirement	Hillview Lifestyle Village	50-100	50-100	100-200
	Childcare centre	Community Kids			5-10
		Goodstart Early Learning Centre	20-50	20-50	50-100
		Kids Inn		10-20	10-20
	School	Edney Primary School			5-10
		High Wycombe Primary School		20-50	50-100
		Matthew Gibney Catholic Primary School	20-50	50-100	100-200
Huntingdale	Childcare centre	Periwinkles Learning and Child Care Centre		5-10	
Kalamunda	Childcare centre	Kids Inn OSHC Club		10-20	10-20
Karawara	Community centre	George Burnett Leisure Centre		5-10	5-10
Kensington	Aged care and retirement	Alexandra Village	5-10		
		Kensington Park Nursing Home	5-10		
	Childcare centre	Ngala Bluebird Child Care Centre	5-10		
	Hospital	Ngala Family Centre	5-10		
	Place of worship	St Martin in the Fields Church	5-10		
	School	Kensington Primary School	5-10		
		Kensington Secondary School	5-10		

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Kenwick	Childcare centre	Fun and Learn Childcare Service	10-20	20-50	50-100
		Kenwick Child Care Centre	50-100	10-20	20-50
	Community centre	Kenwick Community Facility	20-50	20-50	20-50
	Kindergarten or pre-school	Kenwick Early Learning and Care	50-100		
	School	Rehoboth Christian College - Kenwick Campus	20-50	20-50	20-50
		East Kenwick Primary School	20-50	20-50	50-100
		Kenwick Primary School	50-100	10-20	5-10
		Communicare Academy	50-100	50-100	50-100
	Place of worship	International Fellowship Seventh-Day Adventist Church	50-100	5-10	5-10
		The Lifehouse Centre	5-10		
Kewdale	Preschool	Acton Avenue Pre-School Centre	50-100	10-20	20-50
	School	Kewdale Primary School	50-100	20-50	20-50
		Islamic College	5-10		
Koongamia	School	Clayton View Primary School	50-100	20-50	50-100
Langford	Childcare centre	The Learning Tree Lynwood	20-50	20-50	50-100
	Community centre	Langford Community centre	20-50	20-50	50-100
	Kindergarten or pre-school	St Judes Catholic School	20-50	20-50	50-100
	Place of worship	Langford C3 Church	20-50	20-50	50-100
		St Judes Catholic Church	20-50	20-50	50-100
		Whitehouse Community Church	50-100	50-100	100-200
	School	Brookman Primary School	50-100	50-100	50-100
		Langford Islamic College	20-50	20-50	50-100
		St Jude's Catholic Primary School	20-50	20-50	50-100
Lathlain	Childcare centre	YMCA Lathlain OSHC	5-10		
	Kindergarten or pre-school	Lathlain Kindergarten	5-10		
	School	Lathlain Primary School	5-10		
		St Clare's School	5-10		
Lynwood	Childcare centre	Junior Junction Child Care Centre	10-20	20-50	20-50
	Community centre	Lynwood Wandarrah Hall	20-50	20-50	50-100
	Place of worship	St Augustine Church	20-50	20-50	50-100
	School	Bannister Creek Primary School	10-20	20-50	20-50
Maddington	Aged care and retirement	Orange Grove Age Care	20-50	10-20	20-50
	Childcare centre	Orchard Montessori	20-50	10-20	20-50
	Community centre	Maddington Community centre	20-50	10-20	20-50
	Place of worship	Holy Family of Maddington	20-50	10-20	20-50
		Church of the Nazarene	20-50	10-20	20-50
		St Luke's Church	10-20	5-10	10-20
	School	Bramfield Park Primary School	20-50	10-20	20-50
		East Maddington Primary School	10-20	5-10	10-20
		Yule Brook College	20-50	10-20	20-50

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Manning	Aged care and retirement	Brightwater Care Group	10-20	10-20	5-10
	Community centre	Manning Senior Citizens Centre	5-10	5-10	5-10
	Kindergarten or pre-school	Conon Road Kindergarten	10-20	10-20	5-10
	Place of worship	Manning St Peter Anglican Church	10-20	10-20	5-10
		Manning Uniting Church			5-10
	School	Manning Primary School	10-20	10-20	5-10
Middle Swan	Place of worship	Anglican Parish of Swan	20-50	10-20	20-50
		Dreambuilders Church	10-20	10-20	20-50
		Middle Swan Kingdom Hall		10-20	10-20
		Valley Church of Christ	10-20	20-50	20-50
	Hospital	Swan Adult Mental Health Centre	10-20	20-50	20-50
		Swan District Hospital Campus	10-20	20-50	20-50
	School	St Brigid's Catholic Primary School		10-20	20-50
		Swan Christian College	20-50	20-50	20-50
		La Salle College	10-20	20-50	20-50
Midland	Aged care and retirement	Midland Nursing Home		20-50	20-50
		Morrison Lodge			5-10
		Tuohy Pines Nursing Home	20-50	20-50	20-50
	Community centre	Midland Town Hall	10-20	20-50	20-50
	Hospital	Midland Health Campus	10-20	10-20	20-50
		Viveash Rehabilitation Centre	10-20	10-20	20-50
	Place of worship	Church of The Ascension	10-20	20-50	20-50
		Evangel Charismatic Church	10-20	10-20	20-50
		St Brigids Church	10-20	20-50	20-50
		The Potters House	5-10	5-10	10-20
	School	Corridors College	10-20	20-50	20-50
	Tertiary education	Polytechnic West Midland Campus		5-10	
Midvale	Childcare centre	My World Child Care	10-20	10-20	20-50
Mount Pleasant	Place of worship	Bible Presbyterian Church of WA	5-10		
	Community centre	Canning Bridge Senior Citizens Club	5-10		
Orange Grove	School	Orange Grove Primary School		20-50	50-100
Perth Airport	Childcare centre	Ngala Early Learning and Development Service	50-100	20-50	50-100
Queens Park	Childcare centre	ABC Developmental Learning Centre	100-200	50-100	50-100
	Community centre	Harry Turner Pavillion	100-200	50-100	100-200
	Place of worship	Canning Masjid & Islamic Association	100-200	50-100	100-200
		St Joseph's Priory	100-200	50-100	50-100
	School	Queen of Apostles School	10-20	10-20	10-20
		Queens Park Primary School	100-200	50-100	100-200
		Saint Joseph's School	100-200	50-100	50-100
		Saint Norbert College	100-200	50-100	100-200

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Redcliffe	Aged care and retirement	Brightwater Care Group Redcliffe Hostel	5-10		5-10
		Lakeside Aged Care Facility	5-10		
		Lakeside Lodge	5-10		
		Parkview Aged Care Facility	5-10		
	Childcare centre	Mulberry Tree OSHC	10-20		5-10
	Community centre	Redcliffe Park Community centre	50-100	10-20	20-50
	Place of worship	St Maria Goretti Catholic Church	10-20		5-10
	School	Redcliffe Primary School	10-20		5-10
		St Maria Goretti School	10-20		5-10
Riverton	Childcare centre	Warooga Child Care Centre	5-10	5-10	5-10
	Place of worship	Our Lady Queen of Apostles Church	20-50	10-20	10-20
	School	Riverton Primary School	5-10	5-10	5-10
Rivervale	Aged care and retirement	Joyce Fleming Units	5-10		
	Childcare centre	Young Smarties CCC	5-10		
	Community centre	Rivervale Community centre	5-10		
	Place of worship	Elevate Church	5-10		
		Salvation Army Rivervale Corps	5-10		
	School	Tranby Primary School	5-10		
Salter Point	Aged care and retirement	Amana Living - Peter Arney Home	10-20	10-20	5-10
		Gracewood Residential Aged Care Facility	10-20	10-20	5-10
		Murlali Lodge	10-20	10-20	5-10
		Riverside - Salter Point	10-20	5-10	5-10
	School	Aquinas College	5-10		5-10
Shelley	Place of worship	Riverton Baptist Community Church	10-20	10-20	10-20
	Kindergarten or pre-school	Shelley Kindergarten	5-10	5-10	5-10
	School	Shelley Primary School	5-10	5-10	5-10
South Perth	Place of worship	Perth Arabic Christian Church	50-100	5-10	5-10
Stratton	Childcare centre	Goodstart Early Learning Centre	10-20		
		Middle Swan Child Care Centre	10-20		
	Community centre	Stratton Community centre	10-20		
	Place of worship	Swan Valley Seventh-Day Adventist Church	10-20		
	School	Middle Swan Primary School	10-20		

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Number of average daily N65 daytime noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Swan View	Aged care and retirement	Marlborough Retirement Village	20-50	20-50	20-50
	Community centre	Brown Park Recreation Centre	50-100	20-50	50-100
	Childcare centre	Churchill Brook Swan View Family Centre and Child Care Centre	20-50	20-50	20-50
		Kids Inn and Kids Inn OSHC	20-50	20-50	20-50
		Swan View Child Care Centre	20-50	20-50	20-50
	Kindergarten or pre-school	Churchill Brook Family Centre	20-50	20-50	20-50
		Swan View Greenmount Kindergarten	50-100	20-50	50-100
	Place of worship	Salvation Army Swan View Corps	20-50	20-50	20-50
		Swan View Uniting Church	50-100	20-50	50-100
	School	Swan View Primary School	20-50	20-50	20-50
		Swan View Senior High School	20-50	20-50	20-50
Thornlie	Childcare centre	Spencer Road Child Care Centre	10-20		
	Community centre	Thornlie Community centre		5-10	5-10
	Kindergarten or pre-school	Coolabaroo Neighbourhood Centre		5-10	5-10
		Thornlie Kindergarten		10-20	
	Place of worship	Masjid & Australian Islamic College		5-10	5-10
		Perth Cambodian Evangelical Church		5-10	5-10
		Thornlie Baptist Church		5-10	5-10
		Thornlie Church of Christ		5-10	
		Thornlie Church of Jesus Christ of Latter-Day Saints		5-10	10-20
		Thornlie Kingdom Hall	10-20		
	School	Australian Islamic College Perth		5-10	5-10
		Thornlie Primary School		5-10	5-10
		Yale Primary School		5-10	
Victoria Park	Aged care and retirement	Talbot Lodge Nursing Home	5-10		
		The John Keirle Housing Centre	5-10		
	Community centre	Connect - The Homestead (Manna Inc, Potters House Christian Church, Senior Citizens Welfare Association Inc)	5-10		
	Childcare centre	Brighton Nursery and Child Care Centre	5-10		
	Place of worship	St Joachim's Church	5-10		
		St Peter's Anglican Church	5-10		
		Victoria Park Seventh-Day Adventist Church	5-10		
	School	Al-Hidayah Islamic School		5-10	5-10
		Victoria Park Primary School	5-10		
		Ursula Frayne Catholic College	5-10		
		VisABility	5-10		
Waterford	Place of worship	Clontarf Aboriginal College Chapel	10-20	10-20	10-20
		Clontarf Chapel	10-20	10-20	10-20
		Waterford Clontarf Catholic Church	10-20	10-20	10-20
	School	Clontarf Aboriginal Education and Training College	10-20	10-20	10-20

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Facility Name	Number of average daily N65 daytime noise events		
			2025 Without New Runway	2025 With New Runway	2045 With New Runway
Wattle Grove	Place of worship	Salvation in Christ-Helping Ex-Jehovah Witness		10-20	10-20
		Wattle Grove Assembly Hall Jehovahs Witnesses		20-50	20-50
		Wattle Grove Baptist Church		50-100	50-100
		Keswick Christian Convention Centre		10-20	20-50
	School	Wattle Grove Primary School		50-100	50-100
Welshpool	Childcare centre	Goodstart Early Learning Centre	5-10		
West Swan	School	Culunga Aboriginal Community School	10-20	20-50	50-100
	Prison or detention centre	Bandyup Women's Prison	50-100	20-50	50-100
Whiteman	Place of worship	The Potters House Beechboro	5-10	5-10	
Wilson	Aged care and retirement	Agmaroy Nursing Home	20-50	20-50	20-50
		Castledare Village	20-50	20-50	20-50
		River Parks Retirement Village	10-20	10-20	10-20
		River Pines Retirement Village	10-20	10-20	10-20
	Community centre	Wilson Community Hall	10-20	10-20	10-20
	Place of worship	Our Lady of Perpetual Hope	20-50	20-50	20-50
		Wilson Gospel Chapel	10-20	10-20	10-20
	School	Rehoboth Christian College - Wilson Campus	5-10	10-20	10-20
		Wilson Primary School	20-50	10-20	20-50
Woodbridge	Childcare centre	Growzone Guildford Early Learning Centre	20-50	20-50	50-100
	School	Governor Stirling Senior High School	50-100	50-100	50-100
	School	Woodbridge Primary School	20-50	20-50	50-100

Table 25-15 Community facilities within N65 day contours, by suburb (Continued)

Suburb	Facility Type	Number of average daily N65 evening noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Beckenham	Childcare	Buggles Child Care	5-10	5-10	
	Kindergarten or pre-school	Beckenham Kindergarten		5-10	5-10
	School	Beckenham Primary School	5-10		
	Place of worship	Beckenham Community Church	5-10		
		Beckenham Community Church of Christ	5-10		
		City Lighthouse Church of Christ	5-10		
Bellevue	Place of worship	Bellevue Baptist Church	5-10		
		Swan Christian Fellowship	10-20		
Belmont	Place of worship	Airport City Church	5-10		
Boya	Community centre	Boya Community centre	5-10		
Canning Vale	Aged care and retirement	Joseph Banks Aged Care			5-10
	School	Canning Vale College			5-10
	Place of worship	Livingston Seventh-Day Adventist Church			5-10
		Gurdwara Sahib		5-10	10-20
Cannington	Childcare	Treasure Island Child Care Centre	10-20	10-20	10-20
		Tumbleweeed Child Care Centre	5-10		5-10
	Community centre	Communicare Employment & Training Services	10-20	10-20	10-20
	Place of worship	Cannington Seventh-Day Adventist Church	10-20	5-10	5-10
		Cannington Uniting Church	10-20	10-20	10-20
		True Jesus Church Cannington	5-10		
	School	Cannington Community College	10-20	5-10	10-20
		Sevenoaks Senior College	20-50	10-20	10-20
	Tertiary education	Technical College of Western Australia	5-10	5-10	5-10
Caversham	School	Caversham Primary School	10-20	10-20	20-50
		Caversham Training and Education Centre			5-10
Cloverdale	Childcare	Cloverdale Child Care Centre	10-20		
	Community centre	Forster Park Hall	5-10		
	Place of worship	Perth Alliance Church	5-10		
	School	Belmay Primary School	5-10		
Dayton	School	Riverlands School			5-10
East Cannington	Childcare	Happy Tots Childcare centre	5-10		5-10
		YMCA Early Learning Centre		10-20	10-20
	Place of worship	St Francis of Assisi Church	5-10		
	School	Gibbs Street Primary School	10-20	5-10	10-20
Ferndale	Place of worship	Lynwood Christian Church			5-10
Greenmount	Aged care and retirement	Regis Cypress Gardens	10-20		
	Place of worship	Greenmount Church of Jesus Christ of Latter-Day Saints	10-20		
		Greenmount Kingdom Hall	10-20		
		St Anthony's Church	10-20		
	School	Greenmount Primary School	10-20		
		St Anthonys Catholic Primary School Greenmount	10-20		

Table 25-16 Community facilities within N65 evening contours, by suburb
Source: Arup

Suburb	Facility Type	Number of average daily N65 evening noise events			
		Facility Name	2025 Without New Runway	2025 With New Runway	2045 With New Runway
Guildford	Aged care and retirement	Guildford Village	20-50	20-50	20-50
	Kindergarten or pre-school	Guildford Grammar Kindergarten	10-20	10-20	20-50
		Guildford Kindergarten	20-50	20-50	20-50
	Place of worship	Chapel of St Mary and St George Guildford Grammar	20-50	20-50	20-50
		Guildford Wesley Chapel	20-50	20-50	20-50
		St Mary's Church	20-50	20-50	20-50
		St Matthew Church	5-10	5-10	10-20
		St Charles Seminary	10-20	10-20	20-50
	School	Guildford Grammar School	20-50	20-50	20-50
		Guildford Grammar Prep School	10-20	10-20	20-50
		Guildford Primary School			5-10
High Wycombe	Aged care and retirement	Hillview Lifestyle Village	5-10	10-20	10-20
	School	Matthew Gibney Catholic Primary School		5-10	10-20
Kenwick	Childcare	Fun and Learn Childcare Service			5-10
		Kenwick Child Care Centre	5-10		
	Community centre	Kenwick Community Facility			5-10
	Kindergarten or pre-school	Kenwick Early Learning and Care	5-10		
	Place of worship	International Fellowship Seventh-day Adventist Church	5-10		
	School	Rehoboth Christian College - Kenwick Campus			5-10
		Communicare Academy	10-20	5-10	10-20
		East Kenwick Primary School			5-10
		Kenwick Primary School	5-10		
Kewdale	Kindergarten or pre-school	Acton Avenue Pre-School Centre	5-10		
	School	Kewdale Primary School	5-10		
Koongamia	School	Clayton View Primary School	10-20		
Langford	Childcare	The Learning Tree Lynwood	5-10	10-20	10-20
	Community centre	Langford Community centre	5-10	5-10	10-20
	Kindergarten or pre-school	St Judes Catholic School	5-10	10-20	10-20
	Place of worship	Langford C3 Church	5-10	5-10	10-20
		St Judes Catholic Church	5-10	10-20	10-20
		Whitehouse Community Church	10-20	10-20	10-20
	School	Brookman Primary School	10-20	10-20	10-20
		Langford Islamic College	5-10	10-20	10-20
		St Jude's Catholic Primary School	5-10	10-20	10-20
Lynwood	Community centre	Lynwood Wandarrah Hall		5-10	5-10
	Place of worship	St Augustine Church		5-10	5-10
	School	Bannister Creek Primary School			5-10
Maddington	Community centre	Maddington Community centre	5-10		5-10
	Place of worship	Holy Family of Maddington	5-10		5-10
		Maddington Church of the Nazarene	5-10		5-10
	School	Bramfield Park Primary School	5-10		5-10
		Yule Brook College	5-10		

Table 25-16 Community facilities within N65 evening contours, by suburb (Continued)

Suburb	Facility Type	Facility Name	Number of average daily N65 evening noise events 2025 Without New Runway	2025 With New Runway	2045 With New Runway
Middle Swan	Hospital	Swan Adult Mental Health Centre		10-20	10-20
		Swan Christian College		10-20	10-20
		Swan District Hospital Campus		10-20	10-20
	Place of worship	Anglican Parish of Swan		5-10	10-20
		Dreambuilders Church		5-10	10-20
		Valley Church of Christ		10-20	10-20
	School	St Brigid's Catholic Primary School			5-10
		La Salle College		10-20	10-20
Midland	Aged care and retirement	Midland Nursing Home		5-10	10-20
		Tuohy Pines Nursing Home		10-20	10-20
	Community centre	Midland Town Hall		10-20	10-20
	Hospital	Midland Health Campus		5-10	5-10
		Viveash Rehabilitation Centre		5-10	5-10
	Place of worship	Church of the Ascension		10-20	10-20
		St Brigids Church		10-20	10-20
		Evangel Charismatic Church		5-10	5-10
	School	Corridors College		10-20	10-20
Orange Grove	School	Orange Grove Primary School			5-10
Perth Airport	Childcare	Ngala Early Learning and Development Service	5-10		
Queens Park	Childcare	ABC Developmental Learning Centre	10-20	5-10	10-20
	Community centre	Harry Turner Pavillion	20-50	10-20	10-20
	Place of worship	St Joseph's Priory	10-20	5-10	10-20
		Canning Masjid & Islamic Association	20-50	10-20	10-20
	School	Queens Park Primary School	20-50	10-20	10-20
		St Joseph's School	10-20	5-10	10-20
		Saint Norbert College	10-20	10-20	10-20
Redcliffe	Community centre	Redcliffe Park Community centre	5-10		
South Perth	Place of worship	Perth Arabic Christian Church	5-10		
Swan View	Community centre	Brown Park Recreation Centre	10-20		
	Childcare	Kids Inn and Kids Inn OSHC	5-10		
	Kindergarten or pre-school	Swan View Greenmount Kindergarten	10-20		
	Place of worship	Swan View Uniting Church	10-20		
Wattle Grove	Place of worship	Wattle Grove Baptist Church		5-10	10-20
	School	Wattle Grove Primary School		5-10	5-10
West Swan	Prison or detention centre	Bandyup Women's Prison	10-20	5-10	10-20
	School	Culunga Aboriginal Community School		5-10	10-20
Woodbridge	Childcare	Growzone - Guildford Early Learning Centre		5-10	5-10
	School	Woodbridge Primary School		10-20	10-20
		Governor Stirling Senior High School	5-10	5-10	10-20

Table 25-16 Community facilities within N65 evening contours, by suburb (Continued)

Suburb	Facility Type	Facility Name	Number of average daily N60 night noise events		
			2025 Without New Runway	2025 With New Runway	2045 With New Runway
Applecross	Aged care and retirement	Opal Applecross Suites			5-10
Bassendean	Aged care and retirement	Bassendean Nursing Home			5-10
Bentley	Hospital	Bentley Hospital	10-20		
Canning Vale	Aged care and retirement	Joseph Banks Aged Care	5-10	5-10	10-20
	Prison or detention centre	Banksia Hill Detention Centre	5-10	5-10	10-20
		Hakea Prison	5-10	5-10	10-20
Como	Aged care and retirement	McDougall Park Nursing Home			5-10
Ferndale	Aged care and retirement	Howard Solomon Residential Aged Care Facility		5-10	5-10
Greenmount	Aged care and retirement	Regis Cypress Gardens	10-20	10-20	20-50
Guildford	Aged care and retirement	Guildford Village	10-20	10-20	20-50
		St Vincents Aged Care	5-10	5-10	10-20
Helena Valley	Aged care and retirement	National Lifestyle Village	5-10	5-10	10-20
High Wycombe	Aged care and retirement	Hillview Lifestyle Village	10-20	10-20	20-50
Maddington	Aged care and retirement	Arcadia Waters Retirement Villages	5-10		
		Orange Grove Age Care	10-20	5-10	10-20
Manning	Aged care and retirement	Brightwater Care Group Manning			5-10
Middle Swan	Hospital	Swan District Hospital Campus	5-10		5-10
		Swan Adult Mental Health Centre	5-10		10-20
Midland	Aged care and retirement	Midland Nursing Home	5-10		5-10
		Tuohy Pines Nursing Home	10-20	5-10	10-20
	Hospital	Midland Health Campus	5-10	10-20	10-20
		Viveash Rehabilitation Centre	5-10	5-10	10-20
Redcliffe	Aged care and retirement	Brightwater Care Group Redcliffe Hostel	10-20		5-10
		Lakeside Aged Care Facility	5-10		
		Lakeside Lodge	5-10		
		Parkview Aged Care Facility	5-10		
Salter Point	Aged care and retirement	Amana Living - Peter Arney Home			5-10
		Gracewood Residential Aged Care Facility			5-10
		Murlali Lodge			5-10
		Riverside - Salter Point			5-10
Swan View	Aged care and retirement	Marlborough Retirement Village	10-20	10-20	20-50
West Swan	Prison or detention centre	Bandyup Women's Prison	10-20	10-20	20-50
Wilson	Aged care and retirement	Agmaroy Nursing Home	5-10		5-10
		Castledare Village	5-10	5-10	5-10
		River Parks Retirement Village	5-10		5-10
		River Parks Village	5-10		5-10
		River Pines Retirement Village	5-10		5-10

Table 25-17 Community facilities within N60 night contours, by suburb
Source: Arup

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+5 to 10 Events	+10 to 20 Events	+20 to 50 Events	+50 to 100 Events	+100 or more Events	-5 to 10 Events	-10 to 20 Events	-20 to 50 Events	-50 to 100 Events	-100 or more Events		
Applecross	5-10	583	132											132	
Ascot	5-10	81	63							63					
	10-20	69	14							11	3				
	20-50	30													
Aveley	5-10		37											37	
Ballajura	5-10	873	729											729	
Baskerville	5-10	1	5						3	1				1	
	10-20	11	5						2	3					
	20-50	8	4							4					
Bassendean	5-10	257	339						157	174				8	
	10-20	370	371						45	326					
	20-50	455	134							134					
Beckenham	5-10	141													
	10-20	312	138									138			
	20-50	548	1,730	110	31	19			164	138	743	378		147	
	50-100	1,818	1,247	30	5	191	858	80				78		5	113
	100-200	122	20					20							20
Beechboro	5-10	1,008	1,106											1,106	
	10-20	367													
Belhus	5-10		6	5										1	1
	10-20		7	3	4										
Bellevue	20-50	50	5		3	2									
	50-100	280	703	5	22	13			69	109	473			12	
	100-200	378													
Belmont	5-10	683	128							13	115				
	10-20	1,361	81								80	1			
	20-50	228	3								3				
	50-100	35													
Bennett Springs	5-10	641	1,585											1,585	
	10-20	949	5											5	
Bentley	5-10	806	896						226	39	28			603	29
	10-20	357	264							2	71			191	
	20-50	94													
Boya	5-10	16	16						1					15	1
	10-20	24	15						5					10	
	20-50	5	7		1									6	
Brabham	5-10		443	83										360	93
	10-20		251	127	124										190

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events
Source: Wilkinson Murray

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
Brigadoon	5-10	4													
	10-20	2													
Burswood	5-10	579													
	10-20	58													
Canning Vale	5-10	978	1,043	314										729	336
	10-20	1,904	1,533	714										819	32
	20-50	1,756	3,091	1,754	942									395	
Cannington	5-10		86						40	46					
	10-20	86	338						14	95	229				
	20-50	444	919						3	40	670	206			
	50-100	835	672								19	653			
	100-200	1,316	666								7	659			
Carlisle	5-10	344													
	10-20	32													
Caversham	5-10	148	414	5										409	
	10-20	907	760						33					727	
	20-50	548	539		1				162	275	1			100	
	50-100	193	120	2					22	47	11			38	
	100-200	68	54						7	30	4			13	
Cloverdale	5-10	81	265							15	250				
	10-20	297	423								311	112			
	20-50	473	1149								39	1,110			
	50-100	910	1336									1,160	176		
	100-200	1,797	39										39		
	200+	39													
Como	5-10	515	315											315	
	10-20	477	370											370	
Darlington	5-10	31	36						6					30	1
	10-20	54	37						17					20	
	20-50	52	54		39				1					14	
Dayton	5-10	53	2	2											
	10-20	633	682	50	44									588	
	20-50	479	477	35	142	159								141	
	50-100	8	15	4	1	8								2	

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
East Cannington	5-10	42													
	10-20	44													
	20-50	63	239						6	7	78	144		4	
	50-100	532	1266	33	60	134	166	17	25	86	180	527		38	41
	100-200	984	552				5	211				336			212
	200+	174													
Ferndale	5-10	54	53	41										12	
	10-20	122	110	30										80	
	20-50	1,284	1,302	303	77				9	4				909	
	50-100	282	381	37	19				64	116	61			84	
	100-200	64	1							1					
Forrestfield	5-10		892	430										462	692
	10-20		184	79	42									63	52
	20-29		336	36	120	167								13	152
	50-100		86			71	15								
	100-200		1				1								1
Gidgegannup	5-10	37													
	10-20	15													
	20-50	7													
Greenmount	10-20	5	3						2					1	
	20-50	178	119		107									12	
	50-100	384	922	36	73				52	86	675				
	100-200	477													
Guildford	10-20		12						3	9					
	20-29	78	102						65	37					
	50-100	92	56	2					14					40	
	100-200	584	584	212					43	38				291	
Hazelmere	5-10		9	9											9
	10-20	10	10						1					9	
	20-50	131	53	1	13	1			7	2				29	
	50-100	154	214	13	36	159				2	3	1			
	100-200	5	23			16	5				1			1	
Helena Valley	5-10	97	131						27					104	9
	10-20	211	110	16					59					35	
	20-50	567	549	52	372				12					113	
	50-100	225	327		127					113	87				
	100-200	25													

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
Henley Brook	5-10	37	65	11										54	1
	10-20	32	41	28	5									8	
	20-50	46	74	3	2				23	7				39	
	50-100	42	27						6	3				18	
Herne Hill	5-10	9	234	189	10									35	210
	10-20	8	192	117	74									1	136
	20-50	5	7	2	3									2	
High Wycombe	5-10	237	437	306										131	437
	10-20	446	312	147	19									146	238
	20-50	1,057	965	181	254	323								207	444
	50-100	126	1,218	79	127	641	365	4			2				417
	100-200		863			52	274	537							328
Hovea	5-10	10	9						1					8	
	10-20	10	3						2	1					
	20-50	1													
Huntingdale	5-10		68	27										41	68
Jane Brook	5-10	111													
	10-20	522													
	20-50	411													
Karawara	5-10	88	179											179	
Kensington	5-10	1,655													
Kenwick	5-10	10	155									155			
	10-20	52	440								166	274			
	20-50	879	1,322	115	189	185			136	222	302	38		135	7
	50-100	1,145	168		4	65	99								91
Kewdale	5-10	427	210							8	202				
	10-20	168	381								381				
	20-50	447	489								188	301			
	50-100	573	2									2			
	100-200	61													
Koongamia	20-50	245	156		156										
	50-100	195	315		112				99	35	50			19	
	100-200	31													
Langford	5-10		266							16	58	192			
	10-20	18	135						11	25	41	58			
	20-50	1,017	378	19	49				4	86	130	57		33	
	50-100	1,083	1,286	122	419	259			42	158	149			137	
	100-200	50													

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+5 to 10 Events	+10 to 20 Events	+20 to 50 Events	+50 to 100 Events	+100 or more Events	-5 to 10 Events	-10 to 20 Events	-20 to 50 Events	-50 to 100 Events	-100 or more Events		
Lathlain	5-10	478													
	10-20	930													
Lesmurdie	5-10		5	1										4	5
Lynwood	5-10	142	147	102										45	
	10-20	186	189	151	38										
	20-50	710	457	41	323	93									
	50-100	218	628	39	192	354			12	17				14	
Maddington	5-10	212	671	14					62	199	213	59		124	
	10-20	278	1,869						24	270	1362	213			
	20-50	1,675	63	3	8	7			10	6	7			22	
	50-100	973	13			3	10								7
Maida Vale	5-10		18	18											18
Manning	5-10	193	248											248	
	10-20	536	862											862	
	20-50	419	96											96	
Martin	5-10	6	20	7										13	3
	10-20	16	30	1					20	4				5	
	20-50	12													
Middle Swan	5-10	160	373	10					89	209	3			62	8
	10-20	467	389	43	11				37	239				59	3
	20-50	387	211	41	87	42								41	
	50-100	5	5						5						
Midland	5-10	740	381	75										306	70
	10-20	756	391	173	3				13					202	18
	20-50	89	950	96	247	555			1					51	
	50-100		447			447									
Midvale	5-10	119	140	16	5									119	
	10-20	158	123	46	47									30	
	20-50	36	189	24	163	2									
Millendon	5-10	3	10	2										8	2
	10-20	3	1	1											
	20-50	3	4	2					2						
Mount Pleasant	5-10	800	549											549	
	10-20	75													
Orange Grove	5-10	12													
	10-20	28	23		1				4	13				5	1
	20-50	38	99	2	14	75								8	45
	50-100		77			6	71								69

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+ 5 to 10 Events	+ 10 to 20 Events	+ 20 to 50 Events	+ 50 to 100 Events	+ 100 or more Events	- 5 to 10 Events	- 10 to 20 Events	- 20 to 50 Events	- 50 to 100 Events	- 100 or more Events		
Parkerville	5-10	6	10						1		3			6	
	10-20	8	61						5	10	23	19		4	
	20-50	33	31								19	12			
	50-100	60													
Parkwood	5-10	96	238	15	26									197	
	10-20	24	66	44	13									9	
	20-50		14		14										
Queens Park	20-50		264									264			
	50-100	177	546								18	454	74		
	100-200	834	1843								2	938	903		
	200+	1,642													
Red Hill	5-10	4													
	10-20	18													
Redcliffe	5-10	405	140							24	110	6			
	10-20	352	158								141	17			
	20-50	433	203								11	158	34		
	50-100	140	346									28	318		
	100-200	426	22										22		
	200+	67													
Riverton	5-10	338	356											356	
	10-20	573	717	18					66					633	
	20-50	568	395						47					348	
Rivervale	None								656	2,293					
	5-10	862													
	10-20	2,257													
Salter Point	5-10	17	94						14					80	
	10-20	473	630						45					585	
	20-50	412	178											178	
Shelley	5-10	121	158						8					150	
	10-20	157	212						117					95	
	20-50	1,123	1,005						1					1,004	
South Guildford	20-50		195	1					25	48	111	7		3	
	50-100	1,043	841	50	77	32			97	359	38	5		183	
	100-200	344	351		8	110			15	74				144	
South Perth	5-10	333													
Stoneville	5-10	41													
	10-20	15													
	20-50	8													

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	N65 (24-hour) Noise Event Contour	Estimated number of dwellings		Number of dwellings by increase in daily noise events with new runway opening					Number of dwellings by decrease in daily noise events with new runway opening					Dwellings unchanged	Newly affected dwellings
		2025 Without New Runway	2025 With New Runway	+5 to 10 Events	+10 to 20 Events	+20 to 50 Events	+50 to 100 Events	+100 or more Events	-5 to 10 Events	-10 to 20 Events	-20 to 50 Events	-50 to 100 Events	-100 or more Events		
Stratton	5-10	180													
	10-20	401													
	20-50	725													
Swan View	5-10	147	135	22										113	31
	10-20	420	203	103	38									62	
	20-50	806	943	149	766	21			5					2	
	50-100	793	1,323	5	84	50			119	242	775			48	
	100-200	341													
Thornlie	5-10	376	3,098	1,645	277					99	95	25		957	1,604
	10-20	370	1,816	471	498				65	139	247	156		240	190
	20-50	563	107	69							22			16	
	50-100	206													
Upper Swan	5-10	2													
Victoria Park	5-10	3,705													
	10-20	259													
Viveash	10-20	50													
	20-50	330	283		50	20				85	74			54	
	50-100	104	201			201									
Waterford	5-10	21	10											10	
	10-20	419	558						7					551	
	20-50	418	290						18					272	
Wattle Grove	5-10		48	23										25	48
	10-20		118	13	105										118
	20-50		459		111	347	1								459
	50-100		1,265			116	1,149								1,115
Welshpool	20-50		11									11			
	50-100	11													
West Swan	5-10	12													
	10-20	7	13	9	1									3	
	20-50	22	20	1	5					3				11	
	50-100	66	71	1	9	8			13	26	3			11	
	100-200	86	89	3		1			12	33	30			10	
Whiteman	5-10	1	1											1	
Wilson	5-10	22													
	10-20	625	777						81	36				660	
	20-50	2,011	1,881						185	3				1,693	
Woodbridge	10-20	44													
	20-50	300	347		51	72			13	35	79			97	
	50-100	213	211		3	184				5	19				
	100-200	1													

Table 25-18 Estimated number of dwellings per suburb by change in N65 (24-hour) noise events (Continued)

Suburb	Number of dwellings within 2045 N65 day (24-hour) contours							Number of dwellings within 2045 N60 night (11.00 pm to 6.00 am) contours					
	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	200+ Events	Total 24hr	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	Total Night
Applecross	474						**474**	2,120					**2,120**
Ardross								305					**305**
Ascot	206	74	10				**290**	175	98				**273**
Atwell								1,186					**1,186**
Aubin Grove								338					**338**
Aveley	4						**4**	583	184				**767**
Banjup								96					**96**
Baskerville	4	3	7				**14**	11	22				**33**
Bassendean	322	342	465	25			**1,154**	999	562				**1,561**
Beckenham		265	1,193	1,043	634		**3,135**	211	1,825	1,075			**3,111**
Beechboro	1,333	80					**1,413**						
Belhus	25	5					**30**	32	67				**99**
Bellevue				708			**708**			708			**708**
Belmont	741	166	61				**968**	513	77				**590**
Bennett Springs	1,013	449					**1,462**						
Bentley	878	416	34				**1,328**	722					**722**
Boya	16	16	13				**45**	54	77				**131**
Brabham	638	547	272				**1,457**	6					**6**
Bullsbrook	7						**7**	41					**41**
Canning Mills								1					**1**
Canning Vale	1,178	1,195	2,110	1,761			**6,244**	1,719	6,487				**8,206**
Cannington	2	139	809	518	1,213		**2,681**	450	800	1,384			**2,634**
Caversham	87	875	601	187	120	23	**1,893**	554	444	229			**1,227**
Chidlow								22					**22**
Cloverdale	214	355	770	1,427	669		**3,435**	607	1,370	1,450			**3,427**
Como	765	11					**776**	906					**906**
Cullacabardee	22						**22**						
Darlington	39	31	60	12			**142**	58	206	40			**304**
Dayton		135	779	253	9		**1,176**	741	421	12			**1,174**
East Cannington				725	1,332		**2,057**			2,057			**2,057**
Ellenbrook								127					**127**
Ferndale	23	79	506	1,006	233		**1,847**	760	671	416			**1,847**
Forrestdale								2					**2**
Forrestfield	1,284	207	371	139	1		**2,002**	427	660	170			**1,257**
Gidgegannup	2	2					**4**	13	4				**17**
Greenmount		2	31	1,011			**1,044**		16	1,028			**1,044**
Guildford			44	92	116	502	**754**	1	109	644			**754**

Table 25-19 Number of dwellings within 2045 noise event contours, by suburb
Source: Wilkinson Murray

Suburb	Number of dwellings within 2045 N65 day (24-hour) contours							Number of dwellings within 2045 N60 night (11.00 pm to 6.00 am) contours					
	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	200+ Events	Total 24hr	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	Total Night
Hammond Park								804					**804**
Harrisdale	13						**13**	239	118				**357**
Hazelmere	8	10	1	196	94		**309**	9	11	289			**309**
Helena Valley	92	110	244	685			**1,131**	10	574	630			**1,214**
Henley Brook	92	45	56	57			**250**	33	172				**205**
Herne Hill	101	281	116	4			**502**	219	54				**273**
High Wycombe	421	353	691	1,038	1,253	197	**3,953**	400	1,193	2,898			**4,491**
Hovea	6	9					**15**	25	84				**109**
Huntingdale	24						**24**						
Jane Brook								119	168				**287**
Karawara	182						**182**	252					**252**
Karragullen								26					**26**
Kenwick	14	215	592	1,222	33		**2,076**	444	1,544	10			**1,998**
Kewdale	200	204	666	180			**1,250**	925	213	1			**1,139**
Koongamia			8	463			**471**		5	466			**471**
Langford	161	107	189	853	713		**2,023**	106	1,818	237			**2,161**
Lesmurdie	4	1					**5**	5					**5**
Lynwood	112	117	291	578	336		**1,434**	51	982	420			**1,453**
Maddington	237	440	2,381	15			**3,073**	1,205	799				**2,004**
Maida Vale	25						**25**						
Manning	547	736					**1,283**	1,426					**1,426**
Martin	10	18	40				**68**	61	2				**63**
Middle Swan	169	343	332	60			**904**	210	9				**219**
Midland	479	390	870	809			**2,548**	1,392	922				**2,314**
Midvale	137	128	227	21			**513**	2	698	31			**731**
Millendon	6	4	2	2			**14**	15	26				**41**
Mount Helena								97	26				**123**
Mount Pleasant	547						**547**	1,430					**1,430**
Orange Grove			76	123			**199**	7	192				**199**
Parkerville	5	68	32				**105**	73	120	17			**210**
Parkwood	264	93	48				**405**	557	190				**747**
Piara Waters								1,206	109				**1,315**
Queens Park			61	387	2,205		**2,653**		206	2,447			**2,653**
Redcliffe	612	212	206	318	218		**1,566**	398	582	409			**1,389**
Riverton	629	882	176				**1,687**	1,820					**1,820**
Rossmoyne								52					**52**

Table 25-19 Number of dwellings within 2045 noise event contours, by suburb (Continued)

Suburb	Number of dwellings within 2045 N65 day (24-hour) contours							Number of dwellings within 2045 N60 night (11.00 pm to 6.00 am) contours					
	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	200+ Events	Total 24hr	5-10 Events	10-20 Events	20-50 Events	50-100 Events	100-200 Events	Total Night
Salter Point	309	593					**902**	902					**902**
Shelley	291	719	481				**1,491**	1,596					**1,596**
South Guildford				577	683	127	**1,387**		70	1,317			**1,387**
Stoneville								56	154				**210**
Success								586					**586**
Swan View	133	155	711	1,648			**2,647**	147	1,221	1,938			**3,306**
The Vines	170						**170**	915	230				**1,145**
Thornlie	3,471	386	181	10			**4,048**	798	809				**1,607**
Treeby	12						**12**	57	23				**80**
Upper Swan	3						**3**	105	8				**113**
Viveash			35	449			**484**		410	74			**484**
Waterford	34	814	10				**858**	858					**858**
Wattle Grove	48	82	294	844	642		**1,910**	134	1,545	170			**1,849**
Welshpool				11			**11**		11				**11**
West Swan		5	20	37	131		**193**		68	125			**193**
Willetton	5						**5**	15					**15**
Wilson		500	2,158				**2,658**	2,655	3				**2,658**
Woodbridge				500	11		**558**		450	108			**558**
Total	**18,850**	**13,414**	**19,331**	**20,041**	**10,646**	**849**	**83,131**	**36,222**	**29,919**	**20,800**	**0**	**0**	**86,941**

Table 25-19 Number of dwellings within 2045 noise event contours, by suburb (Continued)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26 Hazards and Risks to Airport Operations

This section assesses the hazards and risks to aviation activities as a result of aircraft operations on the new runway.

Detail is also provided on the following areas:

- What hazards and risks are present that may affect aircraft operations on the new runway?
- What action is required to mitigate any identified hazards and/or risks that may affect aircraft operations on the new runway?

26.1 Introduction

The New Runway Project (NRP) will change the way aircraft operate at Perth Airport while also enabling an increase in aviation operations.

A review of the risks posed to aviation activity associated with the operation of the new runway has been completed. The key areas considered were:

- airspace protection,
- communication, navigation and surveillance systems,
- aircraft crash,
- bird and animal strike,
- windshear and turbulence,
- exhaust plumes (high velocity discharge),
- glare,
- hazardous land use surrounding the airport, and
- air traffic management considerations.

Aircraft noise exposure levels and effects on flight paths is covered in Section 22.

26.2 Key Findings

Key findings from the assessment of hazards and risks to aviation activities as a result of aircraft operations on the new runway include:

- No new obstacles have been identified within the protected airspace of the new runway. A declaration of airspace will be updated.
- While the likelihood of an aircraft crash incident will potentially rise with an increase in aircraft operations, overall, the risk of an aircraft crash incident posed by the development of the new runway is as low as reasonably practicable.
- Perth Airport has a comprehensive Wildlife Hazard Management Plan that incorporates monitoring, assessment, reporting, and control methods for bird and animal hazards. Activities include maintaining low grass heights around the airfield and airside areas to deter birds and animals, netting of drainage channels or basins where there is standing water, bird harassment using vehicle lights and horns, cracker shots or live shotgun rounds, and actively removing vegetation around the estate.
- Due to its height and proximity to the estate, the Darling Scarp poses the greatest risk of terrain induced wind shear and turbulence to aircraft operations on the new runway. Modelling shows there is negligible impact due to topography, and turbulence potential on the new runway will be no more severe than that currently encountered at Perth on the existing main runway (03L/21R).
- Some building generated windshear impacts have been identified for the NRP operations.
- There are no existing sources of exhaust plumes of significant vertical velocity (plume rise) that will emanate from ground activities such as vents and stacks, that would pose an unacceptable risk to NRP aircraft operations.
- There are no existing direct light sources that are considered likely to obscure vision or cause confusion and distraction for pilots and air traffic control vision.
- A risk assessment of the hazardous land uses in close proximity to the NRP, found that the BP Fuel Depot in Kewdale and CBH Metro Grain Centre (Grain Silos) in Forrestfield, posed a low risk to the operation of the NRP.
- The reaction time for air traffic controllers to detect movement on the new runway 03R threshold exceeds the upper limit set by the Manual of Standards Part 172. A safety case may be required.

26.3 Policy Context and Legislative Framework

The safety of aircraft and airspace operations is controlled through a large suite of Commonwealth legislation.

The regulatory controls affecting airports and aircraft operations include:

- *Air Navigation Act 1920,*
- Air Navigation Regulations 1947,
- Airports (Building Control) Regulations 1996,
- Airports (Control of On-Airport Activities) Regulations 1997,
- Airports (Environment Protection) Regulations 1997,
- Airports (Protection of Airspace) Regulations 1996,
- *Airports Act 1996*,
- Airports Regulations 1997,
- *Airspace Act 2007*,
- *Aviation Transport Security Act 2004*,
- Aviation Transport Security Regulations 2005,
- *Civil Aviation Act 1988*,
- Civil Aviation Regulations 1988,
- Civil Aviation Safety Regulations 1998,
- Manual of Standards Part 139 – Aerodromes, and
- Manual of Standards Part 172 – Air Traffic Services.

26.4 National Airports Safeguarding Framework – Control of Development in the Vicinity of Airports

The Commonwealth Government recognises that the current and future viability of aviation operations at Australian airports can be impacted by inappropriate developments in areas beyond the airport boundary.

The National Airports Safeguarding Advisory Group (NASAG), comprising high-level Commonwealth, State and Territory transport and planning officials, prepared and released the National Airports Safeguarding Framework (NASF) in July 2012.

The NASF aims to safeguard airports and the communities in their vicinity, and to develop, with State, Territory and Local governments, a national land-use planning regime.

Currently, the NASF is comprised of seven guidance documents:

- Guideline A: Measures for Managing Impacts of Aircraft Noise,
- Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports,
- Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports,
- Guideline D: Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation,
- Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports,
- Guideline F: Managing the Risk of Intrusions into the Protected Airspace of Airports, and
- Guideline G: Protecting Aviation Facilities — Communications, Navigation and Surveillance (CNS).
- Guideline H: Protecting Strategically Important Helicopter Landing Sites.
- Guideline I: Managing the Risk in Public Safety Areas at the Ends of Runways.

Perth Airport believes that the NASF considers a comprehensive range of important safety matters and supports the framework.

As a critical future element of public infrastructure to Western Australia, Perth Airport, including the new runway must be safeguarded against inappropriate land development. Where appropriate, the guidelines mentioned above have been considered in this section.

26.5 Airspace Protection

Protection of airspace required for Perth Airport's current and future needs is essential to provide a safe, predictable environment for the arrivals and departures of aircraft using Perth Airport in all weather conditions.

The Airports (Protection of Airspace) Regulations 1996 (APARs) prescribe airspace around the airports for protection from activities that could pose a hazard to air navigation. These are referred to as controlled activities, and include, but are not limited to:

- construction or erection of any building or other structure that may intrude into prescribed airspace, including construction cranes and equipment,
- an activity that results in artificial or reflected light that exceeds acceptable light intensities or is capable of blinding or confusing pilots,
- an activity that results in air turbulence, and
- an activity that results in the emission of smoke, dust or other particulate matter.

Prescribed airspace comprises the airspace above the lower of two sets of defined invisible surfaces above the ground known as the Obstacle Limitation Surfaces (OLS) and Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS) surfaces.

OLS defines the airspace that should ideally be kept free of obstacles. These surfaces only relate to visual operations or the visual stages of a flight operating under instrument flight navigation. The purpose of the OLS is not to restrict or prohibit all obstacles but to ensure that existing or potential obstacles are examined for their impact on aircraft operations and that their presence is properly taken into account.

PANS-OPS surfaces define the airspace related to aircraft operations that are reliant on instrument navigation. PANS-OPS surfaces are not to be permanently infringed in any circumstance.

The APARs require that details of proposed controlled activities are provided to Perth Airport to be assessed against the OLS and PANS-OPS.

For proposals on the estate, controlled activities are identified and addressed through Perth Airport's development approvals and consent processes.

For proposals off the airport estate, local governments should refer applications for developments or structures that may constitute a controlled activity to Perth Airport for assessment.

Buildings and structures comprise the majority of potential controlled activity, as well as erection and operation of construction cranes, that need assessment. Perth Airport has prepared Structure Height Control Contour plans that indicate the height at which a building or structure triggers the need for a referral to Perth Airport for assessment. There are areas identified immediately adjacent to the airport, and particularly in the final approach and take-off areas, where the airport requires all development and structures to be referred for assessment.

Any controlled activity that is found to infringe the prescribed airspace is referred to Airservices and the Civil Aviation Safety Authority (CASA) for review before being submitted to the Department of Infrastructure, Transport, Regional Development and Communications.

Conditions may be imposed on an approval which will be monitored by Perth Airport, with any breach reported, and rectification required. Developments and structures of a short-term basis (up to three months), typically cranes, may be approved by Perth Airport following consultation with Airservices and CASA.

Perth Airport will not approve any proposal where the activity will affect the safety and efficiency of aircraft operations at Perth Airport.

Perth Airport will follow the Processing Applications under the Airports (Protection of Airspace) Regulations 1996 Guidelines for Operations of Federal Airports published by the then Commonwealth Department of Infrastructure and Transport.

Perth Airport assesses proposed short-term controlled activities against the OLS and PANS-OPS to ensure day to day operations are not impacted by an infringement. Perth Airport also uses the OLS and PANS-OPS to safeguard the new runway, and its associated airspace, against any proposed long-term or permanent development which could also cause an infringement.

In 2001, Perth Airport declared the prescribed airspace including the new runway at 2,700 metres long. Following the approval of the Master Plan 2014 Minor Variation, which altered the runway length from 2,700 to 3,000 metres, Perth Airport has commenced the process of updating the prescribed airspace and declaration in accordance with Part 2 of the APARs. Perth Airport will ensure notice is issued as per the APARs and new prescribed airspace charts are published.

The long-term OLS for Perth Airport is shown in Figure 26-1. The long-term critical PANS-OPS surface for Perth Airport is shown in Figure 26-2. Both Figures 26-1 and 26-2 consider the NRP, and have done so for some time.

Perth Airport completed an assessment to determine if there are any new obstacles within the new runway's OLS and PANS-OPS, considering the 3,000 metre length. No infringements, other than those already identified and lit accordingly for current day operations, were found.

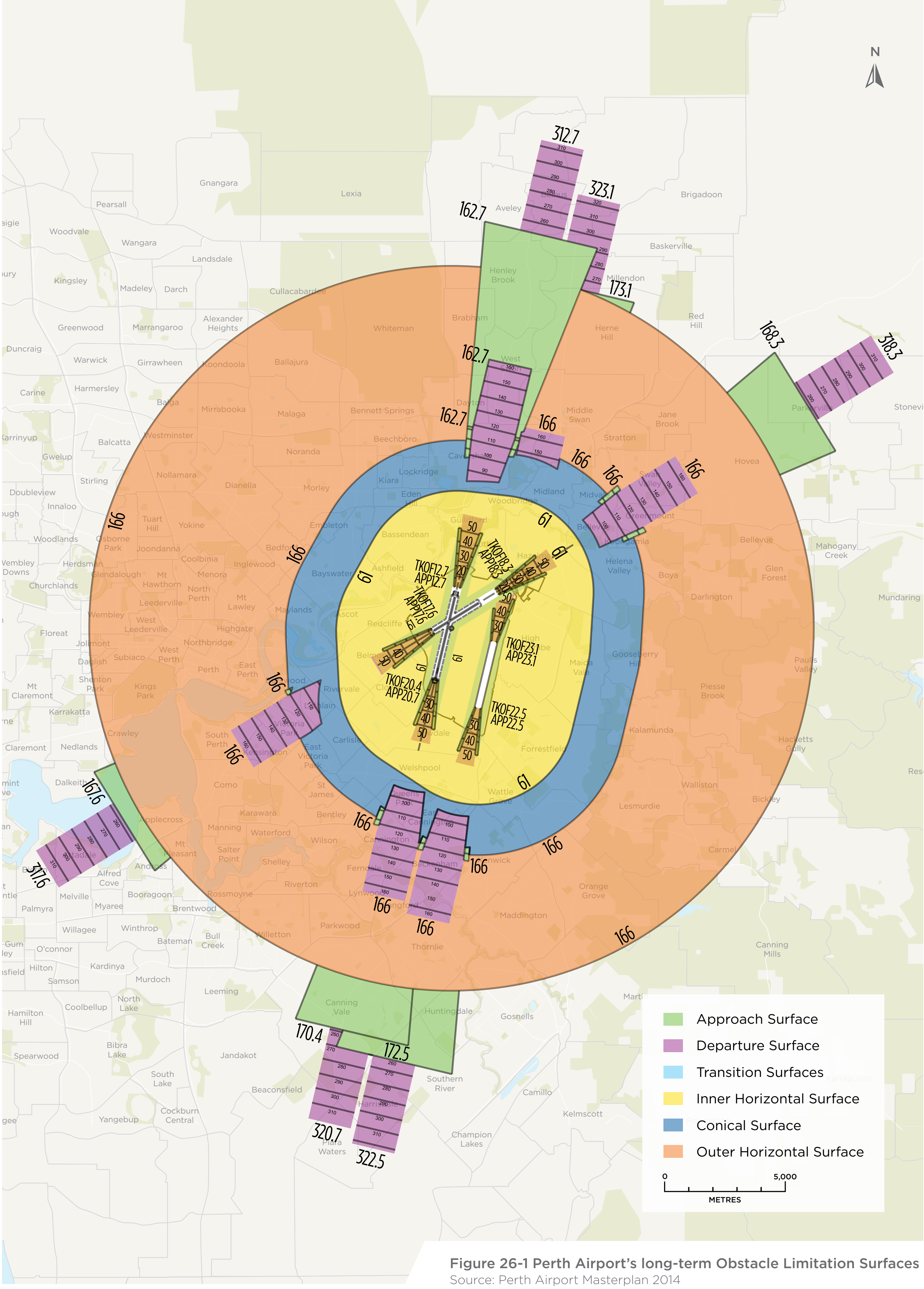

Figure 26-1 Perth Airport's long-term Obstacle Limitation Surfaces
Source: Perth Airport Masterplan 2014

Figure 26-2 Perth Airport's long-term Procedures for Air Navigation Services – Aircraft Operations
Source: Perth Airport Masterplan 2014

26.6 Communications, Navigation and Surveillance Systems

There are a number of communication, navigation and surveillance systems that are critical to the safe and efficient operation of aircraft. Airservices typically installs and maintains these systems at Perth Airport. Such systems required for the NRP, or are currently in operation at Perth Airport, include:

- Instrument Landing System (ILS) (localiser/ glideslope),
- VHF Omnidirectional Range (VOR) / Distance Measuring Equipment (DME),
- microwave link path, and
- terminal area radar.

Objects such as aircraft, buildings, vehicles and other facilities emitting electromagnetic energy can interfere with these systems.

Development and construction proposals on the airport estate, or referred to Perth Airport by surrounding Local governments, are assessed in consultation with Airservices to ensure the performance of such facilities remains acceptable and that current and future anticipated systems are suitably protected in accordance with Civil Aviation Safety Regulations 1988 (CASR) Part 139 and CASR Part 171.

This involves the protection of land for equipment installations (including protection for required services such as a fibre optic communication systems) and any potential airspace required for its operation.

The NRP may include the installation of new communication, navigation and surveillance infrastructure such as an ILS, for each runway end, and additional Advanced Surface Movement Guidance and Control System surveillance equipment. Perth Airport will continue to work with Airservices to identify appropriate sites for the new infrastructure and ensure these are suitably protected now and into the future.

26.7 Aircraft Crash

Perth Airport has never had a fatal aircraft crash involving Regular Public Transport (RPT), charter or general aviation aircraft operating passenger carrying services. There has also never been a fatality involving high capacity commercial aircraft types, similar to those that operate at Perth Airport, in Australia.

According to the aircraft manufacturing company Boeing, commercial aircraft accidents involving fatalities are an infrequent occurrence within Australia and across the globe, with the rate at which fatal accidents happen steadily declining for the past 40 years. The Boeing Company produces a statistical summary of commercial jet airplane accidents every year which shows a decline in fatal aircraft accidents. Figure 26-3 provides a summary of commercial jet aircraft operations specific to the United States, Canada and the rest of the world combined between 1959 and 2016 and indicates that over the 57 years of investigation, the annual fatal accident rate has reduced from 40 (1959) to 0.25 (2016) per million departures.

Figure 26-4 shows the percentage of fatal accidents by stage of flight. Approximately 30 per cent of fatal accidents occur at take-off or landing with another 30 per cent occurring during initial climb or final approach.

International Civil Aviation Organization (ICAO) studies and design manuals suggest that most aircraft crashes occur within 1,000 metres of landing and 500 meters of take-off. Safety areas, located off the ends of the runways (on and off airport), have been used overseas and in other Australian states for several years to minimise the risk of damage by an aircraft during landing or take-off. The NASAG recently published Guideline I: Managing the Risk in Public Safety Areas at The Ends of Runways. The guideline provides an outline of Public Safety Areas (PSA), the suggested methodologies for developing them and their intended application with regard to development on and off airports. Off-airport, land use zoning falls within the jurisdiction of the State Government however to date the guideline has not been incorporated in any planning policy. On-airport, issues related to crash risk are considered by Perth Airport in the approval process when assessing a proposed development.

A PSA is an area of land at the ends of the runways, identified by quantifiable risk contours, within which development is restricted in order to control the number of people on the ground at risk of death or injury in the event of an aircraft accident on take-off or landing. PSA risk contours are developed based on runway use statistics correlated against international crash data, and provide an objective basis for precautionary planning decisions in those areas of highest risk.

Perth Airport has adopted the United Kingdom approach to PSAs, as detailed within Guideline I to assist with assessing appropriate developments.

Under the UK methodology, the PSA is generally broken into two areas representing the following probabilities of being killed or injured per year from an aircraft accident: 1-in-10,000 and 1-in-100,000. Although the boundary of a PSA generally corresponds with the 1-in-100,000 contours, the predicted level of risk within this area may be higher. The model considers the maximum tolerable level of individual third-party risk of being killed as a result of an aircraft accident as 1-in-10,000 per year. Any occupied residential properties or commercial and industrial properties occupied as normal all-day workplaces, within the 1-in-10,000 are not recommended.

In the remaining PSA area between the 1-in-10,000 and 1-in-100,000 individual risk contours, developments which involve a low density of people living, working or congregating is considered acceptable. For example, this may include car parking, open storage or certain types of warehouse development. According to Guideline I, new residential buildings should not be permitted within this area of the PSA, however existing developments may remain.

Perth Airport has developed PSA contours that reflect the ultimate development and demand of the airport at 475,000 movements per year of which the 1-in-10,000 and 1-in-100,000 areas are shown in Figure 26-5.

As Figure 26-5 shows, the 1-in-10,000 contours for the NRP are retained within the airport boundary and therefore developments within this area can be controlled by Perth Airport. The 1-in-100,000 risk contours extend out of the airport boundary to the north and south, however current land uses within these areas align with the guideline.

An assessment of the Air BP fuel depot outside of the estate was completed, including its proposed future expansion plans. The current fuel depot is outside of the 1-in-10,000 contour but partially within the 1-in-100,000 contour. The assessment concluded, based on the guideline, that as the depot was an existing development, the majority of which was light industrial, it may be retained and apportioned it a low level of risk. The proposed extension, which adds three new fuel tanks, is outside of the 1-in-100,00 contour and as it is not expected to require an increase in the number of persons working at the depot it was not considered an incompatible use, although Perth Airport did object to the development as part of the Local Government approval process.

While the likelihood of an aircraft crash incident will potentially rise with an increase in aircraft operations, overall, the risk of an aircraft crash incident posed by the development of the new runway is as low as reasonably practicable.

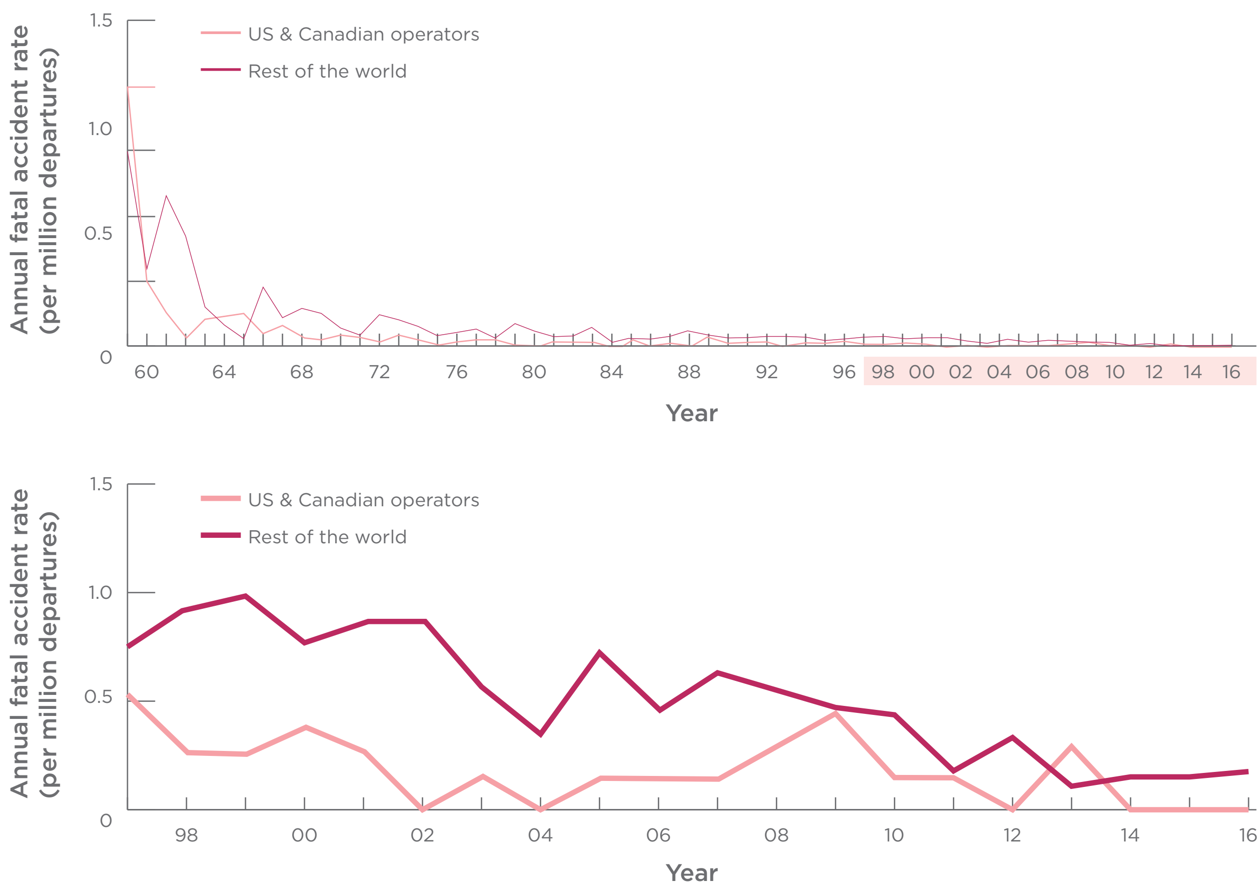

Figure 26-3 Fatal accident rate, global jet fleet,between 1959 and 2016
Source: Boeing Company 2017

	Taxi, load/ unload, parked, tow	Takeoff	Initial Climb	Climb (flaps up)	Cruise	Descent	Initial Approach	Final Approach	Landing
		13%						48%	
Fatal accidents	10%	6%	6%	6%	11%	3%	8%	24%	24%
Onboard fatalities	0%	6%	1%	7%	22%	3%	16%	26%	20%
		6%				Initial approach fix	Final approach fix	46%	
Exposure (Percentage of flight time estimated for a 1.5-hour flight)		1%	1%	14%	57%	11%	12%	3%	1%

Figure 26-4 Percentage of fatal accidents by stage of flight
Source: Boeing Company 2017

Note: Percentages may not sum to 100% due to numerical rounding.

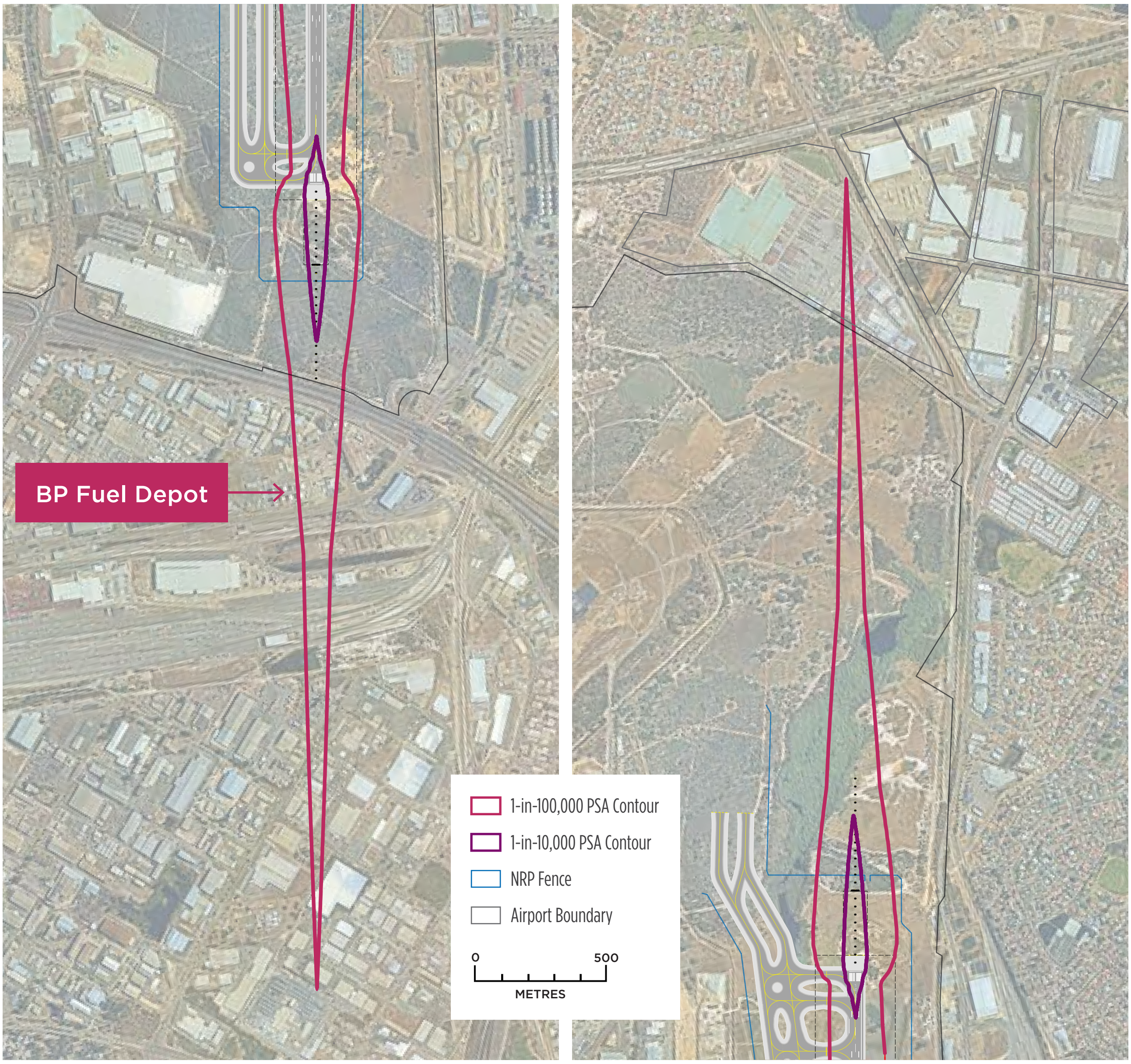

Figure 26-5 New runway public safety area – ultimate capacity
Source: Perth Airport

26.8 Bird and Animal Strike

Wildlife around aerodromes can present serious hazards to aircraft operations. The most obvious of these is the presence of birds, but other animals can also present a hazard. This section outlines Perth Airport's approach to identifying and managing the risk birds and animals pose to aircraft. This review has concentrated on bird activity at Perth Airport as, in terms of wildlife, it represents the greatest risk to aircraft using the new runway.

Although bird strikes have a very low probability of causing aircraft accidents, Perth Airport and the aviation industry take this risk very seriously. All strikes are reported to the Australian Transport Safety Bureau (ATSB).

Due to the mitigation undertaken such as removal of habitat and management plans that are in place, the most probable consequence of an aircraft striking a bird or other wildlife includes damage to aircraft and inconvenience to the travelling public.

The likelihood of aircraft damage incidents resulting from bird strike is affected by:

- time of day and year,
- bird species, types, sizes and their behaviours,
- the phase of aircraft operation at the airport,
- presence of habitats and attractants, and
- monitoring and control measures.

ATSB reporting shows the majority of strikes in Australia occur between 7.30 am and 10.30 am, with a smaller peak between 6.00 pm and 8.00 pm. For Perth Airport, data indicates there is a higher likelihood of a bird strike in the morning between 6.00 am and 8.00 am and a smaller peak between 6.00 pm and 9.00 pm as shown in Figure 26-6. This is generally in line with ATSB nationwide reporting and reflects two distinct peaks over a day.

The periods of increased bird strike activity at Perth Airport coincide with the morning departure peak and evening arrivals peak.

In addition to daily variation, data shows that the likelihood of a bird strike can vary over the year. Analysis of bird strike incident data compiled by the ATSB indicates that there are higher bird strike rates at Perth Airport in January, September, and December, as shown in Figure 26-7.

The ATSB statistics indicate that bird strikes have a higher likelihood of occurring within, or in close proximity to an airport, with the majority of strikes occurring during approach, landing, take-off and initial climb (when the aircraft is at lower heights). ATSB data for the period 2006 to 2015 shows bird strikes reported during landing were most common for all fixed-wing aircraft (39 per cent), followed by take-off (33 per cent), approach (19 per cent) and initial climb (six per cent).

In the six-year period May 2011 to August 2017, there were 536 wildlife incidents recorded by Perth Airport. Of these, 205 were confirmed bird strikes which means that evidence was found of the strike, other reported incidents may be near misses where a pilot has seen a bird fly towards an aircraft but on inspection no evidence was found of an actual strike. The birds which cause the most bird strike incidents at Perth Airport are kestrels (16.1 per cent) and duck species (17.1 per cent). For approximately 15 per cent of confirmed bird strike incidents, the species of bird could not be identified. This is likely to occur when a bird strike has been witnessed, however, evidence has been removed (either in-flight or during cleaning), minor damage to an aircraft is observed but no evidence of wildlife is found, DNA testing is inconclusive, or if only part of a bird carcass has been found. There has been a rise in black cockatoo strikes in recent years (5.4 per cent). Perth Airport recorded its first strike of a black cockatoo in 2014 and then another 10 strikes have occurred. This number may also be higher than indicated, as it can be difficult to identify the number of birds involved in a strike.

Species	Incidents	Percentage of Total
Nankeen Kestrel	33	16.1
Unknown	31	15.1
Australian Wood duck	24	11.7
Galah	15	7.3
Welcome Swallow	14	6.8
Pacific Black Duck	11	5.4
Black Cockatoo	11	5.4
Owl	10	4.9
Other (various species)	56	27.3
Total	**205**	**100**

Table 26-1 Bird strike incidents by significant species – May 2011 to August 2017
Source: Perth Airport

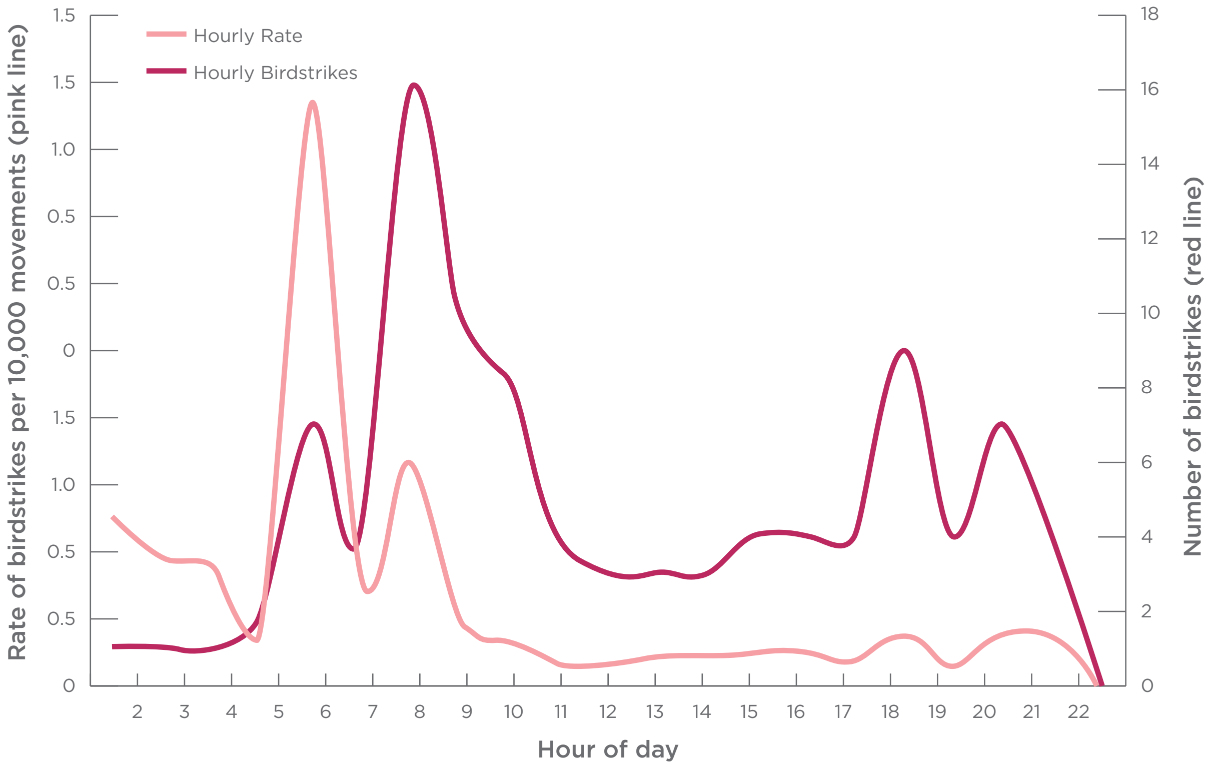

Figure 26-6 Total hourly bird strike counts and rates per 10,000 movements for 2014 – 2015
Source: Australian Transport Safety Bureau

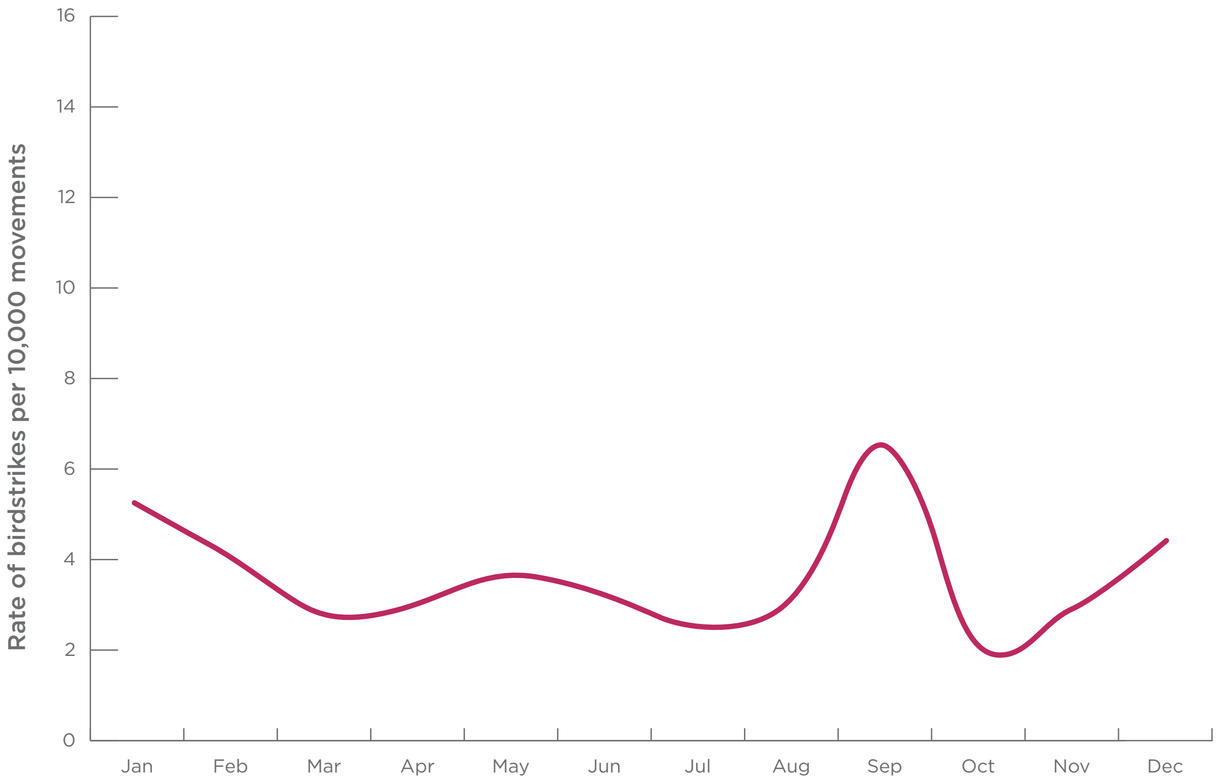

Figure 26-7 Monthly bird strike rates for Perth Airport for 2006-2015
Source: Australian Transport Safety Bureau

26.8.1 Habitat and Attractants

Birds are attracted to airports for numerous reasons. The large, open grassed areas found on an airport provide perfect feeding, resting and nesting areas. Short grass provides protection against predators such as snakes, cats and foxes. However, short grass also attracts predatory birds like raptors (kestrels are a common species at Perth Airport) in search of rodents and other food sources. Water, lying in wetlands or drainage channels and basins on the airport, attracts waterfowl such as ibis and ducks. Large open hangars and other flat roofed buildings typically associated with airports can also provide excellent nesting areas.

A number of habitat areas and attractants for birds and other fauna have been identified in the airport vicinity which are listed in Table 26-2. Some are within the estate, while others are up to 16 kilometres from the airport.

The key bird and fauna habitats or attractants that are also likely to affect operations from the new runway include:

- Munday Swamp, and
- CBH Metro Grain Centre.

Munday Swamp is located approximately 775 metres to the north of the new runway and aircraft will overfly the swamp on departure from runway 03R or arriving on runway 21L. Munday Swamp is an identified habitat for wetland birds such as ducks (a species with a high likelihood of a bird strike incident). Additionally, ibis are known to use Munday Swamp as a nesting ground, with active management of the population undertaken since 2014. Although Ibis are known to nest in Munday Swamp they do not currently account for significant incidents of bird strikes at Perth Airport.

CBH Metro Grain Centre is located on Abernethy Road, in Forrestfield; approximately 400 metres from the estate boundary and 700 metres from the new runway. Grains that have fallen loose during loading, unloading, and transport at CBH are an attractant for ducks that visit the site primarily during night hours. Surveys have shown that some ducks fly to CBH from the north-west, overflying across the estate.

Additionally, development of the NRP will require the construction of new drainage channels and basins in the areas adjacent to the runway. The short grass in the airside areas and standing water in the drainage system will act as an attractant for birds and potentially other fauna similar to existing areas of the airfield.

26.8.2 Bird and Animal Hazard Management

Under Manual of Standards (MOS) Part 139, Perth Airport is required to control the risk of wildlife striking operating aircraft. Perth Airport has a comprehensive Wildlife Hazard Management Plan that incorporates monitoring, assessment, reporting, and control methods for bird and animal hazards. CASA regulates and conducts surveillance and ensures that the risk of wildlife striking aircraft at Perth Airport is being adequately managed.

To minimise the likelihood of a bird strike, Perth Airport implements a number of bird control techniques such as:

- monitoring of bird activity by Airport Operations Officers, particularly during the three hours after sunrise which has been identified as the time with the highest bird activity,
- reducing the amount of water lying on the airport grounds to avoid attracting ducks etc.,
- maintaining the grass at a length which deters birds,
- actively removing vegetation around the estate,
- minimising available food, and
- bird harassment using vehicle lights, horns and cracker shots.

Perth Airport also manages vegetation and open waterways across the estate to minimise the attraction of bird species that may pose a risk to aircraft safety. This includes maintaining low grass heights around the airfield and airside areas for deterrence, and the netting of all major drainage channels or basins airside.

Regular checks are carried out by the Airport Operations Officers to ensure that any carrion or litter airside is removed. Landscaping around the airport is continually under review to ensure that there is no unnecessary congregation of birds or other fauna. Actions include:

- monitoring the activity of birds and other fauna in the existing landscaped areas and, if necessary, making modifications to reduce the attractiveness of these areas, and
- designing landscaping and selecting species to avoid attraction of birds and other fauna.

Perth Airport maintains contact with the State and Local planning authorities about the possibility of conflicting land uses or changing waste disposal strategies such as landfills (for ibis & pelican feeding potential). Perth Airport also monitors any movements from off-site sources of attraction such as landfills that may cause birds to pass or roost in the vicinity of the airport (e.g. ibis).

Safe airfield operations are paramount to ensure the travelling public are not put at risk and Perth Airport recognises that allowing bird habitats adjacent to airfield infrastructure is undesirable.

To minimise this risk and in accordance with our environmental commitments, Perth Airport will seek to identify suitable offsite offsets for habitats which need to be removed for safety reasons.

Aviation safety regulations do not address the risk of bird strikes that occur outside the estate in the same way as they address on-airport risks. The NASF includes guidelines for managing the risk of wildlife strikes in the vicinity of airports, produced to inform State and Local governments. Perth Airport works with these planning authorities to monitor off airport activities that may have an impact on the risk of birds striking an aircraft.

Location	Habitat or Attractant	Comments
Within the estate		
Open water ways within the estate (various locations)	Attractant – water	Bird species, particularly ducks, moving between water bodies, nesting locations or other food sources may fly through arrival and departure flight paths. Ducks and other wetland species have a tendency to flock, particularly if startled.
Munday Swamp (northern end of the new runway)	Habitat for wetland birds (e.g. ducks) and Quenda	
Remnant native vegetation	Habitat for a range of bird species and Quenda.	Fauna moving between these areas will cross the new runway and arrival and departure flight paths.
Grassed areas around runways	Hunting grounds for raptors (e.g. Nankeen Kestrel)	Grassed areas represent good hunting grounds for raptor species. While in the air above these areas, raptors may be directly within the arrival and departure paths of aircraft.
Within 16 kilometres of the Airport		
Drainage basins along Abernathy Road (various locations)	Attractant – water source	Bird species, particularly ducks, moving between water bodies may fly through arrival and departure flight paths. Ducks and other wetland species using drainage basins below or adjacent to flight paths have a tendency to flock, particularly if startled.
Co-Operative Bulk Handling (CBH) Metro Grain Centre and Quaker Oats Distribution Centre (less than one kilometre south east of the new runway)	Food source (spilled grain)	Facilities operators currently implement strategies to deter bird activity as part of grain contamination and disease control requirements.
Swan Canning Riverpark (8.5 kilometres to the south),	Habitat for numerous bird species	Movement of bird species between the Riverpark and habitats within and around Perth Airport (such as wetlands and drainage basins) may result in birds flying though aircraft arrival and departure flight paths.
Tomato Lake Reserve (Kewdale) and various drainage basins (3.3 kilometres to the south west)	Habitat for numerous bird species	Movement of bird species between the Tomato Lake Reserve/drainage basins, and habitats within/around Perth Airport may result in birds flying though aircraft arrival/departure flight paths.
Known black cockatoo night roosts at Lathlain Park, Raphael Park and Curtin University (4.5 and six kilometres to the south west)	Black Cockatoo habitat	Black cockatoos travelling between night roosts and foraging habitat may fly across the new runway and arrivals and departure flight paths.
Remnant native vegetation along Darling Range (five kilometres to the east)	Habitat for raptors, black cockatoos and other terrestrial bird species	Movement of bird species between the Darling Range and remnant native vegetation within/around Perth Airport may result in birds flying though aircraft arrival/departure flight paths.
Red Hill Waste Management Facility (16 kilometres to the northeast)	Food source for pelicans and ibis	Recently has been identified by Perth Airport as a source of pelican activity at the airport.

Table 26-2 Fauna habitats and attractants within 16 kilometres of Perth Airport
Source: Jacobs

The NRP will result in an increased grass area and drainage channels with similar bird hazards to the existing area. This will not necessarily increase the bird strike rate, which is defined as the number of strikes per 10,000 movements, because control techniques similar to those currently in place will also be applied.

As part of the wider Wildlife Hazard Management Plan, Perth Airport has developed an Ibis Management Strategy with active management measures employed in Munday Swamp annually since 2014. Active management of Ibis in Munday Swamp has included:

- surveying,
- removal of nests and eggs (when no chicks are present),
- adult harassment, and
- adult ethical cull, to sustainable numbers, permitted by the State Department of Biodiversity, Conservation and Attractions (considered a last resort and used only when required).

Perth Airport will continue active management of birds, including Ibis, within Munday Swamp to reduce risk.

Perth Airport has been conducting audits of CBH Metro Grain Centre for the past ten years, and has been working with the facility to ensure they minimise the attraction of birds, especially ducks, to mitigate potential strike risk. Perth Airport will continue to work with CBH to minimise the site's attractiveness to birds and develop a Duck Management Strategy.

Overall, provided the ongoing application of the management of bird hazards on and around Perth Airport continues, the risk of aircraft crash incidents as a result of bird strikes with the NRP operation should be considered as low as reasonably practicable and thus broadly acceptable.

26.9 Windshear and Turbulence

The risk of windshear (a change of wind speed or direction over a relatively short distance) created from a large building or terrain in the vicinity of a runway is a critical consideration for safe airport operations. Windshear poses the greatest risk on approach, landing and take-off when an aircraft's speed is low and the pilot's ability to respond is more limited.

26.9.1 Buildings

Building generated windshear becomes critical to safety when a significant obstacle, such as a building, is located in the path of a cross-wind to an operational runway. In such circumstances, wind flow will be diverted around and over the building, causing the cross-wind speed to vary along the runway. In accordance with NASF guidelines, Perth Airport considers the risk of building generated windshear, and turbulence for buildings located:

- 1,200 metres or closer perpendicular to the runway centreline,
- 900 metres or closer in front of runway threshold, and
- 500 metres or closer from the runway threshold along the runway.

Guidelines for considering the risk from building induced turbulence or wind shear is provided in NASF Guideline B - Managing the Risk of Building Generated Windshear and Turbulence. Guideline B was reviewed in 2016 and updated to provide greater clarification and reflect the latest research and methodology for assessing buildings. A draft of the revised Guideline B has only recently been published, therefore Perth Airport initially assessed the potential impact that existing buildings could have on aircraft operations from the new runway using the current Guideline B methodology. Perth Airport is currently undertaking further assessments in line with the revised guidelines.

Guideline B does not attempt to regulate the assessment process or mitigation of risks but rather provide a framework for preliminary assessment of individual risks so that they can be either discounted or made the subject of more detailed analysis.

Building Name	On/Off the Airport Estate	Height (metres)	Height of 1:35 surface at nearest edge to runway centreline (metres)	Action
Woolworths Regional Distribution Centre	On-estate	17.4	10	Further assessment currently underway, detailed below.
Patricks Autocare Processing Facility	On-estate	10.25	4	Within the NRP area, to be removed for new runway.
CBH Forrestfield	Off-estate	20-30*	22	Preliminary detailed assessment underway to determine what further action is required. Physical modelling in wind tunnel is being considered and will be conducted if recommended.
Warehouse 995-1021 Abernethy Rd	Off-estate	9-12	8.5-11	All three buildings have been surveyed for precise height and location data so models can be prepared for physical modelling in wind tunnel.

Table 26-3 Buildings within the 1:35 surface for the new runway
Source: Jacobs; Perth Airport

*CBH Forrestfield is a grain silo facility that consists of large cylindrical silos with overhanging feeder belts. Its shape is more complex than a standard polygonal warehouse.

Guideline B outlines a staged process for the assessment of buildings and obstacles near airports with regards to building generated windshear and turbulence. Firstly, Guideline B defines an area based on distances from the extended runway centreline and runway ends within which buildings and other obstacles are considered to pose a safety risk in terms of windshear and turbulence. This area is referred to as the 'zone of influence'.

The second stage of assessment is to test the 1:35 rule against single buildings or obstacles within the 'zone of influence'. The 1:35 rule proposes that buildings with a perpendicular distance to a runway centreline that is less than 35 times the height of the building should be further assessed and that aerodynamic modelling may be required. The rule is noted as being very conservative and any building that passes the 1:35 rule test is considered not to create unsafe wind effects.

The potential risk of building induced wind shear and/or turbulence posed by existing buildings to aircraft operations on the new runway 03R/21L has been assessed.

The assessment, detailed in Table 26-3, found that only the Woolworths Regional Distribution Centre (WRDC), adjacent to Horrie Miller Drive, and a handful of buildings external to the estate were within the defined zone of influence.

Buildings in High Wycombe and Kewdale which fall within the 'zone of influence' are shielded from the runway centrelines by surrounding topography.

Perth Airport commissioned a wind engineer to conduct quantitative modelling of the WRDC and other identified infringements. Scale models were placed in a wind tunnel and the windshear and turbulence generated in the wake of the buildings was measured along a 3 degrees glidepath to the threshold. By measuring to the threshold rather than the touchdown point, areas traversed by aircraft that approach below the usual flight path of landing aircraft are covered. The wind speed required for the windshear and turbulence criteria from NASF Guideline B to be exceeded were determined. Points lateral to the runway centreline in the wake of the subject buildings were also tested so the attenuation of windshear and turbulence effects with distance could be understood.

26.9.1.1 Turbulence

To ascertain the attenuation of the turbulence and windshear effects generated by the subject structures with increasing distance from the site, testing of individual locations downwind of the subject structures was conducted at varying lateral distances from the runway centreline. These locations were immediately downwind of the corner of the subject structures in an area most prone to wind shear effects caused by the structures. The results indicate that turbulence effects caused by the structures decrease significantly with increasing distance from the structures. While the wind speeds required to exceed the criteria in Guideline B with and without the subject buildings was found to be different in the immediate wake of the buildings, by the time the wind flow had reached the runway centreline virtually no difference could be detected (CPP 2018a, CPP 2018b, CPP 2018c).

The gust wind speeds required to exceed the turbulence criterion are higher than the standard 20 knot cross-wind operational limit wind speed at all heights and for all tested wind directions. The turbulence in the wind tunnel was measured without the subject buildings in place and, in all cases, similar results were observed. This demonstrated that along the glide slope the natural turbulence in the wind is dominant over what is generated in the wake of the subject structures (CPP 2018a, CPP 2018b, CPP 2018c). As such, the level of turbulence even with the subject structures present would be regularly experienced on the existing runway. The level of safety achieved for the current runway 03L/21R could be expected to be replicated on the new runway.

26.9.1.2 Windshear

Perth Airport obtained more than 14 years of half-hourly weather observations (more than 263,000 individual observations) for the development of this MDP. This data was interrogated to ascertain with what frequency the wind speeds required to exceed the criteria in Guideline B have been observed. To ensure the frequency determined from this interrogation has a suitable tolerance, observations of wind from directions 22.5 degrees either side of the critical wind direction were included.

For the warehouses at 995-1021 Abernethy Rd the critical (worst case) wind direction of 112.5 degrees was tested. Wind from this direction would have to exceed 63 knots for the criteria in Guideline B to be exceeded. A secondary wind direction of 135 degrees was also tested and the required wind speed of 84 knots determined(CPP 2018a). There are no records within our weather data of winds between 90 degrees and 135 degrees in excess of 63 knots. Hence, the wind conditions required for building-generated windshear from these warehouses to exceed the Guideline have not been observed within the sourced weather data.

For the CBH Forrestfield facility the critical (worst case) wind direction of 90 degrees was tested. Wind from this direction would have to exceed 71 knots for the criteria in Guideline B to be exceeded. A secondary wind direction of 67.5 degrees was also tested and the required wind speed of 95 knots determined (CPP 2018b). There are no records within our weather data of winds between 67.5 degrees and 112.5 degrees in excess of 71 knots. Hence, the wind conditions required for building-generated windshear from the CBH Forrestfield facility to exceed the Guideline have not been observed within the sourced weather data.

For the WRDC the critical (worst case) wind direction of 292.5 degrees was tested. Wind from this direction would have to exceed 37 knots for the criteria in Guideline B to be exceeded. A secondary wind

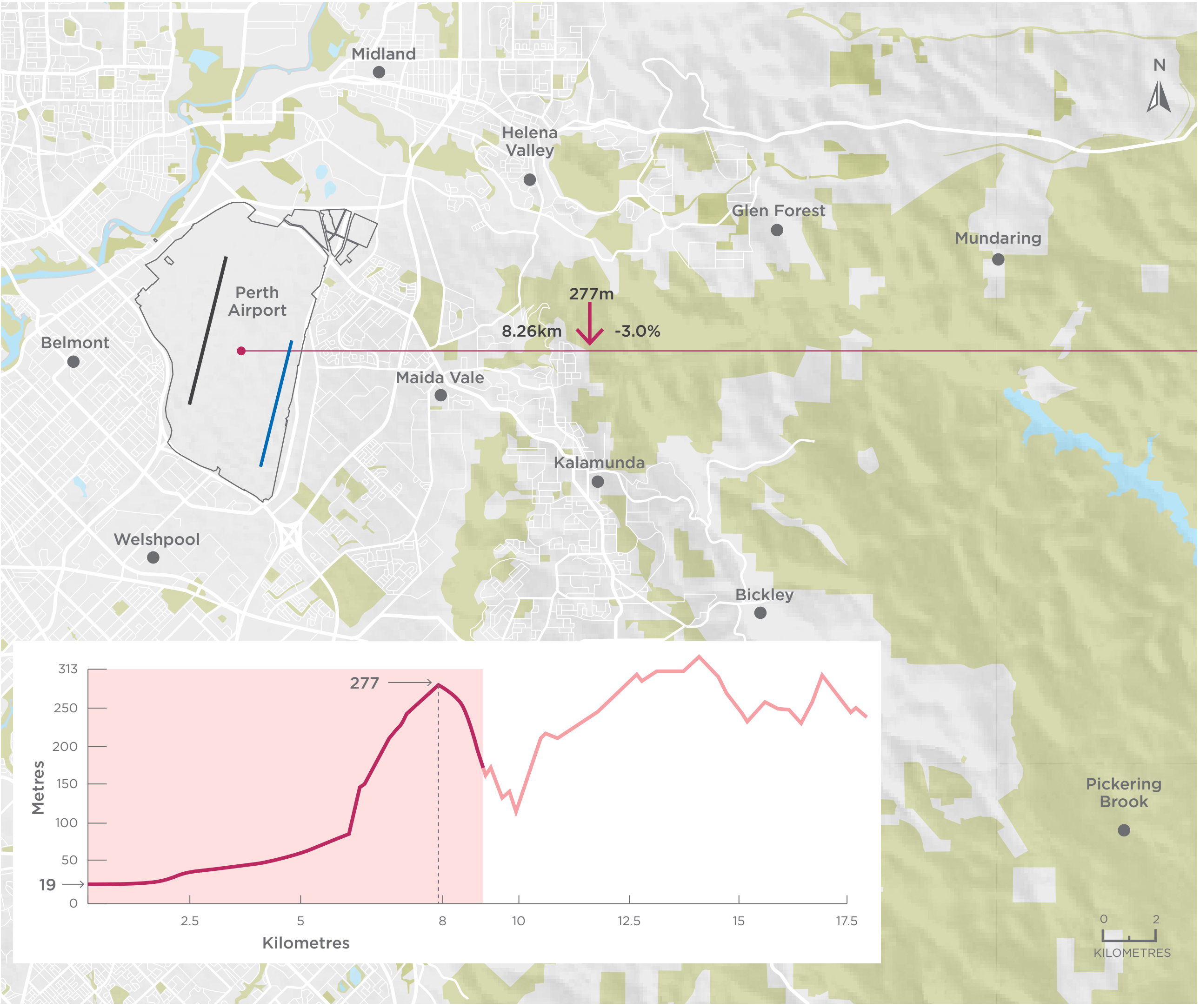

Figure 26-8 Aerial view showing the new runway and topography along an east-west section
Source: Google Earth, 2016

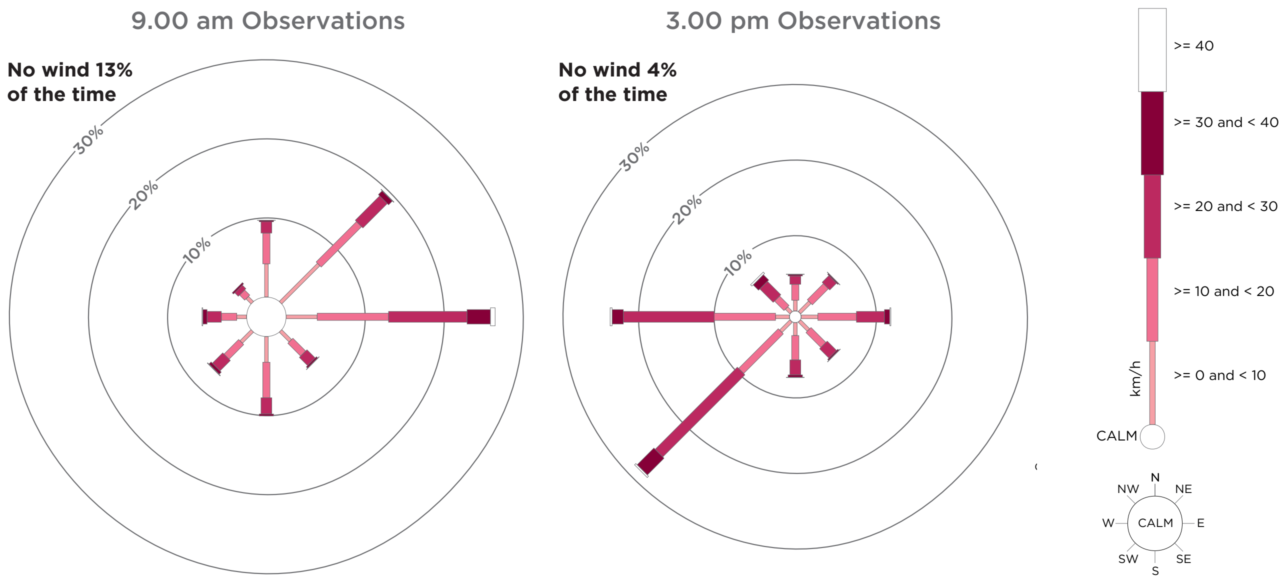

Figure 26-9 Wind rose for Perth Airport
Source: Bureau of Meteorology

direction of 315 degrees was also tested and the required wind speed of 32 knots determined (CPP 2018c). Because these wind speeds are quite close, the tolerance for interrogation of weather data was broadened from 45 degrees to 67.5 degrees (22.5 degrees either side of the two wind directions and the arc in between). There are almost 800 records within our weather data of winds between 270 degrees and 337.5 degrees in excess of 32 knots. This is the equivalent of the criteria in Guideline B being exceeded 0.3% of the time.

Perth Airport will consult with airlines and Airservices Australia on the effect of building-generated windshear on the new runway and the frequency of conditions in which the criteria in Guideline B are exceeded.

While there are currently no further significant building generated windshear impacts identified, it is important to safeguard the new runway from any future developments. Perth Airport will continue to assess developments in the vicinity of the new runway in accordance with the NASF Guideline B.

26.9.2 Terrain

Perth Airport is located on the Swan Coastal Plain approximately eight kilometres west of the Darling Ranges. In the vicinity of Perth Airport, the range rises to heights of approximately 950 feet, as shown in Figure 26-8. Due to its height and proximity to the estate, the Darling Scarp would pose the greatest risk of terrain induced wind shear and turbulence to aircraft operations on the new runway.

To be affected, winds would need to be coming from the east over the Darling Range, before reaching Perth Airport. Winds from the east quadrant are the prevailing winds for the majority of morning observations at Perth Airport, refer to Figure 26-9.

An assessment of the potential risk, with regards to turbulence and wind shear, that terrain in the vicinity of Perth Airport could pose to aircraft operations from the new runway (03R/21L) was undertaken using the Engineering Sciences Data Unit 01008 computer program to model wind speeds and turbulence properties (Cermak, Peterka, Petersen 2016).

The effect of the topography was assessed by comparing the profiles of wind speed and turbulence intensity for Perth Airport, including surrounding buildings and surface roughness, for two scenarios. The first being with an assumed flat terrain and the second with an upstream hill. A single ridge representative of the western part of Kalamunda National Park was considered the most conservative representation for the upstream hill at the airport for a desktop study.

The wind speed profiles and turbulence intensity resulting from the assessment of standard atmospheric boundary layer flows show no significant difference in the wind characteristics resulting from the presence of the hills five kilometres east of the estate, refer to Figure 26-10. This indicates that the local topography appears to have a negligible impact on the wind conditions for arriving aircraft.

While the modelling shows there is negligible impact due to topography, it is generally acknowledged that there is turbulence experienced below 3,000 feet at Perth Airport during the summer months when there is a strong easterly wind gradient. This is notified to pilots via an entry in the aeronautical information publication En-Route Supplement Australia (ERSA). ERSA contains information for pilots operating at the airport. By showing negligible impact, the study confirms that the turbulence experienced on the new runway will be no more severe than that currently encountered at Perth Airport on the existing runways.

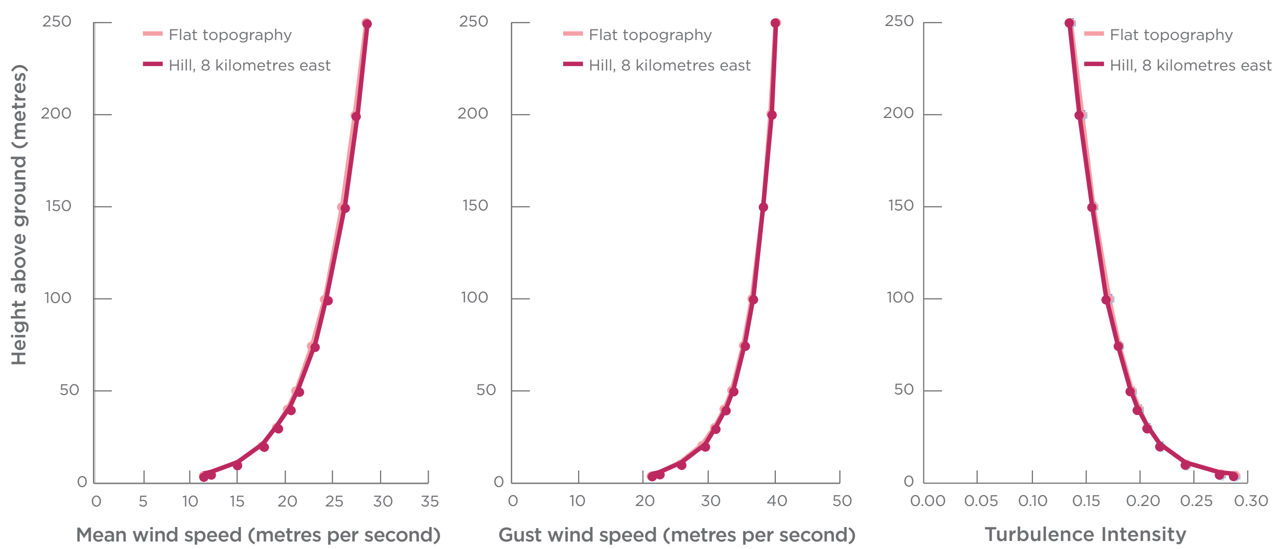

Figure 26-10 Wind characteristics at the airport site with and without an upstream hill
Source: Cermak Peterka Petersen

Figure 26-11 Perth Airport light control zones
Source: Perth Airport

26.10 Exhaust Plumes

Exhaust plumes of significant vertical velocity (plume rise) can emanate from ground activities such as vents and stacks, and can interfere with aircraft operations in various stages of flight.

MOS Part 139 provides that CASA may determine that an exhaust plume, having a velocity in excess of 4.3 metres per second, is or will be a hazard to aircraft operations because of the velocity or location of the efflux.

Information regarding the velocity, temperature, composition of the effluence and any particulate matter must be provided in any application for development on the estate where an exhaust plume is present. After internal review the exhaust plume information is provided to CASA for assessment if required. An example of this process, applicable to Perth Airport, was the construction of the BGC Brickworks on the estate which includes a chimney stack. This development, to the north-east of the airport, was assessed by CASA which determined the specified plume was within acceptable limits and did not pose a risk to airport operations. As part of the approval, conditions were placed on the development to ensure monitoring was regularly undertaken confirming compliance with the specification.

Perth Airport works with local planning authorities to ensure they are informed of the risk from exhaust plumes and encourages the submission to Perth Airport for assessment of information concerning off-airport developments that include exhaust plume(s).

There are no other existing sources of plumes that would pose an unacceptable risk to aircraft operations from the new runway (03R/21L).

26.11 Glare

Glare from ground lights or large reflective surfaces near the runway have the potential to obscure vision or cause confusion and distraction for pilots and air traffic controllers. MOS Part 139 specifies ground lighting intensities (measured at three degrees above the horizontal) within four light zones shown in Table 26-4. The light control zones applied to Perth Airport are shown in Figure 26-11. The zone closest to the runway has the most onerous requirements.

While there are light sources (street and building lights) present to the east of the new runway and within 300 metres from the centreline (Zone A), there are no direct light sources that protrude above the horizontal. The light sources are therefore not considered to be a hazard to aircraft operations. The light sources present within Zone A are also on the estate and come under the control of Perth Airport, should a hazard be identified during flight testing for the new runway, Perth Airport has the ability to remediate the source prior to aircraft operations commencing.

Other light sources contained within Zones B – D, which include various types of lighting, are similar to those encountered on the current runways. While there are potential sources of glare, the risk to aircraft operations, on the new runway is considered low.

Zone	Maximum light source intensity measured at three degrees above the horizontal (candela)	Distance from Runway Centreline (metres)	Distance from Runway Threshold (meters)
A	0	300	1,000
B	50	450	2,000
C	150	600	3,000
D	450	750	4,500

Table 26-4 Manual of Standards Part 139 Ground Lighting Levels
Source: Civil Aviation Safety Authority

26.12 Hazardous Land Use Surrounding the Airport

Hazardous land uses are provided for in industrial zones and allow the presence of facilities related to hazardous industry. State Planning Policy 4.1 State Industrial Buffer (SPP 4.1) defines hazardous industry as *'an industry which, when in operation and when all measures proposed to minimise its impact on the locality have been employed (including measures to isolate the industry from existing or likely future development on other land in the locality), would pose a significant risk in relation to the locality, to human health, life or property, or to the biophysical environment. Examples of such industry include oil refineries and chemical plants'*. Hazards present include those related to individual and societal health, air quality, noise and odour.

In the event of an incident at a hazardous facility, there is the potential for surrounding areas to be affected. Consequently, hazardous land uses should include buffer zones which prescribe allowable occupancies and activities to minimize risk to site occupants, adjoining premises and public areas. The SPP 4.1 states that the extent of the buffer zones should be determined in the context of an assessment of the type of existing or likely industry to be located in the zone. Additionally, controls should be included in the town planning scheme.

Two hazardous facilities were identified in close proximity to the new runway, they are:

- BP Fuel Depot, Abernethy Road, Kewdale, and
- CBH Metro Grain Centre (Grain Silos), Abernethy Road, Forrestfield.

The location of the facilities in relation to the new runway is shown in Figure 26-12.

A risk assessment of these facilities found that they posed a low risk to the operations of Perth Airport and aircraft using the new runway. The risk assessment specific to the BP Fuel Depot, which is south of the new runway and slightly west of the extended centreline, also found there to be a low risk from aircraft operations to the Depot itself.

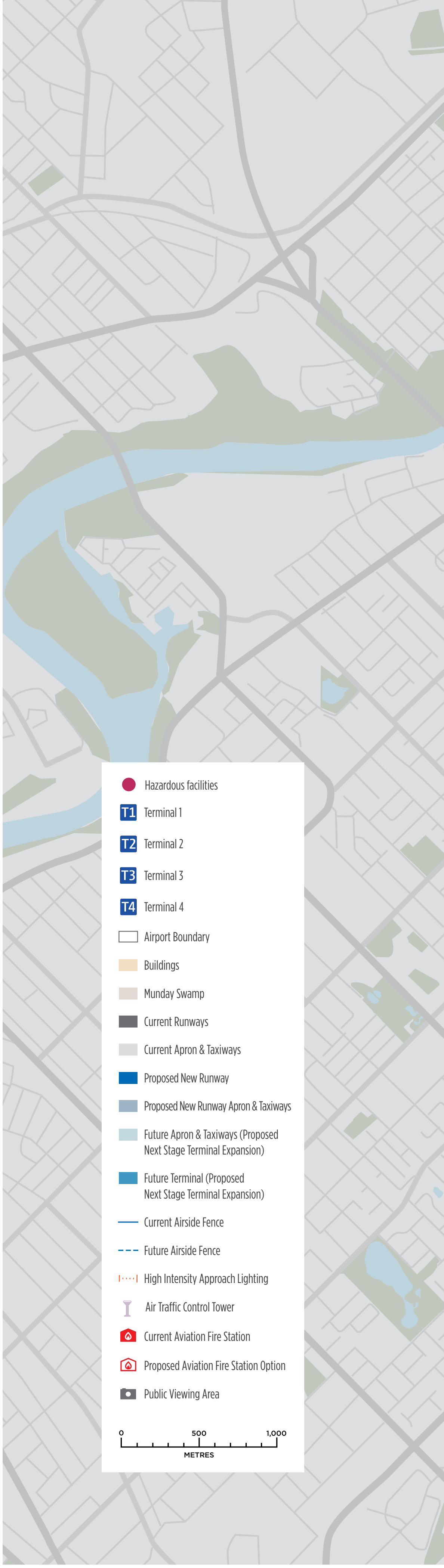

Figure 26-12 Hazardous facilities in close proximity to the new runway
Source: Perth Airport

26.13 Air Traffic Management Considerations

Air traffic management is undertaken at Perth Airport by two control units, the Air Traffic Control (ATC) tower and the Terminal Control Unit (TCU). The ATC tower is responsible for the control of aircraft on the ground and on approach to the airport. The TCU is responsible for aircraft operating in airspace around Perth up to 36 nautical miles from Perth Airport.

The NRP and the procedures adopted for operating a parallel runway will change the way operations are conducted in both the ATC tower and TCU.

New airport infrastructure, such as a new runway, are assessed by Airservices for any impacts on the provision of Air Traffic Control, Aviation Rescue and Fire Fighting (ARFF), communication and navigations services. These services are subject to strict regulations.

26.13.1 Tower Line of Sight

MOS Part 172 requires air traffic controllers within a control tower to have the ability to visually detect movement of a departing aircraft within a certain timeframe, as outlined in Figure 26-13. The MOS Part 172 also states that the five second requirement applies to a control tower commissioned after 1 July 2000. The Perth ATC tower was opened in 1987. Airservices has advised Perth Airport that given the date of commissioning of the tower, this requirement does not apply to Perth Airport ATC Tower.

3.1.2 **Control Towers**

3.1.2.1 Visibility. A control tower first commissioned after 1 July 2000, must enable the controller to have:

(a) adequate visibility to all the manoeuvring area and airspace which are under the controllers' area of responsibility;

(b) a view of all runway ends and taxiways, with suitable depth perception, (refer Advisory Circular);

(c) maximum visibility of airborne traffic patterns with primary consideration given to the view from the aerodrome control position(s);

(d) unobstructed lines of sight from the control tower eye level (refer Advisory Circular) to:

- (i) the manoeuvring area of the aerodrome;
- (ii) the runway approach lights and/or graded areas at ground level for distance Of 300 M from the threshold along the extended centreline, then upward and outward within the take-off climb area normally at an angle not less than 2.5 degrees;
- (iii) the first 150 M of any fire routes service roads adjacent to the areas mentioned in (a) and (b) above;
- (iv) sections of aprons used as a taxiway to a line, at ground level, 15 M from the apron edge, towards the building line;

(e) sufficient visual resolution of all aerodrome movement areas for which he/she has a responsibility;

(f) ability to detect movement of a departing aircraft as soon as possible after it has commenced its take-off run; response times must be kept below 4 seconds, although an upper limit of 5 seconds may be approved in exceptional circumstances.

3.1.2.2 In addition, procedures or facilities are required to ensure:

(a) protection from glare, reflection and noise;

(b) unobstructed view from an existing control tower cab.

Figure 26-13 Extract from Manual of Standards Part 172 relating to air traffic control line of sight
Source: Civil Aviation Safety Authority

26.13.2 Air Traffic Control Staffing

Increased air traffic control staffing levels will be required to facilitate parallel runway operations. Currently with a main runway and a cross runway, aircraft to both runways need to be sequenced and are treated as dependent operations. This means the current runway infrastructure requires one approach controller to process arriving aircraft and one departure controller to process departing aircraft in the TCU.

Parallel runway operations result in the aircraft being reasonably close together laterally when they are on final leg before landing and close monitoring by air traffic control is required to ensure there is no accidental breach of the procedures resulting in one aircraft not remaining on the runway centreline. As a result of this, a parallel runway system requires additional consoles and controllers to man positions for parallel runway operations in the TCU.

In the ATC tower an aerodrome controller is responsible for separating traffic on the duty runway or runways. The current runway infrastructure has one aerodrome controller in the ATC tower. A parallel runway system would require two aerodrome controllers, with one responsible for each runway. The number of additional staff in both the TCU and ATC would be subject to determination by Airservices and will be dependent on peak periods for both arrivals and departures and the mode of operation during off peak times.

26.13.3 Impact of Construction

All developments, works or buildings in the vicinity of the airport generally require an assessment by Perth Airport prior to approval. Perth Airport will assess proposed developments to ensure that no infrastructure, such as underground cables, will be damaged and, as detailed earlier in this section, any buildings or machinery will not infringe the protected airspace limits required to ensure aircraft flight paths remain unobstructed. Airservices may be required to complete an assessment should Perth Airport determine there is an infringement to the protected airspace or if their operations may be impacted. Airservices will assess whether any building or equipment used will infringe the separation tolerances for any approach or departure procedure or interfere with crucial infrastructure such as infringing the path of a microwave link that transmits radar data.

Additionally, an assessment will include any impact to Airservices infrastructure such as navigation aids and other impacts such as activities that may cause afternoon glare in the tower.

This rigid approval process will be required for all phases of construction of the new runway infrastructure and will ensure there is no negative or unexpected impact to air traffic control procedures and therefore airline operations.

The risk posed to aircraft operations as a result of constructing the new runway is as low as reasonably practicable when taking into account the assessment processes undertaken.

26.14 Conclusion

Although a number of potential hazards and risks were identified, the majority are common to aircraft operations around the world, and therefore mitigated, to the highest level possible, through regulatory requirements and standards, airport and aircraft operator's processes and procedures.

While the risk of an aircraft crash incident will always be present around an airport, the mitigation measures currently in place, or to be established when the new runway is constructed, will ensure the risks are as low as reasonably possible.

While it is difficult to define a general risk level for the NRP, based on the hazards identified and their individual risk ratings, the overall risk is considered low and the NRP will be safe for aircraft operations and the public.


HSBC

Appendices

Glossary of Terms

03L/21R
Existing main runway designation

03R/21L
New runway designation

06/24
Existing cross runway designation

Air Route
The designated route for aircraft to fly between two points on the ground.

Air Traffic Control
Air Traffic Controllers manage the safe and orderly flow of aircraft into, out of and between airports.

Aircraft Movement
Either a take-off or a landing by an aircraft.

Aircraft sequencing
The process of air traffic control arranging spacing between aircraft to allow an orderly landing sequence with enough spacing to allow a landing aircraft to vacate the runway prior to the next one being cleared to land.

Airport Central
The terminal area between the existing main and new runways which currently houses Terminal 1 and Terminal 2.

Airport Infrastructure
Refers to all facilities provided at an airport. It includes runways, taxiways, terminals, roads, other buildings and navigation equipment.

Airside
The movement area of an aerodrome, adjacent terrain and building or portions thereof, access to which is controlled.

Airspace
The portion of the earth's atmosphere over which a nation exercises jurisdiction over aircraft in flight.

Airspace Management Plan
The Airspace Management Plan is a high level document that provides the parameters for which detailed flight path planning can be undertaken prior to the construction of the New Runway.

Section 160 of the *Environment Protection and Biodiversity Conservation Act 1999* notes that before the NRP MDP can be approved the Commonwealth Minister for Infrastructure and Transport must consider the advice of the Minister for the Environment in relation to the adoption of implementation of a plan for aviation airspace management involving aircraft operations that have or will have or are likely to have a significant impact on the environment.

Approaches
The course to be followed by an aircraft in approaching for a landing or in joining a traffic pattern.

Apron
A defined area on a land aerodrome intended to accommodate aircraft for loading and unloading passengers, mail or cargo, fuelling, parking or maintenance.

Australian Noise Exposure Contour (ANEC)
An Australian Noise Exposure Contour (ANEC) chart represents a forecast produced for a hypothetical future usage pattern. ANEC forecasts are based on indicative data on aircraft types, flight paths, operating modes etc., and are generally used in environmental assessments to depict potential noise exposure for the scenarios being considered.

Australian Noise Exposure Forecast (ANEF)
Shows the anticipated noise exposure contours for the most likely or preferred long-term development and forecast for an airport.

Australian Noise Exposure Index (ANEI)
An Australian Noise Exposure Index (ANEI) chart is based on historical data from a previous year, where exact numbers and types of aircraft which used the aerodrome are known. It shows the average daily aircraft noise exposure around the aerodrome for that year.

Automatic Dependent Surveillance Broadcast
An air traffic surveillance technology that enables aircraft to be accurately tracked by air traffic controllers and other pilots without the need for conventional radar.

A-Weighted Noise Level (dBA)
This is a value representing the loudness of a sound at a specific time, allowing for the differential response of the human ear to different sound frequencies.

Compass departures
Compass departures sees the runway allocated according to the direction that the aircraft is going.

Continuous Descent Approach
An approach in which the aircraft's height is reduced continuously from a point at a large distance from the airport until it touches the runway. This results in lower noise emission than alternatives in which the aircraft's height may be held constant for sections of the track.

Controlled Airspace
Controlled airspace is airspace where an air traffic control service is provided. Controlled airspace is provided around major airports and between airports to ensure that the majority of aircraft that carry passengers are provided with separation from other aircraft.

Corridor
A representation around an air route that indicates a range of flight paths that may be flown by aircraft as a result of weather diversions or air traffic control intervention. An area that final flight paths may be designed within.

Departure and Arrival Procedure
The Standard Instrument Departures (SID) used for departing aircraft or the Standard Arrival Routes (STAR) used for arriving aircraft

Dependant Approaches
Where aircraft making approaches to each of parallel runways must be provided with air traffic control separation from each other.

Duty Runway
The runway or runways that have been nominated to be used by air traffic control at a given time.

Estate
The grounds and tenancies associated with the Perth Airport land holdings.

Flight Path
The track an aircraft may fly. Flight paths include Air Routes, Departure and Arrival procedures, Approach procedures and flight tracks.

Flight Track
The actual path in the air flown by an aircraft which may vary from the air route or the departure or arrival procedure.

General Aviation (GA)
Refers to all flights other than military and scheduled airline flights, both private and commercial.

HIAL
High Intensity Approach Lighting

Holding
A manoeuvre designed to delay an aircraft already in flight while keeping it within a specified airspace.

Independent Approaches
Where two aircraft can be processed for an approach to each of the parallel runways independent of each other.

Instrument Approach
An instrument approach is required in poor weather conditions where the pilot cannot see the ground and relies on the pilot receiving guidance to land from instruments located in both the aircraft and on the ground.

Instrument Landing System (ILS)
An ILS is a highly accurate navigation aid that uses radio signals to give the pilot vertical and horizontal guidance on a three-degree descent profile to the runway for landing. The ILS provides lateral guidance (localiser) which will keep the aircraft on a heading direct to the runway and descent guidance (glide path) which provides descent guidance to touch down on the runway.

Instrument Meteorological Conditions
When low cloud or reduced visibility do not permit a visual approach and a pilot must make an instrument approach.

L_{A90}
The L_{A90} level is the A-weighted noise level which is exceeded for 90 per cent of the sample period. During the sample period, the noise level is below the L_{A90} level for ten per cent of the time. This measure is commonly referred to as the background noise level.

L_{Aeq}
The equivalent continuous sound level (L_{Aeq}) is the energy average of the A-weighted noise level over a sample period, and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is sometimes used to describe aircraft noise, in which case it refers to the noise level that is due to aircraft only, excluding other noise. Variants of this measure have been defined that cover specific time periods, such as L_{Aeq}, 9.00 am to 3.00 pm.

Major Development Plan (MDP)
As defined by Section 91 (1) of the *Airports Act 1996.*

Master Plan
As defined by Section 71 (2) of the *Airports Act 1996.*

Maximum Noise Level (L_{Amax})
L_{Amax} over a sample period is the maximum A-weighted noise level measured during the period. In the context of aircraft overflight noise, L_{Amax} generally means the maximum A-weighted noise level recorded during a specific overflight, measured using Slow speed, and can therefore also be written L_{ASmax}. In this report, L_{Amax} denotes the maximum level attained during a single overflight.

Movement
Either a take-off or a landing by an aircraft.

N60
N60 is a measure of noise exposure that indicates the average number of aircraft overflights per day (or other specified time period) exceeding 60 dBA. N60 is generally used to describe night time noise exposure.

N65
N65 contour map illustrates the average number of events per day over 65 dBA for a particular area. This corresponds to an outdoor sound level of 65 dBA and an indoor noise level of approximately 55 dBA.

NATS
The United Kingdom's provider of air traffic control services. In addition to providing services to 13 UK airports, and managing all upper airspace in the United Kingdom, NATS provides services around the world spanning Europe, the Middle East, Asia and North America. Additional information on NATS can be found at www.nats.aero

Noise Abatement Procedures

Every major airport has Noise Abatement Procedures (NAPs), which are designed to reduce the impact of aircraft noise on the community. They include procedures for runway use and flight paths.

N-contours

A term used to describe noise through reporting the number of aircraft noise events louder than the specified dBA level.

New Runway Project

The New Runway Project (NRP) includes:

- construction, including clearing and site preparation, of a new runway up to 3,000 metres in length and with associated infrastructure.
- development of an airspace management plan that will cater for the changes to current airspace and flight paths to accommodate operations of the new runway.

Noise Event

An event begins when the noise level exceeds a certain threshold value set in the noise monitor (which will be above the background noise level) and ends when the noise level drops below it.

Required Navigation Procedure (RNP)

RNP is a highly accurate procedure to approach and land on a runway. RNP uses highly accurate on board computer systems to fly via a set of latitudes and longitudes while also providing descent guidance.

Restricted Areas

Restricted areas or airspace is a defined piece of airspace, above land or water, where an aircraft is restricted to fly unless specified conditions are complied with and air traffic control permission is granted.

Runway

A defined rectangular area on a land aerodrome, prepared for the take-off and landing of aircraft along its length.

Runway Heading

Runway heading refers to the magnetic direction in degrees that corresponds to the centerline of the runway. The main runway 21 at Perth has a magnetic heading of 196 degrees so to fly on runway heading would see the pilot fly a heading of 196 degrees magnetic.

Runway Mode

An operating mode is the use of a certain runway or a combination of runways and the mode selected is based on a number of factors and documented selection criteria.

Runway Mode Capacity

How many aircraft that a runway or combination of runways can accommodate in an hour in various weather conditions. It may be a number or arrivals or departures or a combination of both.

Runway Number

The number allocated to a runway end, being that whole number nearest to one tenth of the magnetic bearing of the runway centreline (measured clockwise form magnetic north) when viewed from the approach. Single digit numbers are preceded by zero and where the final numeral of the bearing is five degrees, the number allocated is the next largest number.

Taxiway

A defined path on an aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

- aircraft stand taxilane: a portion of an apron designated as a taxiway and intended to provide access to aircraft stands only,
- apron taxiway: a portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron, and
- rapid exit taxiway: a taxiway connected to a runway at an acute angle and designed to allow landing aircraft to turn off at higher speeds than are achieved on other exit taxiways thereby minimising runway occupancy times.

Terminal Arrivals

When aircraft arrive and depart from the runway nearest the terminal they operate from.

Uncontrolled airspace

Airspace where no air traffic control service is provided. This is where the majority of light aircraft and helicopters operate.

Visibility

A measure of the distance at which an object or light can be clearly discerned.

Visual Approach

A visual approach is an approach to a runway conducted with reference to visual cues and clear of clouds.

Visual Meteorological Conditions

When weather conditions are such that no low cloud or reduced visibility will impact a pilots ability to make a visual approach.

Acronym / Abbreviation

03/21 or 03L/21R	Main runway designation
03R/21L	New runway designation
06/24	Cross runway designation
AAQ NEPM	Ambient Air Quality National Environment Protection Measure
ACES	Airport Consultative Environmental Sustainability Group
ACI	Airports Council International
ADS-B	Automatic Dependent Surveillance Broadcast
AEDT	Aviation Environmental Design Tool
AEPR	Airports Environmental Protection Regulations
AIP	Aeronautical Information Package
Airports Act	*Airports Act 1996*
Airservices	Airservices Australia
ANEC	Australian Noise Exposure Concept
ANEF	Australian Noise Exposure Forecast
ANEI	Australian Noise Exposure Index
ANMS	Aircraft Noise Management Strategy
ANO	Aircraft Noise Ombudsman
AQI	Air Quality Index
AQMS	Air Quality Monitoring Station
AS	Australian Standard
ATC	Air Traffic Control
AWS	Automatic Weather Station
C LL 2000	Class C Controlled Airspace with a Lower Level of 2000 feet
CASA	Civil Aviation Safety Authority
CBD	Central Business District
CDA	Continuous Descent Arrival
CONOPS	Concept of Operations
CTA	Controlled Airspace
DAP	Departures and Approach Procedures
dBA	Weighted decibels which accounts for the varying sensitivity of the human ear to different frequencies of sound
DAWE	Department of Agriculture, Water and the Environment (Commonwealth)
DME	Distance Measuring Equipment
DPLH	Department of Planning, Lands and Heritage
DITRDC	Department of Infrastructure, Transport, Regional Development & Communications (Commonwealth)
DWER	Department of Water and Environmental Regulation (WA)
EDMS	Emissions and Dispersion Modelling System
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPNL	Effective Perceived Noise Level

FAA	USA Federal Aviation Administration
FUA	Flexible Use of Airspace
GA	General Aviation
GDA	Geocentric Datum of Australia
GIS	Geographic Information System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IHD	Ischaemic Heart Disease
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
INM	Integrated Noise Model
IVA	Independent Visual Approach
KT	Knot (wind speed measured in nautical miles per hour)
LTO	Landing Take-off cycle
MDP	Major Development Plan
MGA	Map Grid of Australia
NAP	Noise Abatement Procedures
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NEF	Noise Exposure Forecast
NEPM	National Environment Protection Measure
NFPMS	Noise and Flight Path Monitoring System
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Commonwealth)
NOTAM	Notice to Airmen
NPD	Noise Power Distance
NRP	New Runway Project
ORAT	Operational Readiness Activation and Transition
PAANTWG	Perth Airport Aircraft Noise Technical Working Group
PACF	Perth Airport Community Forum
PAG	Perth Airport Aboriginal Partnership Agreement Group
PAMG	Perth Airport's Municipalities Group
PAPI	Precision Approach Path Indicator
PCF	Planning Coordination Forum
PHCTR	Perth Control Zone
PM	Particulate Matter
RAAF	Royal Australian Air Force
RNP	Required Navigation Procedure
RPT	Regular Passenger Transport
SA HB	Standards Australia Handbook

SAE	Society of Automotive Engineers
SEL	Sound Exposure Level
SFC	Surface
SID	Standard Instrument Departure
SOIR	Simultaneous Operations on Parallel or Near Parallel runways
STAR	Standard Arrival Route
T1	Terminal 1
T2	Terminal 2
T3	Terminal 3
T4	Terminal 4
US EPA	United States of America Environmental Protection Agency
VMC	Visual Meteorological Conditions
VOC	Volatile Organic Compound
WAPC	Western Australian Planning Commission
WARRP	Western Australia Route Review Project
WGS	World Geodetic System 1984 (a global reference system for geospatial information and is the reference system for GPS)
WHO	World Health Organization

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