2023 UPDATED CHRISTCHURCH INTERNATIONAL AIRPORT NOISE CONTOURS

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Fact SHEET 1

INTRODUCTION TO AIRCRAFT NOISE

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1 PLANNING IN THE VICINITY OF AIRPORTS

Airports are essential for transporting people and goods. They are intergenerational assets which connect communities with the rest of the country, and the rest of the world. As aircraft approach and depart an airport, they are lower in the sky and the noise that they make is louder and more apparent – standing out from the background noise levels for short durations. The noise from aircraft is a normal and unavoidable aspect of airport operations.

Noise from aircraft is most noticeable along the extended centrelines of the runways and under the arrival and departure flight paths.

To protect both local communities and airports, and to proactively make sure that airports can serve their communities well into the future, land use planning is important. Planners need to understand which areas of land are affected by aircraft noise. Proactive planning rules protect people from establishing sensitive land uses (like housing, schools or hospitals) in areas that are exposed to higher levels of aircraft noise which might disturb them or affect their quality of life. Those same planning rules also protect and enable airport operations to continue to support the economic and social prosperity of Canterbury, the South Island and New Zealand. As much as possible, the areas under flight paths which are exposed to higher levels of aircraft noise are reserved for things like industrial, agricultural or recreational land uses.

2 HOW AIRCRAFT NOISE IS CREATED

Aircraft noise is caused by two main things, the aircraft's engines, and the aircraft moving through the air (air flowing over the airframe, landing gear and flaps etc).

There are many different types of aircraft using Christchurch Airport – commercial passenger aircraft, freight aircraft, helicopters, the aircraft used by the International Antarctic Centre, general aviation, and military or other government aircraft. Different types and models of aircraft create different levels of noise. Generally, larger aircraft make more noise than smaller aircraft.

THE NOISE WHICH IS HEARD ON THE GROUND IS ALSO INFLUENCED BY:

- The runway which is being used
- Aircraft flight paths and navigation procedures
- Weather conditions (through the effects atmospheric absorption, ground attenuation, cloud cover, wind, temperature, fog)
- Terrain surrounding the airport
- Background noise levels – which change throughout the day (for example, it is usually quieter at night so aircraft noise is more noticeable)

Aircraft are constantly arriving and departing from Airport – so noise will come and go throughout the day and night.

The impact of one aircraft is markedly different to the cumulative impact of many aircraft. A person's annoyance response has been shown to be influenced by the accumulated effects of repeated exposure to noise events. New Zealand Standard 6805:1992 Airport Noise Management and Land Use Planning (NZS 6805) recognises this effect and, consistent with international best practice, aircraft noise is assessed by looking at the average noise exposure on a typical day.

3 HOW AIRCRAFT NOISE CAN AFFECT PEOPLE

Noise can affect people in different ways, depending on factors like loudness, time of day when noise occurs, length of time that it occurs for, and the context that it occurs in. Sometimes noise is just something that is noticeable but not an issue. At the other end of the scale, noise can disturb sleep, and make it hard to hear or have a conversation. Noise from specific aircraft cannot be made quieter, however the paths that aircraft fly can be designed to reduce exposure to aircraft noise over populated areas (as is the case in Christchurch and West Melton). But it is not possible to avoid noise from aircraft entirely. So the best way to avoid aircraft noise affecting people is with proactive town planning.

4 AIRPORT NOISE CONTOURS

In New Zealand, like other countries, town planning to account for aircraft noise exposure is based on contour maps which are created by noise modelling. The noise contours show the extent of exposure to aircraft noise and the areas where higher levels of aircraft noise occurs. NZS 6805 Airport Noise Management and Land Use Planning recommends using noise contours and guides this process.

NZS 6805 recommends that the noise contours need to account for future airport growth and use over time so that they are a reliable and effective long-term planning tool, not just a snapshot in time.

Air noise contours should be updated approximately once a decade, to reflect changes in aircraft fleet, flight path adjustments and usage and future traffic projections for various aviation segments including commercial scheduled passenger and freight aircraft.

The existing air noise contours for Christchurch Airport (Existing Noise Contours) were approved in 2008. They are now due to be re-modelled in accordance with the Canterbury Regional Policy Statement (CRPS). The CRPS directs that the modelling inputs, assumptions and outcomes shall be peer reviewed by an independent panel of experts. This is discussed further in *Fact Sheet 3: Overview of the air noise contour remodelling and peer review process.*

The shape and size of air noise contours are caused by various factors, which all need to be put into the model.

The work undertaken by CIAL's experts in updating the projected noise contours involved considering a range of scenarios for key assumptions:

- **Planned airport runway development to enhance capability, safety, efficiency;**
- **Air traffic, including future international and domestic routes and fleet mix;**
- **Ultimate runway capacity;**
- **Location and usage of current flight paths and, based on best available information, how flight paths may evolve in the future;**
- **The variations in runway usage based on meteorological conditions throughout the year, historic variations from year to year, and how this may be impacted by climate change.**

The modelling also accounts for the difference in noise sensitivity to daytime and night-time flights.

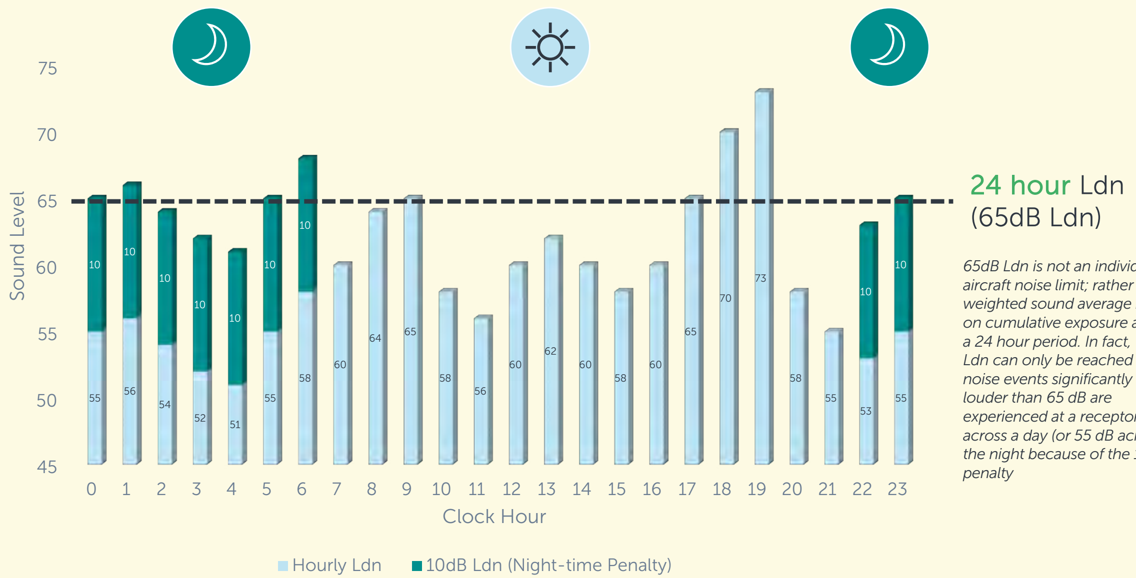
CIAL's Expert Team have completed a rigorous modelling exercise to produce Updated Noise Contours and this work was provided to Environment Canterbury for peer review by the Independent Expert Panel appointed by Environment Canterbury. This peer review process is now complete and CIAL's Expert Team consider that the 2023 Updated Noise Contours should be used for planning processes in Canterbury.

5 WHAT DOES "DBA" AND "LDN" MEAN?

Noise is measured on a logarithmic scale in a unit called a decibel (dB). Measurements of noise usually have a correction factor applied to reflect the sensitivity of the human ear. This factor is an industry approved standard and is referred to as the "A-weighting" and results in environmental noise usually being measured in dBA units. The noise level of normal daytime urban-based activities typically varies between 40dBA and 85dBA. On this scale, an increase in the noise level of 10dBA is perceived to be a doubling or a decrease of 10dBA as a halving in loudness. For example, most people perceive a noise event of 85dBA to be about twice as loud as an event of 75dBA.

The noise levels from an individual overflight are usually reported as the maximum level in dBA, even if it is only at this level for a duration of less than a few seconds.

NZS 6805 uses the Ldn metric for airport noise contours which is the equivalent sound level for a 24-hour period with an additional 10dBA imposed during night-time hours of 10pm to 7am. This night weighting accounts for people's increased sensitivity to noise at night and the sound environment at night being quieter.



65dB Ldn is not an individual aircraft noise limit; rather it is a weighted sound average based on cumulative exposure across a 24 hour period. In fact, 65dB Ldn can only be reached if noise events significantly louder than 65 dB are experienced at a receptor across a day (or 55 dB across the night because of the 10 dB penalty

KEY INPUTS INTO THE NOISE CONTOUR MODELLING

6 LONG TERM PLANNING USING ULTIMATE RUNWAY CAPACITY

Modelling is based on the ultimate runway capacity of Christchurch Airport – that is, the busiest that Christchurch Airport can ever be based on its physical constraints (the practicalities of air traffic control and how aircraft take-off, taxi and land on the runway) and expected operational characteristics. Ultimate runway capacity is determined by experts in aviation and airport planning. It is important that the contours show the noise that will be generated when Christchurch Airport is at ultimate runway capacity so that planners can take the full extent of projected noise into account and anticipate this in planning decisions.

The exact date at which ultimate runway capacity is reached will shift in response to events like the recent COVID-19 lockdown or in response to uplifts in air travel demand - ultimate capacity may be reached between 50 to 60 years into the future. But the point is that it will be reached and should be anticipated in planning documents.

8 WILL AIRCRAFT GET QUIETER?

In the past, improvements in engineering and design have meant that newer aircraft models have been quieter. But there is no guarantee that aircraft will continue to get quieter in the future. Recent engineering focus is to reduce engine emissions, not necessarily noise reduction.

New aircraft must comply with the latest noise standards as defined by ICAO, an agency of the United Nations and international body setting rules and regulations for international civil aviation. These noise certification standards for aircraft have become more stringent over time. However, at any point in time there will still be older noisier aircraft flying as the changeover of an airline fleet occurs over an extended period, and the useful operational life of modern jet aircraft is well beyond twenty years. The impetus for an airline to upgrade its fleet is very often driven by fuel efficiency of newer aircraft, as well as greater capability (range or payload) with the added benefit of more new generation quieter aircraft. So, given there is no clear evidence that aircraft will get appreciably quieter in the future, it is not advisable to rely on that for modelling purposes.

The modelling used for the 2023 Updated Noise Contours accounts for aircraft that are already flying, or are anticipated to be introduced into fleets of airlines most likely to be using Christchurch Airport. This incorporates consideration of new generation aircraft. The modelling does not, however, attempt to speculate on the noise profile or potential use of aircraft models that are in developmental phases.

7 AIRCRAFT FLEET

The overall makeup and mix of the fleet of aircraft using Christchurch Airport is considered when modelling the noise contours because each type of aircraft – and the make and model – has a different noise profile. The modelling software (known as AEDT) has in-built profiles for different makes and models of aircraft so that an accurate picture of the fleet used by airlines can be built. Airline companies have provided information about the fleet they use to inform these assumptions. The experts have also used measurements of specific aircraft operating at Christchurch Airport to improve accuracy of the noise modelling.

The aircraft noise and operating performance parameters in AEDT are sourced from:

- International Civil Aviation Organisation (ICAO) Aircraft Noise and Performance Database (ANP);
- Eurocontrol Base of Aircraft Data (BADA).

9 FLIGHT PATHS AND PRECISE NAVIGATION

Newer navigation technology can change aircraft flight paths - such as Required Navigation Performance (RNP). RNP is satellite-based aircraft navigation technology specifications under Performance Based Navigation (PBN) to help aircraft operate along a precise flight path with a high level of accuracy. PBN offers safety and efficiency benefits compared to visual navigation of flight paths. Over time this permits new flight paths to be considered in addition to existing arrival and departure paths and changes the distribution of traffic across existing and new flight paths as more aircraft, airlines and pilots use the new technologies. Precise navigation can, where possible, help aircraft to avoid sensitive areas but in doing so can concentrate noise along these precise flight paths.

Historically, aircraft approached and departed Christchurch Airport straight on, but flight path design and procedures changes from time to time. Since 2018, increasingly aircraft have been turning onto final approach closer to Christchurch Airport - angling away from urban areas. This affects the shape of the noise contours.

Another way in which flight paths have changed in recent years is air traffic control now require aircraft to depart the airport using the Divergent Missed Approach Protection System (DMAPS). DMAPS are departure tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control. Aircraft have been required to use DMAPS departures since 2020.

When DMAPS procedures were designed, the opportunity was taken to mitigate noise impacts by making the turns in the direction of less populated areas, namely to the north-west and south-west, rather than north-east and south-east.

Performance Based Navigation (PBN)

RNAV = Navigation specification without performance monitoring and alerting system

RNP = Navigation specifications with performance monitoring and alerting system

DMAPS
RNAV departure procedure to protect missed approach for RNP arrivals

RNP arrivals at Christchurch Airport

The modelling for the 2023 Updated Noise Contours takes account of these navigation specifications and procedures, and historical analysis of actual radar flight track data that has been supplied by Airways. This data shows actual historic flight paths and is used as the basis for the flight tracks and spread assumptions used in the noise modelling. This is discussed further in *Fact Sheet 4: Outcome of the peer review process – updates to the 2021 Draft Updated Noise Contours.*

10 RUNWAY USAGE

There are four runway ends at Christchurch Airport. Aircraft generally take off and land into the wind. The main runway (with ends facing north-east and south-west) is used most of the time and aligns with the prevailing wind conditions. On occasions when there are sufficiently strong current or forecast north-westerly winds so that air traffic control declares the runway 'in-use', the crosswind runway is used to ensure aircraft continue to take off and land into the wind. Use of the crosswind runway tends to increase in the summer months when north-westerly winds are more frequent.

The area of land affected by noise from an individual aircraft changes depending on which runway is used. To model the overall noise environment, the contours account for the proportional split between each runway end.

11 CLIMATE CHANGE

Climate change has the potential to impact the size and shape of the contours in two ways. NIWA predicts that the frequency of north-westerly winds will increase due to climate change, which will increase use of the crosswind runway. NIWA also predicts an increase in temperature and more hot/humid conditions, which could impact the propagation of sound. The predicted impacts of climate change have been tested in the modelling.

Fact SHEET 2

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

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Air traffic management (ATM) systems are essential for the safe and efficient flow of aircraft in the air, on approach to and departure from an airport runway.

1 WHAT IS AN AIR TRAFFIC MANAGEMENT SYSTEM?

The ATM system provides for aircraft flights from departure and en-route to arrival and landing; elements include Air Traffic Services (ATS) such as Air Traffic Control (ATC), Airspace Management (ASM), and Air Traffic Flow Management (ATFM).

KEY COMPONENTS ARE:

- **Regulations, procedures, and organisation of airspace around the airport and en-route.**
- **An organisation and highly trained staff providing ATC services.**
- **Computer systems providing ATC with information on the status, location, separation, and projected flight paths of aircraft in the airspace and on the ground, and associated decision support to expedite air traffic flows safely and efficiently.**
- **Communications, navigation and surveillance (CNS) systems, employing digital technologies, including satellite navigation systems applied in support of a local and global ATM.**

2 EVOLUTION OF AIR TRAFFIC CONTROL

Conventional navigation was originally through visual flight. It then progressed to aircraft operations relying on ground-based radio navigation aids such as NDB (non-directional beacon), VOR (very high frequency omni-directional range), and DME (distance measuring equipment) to navigate to or from an airport. Where there is coverage, particularly in high density airspace corridors, there may be a higher level of intervention such as radar guidance from air traffic control centres.

Conventional air routes were based on old aircraft capabilities and navigation means. This resulted in large protection areas and separation criteria to cope with the limited accuracy of estimated aircraft positions. Navigation routes were based on ground-based navigation aids which were overflown and/or provided a position relative to these facilities. Consequently, flight path design had limited flexibility and air routes had limited capacity as traffic through the airspace increased. Although still in wide use, visual and ground-based navigation is no longer suitable for a modern aviation industry with denser air routes and higher levels of safety and efficiency in terms of aircraft fuel burn, emissions, noise impact, and maximising airspace and runway capacity.

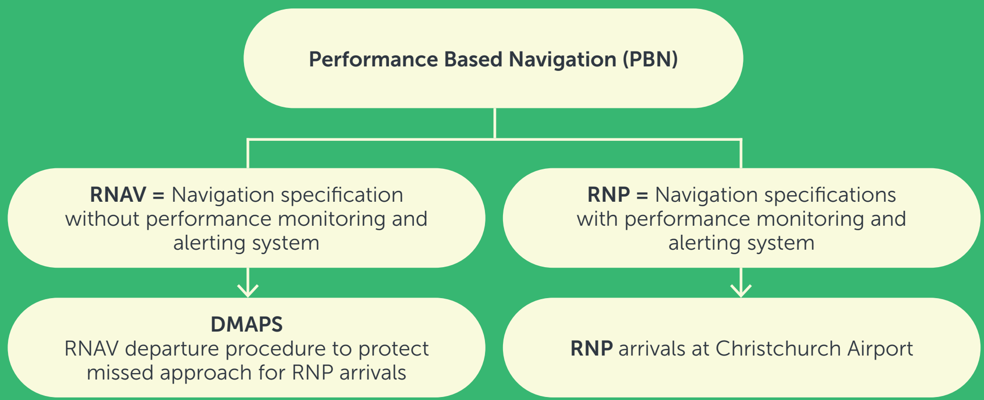
3 PERFORMANCE-BASED NAVIGATION (PBN)

Air navigation has transitioned from conventional ground-based radio navigation aids to **performance-based navigation (PBN)**. PBN is an advanced, satellite-enabled form of air navigation that creates precise three-dimensional (3D) flight paths. These procedures and routes offer several operational benefits, including enhanced safety, increased efficiency, reduced carbon footprint, and reduced cost. PBN allows more direct optimised flightpaths, continuous climb and descent, and other efficiencies in aircraft operations which translate into reduced aircraft fuel burn, emissions and airspace congestion.[1]

The objective of PBN is to improve the precision of aircraft navigation through the introduction of a globally recognised set of standards defined by the International Civil Aviation Organization (ICAO). Historically the air transport route network was designed with reference to ground-based radio navigation aids. Pilots navigated from point to point along a set of fixed routes based on the location of the aids. The development of area navigation (RNAV) in aircraft Flight Management Systems (FMS) removed the dependency on ground-based aids.

RNAV stands for **Area Navigation** and refers to the capability of an aircraft pilot to fly any desired flight path, defined by waypoints such as geographic fixes (latitude and longitude) and not necessarily by reference to ground navaids.

RNAV has been enhanced by the development of Global Navigation Satellite Systems (GNSS) that enable much more accurate aircraft positioning. There are different specifications of PBN which vary depending on the level of accuracy, consistency and functionality that the aircrafts' navigation systems have to meet.



RNAV specifications describe the basic level of performance. The New Zealand en-route network is based on RNAV 2 where '2' denotes a performance requirement of +/- 2 Nautical Miles for 95% of the flight time. The RNAV 1 specification (+/- 1 Nautical Mile) is considered the minimum standard for introducing new arrival and departure routes in busy terminal airspace like Auckland. In practice the track keeping accuracy achieved by aircraft is much more accurate than the 2 or 1 miles implied by 'RNAV 2' and 'RNAV 1'.

RNP (Required Navigation Performance)[2] is a similar specification to RNAV but requires that aircraft have systems to monitor navigation performance and alert the flight crew if the required levels are not being achieved. RNP applications are also more precise and include advanced capabilities like curved paths.[3]

When PBN procedures were introduced at Christchurch International Airport via the RNP arrivals and Divergent Missed Approach Protection System (DMAPS) departures the opportunity was taken to mitigate noise impacts by making the turns in the direction of less populated areas, namely to the north-west and south-west, rather than north-east and south-east.

[1] CANSO and ACI, Use of Performance Based Navigation (PBN) for Noise Management, Shaping our Future Skies, Feb 2020. www.canso.fra1.digitaloceanspaces.com/ uploads/2021/04/use_of_performance_based_navigation_pbn_for_noise_management.pdf

[2] The latest version of Airways AIPs now denotes RNP (as described here) as RNP-AR (Authorisation Required), with RNP now referring to the RNAV specification described above. For the purposes of this report the terminology RNP is applied throughout as described above.

[3] Airbus ProSky, PBN Implementation from Industry perspective RNAV, RNP & RNP, ICAO AFI/MID ASBUS Implementation workshop 23-26 Nov 2015, Cairo. www.icao.int/MID/ Documents/2015/AFI-MID%20ASBU%20Impl.%20Workshop/2.1-3%20AIRBUS%20PBN%20 Impl.%20from%20Industry%20perspective.pdf

4 REQUIRED NAVIGATION PERFORMANCE ARRIVALS AT CHRISTCHURCH AIRPORT

Advanced PBN procedures with CAA Authorisation Required (termed RNP AR) have been introduced to shorten flightpaths and reduce flight time, fuel burn and CO_2 emissions for suitably capable aircraft arriving into Christchurch Airport (most jets and some turboprops).

5 DIVERGENT MISSED APPROACH PROTECTION SYSTEM AT CHRISTCHURCH AIRPORT

DMAPS is an innovative system that has been introduced at Christchurch Airport. DMAPS protects PBN approaches which, in the event of a go-around or missed approach, ensures pre-programmed routes will diverge at 30 degrees from aircraft on a PBN departure. This enhances safety, while improving aerodrome capacity by 40% in nearly all-weather conditions – a feature which reduces airborne and ground holding and so also reduces flight times and generates environmental efficiencies.

6 OTHER NAVIGATION TERMS AT CHRISTCHURCH AIRPORT

Parts of this report refer to the following terms which are briefly described below:

ILS approach

Visual approach

Radar tracks

SIDs/STARs/ Cancelled SIDs

INSTRUMENT LANDING SYSTEM (ILS) APPROACH

An aircraft in the final phase of flight to land on a runway, using guidance from a ground-based landing aid.

An Instrument Landing System (ILS) allows aircraft to land at an airport when there is poor or low visibility. An ILS is comprised of two transmitters—the localiser and glide slope. This ensures the aircraft is within the lateral and vertical parameters for the runway being used.[4]

VISUAL FLIGHT PATH AND VISUAL APPROACH AND DEPARTURE

Instrument flight procedure design and Instrument Flight Rules (IFR) are procedures and rules which enable aircraft to operate in all weather conditions, including when navigation by visual references is not possible. In contrast Visual Flight Rules (VFR) are procedures and rules for how aircraft are to be operated when the pilot uses visual reference to the ground or water to navigate. In the case of visual landing, the pilot must establish and maintain visual contact with the runway from a specified minimum altitude above the airport.

RADAR TRACKS

Radar tracks are a dataset of actual historical flown aircraft flight tracks departing from and arriving at Christchurch Airport. Airways provided this data to the project team for use in flight track modelling.

STANDARD INSTRUMENT DEPARTURES (SIDS), STANDARD TERMINAL ARRIVAL ROUTES (STARS), CANCELLED SIDS

'Standard Instrument Departure (SID)/Standard Terminal Arrival Route (STAR) procedures are a means of graphically communicating large amounts of complex information that would otherwise need to be issued by Air Traffic Control. Both depict the lateral profile of an instrument departure or arrival route and the level and speed restrictions along it. SID/STAR phraseology allows ATC and aircrew to communicate and understand detailed clearance information that would otherwise require long and potentially complex transmissions.[5]

SIDs and STARs are also used to de-conflict the departure and arrival paths of flights, and leverage the capabilities of modern flight management systems to fly precise trajectories. All of these, when coupled with good airspace design, facilitates the use of continuous climb operations (CCO)/continuous descend operations (CDO) procedures leading to an overall reduction in phraseology, workload and improves operational efficiency.'[6]

The pilot must comply with a published SID and STAR, both specify track, vertical profile and any speed requirements. Any specified element of a SID or STAR can be cancelled or amended by the air traffic controller. A pilot may request a SID or STAR (or portion of this) to be cancelled and ATC may approve or deny this request. A SID or STAR cancellation may facilitate a reduction in distance to be flown, an approval to avoid hazardous weather, or be required to maintain separation with other aircraft.

This is explained further in *Fact Sheet 4: Outcome of the peer review process – updates to the 2021 Draft Updated Noise Contours.*

[4] Air Services Australia, Our Technology. https://www.airservicesaustralia. com/about-us/our-services/how-air-traffic-control-works/our-technology/

[5] STARS, https://www.icao.int/airnavigation/sidstar/Documents/New%20 SID%20n%20STAR%20Phraseologies%20 Communication%20Leaflet.pdf

[6] https://www.icao.int/airnavigation/sidstar/Pages/Background.aspx

Fact SHEET 3

OVERVIEW OF THE AIR NOISE CONTOUR REMODELLING AND PEER REVIEW PROCESS

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INTRODUCTION

On 1 September 2021 the Canterbury Regional Council (Environment Canterbury) formally requested that Christchurch International Airport Limited (CIAL) undertake a technical remodelling of the air noise contours relating to Christchurch International Airport (Christchurch Airport), as required by the Canterbury Regional Policy Statement (CRPS). CIAL was asked to provide the modelling inputs, assumptions, and outputs to be peer reviewed by an independent expert panel appointed by Environment Canterbury (the Independent Expert Panel).

In November 2021, CIAL and its experts provided a set of draft remodelled air noise contours to Environment Canterbury (the 2021 Draft Updated Noise Contours) and published the report '*2021 Christchurch International Airport Expert Update of the Operative Plan Noise Contours For Review By Environment Canterbury's Independent Expert Panel*'.

In May 2023 the peer review process concluded and a final set of remodelled air noise contours were produced (the 2023 Updated Noise Contours). The peer review process resulted in updates to several assumptions and modelling inputs used in the 2021 Draft Updated Noise Contours and resulted in changes to the shape and size of the 2023 Updated Noise Contours.

TIMELINE OF AIR NOISE CONTOUR REMODELLING AND PEER REVIEW PROCESS

The key dates of the project to update the Christchurch Airport air noise contours are illustrated by the following timeline:

AUGUST 2018
CIAL commissioned an expert team to undertake remodelling of the existing air noise contours for Christchurch Airport.

MARCH 2020
CIAL paused the remodelling process due to the COVID-19 pandemic.

MAY 2021
CIAL recommenced the remodelling process.

NOVEMBER 2021
CIAL's experts published the 2021 Draft Remodelled Noise Contours and submitted them to Environment Canterbury.

APRIL 2022
Environment Canterbury engaged the Independent Expert Panel to review the 2021 Draft Updated Noise Contours.

JULY 2022
CIAL's experts received the Independent Expert Panel's initial review findings on the 2021 Draft Updated Noise Contours.

JULY 2022 TO APRIL 2023
Peer review process ongoing, with ongoing dialogue between the Independent Expert Panel and CIAL's experts to refine technical inputs and assumptions.

APRIL 2023
Independent Expert Panel indicated interim agreement with 2023 Updated Noise Contours.

JUNE 2023
Final technical reporting prepared by CIAL's experts.

JULY 2023
Final reporting expected to be completed by the Independent Expert Panel. Remodelling and peer review process then concludes.

The Independent Expert Panel review covered all aspects of the modelling work relating to all four workstreams. The peer review process was highly detailed and required a working relationship between CIAL's experts and the Independent Expert Panel over a period of approximately 18 months to ensure the 2023 Updated Noise Contours were based on the best available technical inputs and assumptions.

STAGE 1: PREPARATION OF THE 2021 DRAFT UPDATED NOISE CONTOURS

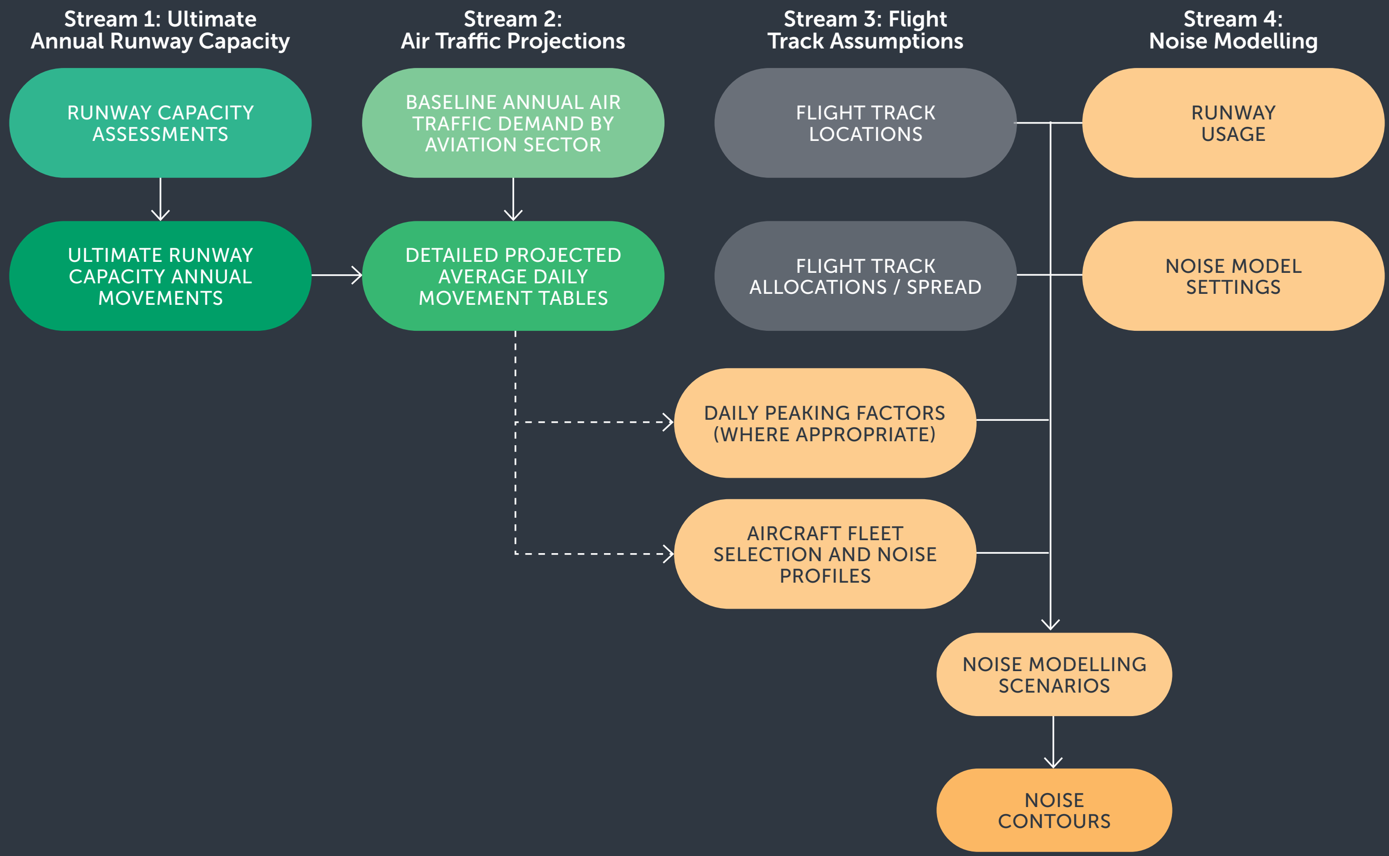
In anticipation of a request to remodel the air noise contours by Environment Canterbury, CIAL began the process of commissioning experts to remodel Christchurch Airport's noise contours in 2018.

CIAL's experts were from Marshall Day Acoustics, Airbiz, and CIAL. Consultation was held with Airways New Zealand (Airways), New Zealand's Air Traffic Service provider, and airlines that use Christchurch Airport. After being interrupted by COVID-19, the project recommenced in 2021.

Preparation of 2021 Draft Updated Noise Contours was structured based on four key workstreams, the outputs of which all interact to produce the air noise contours.

These are illustrated in the flow chart.

2021 Modelling Update Process: Expertise and Inputs



STAGE 2: PEER REVIEW OF 2021 DRAFT UPDATED NOISE CONTOURS

THE KEY STEPS THAT OCCURRED IN THE PEER REVIEW PROCESS WERE:

• **Submission:** The 2021 Draft Updated Noise Contours and associated technical reports (technical reports) were submitted to Environment Canterbury.

• **Preliminary Review:** Environment Canterbury appointed the Independent Expert Panel who were provided with the 2021 Draft Updated Noise Contours and associated reporting.

• **Initiation Meeting:** A meeting was held with the Chair of the Independent Expert Panel, who holds overall responsibility for delivering the Independent Expert Panel review, and CIAL and the Airbiz project management team. The purpose of this meeting was to discuss the administration of the peer review.

• **Initial Request for Information:** The Independent Expert Panel submitted an initial request for information in April 2022. This listed technical files that the Independent Expert Panel would need to review and provided questions from their initial review of the technical reports.

• **Request for Information Briefing:** The Independent Expert Panel met with CIAL, Airbiz and Marshall Day Acoustics to:

(a) make introductions;

(b) discuss the peer review scope, process, and timeframes; and

(c) to discuss the Independent Expert Panel's initial request for information.

• **Information Provision:** CIAL's experts provided the files and documentation requested. Where required, the Independent Expert Panel sought clarification from CIAL's experts.

• **Second Request for Information:** In June 2022 the Independent Expert Panel submitted a further request for information to CIAL's experts.

• **Information Provision:** CIAL's experts provided the files and documentation requested. Where required, the Independent Expert Panel sought clarification from CIAL's experts.

• **Initial Findings**: In July 2022 CIAL's experts received the Independent Expert Panel's initial review findings report (Initial Report). The Initial Report provided preliminary findings and recommendations for each of the four workstreams.

• **Iterative Technical Reviews:** Following the Initial Report, CIAL's experts iteratively addressed issues raised by the Independent Expert Panel in writing and in virtual meetings. This continued until all issues identified by the Independent Expert Panel were resolved.

• **Iterative Reporting Reviews:** The Independent Panel reviewed the draft reports prepared by CIAL's experts to confirm the methodology and assumptions were adequately explained. Again this was an iterative process - the Independent Expert Panel was given the opportunity to and did provide feedback on the reporting.

• **Interim Agreement on Contours:** In May 2023 the Independent Panel provided initial agreement on the assumptions, AEDT noise model inputs and noise contour line calculation process used to produce the 2023 Updated Noise Contours. The Independent Expert Panel's final findings will be provided in the Independent Expert Panel report expected to be released in July 2023.

• **Final Review Report:** The Independent Expert Panel will document its findings in a final report to Environment Canterbury which is expected to be released by July 2023.

STAGE 3: 2023 UPDATED NOISE CONTOURS AND TECHNICAL REPORTS PUBLISHED

This report presents the 2023 Updated Noise Contours and the technical reports prepared by CIAL's experts.

The Independent Expert Panel's final report and technical reports will be published separately.

Fact SHEET 4

OUTCOME OF THE PEER REVIEW PROCESS – UPDATES TO THE 2021 DRAFT UPDATED NOISE CONTOURS

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INTRODUCTION

As outlined in *Fact Sheet 3: Overview of the air noise contour remodelling and peer review process,* CIAL's experts prepared the *2021 Draft Updated Noise Contours* which were then peer reviewed by an Independent Expert Panel appointed by Environment Canterbury. The peer review process has concluded and 2023 Updated Noise Contours are presented in this report. The peer review process resulted in refinements to some of the assumptions and modelling inputs previously used to produce the 2021 Draft Noise Updated Contours. Adjustments made following the peer review process mean the shape and size of the 2023 Updated Noise Contours are different, but ensure that the 2023 Updated Noise Contours are based on the most appropriate technical evidence at this time. The main drivers of change are explained below.

MAIN DRIVERS OF CHANGE

DEPARTURE FLIGHT TRACKS:

The departure flight tracks used for modelling the 2021 Draft Updated Noise Contours were assumed to match the then-current published departure procedures, as advised by Airways. Published procedures are documented on the Aeronautical Information Publication (AIP) New Zealand and are used by pilots for navigation purposes.

During the peer review process, the Airways radar data for Christchurch Airport was revisited. It was observed that while, on departure, some aircraft maintain the published procedure, most aircraft initially followed these procedures and then leave the defined flight tracks at various points.

Airways advised that this is common practice at Christchurch Airport and could be expected to continue in the future. Airways also advised that, in the future, it may progressively design and publish a range of new departure procedure tracks which may more closely align with the common flight paths actually flown. It was important to take this information into account, as the air noise contour remodelling process also determines the parameters of noise compliance at Christchurch Airport.

In light of that analysis and Airways' updated advice, the 2023 Updated Noise Contours are based on selected published departure procedures (where analysis of radar data showed there is a sufficient volume of flights that follow these) and also radar data for Christchurch Airport to define a range of other commonly used alternative flight paths. Based on Airways' updated advice this represents the best available view of current and likely future flight paths and:

- Is representative of where aircraft are likely to fly when or if new departure procedure tracks are published in the future;
- Includes a selection of movements based on current published departure procedure tracks; and
- Excludes those parts of the published departure procedure tracks which are not currently followed for the full length nor are they expected to be in the future.

This change in approach required a detailed analysis by Airbiz of initially one month and later 12 months of radar data obtained from Airways to update the departure flight tracks Airways then reviewed the revised departure tracks for the noise model.

The Independent Expert Panel also reviewed and provided feedback on the revised departure tracks and further refinements were made. This required a great deal of detailed revision to ensure the flight track assumptions were robust and were reflected appropriately in the modelling.

Why don't aircraft always follow published departure procedures for their full length?

Aircraft flying from one airport to another go through three general phases of flight:

- A 'departure' phase - where the aircraft departs the runway and then navigates the airspace around an airport using a specific departure procedure. For the majority of jet and turbo-prop aircraft that depart Christchurch Airport these departure procedures are identified as Standard Instrument Departures (SIDs).
- An 'enroute' phase - where aircraft proceed towards a destination either via a published air route or, if no published route exists, via a flight planned route.
- An 'arrival' phase – where the aircraft enter the arrival route structure of the destination airport and join a specific arrival procedure to land on the nominated runway. An arrival phase is considered to start from where the aircraft leaves its cruising altitude. For the majority of jet and turbo-prop aircraft that use Christchurch Airport these published arrival procedures are called a Standard Terminal Arrival Route.

It is important for safety and runway capacity reasons that aircraft in the airport's airspace operate in a safe, orderly and predictable way so air traffic control can direct them to proceed towards a runway for landing in a safe and efficient manner. In the arrival phase, examination of Airways radar data demonstrates that aircraft do typically follow published arrival procedures as they get closer to Christchurch Airport and land on the nominated runway.

In the departure phase, analysis of Airways departure radar data showed that aircraft take-off from the runway using published procedures but that they often diverge from the published procedure. Diverging from a defined SID (track, altitude or speed) may be at pilot request to air traffic control or initiated by air traffic control for reasons such as route efficiency, weather avoidance, better noise or emissions outcomes and tactical separation with other aircraft. Aircraft will eventually either re-join the published procedure or will connect with the enroute network at a later waypoint.

This practice is typically referred to as a "cancellation of a Standard Instrument Departure" or "cancelled SID". Airways has confirmed this as common practice at Christchurch Airport, and also at busy airports throughout the world, and can be expected to continue to occur.

Based on these refinements, the 2023 Updated Noise Contours reflect the updated departure flight tracks.

FLEET MIX:

During the peer review process, it was identified that in the medium to long term some regional routes e.g. Christchurch-Hamilton would be expected to have narrow-body jet aircraft (e.g. A320Neo) flying on them rather than smaller turbo-prop aircraft (e.g. ATR-72). As a result, the predicted future aircraft fleet mix for several regional routes was updated to introduce jet aircraft where there are currently only turbo-prop aircraft flying.

This type of aircraft fleet change is driven by the airlines as they seek to align passenger demand with aircraft capacity i.e. where the regular passenger demand on a route increases to a point where it is better met by using a larger capacity aircraft. This fleet change can occur for the busiest times of the day, on certain days of the week, seasonally or at all times when passenger demand on a particular route reaches a sufficient threshold.

Future fleet mix assumptions for regional routes where annual passenger demand was forecast to grow high enough, such as Christchurch-Dunedin, were updated to include a portion of jets in place of turbo-props. For other regional routes, such as Christchurch-Marlborough, the turbo-prop assumption was retained in full.

This resulted in a higher proportion of regional jet movements and a lower proportion of turbo-prop movements overall.

OTHER DRIVERS OF CHANGE

Several other updates occurred during the review process, although these had less impact on the size and shape of the 2023 Updated Noise Contours compared to Flight Track and Fleet Mix changes outlined above.

MODELLING SOFTWARE:

The INM was used to prepare all inputs (runway geometry, flight tracks, schedule of operations etc) for the 2021 Draft Updated Noise Contours. These were then imported into the most recent software, the AEDT, to produce the 2021 Draft Updated Noise Contours.

To reflect current best practice and to include current aircraft types available in AEDT and not INM, a new 2023 AEDT model was developed from the 'ground-up'. This new model also included the revised track data.

ULTIMATE CAPACITY:

The Existing Noise Contours and the 2023 Updated Noise Contours for Christchurch Airport are based upon what the projected aircraft noise exposure in the vicinity of Christchurch Airport operating at its ultimate runway capacity.

Globally, there are a range of definitions of ultimate capacity and approaches to calculating ultimate capacity. Through the peer review process CIAL's experts gained acceptance of the adopted methodologies from the Independent Expert Panel.

In consultation with Airways, the ultimate runway capacity has been assessed based on a reasonable understanding of current and future airspace and airfield operations, and air traffic management procedures. Reasonably expected improvements to these that could increase the future ultimate capacity of the airfield have also been applied, as agreed with Airways.

During the peer review the Independent Expert Panel noted that there are other potential improvements that might increase runway capacity further. However, it was ultimately agreed that those potential enhancements should not be applied as there is no firm evidence base for alternative assumptions. The 2023 Updated Noise Contours use the best available local information and projections at this time, including the assessment of when the runway approaches ultimate practical capacity. This ensures the appropriate balance between safeguarding Christchurch Airport, an irreplaceable and vital national and regional transport connectivity infrastructure asset, and unreasonable levels of land use restrictions.

This approach was discussed and agreed between CIAL's experts and the Independent Expert Panel.

1 Executive SUMMARY

GLOSSARY

THE BELOW GLOSSARY OF TERMS IS COMMON TO ALL OF THE REPORTS IN THIS PACKAGE.

Term	Description
2021 Draft Updated Noise Contours	The draft air noise contours modelled by CIAL's Expert Team in 2021 for peer review by the Independent Expert Panel.
2021 Draft Remodelling Report	2021 Christchurch International Airport Expert Update of the Existing Noise Contours For Review By Environment Canterbury's Independent Expert Panel.
2023 Updated Noise Contours	The final updated air noise contours to replace the Existing Noise Contours, modelled by CIAL's Expert Team and peer reviewed and confirmed by the Independent Expert Panel.
AANC	Annual Aircraft Noise Contour. Prepared annually to determine compliance with the 65dB Ldn Air Noise Compliance Contour.
AEDT	Aviation Environmental Design Tool. A proprietary noise model created by the FAA used to calculate noise contours around an airport (replacement of the FAA's INM model).
AIP	Aeronautical Information Publication New Zealand. Contains aeronautical information essential to air navigation in New Zealand.
Airways	Airways New Zealand, the sole Air Traffic Service provider in New Zealand.
Airbiz	Aviation consultants engaged by CIAL to be part of CIAL's Expert Team.
Ambient Noise	The totally encompassing sound in a given situation at a given time, from all sources near and far including the specific sound.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
Base Case	Initial noise contour run with standard and selected baseline inputs which all other sensitivity runs are compared to.
Christchurch Airport	Christchurch International Airport.
CIAL	Christchurch International Airport Limited.
CIAL's Expert Team	The team of experts engaged by CIAL to remodel the Existing Noise Contours.
Cliflo	The web system that provides access to New Zealand's National Climate Database.
Continuous Descent Approach	An aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight.
Continuous Climb Operations	An aircraft operating technique allowing the execution of a flight profile optimised to the performance of aircraft, leading to significant economy of fuel and environmental benefits in terms of noise and emissions reduction.
Crosswind Runway	Refers collectively to Runway 11 and Runway 29.
CRPS	Canterbury Regional Policy Statement.
Current Fleet	Refers to the fleet mix that currently operates at Christchurch Airport.
Current Runway Configuration	Refers to the currently existing main and crosswind runway. Does not include any proposed extensions.
Daytime	The hours from 7am to 10pm (as per NZS 6805).
dB	Decibel. The unit of sound pressure level. Expressed as a logarithmic ratio to base 10 of sound pressure P relative to a reference pressure of Pr=20 mPa i.e. dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear.
Displaced Approach Threshold	The landing threshold is marked on the runway to denote the beginning of the designated space for landing under non-emergency conditions. The displacement is the distance from the runway endpoint to the landing threshold markings. It must be defined in the noise model to inform the arrival flight profiles.
DMAPS	Divergent Missed Approach Protection System. Departure procedures with tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control. These procedures enhance safe separation of planes, increased capacity, efficiency and predictability.

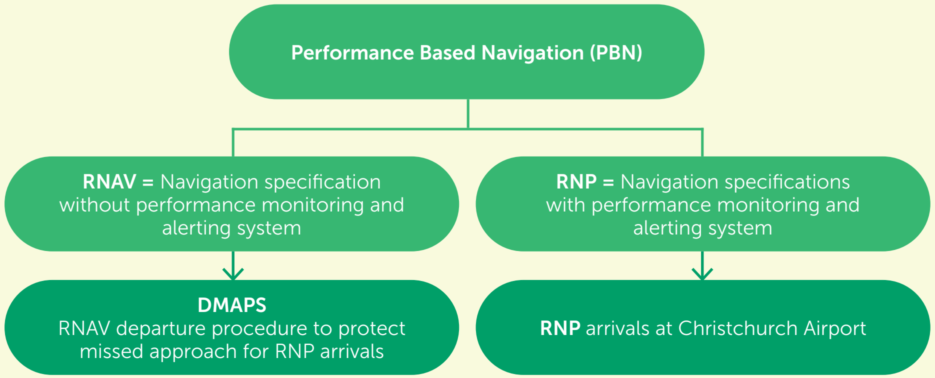
GLOSSARY CONT.

DMAPS Tracks	Refers to the flight tracks currently in use at Christchurch Airport as described by Airways, with PBN procedures in place and DMAPS departures.
Environment Canterbury	Canterbury Regional Council.
FAA	The United States Department of Transportation Federal Aviation Administration, the developer of the INM and the AEDT noise models.
FBO	Fixed Base Operator. An enterprise which operates from the airport and carries out general aviation activities such as air ambulance, charters, and business jets.
Flight Operations Input	The input into the noise model containing the aircraft operations broken down by runway, track, aircraft type, profile, stage length and time of day.
Future Fleet	Refers to the fleet mix that could operate into Christchurch Airport in the future. Includes new generation aircraft but not futuristic aircraft that are only in the conceptual design stage.
Future Runway Configuration	Refers to the envisaged future main and crosswind runway. Includes proposed extensions to Runway 11 and Runway 20 as outlined in the 2017 Christchurch Airport Master Plan.
ILS Approach	Instrument Landing System Approach. A type of approach that uses a precision runway approach aid based on ground-based landing aids where two radio beams provide vertical and horizontal guidance to pilots on aircraft instrumentation to execute a landing.
Independent Expert Panel	The panel of independent experts appointed by Environment Canterbury to review the 2021 Draft Updated Noise Contours.
INM	The FAA's Integrated Noise Model. A proprietary noise model used to calculate noise contours around an airport. INM was replaced by AEDT.
IPCC	Intergovernmental Panel on Climate Change.
LAeq	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level.

LAmax	The A-weighted maximum noise level. The highest sound level which occurs during the measurement period.
Ldn	The day-night noise level which is calculated from the 24-hour LAeq with a 10-dB penalty applied to the night-time (2200-0700 hours) LAeq.
Main Runway	Refers collectively to Runway 02 and Runway 20.
MDA	Marshall Day Acoustics, engaged by CIAL to be part of CIAL's Expert Team.
MRO	Maintenance, repair and overhaul.
NASA	The US National Aeronautics and Space Administration.
National Climate Database	Database of weather and climate measurements in New Zealand. Collated by NIWA.
Night-time	The hours 10 pm to 7am (as per NZS 6805).
NIWA	National Institute of Water and Atmospheric Research.
No-DMAPS Tracks	Refers to the flight tracks operating at Christchurch Airport as described by Airways which were used prior to 2020. Does not include DMAPS departures.
Noise	A sound that is unwanted by or distracting to the receiver.

GLOSSARY CONT.

Noise Model	A software program used to model aircraft noise to produce the noise contours. The INM and the AEDT are types of noise model. It allows outputs in a range of metrics for noise impact assessment.
NZS 6805	New Zealand Standard 6805:1992 "Airport Noise Management and Land Use Planning".
Existing Noise Contours	The Noise Contours currently in the CRPS and Christchurch, Selwyn and Waimakariri District Plans.
PBN	Performance-Based Navigation. Encompasses a shift from ground-based navigation aids emitting signals to aircraft receivers, to 'in-aircraft' systems that receive satellite signals from sources such as the Global Positioning System (GPS).



Piano Keys (or Threshold Markings)	Pavement runway threshold marking comprising a series of parallel, longitudinal, stripes across the width of the runway, commencing at a point approximately 6 metres from the runway end indicating the start of the portion of the runway that can be used for landing and take-off.

Radar data	Radar data is a dataset of actual historical flown aircraft flight tracks departing from and arriving at Christchurch Airport. Airways provided this data to the project team for use in flight track modelling.
Residual Noise	The residual noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
RNAV	Area Navigation. Is a type of PBN. Refers to the capability of an aircraft pilot to fly any desired flight track, defined by waypoints such as geographic fixes (latitude and longitude) and not necessarily by reference to ground navigation aids.
RNP	Required Navigation Performance. Is a type of PBN. A similar specification to RNAV, but requires that aircraft have systems to monitor navigation performance and alert the flight crew if the required levels are not being achieved. RNP applications are also more precise and include advanced capabilities like curved paths.
RNP-AR	Required Navigation Performance Authorisation Required. A higher standard type of RNP currently used for some approach procedures.
RNP Approach	Required Navigation Performance Approach. Is a type of PBN approach that allows an aircraft to fly a specific track between two 3-dimensionally defined points in space.
Runway 02	Runway 02 is the main runway with aircraft landing and taking off in a northerly direction (heading approximately 020 degrees magnetic)
Runway 11	Runway 11 is the crosswind runway with aircraft landing and taking off in an easterly direction (heading approximately 110 degrees magnetic)
Runway 20	Runway 20 is the main runway with aircraft landing and taking off in a southerly direction (heading approximately 200 degrees magnetic)
Runway 29	Runway 29 is the crosswind runway with aircraft landing and taking off in a westerly direction (heading approximately 290 degrees magnetic)

GLOSSARY CONT.

Runway 02/20	The main runway made up of Runway 02 in one direction and Runway 20 in the other direction.
Runway 11/29	The crosswind runway made up of Runway 11 in one direction and Runway 29 in the other direction.
SAE-AIR-1845	SAE-Aerospace Information Report-1845:1986 "Procedure for the Calculation of Airplane Noise in the Vicinity of Airports".
SAE-APR-866A	SAE-Aerospace Recommended Practice-866A:1975 "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise"
SAE-ARP -5534	SAE-Aerospace Recommended Practice-5534:2013 "Application of Pure Tone Atmospheric Absorption Losses to One-Third Octave Band Data"
SEL or LAE	Sound Exposure Level. The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
Sensitivity Run	Several runs taken to isolate or understand the effect of certain inputs and assumptions to the noise contours such as fleet changes or changes to flight tracks.
SIMOPS	Simultaneous Operations. Refers to simultaneous landings on one runway while take-offs are taking place on the other runway. It is enabled by extending the Main Runway.
SRTM	Shuttle Radar Topography Mission. Is an international research effort that obtained digital elevation models on a near-global scale, to generate a high-resolution digital topographic database of Earth.
Start of Roll (or Displaced Take-off Threshold)	Distance from the physical end of the runway to the average position of noise-producing engines at the start of take-off roll, which is the portion of an aircraft operation on the runway accelerating from a standstill to reaching a speed where there is sufficient lift generated to become airborne.
Step Down Approach	An aircraft operating technique in which an aircraft descends via a series of steps. This involves level fly segments and periods of descent. Continuous descent approach is slowly replacing step down approach as they are quieter and more efficient.
Visual Approach	An approach when either part or all an instrument approach procedure is not completed, and the approach is executed by the pilot in command with visual reference to the terrain and other traffic.

INTRODUCTION TO NOISE CONTOUR REMODELLING

1 This report introduces the background and context for the remodelling of the air noise contours for Christchurch Airport.

2 This report is part of a suite of documents which explain the inputs, assumptions, and outcomes of the remodelling process.

- **2.1** Volume 1 (this report) introduces the process and reasons for remodelling the Existing Noise Contours, and provides an overview of the inputs, assumptions and outcomes of the work completed;
- **2.2** Volumes 2, 3 and 4 have been prepared by expert aviation consultants. These technical reports explain the modelling inputs and assumptions made with respect to the flight tracks, aircraft fleet mix, air traffic projections, and ultimate runway capacity of Christchurch Airport;
- **2.3** Volume 5 has been prepared by expert acoustics consultants with aircraft noise experience. This report explains; the noise modelling inputs and assumptions, the modelling methods used, and the modelling outcomes.

3 Technical input into this project has been provided by:

- **3.1** MDA – noise modelling and measurements for model calibration;
- **3.2** Airbiz – ultimate runway capacity, air traffic projections, and flight track assumptions;
- **3.3** Airways – flight track and aircraft operational procedure information;
- **3.4** CIAL – in consultation with airlines, information regarding air traffic demand, scheduling of aircraft movements and fleet mix and runway extension plans in the Christchurch Airport Master Plan.

PURPOSE OF NOISE CONTOURS

4 Airports are essential for transporting people and goods. They are intergenerational assets which enable economic growth, support social wellbeing, and connect communities within New Zealand and around the world.

5 Noise from aircraft departing and arriving is a normal and unavoidable aspect of airport operations. However, this aircraft noise also affects people who live and work on land close to an airport or under flight paths.

6 To protect both local communities and airport operations, and to proactively make sure that airports can serve their communities well into the future, land use planning is important. Planners preparing district and regional plans need to understand which areas of land are predicted to be affected by aircraft noise. Proactive planning rules protect people from establishing sensitive land uses (like housing, schools or hospitals) in areas that are exposed to higher levels of aircraft noise which might disturb them or affect their quality of life. Those same planning rules enable airport operations to continue to support and benefit communities.

7 Noise contours help to identify areas where urban growth is best located, and they help identify areas where land uses like industrial, agricultural or recreational activities would be more appropriate.

8 The area of land affected by aircraft noise is identified through a modelling process, which generates contour lines on a map showing the level of noise expected to be experienced on the ground – an airport's noise 'footprint'.

9 NZS 6805 guides the noise contour modelling process and the associated land use planning and airport noise compliance rules.

10 The Existing Noise Contours and the 2023 Updated Noise Contours for Christchurch Airport are based upon what the aircraft noise is predicted to be when Christchurch Airport is operating at ultimate runway capacity. NZS 6805 recommends that a projection should be made of future aircraft operations to determine the noise contours, and that the projection be based on a 10 year period at a minimum. This is because noise contours are required to be representative of the future projected aircraft operations, not simply a snapshot of aircraft noise at a given time. Airport planning is also done on a long time horizon (typically around 50 years into the future). This then aligns with the land using planning processes which also take a longer-term view of urban growth needs and are subject to periodic updates.

AIRCRAFT NOISE

11 Aircraft noise is caused by two main components, the aircraft's engines and the aircraft moving through the air (air flowing over the airframe, landing gear and flaps etc).

12 At Christchurch Airport there are both fixed wing and rotary wing (predominantly helicopters) aircraft operating. Fixed wing aircraft are used for commercial scheduled passenger services, dedicated freight, other commercial operations, Antarctic operations based at the International Antarctic Centre, general aviation, and military or other government operations. Rotary wing aircraft are used for various commercial operations, emergency and rescue services, general aviation, and military or other government operations.

13 Different types and models of aircraft create different levels of noise. Generally, larger aircraft (usually equipped with jet engines) make more noise than smaller aircraft (generally driven by turbine or piston propellors). Rotary wing aircraft such as helicopters have quite different operating and noise characteristics from fixed wing aircraft.

14 The aircraft noise which is heard on the ground is also influenced by a variety of other factors, including:

14.1 The runways used for arrival or for take-off;

14.2 Aircraft lateral flight paths, navigation procedures, typical spread across a notional central (backbone) flight path and the vertical flight profile including application of thrust at various stages of the take-off or landing procedure;

14.3 Weather conditions (through the effects of atmospheric absorption, ground attenuation, cloud cover, wind, temperature, fog) – particularly seasonal north-westerly wind conditions;

14.4 Terrain surrounding the airport – both in terms of the way it influences aircraft operational procedures to maintain clearance from obstacles and how the sound from the aircraft travels;

14.5 Background noise levels – which change throughout the day (for example, it is usually quieter at night so aircraft noise is more noticeable).

15 Christchurch Airport operates 24/7 however noise levels change throughout the day and night. The impact of one aircraft is markedly different to the cumulative impact of many aircraft. A person's annoyance response has been shown to be influenced by the accumulated effects of related exposure to noise events. NZS 6805 recognises this effect and, consistent with international best practice, aircraft noise is therefore assessed by looking at the average noise exposure on a typical day.

AIRCRAFT NOISE: UNITS OF MEASUREMENT AND LDN METRIC

16 Noise levels are measured on a logarithmic scale in dB. Measurements of noise usually have a correction factor applied to reflect the sensitivity of the human ear. This factor is referred to as the "A-weighting" and environmental noise is usually measured in dBA units. The noise level of normal daytime urban-based activities typically varies between 40dBA and 85dBA. On this scale, an increase in the noise level of 10dBA is perceived to be a doubling loudness or a decrease of 10dBA as a halving in loudness. For example, most people perceive a noise event of 85dBA to be about twice as loud as an event of 75dBA.

17 NZS 6805 uses the Ldn cumulative metric for airport noise contours which is the equivalent sound level for a 24-hour period. An additional 10 dBA penalty is imposed during night-time hours of 10pm to 7am. This night weighting accounts for people's increased sensitivity to noise at night. A single aircraft movement at night is equivalent to 10 of the same aircraft movements during the day.

EXISTING NOISE CONTOURS

18 The Existing Noise Contours were approved in 2008.

19 The panel of experts at that time agreed that the Christchurch Airport air noise contours were to be modelled based on the following inputs and assumptions (in summary):

19.1 The contours were to be representative of what the aircraft noise impact would be when Christchurch Airport reaches its capacity;

19.2 The ultimate capacity scenario used was 175,000 commercial passenger aircraft movements per annum (the panel concluded that Christchurch Airport infrastructure could support 175,000 commercial passenger aircraft movements per annum and 225,000 total operations per annum (including general aviation);

19.3 Only commercial passenger aircraft movements and a nominal allocation of freight movements (five per week) were modelled – other movements such as actual freight movements, general aviation, Antarctic, helicopters, and military and other government aircraft movements were not included in the modelling;

19.4 The future extension of the Crosswind Runway was accounted for;

19.5 The proportional split between usage of each end of the Main runway was assumed to be 52%/31% (for runway ends 02 and 20 respectively). Modelling was adjusted to account for seasonal north-westerly wind conditions which result in increased usage of the Crosswind Runway at particular times of the year. The number of movements on those runway ends was scaled up in the model;

19.6 The A380 and B747-400 aircraft were replaced with the B777-300 noise profile in the modelled fleet mix;

19.7 Flight paths (also known as flight procedures or flight tracks) for approach and departure to Christchurch Airport which were in use at the time – aircraft predominantly arrived and departed “straight on” to the airport runways.

20 Several of the above assumptions and inputs into the Existing Noise Contours needed updating. This is explained below.

REASONS FOR REMODELLING THE EXISTING NOISE CONTOURS

21 There have been noise contours for Christchurch Airport shown in planning documents since 1994. The first noise contours were updated in 2008 (to produce the Existing Noise Contours which are in the current plans). This remodelling process to produce the 2023 Updated Noise Contours is the second update.

22 Over time, aviation industry practices and airport operations change and evolve. It is appropriate and accepted practice to periodically update the noise contour modelling to ensure that it accounts for changes in inputs or assumptions such as updated air traffic management and control procedures, or changes to the aircraft fleet mix.

23 Policy 6.3.11(3) of the CRPS provides that, prior to a review of Chapter 6 of the CRPS, Environment Canterbury may request CIAL to undertake a remodelling of the air noise contours relating to Christchurch Airport. CIAL received a formal request from Environment Canterbury, pursuant to Policy 6.3.11(3), on 1 September 2021.

24 The CRPS provides that any remodelling in terms of Policy 6.3.11(3) shall:

- involve an assessment of projected future airport business growth and operation and shall take into account, but not be limited to aircraft movements, flight tracks, fleet mix and runway utilisation; and
- be accompanied by the report of an independent panel of airport noise experts who have undertaken a peer review of the inputs, assumptions and outcomes of the remodelling; and
- shall be provided to Environment Canterbury in the form of a comprehensive report along with an executive summary or summary report.

25 The suite of documents in this report explain the remodelling that has been completed by CIAL’s Expert Team and peer reviewed by the Independent Expert Panel appointed by Environment Canterbury.

OVERVIEW OF PROCESS

26 In anticipation of a formal request from Environment Canterbury, CIAL began the process of commissioning experts to remodel the Existing Noise Contours in 2018. This work was partially completed when the COVID-19 pandemic began in March 2020, temporarily halting progress. The project recommenced in 2021.

27 CIAL commissioned aviation experts and acoustics experts with experience in aircraft noise to identify appropriate modelling inputs and assumptions, and to carry out the modelling for the 2023 Updated Noise Contours. Airways has also provided information on flight tracks and air traffic navigational matters as part of a consultative process as input into modelling. Airline companies have similarly provided input on aircraft fleet mix assumptions.

28 On 1 September 2021 Environment Canterbury formally requested that CIAL undertake a technical remodelling of the Existing Noise Contours and provide the modelling inputs, assumptions, and outputs to Environment Canterbury to be peer reviewed by an Independent Expert Panel.

29 In November 2021, CIAL and the CIAL Expert Team provided the 2021 Draft Updated Noise Contours to the Environment Canterbury and published the 2021 Draft Remodelling Report.

30 In May 2023 the peer review process concluded and the 2023 Updated Noise Contours were produced. The peer review process resulted in updates to several assumptions and modelling inputs used in the 2021 Draft Updated Noise Contours and resulted in changes to the shape and size of the 2023 Updated Noise Contours.

31 The peer review process is described in *Fact Sheet 3: Overview of the air noise contour remodelling and peer review process.*

2023 UPDATED NOISE CONTOURS – MODELLING PROCESS

32 CIAL's Expert Team has undertaken modelling to produce the 2023 Updated Noise Contours.

33 The 2023 Updated Noise Contours are a different shape and size than the Existing Noise Contours. This reflects changes in aviation practices and operations since 2008, changes in assumptions, and a change in noise modelling software that was used.

MODEL USED

34 The 2023 Updated Noise Contours have been modelled using the AEDT software program developed and maintained by the FAA in the United States. The AEDT models aircraft performance in space and time to predict noise levels on the ground. The AEDT replaces the INM Version 7d modelling tool previously provided and approved by the FAA. The INM, which was used to model the Existing Noise Contours, is no longer supported by the FAA and will not receive updates of new aircraft types and profiles in the future. The 2023 Updated Noise Contours have been calculated in AEDT version 3e, the latest version available at the time.

35 NZS 6805 states that the model to be used for the noise contour is "the FAA Integrated Noise Model or other appropriate models". FAA replaced INM with AEDT and no longer recommends use of INM for aircraft noise modelling. In fact, FAA requires the use of AEDT for aircraft noise modelling in the United States. AEDT is therefore clearly the successor to the INM model originally specified in NZS 6805.

36 As with any modelling software, there is generally a difference between what is modelled and what is measured on the ground. It is best practice in New Zealand to verify a noise model with measurements and adjust the inputs or assumptions to more closely match the measured noise levels from actual aircraft operations. There are several ways to 'calibrate' the noise model. The ways in which the noise model was calibrated are detailed in Volume 5 of this report.

MODELLING APPROACH

37 To determine the influence of the various factors on the air noise contours for Christchurch Airport, a Base Case was developed which included standard and selected baseline inputs that could then be altered to explore and isolate model inputs through sensitivity runs. The Base Case is an initial noise contour run with inputs which were generally consistent with those used for the Existing Noise Contours.

38 Compared to the Base Case, Sensitivity Runs show the difference and changes caused by each modelling factor to the size and shape of the noise contours. This allows each factor to be isolated and enables a better understanding of the makeup of the contours and the influence of each input / assumption. Sensitivity Runs were undertaken in the preparation of the 2021 Draft Updated Noise Contours and were discussed in Volume 5 of the 2021 Draft Remodelling Report.

39 Once the suite of most appropriate model inputs and assumptions were determined, based on advice from CIAL's Expert Team of various disciplines, and following the peer review process, the 2023 Updated Noise Contours were produced.

SUMMARY OF INPUTS AND ASSUMPTIONS USED FOR 2023 UPDATED NOISE CONTOURS

40 The sensitivity study summarised in the 2021 Draft Remodelling Report (Volume 5) tested various input options to help identify which inputs to include in the 2023 Updated Noise Contours. The outcome of this study and a subsequent review by the Independent Expert Panel is that the 2023 Updated Noise Contours include the following assumptions:

- Current and expected future flight tracks, spread, and allocation based on discussions with Airways and analysis of radar data of recent aircraft activity, providing the best current view of existing and expected future flight tracks, spread and allocation;
- Forecast future fleet mix;
- DMAPS and RNP flight paths;
- Commercial scheduled passenger aircraft, freight, FBO/small commercial, airline/MRO (excludes Antarctic, military, government);
- Helicopters (excludes military and rescue helicopters);
- Taxiing of aircraft on the ground to and from runways;
- Updated runway throughput rates based on discussion with Airways considering future air traffic management capabilities;
- 201,000 scheduled passenger aircraft movements at runway capacity (as opposed to 175,000 in the Existing Noise Contour assumptions);
- 10% more usage of Runway 29 to account for climate change;
- Calibration of noise model using flight profiles and departure stage lengths based on New Zealand specific noise monitoring; and
- Runway maintenance diversion of aircraft from main to cross-runway during limited days and hours of main runway closure (for Annual Average only).

DISCUSSION OF MODELLING INPUTS AND ASSUMPTIONS

41 The inputs and assumptions are explained in detail in Volumes 2 through 5 of this report. An overview of the main inputs and assumptions is provided below.

42 The key modelling inputs that affect the shape and size of the noise contours are (in no particular order of importance) flight paths, runway usage, total movements when Christchurch Airport reaches ultimate runway capacity, aircraft fleet, and the inclusion of freight movements.

43 Air noise contours in New Zealand are based on forecast future aircraft movements. NZS 6805 recommends a minimum of 10 years time horizon is used for the projection. For Christchurch Airport, the approach approved by the panel of experts in 2008 and followed in the updated modelling is to input an assumption of aircraft movements when the runways and other infrastructure at Christchurch Airport is operating at **ultimate runway capacity**. For high density, mature international airports, international industry practice favours ultimate runway capacity.

44 In consultation with Airways the ultimate runway capacity has been assessed based on a reasonable understanding of current and future runway operations. Current airspace and airfield operational and system capacity considerations and improvements that could affect the ultimate capacity of the airfield have been applied. Additional potential enhancements beyond those currently proposed at Christchurch Airport were considered but have not been applied as there is no firm evidence base for alternative assumptions.

45 The justification, methodology and calculation of the ultimate runway capacity at Christchurch Airport for noise contour modelling purposes is described in Volume 2 of this report.

46 Ultimate runway capacity is based on the scheduled commercial passenger aircraft movements. Other movements such as freight or general aviation aircraft movements will fit around commercial passenger arrivals and departures (as even at capacity there will be a distribution across the day of peak and off-peak demand).

47 The 2023 Updated Noise Contours are modelled based on ultimate runway capacity at Christchurch Airport of 201,000 commercial passenger aircraft movements (to which freight and other aircraft movements are added). Helicopters are also modelled, but they are not runway movements and operate from designated helipads on their own flight paths. It has been assumed that, while Christchurch Airport is still moving towards ultimate runway capacity, there will be a number of general aviation (aeroclub and recreational light aircraft) aircraft using the airspace which will eventually be displaced to other airfields as commercial scheduled passenger, freight, and other commercial flights increase. Ultimate runway capacity and air traffic projection calculations and assumptions are discussed in detail in Volumes 2 and 3.

48 Significant, once-in-a-generation changes to **flight paths** have been implemented in the last few years to enable improvements in safety, move flight paths away from populated urban areas and improve fuel efficiency, carbon efficiency and flight time. These changes have had an effect on the shape of the 2023 Updated Noise Contours:

48.1 In 2018 Airways adopted RNP for some arriving aircraft. This procedure involves an onboard computer taking control of the aircraft at approximately 15 nautical miles out from touchdown and flying a tightly controlled flight path (including constant descent glide slope) using GPS navigation. One of the consequences of this procedure is more tightly controlled flight paths with less track spreading and consequential 'bumps' in the outer noise contours.

48.2 In 2020, Airways introduced DMAPS departures. This procedure requires aircraft departing on the main runway to turn 15 degrees to the west when they reach an altitude of 500 feet (i.e. relatively early in the departure procedure). This has the effect of reducing the size of the noise contours on the east side of Christchurch Airport and increasing the size to the west.

49 In the 2021 Draft Updated Noise Contours the departure flight tracks used for modelling were assumed to match the then current published departure procedures, as advised by Airways.

50 During the peer review process, the Airways radar data for Christchurch Airport was revisited. It was observed that while, on departure, some aircraft maintain the published procedure, most aircraft initially followed these procedures and then leave the defined flight paths at various points.

51 Airways advised that this is common practice at Christchurch Airport and could be expected to continue at Christchurch Airport in the future. Airways also advised that, in the future, it may progressively design and publish a range of new departure procedure tracks which may more closely align with the common flight paths actually flown at present.

52 Based on this, the 2023 Updated Noise Contours use selected published departure procedures (where analysis of radar data showed there is a sufficient volume of flights that follow these) and also reference current radar data to define a range of other commonly used alternative flight paths. This process is described earlier in this document in *Fact Sheet 4: Outcome of the peer review process* – updates to the *2021 Draft Updated Contours*.

53 Flight tracks assumptions and inputs are explained in detail in Volume 4.

54 A parameter that has a major influence on both the shape and size of the noise contours is the runway usage or runway splits:

54.1 Christchurch Airport has four runway ends – a Main Runway (also known as Runway 02/20) and a runway that is used in north-westerly (crosswind) conditions (also known as Runway 11/29).

54.2 Aircraft operate most efficiently and safely if they take-off and land into the wind. Thus, if the wind is blowing from the north-east, then aircraft will be directed to take-off on the Main Runway heading north-east and arrivals will approach from the south and land facing north-east.

54.3 The Main Runway (with ends facing north-east and south-west) is used most of the time and aligns with the prevailing wind conditions. On occasions when there are sufficiently strong current or forecast north-westerly winds to the extent that air traffic control declares the runway 'in-use', the Crosswind Runway is used to ensure aircraft continue to take-off and land into the wind. The Crosswind Runway is also used while maintenance is done to the Main Runway.

54.4 The noise footprint of an aircraft on arrival is different in shape to that of a departure. In addition, the distribution of the prevailing wind direction varies throughout the year and from one year to the next. The combined effect of these two factors (noise footprint and wind variation) is that the noise exposure at a given receiver location will vary with wind direction/runway usage.

54.5 Christchurch experiences seasonal changes in prevailing wind conditions. Over several months of the year north-westerly winds are more frequent and this means the use of the Crosswind Runway increases. Noise from aircraft using the Crosswind Runway is heard over Christchurch City.

54.6 Departures on Runway 11 are extremely rare. This is because of a longstanding operational protocol to avoid departing aircraft flying over populated urban areas, the short runway length, and lighter wind strength at this orientation.

55 Volume 5 discusses how the allocation of aircraft movements to runway end was determined based on:

- Analysis of actual data of runway usage for the period 1999-2019, including the considering seasonal increased use of the Crosswind Runway;
- Capability of the Crosswind Runway – not all aircraft can operate on the Crosswind Runway due to the runway length;
- Assumptions about potential climate change effects that are expected to increase the prevalence of north-westerly wind patterns.

56 The 2023 Updated Noise Contours include commercial passenger aircraft movements, freight movements, flights associated with airline maintenance, other commercial aviation (fixed-base operators and small commercial operators) and helicopter movements (excluding military and rescue helicopters). Demand for freight flights has changed since earlier modelling in 2008. There are now dedicated freight flights at Christchurch Airport which were not operating in 2008 (freight at that time was mainly loaded into passenger aircraft, but demand has now increased such that dedicated freight flights are operating).

57 The 2023 Updated Noise Contours exclude Antarctic, military and government fixed wing aircraft movements and military and rescue helicopter movements. Christchurch Airport must be able to facilitate military, government and emergency/rescue aircraft movements (fixed wing or helicopter) at all times. Military and government movements are often in response to natural disasters or emergencies and as such Christchurch Airport has limited ability to schedule, predict or manage when these movements will be required. Military and government movements are excluded or managed separately at a number of New Zealand Airports. Generally, they comprise a small number of movements and do not have a significant impact on the noise contours.

58 Antarctic movements have been excluded from the noise contours. Similar to military movements, Christchurch Airport has limited ability to schedule, predict or manage when these Antarctic movements are required and will occur. Antarctic movements are also unique to the "Antarctic Season" (Spring / Summer) which is limited in duration and driven by weather conditions in Antarctica.

59 It has been assumed that as Christchurch Airport approaches ultimate runway capacity, general aviation (aeroclub and recreational light aircraft) movements will be displaced to other airports and that, once operating at capacity, there will be no general aviation movements because the slots will be filled by commercial passenger, freight, and other Antarctic/military/government flights. This is discussed in detail in Volume 3.

60 Another change in the input parameters compared to the Existing Noise Contours is the modelled aircraft type or **fleet mix**. CIAL has had discussions with the main airline operators at Christchurch Airport as to which aircraft they are likely to be flying in the foreseeable future and those projections are included in the noise modelling. The modelling accounts for new generation aircraft.

61 The modelling software has inbuilt **noise profiles for various existing aircraft models.** These noise profiles have been used in the modelling to represent the current and future fleet mix. In some cases, the noise predictions have been calibrated against available measurements for similar operations and adjusted if necessary to ensure they are predicting noise impacts as closely as practicable for existing aircraft types.. The modelling does not attempt to speculate on the noise profile of any aircraft models that are in developmental phases.

62 Other inputs related to airport operations are included in the modelling. The 2023 Updated Noise Contours model the effect of future **runway extensions** which are shown in the Christchurch Airport Master Plan for both the Crosswind and Main Runways. The modelling also accounts for annual runway **maintenance.** Runway maintenance occurs at night on the main runway on a small proportion of days per year. On the nights when runway maintenance occurs aircraft that would normally use the Main Runway must use the Crosswind Runway which increases the extent of the noise contour on this runway.

63 **Climate change** has the potential to impact the size and shape of the contours in two ways:

63.1 NIWA predicts that the frequency of north-westerly winds will increase due to climate change, which will increase use of the Crosswind Runway;

63.2 NIWA also predicts an increase in temperature and more hot/humid conditions, which could impact the propagation of sound.

64 As outlined above, the predicted impacts of climate change have been accounted for in the model – assuming a 10% increase in the usage of the Crosswind Runway caused by the predicated increased frequency of north-westerly wind conditions.

OUTER ENVELOPE AND ANNUAL AVERAGE

65 The suite of documents prepared by CIAL's Expert Team puts forward two options for modelling the 2023 Updated Noise Contours for Environment Canterbury's consideration (these two modelling options are discussed in detail in Volume 5):

65.1 Outer Envelope - a final contour based on the busiest three-month period of use on each runway (taking data from the past 20 years); and

65.2 Annual Average - a final contour based on the annual average runway usage.

66 The Outer Envelope future noise contour is a composite of four scenarios which represent the highest recorded runway usage on each runway end over a three month period. The Outer Envelope of these four noise contours is taken to form the final noise contour.

67 The Annual Average future noise contour is a single noise contour run to represent noise over an entire calendar year instead of the busiest three months for each runway end. The historical annual average runway splits are used for this run.

68 NZS 6805 suggests that the busiest three-month period "or such other period as is agreed" is used to prepare noise contours. NZS 6805 therefore provides flexibility to adopt the approach most appropriate to each airport based on specific context.

69 CIAL's Expert Team and the Independent Expert Panel agreed that both the Outer Envelope and Annual Average options are technically valid methods of modelling noise contours. Both of these methods are used at various airports in New Zealand. As per the CRPS, the scope of the Independent Expert Panel peer review process was to review the inputs and assumptions used for both methods. Additional policy and planning input is required to determine which method is more appropriate for inclusion in the CRPS and District Plans and for setting land use controls in Canterbury.

CONCLUSION

70 The above provides an overview of the remodelling process, reason for undertaking the remodelling work, peer review process, comparison and history of the Existing Noise Contours, key inputs and assumptions, and approach to modelling the 2023 Updated Noise Contours.

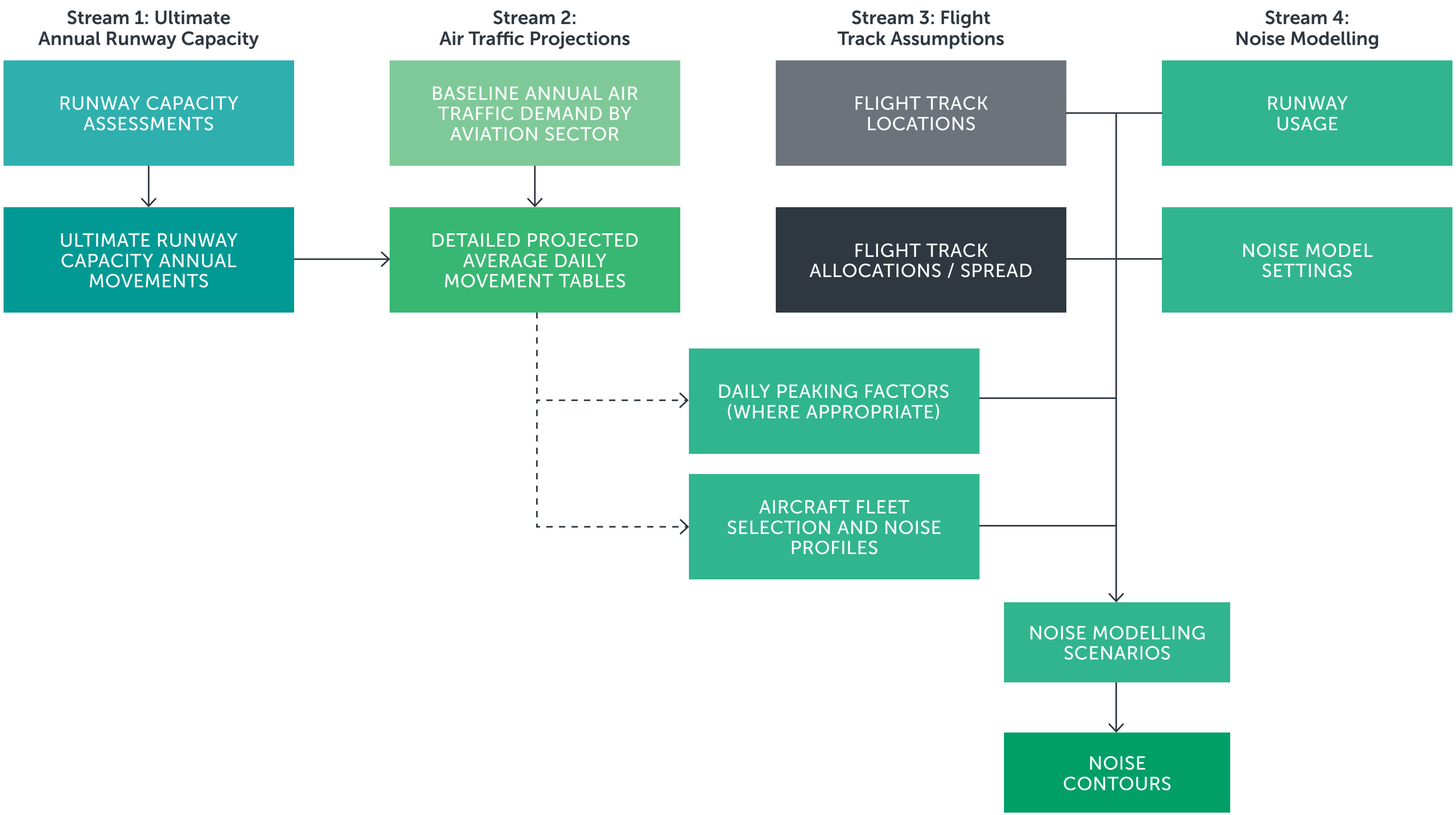
71 Please refer to the accompanying technical documents for further detail:

71.1 Volumes 2, 3 and 4 have been prepared by expert aviation consultants. These technical reports explain the modelling inputs and assumptions made with respect to the flight track assumptions, aircraft fleet mix, air traffic projections, and ultimate runway capacity of Christchurch Airport;

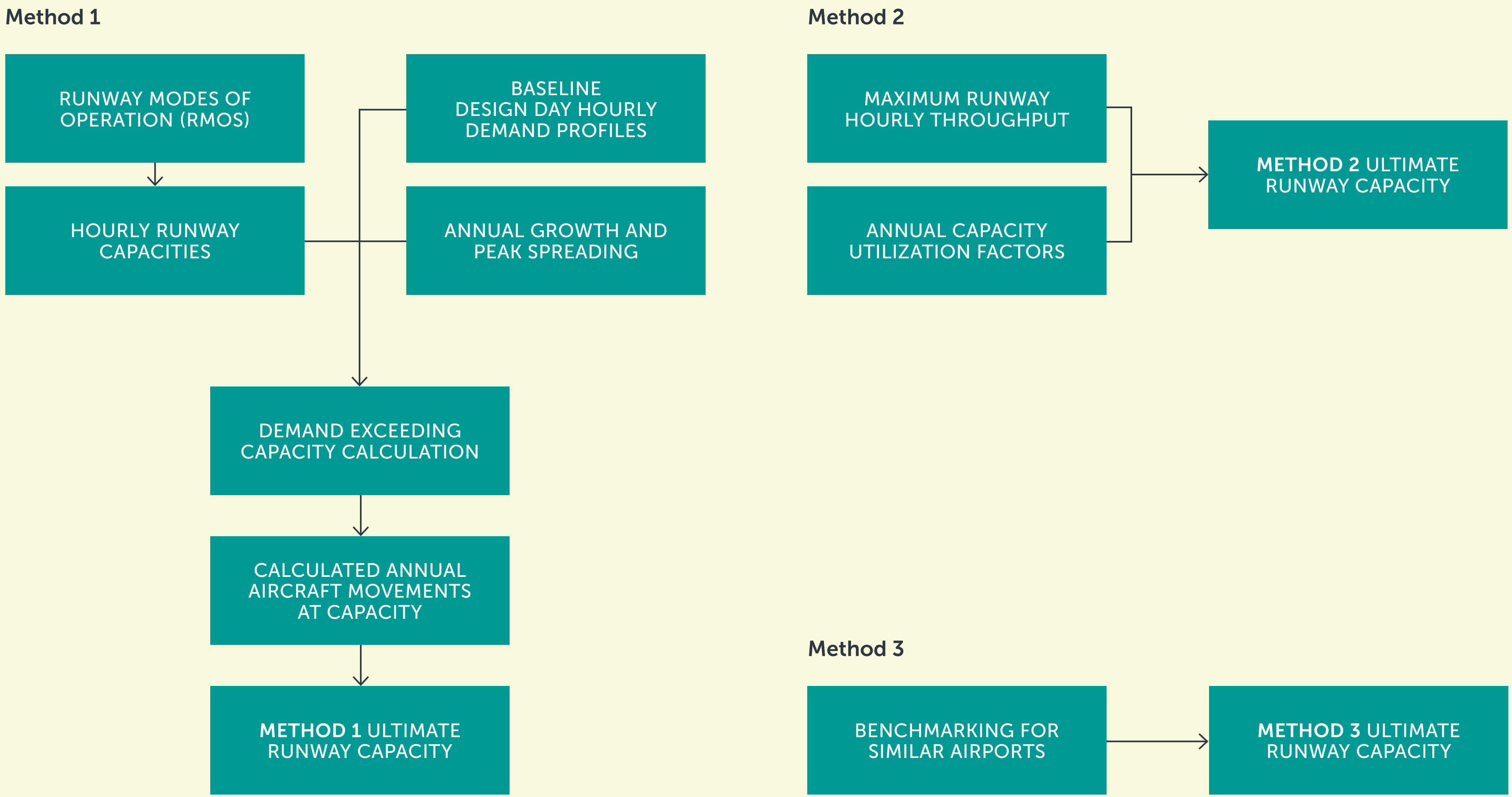
71.2 Volume 5 has been prepared by expert acoustics consultants with experience in aircraft noise. This report explains: the acoustic inputs and assumptions, the modelling methods used, the sensitivity analysis which has been undertaken, and the modelling outcomes.

MODELLING UPDATE PROCESS

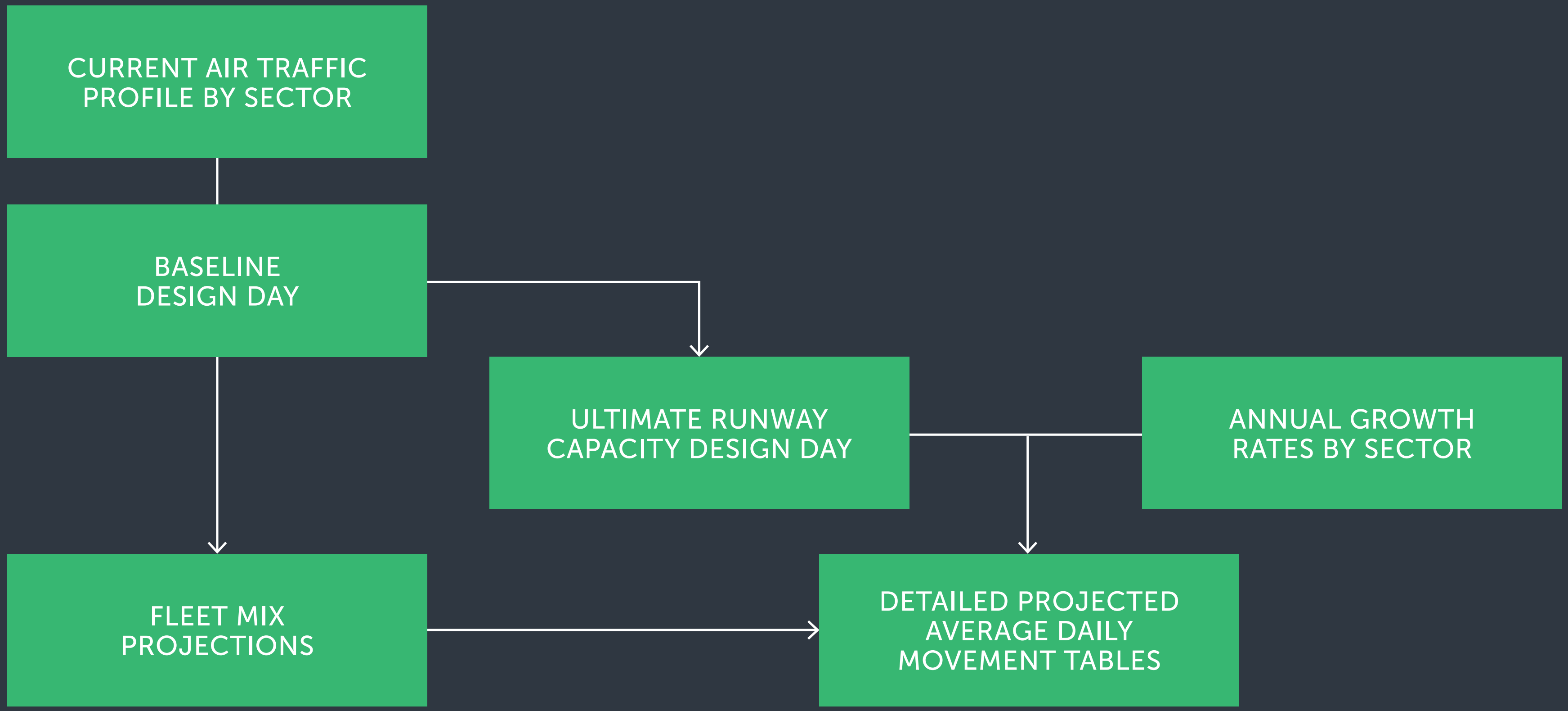
EXPERTISE AND INPUTS



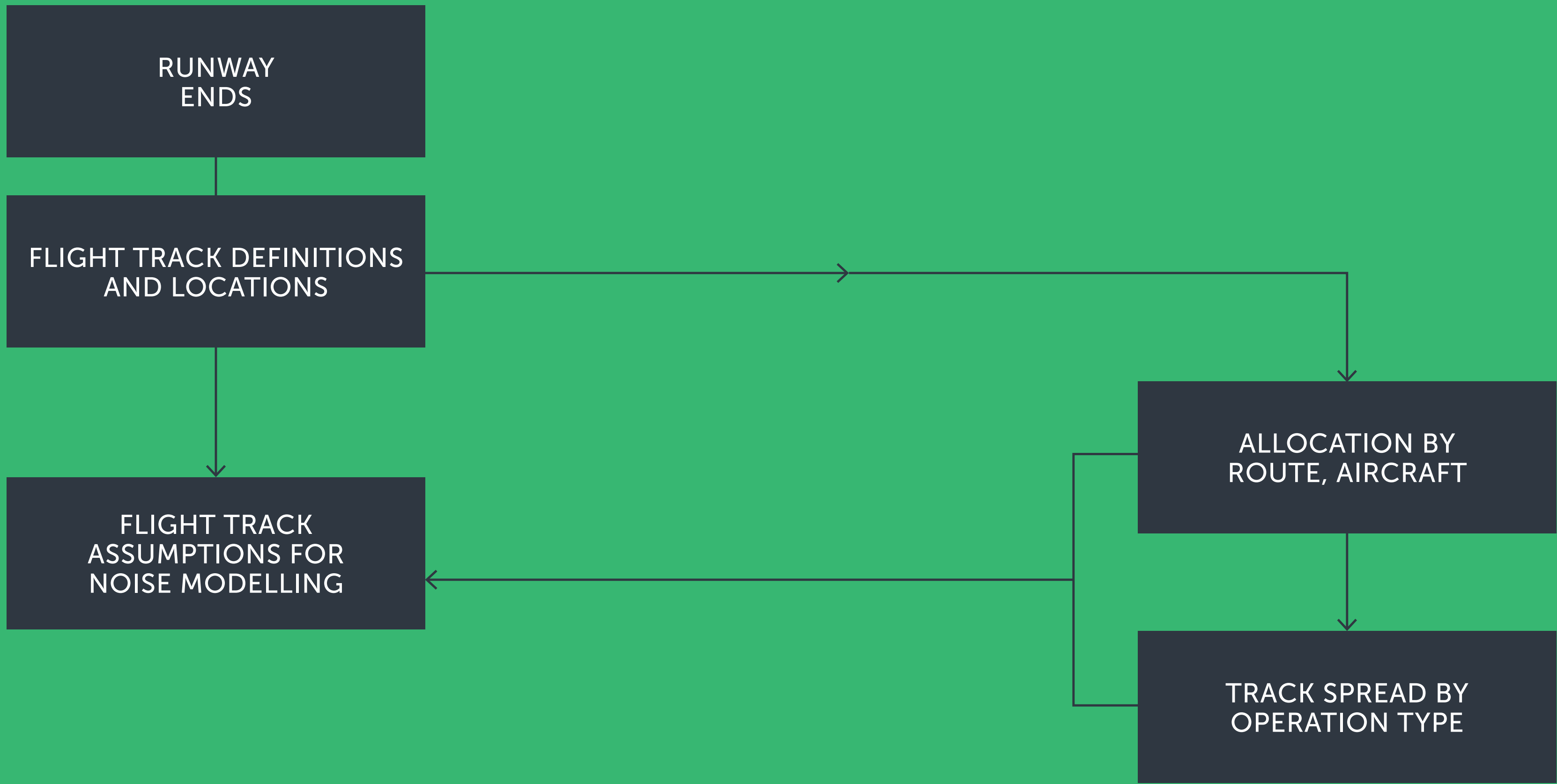
STREAM 1: ULTIMATE ANNUAL RUNWAY CAPACITY



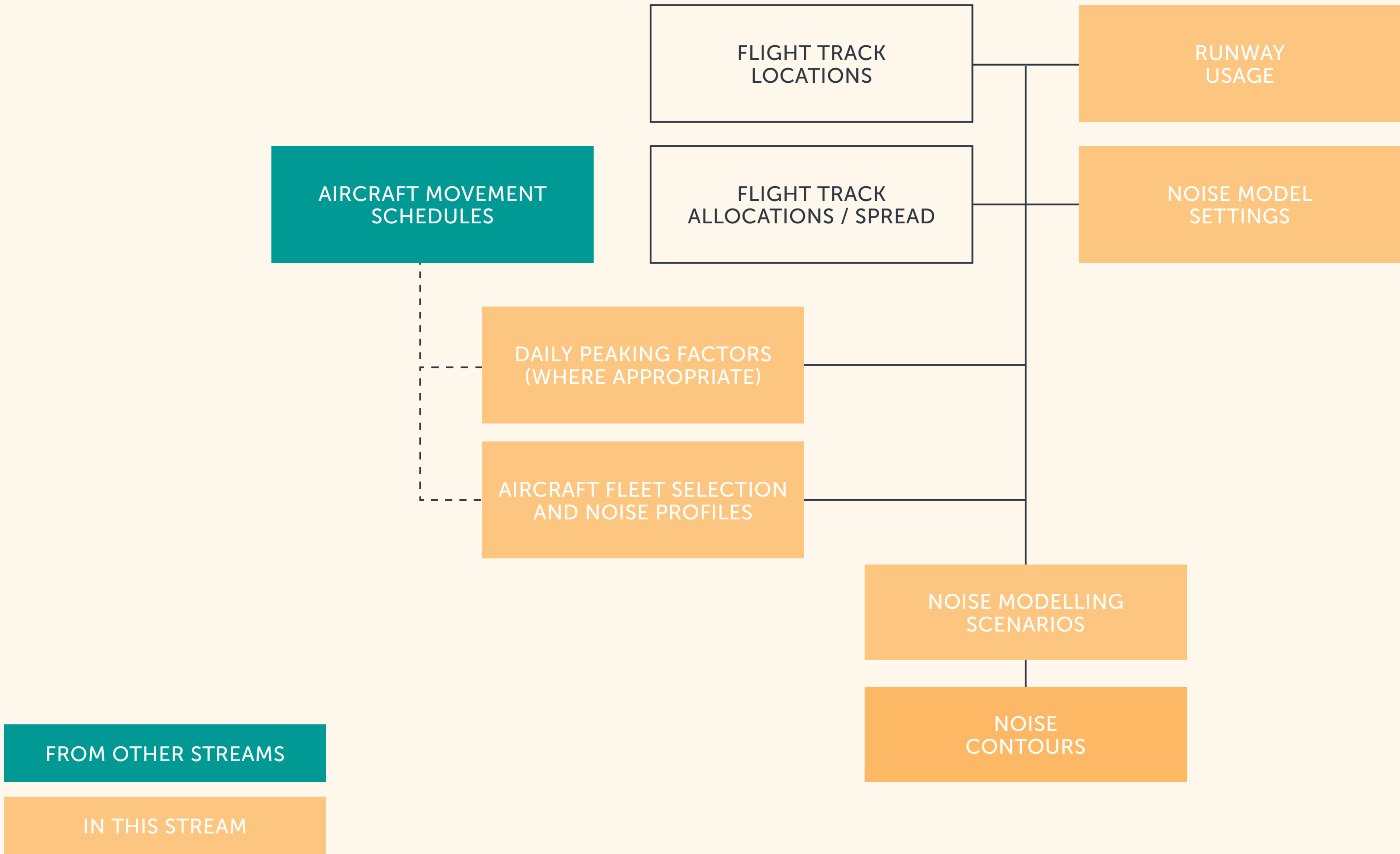
STREAM 2: AIR TRAFFIC PROJECTIONS



STREAM 3: FLIGHT TRACK ASSUMPTIONS



STREAM 4: NOISE MODELLING



2 CHRISTCHURCH AIRPORT ULTIMATE RUNWAY CAPACITY

2023 Airport Noise Contours Update

Volume 2: Ultimate Capacity Report

Christchurch International Airport Ltd

5 May 2023

AIRBIZ

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01. Introduction

This report is Volume 2: Ultimate Runway Capacity Report and describes the methodology, assumptions, parameters and outcomes of an assessment of the ultimate practical capacity of the Christchurch International Airport runway system.

CIAL have engaged several technical experts to prepare the updated noise contours and have relied on their advice and expertise to agree key aspects of the work with CIAL where appropriate, as well as to determine methodologies, assumptions and results. In addition CIAL and Environment Canterbury (ECan) have an agreed technical review process using experts engaged through ECan to review the technical work undertaken by CIAL's consultants.

The technical output in the form of a set of contours on a cadastral map is supported by technical reports including the methodology and key assumptions used in developing the contours. This volume covers the output and development of **Ultimate Runway Capacity**.

Other technical support volumes cover the topics:

- VOLUME 3: Air Traffic Projections
- VOLUME 4: Flight Tracks
- VOLUME 5: Noise Modelling.

The purpose of this assessment is to identify a notional value for the ultimate capacity of the runway system for noise modelling purposes. It uses the annual aircraft movement forecasts described in Volume 3: Air Traffic Projections. Based on the annual demand when the runway system approaches capacity, an average day detailed disaggregated schedule for this year can be extracted from the demand model and used in noise modelling.

Ultimate Practical Capacity

Both the existing (operative) and proposed noise contours use air traffic activity levels when the Christchurch Airport runway system approaches its practical capacity. For the purposes of this project this has been termed 'ultimate capacity'. In consultation with Airways, ultimate capacity has been assessed based on a reasonable understanding of current and future runway operations, that apply current airspace and airfield operational and system capacity considerations and improvements that could affect the ultimate capacity of the airfield.

Additional potential enhancements beyond those currently proposed at Christchurch Airport were considered but have not been applied as there is no firm evidence base for alternative assumptions.

The assessment made is considered an appropriately detailed long term strategic assessment of ultimate runway capacity for use in noise modelling to generate land use planning guidance for airport and community safeguarding.

02. Methodology

While this is a high-level long term strategic assessment of ultimate runway capacity, a number of independent methods were used to ensure that the resulting figure was robust and defensible.

The methodology to assess the ultimate runway capacity consisted of four elements:

1. Establish assumptions through consultation with Airways on Runway Modes of Operations (RMOs) and their relevant capacity throughputs in terms of arrival, departure and overall movements per hour

2. Estimate ultimate runway capacity using a bespoke model, based on the above hourly capacity throughputs and a scaled up design day aircraft movement profile which also considers the potential for future peak spreading. Antarctic, Freight and GA movements would be in addition to scheduled movements and are demonstrated to be able to operate around scheduled movements in remaining shoulder periods.

3. Using a second independent methodology to derive ultimate runway capacity based on peaking factors.

4. Using benchmarking as the third independent method to compare with the initial two estimates.

These three independent methods that were compared to arrive at the ultimate runway capacity for noise modelling purposes are illustrated on the next page.

The air traffic demand studies described in Volume 3: Air Traffic Projections, were prepared in 2019 for use in the noise modelling. In the middle of the study the COVID-19 Pandemic dramatically altered the aviation landscape as borders were closed and most aviation activity ceased or was severely curtailed. In New Zealand there was a relatively rapid recovery of domestic traffic towards the end of 2020, although international borders were still closed to passengers. When finalising the recontouring project through 2021-2023, CIAL prepared updated passenger forecasts which considered scenarios for air traffic recovery in the short, medium and long term. These were generally the same as pre-COVID, just that for it was assumed that it would take longer to reach any future projected traffic level (a 'COVID delay'), this is discussed in detail in the Volume 3: Air Traffic Projections. As this recontouring study is based on the ultimate runway capacity, such changes were not material to the outcomes or the noise modelling based on the assumed capacity, other than ultimate runway capacity is said to be reached later than was previously the case.

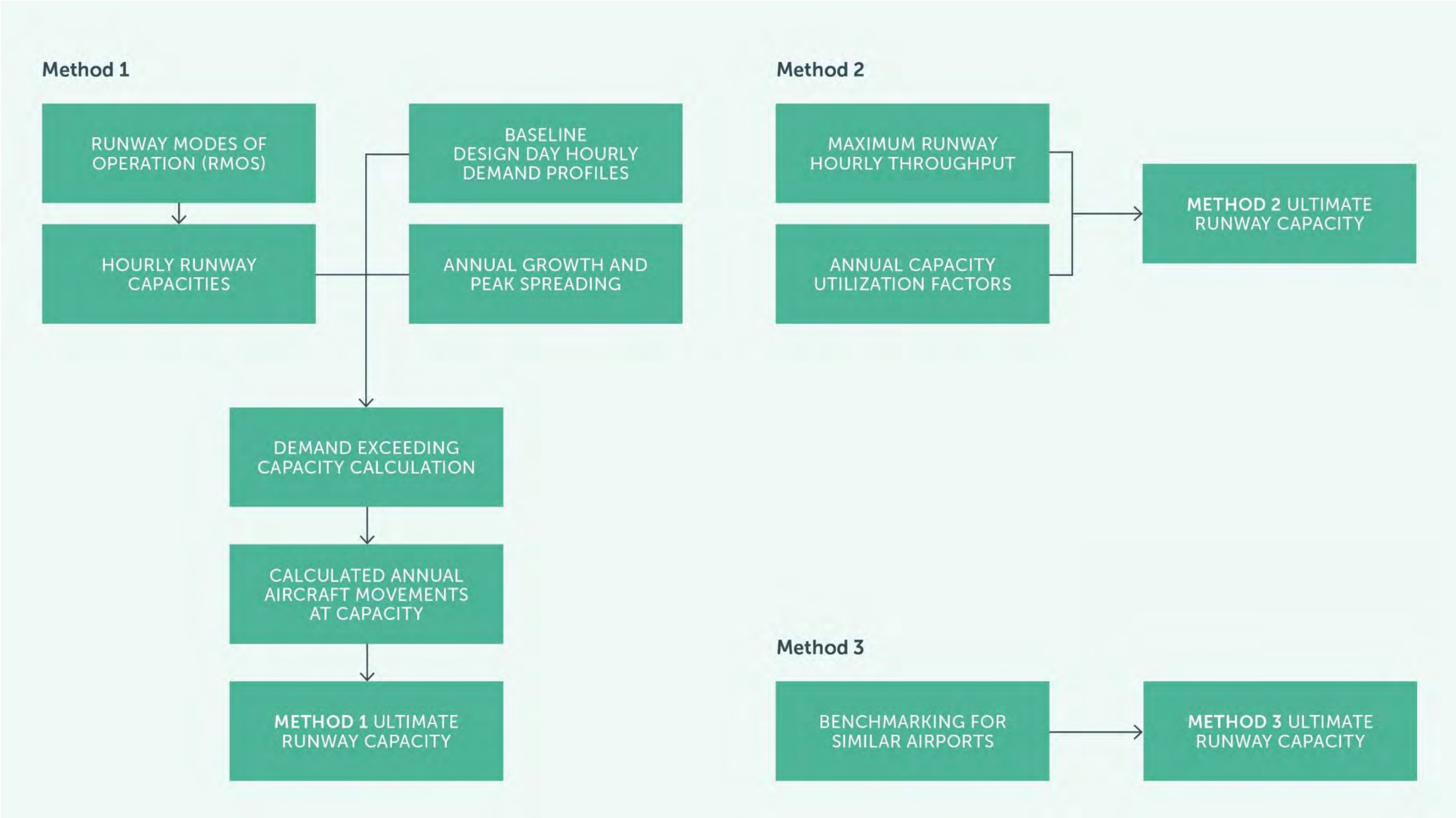


Figure 1 Methodology

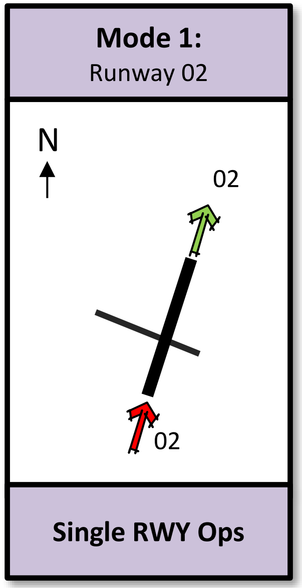
03. Runway Modes of Operation (RMOs)

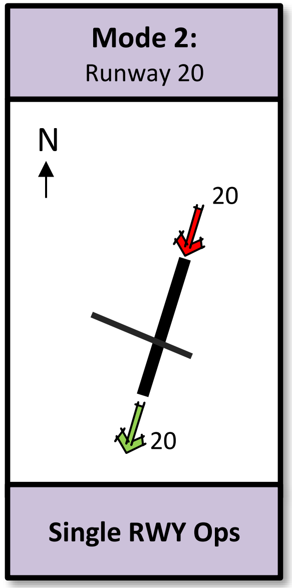
Airbiz in consultation with Airways identified a range of Runway Modes of Operations (RMOs) that considered the current airfield infrastructure and a possible future scenario with extended runways. The purpose of this assessment was to test if various RMOs result in higher or lower hourly capacities, to inform the calculation of ultimate capacity. This section presents the RMOs tested and then identifies which RMO has been adopted for the calculation of ultimate capacity.

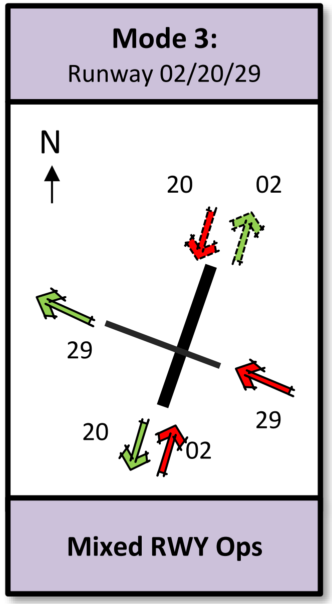
1. Current Airfield RMOs

The figures shown on the following page are Runway Modes of Operations (RMOs) for the current airfield as discussed and agreed with Airways.

These RMO scenarios assume the current Christchurch Airport airfield layout and Divergent Missed Approach (DMAPS) procedures which were implemented in March 2020 providing for a 15° divergence on departures and missed approach. This permits fine weather capacity throughput to be maintained even in poor weather conditions.

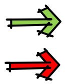






Single Runway 02 NE/E wind: 50% - 60% of the time	Single Runway 20 SW wind: 30% - 40% of the time	Single Runway 29 (with some WB ops on 02/20) NW/W wind: 10% of the time
Downwind Tolerance: 0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition RWY 02 is preferred direction.	**Downwind Tolerance:** 0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition	**Downwind Tolerance:** 0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition Mode 3 only used when more than 15kts crosswind on RWY 02/20. RWY 29 can only be used by NB Jets & TP. WB Jets to use RWY 02 depending on X-wind limits. Use of 02 or 20 by internationals is wind dependent.

Figure 2 Current Airfield RMOs



2. Extended Runway RMOs

The following table illustrates RMOs for extended runways as protected for in the CIAL Master Plan.

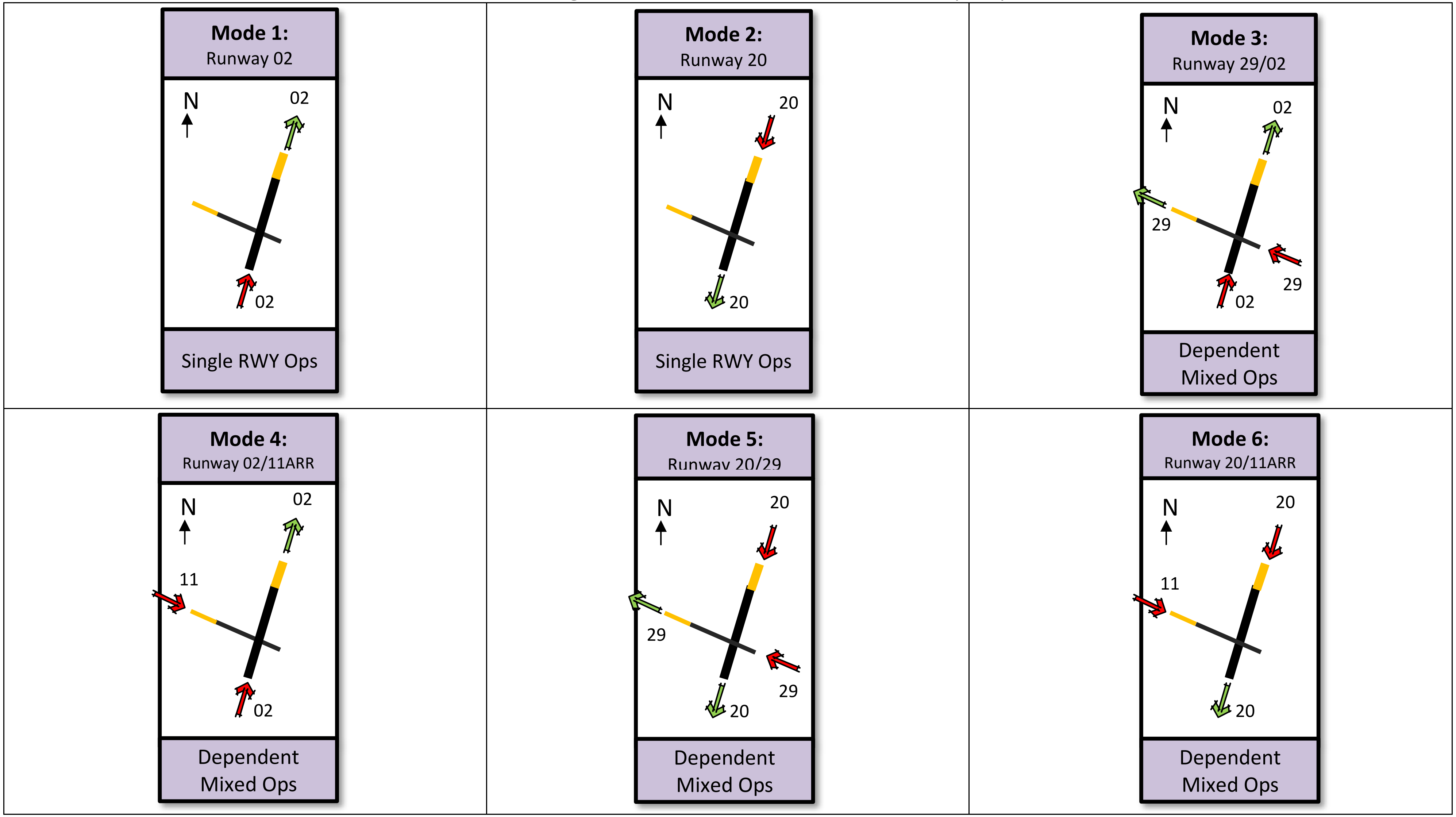


Figure 3 Extended Runway RMOs

Airways made the following additional comments on these RMOs:

- All turboprops can do intersection departures on Runway 02/29
- Busy periods typically last for 30-45 mins, not 1 hour
- 10-12 departures may be scheduled in 15 mins, and spread over 30 mins in reality
- Potentially 2 biases in 1 hour, e.g. departure bias for 30 mins, arrival bias for 30 mins
- In the current layout, pushbacks hold up aircraft taxiing on Taxiway A, limiting the runway capacity.

Capacities quoted in this document assume no taxiway limitations.

- Runway extensions would reduce capacity at night by around 5%. Runway exit points will be further from the landing threshold increasing Runway Occupancy Times (ROT) with no other suitable exit points. At night reduced runway separations are not available and thus occasionally affect the throughput.

The Runway Modes of Operations (RMOs) as discussed and agreed with Airways for when runway extensions are developed are shown below. They assume the following:

- Extended runways as shown in orange.
- DMAPS procedures with 15^{o} divergence on departures and missed approach (implemented March 2020)/

Airways advised that DMAPS with 15^{o} divergence on departure and for missed approach allows fine weather capacity throughput to be maintained even in poor weather conditions. Further detail of flight tracks can be found in Volume 4: Flight Track Assumptions.

RMOs for the extended runway scenarios were also considered under two separate operating scenarios:

- Simultaneous Operations (SIMOPS)
- Land and Hold Short Operations (LAHSO)

These are facilitated by the protected future runway extensions and are shown below.

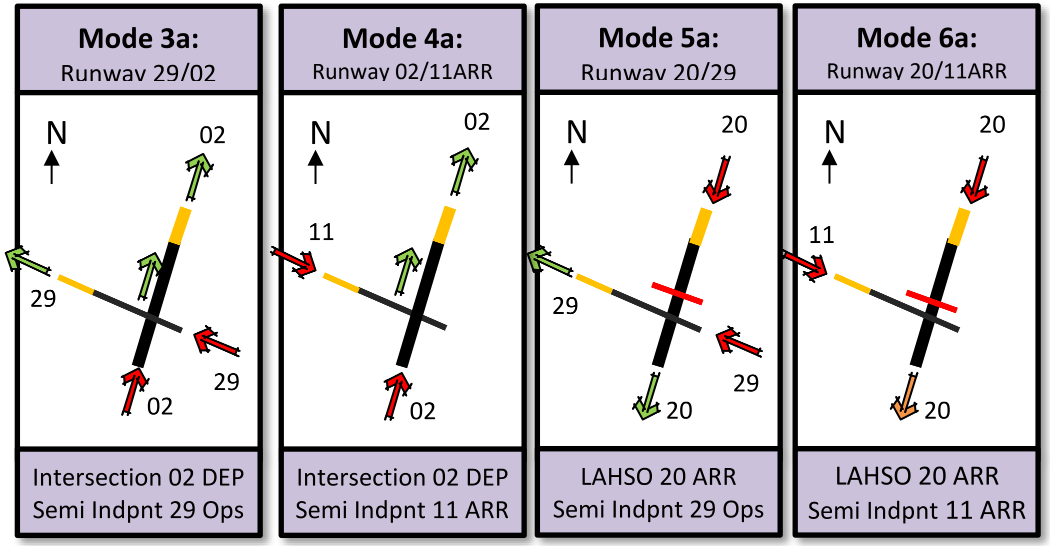


Figure 4 SIMOPS/LAHSO RMOs

Airways consider that these RMOs do not provide additional capacity. In addition, according to Airways, further ground infrastructure constraints and some airspace constraints would not allow efficient SIMOPS or LAHSO operations. Such modes would therefore not provide any additional capacity to the dependent Mixed Operations presented on the previous page and were not considered further the ultimate runway capacity assessments.
Other Runway Modes with runway extensions were considered by Airways to not be operationally viable.

Conclusion:

Based on consultation with Airways ultimate capacity calculations are based on Current Airfield RMOs 1 and 2 as illustrated below.

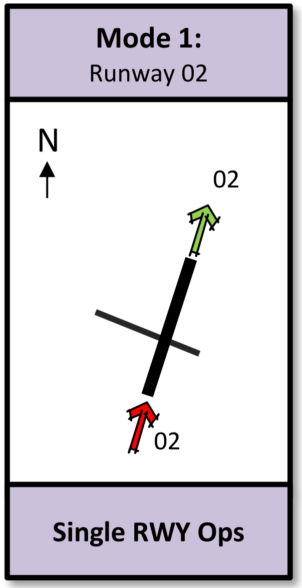
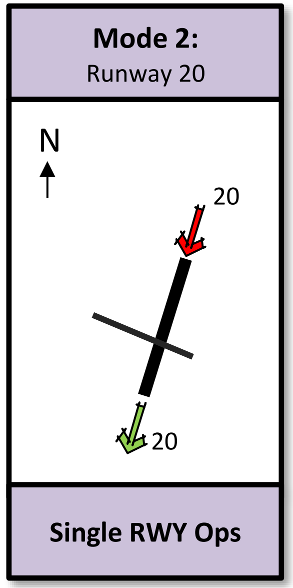
	
Single Runway 02 NE/E wind: 50% - 60% of the time	Single Runway 20 SW wind: 30% - 40% of the time

Figure 5 Selected RMOs

04. Hourly Runway Capacities

Indicative capacities for each RMOs previously described were sought from Airways for a range of traffic conditions (arrival bias, departure bias, balanced traffic). Peak capacities were those that can be processed for a one-hour peak and sustained capacities are those that can be maintained for say 3 hours.

The 3-hour period reflects what may happen close to capacity where peaks are spread across a few hours. Applying a 3-hour capacity emulates the implementation of a Runway Demand Management Scheme (RDMS, or slot control) like at Brisbane[1] and Perth as demand at both airports approached prevailing runway capacities resulting in increased traffic delays.

Schedule data of the busiest 3 months (October, November and December 2017) for FY18 was provided by CIAL and a design day (6/10/2017) was selected by CIAL with assistance and review by Airbiz. Runway bias between arrival and departures by clock hour for a current design day profile is shown following in Figure 6 and Figure 7. These are shown for a clock hour and for 3-hour moving hour which dampens pronounced arrival or departure biases.

Hourly capacities were provided by Airways for both good and poor weather scenarios. All the hourly capacities for relevant RMOs are listed in the Appendix of this report. For modelling sensitivity purposes the sustained capacity was notionally set at three times the hourly capacity. Airways advised that the peaks usually last 30 minutes and the sustained 3-hour capacity is similar to the hourly capacity.

[1] *Between the time of undertaking this capacity assessments and finalising this report, Brisbane Airport commissioned a new parallel runway in 2020, significantly increasing capacity.*

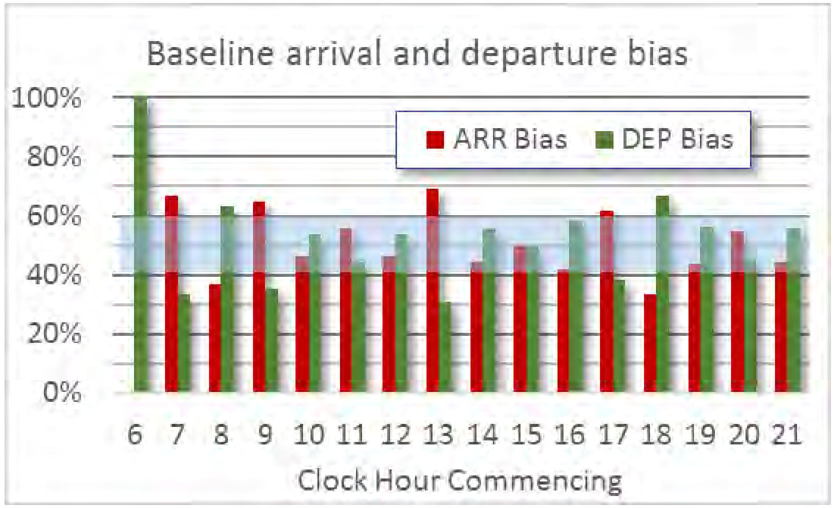


Figure 6 Baseline Arrival and Departure Bias

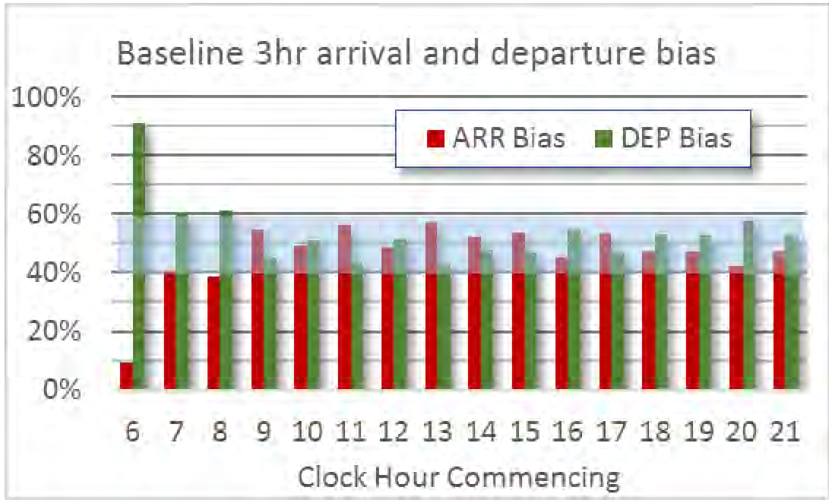


Figure 7 Baseline 3hr Arrival and Departure Bias

The analytical model used to assess the ultimate annual capacity compares projected demand versus hourly capacities for a design day. The tables (refer Figure 21 Appendix 2) show the assumed one hour (peak) for the following three scenarios for RMO 1&2 (Single 02/20 Runway Operations) with DMAPS.

1. Scenario 1 Current Operations
2. Scenario 2 is Future Potential if Mixed Rate Capacity increase to 52 is realised.
3. Scenario 3 is Future Potential if Mixed Rate Capacity increase to 52 and ECAM allowing ARR/DEP weighting is realised

Hourly capacities for each of those scenarios vary depending on an arrival or departure bias or similar numbers of arrivals and departures in the busy hour. The potential for short exceedances was accounted for elsewhere in the modelling.

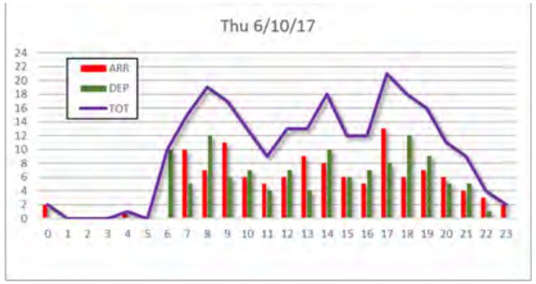
Further detail on hourly capacities is included in Appendix 2.

05. Annual Projections and Daily Profile

The daily scheduled passenger aircraft movement profile by clock hour tabulated and plotted below was extracted from the selected design day (6/10/2017) and is shown below.

It was used as a base for modelling, for Airways agreement of potential runway modes and their indicative capacities under a range of traffic conditions (arrival bias, departure bias, balanced traffic).

The extended annual aircraft movement projection split between International, Domestic and Regional is shown bottom right. More details of Air Traffic Projections can be found in Volume 3.



CH	ARR	DEP	TOT
0	2		2
1			0
2			0
3			0
4	1		1
5			0
6		10	10
7	10	5	15
8	7	12	19
9	11	6	17
10	6	7	13
11	5	4	9
12	6	7	13
13	9	4	13
14	8	10	18
15	6	6	12
16	5	7	12
17	13	8	21
18	6	12	18
19	7	9	16
20	6	5	11
21	4	5	9
22	3	1	4
23	2		2
	117	118	235

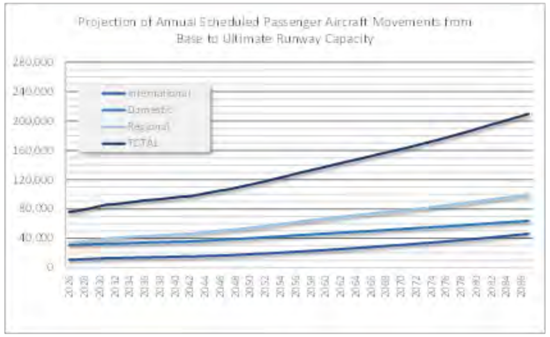


Figure 8 Annual Aircraft Movement Projection and Base Design Day

The 'daily profile used for the Capacity Model was the 6/10/17 selected from several candidate representative days with similar total daily movements (around 90th percentile, also checked against the mean of this busy "slice"). However, as a macro model purposed with matching hourly demand to hourly arrival, departure and total runway capacity for available runway operating modes, this was projected forwarded differently from the demand-based design day[2]. For Christchurch Airport runway capacity is less sensitive to incremental changes in fleet mix (this is a secondary determinant), the primary determinants of when runway capacity is reached is:

- the demand profile across the day,
- the mix of arrivals and departures (separately and combined), and
- the ability and willingness of airlines to reschedule movements to available hourly capacity outside of peaks when approaching runway capacity.

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[2] *For a long term macro model it was decided that the hourly baseline profile could be grown at the annual growth rate without considering changes to the profile across the day. This flattening of peaks was considered implicitly by the user selecting scenarios with "tolerance" for exceedance of demand in peaks. In practice the exceedances would be dissipated by airline rescheduling out of peak into adjacent shoulder, or spillage of movements into subsequent hours due to delay (demand > capacity = delay).*

Only RPT demand was considered in the Capacity Model, as it was assumed (and checked visually on scaled up demand vs capacity profiles) that there was enough additional capacity in the shoulder periods to accommodate the other traffic, which was assumed to be more "elastic" than RPT in terms of scheduling across a busy day, or outside of the busiest days.

It was also recognised that the Ldn noise contours were more sensitive to changes in day/night split, aircraft types, runway selection, flight path allocation for route (O/D), track spread, rather than a change (even 10%) in annual (or derived daily average) quantum of runway movements (also considering logarithmic relationship between noise and air traffic movements). The relative granularity of the various elements of the demand and capacity models reflects this.

The Method '2' analysis of runway capacity (refer Section 09) was used to test the effects of peak spreading, which changes the daily profile by widening the peak periods.

06. Runway Capacity Methodology

An analytical model was used to calculate the Ultimate Runway Capacity in terms of aircraft movements, using the following inputs:

1. A currently or projected daily profile of hourly arrivals and departures
2. A long-term projection of annual aircraft movement split by International and Domestic/Regional
3. Separate notional hourly runway movement capacities for arrivals, departures and total for the highest capacity and most commonly used runway modes of operation during periods of high demand; different capacities for arrival or departure biased hours versus hours with balanced arrivals and departures
4. A scenario based assessment was used to adjust the tolerance for exceedance of notional runway capacities in terms of magnitude and duration:
    - For example, if runway capacity is 40 movement per hour, an allowance to exceed by up to 3 hourly movements, assuming that the movements not processed are delayed and move into the following hour and/or some peak spreading in schedules through self-imposed or regulated demand management as the system approaches capacity)
    - Allowing a nominal hourly exceedance for a specified number of hours across the day.

This methodology is outlined in the graphic below.

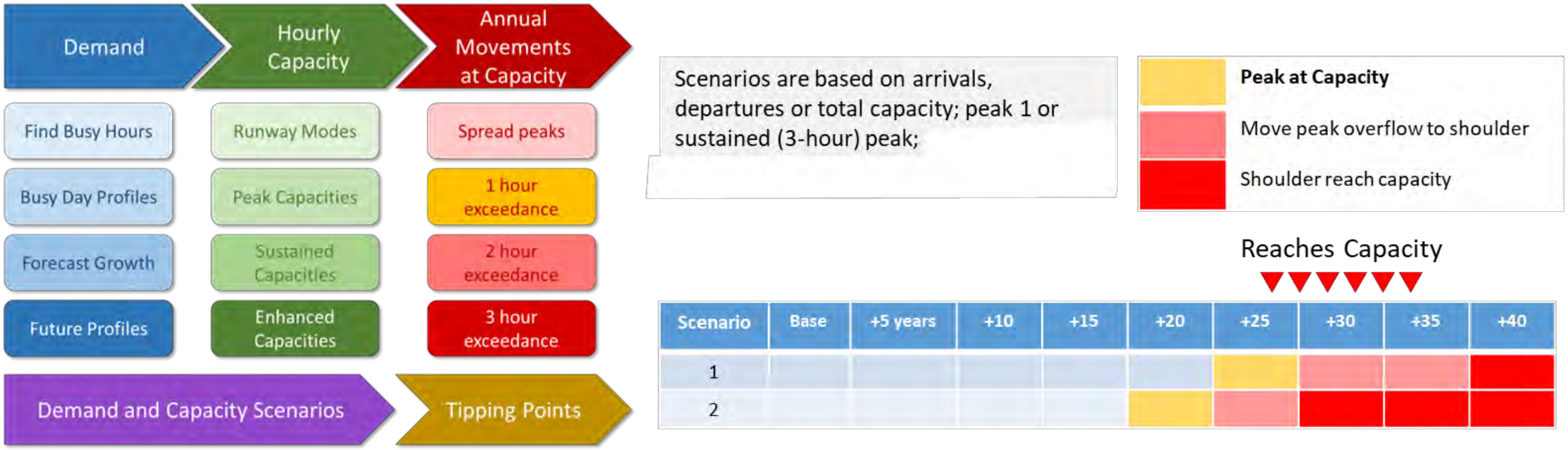


Figure 9 Ultimate Runway Capacity Methodology

Definition of 'Ultimate Capacity' for modelling purposes

This section sets out the rationale and basis for using a future runway capacity approach to developing airport noise contours at Christchurch Airport.

CIAL is both an airport operator of national and regional significance and a member of the local and regional community within which it resides and whom it serves. CIAL's actions must therefore ensure a balance where there are competing priorities. A good example of this is the airport safeguarding which involves guidance on land use planning in the vicinity of the airport. The airport subscribes to the following international and national policies and regulatory frameworks:

1. International Civil Aviation Organisation (ICAO) proposed Balanced Approach to Aircraft Noise Management which promotes finding practical solutions to aircraft noise related issues, including recommended land use compatibility

2. New Zealand Standard NZS6805 with the objective to *"ensure communities living close to the airport are properly protected from the effects of aircraft noise whilst recognizing the need to be able to operate an airport efficiently."*

Context

CIAL had previously prepared a set of noise contours in accordance with New Zealand regulations and standards, which were then implemented in local district and municipal planning rules. These noise exposure contours are currently being updated by CIAL (the 'proposed' contours) in line with these regulations and standards.

The existing and proposed contours prepared by CIAL have been developed in accordance with New Zealand Standard NZS6805 (NZS) and are based on a range of inputs such as current flight tracks and possible future modifications, current and possible future airline fleet mix, projected future annual air traffic.

Specifically both the existing and proposed contours use air traffic activity levels when the Christchurch Airport runway system approaches its practical capacity. For the purposes of this project this has been termed 'ultimate capacity'.

NZS 6805 §1.4.3.1 (drafted in 1992) recommends a **minimum** of a 10-year period is used in projecting future traffic and noise exposure contours. This is a relatively short horizon which risks exposure of future urban development to higher levels of aircraft noise or severe constraints on an airport, a unique and vital community transport, economic and employment asset that ensures connectivity for the movement of people and goods. Similarly there are other jurisdictions where the noise exposure contours are based on a theoretical runway capacity, ostensibly to ensure airport safeguarding. In the case of the major trunk airports in Australia (refer AS2021-2015 Appendix A3 *"…in the case of some of the busier civil airports, it may represent the airport operating at 'ultimate capacity'*[3]*"* (p143)) it has now become accepted practice to use noise exposure contours based on when the runway system approaches ultimate practical capacity (often referred to "ultimate capacity".).

Establishing noise contours based on ultimate capacity provides long term protection for airport operations from sensitive land uses that might otherwise be developed around the airport. Assuming no significant change to the airport operating environment (such as a new runway or new flight tracks), using a capacity-based approach generally results in reasonably stable noise exposure boundaries. Being updated every 10 or so years this provides

[3] *In the ANEF Manner of Endorsement the reference is explicitly to "ultimate practical capacity". See https://www.infrastructure.gov.au/sites/default/files/migrated/aviation/environmental/airport_safeguarding/files/2017_ANEFs.pdf and https://www.airservicesaustralia.com/industry-info/anefs-and-aneis/ (accessed 28/11/22), noting also that all major airports in Australia are "federally leased airports" and as part of the regulated planning framework must prepare a Master Plan for a 20 year horizon, including an endorsed aircraft noise exposure map (**minimum** forecast being 20 years, but now generally accepted as "ultimate (practical) capacity").*

an appropriate degree of certainty in land use zoning around an airport.

In considering this CIAL has chosen to take a balanced approach to determining what the airport capacity is, to provide a reasonable level of protection for future operations and a reasonable level of restriction and impact on the community from the protections imposed by the noise contours.

Basis of defining Ultimate Capacity

In consultation with Airways, ultimate capacity is assessed based on a reasonable understanding of current and future runway operations, that apply current airspace and airfield operational and system capacity considerations and improvements that could affect the ultimate capacity of the airfield.

We have not sought to apply other enhancements and assessments that might increase ultimate capacity further, based on air traffic management procedures in other regions as there is no firm evidence base for alternative assumptions.

The CIAL contour update uses the best available local information and projections at the time of preparing noise exposure contours, including the assessment of when the runway approaches ultimate (practical) capacity. This ensures the appropriate balance between airport safeguarding of this irreplaceable and vital national and regional transport connectivity infrastructure and unreasonable levels of land use restrictions.

07. Ultimate Annual Runway Capacity

This section addresses the rationale for selecting the annual air traffic demand when the airport approaches ultimate practical capacity, assessed using the heatmap for scenarios within the ART Capacity model.

The model allows the user to specify:

- A forecast scenario, or multiple scenarios
- A capacity scenario, or multiple scenarios
- The "amplitude" of exceedances, how far can hourly demand exceed hourly capacity and notionally spill forward or backward by either slot scheme, delay or airline rescheduling
- The "frequency" of exceedances, how many clock hours across the day can be above capacity.

Based on these parameters a heat map is generated of when the system "approaches practical capacity". For the year and corresponding annual traffic forecast the scaled-up design day hourly movement profile is also generated for each scenario.

Rather than specifying a particular slot control regime and calculate implied delays for aircraft that cannot be processed in a clock hour due to demand being above capacity, demand vs capacity has been arithmetically averaged the across these 14 hours to check the "headroom" available for any peak spreading mechanism.

To determine when demand can be considered to be approaching practical capacity the capacity boundaries of that envelope have been calculated for scenarios based on the varying capacity rates supplied by Airways and a range of exceedance criteria (use of threshold criteria is explained below). This methodology covers a broad range of assumptions. It is also appropriate for an "ultimate capacity" noise contour using long-term air traffic forecasts which are reasonable and supported by robust assumption, and is inherently has a high degree of uncertainty relative to a short-term forecast.

The thresholds have been refined to reflect exceedances of demand over capacity across the design day by using two parameters; 'Tolerances' of movements above capacity (amplitude) and 'Maximum Hours' (instances across the design day) where demand is allowed to exceed capacity. The base design day profile is projected forward by scaling up by the aggregated annual aircraft movement growth rate (% applied equally across all clock hours), without trying to do any peak spreading. Peak spreading is "implicit" in the application of the range for Tolerance and Maximum Hours, without making arbitrary adjustments the long-term demand curve (see Figure 10, Figure 11 and Figure 12).

A range of 1-4 movements above capacity have been applied for Tolerance and 1-4 hours for Maximum Hours and 24 scenarios were run based on this. this range is considered a reasonable basis for describing when the airport can be said to be “approaching practical capacity” for the purposes of this study.

However, pushing the tolerance even higher reflects a flat-line demand profile (exceedances in peaks when moved fill all the shoulders). This does not reflect what is observed in this region at busy airport where demand approaches capacity and significant investment is capacity enhancement is initiated. There are still distinct peaks – typically morning and afternoon, and sometimes in the middle of the day. In our opinion and that of CIAL it would not provide a credible basis for the noise contours and land use controls.

Based on this methodology an annual capacity of 201,000 scheduled annual aircraft movements was identified, which for convenience can be referenced as around 200,000 annual scheduled passenger aircraft movements. Examples of model outputs and the results of the assessment are illustrated below.

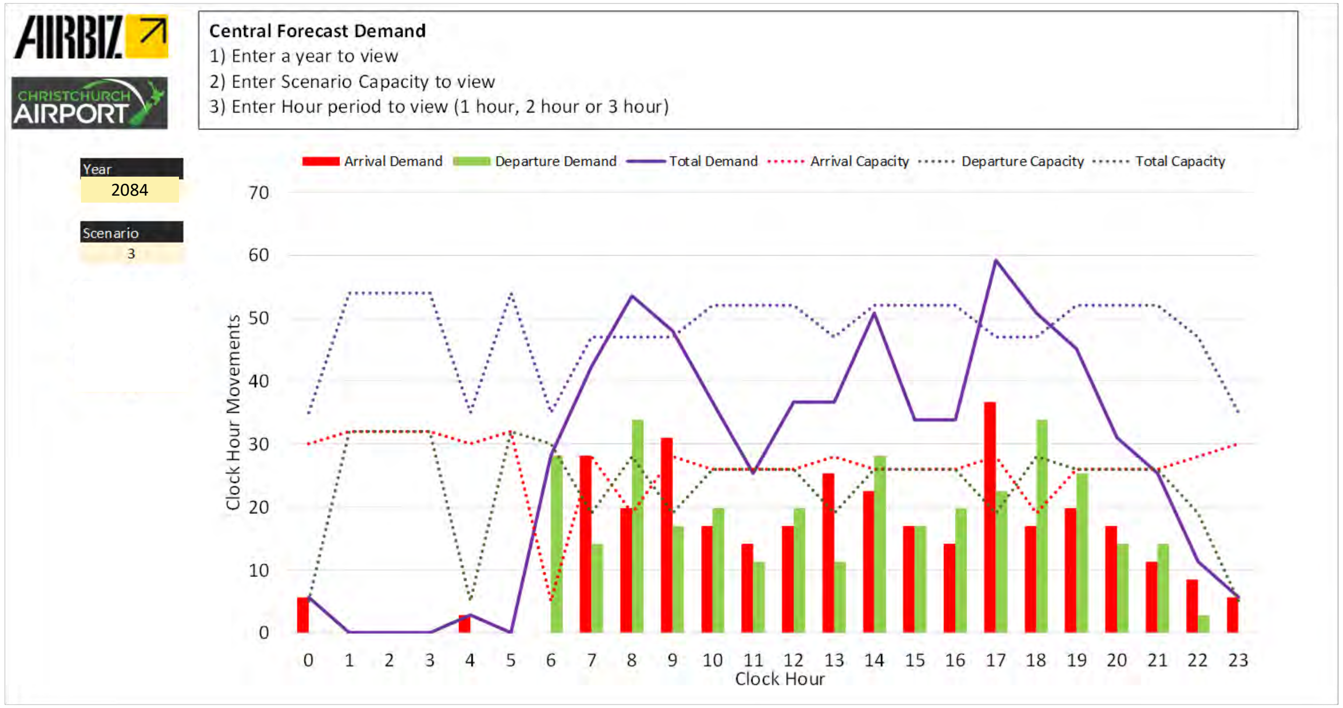


Figure 10 Clock hour demand vs capacity for a selected run and year considered to be “approaching capacity”.

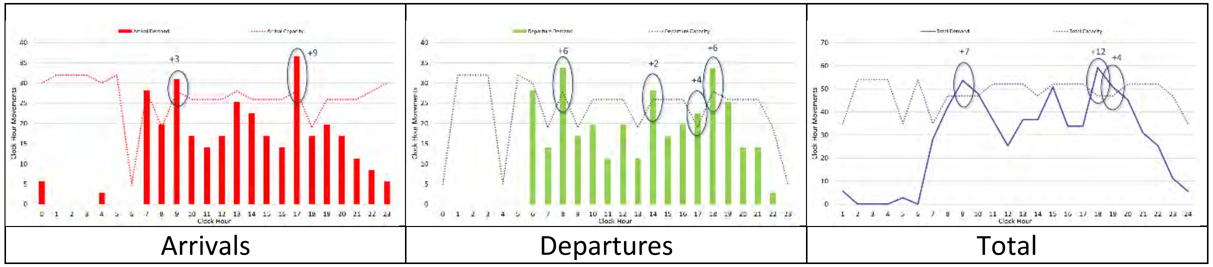


Figure 11 Individual plots for (Arr, Dep,Total) illustrating clock hour “exceedances” (demand > capacity)

Figure 12 Exceedances (above the line); “headroom” averaged across all hours (6:00am to 19:59pm)

The following heat map illustrates the results of 24 runs assessed. Relevant columns headings are:

- **Capacity Scenario**
  - **3** = Potential if Mixed Rate Capacity increase to 52 and ECAM allowing ARR/DEP weighting is realised
  - **2** = Potential if Mixed Rate Capacity increase to 52 in realised
- **Tolerance** = A range of 1-4 hourly movements above hourly capacity
  - **T1 =** 1 hourly movement above hourly capacity
  - **T2 =** 4 hourly movements above hourly capacity
- **Over Capacity (threshold)** = Number of instances across the design day where demand is allowed to exceed capacity.
  - **A =** 1-3 hours above capacity
  - **B =** 1-4 hours above capacity.
- **Year =** the year the Over Capacity threshold is reached e.g. for Run 1, the Over Capacity threshold A is reached in 2086.

The heat map then illustrates the number of hours above capacity for each run assessed using the colour palette. A 'minimum' year and corresponding annual aircraft movements are identified for each group of 3 runs (Arrival/Departure/Total) based on the Over Capacity threshold, for example:

- For runs 1-3 the assessment results in Over Capacity being reached in 2077/2081/2086.
- The minimum year for this is then identified (2077) in the adjacent column with the associated annual aircraft movements (180,000).

The results of the assessment across all 24 runs are then assessed to identify the minimum (earliest) and maximum (latest) year capacity is reached and a median year and corresponding annual aircraft movements is determined to identify when ultimate capacity is said to be reached.

Run	Operational Trigger (Arr/Dep/Total)	Capacity Scenario	2018	2019	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	Year	Min of 3		Tolerance	Over Capacity
1	A	3																1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	4	4	4	4	2086			T1	A
2	D	3																					2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	2077			T1	A
3	T	3																		1	1	1	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	2081	2077	180,000	T1	A
4	A	3																											2	2	2	2	2	3	4	4	4	4	2087			T1	B
5	D	3																					2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	2082			T1	B
6	T	3																								2	2	2	3	3	3	3	4	4	4	5	5	5	2085	2082	195,000	T1	B
7	A	3																						1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2091			T2	A
8	D	3																											2	2	2	2	2	3	3	3	4	4	2086			T2	A
9	T	3																						1	1	1	1	1	1	2	2	2	3	3	3	3	4	4	2085	2085	204,000	T2	A
10	A	3																																	2	2	2	2	2091			T2	B
11	D	3																											2	2	2	2	2	3	3	3	4	4	2089			T2	B
12	T	3																												2	2	2	3	3	3	3	4	4	2089	2089	216,000	T2	B
13	A	2											1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4	4	4	5	5	2082			T1	A
14	D	2																					2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	2077			T1	A
15	T	2															1	1	1	1	1	1	1	1	1	2	2	2	3	4	4	4	4	4	4	5	5	5	2081	2077	180,000	T1	A
16	A	2																						2	2	2	2	2	2	3	3	3	3	4	4	4	5	5	2086			T1	B
17	D	2																					2	2	3	3	3	3	3	4	4	4	4	4	4	4	5	5	2082			T1	B
18	T	2																								2	2	2	3	4	4	4	4	4	4	5	5	5	2082	2082	195,000	T1	B
19	A	2																		1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	2089			T2	A
20	D	2																											2	2	2	2	2	3	3	3	4	4	2086			T2	A
21	T	2																			1	1	1	1	1	1	1	1	1	2	2	2	3	3	4	4	4	4	2085	2085	204,000	T2	A
22	A	2																													2	2	2	2	2	2	3	3	2091			T2	B
23	D	2																											2	2	2	2	2	3	3	3	4	4	2089			T2	B
24	T	2																												2	2	2	3	3	4	4	4	4	2087	2087	210,000	T2	B

Year	Aircraft	
2077	180,000	Min
2089	216,000	Max
2084	201,000	Median

Figure 13 Heat map for 24 runs

08. Daily Profile at Capacity

The model output chart below shows the hourly demand with corresponding capacities for 201,000 annual movements for Scenario 3. These hourly runway capacities vary depending if the hourly traffic is balanced or arrival or departure biased.

Mixed mode independent parallel runway capacity is shown as 52. The demand profile is very peaky, hence the “trigger” is set above the 52 movements. This also considers potential for peak spreading or delays in single hours pushing movements to subsequent hours.

At this level of demand of around 200,000 annual scheduled passenger aircraft movement, there are occasional exceedances of total, arrival and departure capacities. The “design day” is a typical busy day at around 95th percentile in terms of daily traffic. There is still some room for peak spreading across the day and across the year, but there will be delays and the runway system should be considered “approaching capacity”.

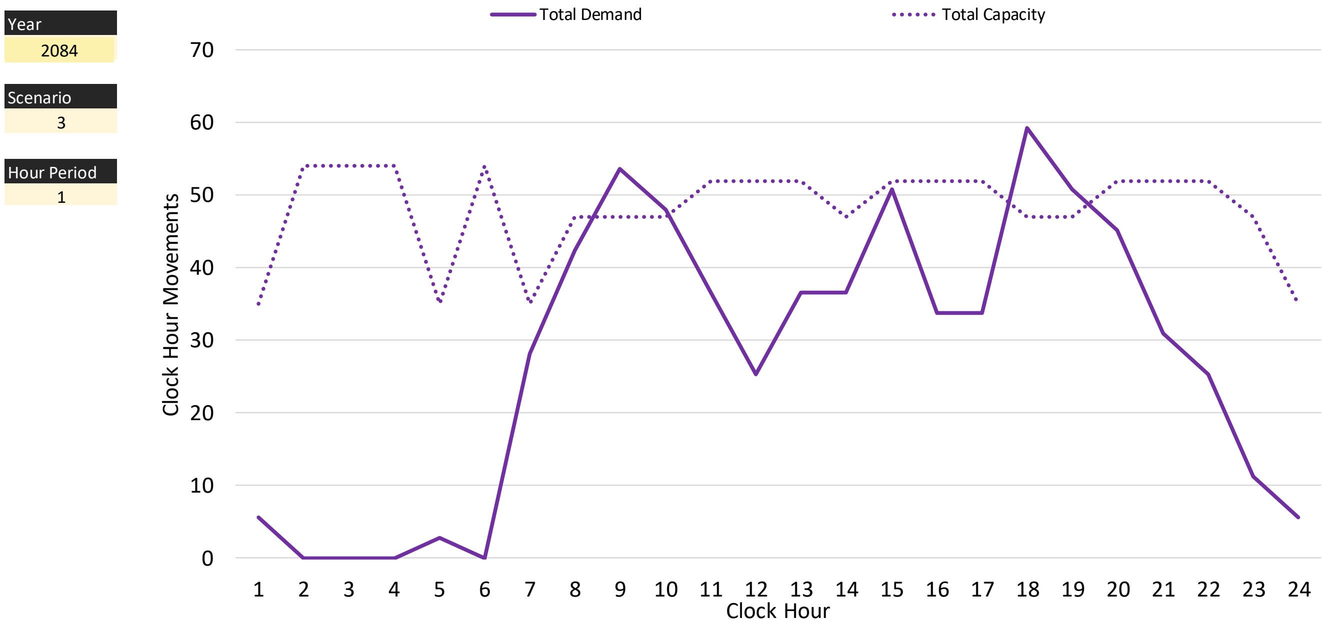


Figure 14 Daily Profile at 201,000 Capacity (1hr)

09. Method 2 - Peak Spreading Factor

Using Method 2, peak spreading factors were used to assess long term runway capacity, based on ratios of hourly practical runway capacity versus annual aircraft movements.

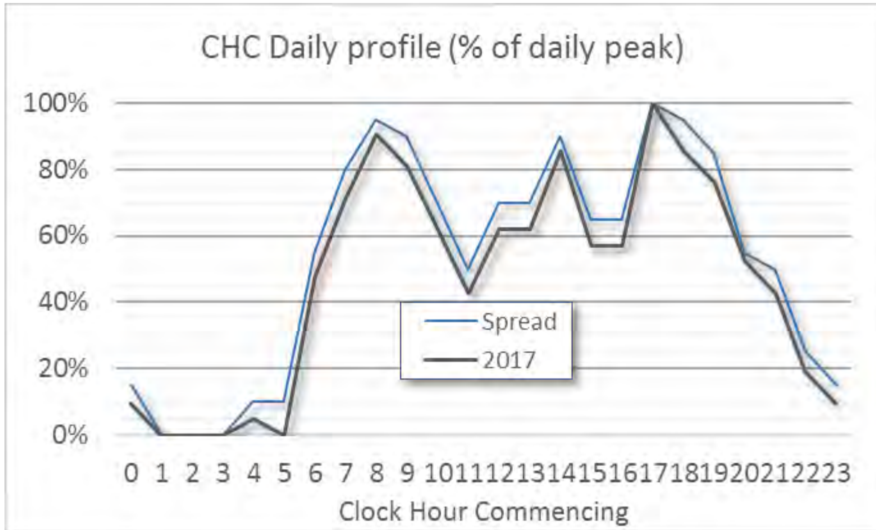
The shape of demand for the 2017 Design Day (6/10/2017) is shown opposite. Hourly ratios of demand to the busiest hour in the day were then adjusted marginally upward to account for potential further peak spreading as runway capacity is reached.

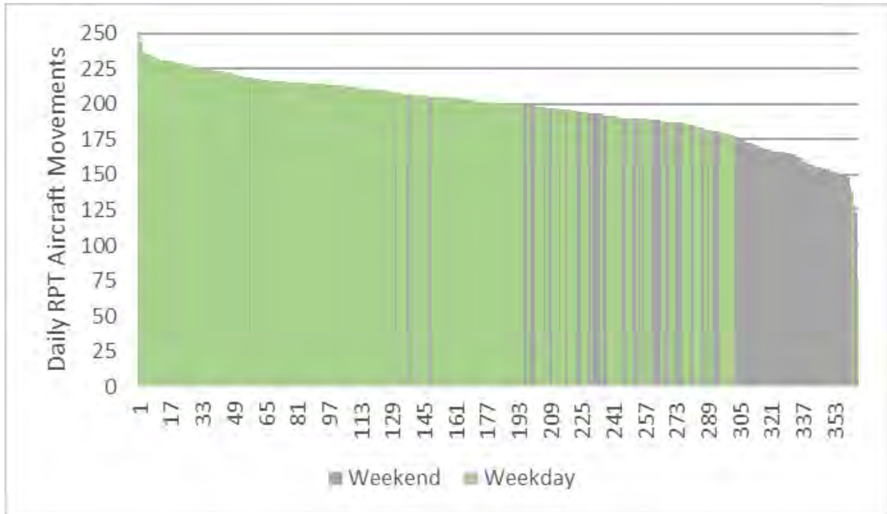
Peak spreading factors were used to assess long term runway capacity, based on ratios of hourly practical runway capacity versus annual aircraft movements

Figure 15 Peak Spreading Factor

WD = Weed Day

WE = Weekend





FY2018 slicing					
Ratio of busiest daily movements (top slice) to average					
WD1	232	WE1	203	WD	207
WD	207	WE	174	WE	174
Ratio	**89%**	Ratio	**86%**	Ratio	**84%**

The current notional busy hour capacity (all movements) for a single runway at Christchurch is 47-52 hourly movements(refer Figure 21 Appendix 2) depending on the arrivals or departures bias. The busy hour scheduled passenger aircraft movements in the design day (16/10/2017) was 21.

The ratios for busy weekday, busy weekends, average weekdays, average weekends were derived for the current traffic and shown below, including the actual daily movements in a 2014 base (72,500 annual scheduled passenger aircraft movements).

Using a notional busy hour capacity of 47 movements per hour and marginally adjusting these up for the future projection of a single runway capacity gives an annual capacity around 200,000 annual movements assuming that other traffic is moved out of the scheduled passenger aircraft peak.

From analysis of 2014 annual and daily aircraft movement profiles								
Hourly Peak Capacity	47					21	2017	
Utilisation	55%				WD1	46%		
Daily	620				WD1	232		
Busy Weekday peaking	92%	Ave	571			89%	207	Ave
Weekday to Weekend	87%	Ave	540			**84%**	174	Ave
Busy Weekend peaking	90%	Ave	486			**86%**	203	WE1
Weekdays	260		148,400				53,820	
Weekends	104		50,520				18,096	
			198,920				71,916	
Convert to 365	100.27%		**200,000**				**72,500**	

Figure 16 Hourly Capacity Demand vs Capacity

10. Method 3 - Benchmarking

Method 3 starts with taking the runway peak hourly capacity hypothetically assuming it is maintained for 24 hours a day, 365 days a year which calculates a maximum annual 24/7 throughput. The ratio of this to the actual or projected annual movements gives a “utilization ratio” (annual average peaking factor). This typically ranges below 40% (for airports with pronounced peaks, such as Perth) and above 60% for mature airports (consistent demand across the day, the week and the year).

Benchmarking for a range of airports that are close to the practical capacity of their current runway systems is shown below and compared to the current Christchurch ratio of around 40% for scheduled passenger aircraft movements. Using an annual average peaking factor of 50% and some further peak spreading over the design day (as shown previously), gives a projected runway capacity of around 205,000 annual scheduled passenger aircraft movements, assuming a maximum hourly capacity of 47 movements (see as shown in Figure 21 for Scenario 3 in Appendix 2). This assumes that the busiest periods have somewhat biased arrivals or departure peaks as per current patterns. However, if the future busy periods as the airport approaches capacity have balanced arrivals and departures (roughly 50/50 ratio) as shown in Figure 21 for Scenario 3 this could increase to 52 movements per hour and increase annual capacity. The result for Method 3 is considered as a range of 205,000 to 225,000 annual aircraft movements

			Benchmarking						
	CHC	CHC 2014	AKL 2017	BNE 2018	SYD	MEL	PER	LHR	LGW
Hours	24	24	24	24	24	24	24	24	24
Days per year	365	365	365	365	365	365	365	365	365
Peak hour AC mvts	47	21	45	50	80	57	50	85	50
Maximum annual 24/7	411,720	183,960	394,200	438,000	700,800	499,320	438,000	744,600	438,000
Annual capacity	205,000	72,500	172,765	215,000	350,000	240,000	130,000	475,000	285,000
Peaking factor	50%	39%	**44%**	**49%**	**50%**	**48%**	**30%**	**64%**	**65%**

Figure 17 Benchmarking Peak Aircraft Movements

11. Conclusion

Assessed Ultimate Annual Runway Capacity

Three independent methods were used to derive the Ultimate Runway Capacity for Aircraft Movements: (1) Analytical model, (2) Peak Spreading Factor and (3) Benchmarking.

Based on the results, this was assessed as between 181,000 and 218,000 annual scheduled passenger aircraft movements, with a median value being 201,000, for convenience this can be referenced as around 200,000 annual scheduled passenger aircraft movements.

This is based on a notional single runway peak (with balanced arrivals and departure) throughput of 52 hourly movements (based on consultation with Airways and a scaled up design day movement profile with some future peak spreading. Freight and other movements would be in addition and are illustrated in the table below. GA movements are assumed to have relocated to another aerodrome as this airport approaches capacity.

(b) As for case (a) but 50% of FBO/Small Commercial traffic displaced

200,000 Scheduled Movements	Annual Aircraft	Cumulative
Scheduled Passenger	200,683	**200,683**
Freight	15,227	215,910
Airline/MRO	5,244	221,154
FBO/Small Commercial(1)	14,515	235,670
Antarctic/Military/Govt	8,207	243,876
Helicopter	35,007	35,007
Note (1) Reduced by 50%		

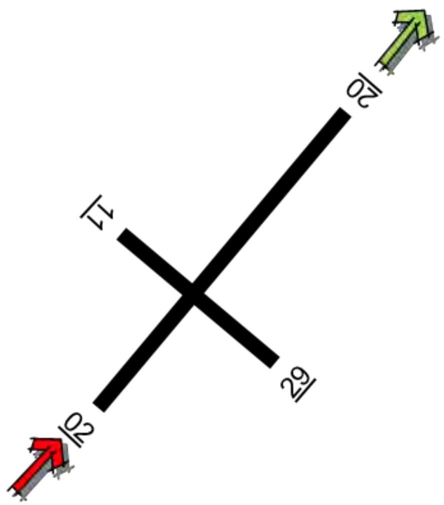
Figure 18 Ultimate Practical Capacity - including non-scheduled movements

A comparison with the 2008 (current basis for the Operative Contours) Expert Panel Ultimate Capacity estimate is included in Appendix 3.

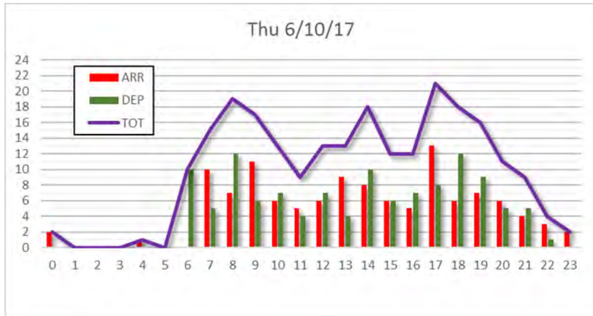
Appendix 1 Runway Modes of Operation

1. MODE 01

→ **Single Runway 02**	→ **NE/E wind: 50% to 60% of the time**
→ Downwind tolerance	→ 0 knots during busy period or WET condition → 5 knots during non-busy period or DRY condition
→ Noise abatement	→ No preferred direction



→ ***Arrivals***	→ **02**
→ ***Departures***	→ **02**



1 HOUR CAPACITY –

Scenario 1 - Current				
Arr	**Dep**	**Arr**	**Dep**	**Total**
90-100%	0-10%	24	5	29
60-90%	10-40%	24	18	42
40-60%	40-60%	24	24	48
10-40%	**60-90%**	18	26	44
0-10%	**90-100%**	5	27	32

Figure 19

Appendix 2 – Operational Information

Introduction

Airways New Zealand have provided the hourly runway throughput assumptions for the derivation of when the Christchurch Airport runway system will approach (practical) ultimate capacity.

While some benchmark airports in North America and Europe may achieve high hourly, daily and annual runway capacities, there are several infrastructure and operational constraints that will preclude Christchurch Airport from achieving similar numbers, even in the longer term.

These runway capacity constraints are summarised below under various headings.

The overall airport land area and airfield configuration, including its spatial relationship to the terminals and associated aircraft parking area, are shown in the Airport Master Plan (20-year horizon). The graphic below includes some comments on this layout in terms of future runway capacity enhancement. It is clear that there is not enough separation between aircraft stands and the main runway to develop a full dual parallel taxiway system required to achieve the highest runway capacities. A single parallel taxiway system in turn limits the development of safe and effective multiple Rapid Exit Taxiways (RETs) and storage of aircraft in deep or multiple departure queues.

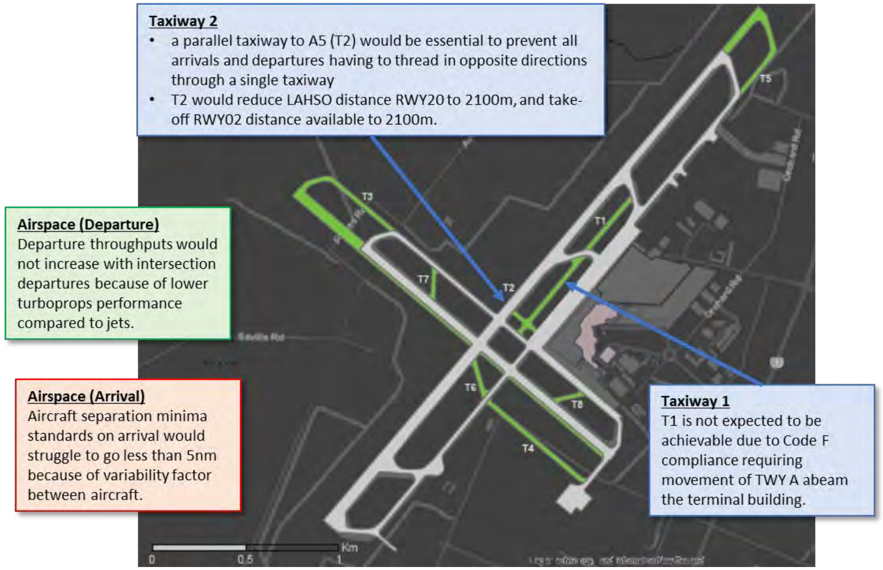


Figure 20

The nature of demand in a relatively small island state (compared to continental Europe/UK and North America) influences the current patterns of arrivals and departures and fleet mix. There is no basis to expect that these aviation market structures, which create the typical daily movement profile and hourly arrival/departure biases, will change dramatically in the future.

The supporting explanations for the adopted capacities sought by the review panel include:

- Provide a description and context of the constraints/limitations at Christchurch Airport that limit future capacity enhancements (e.g. taxiway system, lack of RETs etc).
- Provide a written methodology/assumptions on how hourly capacities were calculated.
- Confirm the tabulation of these hourly capacities for current and future scenarios by notional hourly arrival/departure demand bias.

The following text is as received from Airways.

Capacity Limitations as Documented by Airways

Runway Occupancy Time

- Limited taxiway exit options (6 TWYs in 3200m of RWY).
- No high speed TWY exits.
- A high variance surrounding average ROT times (largely airline dependent).

Arrival Only Capacity

- Wide fleet type mix and hence speed type mixes for arrivals.
- High variance around arrival speed profiles within aircraft types (30 seconds at 2SD inside 5nm final), requires standard arrival spacing of 4nm to have reasonable assurance of achieving 3nm.
- Wake Turbulence separation, limited effect after less than 5% heavy arrivals, limited effect in front of less than 5% light arrivals. PANS OPS ATM Partial RECAT under consideration by Airways may enable removal of light wake turbulence separation behind AT76 / DH8 or smaller.
- Flow management tools are not configured for anything other than mixed operations. Enhanced Flow Control Tooling is under consideration by Airways that may enable of arrival biased flow rates.

Mixed Mode Capacity

- Regulatory requirement to have assurance of separation in the event of a missed approach
- Pre 2020 reliance on radar separation or instructing aircraft under suitable weather conditions to enter the visual circuit. These methods had various efficiency and risk challenges.
- March 2020 change to a Divergent Missed Approach Protection System (DMAPS). Increase in capacity, decrease in risk.
- Incremental Improvement of DMAPS after concept proving is under consideration by Airways that may enable an increase in capacity rates (mixed rate from 48 to 52).
- Parallel grass RWY to the west limits early turns from the RWY centreline on RWY02/20.

Departure Rates

- A single initial departure track is used requiring radar separation to be in place for successive departures.
- High density residential to the east limits eastward departure tracks.
- West Melton Aerodrome (South West) limits SW departure tracks.
- High numbers of Commercial GA are often at high density in the CTR outside of current Instrument Flight Procedure Protection Areas.
- Parallel grass RWY to the west limits early turns from the RWY centreline on RWY02/20.

Other limitations

- A single parallel Taxiway for RWY02/20 and RWY11/29 limits available taxi paths.
- Many gate pushbacks enter and block the only available taxiway.
- Weather conditions do, on less than 10% of occasions, require the use of RWY29 for all but heavy arrivals.

Capacity Calculations

- Mixed mode capacities allow for interactions between all scheduled jet and turboprop traffic.
- A cycle time (for a departure / arrival pair) of 2.50 minutes is required for required divergent separations to be achieved. This time is a sum of the ROT of the previous arrival (to two SD on the longer side), plus the time from commencement of take-off roll until the required separation elements are in place for a departure (prior to the following arrival crossing the arrival threshold).
- Capacity is stable for all weather conditions except fog and exceptional hazardous conditions.

- Arrival only capacity rates are currently not valid as the current Collaborative Arrival Manager has set arrival rates at a mixed rate and introduced ground delay to achieve this rate.
- Departure capacities are based on fleet mix weightings to achieve required radar separation after departure.

Departure Bias Scenarios

Airways have also noted the following in regard to the departure bias scenario:

- Christchurch only has one departure path and departure timing is controlled by CH TWR under the Tower Initiated Departure Sequence (TIDS).
- The TIDS distances ensure that radar separation will be assured post departure and allows for speed variation within 4 speed bands.
- For a jet aircraft following a RPT turboprop aircraft the departure must be 3.0nm past the upwind end of the runway before the next departure is released. Including the take-off roll time this takes a little over 2 minutes. For a RPT turboprop following an RPT turboprop the distance is 2.5nm, a time of very close to 2 minutes.
- For leading jets the time reduces to 1 minute for following non jets, and 1.20 for following jets. These times are extended to two minutes for light aircraft, e.g. PC12, BE20/30/35/350.
- Put all this together and an average departure interval of 2 minutes is about spot on, giving 30 departures per hour.
- If departure demand was higher, consideration could be given to creating additional departure flight paths. Restrictions on this ability have already been forwarded in Airways prior consultation returns.
- A departure rate of 29 per hour was provided by Airways for the bottom two scenarios, with one movement allocated for training flight. However, as training movements are excluded from capacity calculations (as it is assumed that training has relocated to another airport) a departure rate of 30 is maintained.

Tabulation of Varied Arrival and Departure Capacities for Traffic Biases

Airways have provided the following hourly capacities for the various scenarios presented, these are the basis for the hourly capacity modelling undertaken to determine ultimate capacity..

Scenario 1 - Current

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	24	5	29
60-90%	10-40%	24	18	42
40-60%	40-60%	24	24	48
10-40%	**60-90%**	18	26	44
0-10%	**90-100%**	5	27	32

Scenario 2 - Potential if Mixed Rate Capacity increase to 52 in realised

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	26	5	31
60-90%	10-40%	26	19	45
40-60%	40-60%	26	26	52
10-40%	**60-90%**	19	28	47
0-10%	**90-100%**	5	30	35

Scenario 3- Potential if Mixed Rate Capacity increase to 52 and ECAM allowing ARR/DEP weighting is realised

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	30	5	35
60-90%	10-40%	28	19	47
40-60%	40-60%	26	26	52
10-40%	**60-90%**	19	28	47
0-10%	**90-100%**	5	30	35

Figure 21 Hourly Capacities by Scenario

Appendix 3

Comparison with Expert Panel Estimate

The 2008 Expert Panel Report used three approaches to determine the ultimate capacity of the airport.

The first was a simple model of maximum operations in 15-minute blocks based on a random sequence of arrivals and departures and the required sequencing gap applied by Air Traffic Control between each runway operation. The base demand was scaled up until one (or more) of the 15-minute periods equalled capacity. In hindsight this seems unnecessarily conservative as it does not consider peak spreading over the daily profile as an airport approaches capacity.

The second approach looked at planned terminal and gate layout in the 2025 timeframe and therefore the number of runway movements this may support. Again this seems unreasonably conservative due to the short time horizon considered (less than 20 years) and the fact that aircraft stands are not usually a constraint on runway capacity where there are areas for expansion for additional aircraft parking as demand requires further investment in airfield and terminal capacity.

The third method was based on benchmarking against other airports with single runway layouts, but corrected for the local Christchurch demand patterns. It is unlikely that demand at runway capacity would be maintained across all operational hours (say every hour equally busy from 6am to 8pm, and assuming early morning and late evening hours are off-peak). However, as with the first method, if not peak spreading is considered, this seems unduly conservative as it is generally accepted that as demand increases at an airport with capacity constraints during peaks, a degree of spreading across adjacent hours will occur.

Nevertheless, based on all these three approaches the Expert Panel "determined that Christchurch International Airport, with an extension of runway 11/29 would be able to support 175,000 scheduled operations per year". It is important to note that the Expert Panel noise contours only included scheduled passenger aircraft movements.

For the purposes of this calculation only scheduled movements were included (airline schedules passenger aircraft movements) as other movements were assumed more flexible and as with other major airports with international, domestic and regional services, as demand approaches capacity the "other" aircraft movements (cargo, maintenance etc.) are displaced from the peak into the shoulders.

The noise modelling included the following fixed wing aircraft traffic:

- Scheduled passenger services (by airlines such as Air NZ, Jetstar, international and regional airlines)
- Freight

- Airline/MRO movements without passengers position aircraft for maintenance
- Fixed base operations (FBO) and small commercial operations (non-scheduled)

Antarctic, Military and Government air traffic was forecast for the long term, and assumed to still operate at Christchurch, but not included in the noise contours (see Volume 5: Noise Modelling).

Helicopter (rotary wing) operations from helipads is in addition to fixed wing operations. At very busy hub airport the GA (Aeroclub) operations are displaced to other aerodromes.

The tables on the following page show annual aircraft movements for the following 3 cases:

a) 2008 Expert Panel Report Base Case with scheduled passenger movements around capacity of 175,000 annual movements

b) A capacity of around 200,000 annual movement for scheduled passenger movements, assuming a greater tolerance to delay, or more flexibility in peak spreading as the runway approaches capacity.

For these two cases, the other fixed wing traffic (cargo, Airline/MRO, FBO/Small Commercial) was assumed to fit in the shoulder periods across the day around the peaks for scheduled traffic. The Antarctic/Military/Government would be in addition. A further case was also considered:

c) As for case (b), but assuming that 50% of the FBO/Small Commercial traffic was displaced to another aerodrome rather than in the shoulder periods.

The application of a seasonal peaking factor across all traffic for the busiest 3 months is described in Volume 5: Noise Modelling.

The columns overleaf for each case show: the nominal annual aircraft movements for each sector, the cumulative traffic.

(a) 2008 Expert Panel Base Case Capacity

175,000 Scheduled Mvts	Annual Aircraft	Cumulative
Scheduled Passenger	175,522	**175,522**
Freight	10,041	185,563
Airline/MRO	4,543	190,106
FBO/Small Commercial	17,499	**207,605**
Antarctic/Military/Govt	5,523	213,128
Helicopter	26,927	26,927

(b) Capacity of 200,000 annual scheduled passenger movements

200,000 Scheduled Movements	**Annual Aircraft**	**Cumulative**
Scheduled Passenger	200,683	**200,683**
Freight	15,227	215,910
Airline/MRO	5,244	221,154
FBO/Small Commercial	29,030	250,185
Antarctic/Military/Govt	8,207	258,392
Helicopter	35,007	35,007

(c) As for case (b) but 50% of FBO/Small Commercial traffic displaced

200,000 Scheduled Movements	**Annual Aircraft**	**Cumulative**
Scheduled Passenger	200,683	**200,683**
Freight	15,227	215,910
Airline/MRO	5,244	221,154
FBO/Small Commercial(1)	14,515	235,670
Antarctic/Military/Govt	8,207	243,876
Helicopter	35,007	35,007
Note (1) Reduced by 50%		

Figure 22 Annual Aircraft Movements at Capacity

3 CHRISTCHURCH AIRPORT AIR TRAFFIC PROJECTIONS

AIRWAYS
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AIRBIZ

2023 Airport Noise Contours Update

Volume 3: Air Traffic Projection Report

Christchurch International Airport Ltd

5 May 2023

AIRBIZ

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01. Introduction

1. Objective

This documentation supports the technical study which delivers an updated set of noise contours for Christchurch Airport to be provided to planning authorities to consider as a basis for updates of District and City plans.

CIAL have engaged several technical experts to prepare the updated noise contours and have relied on their advice and expertise to agree key aspects of the work with CIAL where appropriate, as well as to determine methodologies, assumptions and results. In addition CIAL and Environment Canterbury (ECan) have an agreed technical review process using experts engaged through ECan to review the technical work undertaken by CIAL's consultants.

The noise contours are based on the requirements and guidelines in the current New Zealand Standard Airport Noise Management and Land Use Planning (NZS6805:1992).

The technical output in the form of a set of contours on a cadastral map is supported by technical reports including the methodology and key assumptions used in developing the contours. This volume covers the output and development of **air traffic projections**.

Other technical support volumes cover the topics:

- VOLUME 2: Ultimate Runway Capacity
- VOLUME 4: Flight Tracks
- VOLUME 5: Noise Modelling.

The objective of the **air traffic projections** task stream was to prepare:

- Aircraft runway movement profiles to be used in determining the ultimate capacity of the runway system; and
- The aircraft movement demand scenarios used in the noise modelling.

The ultimate capacity calculations required clock hour profiles of a design (busy) day. This included hourly arrivals and departures by sector and aircraft classification (wake turbulence category for separation requirements) and departure destination for runway allocation based on runway length required.

The noise modelling required the number of aircraft movements on an annual average day disaggregated by aircraft type (by agreed categories), arrival/departure, origin/destination (by region, to determine departure stage length, runway, and track allocation), and day/night.

2. COVID-19 Disruption

Scheduled passenger flights generate the largest share of air traffic movements at Christchurch Airport and is driven by passenger demand. The forecast of passenger demand, which was first prepared in 2018, and updated at the end of 2022 to account for COVID-19 impact and to incorporate feedback from Environment Canterbury's technical review experts, is documented in more detail in Chapter 04 below.

At the end of 2022, based on an assessment of the domestic and international recovery, visitor sentiment and profile, CIAL estimated that total passenger numbers at Christchurch Airport should fully recover to FY2019 levels in FY2026[1,2]. In addition, CIAL assessed that the longer-term assumptions adopted in the original FY2018 forecast are expected to remain valid, and therefore the original post-FY2019 rate of growth of the passenger forecast could be expected to resume from FY2026. Thus, the overall effect of the COVID-19 disruption period is expected to be a 7 year delay or shift of the trajectory of the forecast from FY2019 to FY2026.

Chapter 04 below lays out the assumptions, considerations and the methodology used in the passenger demand forecast, which starts from FY2019. In the interest of maintaining consistency with the basis for the forecast, the considerations are presented using FY2019 as the first year of the forecast.

3. Projections Prepared

Separate traffic projections were generated for the following categories of activity:

a. Scheduled passenger flights

b. Other – Non-scheduled commercial (airline repositioning and maintenance; FBO and small commercial;

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[1] https://www.christchurchairport.co.nz/globalassets/about-us/who-we-are/financial-reports/regulatory-disclosures/disclosure-relating-to-reset-of-aeronautical-prices-jul-22-jun-27.pdf

[2] https://www.christchurchairport.co.nz/globalassets/about-us/who-we-are/financial-reports/2023-statement-of-intent.pdf

military, government, and Antarctic flights)

c. Freight

d. Helicopters

e. General aviation (aeroclub and similar recreational).

The commercial scheduled passenger flights category has the largest number of aircraft movements and required the greatest number of assumptions.

02. Methodology

1. Overall Methodology

The overall process is as follows for each forecast of categories of activity listed in Section **Error! Reference source not found.**:

01. The baseline of the forecast was established from historical data. In this case the baseline year was FY2018.

02. Annual growth was forecast by appropriate demand driver such as passengers and freight volume.

03. Annual changes were forecast in fleet mix and day/night split on a region basis.

04. The year when the forecast annual aircraft movements for scheduled passenger activity reaches the "ultimate runway capacity" is identified.

05. Annual average day for noise modelling is calculated by dividing the annual figure by 365.

This methodology is expanded upon in Sections 02.3 to 02.7 below for the category of scheduled passenger flights.

The New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning", allows for consideration of a design day based on the average day calculated from all operations in the busiest three months of the year. This accounts for seasonal variations in aircraft movements. The daily profiles generated in this task were for annual average rather than busiest three months. The methodology and analysis which determined "peaking factors" from historical records to account for the busiest 3 months are described in Volume 5 – Noise Modelling.

2. Forecast Baseline

The FY2018 baseline was generated using the following approach.

01. Aircraft movements sourced from CIAL movement data supplied by Airways for the 12 month period ended 30 June 2018.

02. The segmentation used in the aircraft movement forecast model[(a)] is applied to the aircraft movement data before aggregation.

03. The sum of movements by segment for each clock hour calculated for the 12 month period.

04. The total movements per segment and clock hour are then divided by the number of days in the period (365) to derive average daily aircraft movements for each.

(a) aircraft movement model – segmentation

- Region
- Aircraft Category
- Direction

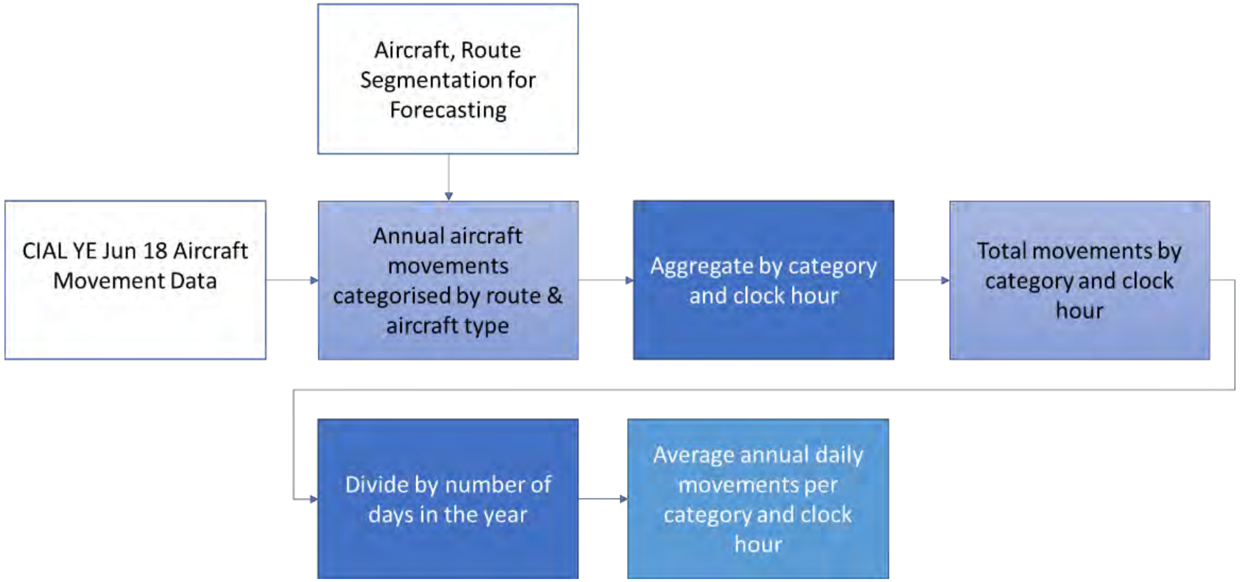
These steps are illustrated in the following flowchart shown in Figure 02-1.

The primary historic **data inputs** were:

01. The FY2018 design day baseline (FY18) movement profile. This grouped arrivals and departures by clock hour for the concatenated grouping of regions and main aircraft categories.

02. Historic peaking factors (discussed separately in Volume 5 – Noise Modelling).

2018 Aircraft Movements by Clock Hour



3. Scheduled Traffic Projections

Projections were made of:

01. The annual passenger growth forecasts by region
02. Fleet mix at the region level
03. Average seats (at the region level) for the aircraft categories
04. Up-gauging of aircraft size categories at the region level
05. Annual aircraft movements derived from the above four projections
06. Changes in day/night split of aircraft movements from the baseline at the region level.

All the projection tables in the model had annual values. In this way, for any runway capacity scenario the annual movements would be correlated back to a notional forecast year, which would have all the detail of region, aircraft, and time of day.

Annual scheduled passenger demand forecasts are described in Chapter 04 below.

4. Fleet Mix, Average Seats and Up-gauging

A baseline fleet mix for each region was created from historical data. This was then projected forward and adjustments made (in 5-year blocks) at the region level considering how an airline serving this region may up-gauge over time to accommodate growth in passenger demand (increase frequency, increased competition on a region or increase in seats through changes in equipment). A separate table of anticipated seating densification for an aircraft category was also populated. The future average seats were representative of possible aircraft type and seating densities that could fulfil a similar role to the aircraft currently operating in that category. Similar methodologies were used for the other projection tables in the model.

5. Day/Night Splits

For the day night split, the hourly movements by region and aircraft category in the baseline were aggregated into "day" (7am to 10pm) or "night" as per the Ldn noise metric. A projection table was created of possible incremental changes to this split at the region and aircraft level based on similar considerations to the fleet mix projection tables as described above. Specific flight timing as per route development assumptions, for example a new route to Rarotonga operating at 10pm and 6am will increase the proportion of night movements for that region. Schedule spreading based on market growth. For example, from historic data it can see the proportion of Night period aircraft movement grows as domestic routes grow as the Day period that is preferred for domestic travel saturates. The number of day and night flights are then calculated by multiplying the average daily movements by the share of day/night movements respectively.

6. Annual Aircraft Movement Projections

The demand output is a **table of average day (annual/365)** arrivals and departures by region, aircraft category and day/night which could be fed directly into the noise modelling. The noise modelling would then post-process this for peaking factors (busy 3 months) and specific representative aircraft model for noise profiles. These “transfer tables” from the Demand task to the Noise Modelling task are shown in the Appendix to this report.

7. Noise Modelling Inputs

The final outputs from the demand modelling are an average day (annual/365) for each forecast (schedule passengers, freight etc.) and peaking factors which were applied in the Noise Modelling and described in that report.

As mentioned in Section 02.4 above the detailed aircraft movement forecast was prepared in 5 yearly increments. Therefore, the target year for runway capacity can fall between two years. In that case the average day is prepared via a linear interpolation between the years on either side. For example, if the target year is 2084 then the 2084 average busy day is prepared through linear interpolation between the average days of 2082 and 2087.

03. The Role of Christchurch Airport

1. General

Christchurch Airport is of significant importance to New Zealand, the South Island, the Canterbury region and Christchurch City as an essential transportation connectivity hub and base for all types of aviation activity now and in the future. Christchurch Airport has no curfew and is operationally available 24 hours a day, seven days a week. Its 24/7 availability is a significant operational advantage for the Airport's users and the communities it serves.

Prior to the COVID-19 pandemic there were direct air service connections from Christchurch Airport to ten international destinations including Sydney, Melbourne, Brisbane, Perth, Gold Coast, Singapore, Guangzhou, Hong Kong, Rarotonga, and Nadi, with nine international airlines represented. Scheduled traffic in the financial year 2019 comprised 92,345 domestic and 11,593 international aircraft movements[3] carrying 6.3 million annual passengers[4] and making Christchurch Airport the second busiest commercial passenger airport in New Zealand[5].

Christchurch Airport is also of international importance, due to its proximity to Antarctica and its role in facilitating scientific exploration of the continent.

Christchurch Airport is a nominated "alternate" for Auckland Airport. If aircraft bound for Auckland are not able to land there for reasons such as poor weather, an accident blocking the runway or other operational reasons, they can be diverted to Christchurch Airport. Other "alternate" options for Auckland Airport diversions include:

- Wellington Airport. However, the runway is not suitable for most large wide body aircraft, and
- The Ohakea Royal New Zealand Air Force Base. However, this does not have suitable passenger processing facilities, the runway is shorter than Christchurch and the Ohakea Air Force Base does not have other scheduled services making it slower for passengers to be processed and sent on to final destinations.

As the gateway to the South Island, Christchurch Airport serves as a regional hub, connecting international and domestic passengers across the South Island. Christchurch Airport also provides critical air connectivity for the movement of international air freight into and out of the South Island and New Zealand, linking into international

[3] A "movement" of an aircraft (or a passenger) is counted for each arrival, departure or transit/transfer.
[4] Christchurch Airport 2019 Annual Report and CIAL data
[5] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR005

freight hubs in Australia, Singapore, China, and the United States.

Statistics New Zealand notes that Christchurch Airport is the second ranking airport for air freight imports and exports in New Zealand (after Auckland), accounting for $3.14 billion New Zealand dollars' worth of air freight in 2017/18[6]. Statistics New Zealand also notes that: *"Air freight carries less than 1% of our trade by volume, but about 16% of our exports and 22% of our imports by dollar value.[7]"* Christchurch Airport plays a key role in this trade.

Infrastructure at Christchurch Airport, such as the runways, taxiways, and aprons, provide the basis for air service operators to connect Christchurch, the wider region, and the South Island to the rest of New Zealand and the world.

The main runway at Christchurch Airport is the second longest runway in New Zealand at 3,287m, allowing air services by new generation aircraft such as the Airbus A350 and Boeing 787, and the world's largest passenger aircraft, the Airbus A380. These aircraft types are critical to passenger capacity and the supply of capacity for international air freight which travels in the belly-hold of these aircraft or on dedicated freight aircraft.

The main runway at Christchurch Airport is the only runway in the South Island capable of servicing these large wide body aircraft types without restrictions. If this runway is consistently not available for use, widebody international aircraft (passenger and dedicated freighters) would need to use runways in the North Island. Therefore, Christchurch Airport it is an essential piece of transport infrastructure for the South Island.

2. Scheduled Passenger Services

Domestic

In FY2019 Christchurch Airport recorded 5,164,504 domestic passenger movements[8] making it the third busiest airport in New Zealand[9] for domestic passengers.

In FY2019 Christchurch Airport had 105,000 domestic-to-international transferring passengers and 245,000 domestic-to-domestic transferring passengers[10], illustrating its key role in regional connectivity for the lower South Island and as a hub for Air New Zealand in the South Island, distributing and collecting passengers onto trunk domestic services.

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[6] https://www.transport.govt.nz/statistics-and-insights/air-and-sea-transport/sheet/air-freight

[7] https://www.transport.govt.nz/statistics-and-insights/air-and-sea-transport/sheet/air-freight (accessed 14/07/2021)

[8] Christchurch Airport 2019 Financial Statements

[9] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR004

[10] CIAL data

Domestic data recording reasons for travel is not generally collected other than in periodic sample surveys, however it is generally understood that Christchurch Airport facilitates travel for leisure, business, visiting friends and relatives, education and medical reasons amongst others.

In FY2019 Christchurch Airport was serviced domestically[11] by Air New Zealand, Jetstar, Air Chathams and Sounds Air on trunk and regional routes.

International

In 2019 Christchurch Airport recorded 1,766,937 international passenger movements[12] making it the second busiest airport in New Zealand[13] for international passengers.

Christchurch Airport provides a key role across a range of social and economic needs and is important in delivering tourists directly to the South Island. In 2019 the main reasons for travel for international passengers arriving at Christchurch Airport were holiday/leisure (63%) and visiting friends and relatives (24%). Discretionary travel is therefore highly significant for Christchurch Airport, with 6 in 7 international visitors arriving for the purpose of holiday or visiting friends and relatives.[14]

In 2019 Christchurch Airport was serviced internationally[15] by Air New Zealand, Emirates, Qantas, Jetstar, Virgin Australia, Singapore Airlines, China Southern Airlines, Cathay Pacific Airlines and Fiji Airways.

3. Air Freight and Mail

Domestic

Air freight, small parcels and mail is carried into and out of Christchurch Airport in the belly-hold of scheduled passenger operations or on dedicated air freight services.

Christchurch Airport is one of three South Island locations for Air New Zealand's domestic air freight operation 'Air New Zealand Cargo' (the others are Nelson and Queenstown). The airline's air freight products tend to focus on general and perishable goods and pets, and are principally transported on their scheduled passenger aircraft

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[11] Source: Airbiz analysis of Flight Global Diio 2019 domestic schedules for Christchurch Airport
[12] Christchurch Airport 2019 Financial Statements
[13] New Zealand Ministry of Transport website - Air and Sea transport - air passengers AR006
[14] Airbiz analysis of NZ Stats Infoshare International Travel and Migration data for Christchurch Airport international visitor arrivals for the year to June 2019
[15] Source: Airbiz analysis of Flight Global Diio 2019 international schedules for Christchurch Airport

services which operate through the day and early evening.

Air freight is also carried in the belly-hold of other domestic commercial airlines such as Jetstar and Air Chathams; this is handled by a ground handler at Christchurch Airport where it is consolidated for air transport or distributed via freight forwarding companies onto the road network.

Christchurch Airport is a critical component in New Zealand's small parcel and mail distribution infrastructure, serving as the South Island hub in Parcelair's network, connecting to Auckland for the upper North Island and Palmerston North for the lower North Island.

Parcelair is a joint venture between Fieldair Holdings (a subsidiary of Freightways) and Airwork, and services the overnight air freight, courier and mail connectivity needs for principal clients Freightways and NZ Post.

Christchurch Airport facilitates the transfer of domestic and regional air freight onto international services, supporting industries such as salmon farming from Nelson/Tasman onto international services.

International

In 2019 Christchurch Airport recorded approximately 120,000 international tonnes of air freight and mail. In terms of volume and value, Christchurch Airport accounts for 14% of all New Zealand's international air freight, making it the second busiest airport [16]in New Zealand for freight and mail.

In 2019 at Christchurch Airport, 70% of international air freight and mail was carried in the belly-hold of passenger aircraft and 30% on dedicated international freight aircraft[17].

DHL, Qantas and Air New Zealand have used Christchurch Airport for their dedicated international air freight operations, linking into their individual distribution centres located at the Airport.

During and prior to the COVID-19 pandemic, Christchurch Airport had a typical 5 day a week dedicated freighter service (with some weekly variations) on a B767 freighter taking freight from the Christchurch to Sydney. This is a triangular AKL-CHC-SYD flight operating year-round. On top of this, Christchurch occasionally have freighters going to Brisbane and Melbourne, especially during the summer peak export season.

International heavy air freight is screened at Christchurch Airport before being imported or exported on dedicated freighters or in the belly-hold of scheduled passenger services.

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[16] Airbiz analysis of New Zealand Ministry of Transport website Air Freight statistics for FY18
[17] CIAL data

4. Antarctic Operations

Christchurch Airport is New Zealand's gateway to Antarctica, with a well-established International Antarctic Centre[18]. This includes a dedicated Antarctic aircraft apron where cargo is airlifted, with its own airport departure terminal for personnel travelling to and from Antarctica during the summer season. It serves as a base for the United States, New Zealand and Italian[19] Antarctic Programs.

Christchurch Airport also provides key emergency access to the continent as recently illustrated by an emergency medical evacuation. Stuff.co.nz quotes:

> *"A military aeroplane was called in to carry out a medical evacuation of a member of the United States Antarctic Program who had been injured in Antarctica. A Royal New Zealand Air Force C-130 Hercules left Christchurch at 10.25pm on Sunday for the seven-hour, 3920km flight to the US-run McMurdo Station on Ross Island."*[20]

This further illustrates the essential role Christchurch Airport in Antarctic operations.

5. Airport Campus Role

Aviation servicing infrastructure on Christchurch Airport's campus is intrinsically linked to the air service operations and passenger, baggage, and freight flows that the Airport facilitates. There are a range of businesses located at Christchurch Airport that provide ancillary support to the air service operations, as well as commercial and service-related offerings.

6. COVID-19 Pandemic Role

During the COVID-19 pandemic, Christchurch Airport has played a key role maintaining international and domestic passenger connectivity, whilst meeting health requirements through specific operational protocols enabled within the Airport's terminal infrastructure.

During the pandemic, the importance of air freight has been further emphasised. Christchurch Airport enables direct and large capacity freighter movements and belly-hold freight and forms part of a connected and diversified

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[18] https://www.christchurchairport.co.nz/about-us/who-we-are/gateway-to-antarctica/ (accessed 14/07/2021)
[19] https://www.comnap.aq/our-members/programma-nazionale-di-ricerche-in-antartidepnra/ (accessed 14/07/2021)
[20] https://www.stuff.co.nz/national/125725259/air-force-carries-out-nighttime-medical-evacuation-from-antarcticas-mcmurdo-station

freight transport network to and from New Zealand. This helps ensure the availability of key goods in New Zealand that require movement by air and helps mitigate the worst impacts of supply chain constraints to freight movements via shipping brought on by the pandemic.

7. Disaster Recovery

Airports are critical links in disaster response and recovery, providing critical staging areas for disaster management, enabling fast medical evacuations and transport and providing important resilience to the overall transport network when roads, rail and maritime transport are compromised.

CIAL is a designated 'Lifeline Utility' in the New Zealand Civil Defence Emergency Management Act 2016. Section 60 of that Act notes that Lifeline Utilities must:

> *"… ensure that it is able to function to the fullest possible extent, even though this may be at a reduced level, during and after an emergency and participate in the development of the national civil defence emergency management strategy and civil defence emergency management plans."*

Christchurch Airport plays an essential role in local, regional, and national disaster management. This places a range of requirements on the Airport and confirms its importance as a key asset for Canterbury and the wider South Island following any large-scale incident. The following are examples of Christchurch Airport's role in Disaster Recovery.

→ 2011 Christchurch Earthquakes – Christchurch Airport was the main arrival and departure point for a wide range of local and international rescue teams. Emergency supplies were airlifted into Christchurch and many of the critically injured were evacuated out. Christchurch Airport was credited with contributing to helping save dozens of lives due to the ability to reopen the facility so quickly and keep it open 24/7. In the seven days following the initial earthquake, more than 45,000 passengers were moved out of Christchurch utilising a 'shuttle service' to Auckland.

→ 2016 Kaikoura Earthquake – Due to Kaikoura being essentially cut off from all other towns by road and rail, air transport into and out of Kaikoura was vital. Christchurch Airport was the initial staging point for military and private air response. Large aircraft with supplies would arrive at Christchurch Airport and be helicoptered out to Kaikoura. Those evacuated from Kaikoura would often be airlifted back to Christchurch.

→ 2017 Port Hills Fires – Christchurch Airport quickly became the staging point for all fixed wing and many helicopter aerial assault aircraft fighting the Port Hills fires. Christchurch Airport hosted on site the various aircraft and crews, making sure they had water available to refill aircraft as well as resting facilities for crews. In addition, over a period of 10 days, Christchurch Airport provided over 20 skilled staff to assist in the Emergency Operations Centre in Rolleston supporting the response effort.

- → 2020 COVID-19 Repatriation Evacuations – In April and May 2020, thousands of stranded tourists visiting the South Island were evacuated to their home countries through Christchurch Airport. Visitors from Germany, the Netherlands, the UK, France, and a range of other European countries all boarded repatriation flights at Christchurch Airport in a desperate attempt to get home as international borders shut. At the same time, hundreds of Kiwis were repatriated back to New Zealand on charter flights due to the disruption to commercial flights and border restriction.
- → 2019 Rangitata Floods – This affected many international tourists and there were many general aviation fixed wing and helicopter operators ferrying passengers between Timaru and Christchurch to enable them to continue their journey or catch international flights which would otherwise have not occurred due to road and rail outages.

04. Passenger Demand Forecast

1. Introduction

The passenger demand forecast was established in 2018 and updated at the end of 2022 to account for COVID-19 disruptions.

An assessment of traffic recovery, visitor sentiment and visitor profile after New Zealand borders reopened suggested that many of the assumptions made in the original forecast remain valid, and that the trajectory of the original forecast would be applicable when the market is fully recovered. In addition, based on initial traffic recovery and industry insights, CIAL estimated that its passenger numbers would fully recover to 2019 levels in 2026[1,2], after which pre-COVID-19 growth assumptions could be applied. Thus, the overall effect of the COVID-19 disruption period is expected to be a 7 year delay or shift of the trajectory of the forecast from 2019 to 2026.

A discussion of the impact COVID-19 had on CIAL passenger numbers is presented in the next section, together with the potential pathways and characteristics of recovery. This is followed by a documentation of the passenger demand forecast.

With 2019 as the first year of the forecast, the passenger demand forecast is divided into three parts, the medium-term (2019-2025), long-term (2026-2040) and post-2040 forecasts. The basis and methodology used for these three periods are different. The rationales of each of the forecast parts are illustrated below after the COVID-19 impact section.

2. COVID-19 Impact to Passenger Demand

The COVID-19 pandemic has had a profound impact on aviation, significantly reducing airline capacity and passenger movements. The rate and shape of the recovery of passenger demand for the next few years remains uncertain although it is widely expected to have an initial recovery phase followed by a subsequent growth phase that is likely a continuation of pre- COVID-19 normal growth.

The following captures the major drivers of the recovery, which is adopted in CIAL's Price Setting Exercise 2022[1] and FY23 Statement of Intent[2].

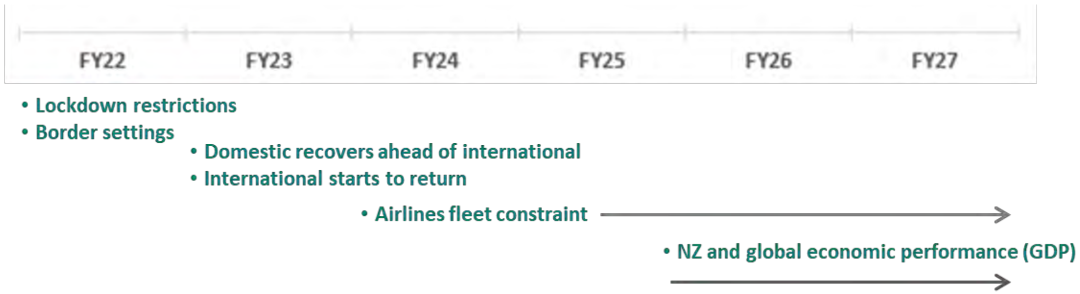

Figure 04-1 Drivers of CIAL Passenger Recovery (source: CIAL Internal Analysis)
**Note CIAL financial year ends at 30 June*

Within CIAL recovery path, the initial phase (FY23 – FY24/25) is characterised by:

- Domestic travel recovering and growing as economic activities resume to normal levels.
- Short haul traffic (Tasman and Fiji) recovery driven by visiting friends and relatives travel, and benefits from the substitution of long-haul leisure travels with Tasman / Pacific Island trips by New Zealanders and Australians.
- Correspondingly, domestic leisure travel will reduce when borders reopen, as some travellers switch back to international travel.
- Slower restart of international traffic. International recovery is a direct function of airlines' ability to re-mobilise fleets and crew.
- Uncertainty around when the current high airfare environment ends, and how much it affects demand.

This is followed by FY25-FY27, when demand is driven by:

- Airlines' financial performance and risk appetite
- Economic conditions in New Zealand and those in CIAL's major tourism source markets

Domestic Recovery

The domestic air traffic has demonstrated some resilience as domestic economic activities resume from COVID-19 lockdowns. Over the past two years, it has managed to recover relatively quickly each time domestic travel restrictions were eased.

Domestic traffic has recovered well in the second half of 2022, as economic activities, visiting friends and relatives, and leisure travel normalises. Filed seats in November 2022 to February 2023 were between 88% to 90% of pre-

COVID-19 levels.

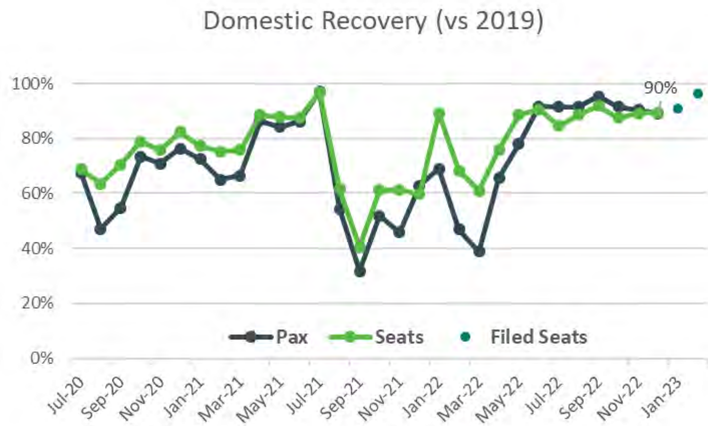

Figure 04-2 CIAL Domestic Recovery

From the second half of 2022, the constrained domestic air operation resulted in very high yields and loads across the domestic network. The arrivals of international visitors also add to the demand for domestic services, as visitors travel around the country. The domestic traffic recovery is established based on airlines' planned fleet size in coming years, considering CIAL's pre- COVID-19 share and growth pattern.

International Recovery

The forecasting of international passenger recovery at CIAL carries more complexity and uncertainty, as it hinges on assumptions around:

- the financial position and confidence to travel of potential travellers
- attractiveness of New Zealand as a tourism destination
- airlines financial position and risk appetites, aircraft and crew capacity
- an element of environmental concerns regarding long haul flying for leisure purposes.

Therefore, a recovery mile-stone approach is adopted, referencing market surveys, New Zealand and global forecasts. References below are used, with adaptations to reflect the unique position CIAL is in:

- On the global level, IATA forecast that Origin and Destination passengers will fully recover in 2024 (Figure 04-1)
- The Tourism Industry Roadmap 2022 – 2024, developed by the Tourism Industry Aotearoa, an independent

association that represents all sectors of New Zealand's tourism industry, estimated between 51% and 86% recovery at the end of 2024 (Figure 04-2)

- Tourism New Zealand's active considerer surveys showed the level of confidence of and when active considerers think they would travel to New Zealand.

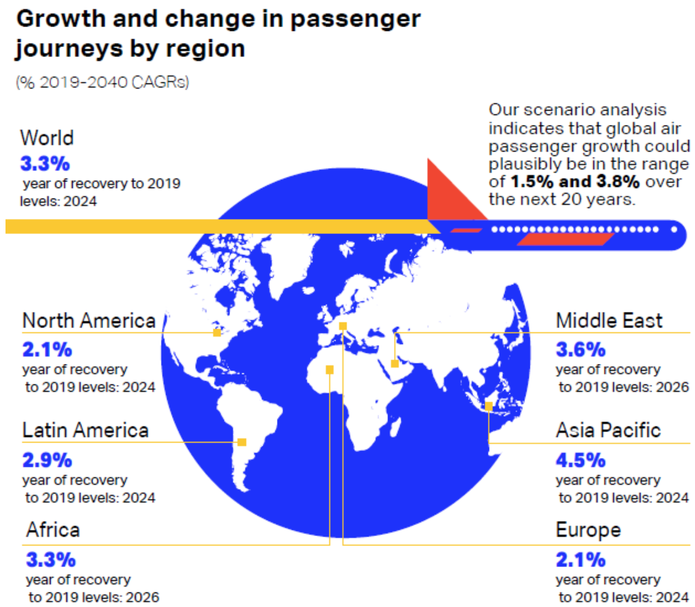

Figure 04-1 Projected Traffic Recovery by Region (source: IATA)

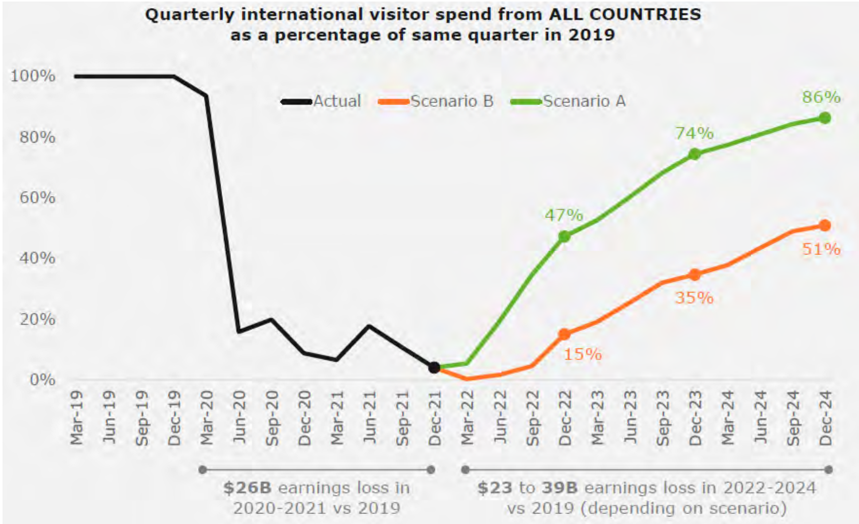

Figure 04-2 Projected Recovery of International Visitor Spend in New Zealand (source: Tourism Industry Aotearoa)

International demand at Christchurch Airport in recent months has been restricted by capacity, as airlines could not resource enough crew to operate the frequencies they would like to operate. This results in passenger recovery ahead of capacity recovery (also seen in the domestic market).

In December 2022, Christchurch Airport was at 54% international recovery compared to the same month in 2019. At the time of writing this report, filed capacity in the first few months in 2023 was above 50% of pre-COVID-19 levels.

Tourism recovery has been seen to rebound strongly at the Airport. Feedback from the industry indicates that demand for New Zealand is strong. Initial tourism data also shows some positive signs.

Tourism New Zealand's Active Considerers results[21] are used to monitor the attractiveness of New Zealand is a tourism destination. Survey results have shown that the willingness to travel to New Zealand remain high among active considerers in major tourism source markets. A high proportion of active considerers indicates strong intent to travel once the border reopens.

[21] https://www.tourismnewzealand.com/assets/insights/intl-research/covid-impact/COVID-impact-on-intentions-to-travel-in-AU-FINAL-June-22.pdf

In addition, the fact that passenger recovery is ahead of seats recovery, which results in exceptionally high load factors on both domestic and international flights, also suggest strong demand.

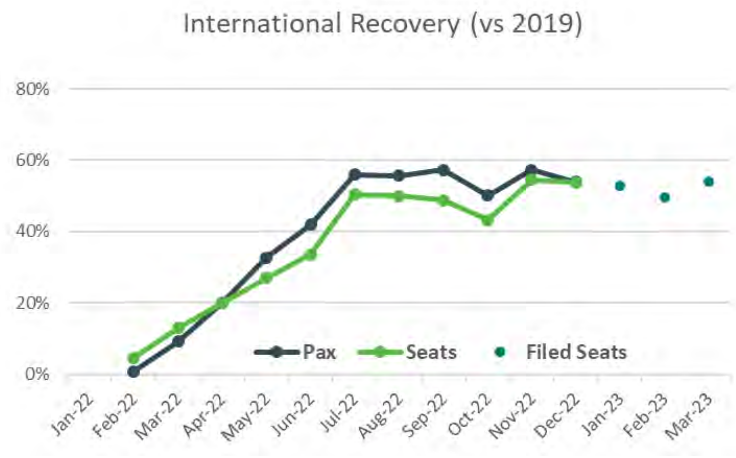

Figure 04-3 CIAL International Recovery

Total Passenger Recovery

At the time of writing this report, CIAL had observed strong pent-up demand in domestic and international travel when travel restrictions were lifted. Apart from the constraints placed by the limited capacity available, CIAL had not observed any sign indicating a change in demand profile in the domestic nor the international markets from their pre- COVID-19 conditions. This implies that the assumptions used in the original demand forecast models, as well as the forecast itself, remain valid in a post- COVID-19 environment when air traffic has fully recovered.

Based on CIAL analysis[1,2] it is estimated that passenger numbers would fully recover to 2019 levels in FY26 (year ending 30 June 2026). Correspondingly, the forecast set out in the Price Setting Exercise 2022[1] is adopted for FY23-FY27, and the original demand forecast trajectory applied from FY27. Note that in the short term, passenger numbers could still be pushed either way by airlines' ability to add capacity domestically and internationally at Christchurch Airport.

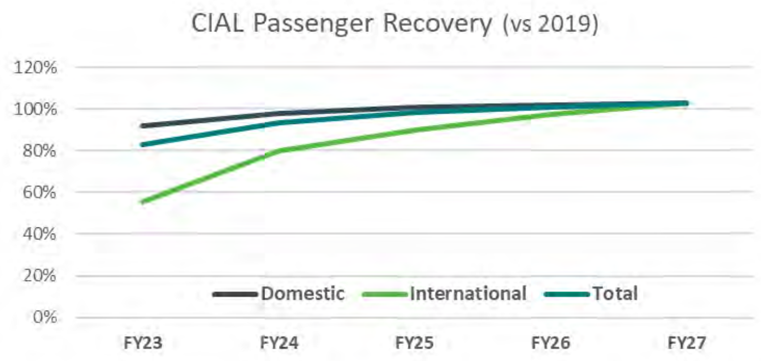

Figure 04-4 CIAL Passenger Recovery Forecast for FY23-FY27

The following sections illustrate rationales considered in the medium-term (2019-2025), long-term (2026-2040) and post-2040 forecast.

3. Medium-term 2019-2025 forecast

** Medium-term now applies to the trajectory of growth in the period 2026 – 2032 after accounting for the 7 year delay due to COVID-19 disruptions*

In this forecast, passenger traffic was divided into three market segments - Inbound (international visitors), Outbound (New Zealanders' international outbound travel) and Domestic.

International Inbound (inbound overseas visitor traffic)

The inbound visitor market represents over 60% of Christchurch Airport's international traffic.

The forecast of the inbound visitor market was based on the Ministry of Business, Innovation and Employment's (MBIE) tourism forecast, historical growth at Christchurch Airport and the potential of further market penetration for each of the top 10 markets.

The 15-year, 10-year and 5-year compounded annual growth rates (CAGRs) of the top 10 inbound visitor markets were used as historical reference.

Growth rate for each market were selected based on MBIE's forecast[22] (2018-2024) with considerations of the potential for further market penetration. They were then checked against the 15-, 10- and 5-year CIAL historical growth to ensure they were within historical range, unless there were reasons suggesting they would behave differently.

Break out Inbound by major markets (as MBIE breakout & corresponding growth rates)

CHC actual arrival growth

15-year	*2003-18*	*3.6%*	*16.6%*	*6.9%*	*9.3%*	*8.1%*	*-14.4%*	*-0.8%*	*8.0%*	*-0.8%*	*-0.8%*	*4.1%*
10-year	*2008-18*	*-0.5%*	*20.7%*	*5.2%*	*6.5%*	*8.1%*	*-17.6%*	*-0.9%*	*6.8%*	*-3.7%*	*-1.7%*	*2.6%*
5-year	*2013-18*	*4.2%*	*35.4%*	*11.3%*	*15.9%*	*5.8%*	*-12.6%*	*13.4%*	*9.0%*	*4.9%*	*8.5%*	*6.7%*
	Growth Adopted	3.1%	15.0%	5.5%	6.0%	3.4%	0.0%	4.2%	5.0%	3.5%	6.0%	3.1%
	FY18 Arr	261,056	54,032	23,472	9,072	4,544	5,792	19,728	18,752	39,728	24,720	93,600
	Mix	47%	10%	4%	2%	1%	1%	4%	3%	7%	4%	17%

FY	**Inbound**	**AU**	**CN**	**DE**	**IN**	**ID**	**JP**	**KR**	**SG**	**UK**	**US**	**Other**	***Inbound Growth***
2018	1,140,431	536,913	111,128	48,275	18,658	9,346	11,912	40,575	38,567	81,709	50,842	192,507	
2019	1,193,174	553,364	127,797	50,910	19,778	9,659	11,912	42,260	40,495	84,560	53,882	198,557	4.6%
2020	1,249,781	570,319	146,966	53,689	20,965	9,983	11,912	44,015	42,520	87,510	57,105	204,797	4.7%
2021	1,310,683	587,794	169,011	56,620	22,222	10,318	11,912	45,842	44,646	90,564	60,520	211,233	4.9%
2022	1,376,368	605,804	194,363	59,711	23,556	10,664	11,912	47,746	46,878	93,724	64,139	217,872	5.0%
2023	1,447,395	624,366	223,517	62,970	24,969	11,022	11,912	49,729	49,221	96,994	67,975	224,719	5.2%
2024	1,524,396	643,496	257,045	66,408	26,467	11,391	11,912	51,794	51,682	100,379	72,040	231,781	5.3%
2025	1,608,095	663,213	295,601	70,033	28,055	11,773	11,912	53,945	54,266	103,881	76,349	239,066	5.5%

Table 04-1 Forecast of Major Inbound Markets at CIAL

International Outbound (New Zealanders' outbound international traffic)

Historical New Zealanders' outbound traffic growth at CIAL, and those of the South Island and New Zealand from 2008 was considered. 5-year (2008–2013 and 2013-2018) and 10-year (2008-2018) annual growth rates were evaluated.

Within a shorter timeframe (5-year period), Christchurch Airport's outbound traffic was affected by the Christchurch earthquakes in 2010/2011. Christchurch Airport experienced a drop in outbound traffic between

[22] https://www.mbie.govt.nz/immigration-and-tourism/tourism-research-and-data/international-tourism-forecasts/previous-international-tourism-forecasts/2018-2024/

2008-2013 (-2.1% pa). However, the strong rebuild of the city and of the Airport's international capacity produced an above average growth in the subsequent 5-year period between 2013-2018 (4.8% pa).

A 10-year period tend to provide a good reference for medium-term growth, eliminating short-term spikes in growth. In the 10-year between 2008-2018, outbound traffic growth of the South Island and New Zealand were 3.2% and 4.0% per annum respectively.

Therefore, 4% pa was adopted for the first two years in the medium-term forecast (Table 04-2). This growth rate was then being lowered to 3.5%, 3.0% and 2.8% in subsequent years to 2025 to reflect slowing growth.

Domestic (domestic traffic)

The adopted medium-term growth (from 3.5% pa in 2018 to 3.0% in 2025) was based on historical Christchurch Airport domestic passenger growth and moderated by Airbus 10-year forecast for the domestic Australia/New Zealand market.

The 5-year domestic growth rate at Christchurch Airport for 2013-2018 was 4.0% pa. The growth rate in the last two years (2016-2018) was lower at 3.5% pa. Airbus predicted annual growth rates of 3.4% between 2017-2027, and 2.8% between 2027-2037.

The most recent annual actual growth of 3.5% pa was adopted for the first two years in this medium-term forecast (Table 04-2). Similar to outbound traffic growth, the growth rate was then lowered gradually to 3.0% pa in 2024 and 2025 to reflect saturation of this market.

FY	Inbound	Outbound	Domestic	Total	Outbound	Domestic	Total
2018	1,140,431	614,078	5,111,454	6,865,963			
2019	1,193,174	638,641	5,290,355	7,122,170	4.0%	3.5%	3.7%
2020	1,249,781	664,187	5,475,517	7,389,485	4.0%	3.5%	3.8%
2021	1,310,683	687,433	5,650,734	7,648,850	3.5%	3.2%	3.5%
2022	1,376,368	708,056	5,831,557	7,915,982	3.0%	3.2%	3.5%
2023	1,447,395	729,298	6,018,167	8,194,860	3.0%	3.2%	3.5%
2024	1,524,396	749,719	6,198,712	8,472,827	2.8%	3.0%	3.4%
2025	1,608,095	770,711	6,384,674	8,763,479	2.8%	3.0%	3.4%

Table 04-2 Annual Forecast for 2019 – 2025 *(translates to 2026 – 2032 after COVID-19 adjustment)*

4. Long-term 2026-2040 Forecast

** Long-term now applies to the trajectory of growth in the period 2033 – 2047 after accounting for the 7 year delay due to COVID-19 disruptions.*

In the long-term (2026-2040) forecast, inbound and outbound traffic are grouped into six major markets: Australia, China, Europe, Asia Developed, Asia Emerging and Other. The adopted growth rates for these markets were based on Airbus's projection for 2027-2037 and Christchurch Airport's historical growth.

In the Airbus Global Market Forecast 2018-2037, regional CAGR for 2017-2027 and 2027-2037 for Australia/NZ to major regions in the world are extracted and shown in Table 04-3. A slowing growth is seen within the two 10-year periods for every region.

Traffic data from Sabre (a major air traffic data provider) was used to obtain CIAL's historical data, as digital records of Christchurch Airport passenger numbers only date back to 2012. CAGRs between 2002-2017 (15-year), 2007-2017 (10-year) and 2012-2017 (5-year) were calculated and shown below.

The adopted growth rates were based on Airbus forecast growth rates for each region and moderated with actual CIAL's traffic and visitor growth to ensure they do not exceed historical values. Traffic data from Sabre includes both inbound and outbound traffic for a market, while visitor data consists of only inbound visitor traffic only.

The adopted annual growth rates for 2025-2040 are as follow. They were generally equal to or lower than the Airbus projection.

		Europe	Australia	China	Asia Deve	Asia Emer	Other	Domestic
Airbus	2017-27	*5.4%*	3.1%	6.7%	3.3%	6.4%		3.4%
	2027-37	*3.8%*	2.8%	4.6%	2.9%	5.0%		2.8%
Sabre	15-yr	1.2%	1.8%	12.4%	-2.5%	3.7%		
Historical	10-yr	2.0%	0.2%	15.1%	-3.4%	4.8%		
	5-yr	7.2%	1.2%	8.3%	7.6%	0.3%		
Visitor arr	15-yr	1.2%	3.6%	16.6%	-4.4%	8.8%		
Historical	10-yr	-1.3%	-0.5%	20.7%	-4.6%	7.0%		2.0%
	5-yr	7.0%	4.2%	35.4%	5.4%	11.9%		4.0%
Long-term Forecast								
Adopted	2025-40	1.9%	2.8%	4.6%	2.7%	5.0%	3.0%	2.7%

Table 04-3 Long-term Annual Growth Rates

The total passenger projected for 2040 was at 13.3 million, shown in Table 04-4 below.

	Domestic	International						Total
CAGR	2.7%	2.8%	1.9%	4.6%	2.7%	5.0%	3.0%	
FY	Domestic	AU	Europe	CN	Asia Develc	Asia Emerg	Other	Total
2025	6,384,674	1,147,464	348,914	316,210	189,595	146,496	230,127	8,763,479
2026	6,557,060	1,179,593	355,543	330,756	194,714	153,821	237,031	9,008,517
2027	6,734,100	1,212,622	362,298	345,970	199,971	161,512	244,141	9,260,615
2028	6,915,921	1,246,575	369,182	361,885	205,370	169,588	251,466	9,519,987
2029	7,102,651	1,281,479	376,197	378,532	210,915	178,067	259,010	9,786,850
2030	7,294,423	1,317,361	383,344	395,944	216,610	186,970	266,780	10,061,432
2031	7,491,372	1,354,247	390,628	414,158	222,459	196,319	274,783	10,343,965
2032	7,693,639	1,392,166	398,050	433,209	228,465	206,135	283,027	10,634,690
2033	7,901,367	1,431,146	405,613	453,136	234,634	216,441	291,518	10,933,855
2034	8,114,704	1,471,218	413,319	473,981	240,969	227,263	300,263	11,241,718
2035	8,333,801	1,512,413	421,172	495,784	247,475	238,627	309,271	11,558,543
2036	8,558,814	1,554,760	429,175	518,590	254,157	250,558	318,549	11,884,602
2037	8,789,902	1,598,293	437,329	542,445	261,019	263,086	328,106	12,220,180
2038	9,027,229	1,643,046	445,638	567,398	268,066	276,240	337,949	12,565,566
2039	9,270,964	1,689,051	454,105	593,498	275,304	290,052	348,087	12,921,062
2040	9,521,280	1,736,344	462,733	620,799	282,737	304,555	358,530	13,286,979

Table 04-4 Annual Forecast for 2026 – 2040 *(translates to 2033 – 2047 after COVID-19 adjustment)*

Validation

The passenger forecast for 2040 was then validated from three perspectives:

A. Total traffic is compared against the Ministry of Transport forecast.

B. Ensure the forecast growth in propensity to travel does not exceed historical and forecast growth in wealth.

C. Ensure the population required to produce the domestic and outbound traffic is within the projected population range.

A. Total traffic is compared against the Ministry of Transport forecast (domestic and international)

In the Ministry of Transport's 2043 traffic forecast[23], a few scenarios were created to model New Zealand's land and air traffic in 2043. The scenarios encompass trends in technology, lifestyle and travel behaviours in the next thirty years, which were detailed in the report.

The domestic and international air traffic forecast of the three major scenarios (Base, Metro-Connected and Golden Triangle) for Christchurch Airport were interpolated and compared with CIAL's 2040 forecast, presented in Figure 04-5 below. It indicates clearly that CIAL's 2040 passenger forecast for domestic and international is within the range of these three scenarios.

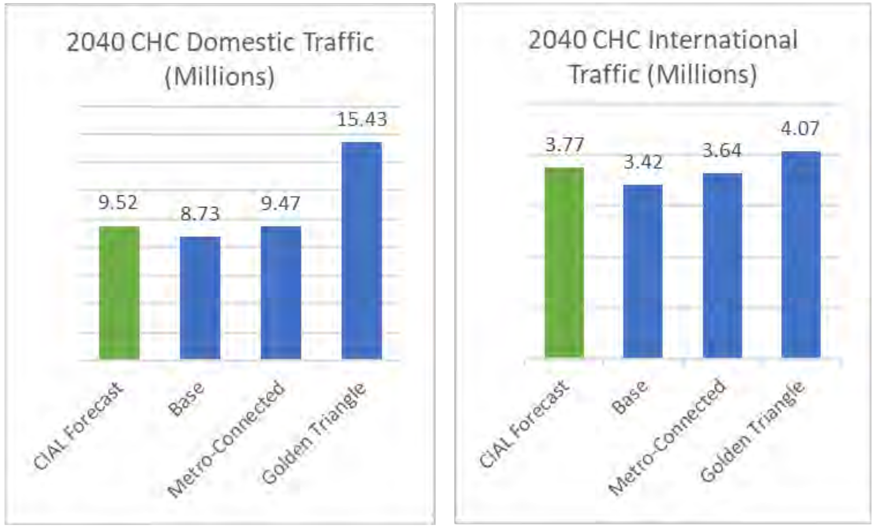

Figure 04-5 CIAL Forecast for 2040 vs Ministry of Transport Forecast

B. Ensure the forecast growth in propensity to travel does not exceed historical and forecast growth in wealth (domestic and international outbound)

This section examines the forecast growth in propensity to travel to ensure it does not exceed historical and forecast

[23] https://www.transport.govt.nz/assets/Uploads/Report/TransportOutlookFutureState.pdf

growth in wealth.

The forecast growth in propensity to travel, for domestic and international outbound traffic, is represented by CAGR of trips per capita between 2018 and 2040.

The growth in wealth is represented by the growth in GDP per capita, a general proxy for personal wealth.

From the median forecast of South Island's population[24], the implied per capita domestic and international outbound trips are 3.83 and 0.53 in 2040. From their current levels of 2.30 and 0.23, it corresponds to 2.3% and 3.0% annual growth (CAGR) respectively.

These growth rates (2.3% and 3.0%) are lower than historical and forecast GDP growth projected by the Ministry of Business, Innovation and Employment (cells highlighted in blue in Table 04-5).

	2018	2038	2043	2040	CAGR
South Island population forecast	1,109,900	1,236,100	1,255,500	1,243,860	
Trips per capita through CHC (domestic)	2.30			3.83	**2.3%**
Trips per capita through CHC (international outbound)	0.28			0.53	**3.0%**

	2000-2017	2010-2017
Growth in NZ GDP per capita (actuals, CAGR)	**3.97%**	**3.48%**
	2015-2020	**2020-2025**
Forecast growth in NZ GDP (CAGR)	**3.00%**	**2.70%**

Table 04-5 Check for Forecast Trips per capita in 2040

On the other hand, the Ministry of Transport's Transport Outlook estimated that "Annual per capita international departures for New Zealand residents are projected to almost double from 0.5 in 2015 to almost 1 trip by 2043." (p50 of report). In comparison, CIAL's forecast for 2040 was 0.53 outbound trips per capita, which is below this projection. This is due to the fact that historically outbound trips in the South Island lagged behind those for the whole country, which is dominated by Auckland.

[24] Statistics New Zealand's population forecast 2016-2068

C. Ensure the population required to produce the domestic and outbound traffic is within the projected population range (domestic and international outbound)

If propensity to travel was to grow at a slower rate between 2024 and 2040, a larger population base would be required to realise the forecast traffic levels. This analysis confirms that even if the annual growth of propensity to travel is reduced by as much as 0.5 percentage points, the population required to realise the traffic forecast in 2040 is within the bounds of New Zealand's long-term population forecast[24].

The forecast annual growth of domestic and international outbound trips per capita were 2.3% and 3.0% respectively (Table 04-5). If the growth were to be lower, the resulting trips per capita in 2040 would be lower too.

For instance, at an annual growth of 2.3%, the anticipated domestic trips per capita in 2040 was 3.83. If the growth rate was lowered by 0.5 percentage points to 1.8%, the resulting trips per capita would be 3.44 in 2040 (Table 04-6). At 3.44 trips per capita, the population required to generate the same 9,521,280 domestic traffic in 2040 (Table 04-4) is 1,385,376, higher than the median South Island population forecast of 1,243,860.

Table 04-6 below presents this for 0.1%, 0.3% and 0.5% point reductions in growth rates.

The resulting population required to realise the forecast 2040 traffic levels were 1.27, 1.33 and 1.38 million respectively. These three population levels remain within Statistics New Zealand's median and high population forecast for 2040 (yellow lines in Figure 04-6).

		Growth Rate Reduction		
	No Reduction	***0.1%***	***0.3%***	***0.5%***
Trips per capita (2040)				
Domestic	3.83	3.75	3.59	3.44
International outbound	0.53	0.52	0.50	0.48
Implied South Island population required (2040)				
Domestic		1,270,903	1,326,850	1,385,376
International outbound		1,270,727	1,326,299	1,384,416
Median South Island population foercast (2040)				1,243,860

Table 04-6 Impact of Slower Growth in Propensity to Travel

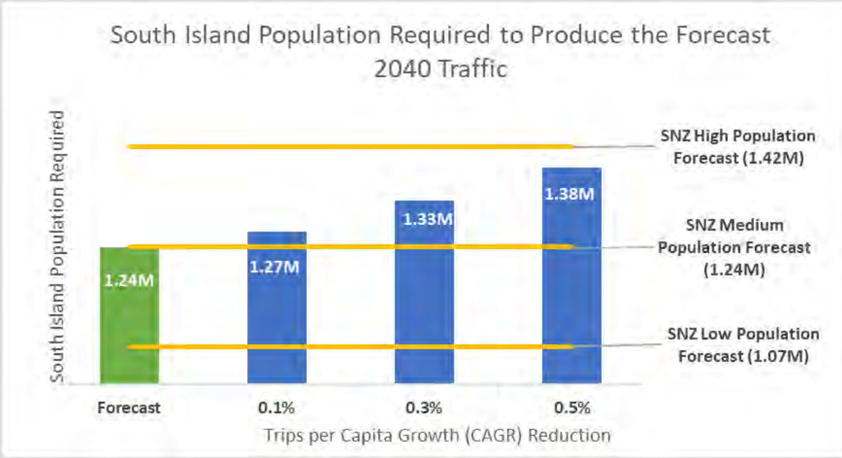

Figure 04-6 South Island Population Required to Produce Forecast 2040 Traffic (SNZ = Statistics New Zealand)

5. Post-2040 Forecast

** Post-2040 now applies to the trajectory of growth in the period post-2047 after accounting for the 7 year delay due to COVID-19 disruptions*

At Christchurch Airport's current traffic level, runway capacity is not anticipated to be reached for several decades. In order to generate aircraft runway movement profiles and demand scenarios for ultimate capacity and noise modelling, the passenger demand forecast is being extended past 2040 up to 2100.

In the very long term, visibility of travel demand and tourism is very low, and thus presents significant challenge in forecasting demand. However, over the long run, it is anticipated that airport passenger movement growth is governed by projected growth in the economy, long-term air travel trends, as well as the point an airport is in along its growth path.

Three areas below were referenced in selecting appropriate growth rates beyond 2040:

01. Industry and Air Travel Trend

02. Benchmark Against Growth Paths of Similar Airports

03. New Zealand Long-term GDP and Population Projections

Industry and Air Travel Trend

In the past 40 years, there have been massive growth in global air travel, driven by the growth of the middle-class population, globalization trend, air traffic liberalization, and facilitated by advancement in aircraft technology.

In the Vision 2050 report[25], International Air Transport Association (IATA) noted that from 1970, global air traffic grew alongside world trade. In fact, 'World scheduled Revenue Passenger Kilometres' grew faster than the growth in world trade between 1970 – 1998. This trend inflected in 1998, after which the growth in scheduled Revenue Passenger Kilometres dropped below that of world trade. This indicated that air travel in some countries might have gone into a maturity stage. International Civil Aviation Organization (ICAO), in its Developing a Long Term Air Traffic Demand Forecast Model[26] document, recognizes this maturation process, in which travel demand matures as income (measured by GDP per capita) grew, represented by an S-curve in Figure 04-8 below.

Figure 04-9 shows that New Zealand already has a very high propensity to travel. It is worth noting that New Zealand's current GDP per capita is now on the plateau of the growth curve. This suggests that further growth in GDP per capita will lead to small growth in trips flown.

Along the same line, an ICAO Long-Term Traffic Forecasts[27] projects declining growth rates for the three periods from 1995 – 2045 for all regions in the world (Figure 04-10).

All this points to lower air traffic growth rates over the longer term at Christchurch Airport.

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[25] https://www.iata.org/contentassets/bccae1c5a24e43759607a5fd8f44770b/vision-2050.pdf
[26] https://www.icao.int/sustainability/Documents/RTK%20ranking/ICAO_LTF_MODEL_DOC.pdf
[27] https://www.icao.int/sustainability/documents/ltf_charts-results_2018edition.pdf

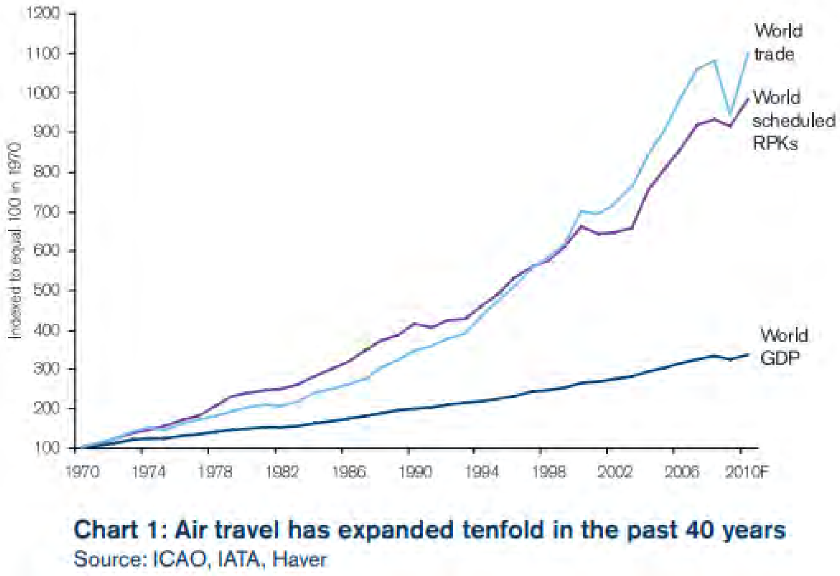


Figure 04-7 Air Travel has Expanded Tenfold in the Past 40 Years (source: IATA[25])

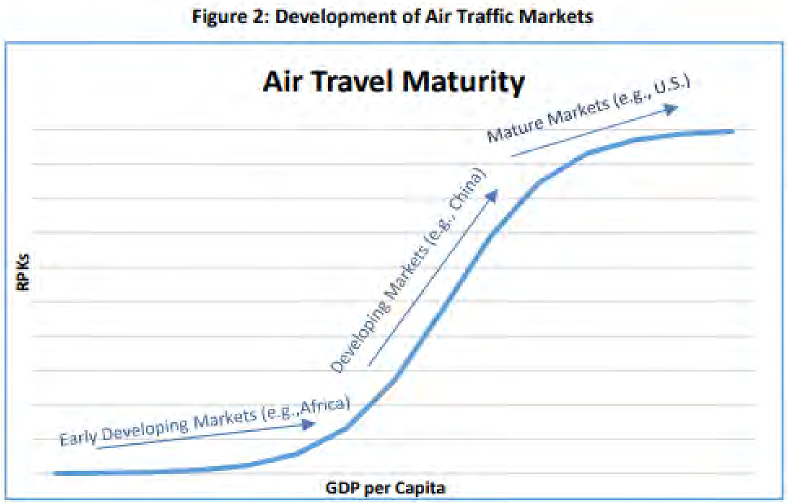


Figure 04-8 Development of Air Traffic Markets (source: ICAO[26])

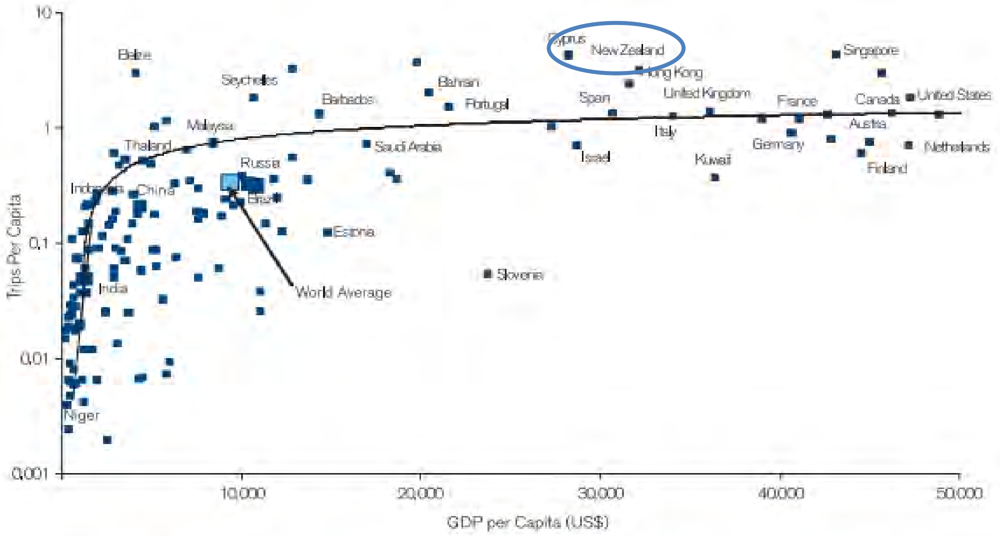


Chart 2: Travel markets at very different stages of development
Source: IATA PaxIS, IMF

Figure 04-9 Trips per Capita by Country (source: IATA[25])

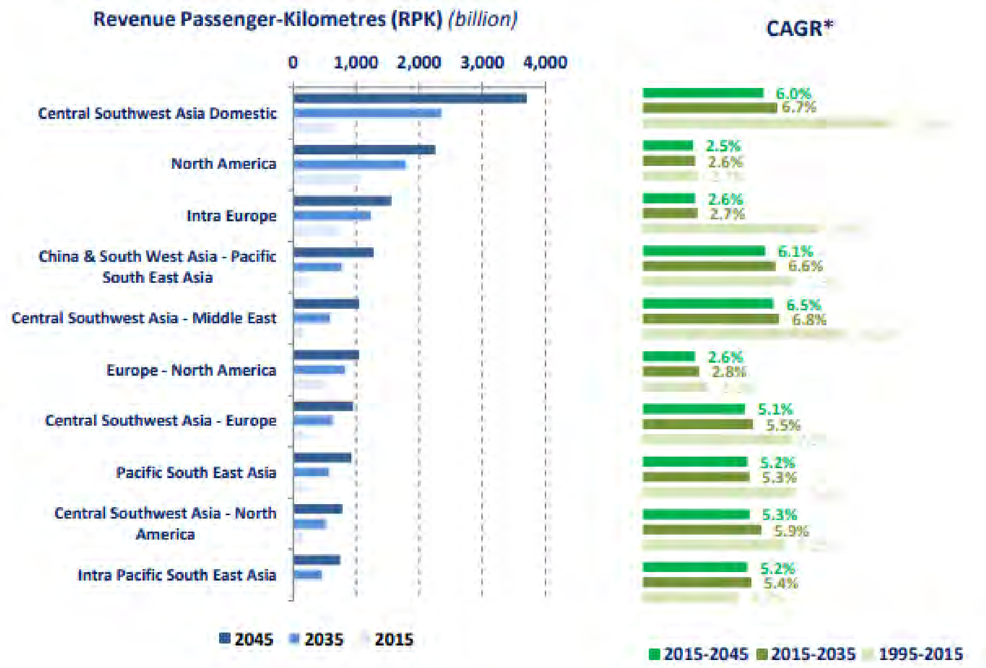


Figure 04-10 ICAO Long-Term Traffic Forecasts (source: ICAO[27])

Benchmark Against Growth Paths of Similar Airports

Growth paths of major airports in this region could potentially provide a reference for Christchurch Airport's future growth, especially their growth trajectories beyond 13 million passenger movements, which is the forecast total passenger number for Christchurch Airport in 2040. Bureau of Infrastructure and Transport Research Economics (BITRE) data for Australia airports dates back to 1985, and as such provides a good source of information. However, data for New Zealand airports (Auckland airport in particular), is only available from 2008, thus does not provide a long enough trend, and is not used in this study.

There are only three airports in Australia that have grown past 13 million annual passenger movements in 2019, which are Sydney (SYD), Melbourne (MEL) and Brisbane (BNE). Plotting their CAGRs against the number of years after they reached 13 million passenger movements shows distinctive declining growth trends.

These three airports are quite different in the type of cities they serve, their catchment areas, as well as capacity offered by their hub airlines. Despite the fact that all shares a declining growth trend with time, SYD has the highest growth rates in all periods, followed by MEL and BNE. This is likely driven by the relative importance in economy and international connectivity of these three airports. It is worth noting that SYD and MEL are Qantas' largest and second largest hubs, while BNE is serving as Virgin Australia's largest hub. Seat capacity offered by these hub carriers at these airports, in descending order, is SYD, MEL and BNE. Seat capacity of these hub airlines at these airports in turn directly drives the airports' passenger numbers.

This brings to the point that large hub cities experienced significantly higher growth compared to non-hub cities, observed by the chart below in the IATA Vision 2050 report (Figure 04-12).

As Christchurch Airport is a smaller airport focusing in serving the South Island population as well as the tourism market, it is not a hub airport to any airline. It is hence anticipated that Christchurch Airport's long-term growth will share a path similar to these airports, but at lower growth rates and with gentler decline.

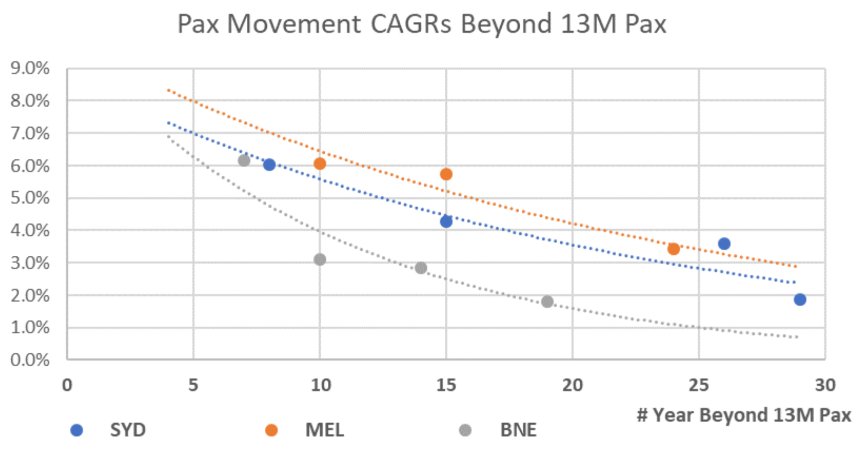


Figure 04-11 Passenger Movement Growth (CAGR) at SYD, MEL and BNE After Reaching 13 million annual passengers

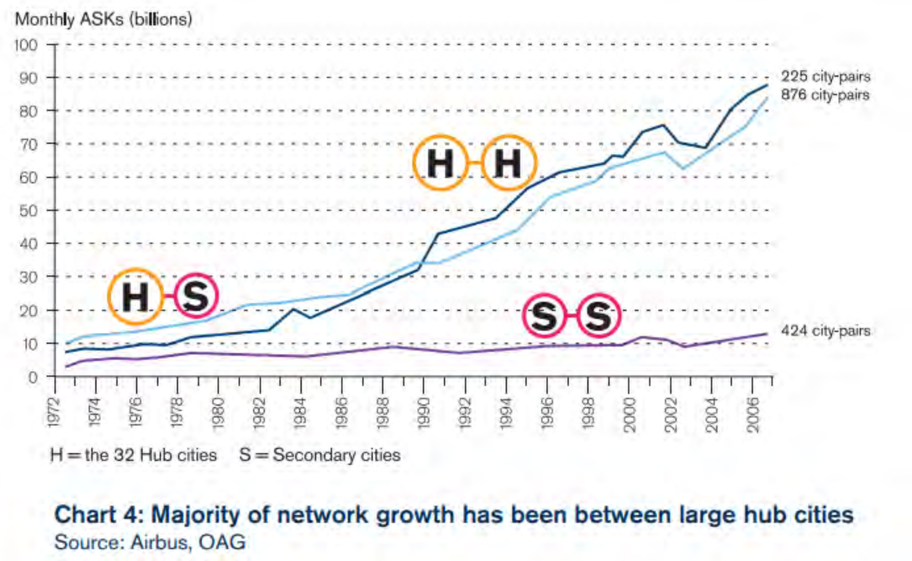


Figure 04-12 Majority of Network Growth has been between Large Hub Cities (source: IATA[25])

New Zealand Long-term GDP and Population Projections

Statistics NZ provides long-term projections of New Zealand population to 2073[28]. It noted that in the long term, there is an increase in numbers and proportions of the population at the older ages. Furthermore, population growth will slow as New Zealand's population ages, and the gap between the number of births and deaths narrows.

The New Zealand government does not publish a long-term GDP forecast. One other credible source of this information is provided by the OECD[29], which is being referenced here.

It is observed that both the GDP and the population for New Zealand are projected to grow at declining growth rates in the long term. GDP per capita for the country is thus following a similar trend.

[28] https://www.stats.govt.nz/information-releases/national-population-projections-2022base2073/
[29] https://data.oecd.org/gdp/real-gdp-long-term-forecast.htm#indicator-chart

10-year CAGRs

	2030 *(f)*	2040 *(f)*	2050 *(f)*	2060 *(f)*
GDP	2.5%	1.7%	1.6%	1.6%
Population	0.7%	0.7%	0.5%	0.4%
GDP/capita	1.8%	1.1%	1.1%	1.1%
CIAL Pax Movement	3.1%	2.9%	2.5%	2.1%

Table 04-7 10-Year Growth (CAGR) of GDP, Population and CIAL Pax Movement

Growth Rates Adopted and Validation

Based on the above, it is assumed that Christchurch Airport's international and domestic traffic will experience declining growth from 2041 onwards.

As domestic traffic is dominated by New Zealand resident passengers, the declining growth reflects the decline in GDP and population growth. From annual growth of 2.7% in 2040, domestic traffic annual growth rate is assumed to decrease gradually to 1.8% in 2060, and 1.5% in 2080.

A validation was completed for the domestic traffic forecast, to ensure it did not result in exceptionally high propensity to fly.

Based on the population projection for 2060, the domestic traffic forecast implies 4.89 domestic trips are flown per capita per year. This is 6% above the 4.61 domestic trips in 2018, which is a reasonable increase and a possible outcome for 2060.

On the other hand, as a significant contributor to CIAL's international traffic, inbound tourism is driven more by the economic conditions in its tourism source markets and New Zealand's attractiveness as a destination. It is assessed that the overall economic conditions in these tourism source markets could achieve higher growth compared to New Zealand's, since a good proportion of these markets is made up of developing economies.

The New Zealand Ministry of Transport's Transport Outlook: Future State[30] was used as a reference to inform future growth for international (and domestic) traffic. In this outlook the range of implied growth for CIAL's international traffic is between 3.3% and 4.2% per annum between 2015 and 2043, under the scenarios considered.

A comparison of the cumulative growth path of this forecast with the 'Base' and '@home in town and country' scenarios in the Transport Outlook (scenarios with the lowest and highest projections) indicates that the adopted

[30] https://www.transport.govt.nz//assets/Uploads/Report/TransportOutlookFutureState.pdf

CIAL growth rates are nearer to the lower range in 2043, indicating that the CIAL forecast is conservative for this period.

Based on the considerations above, the average annual international growth is kept from 2040 to 2050 and is assumed to start to decline from 2050.

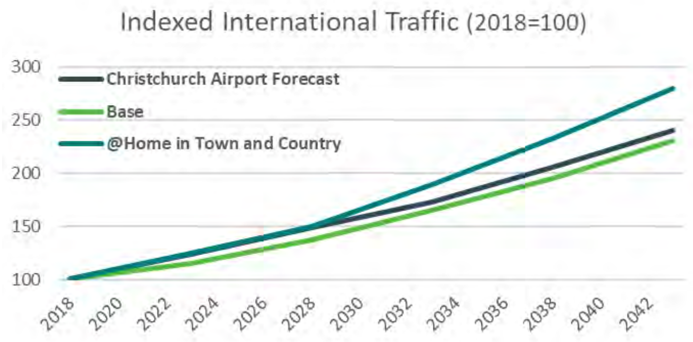


Figure 04-13 Indexed International Traffic Comparison (2018 – 2043)

This results in total traffic growing at an annual rate of 2.8% in 2040, to 2.5% in 2050 and 1.9% in 2080, shown below.

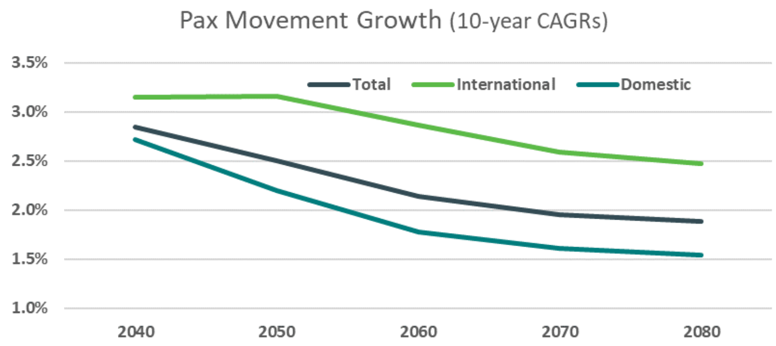


Figure 04-14 Growth Rates Adopted Beyond 2040

6. Resulting Demand Forecast

Applying the COVID-19 recovery forecast for 2023-2027[1], the medium-term and long-term forecast, then employing the growth rates adopted for years beyond 2040, the resulting passenger demand projections for domestic and international passengers are shown below. It is projected that in year 2100, CIAL would reach 22.9 and 16.1 million annual domestic and international passengers respectively. The corresponding total passenger movement is 39.0 million.

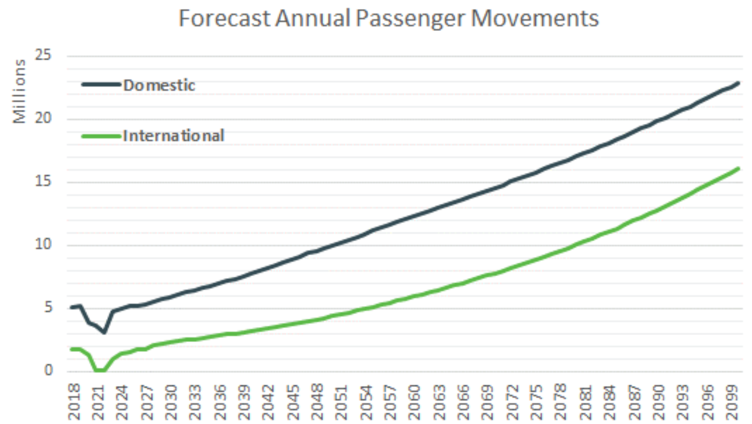


Figure 04-15 CIAL Passenger Demand Forecast

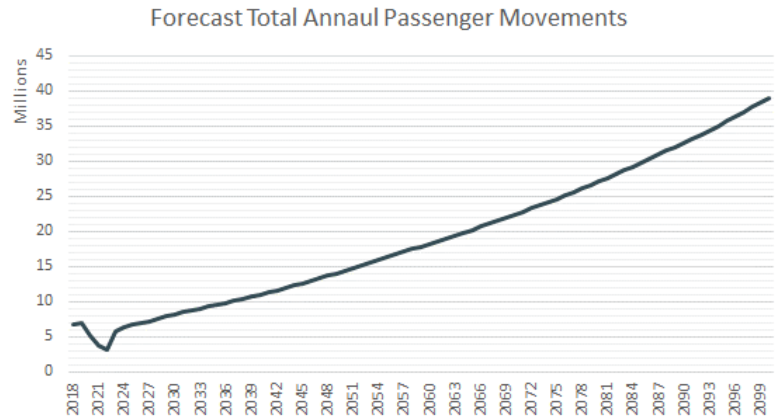


Figure 04-16 CIAL Total Passenger Demand Forecast

05. Fleet Projections

Aircraft categories used were generally based on seat capacity rather than specific aircraft models. This was so that representative aircraft models could selected separately as part of the noise modelling process. However, specific models were nominated as "design aircraft" for the noise modelling. Only aircraft currently certified and in operation were included. Consideration was given to the likely future dominant aircraft types for sectors/region where older models are phased out of the airline fleets (e.g. replace A320ceo with A320neo etc.). The scheduled passenger aircraft fleet projections are tabulated below.

It should be noted that the representative aircraft listed below are for use in calculating aircraft movements from annual passengers through typical seating configurations and load factors. For noise modelling a different aircraft model than listed in the tables below with a specific engine configuration may be selected for a given category to represent the typical noise profile for take-off and landing in the noise modelling software. This selection process is detailed in Volume 5 – Noise Modelling.

Table 05-1 International Aircraft Categories

Category	Typical Usage	Current Average Seats based on	Future Average Seat Assumption
Very Large Widebody (VLWB)	Largest Hub routes	EK A388 variants	Densification of current capacity
Large Widebody (LWB)	High capacity short/long haul		Boeing B779 max 414 seats x 90%
Medium Widebody (MWB)	Bulk of long-haul capacity	SQ B772, NZ B789, CX A359	Boeing B778 max 365 seats x 90%
Small Widebody (SWB)	Tasman/Low capacity long-haul	CZ B788	Some densification, incl premium carriers with lower density
Large Narrowbody (LNB)	Bulk of short-haul capacity		NZ and JQ average density + 5%
Medium Narrowbody (MNB)	Low-capacity short haul routes	NZ A320, QF B738, JQ A320	Current density + 5%

Table 05-2 Domestic Aircraft Categories

Category	Typical Usage	Current Average Seats based on	Future Average Seat Assumption
Large Widebody (LWB)	AKL-CHC route	NZ B77W	Boeing B779 max 414 seats x 90%
Medium Widebody (MWB)	AKL-CHC route	NZ B772, B789	Boeing B778 max 365 seats x 90%
Small Widebody (SWB)	AKL-CHC route		Estimate of expected configuration
Large Narrowbody (LNB)	Bulk of domestic jet capacity		NZ and JQ average density + 5%
Medium Narrowbody (MNB)	Smaller domestic jet routes/regions	NZ A320, JQ A320	NZ and JQ average density + 5%
Large Turboprop (LTP)	Bulk of domestic turboprop capacity	NZ AT76	Densification of current configuration
Medium Turboprop (MTP)	Routes where runway length limited	NZ DH8C	No change
Small Turboprop (STP)	2nd tier airline regional routes/regions		New aircraft design
Very Small Turboprop (VSTP)	2nd tier airline regional routes/regions	S8 PC12	No change

Table 05-3 Assumed average seats for International and domestic current and future fleets

		Current		Future	
International	**Category**	**Examples**	**Ave Seats**	**Examples**	**Ave Seats**
	VLWB	A388	500	A388	525
	LWB			B779	370
	MWB	B772, B789, A359	290	B789, A359, B778	330
	SWB	B788	230	B788, B797(1)	260
	LNB			A21N	225
	MNB	A320, B738	175	A20N, B38M	185
Domestic	**Category**	**Examples**	**Ave Seats**	**Examples**	**Ave Seats**
	LWB	B77W	345	B779	370
	MWB	B772, B789	310	B789, B778	330
	SWB			B797	270
	LNB			A21N	225
	MNB	A320	175	A20N	185
	LTP	AT76	68	AT76, DH8D	75
	MTP	DH8C	50	DH8C	50
	STP			New aircraft design	20
	VSTP	PC12	9	PC12	9

Note (1): The Boeing 797 is a replacement for the B767 (220 to 270 seats, range up to 11,000km). It is a small wide-body with medium-haul range for which Boeing has been doing market testing, prior to commitment to design and build. It is also a replacement option for the single-aisle B757 (240 to 290 seats, range 7,000km). The B767 and B757 are no longer in production. At the time of writing Boeing is progressing engineering and manufacturing forward technology development, but no orders are being taken from airlines. It is expected have 220-270 seats and a range of 10 to 11 hours. The current Boeing fleet has a gap and needs to compete with the 200 to 230 seats Airbus A321neo, although this is a single-aisle model. With post- COVID-19 recovery demand in the aviation sector, and previous strong interest from airlines, it would be anticipated that Boeing will progress development efforts in the near future.

06. Aircraft Movement Projections

1. Introduction

The assumptions for each category of aircraft movement are given below. The projections are for an unconstrained future based on the understanding of the existing drivers of passenger and other demand for aviation services.

The projected aircraft movements at ultimate runway capacity are split by traffic categories:

- **a.** Scheduled passenger flights
- **b.** Other – Non-scheduled commercial (airline repositioning and maintenance; FBO and small commercial; military, government, and Antarctic flights)
- **c.** Freight
- **d.** Helicopters
- **e.** General aviation (aeroclub and similar recreational).

2. Scheduled Annual Passenger Demand

Scheduled passenger aircraft make up most aircraft movements at Christchurch Airport. This aircraft movement projection is based on the long-term view of future passenger demand which was prepared specifically for the noise contour project.

The scheduled passenger demand forecast is described in Chapter 04 above.

3. Scheduled Passenger Aircraft Movements

Methodology

The overall methodology is described in Chapter 02 above. More specifically, the scheduled passenger aircraft movements by region, aircraft category and year were calculated using the following methodology shown in Figure 06-1:

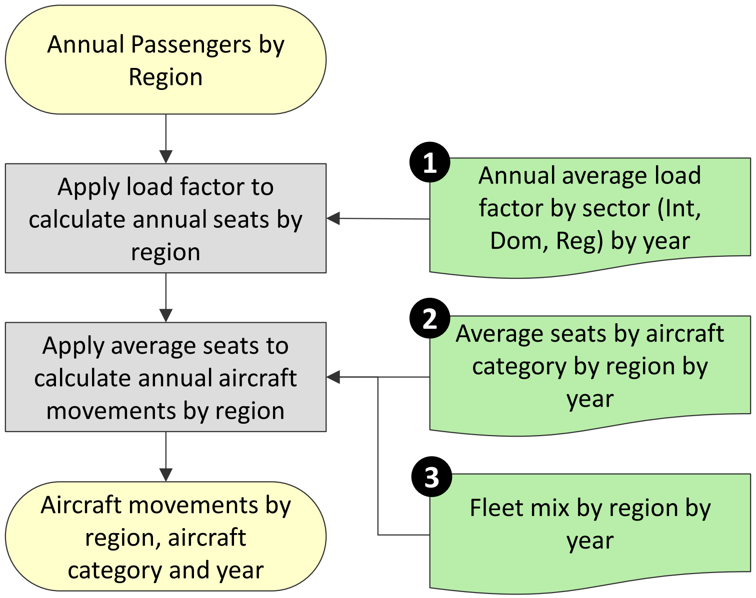


Figure 06-1 Methodology to Calculate Annual Aircraft Movements

Notes:

Input 1: Load Factor

In 2018 the load factors were 78% for international, 83% for domestic and 80% for regional. The average load factor for each sector (international, domestic, and regional) are projected to gradually increase to an annual average of 85% for all aircraft movements.

Inputs 2 and 3: Average seats and fleet mix

Progressively as routes/regions grow airlines will operate higher seat capacity aircraft, increasing average seats per movement. Airlines do this by both operating larger aircraft and increasing the number of seats on existing aircraft. Airlines have progressively added seats to their existing aircraft configurations, making the seating denser to maximise revenue, increasing average seats per movement.

Replacement aircraft will continue to be produced for each aircraft size segment. It has been assumed that new aircraft in the 19/20 seat, and 250 seat seating capacity categories will become available within the next 10 years.

The assumptions around the change in average seats by aircraft category are discussed in Chapter 05 above.

4. Jets on Regional Routes

Introduction

It is reasonable to expect that within the horizon of the forecast period jet aircraft will begin operating on additional routes/regions when justified by greater passenger demand.

To inform which regional routes should be considered for the introduction of jets domestic benchmarks were first considered. This gave some insight into how airlines may operate regional routes into the future. As historical flight schedules are only available back to 1 January 2009 there is limited evidence as to how routes regions have previously developed over the long term.

Using insight drawn from the relevant domestic benchmarking a scenario was developed which described how two airlines may operate a New Zealand regional route connecting to Christchurch as it grows.

There are currently three routes in New Zealand which are regularly operated by both jet and turboprop aircraft. They are:

→ Christchurch to Wellington
→ Queenstown to Christchurch
→ Queenstown to Wellington

Queenstown to Christchurch / Wellington

The market dynamics and operational requirements at Queenstown Airport are different to other airports in New Zealand. The specific conditions which determine Queenstown Airport's flight schedule typically do not exist at other regional airports in New Zealand. Queenstown Airport was not considered a reliable benchmark for the future performance of other New Zealand regional airports. Therefore, the Christchurch to Queenstown and Wellington to Queenstown routes were disregarded as relevant benchmarks for other regional routes.

Christchurch to Wellington

Flight schedules from 1 January 2009 to 31 December 2022 for the Christchurch to Wellington route were analysed to understand the history of aircraft type usage on that route.

The following observations were made:

→ Before 2016 a greater proportion of aircraft movements were by jets rather than turboprops
→ The years with the highest proportion of jet aircraft movements, 2009-2015, occurred when Air New Zealand was operating the 133 seat B737-300.
→ After the transition from B737-300 to the now 171 seat A320 domestic jet aircraft Air New Zealand changed

the operating model towards a greater proportion of 68 seat ATR72 aircraft movements and higher frequency.

Current Typical Pattern of Activity

Between 2016 - 2019 the schedule settled into a typical pattern of:

→ Air New Zealand operating one service per hour between 6:00 to 21:00.

→ Air New Zealand operating 2 to 3 jet services per day:

- One in the morning peak (7:00 to 9:00)
- One in the early evening peak (17:00 to 19:00)
- A third service in the afternoon.

→ Jetstar operating 2 jet services per day in the morning and early evening peaks.

Since the pandemic a greater proportion of Air New Zealand aircraft movements have been operated by jets. The total seat capacity in 2022 is lower than in 2019 for both airlines. It is not yet clear whether or not this more recent schedule data represents a change to how Air New Zealand intends to operate this route for the medium term.

Conclusion

The 3 years before the COVID-19 pandemic (2017 to 2019) provide a model for how Air New Zealand may operate New Zealand regional routes as they grow to a size where jet aircraft are regularly used.

Historic schedules do not provide any useful insights into how a second airline may operate jet aircraft on regional routes in competition with Air New Zealand. Jetstar did briefly operate 5 Q300 aircraft in New Zealand. These were primarily used on the largest regional routes out of Auckland. These services competed with Air New Zealand using similar aircraft to the Air New Zealand turboprop fleet.

Methodology

The method adopted to determine the forecast regional fleet mix was to develop an airline operating scenario which could be applied to each route/region. The scenario is for two airlines operating with a fleet mix like that operated by Air New Zealand on the Christchurch to Wellington route between 2017 and 2019.

The indicative long-term fleet mix for two airlines on a typical busy day is shown in Table 06-1. This fleet mix has more aircraft movements and seats than is currently operating on the Christchurch to Wellington route.

Clock Hour	Airline 1		Airline 2		Total
	Narrow Body Jet	Turboprop	Narrow Body Jet	Turboprop	
Departures	3	12	2	5	**22**
Movements	6	24	4	10	**44**

Table 06-1 Indicative Long-Term Fleet Mix

As the number of aircraft movements required to carry the forecast annual passengers on each regional route increases assumptions had to be made as to how medium narrow body jet aircraft would be introduced. In the absence of any historical data as this has not previously occurred in New Zealand judgements had to be made. Scenarios were developed that gave the target fleet mix to be adopted at each level of aircraft movements.

Two scenarios were developed. A default scenario and a second scenario for the two closer airports in the South Island with sufficient forecast demand for future jet services, Dunedin and Nelson. This difference was adopted to recognise that the faster speed of jet aircraft provides greater benefit over longer sectors whereas very short sectors are not typically operated by jet aircraft. Therefore, in the Dunedin and Nelson scenario it was assumed that jet aircraft would be introduced at a higher frequency threshold than in the default scenario.

Based on the Wellington benchmark frequency thresholds were developed to identify when jet aircraft may be introduced onto a regional route, these are:

Daily Frequency At or Above		Jets
Default	Dunedin and Nelson	
10	12	1
14	16	2
18	19	3
19	21	4
21	22	5

Table 06-2 Frequency Thresholds

The process to introduce medium narrow body jets was completed manually by adjusting the fleet mix percentages to produce a fleet mix that aligns with the table above.

This method of assessment was applied to all regional routes in the forecast.

5. Scheduled Passenger Aircraft Movement Forecast

Scheduled passenger aircraft movements are forecast to reach ultimate runway capacity of 201,000 annual aircraft movements in FY2084 (with the expected 7 year COVID-19 delay applied). The forecast is shown in Figure 06-2 below. In FY2084 the forecast is for:

→ 43,000 international aircraft movements
→ 62,000 domestic aircraft movements
→ 96,000 regional aircraft movements

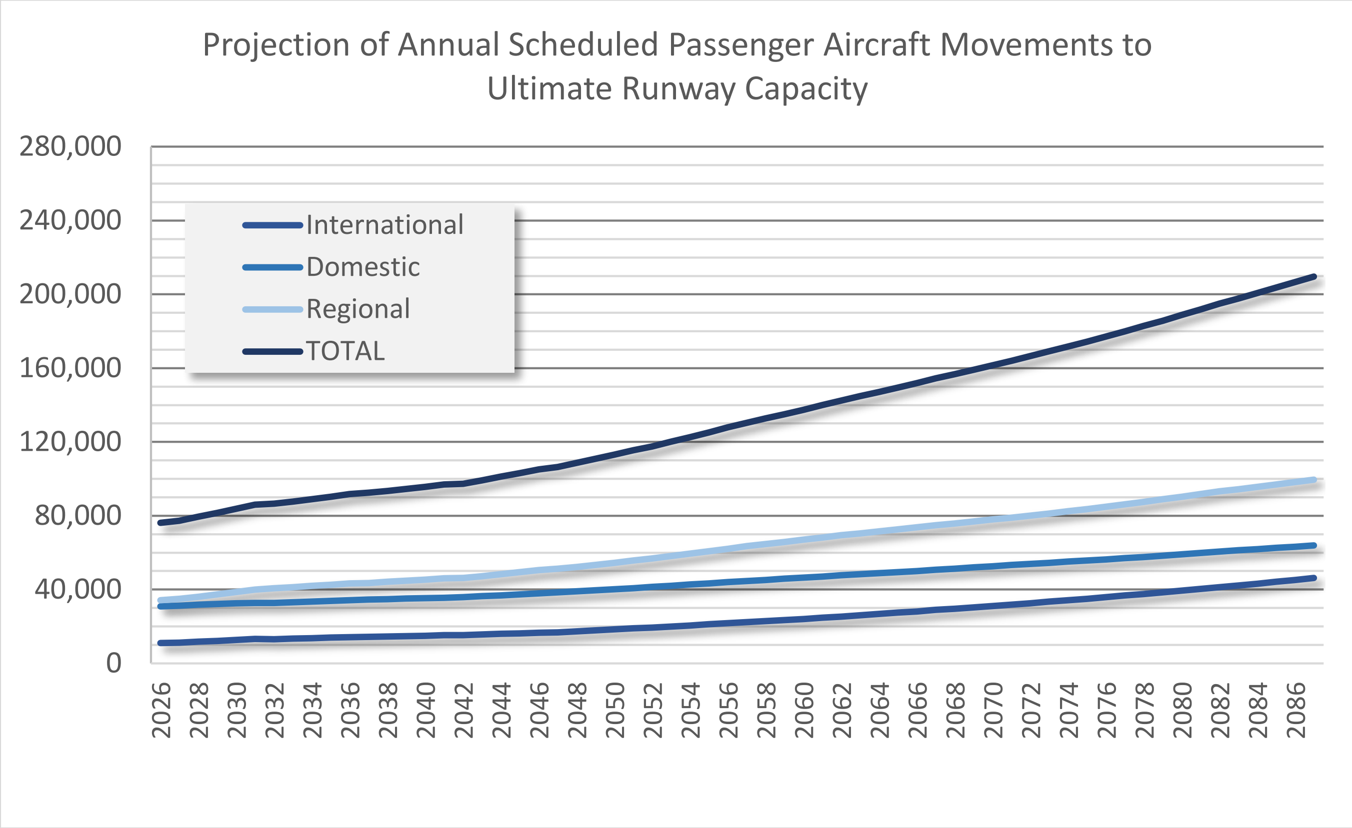
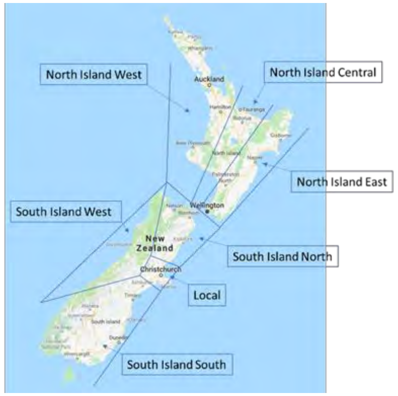


Figure 06-2 Scheduled Passenger Aircraft Movement Forecast

Non-Scheduled Domestic Aircraft Movement Regions



6. Other – Non-Scheduled Commercial

This category is separated into three sub-categories, each of which have their own growth assumptions.

Airline Repositioning and Maintenance

This includes all aircraft repositioning movements and airline aircraft arriving for maintenance and testing. Christchurch is a maintenance hub for aircraft and jet engine servicing for airlines from New Zealand, Australia and around the Pacific. Growth is driven by increases in passenger aircraft movements as well as increases in airline fleet size. As such, the growth rates for total passenger aircraft movements have been replicated for this category.

Military, Government and Antarctic

This category includes all military and government aircraft, as well as Antarctic operations, both military and non-military. Historically these movements have grown by approximately 2% per year. This growth rate has been applied for the term of the projection, except for Antarctic operations, where higher growth is expected for the period FY25-30 due to the planned rebuild of US and New Zealand Antarctic bases.

The Updated Noise Contours exclude Antarctic, military and government movements. Christchurch Airport must be able to facilitate Military and Government aircraft movements at all times. Military and government movements are often in response to natural disasters or emergencies and as such the Airport has limited ability to schedule, predict or manage when these movements will be required. Military and government movements are excluded or managed separately at a number of New Zealand Airports. Generally, they comprise a small number of movements and do not have an impact on the noise contours.

Antarctic movements have been excluded. Similar to Military movements, the Airport has limited ability to schedule, predict or manage when these Antarctic movements are required and will occur. Antarctic movements are also unique to the "Antarctic Season" (Spring / Summer) which is limited in duration and driven by weather conditions in Antarctica.

FBO and Small Commercial

Most of this category's movements are air ambulances, but they also include charters, business jets and other small commercial operators. The long-term average growth rate has been used for projecting growth for most movements in this group. However, jet aircraft movements are anticipated to increase at a greater rate as FBO operations continue to grow and air ambulance fleets are upgraded from turboprops.

It has been assumed that before the Airport reaches ultimate runway capacity 50% of the FBO and Small Commercial aircraft movements would be displaced and relocate to other aerodromes. No assumptions have been made as to when or how this would occur. As the FBO and Small Commercial aircraft movement forecast cannot be accurately expressed over time no graph has been provided for this forecast.

The forecast for Other – non-scheduled commercial aircraft movements in FY2084 is:

- → 5,000 Airline and MRO aircraft movements
- → 62,000 Antarctic, Military and Government aircraft movements
- → 96,000 FBO and Small Commercial aircraft movements.

The day / night split in the forecast is based on the current movement split.

7. Freighter Movement Forecast

At Christchurch Airport, air cargo is carried in both the belly hold of passenger aircraft, as well as on dedicated freighters. However, there is no information on the split between belly hold and dedicated freighters that is available to CIAL.

Due to this, the approach CIAL took was to project dedicated cargo movements based on its historical growth, independent of cargo that is carried in the belly of passenger aircraft.

In the last 10 years, freight capacity through Christchurch Airport by volume increased by an average of 3% per annum – broadly in line with GDP growth which has growth at an average of 2.8% per annum over the previous 20 years. Growth has also been assisted by changes in consumer purchasing from physical to online shopping which has significantly increased the amount of high priority freight.

Growth Rates

The forecast is based on two premises:

01. There is a significant amount of freight that is currently being trucked from the South Island to Auckland Airport, to be exported through Auckland Airport. It is CIAL's intention to increase the share of South Island's air freight export through Christchurch Airport. As Christchurch Airport's freight export does not yet represent its fair share of South Island's air freight export compared to the South Island's share of export production, it is within CIAL's strategy to increase it. The potential for air freight development is significant.

02. It is also within CIAL's strategic plan to attract increased e-commerce operator presence at the Airport. Freighter movement carrying parcels is another strong growth sector driven by e-commerce. CIAL have seen strong demand in this area recently.

The forecast of cargo volume on dedicated freighters were done into two phases, the pre-2040 and the post-2040 periods.

In the pre-2040 period, the growth rates were based on historical growth. Additional scheduled movements were introduced via a new East Asia region and Trans-Tasman region in specific years, causing step jumps in cargo volume in the corresponding years. In domestic, it was assumed that the growth rates on the Auckland region increases slightly every five years to 2040, while growth for the Palmerston North region is to remain at 3% throughout the period, based on historical growth pattern, and the understanding of the region's potential.

The growth rates post-2040 for the four regions in the forecast reduce every 10 years, to reflect the fact that with similar absolute increase in volume, a larger base number causes the growth rates to decline. The cargo freighter operation at Christchurch Airport is small, any addition or removal of a weekly frequency, or any addition or withdrawal of operators would cause huge swings to the growth rate. The growth rates adopted are average growth rates over the ten-year period, and are anticipated to represent the average change over the period.

Day / Night Split

The day / night split in the forecast is based on the current movement split. It is understood that the current schedule is designed to fulfil current operational and fleet requirements. .

Forecast

The freight aircraft movements forecast in FY2084, shown in Figure 06-3 below, is:

→ 43,000 international aircraft movements

→ 62,000 domestic aircraft movements

→ 96,000 regional aircraft movements

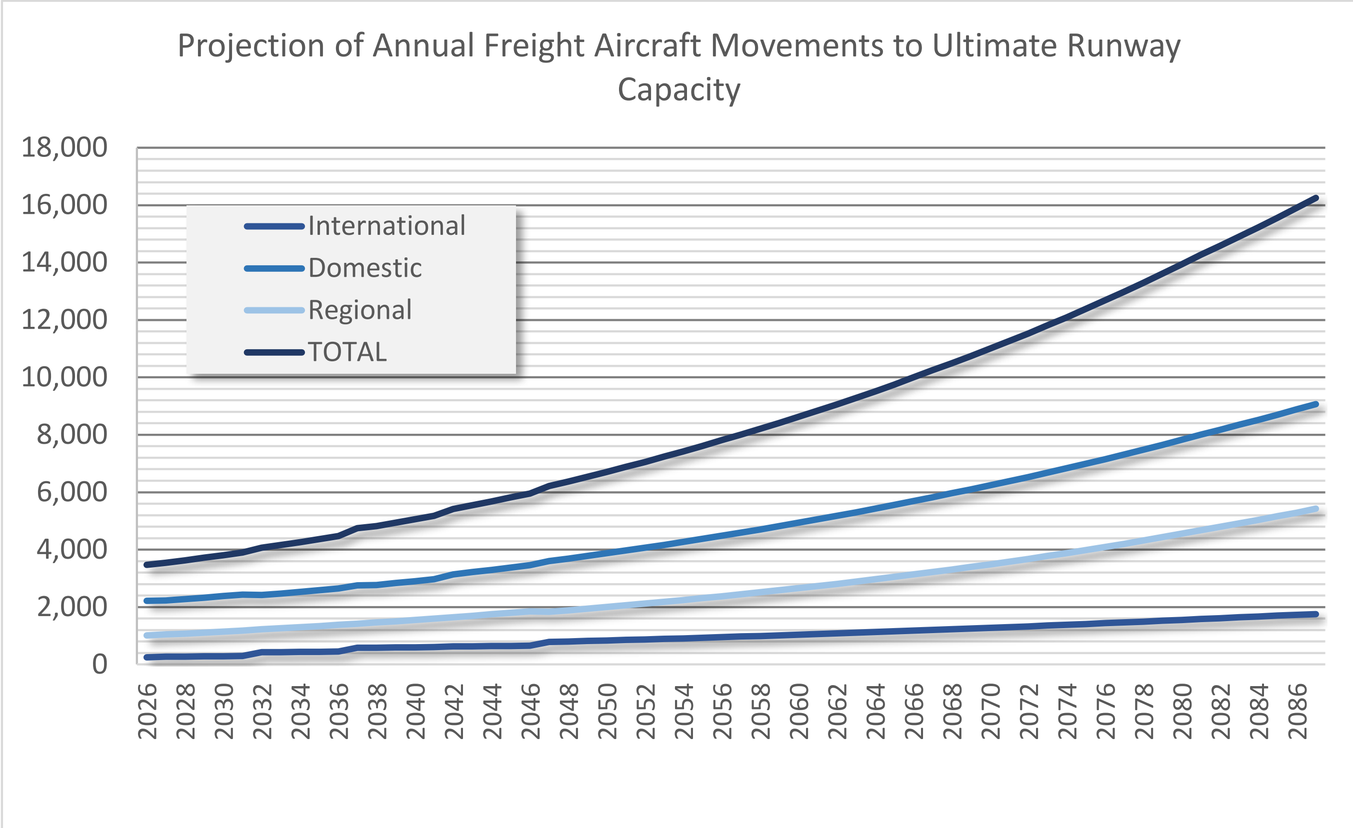


Figure 06-3 Freight Aircraft Movement Forecast

8. Helicopters

Helicopters operations at Christchurch Airport are unlike those at other large New Zealand airports. At Christchurch Airport there is a wide range of facilities, being a hub for the regional rescue helicopters, two training providers, maintenance operators as well as tourism and agricultural services. Christchurch Airport is in an ideal location to avoid helicopter noise across the city as much as possible for the purposes above, and it is considered unlikely there will a dedicated heliport any closer to Christchurch city in the future due to noise issues, as there is no harbour or lake to mitigate noise impact as is present in other locations.

In determining Ultimate Runway Capacity, it is assumed that helicopter operations will not use the same arrival and departure flight paths as fixed wing aircraft so as not to constrain growth. Similar to other high-capacity airports, it is assumed that operations from helipads will be directed into specific airspace lanes operating independent from fixed wing operations.

The current operators have long term commitments to their facilities, some of which are purpose built which makes relocation to other facilities unlikely. With the presence of helicopter maintenance facilities, many non-Christchurch Airport based operators regularly visit the airport.

For the noise modelling, helicopter movements were separated into sub-categories with growth assumptions for each group as follows.

The day / night split in the forecast is based on the current movement split.

Assumptions

<u>Rescue Helicopters</u>

There is a rescue helicopter base at Christchurch Airport and the number of movements has been growing by around 100 movements per year for the past 4 years. The projection is for this increase of 100 movements per year to continue as Christchurch Hospital capacity and population increases, which is the equivalent of one extra mission per week.

This category of activity was excluded from the noise modelling as the noise management standard for helicopters does not apply to emergency helicopter operations[31].

<u>Commercial</u>

This group includes agricultural, logistical, and training movements. Flight training could be relocated to another airport in the future if airspace issues become a problem, however both current training organisations are an extension of other operations based at the Airport. Airspace issues are not as significant for operators on the western side of the Airport for training.

For the traffic projections initially the same 2.7% short term growth rate was used, as operations are like other fixed-wing small commercial operators at Christchurch Airport. This growth reduces over time to avoid compounding growth that could exceed available infrastructure and airspace limits around the airport.

<u>Tourism</u>

For the purposes of this study it is assumed that AS50 and EC120/EC130 aircraft are the used for both for tourism

---

[31] NZS 6807:1994 Noise Management and Land Use Planning for Helicopter Landing Areas, section C1.1.

operations such as tours and charters, as well as other commercial work. The growth rates for these movements are a 50/50 split between international passenger growth as is the primary source of business for tourism operations and the commercial growth rate used above.

Military

All military movements are assumed to grow by the same 2% long term growth rate as military fixed-wing operators at the Christchurch Airport.

This category of activity was excluded from the noise modelling as Christchurch Airport must be able to facilitate Military aircraft movements at all times. Military movements are often in response to natural disasters or emergencies and as such the Airport has limited ability to schedule, predict or manage when these movements will be required. Military movements are excluded or managed separately at a number of New Zealand Airports. Generally, they comprise a small number of movements and do not have an impact on the noise contours.

Forecast

The helicopter aircraft movements forecast in FY2084, shown in Figure 06-4 below, by location is:

- → 15,000 GCH Aviation helicopter movements
- → 20,000 HeliCentre helicopter movements
- → 240 military apron helicopter movements.

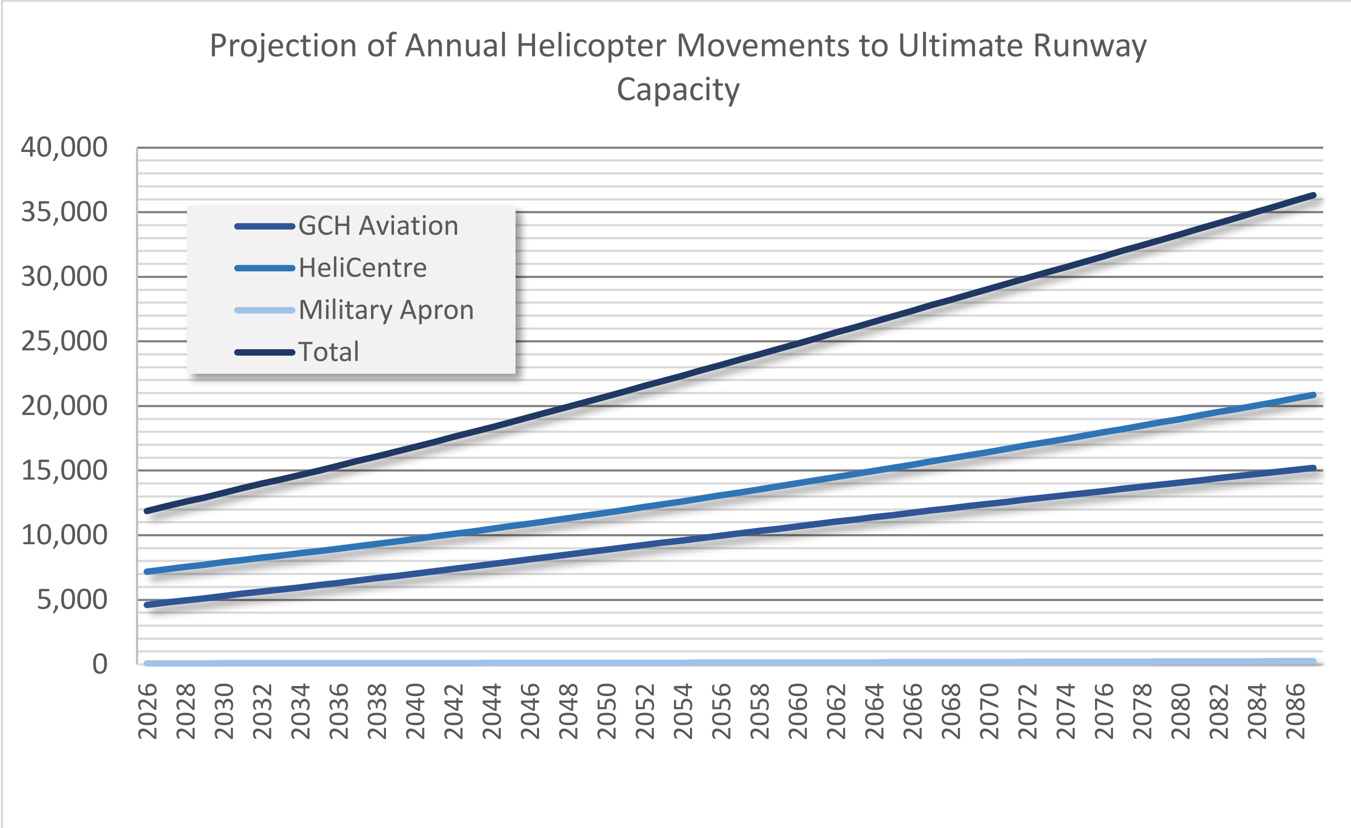


Figure 06-4 Helicopter Movement Forecast

9. General Aviation

This refers to aeroclub type flying training and recreational flying in light aircraft.

No growth has been projected for general aviation and if required the same level of activity could be assumed for the long-term. However, general aviation aircraft for this Ultimate Runway Capacity noise contour update it was assumed that in the long term all this traffic transitions to alternative airfields as other commercial traffic movements put constraints on available airport infrastructure and airspace. Therefore, general aviation average daily traffic tables are not included in the Appendix.

Appendix

Average Daily Movements for Noise Modelling Provided to MDA

The following tables were provided to MDA for noise modelling for average daily aircraft movements **before** application of any peaking factors to account for the busiest 3 months (refer Volume 6 – Noise Modelling).

The projections were provided for by traffic segment for a notional runway capacity of 201,000 scheduled passenger aircraft movements with the runway slots prioritised for scheduled airlines and other traffic spread outside of daily peaks. It also assumed reduction of 50% in FBO and Small Commercial movements at the Airport to provide additional daily scheduled passenger aircraft movements and with the remaining 50% FBO and Small Commercial movements that is displaced assumed to relocate to other aerodromes.

These daily movements are broken down by:

- Sector
- Region
- Aircraft category
- Arrivals and departures
- Day and night.

The tables are in the following categories of activity:

a. Scheduled passenger flights (by commercial airlines)
b. Non-scheduled commercial, military, government, and Antarctic flights
c. Freight
d. Helicopters

Scheduled Passenger Flights 201,000

Source:
12609w105s CHC Forecast Model RPT post EP.xlsx

Sector	Region	AC_Cat	201,000 ARR Day	201,000 ARR Night	201,000 DEP Day	201,000 DEP Night
Int	North America	MWB	1.0	0.0	1.0	0.0
Int	Pacific Islands East	MNB	0.1	0.1	0.1	0.1
Int	Pacific Islands North	LNB	0.1	0.0	0.1	0.0
Int	Pacific Islands North	MNB	1.0	0.1	1.0	0.1
Int	East Asia	LWB	5.6	0.7	5.6	0.7
Int	East Asia	MWB	3.7	0.5	3.7	0.5
Int	North East Asia	MWB	1.8	0.0	1.8	0.0
Int	Middle East	VLWB	1.8	0.0	1.8	0.0
Int	Western Australia	LNB	0.9	0.0	0.9	0.0
Int	Trans-Tasman	LWB	3.4	3.0	3.4	3.0
Int	Trans-Tasman	SWB	8.9	7.9	8.9	7.9
Int	Trans-Tasman	LNB	9.9	8.8	9.9	8.8
Dom	Auckland	MWB	5.4	0.0	5.4	0.0
Dom	Auckland	SWB	20.6	0.0	20.6	0.0
Dom	Auckland	LNB	34.4	3.8	34.4	3.8
Reg	Hamilton	MNB	0.9	0.1	0.9	0.1
Reg	Hamilton	LTP	9.3	0.8	9.3	0.8
Reg	Tauranga	LTP	7.4	0.4	7.4	0.4
Reg	Rotorua	LTP	7.8	0.4	7.8	0.4
Reg	Napier	MNB	0.1	0.0	0.1	0.0
Reg	Napier	LTP	8.3	0.6	8.3	0.6
Reg	New Plymouth	LTP	5.0	0.2	5.0	0.2
Reg	Palmerston North	MNB	1.0	0.1	1.0	0.1
Reg	Palmerston North	LTP	9.9	0.6	9.9	0.6
Dom	Wellington	MNB	12.8	1.1	12.8	1.1
Dom	Wellington	LTP	6.1	0.5	6.1	0.5
Reg	Nelson	MNB	1.7	0.2	1.7	0.2
Reg	Nelson	LTP	13.2	1.3	13.2	1.3
Reg	Blenheim	STP	3.3	0.0	3.3	0.0
Reg	Blenheim	VSTP	0.8	0.0	0.8	0.0
Reg	Hokitika	LTP	3.1	0.0	3.1	0.0
Reg	Hokitika	MTP	0.8	0.0	0.8	0.0
Reg	Dunedin	MNB	2.1	0.2	2.1	0.2
Reg	Dunedin	LTP	14.8	1.3	14.8	1.3
Reg	Queenstown	MNB	4.9	0.5	4.9	0.5
Reg	Queenstown	LTP	4.9	0.5	4.9	0.5
Reg	Invercargill	MNB	2.3	0.2	2.3	0.2
Reg	Invercargill	LTP	13.9	1.2	13.9	1.2
Reg	Chatham Islands	MNB	0.1	0.0	0.1	0.0
Reg	Chatham Islands	LTP	0.1	0.0	0.1	0.0
Reg	Other North Regional	MTP	2.1	0.0	2.1	0.0
Reg	Other South Regional	VSTP	4.7	0.0	4.7	0.0

Non-Scheduled Commercial, Military, Government and Antarctic Flights

Source:

12609w113j CHC Forecast Model Non-Scheduled post EP.xlsx

			201,000	201,000	201,000	201,000
			ARR	ARR	DEP	DEP
Type	Region	Aircraft Type	Day	Night	Day	Night
Airline/MRO	Local	Medium Two Engine Turboprop	0.9	0.0	0.9	0.0
Airline/MRO	Local	Medium Jet	0.2	0.0	0.2	0.0
Airline/MRO	South Island North	Light Single Engine Turboprop	0.1	0.0	0.1	0.0
Airline/MRO	South Island North	Medium Two Engine Turboprop	0.6	0.1	0.6	0.1
Airline/MRO	South Island South	Medium Two Engine Turboprop	0.7	0.0	0.7	0.0
Airline/MRO	South Island South	Medium Jet	0.5	0.0	0.5	0.0
Airline/MRO	North Island Central	Medium Two Engine Turboprop	0.2	0.0	0.2	0.0
Airline/MRO	North Island East	Medium Two Engine Turboprop	0.9	0.2	0.9	0.2
Airline/MRO	North Island East	Medium Jet	0.3	0.1	0.3	0.1
Airline/MRO	North Island West	Medium Two Engine Turboprop	0.5	0.0	0.5	0.0
Airline/MRO	North Island West	Medium Jet	0.7	0.1	0.7	0.1
Airline/MRO	North Island West	Heavy Two Engine Jet	0.1	0.0	0.1	0.0
Airline/MRO	Int West	Medium Jet	0.5	0.6	0.5	0.6
Airline/MRO	Int North	Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Light Single Engine Piston	0.6	0.0	0.6	0.0
Antarctic/Military/Govt	Local	Light Single Engine Turboprop	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	Local	Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Medium Four Engine Turboprop	0.6	0.0	0.6	0.0
Antarctic/Military/Govt	Local	Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Heavy Four Engine Jet	0.5	0.1	0.5	0.1
Antarctic/Military/Govt	South Island North	Light Multi Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	South Island North	Medium Four Engine Turboprop	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	South Island North	Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	South Island South	Light Multi Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	South Island South	Medium Four Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	North Island Central	Light Single Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island Central	Light Multi Engine Turboprop	0.7	0.0	0.7	0.0
Antarctic/Military/Govt	North Island Central	Medium Four Engine Turboprop	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	North Island Central	Medium Jet	0.7	0.0	0.7	0.0
Antarctic/Military/Govt	North Island East	Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	North Island East	Medium Four Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island East	Medium Jet	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	North Island West	Medium Four Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island West	Medium Jet	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	Antarctica	Medium Four Engine Turboprop	1.1	0.5	1.6	0.1
Antarctic/Military/Govt	Antarctica	Medium Jet	0.2	0.1	0.3	0.0
Antarctic/Military/Govt	Antarctica	Heavy Four Engine Jet	0.8	0.3	1.1	0.0
Antarctic/Military/Govt	Int West	Medium Four Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int West	Medium Jet	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	Int West	Heavy Four Engine Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int North East	Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int North East	Heavy Four Engine Jet	0.3	0.0	0.3	0.0

Non-Scheduled Commercial, Military, Government and Antarctic Flights continued

Source:
12609w113j CHC Forecast Model Non-Scheduled post EP.xlsx

			201,000	201,000	201,000	201,000
			ARR	ARR	DEP	DEP
Type	Region	Aircraft Type	Day	Night	Day	Night
FBO/Small Commercial	Local	Light Single Engine Piston	1.0	0.0	1.0	0.0
FBO/Small Commercial	Local	Light Multi Engine Turboprop	0.5	0.0	0.5	0.0
FBO/Small Commercial	South Island North	Light Multi Engine Turboprop	4.6	0.3	4.6	0.3
FBO/Small Commercial	South Island North	Medium Two Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	South Island South	Light Multi Engine Piston	0.7	0.0	0.7	0.0
FBO/Small Commercial	South Island South	Light Single Engine Turboprop	0.3	0.0	0.3	0.0
FBO/Small Commercial	South Island South	Light Multi Engine Turboprop	2.2	0.2	2.2	0.2
FBO/Small Commercial	South Island West	Light Multi Engine Turboprop	3.2	0.2	3.2	0.2
FBO/Small Commercial	Chatham Islands	Light Multi Engine Turboprop	0.3	0.0	0.3	0.0
FBO/Small Commercial	North Island Central	Light Multi Engine Turboprop	0.4	0.0	0.4	0.0
FBO/Small Commercial	North Island Central	Medium Jet	0.1	0.0	0.1	0.0
FBO/Small Commercial	North Island East	Light Single Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	North Island East	Light Multi Engine Turboprop	1.1	0.1	1.1	0.1
FBO/Small Commercial	North Island East	Medium Two Engine Turboprop	0.7	0.1	0.7	0.1
FBO/Small Commercial	North Island East	Medium Jet	0.3	0.0	0.3	0.0
FBO/Small Commercial	North Island West	Light Single Engine Turboprop	0.3	0.0	0.3	0.0
FBO/Small Commercial	North Island West	Light Multi Engine Turboprop	1.1	0.2	1.1	0.2
FBO/Small Commercial	North Island West	Medium Two Engine Turboprop	0.9	0.1	0.9	0.1
FBO/Small Commercial	North Island West	Medium Jet	0.3	0.0	0.3	0.0
FBO/Small Commercial	Int West	Medium Jet	0.4	0.1	0.4	0.1

Freight

Source: 12609w112g CHC Forecast Model Cargo post EP.xlsx			201,000	201,000	201,000	201,000
			ARR	ARR	DEP	DEP
Sector	Region	AC_Cat	Day	Night	Day	Night
Int	East Asia	MWB	0.2	0.4	0.2	0.4
Int	Trans-Tasman	MWB	0.2	0.2	0.2	0.2
Int	Trans-Tasman	SWB	0.3	0.4	0.3	0.4
Int	Trans-Tasman	LNB	0.4	0.2	0.4	0.2
Dom	Auckland	SWB	0.0	1.0	0.0	1.0
Dom	Auckland	LNB	0.2	0.0	0.2	0.0
Dom	Auckland	MNB	2.1	8.4	2.1	8.4
Reg	Palmerston North	MNB	1.8	4.3	1.8	4.3
Reg	Palmerston North	VSTP	0.2	0.6	0.2	0.6

Helicopters

Source: 12609w115g CHC Forecast Model Helicopter post EP.xlsx		201,000	201,000	201,000	201,000
		ARR	ARR	DEP	DEP
Airport Area	Aircraft Group	Day	Night	Day	Night
GCH Aviation	BK117	8.3	1.0	8.3	1.0
GCH Aviation	AS50	1.3	0.1	1.3	0.1
GCH Aviation	EC20	4.0	0.0	4.0	0.0
GCH Aviation	R44	2.1	0.0	2.1	0.0
GCH Aviation	R22	3.4	0.0	3.4	0.0
HeliCentre	A109	0.0	0.0	0.0	0.0
HeliCentre	EC20	5.8	0.0	5.8	0.0
HeliCentre	AS50	5.2	0.1	5.2	0.1
HeliCentre	B06	2.3	0.0	2.3	0.0
HeliCentre	MD52	2.8	0.1	2.8	0.1
HeliCentre	R44	2.5	0.1	2.5	0.1
HeliCentre	R22	0.8	0.1	0.8	0.1
HeliCentre	H269	0.6	0.0	0.6	0.0
HeliCentre	G2CA	7.1	0.1	7.1	0.1
Military Apron	NH90	0.1	0.0	0.1	0.0
Military Apron	H2	0.1	0.0	0.1	0.0
Military Apron	A109	0.2	0.0	0.2	0.0

4 CHRISTCHURCH AIRPORT FLIGHT TRACK ASSUMPTIONS

AIRWAYS
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AIRBIZ

2023 Airport Noise Contours Update

Volume 4: Flight Tracks Report

Christchurch International Airport Ltd

5 May 2023

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01. Introduction

1. Objective

This report supports the technical study which delivers an updated set of noise contours for Christchurch Airport, to be provided to planning authorities to consider as a basis for updates of District and City plans.

Christchurch International Airport Limited (CIAL) have engaged several technical experts to prepare the updated noise contours and have relied on their advice and expertise to agree key aspects of the work with CIAL where appropriate, as well as to determine methodologies, assumptions and results. In addition CIAL and Environment Canterbury (ECan) have an agreed technical review process using experts engaged through ECan to review the technical work undertaken by CIAL's consultants.

The updated noise contours are based on the requirements and guidelines in the current New Zealand Standard Airport Noise Management and Land Use Planning (NZS6805:1992).

The technical output in the form of a set of contours on a cadastral map is supported by technical reports including the methodology and key assumptions used in developing the noise contours. This report covers the output and development of flight track assumptions.

Other technical support volumes cover the topics:

- VOLUME 2[1]: Ultimate Runway Capacity
- VOLUME 3: Air Traffic Projections
- VOLUME 5: Noise Modelling.

The flight track assumptions documented in this report rely on extensive iterative consultation and review with Airways Corporation of New Zealand Limited (Airways), the national Air Navigation Services Provider.

Flight tracks determined to be used as the basis for noise contour modelling relied on Airways radar data of actual aircraft flown tracks arriving and departing Christchurch International Airport, with supporting references made to Civil Aviation Authority of New Zealand's (CAA) Aeronautical Information Publication (AIPs) as required.

[1] Volume 1 is an Executive Summary.

The main flight track assumptions (vertical and lateral location and spread and traffic allocation) as documented in this report are grouped as follows:

- Approach type splits (Visuals, Instrument Landing System (ILS) / RNAV and RNP)
- Backbone arrival (ARR) or departure (DEP) flight track definition, where 'backbone' refers to the centre of the flight track. The majority of aircraft are modelled to fly along this central backbone, with a proportion also modelled to fly either side of this line (see Track Spread assumptions).
- Track allocation by aircraft type (Jet vs. Turbo-props), and Origin or Destination
- Track spread assumptions
- Altitude profiles for RNP ARR and DEP
- Helicopter tracks.

Further details on updated flight track assumptions are provided on the following pages.

2. PBN at Christchurch

Since the preparation of the Operative Contours there have been significant changes to the flight procedures at Christchurch Airport. An introductory explanation of the various types of procedures such as PBN, RNAV, RNP, ILS etc. is provided as part of Volume 1.

The following information are useful references in relation to the flight tracks defined and presented in this report.

- Air navigation has transitioned from conventional ground-based radio navigation aids to performance-based navigation (PBN).
- RNAV stands for Area Navigation and refers to the capability of an aircraft pilot to fly any desired flight track, defined by waypoints such as geographic fixes (latitude and longitude) and not necessarily by reference to ground navaids.
- RNP (Required Navigation Performance)[2] is a similar specification to RNAV, but requires that aircraft have systems to monitor navigation performance and alert the flight crew if the required levels are not being achieved. RNP applications are also more precise and include advanced capabilities like curved paths.

[2] The latest version of Airways AIPs now denotes RNP (as described here) as RNP-AR (Authorisation Required), with RNP now referring to the RNAV specification described above. For the purposes of this report the terminology RNP is applied throughout as described above.

Other common terms referenced are: Instrument Landing System (ILS) approach, visual approach, cancelled SIDs (to facilitate reduction in distance to be flown, an approval to avoid hazardous weather, or required to maintain separation with other aircraft).

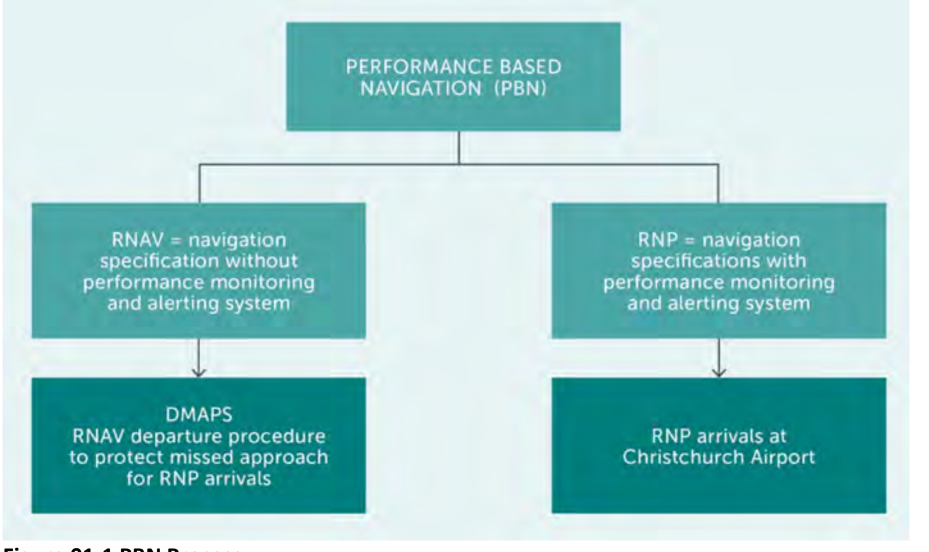


Figure 01-1 PBN Process

RNP arrivals at Christchurch Airport

Advanced PBN procedures with RNP have been introduced to shorten flightpaths and reduce flight time, fuel burn and carbon dioxide (CO_2) emissions for suitably capable aircraft arriving into Christchurch (that being most jets and some turbo-props currently).

DMAPs departure tracks at Christchurch Airport

Divergent Missed Approach Protection System (DMAPS) is an innovative system that has also been introduced at Christchurch. DMAPS protects for PBN approaches in the event of a go-around or missed approach, by ensuring a PBN departure will follow a pre-programmed routes and diverge at 30 degrees. This enhances safety, while improving aerodrome capacity in nearly all weather conditions – a feature which reduces airborne and ground holding and so also reduces flight times and generates environmental efficiencies.

Marginal track changes versus generational changes

It is internationally recognised that noise contours for airport and community safeguarding need regular updates to account for the dynamics of the aviation industry in terms current and projected aircraft fleet mix, relative growth of various sectors – international, domestic, freight etc. In addition, there can be changes in air traffic management / air traffic control procedures or allocation between RNP, ILS/RNAV or Visual tracks as a greater proportion of the aircraft fleet operating at an airport becomes more technologically capable.

Since the preparation of the Operative Contours there was the implementation of new RNP arrivals and DMAPS departures by Airways at Christchurch Airport. This is part of the global move from terrestrial to satellite based navigation and is a "step-change" for the aviation industry. It is a generational change in technology and capability and accounts for many of the differences in the outcomes of noise contours for this study compared to the Operative Contours, alongside other changes such as using radar data and fleet mix changes.

3. Other Considerations

Published procedures vs radar tracks

During this study analysis of radar data supplied by Airways showed that for a large portion of scheduled departures aircraft initially depart on published procedures and then divert off these procedures and on towards their destination, termed a cancellation of the Standard Instrument Departure (SID) or 'cancelled SID'.

For arrivals aircraft generally track along the published procedures as they approach the airport.

This is discussed further in Section 2.

Flight tracks analysed vs. modelled operations

This report documents flight tracks for scheduled and non-scheduled aircraft movements including helicopters. The outputs of this report are flight tracks for fixed and rotary wing aircraft which are used in technical modelling to generate noise contours. During the project it was agreed to exclude the following from noise modelling:

- Emergency aircraft/emergency helicopter operations
- Antarctic, military and government operations.

Emergency aircraft, military and government movements are often in response to natural disasters or emergencies and as such the Airport has limited ability to schedule, predict or manage when these movements will be required. These movements are excluded or managed separately at a number of New Zealand Airports.

Similar to Military movements, the Airport has limited ability to schedule, predict or manage when these Antarctic movements are required and will occur. Antarctic movements are also unique to the "Antarctic Season" (Spring / Summer) which is limited in duration and driven by weather conditions in Antarctica.

This is discussed further in the Volume 5 report.

02. Methodology

1. Introduction

There are two sources of information for flight tracks for noise modelling: Published flight procedures and radar data showing actual flown tracks of aircraft. Airways provided both sets of data.

The flown tracks shown in radar data supplied by Airways were compared with the published procedure tracks:

- Where there was a close alignment between flown tracks and procedures, the procedures were adopted.
- Where the flown tracks differed from procedures, a new backbone track was prepared based on the flown tracks and this was adopted.

The comparison was made separately for arrivals and departures.

For departure flight tracks, discussion with Airways resulted in confirmation that the radar data analysed (from which backbones have been prepared) represent the best current view of existing and expected future flight tracks.

2. Fixed Wing Arrivals Flight Tracks

It was found by inspection of Airways radar data that arriving aircraft typically follow flight procedures. An example of the alignment between procedures and flown tracks is shown in Figure 02-1 below.

Therefore, the flight procedure tracks were adopted for noise modelling.

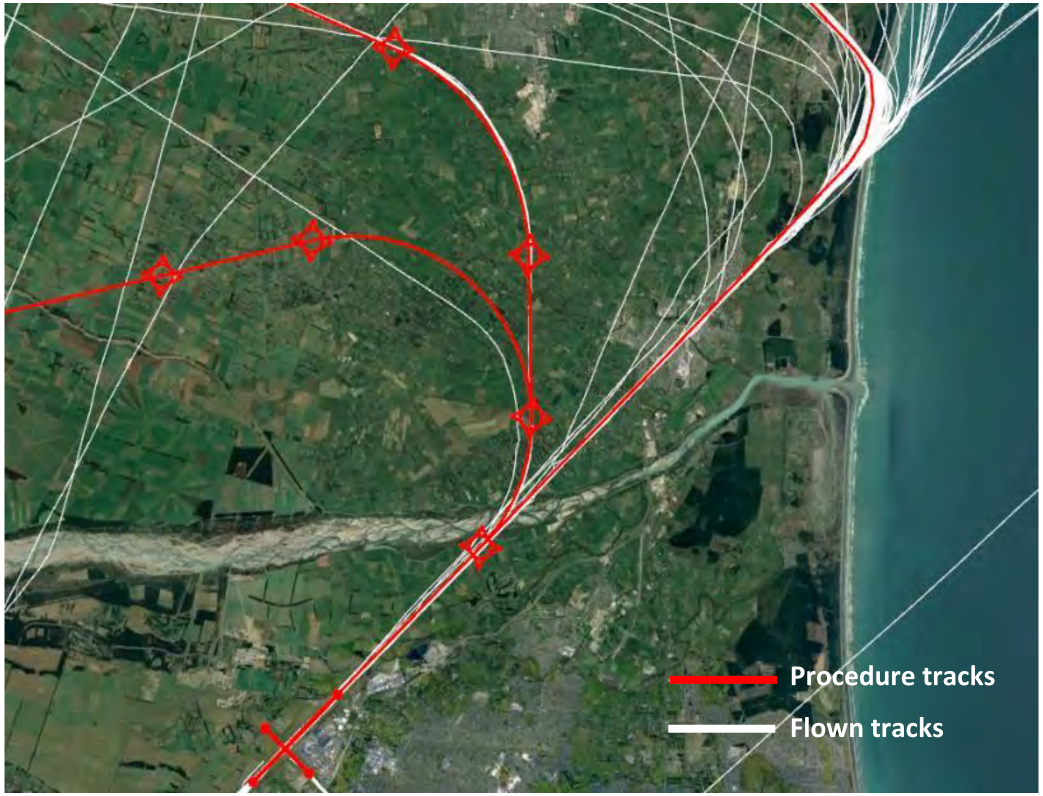


Figure 02-1 Runway 20 International Jet Arrivals example

3. Fixed Wing Departure Flight Tracks

It was found by inspection of Airways radar data that many departing aircraft follow published flight procedures for the initial phase of their departure from Christchurch Airport and then divert off these:

- Figure 02-2 below shows flown departure tracks from Airways radar data for Runway 02 against the procedure tracks.
- Figure 02-3 below shows flown departure tracks from Airways radar data for Runway 20 against the procedure tracks.

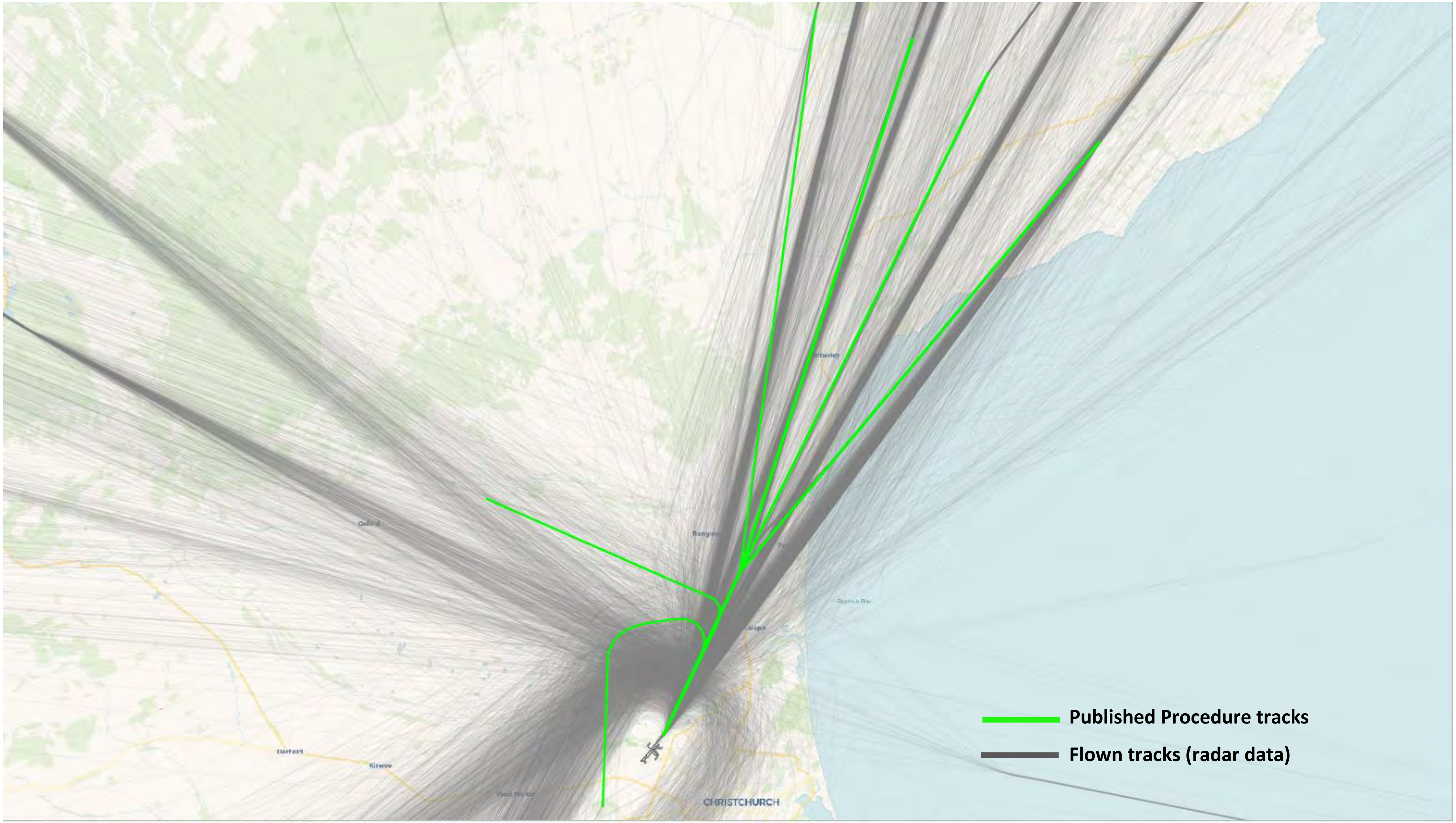


Figure 02-2 Runway 02 Departures Procedure vs Flown Tracks

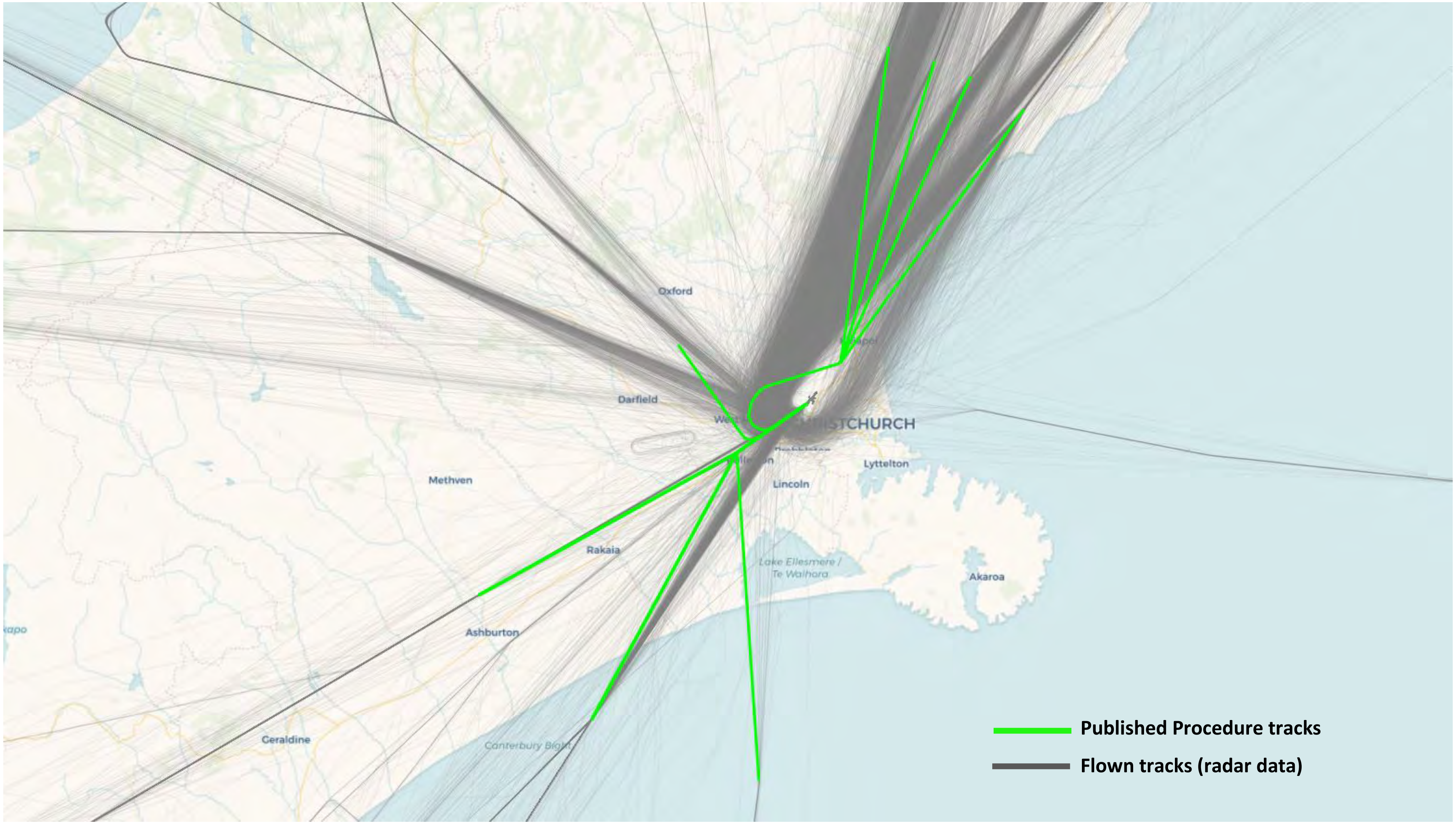


Figure 02-3 Runway 20 Departures Procedure vs Flown Tracks

On departure pilots will take-off following published flight procedures and then in flight may request to air traffic control to allow them to divert from the published procedure departure track.

Airways has advised that this is a common practice at busy airports throughout the world and can be expected to continue to occur at Christchurch Airport.

Based on analysis of the radar data it was agreed with Airways to use the flown tracks (radar data) as the basis for departure flight tracks for noise modelling. In consultation with Airways, the flown tracks (radar data) was determined to be the best current representation of current and future flight tracks. Airways have advised that there are no current plans for flight tracks to be changed or evidence for future behaviour change by aircraft operators.

Airways provided departures radar data for 12months from December 2021 to November 2022 to be used to determining departure flight tracks to be used for noise modelling.

The steps taken to identify the flown tracks for noise modelling (presented in Chapter 05 of this report) are discussed below and illustrated in Figure 02-4 below.

1. **Step 1: Plot Airways 12months of Radar Track Data**: An analysis of the radar data was undertaken to identify common departure flight tracks by route e.g. flight tracks on the CHC-AKL route were isolated and plotted. This was undertaken for all routes in the dataset and enabled identification of the most commonly used flight tracks or corridors across various destinations.
2. **Step 2: Prepare Flight Track Backbones**: Based on the Step 1 analysis flight track 'backbones' were prepared. These backbones identify the nominal centre or most commonly flown path of each flight track based on visual interrogation of the radar data.
3. **Step 3: Apply track spread:** Based on the radar data and the 'backbones' drawn an analysis is undertaken on the spread of flight tracks either side of the drawn backbone. An extent line is drawn each side of the backbone based on visual interrogation of the radar data. Modelling then applies 'spread' of aircraft along the drawn backbone and between the two associated extents. This is further discussed in the Volume 5: Modelling Report.

Step 1: Plot Airways 12months of Radar Track Data

Plot radar track data to highlight the most commonly used flight corridors.

Step 2: Prepare Flight Track Backbones

Trace the aggregated radar flight tracks to create route specific 'backbones' (i.e. CHC-AKL)

Step 3: Apply Track Spread

Trace the extent of spread of activity either side of defined backbones.

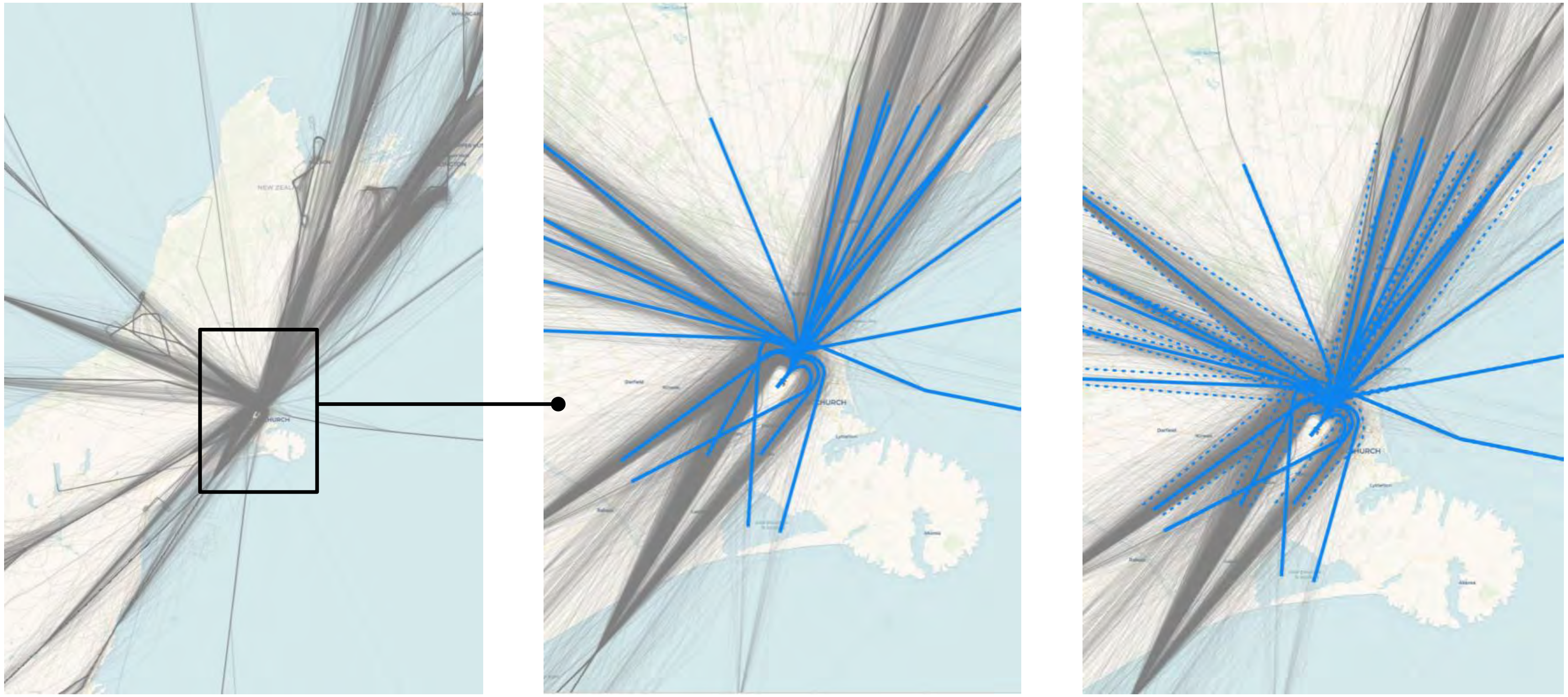


Figure 02-4 Steps to develop flown tracks *(images are indicative of the steps followed and not representative of outcomes)*

4. Helicopter Flight Tracks

Helicopters do not operate using flight procedure tracks, therefore like the fixed wing departures the flight tracks for helicopters were based on actual flight tracks provided by Airways. The same process described in Figure 02-4 was used (helicopter flight tracks are presented in Chapter 05 of this report).

03. Track Comparison: Operative Plan vs Updated Tracks

The following slides compare the Operative Contours flight tracks with the updated flight tracks prepared for this noise modelling process, for the following breakdowns:

- RWY 02 Arrivals
- RWY 20 Arrivals
- RWY 29 Arrivals
- RWY 11 Arrivals
- RWY 02 Departures
- RWY 20 Departures
- RWY 29 Departures

Note that all flight tracks (except for RWY 11 arrivals) have undergone significant changes since the Operative Plan was implemented. The most significant changes come from:

- the introduction of RNP procedures for arrivals
- the introduction of DMAPS procedures for departures.

In addition, the updated flight tracks which the new contours are based now use radar data to define the flight tracks, whereas the Operative Contours used published procedures only.

RNP arrivals enable shorter final approaches, whilst the DMAPS departures sees all traffic diverge from the runway centreline.

The Updated Flight Tracks are provided in Chapter 05 of this report.

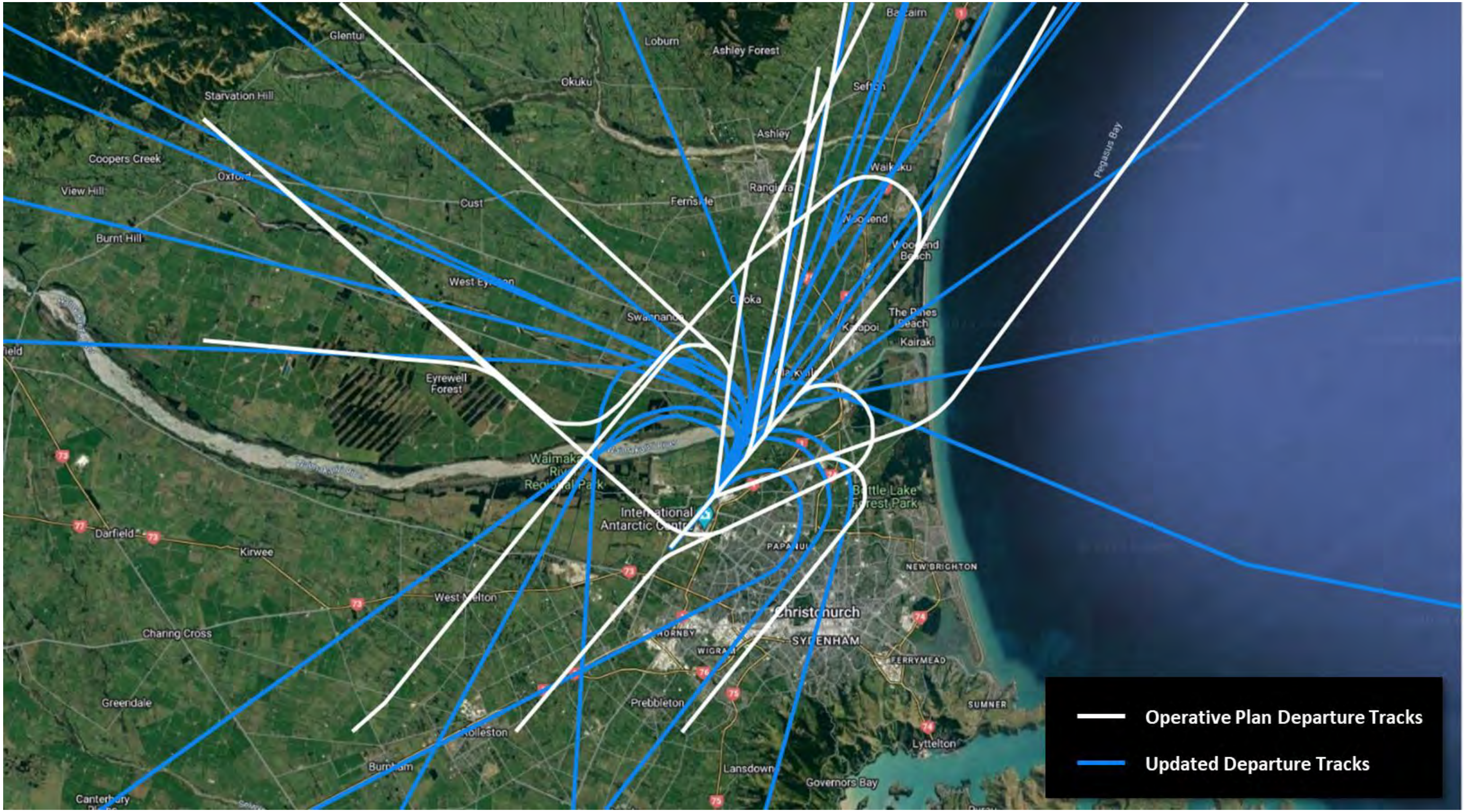


Figure 03-1 Operative Plan vs Updated Tracks: Runway 02 Departures (illustrative)

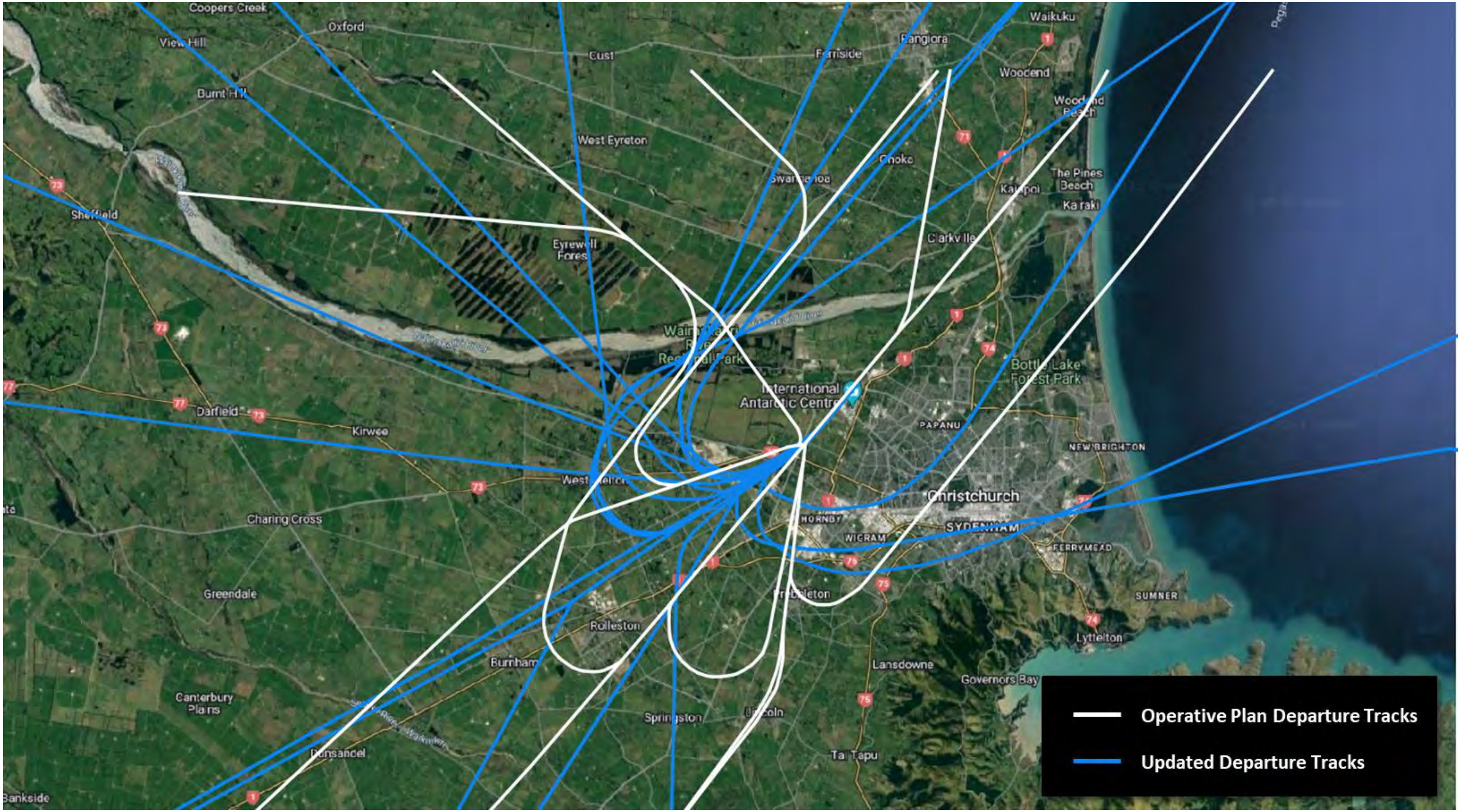


Figure 03-2 Operative Plan vs Updated Tracks: Runway 20 Departures (illustrative)

Figure 03-3 Operative Plan vs Updated Tracks: Runway 29 Departures (illustrative)

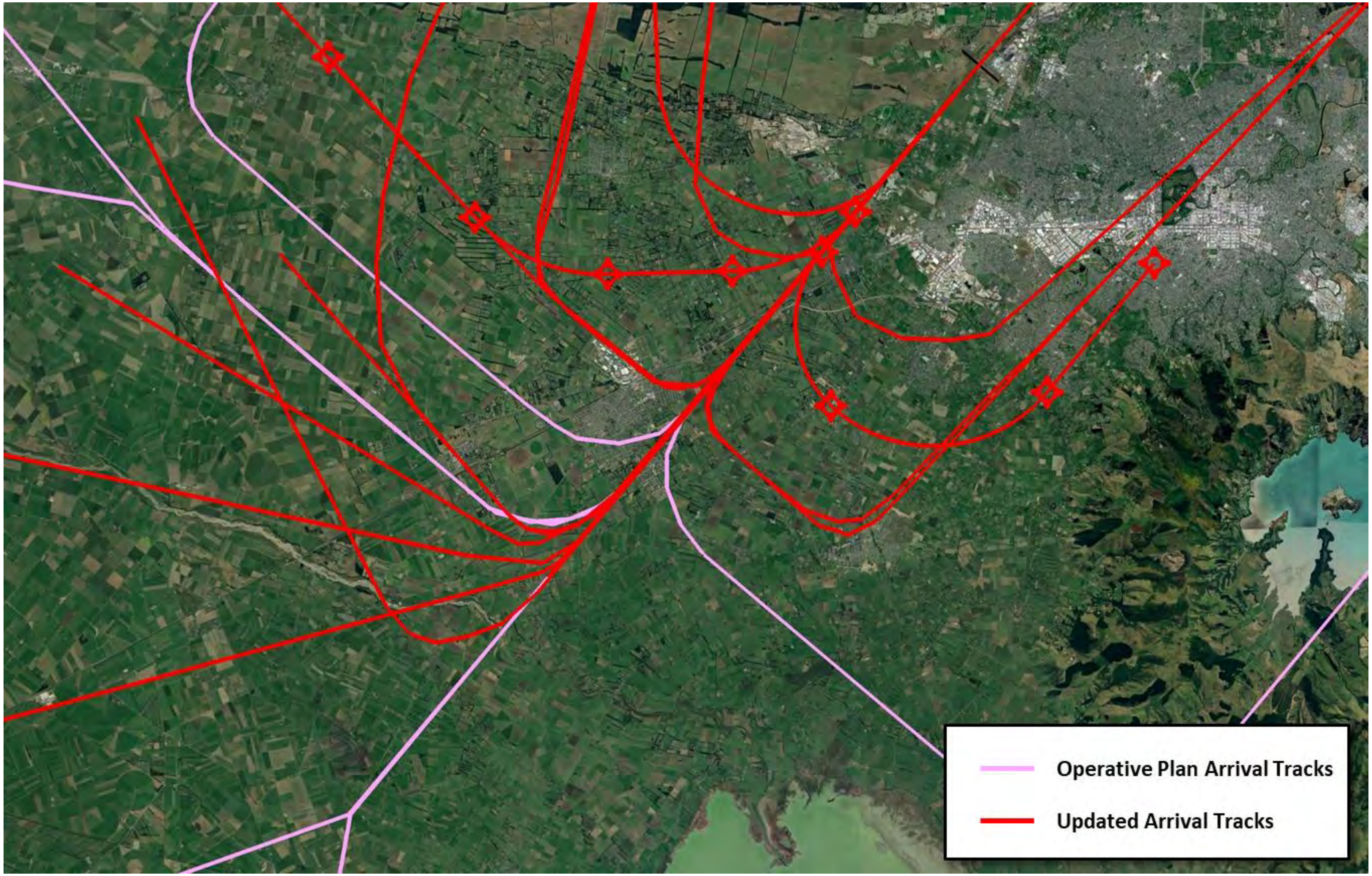


Figure 03-4 Operative Plan vs Updated Tracks: Runway 02 Arrivals

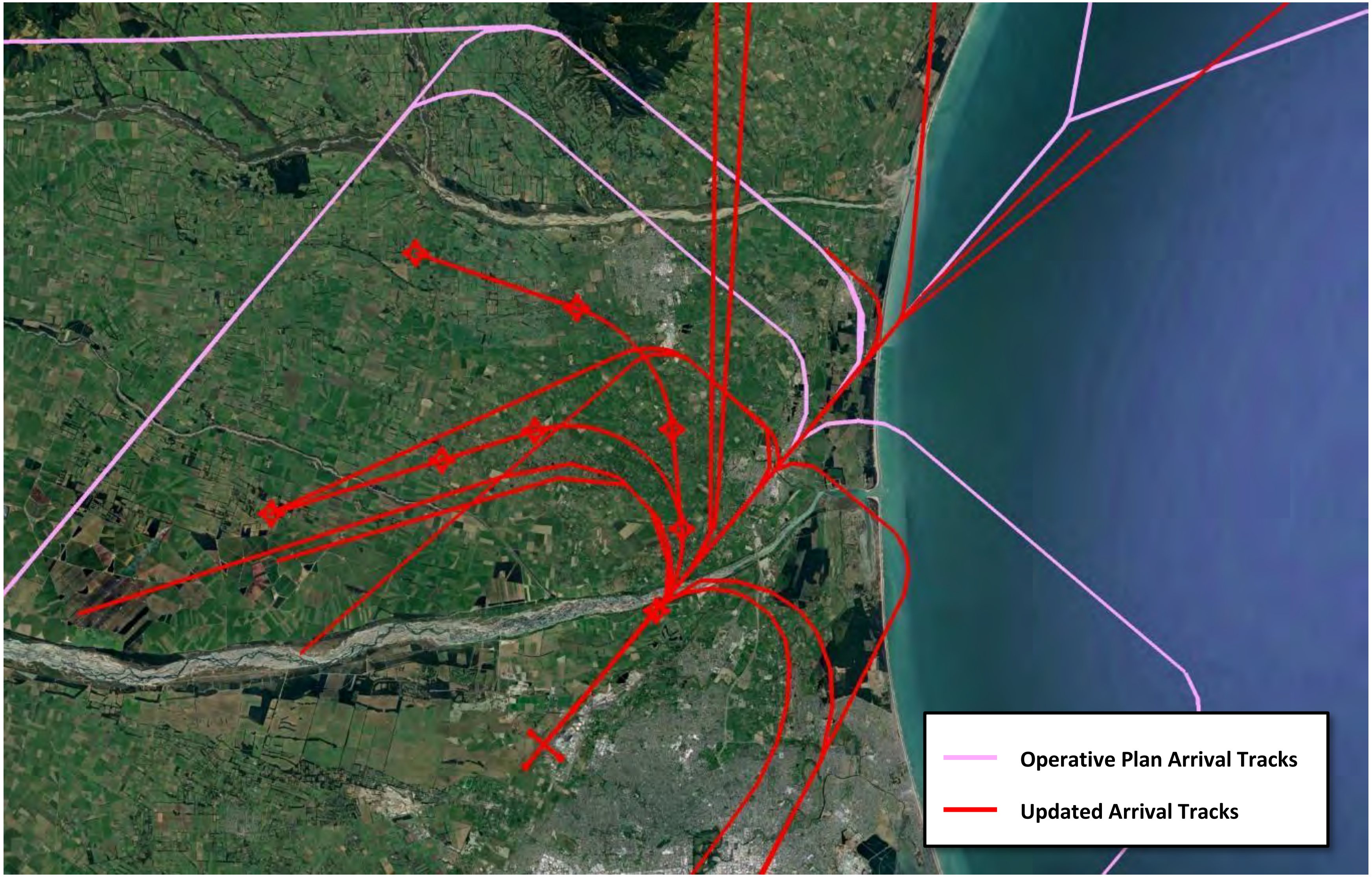


Figure 03-5 Operative Plan vs Updated Tracks: Runway 20 Arrivals

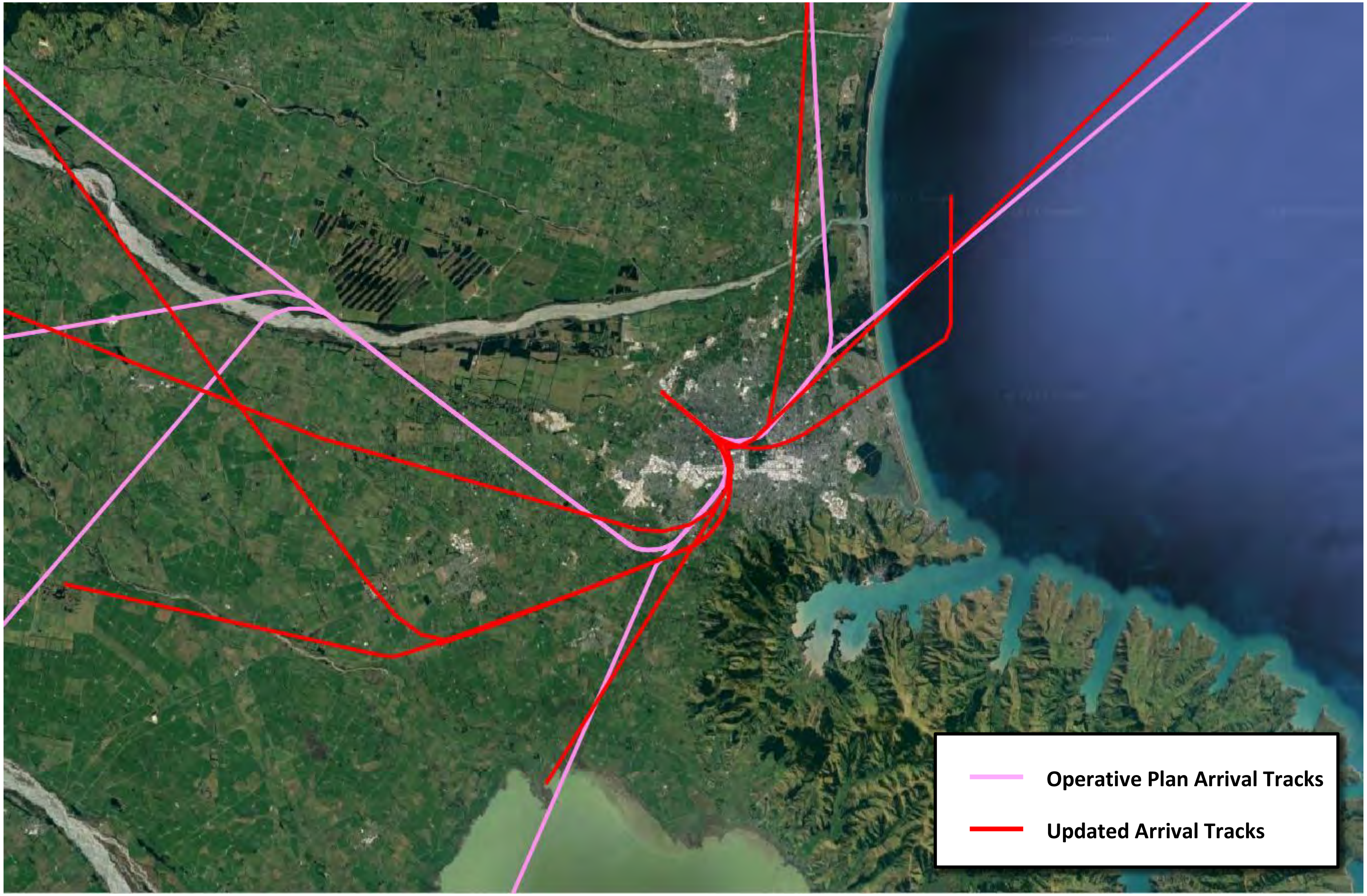


Figure 03-6 Operative Plan vs Updated Tracks: Runway 29 Arrivals

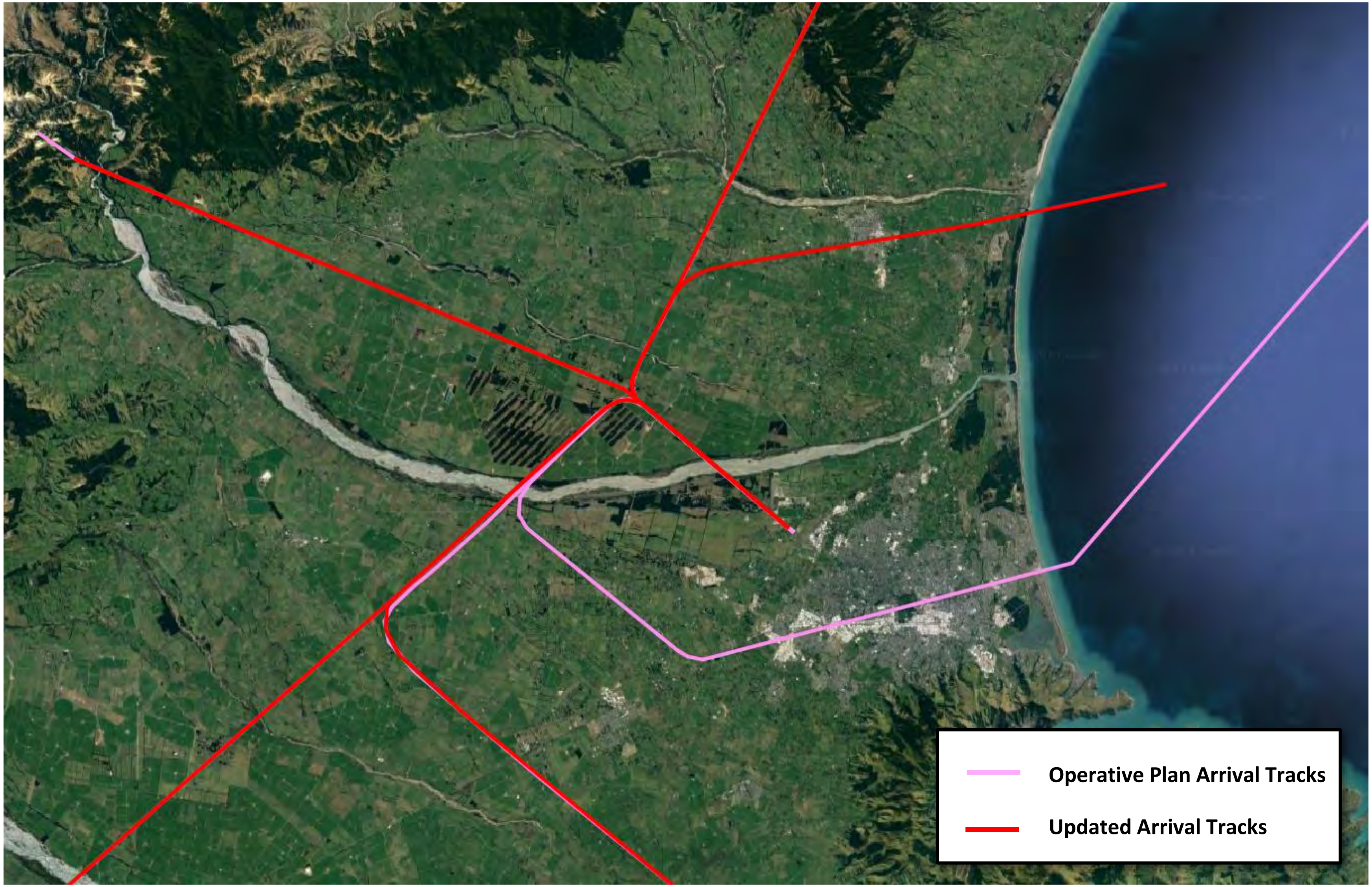


Figure 03-7 Operative Plan vs Updated Tracks: Runway 11 Arrivals

04. Updated Flight Tracks: General Assumptions

1. Introduction

The following assumptions for the updated flight tracks are included in this section:

01. Runways

- Current vs Extended Runway Configurations
- Adjustments for extended runway

02. Flight Track Definitions

- Sources of information
- Procedure types

03. Approach Splits (Visuals, ILS and RNP splits)

- Arrival tracks are assumed to be either Visual, ILS or RNP. For origins with more than one track option, a percentage split across the different approach types is applied.

04. Departure Splits

- Scheduled services - by destination and jet/turbo-prop
- Non-scheduled services

05. Track Spread

- Fixed wing (RNP arrivals, Non-RNP arrivals, departures)
- Helicopters

06. Altitude profiles

- Modelling assumptions boundaries
- Arrival profiles
- Departure profiles
- Helicopter profiles

2. Airport Master Plan Runway Extension

Shown below are the two runway configurations for the current system and if the runways are extended based on the Master Plan.

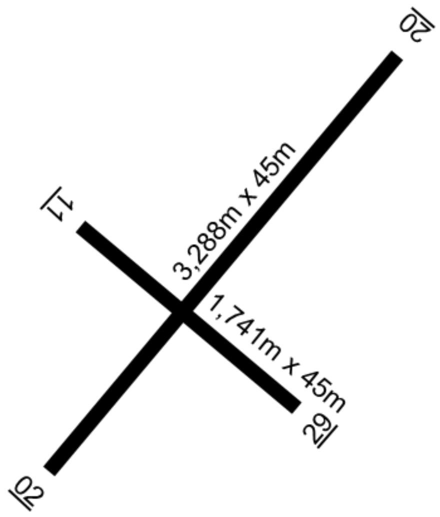


Figure 04-1 Current Runways

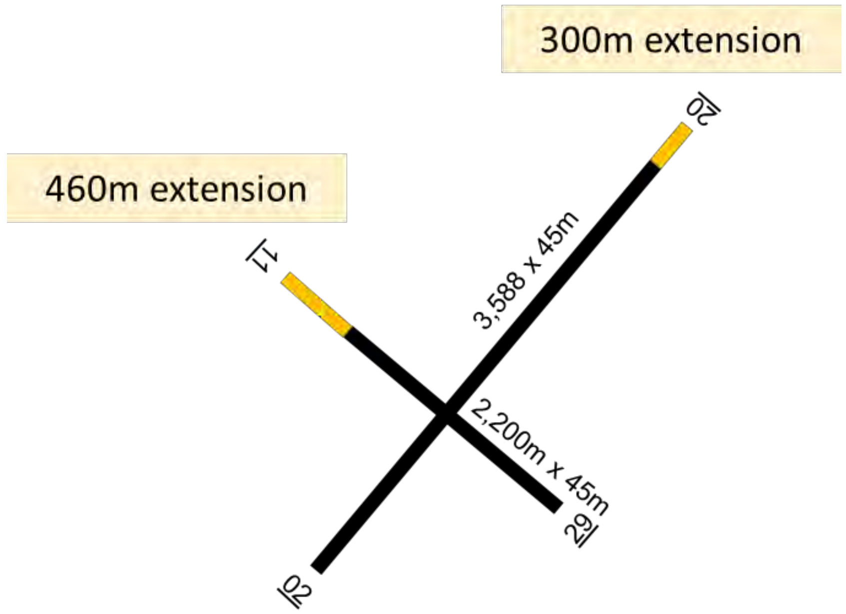


Figure 04-2 Extended Runways (MP)

Adjustments for extended runway:

- → Start of roll position for long haul international departures from Runway 20 are pushed as per the same length of the 300m extension to the North
- → Runway 11 landing threshold has been pushed out by the length of Runway 11/29 extension of 460m to the West and therefore the arrival flight track touchdown points and descent profiles have shifted accordingly.
- → Runway 20 landing threshold has been pushed out by the length of Runway 02/20 extension of 300m to the North and therefore the arrival flight track touchdown points and descent profiles have shifted accordingly..
- → Runway 29 departures have not had any changes applied and the current radar data geometry is maintained.

3. Flight Tracks Definition

Sources of information and procedure types:

→ Arrival tracks are based on published approaches in the Aeronautical Information Publication with some changes advised by Airways and verified using radar data.

→ Departure tracks are based on radar data provided by Airways as discussed in Section 2.3.

4. Departure Splits

Scheduled Services

Radar data was used to determine the proportion of aircraft movements to a destination across multiple tracks (where this existed), for a Christchurch (CHC)-Wellington (WLG) example:

- Flights to WLG were segmented in the radar data,
- These were then segmented again by jet and turbo-prop,
- Jet radar data was analysed to determine the backbone tracks used,
- Turbo-prop radar data was analysed to determine the backbone tracks used,
- Where the radar data was found to use two or more different flight tracks enroute to WLG the total number of aircraft movements in the 12-month radar data sample on each was identified,
- From this a proportion on each track was identified e.g. flight track 1 60% of jet movements to WLG and flight track 2 40% of jet movements to WLG.

Future Jet Services on Regional Routes

Some current routes are only serviced by turbo-prop aircraft from CHC, such as CHC to Dunedin (DUD). In the future it is forecast that jets will operate on certain regional routes where there are currently only turbo-prop operations (refer the Volume 3: Air Traffic Projections Report). For these cases, as there is no radar data to enable a specific analysis of jet movements, jets are assumed to follow the current turbo-prop flight track backbones identified e.g. future jet services CHC-DUD are assumed to follow the current turbo-prop backbone CHC-DUD.

Non-Scheduled

Non-scheduled destinations followed a similar methodology as scheduled services. A map of New Zealand was segmented by region to determine which non-scheduled tracks in the radar data were serving each region. The data was then interrogated to determine the proportion of aircraft movements to a region across multiple tracks (where this existed). For example, for the identified region 'North Island East':

- Flights to North Island East were segmented in the radar data,
- These were then segmented again by jet and turbo-prop (where multiple types existed),
- Jet radar data was analysed to determine the backbone tracks used,
- Turbo-prop radar data was analysed to determine the backbone tracks used,
- Where the radar data was found to use two or more different flight tracks enroute to North Island East the allocation was proportionality split across the flight tracks.

5. Approach Splits

The following assumptions regarding RNP/ILS/Visual approaches are based on consultations with Airways. Where RNP/ILS/VISUAL approach tracks are unavailable, the operation will use whatever approach track is available, for example, RWY 02 jet arrivals from Queenstown (ZQN) can only use the ILS track. In the following table:

- WBJ means Large Wide Body / Medium Widebody aircraft such as A380 / B787-9,
- NB means Narrowbody aircraft such as A320,
- Turbo-props mean turbo-prop type aircraft such as the ATR72 or Q300.

WBJ Jets	Runway End	RNP	ILS/ RNAV	Visual
Approach Splits	RWY02*	30%	70%	0%
	RWY20	10%	90%	0%

MWB /SWB Jets	Runway End	RNP	ILS/ RNAV	Visual
Approach Splits	RWY29	80%	0%	20%
	RWY11	0%	0%	100%

NB Jets	Runway End	RNP	ILS/ RNAV	Visual
Approach Splits	RWY02	85%	10%	5%
	RWY20	10%	80%	10%
	RWY29	80%	0%	20%
	RWY11	0%	0%	100%

Turbo props	Runway End	RNP	ILS/ RNAV	Visual
Approach Splits	RWY02	75%	20%	5%
	RWY20	35%	60%	5%
	RWY29	80%	0%	20%
	RWY11	0%	0%	100%

Table 04-1 Approach Splits

Note:*
- A380 on Runway 02 are allocated 100% to the ILS/RNAV based on Airways advice
- A380 on Runway 20 are allocated 10% RNP/90% ILS/RNAV based on Airways advice.

Runway 11 – it was agreed with Airways to categorise these approaches as 'visual' tracks, however we note that there are published procedures for Runway 11 arrivals which (at least some) aircraft may follow. The agreed tracks represent the published procedures inside of the final approach path and the areas where the tracks diverge from the instrument procedure are well outside the outer contour and do not have an effect on the modelling. Detailed splits are provided in the Appendix.

6. Track Spread – Fixed Wing

Track spread (either side of a central track backbone) has been determined in the following ways:

Departures

- Airbiz analysed the radar data supplied by Airways and determined outer 'extents' either side of a central backbone track and supplied these to Marshall Day Acoustics for modelling, refer Volume 5 Noise Modelling report section 4.3.2 for further information.

Arrivals

- Arrivals track spread was prepared by Marshall Day Acoustics, refer Volume 5 Noise Modelling report section 4.3.1 for further information.

7. Track Spread Assumptions – Helicopters

Helicopter track spread was determined initially through analysis of radar data supplied by Airways. This was prepared by Marshall Day Acoustics, refer Volume 5 Noise Modelling report section 4.5 for further information.

Figure 04-3 illustrates the track dispersion based on the radar data supplied.

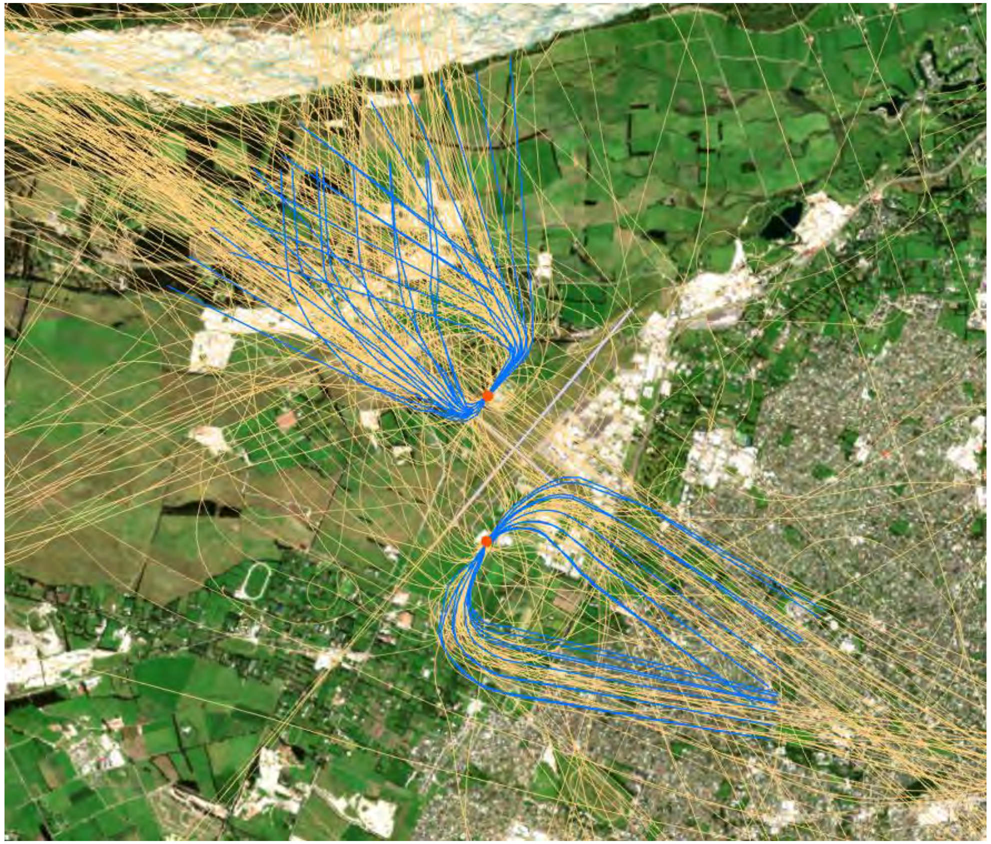


Figure 04-3 Helicopter Spread

8. Altitude Profiles – Modelling Assumptions Boundaries

Shown below are distance range circles around Christchurch Airport.

Changes to flight track or altitude profile parameters were changed if they would have an impact on the noise contours. Based on previous preliminary contours it was assumed that the majority of the contours will be contained **within 10nm**.

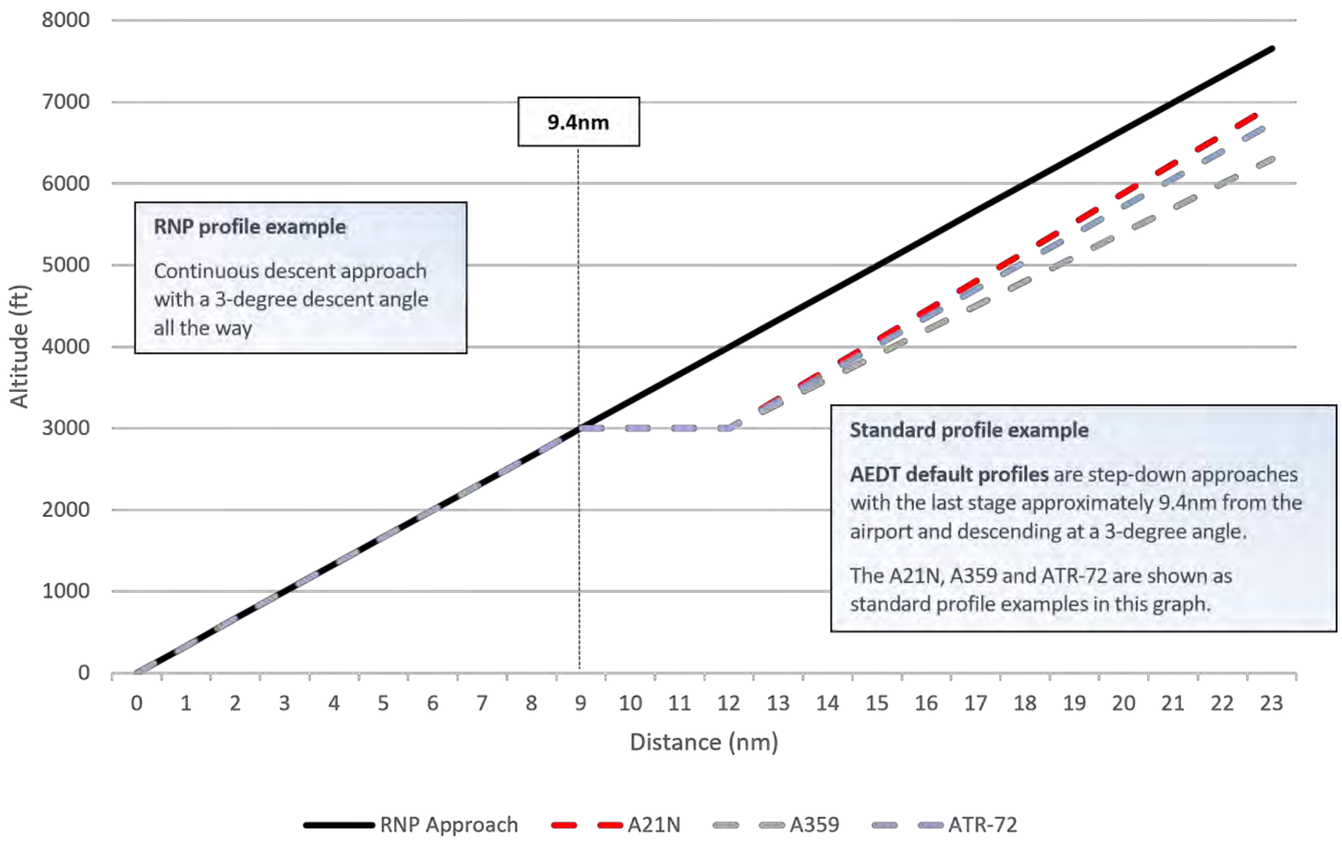
Where appropriate, AEDT default modelling parameters were used, however when justified changes were made and these are discussed in the following two sections.

Figure 04-4 Modelling Assumptions Boundaries

9. Altitude Profiles– Arrivals

There are two types of approach profiles used for arrivals. The first is a step-down approach (see dashed profiles in graphic) used by visual and ILS arrivals where aircraft fly horizontally and then 'step down' incrementally to a lower altitude. This type of profile is the standard in the noise model. RNP arrivals use a different profile called a constant descent, where they descend linearly without stepping down (see black profile in graphic). Both the step down and RNP profiles switch to a constant descent profile within 10nm of the runway (at 9.4NM) ,as the noise contours do not generally extend beyond this the standard profile has been adopted for modelling, refer Volume 5 Noise Modelling report section 5.7 for further information.

Figure 04-5 Arrival Altitude Comparison



10. Altitude Profiles– Departures

For departures AEDT standard departure profiles with the stage length corresponding to the destination have been adopted and a calibration applied where required. Refer the Volume 5: Noise Modelling report Section 5.7 for further information.

11. Altitude Profiles – Helicopters

The standard helicopter altitude profiles available in AEDT assume helicopters level out at 1000 ft for both arrivals and departures.

This assumption was checked by reviewing flown helicopter tracks provided by Airways. A summary of the altitudes flown by helicopters is shown in Figure 04-6 below. The actual helicopter activity confirmed that adopting the standard AEDT altitude profile was a reasonable decision.

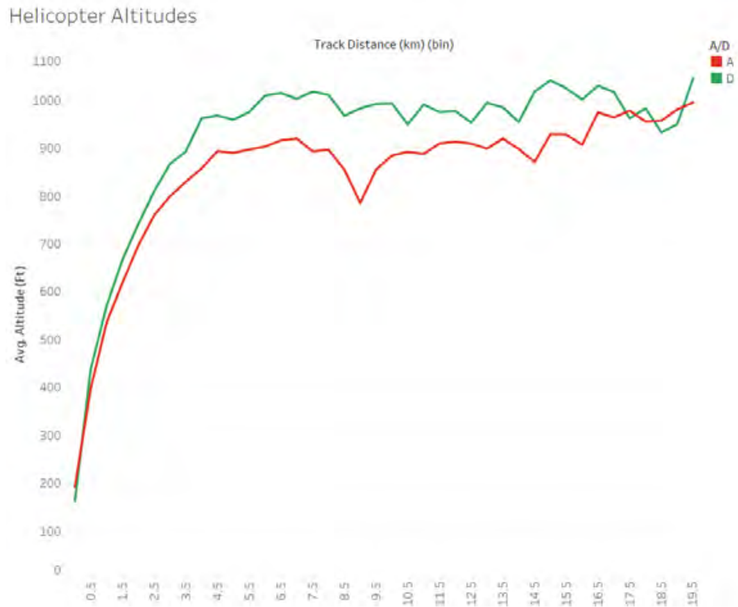


Figure 04-6 Average Helicopter Altitude at Christchurch Airport

Kilometres

05. Flight Tracks: Backbones and Allocations

This section presents the flight tracks adopted for nosie modelling for all runways and for arrivals and departures.

→ Arrival flight tracks adopted for modelling are based off published procedures and analysis of Airways radar data from the second week in July 2017, October 2017, January 2018 and March 2018 and extensive review by Airways in 2021.

→ Departure flight tracks adopted for modelling are based on analysis of Airways radar data from December 2021 to November 2022.

  - The analysis of the radar data results in some flight track backbones that follow published procedures for an initial period before diverging off these towards a destination. Analysis of the radar data also resulted in some published procedures being able to be adopted.

This section presents the scheduled Departure flight tracks adopted, the scheduled Arrivals flight tracks adopted and non-scheduled allocations of aircraft movements to the scheduled aircraft flight tracks.

Refer to the Appendix for region allocation splits for arrival and departure tracks.

Antarctica tracks illustrated in the international allocation graphics are not modelled or referred to in the region allocation splits noted above (Refer to Volume 3 Air Traffic Projection Report Section 6.6).

North East Asia
Trans-Tasman

Backbone Destination

02JDI7B_LTNWC

Backbone Code

The colour of the Backbone Code (for modelling purposes) box relates to the colour of the lines as discussed opposite.

Key Description

The following graphics illustrate flight track 'backbones' which have been identified based on analysis of the radar data supplied. The table below describes the key.

Key	Title	Description
	Departure Backbones	Radar flight track backbones adopted for modelling based on analysis of radar data. Tracks initially follow published procedures and then divert off these towards a destination.
	Departure Published SID Backbones	Published procedure backbones adopted for modelling based on radar data supporting their use.
	Arrival backbones	Arrival backbones.

Figure 05-1 Key Description

Each graphic has several boxes to indicate the destinations of aircraft on each backbone and the Airbiz generated backbone code (for modelling purposes) discussed opposite.

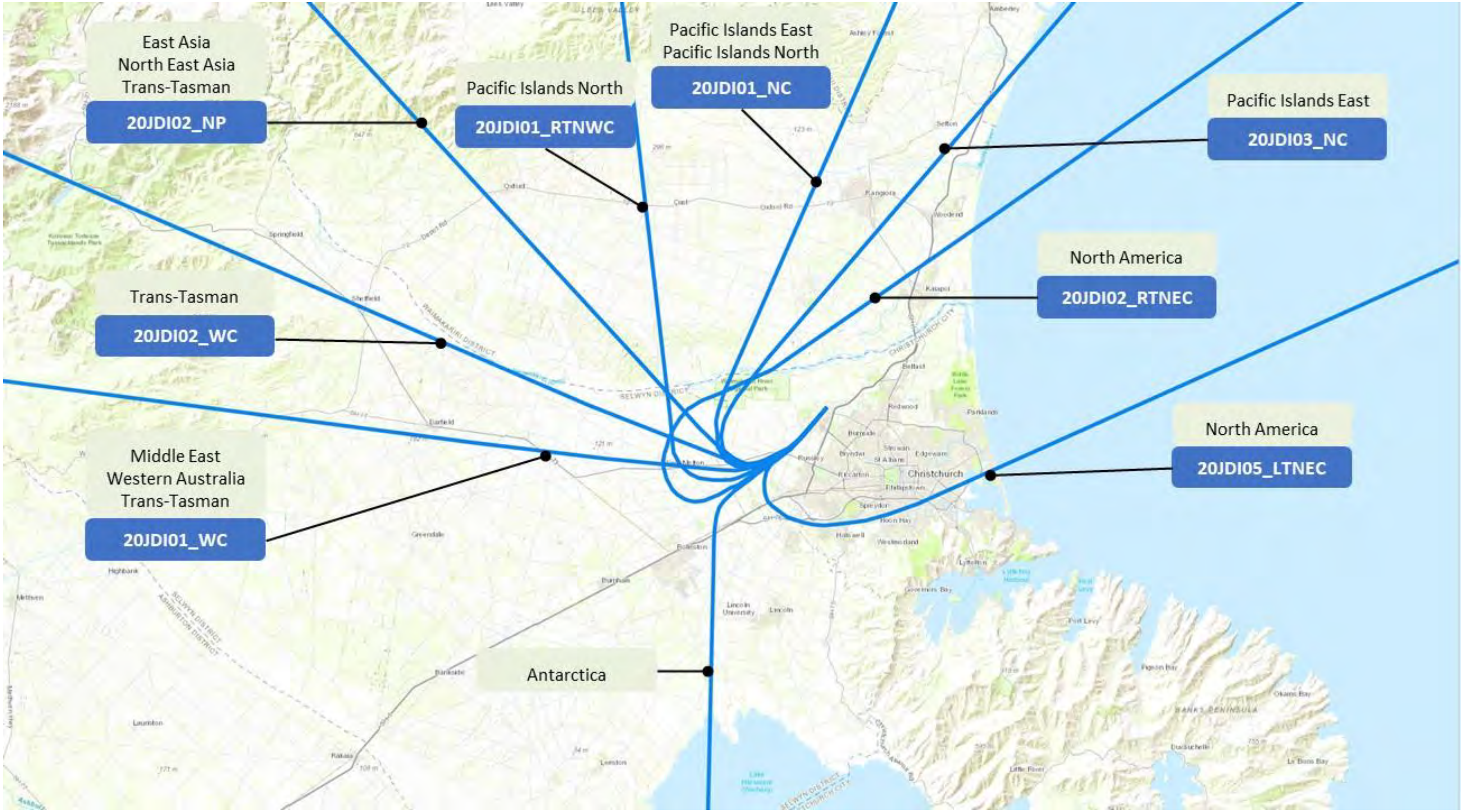


Figure 05-2 Runway 20 Jet International Departure Adopted Flight Tracks (Antarctica is not modelled)

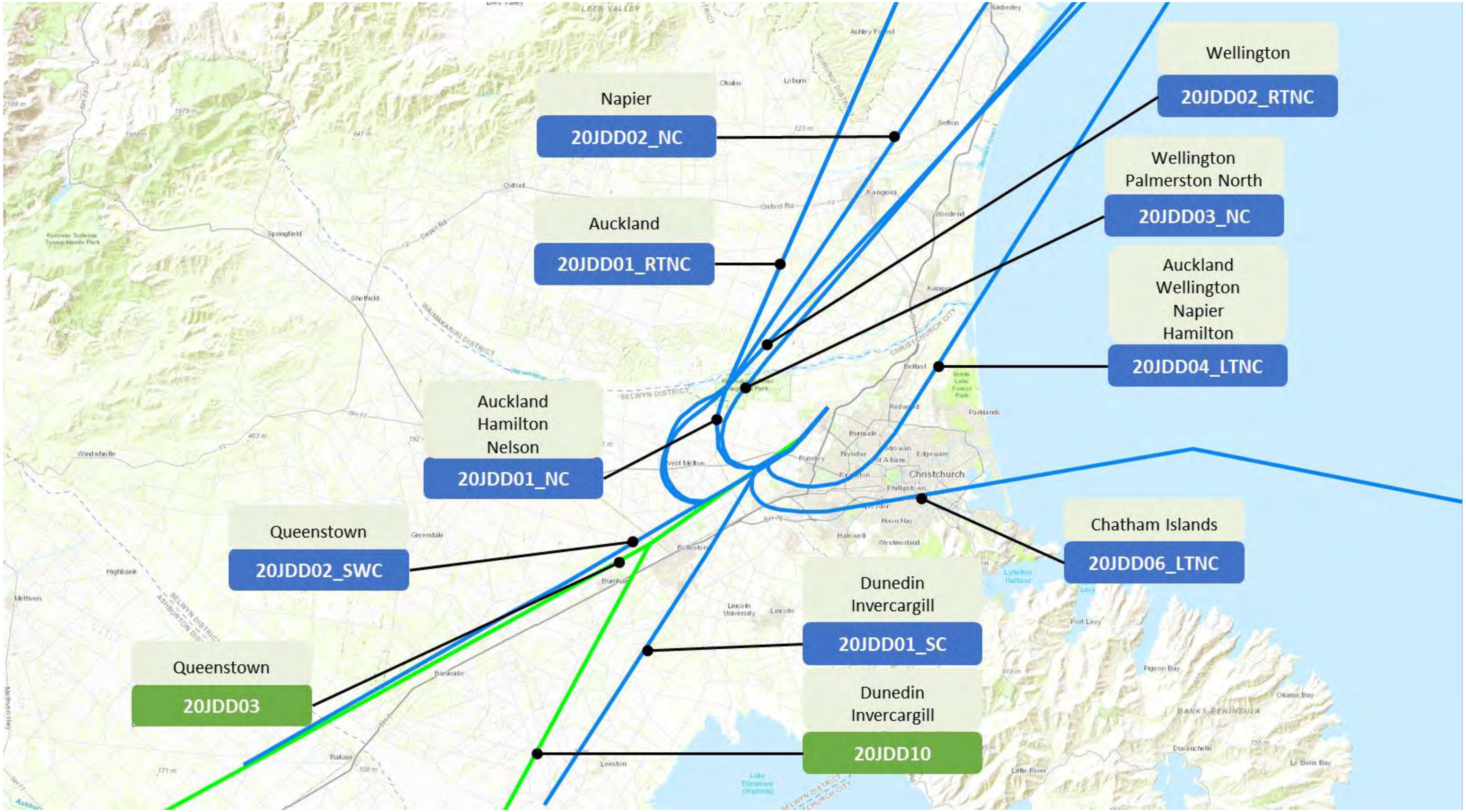


Figure 05-3 Runway 20 Jet Domestic Departure Adopted Flight Tracks

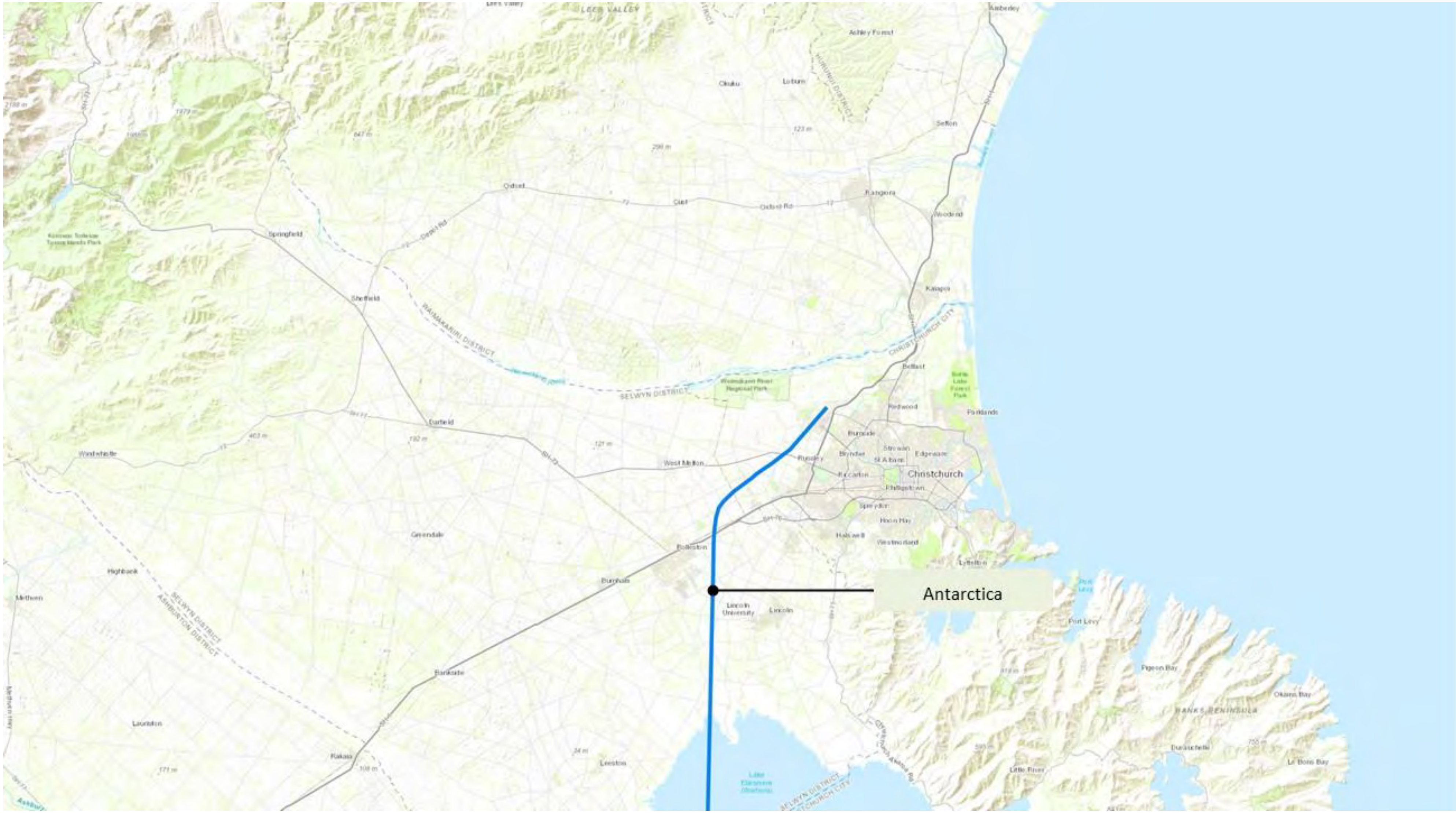


Figure 05-4 Runway 20 TP International Departure Adopted Flight Tracks (Antarctica is not modelled)

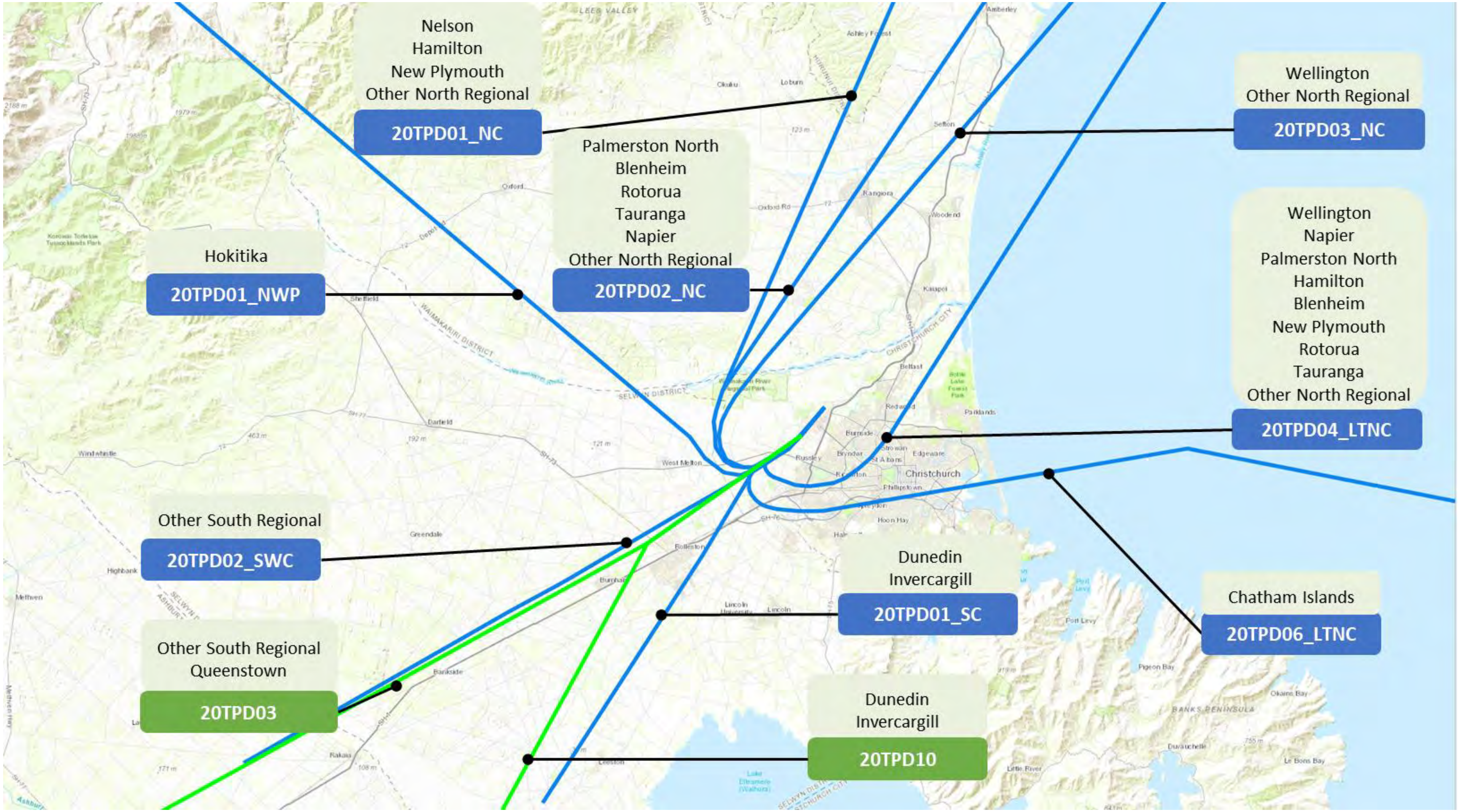


Figure 05-5 Runway 20 TP Domestic Departure Adopted Flight Tracks

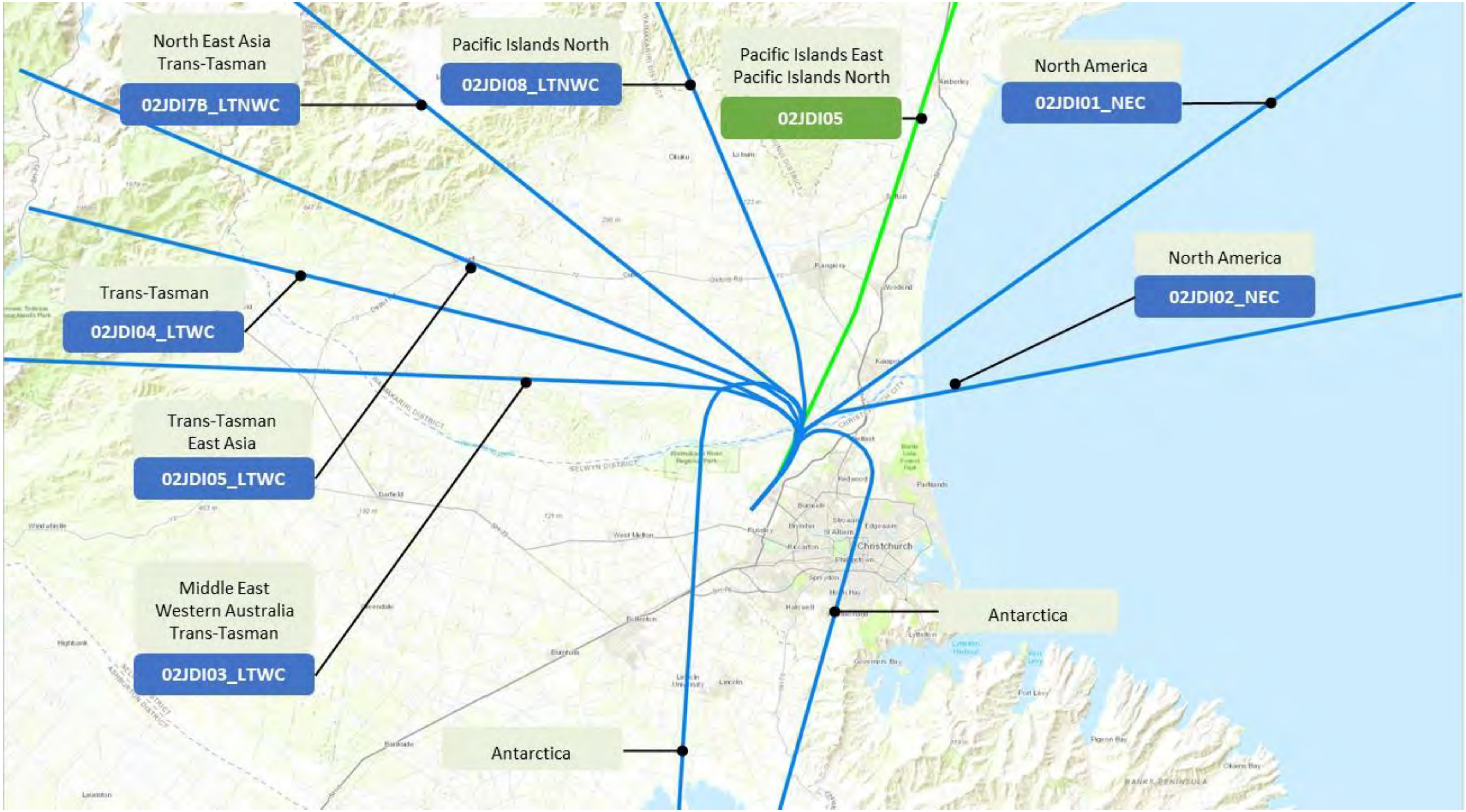


Figure 05-6 Runway 02 Jet International Departures Adopted Flight Tracks (Antarctica is not modelled)

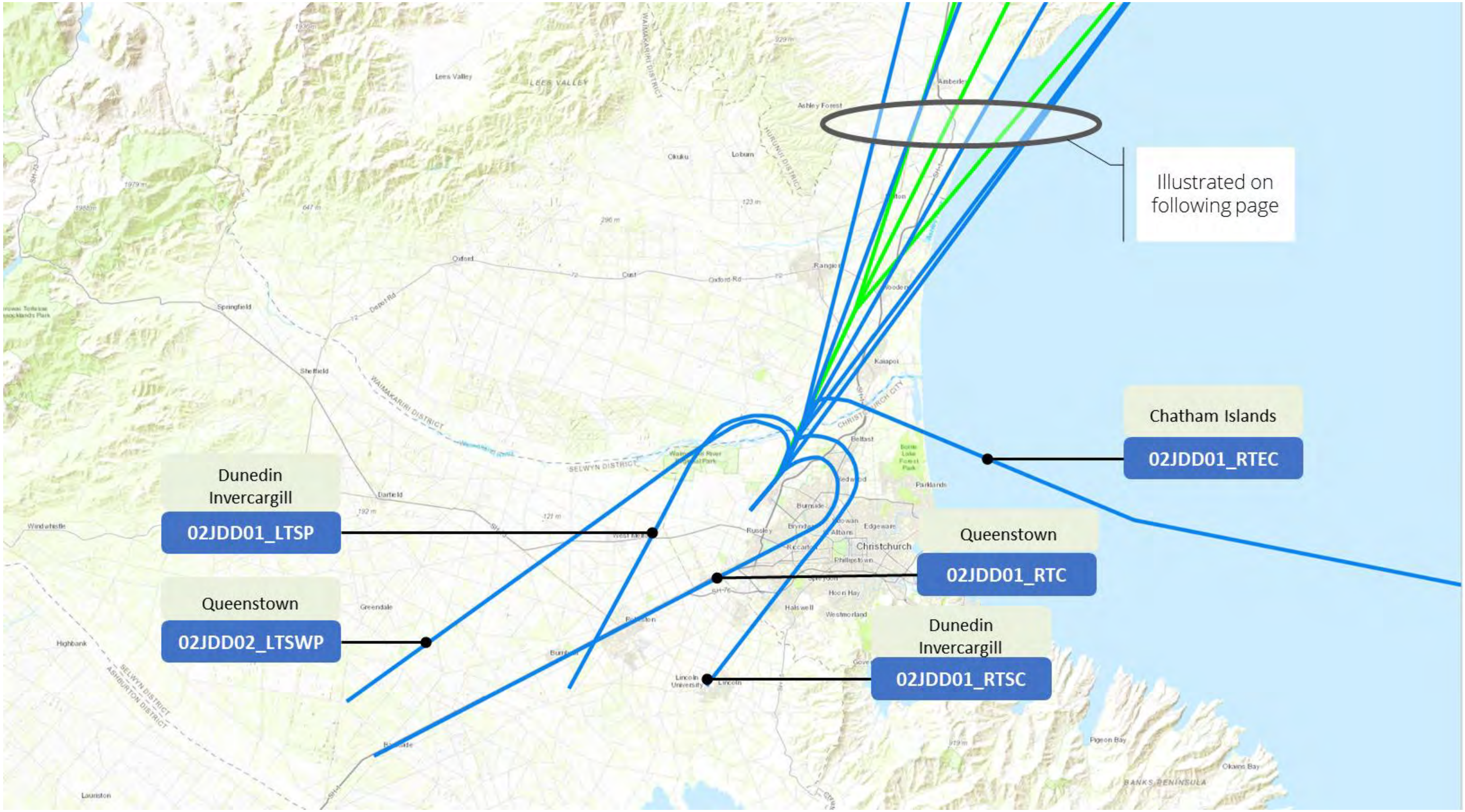


Figure 05-7 Runway 02 Jet Domestic Departure Adopted Flight Tracks

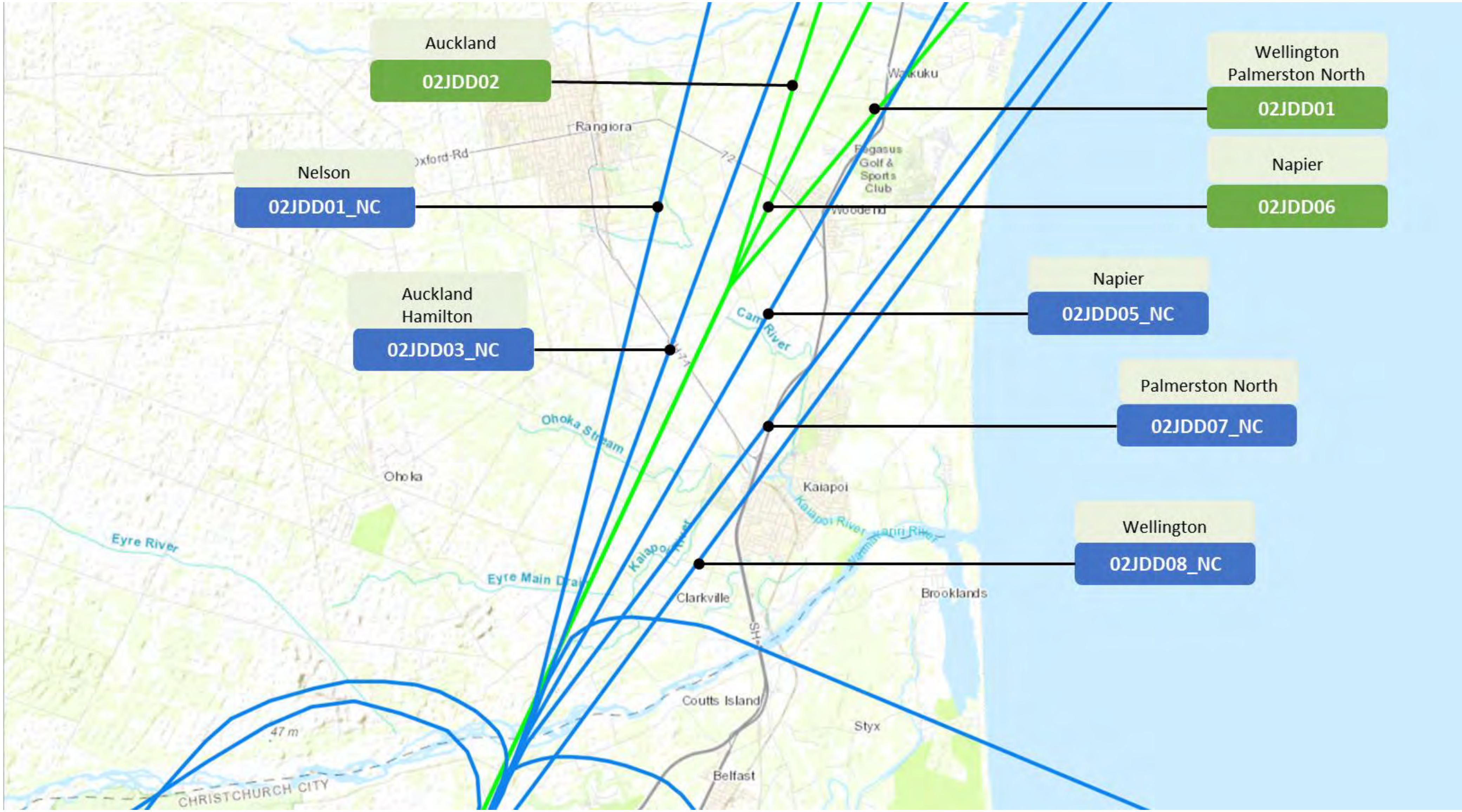


Figure 05-8 Runway 02 Jet Domestic Departure Adopted Flight Tracks

Figure 05-9 Runway 02 TP International Departure Adopted Flight Tracks (Antarctica is not modelled)

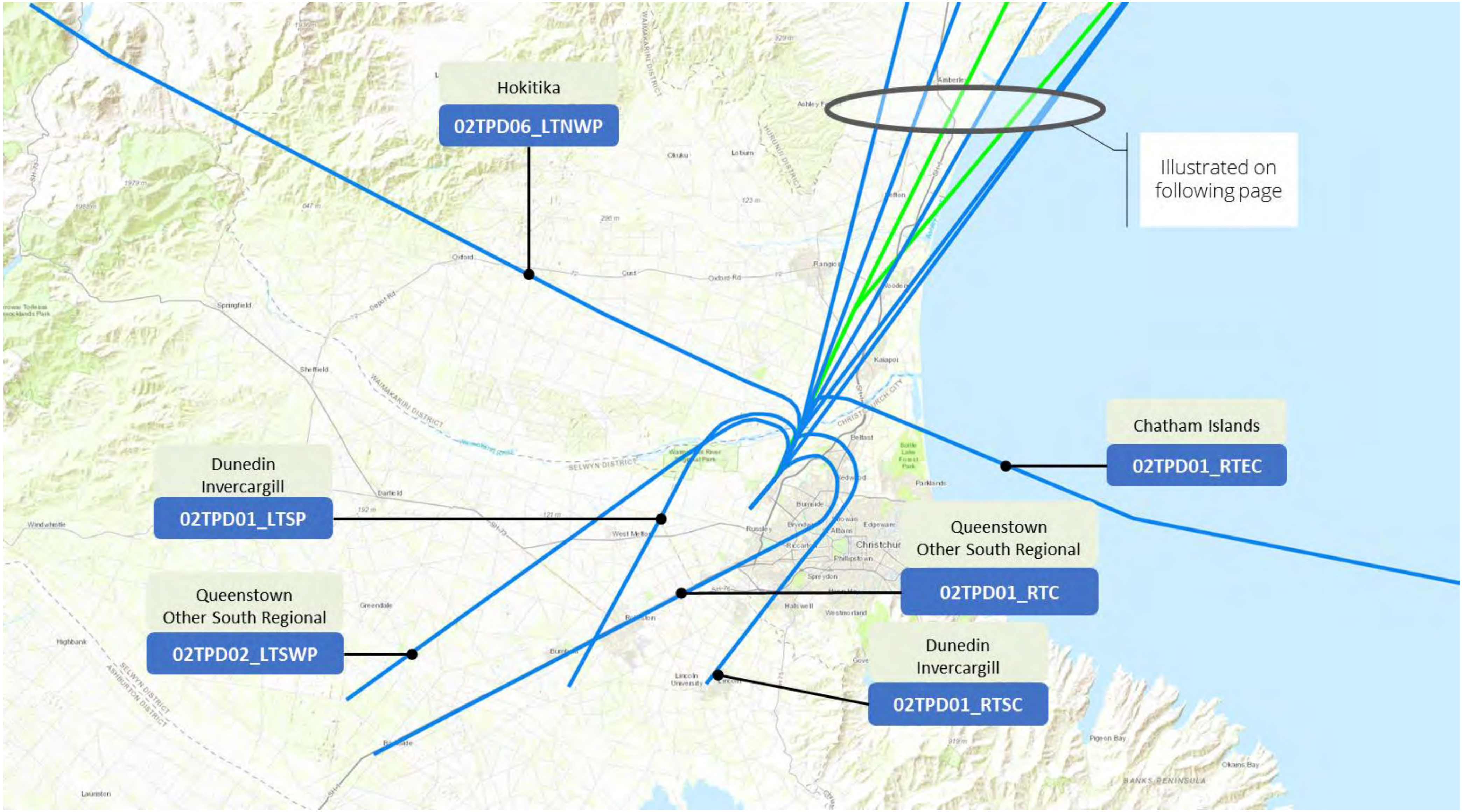


Figure 05-10 Runway 02 TP Domestic Departure Adopted Flight Tracks

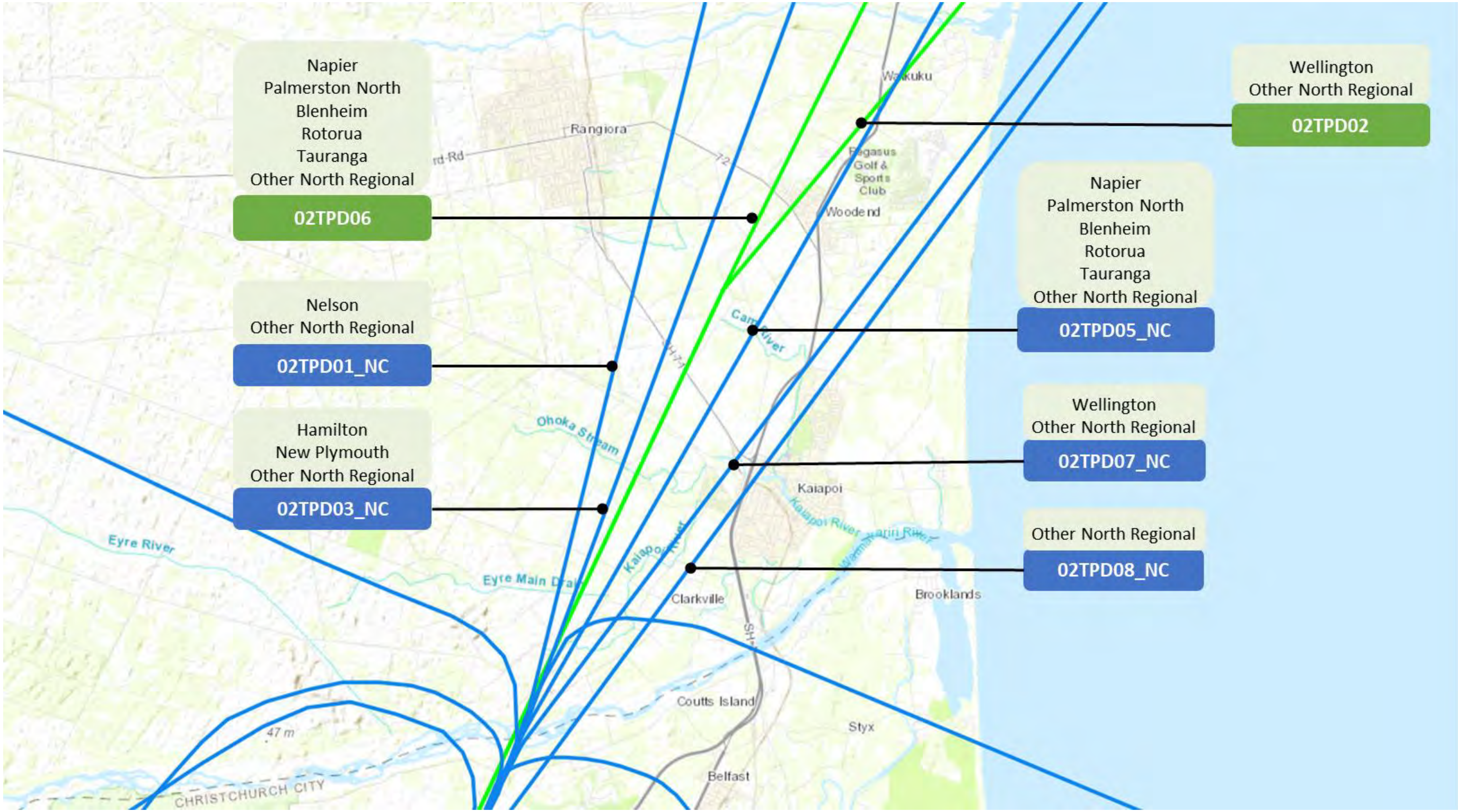


Figure 05-11 Runway 02 TP Domestic Departure Adopted Flight Tracks

Figure 05-12 Runway 29 Jet International Departure Adopted Flight Tracks (Antarctica is not modelled)

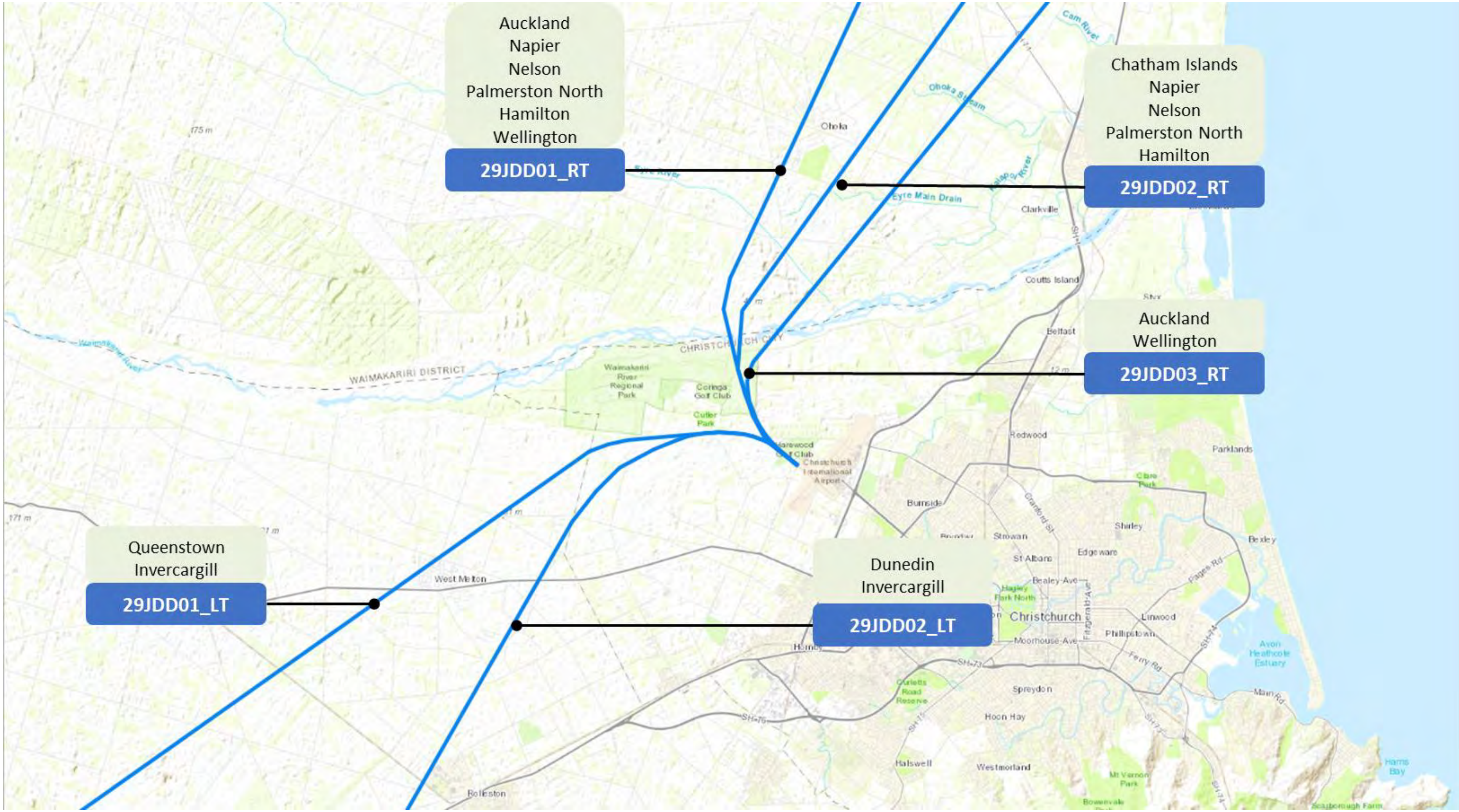


Figure 05-13 Runway 29 Jet Domestic Departure Adopted Flight Tracks

Figure 05-14 Runway 29 TP International Departure Adopted Flight Tracks (Antarctica is not modelled)

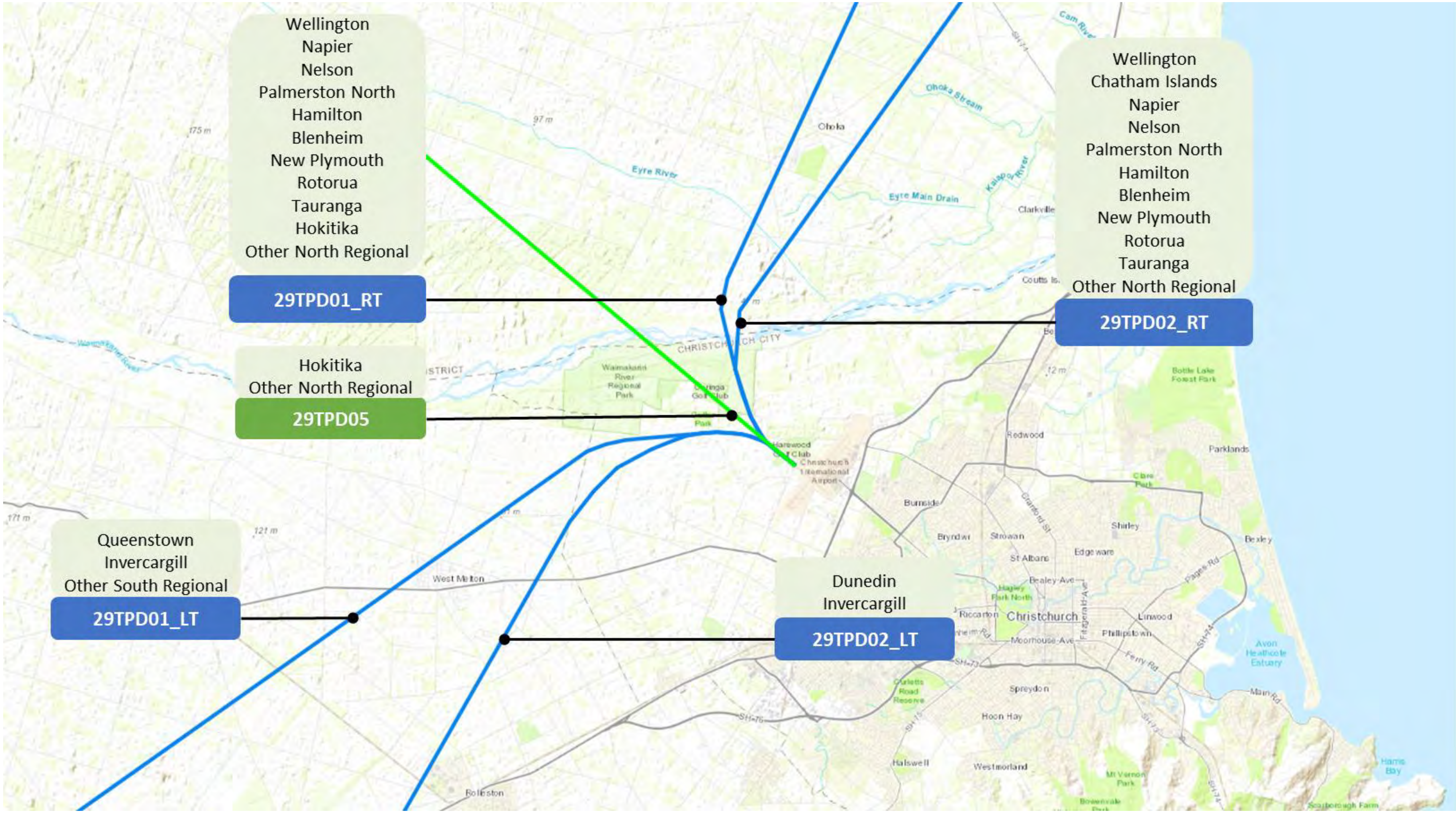


Figure 05-15 Runway 29 TP Domestic Departure Adopted Flight Tracks

Adopted Scheduled Arrival Flight Tracks

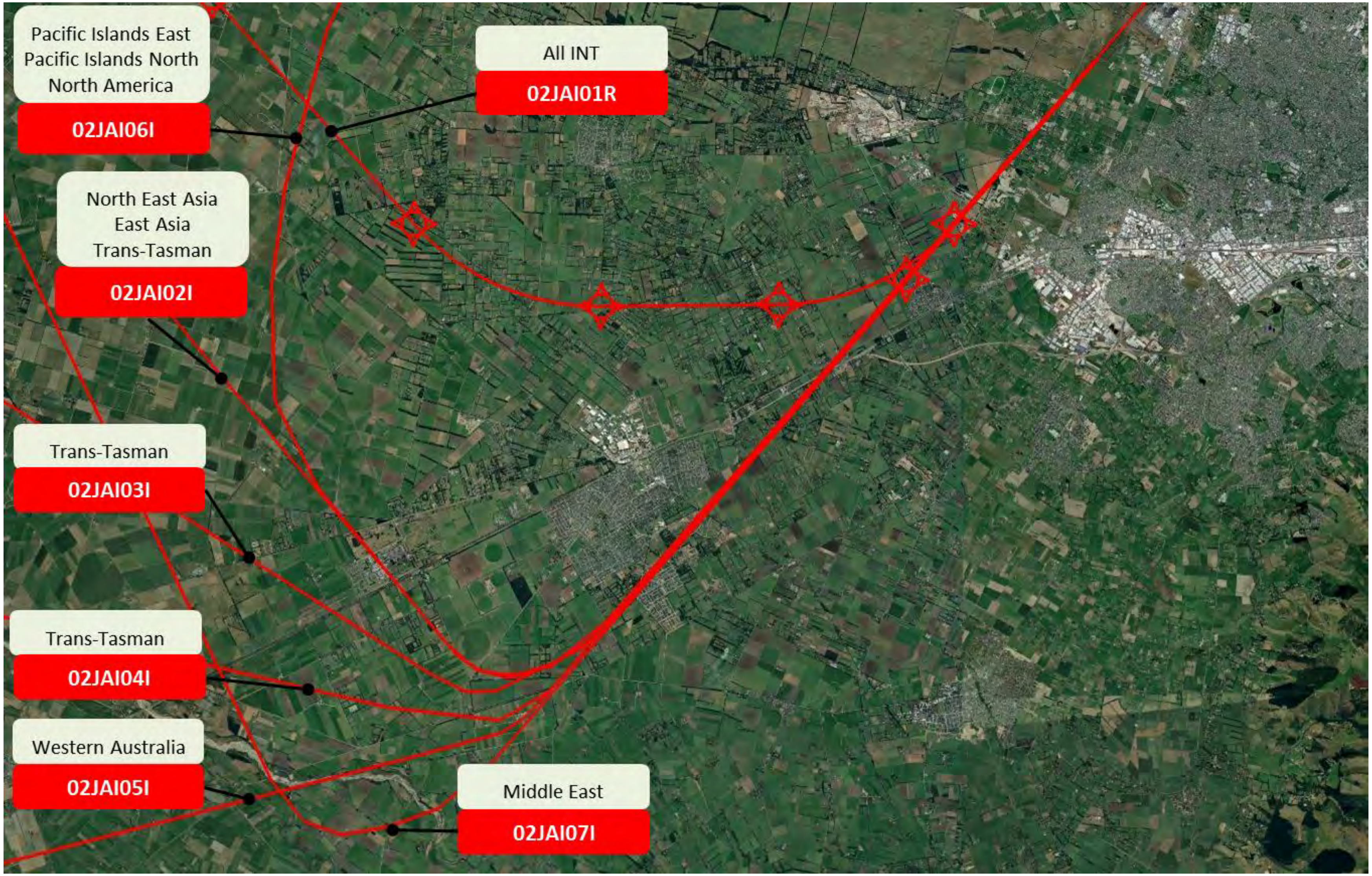


Figure 05-16 Runway 02 Jet International Arrival Adopted Flight Tracks

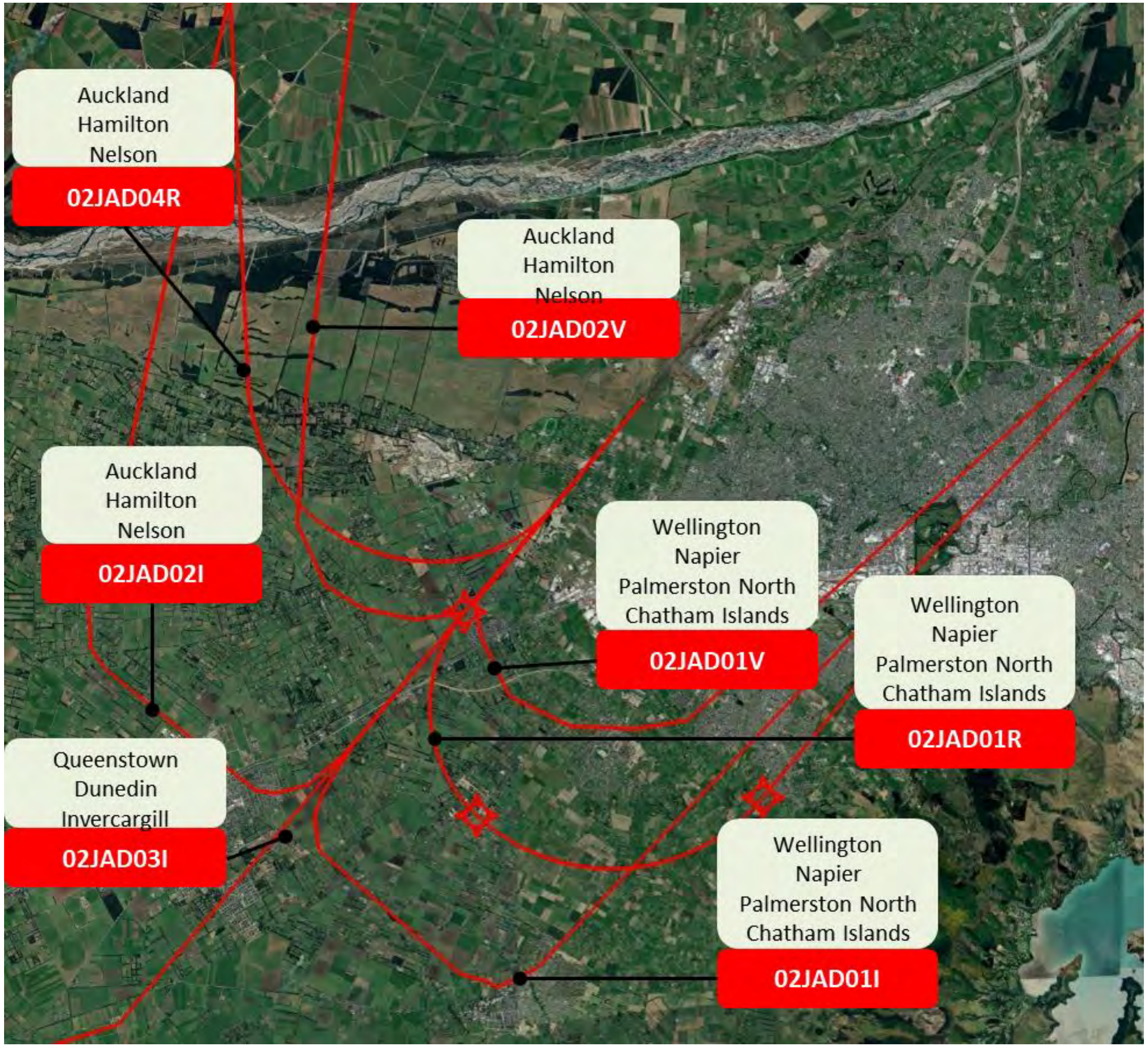


Figure 05-17 Runway 02 Jet Domestic Arrival Adopted Flight Tracks

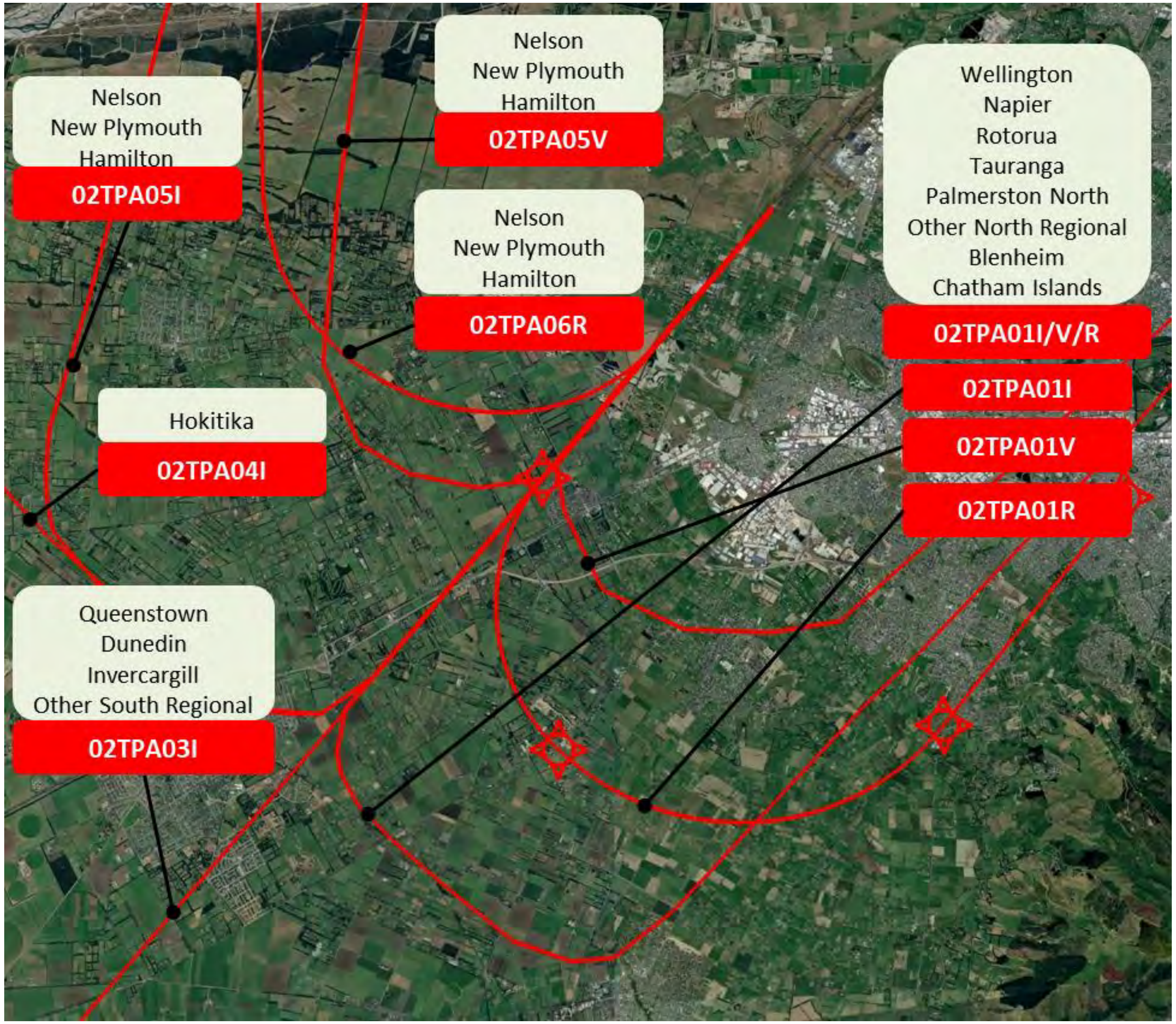


Figure 05-18 Runway 02 TP Domestic Arrival Adopted Flight Tracks

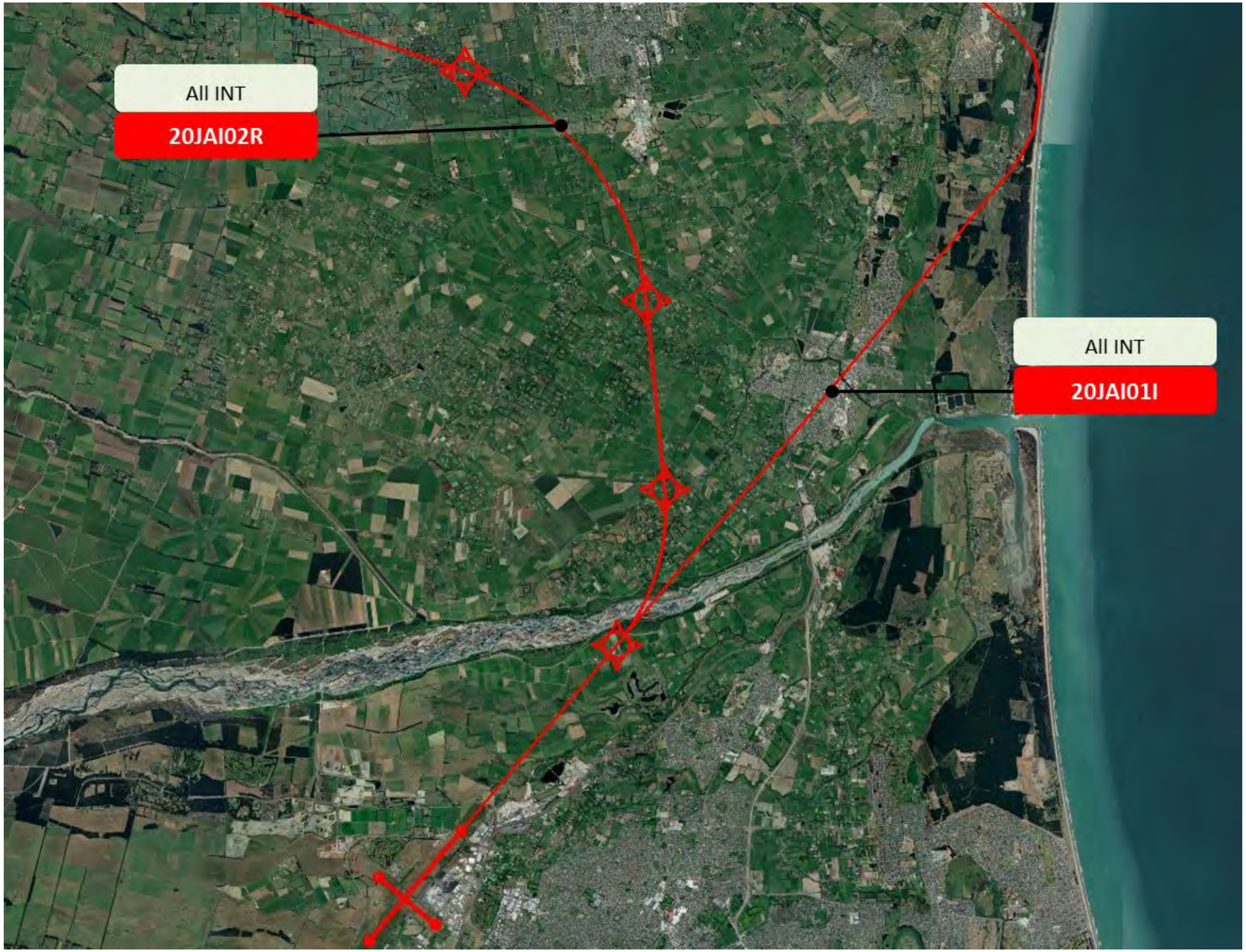


Figure 05-19 Runway 20 Jet International Arrival Adopted Flight Tracks

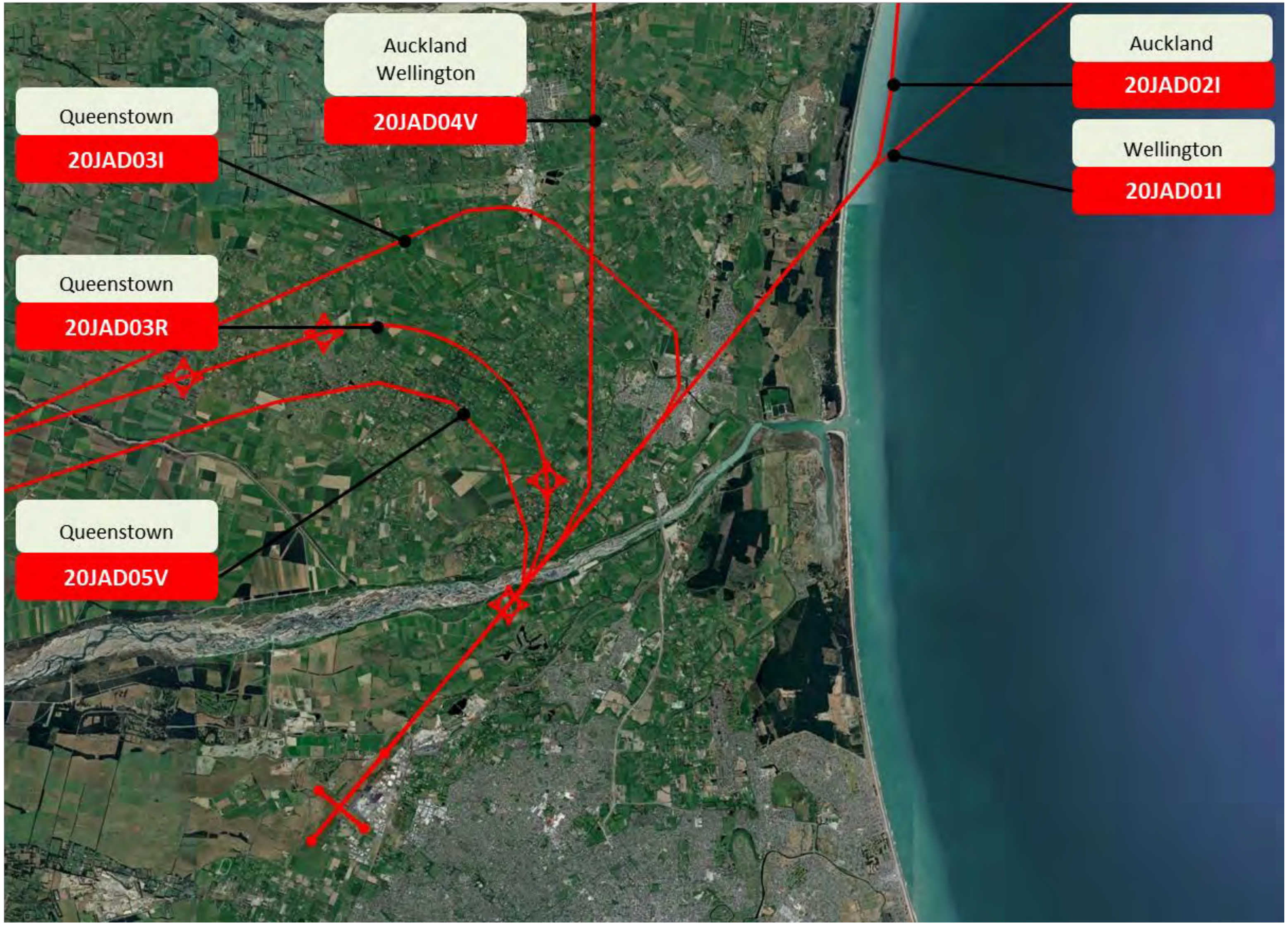


Figure 05-20 Runway 20 Jet Domestic Arrival Adopted Flight Tracks

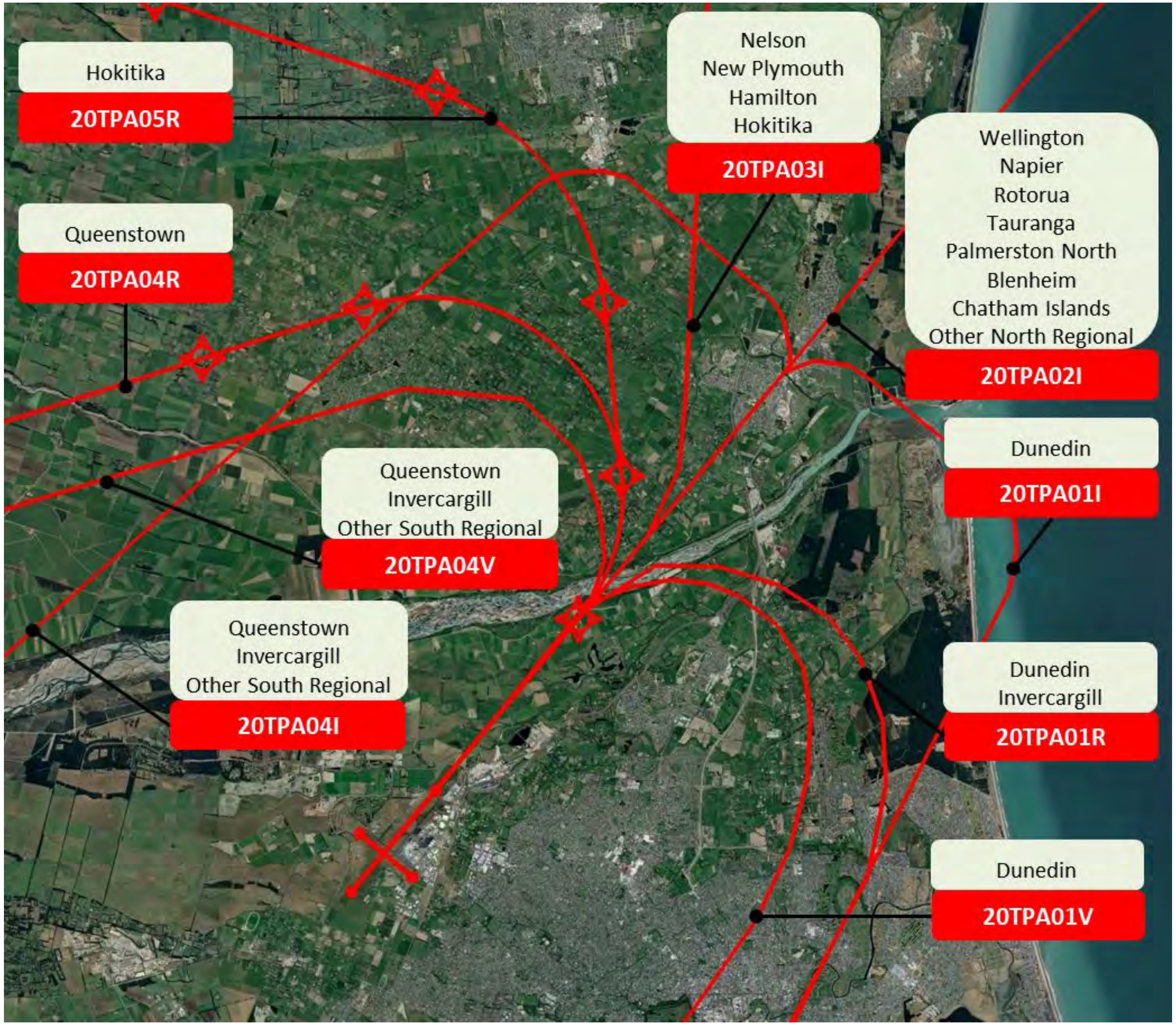


Figure 05-21 Runway 20 TP Domestic Arrival Adopted Flight Tracks

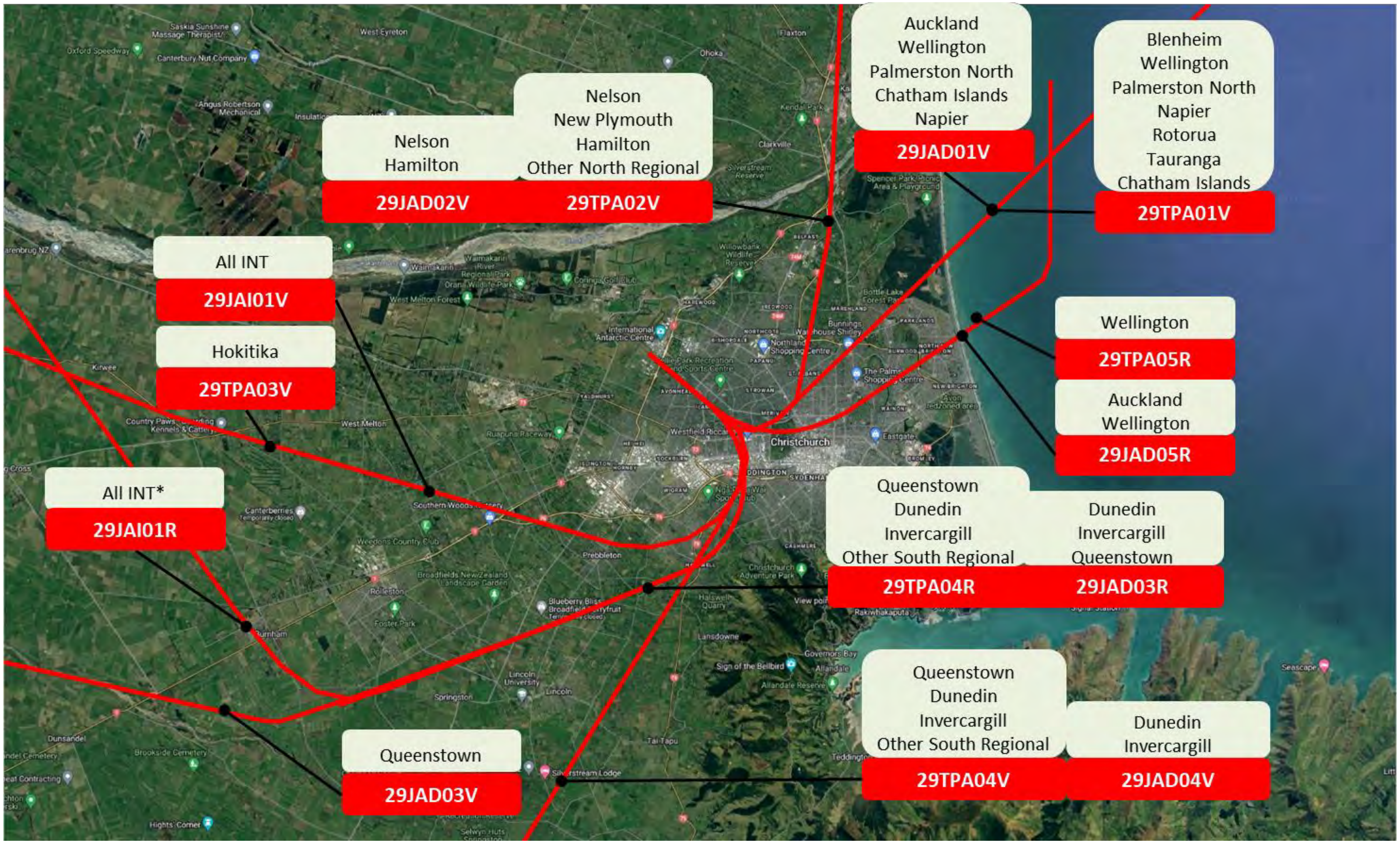


Figure 05-22 Runway 29 Jet and TP Domestic Arrival Adopted Flight Tracks

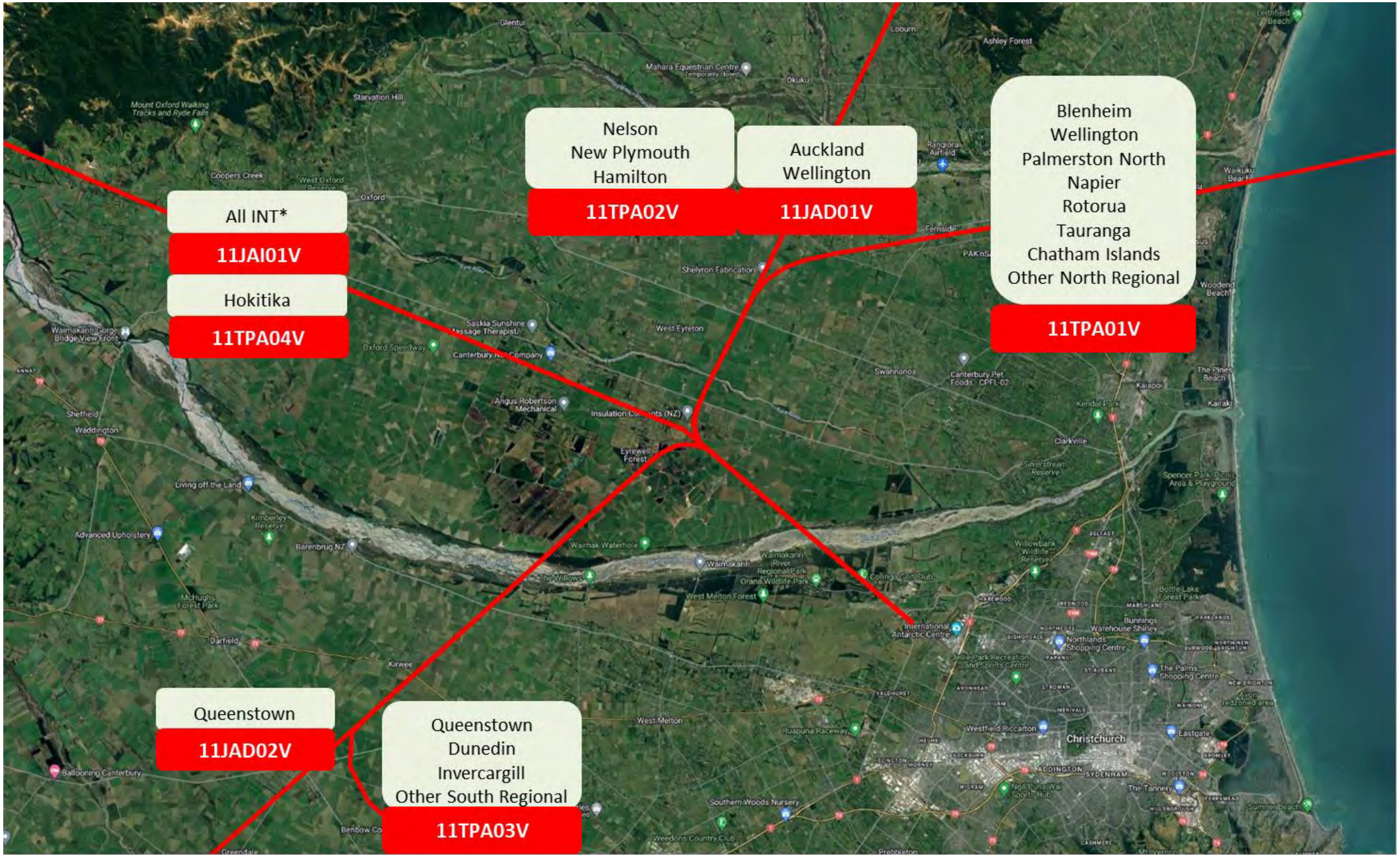
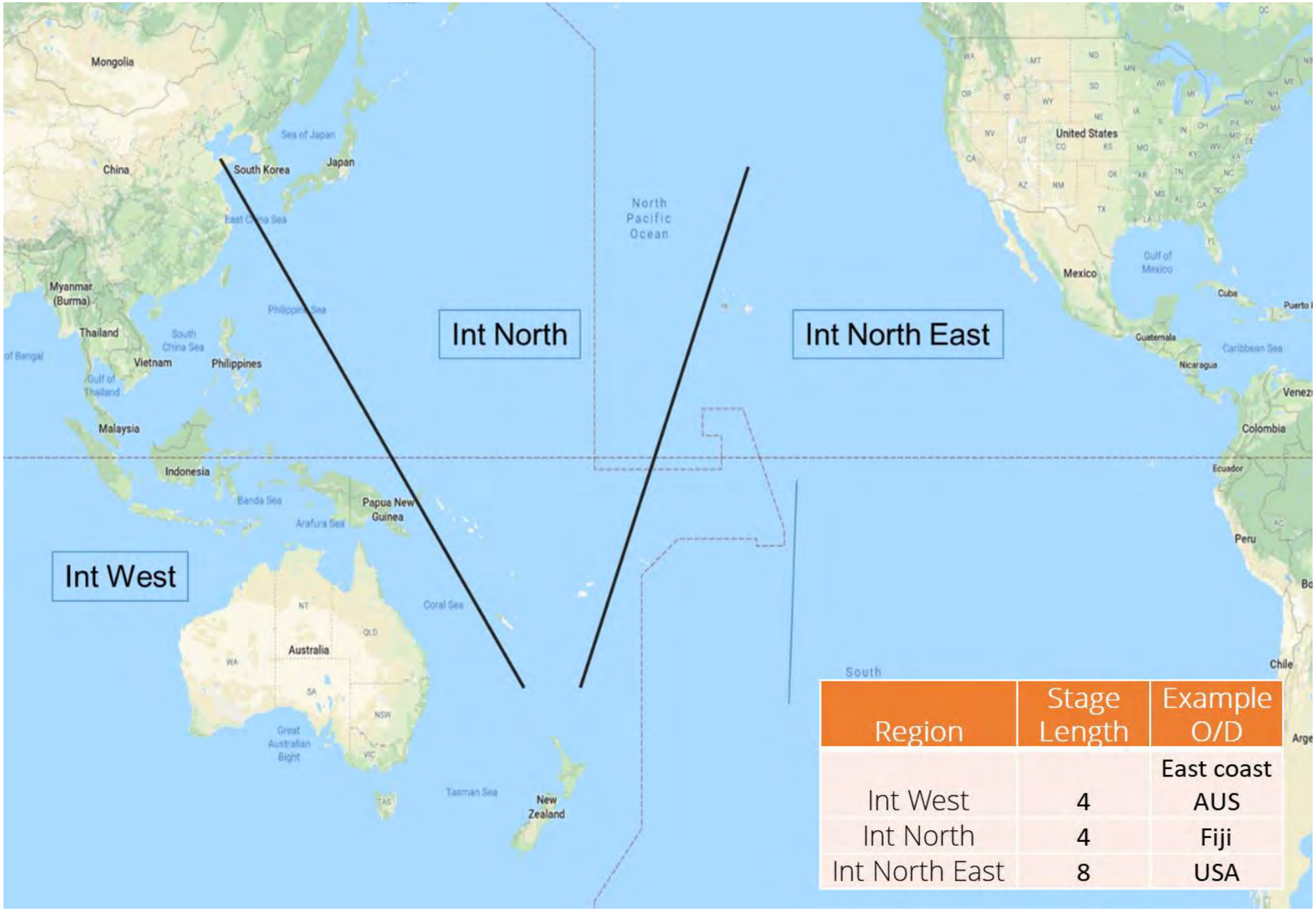


Figure 05-23 Runway 11 Jet and TP Domestic Arrival Adopted Flight Tracks

Other (non-scheduled)Flight Tracks: Backbone and Allocation



Region	Stage Length	Example O/D
Int West	4	East coast AUS
Int North	4	Fiji
Int North East	8	USA

Figure 05-24 Other International Aircraft Regions

Region	Stage Length
Local	1
South Island North	1
South Island South	1
North Island Central	1
North Island East	1
North Island West	1
South Island West	1
Chatham Islands	1
Antarctica	5

Figure 05-25 Other Domestic Aircraft Movement Regions

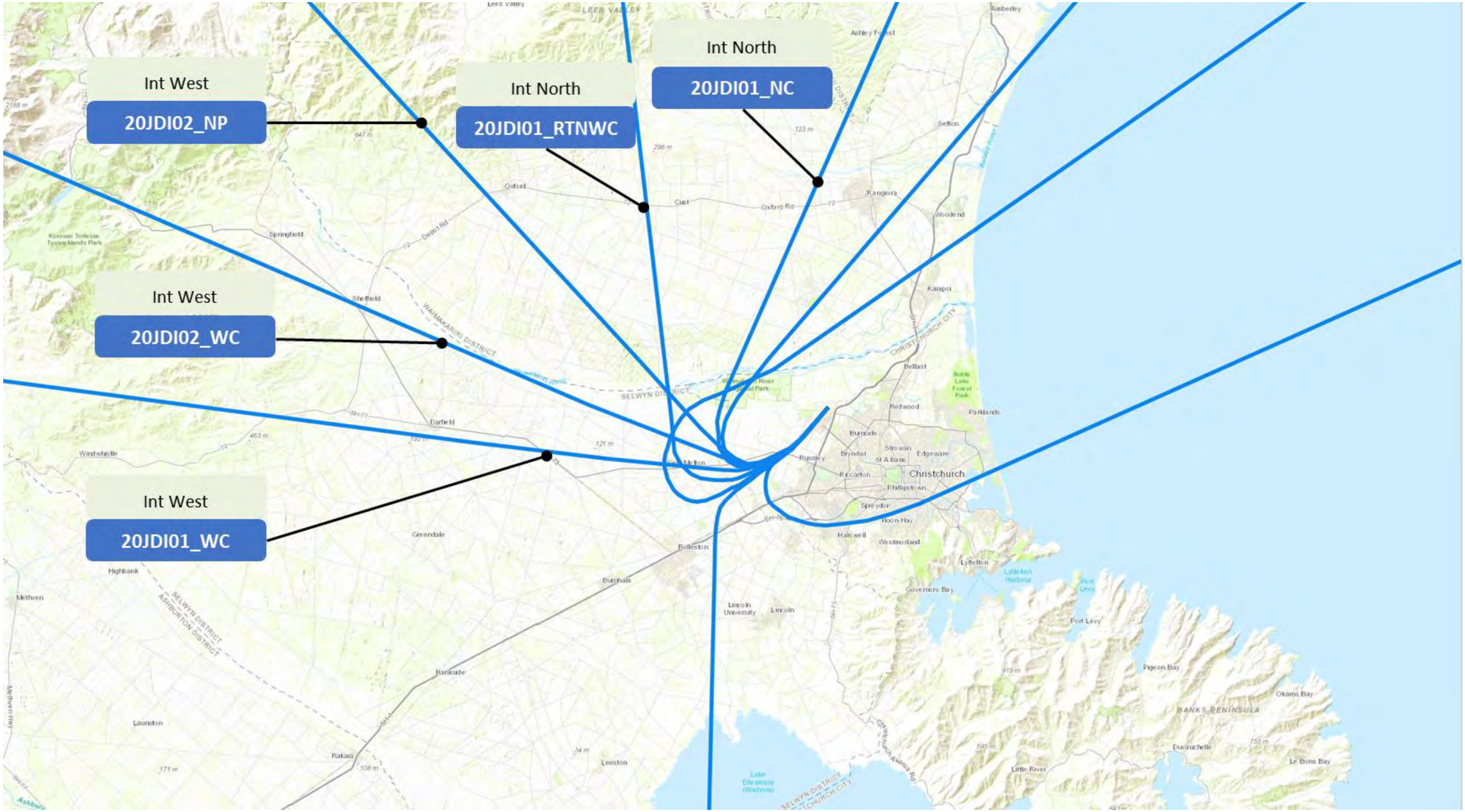


Figure 05-26Runway 20 Jet International Departures

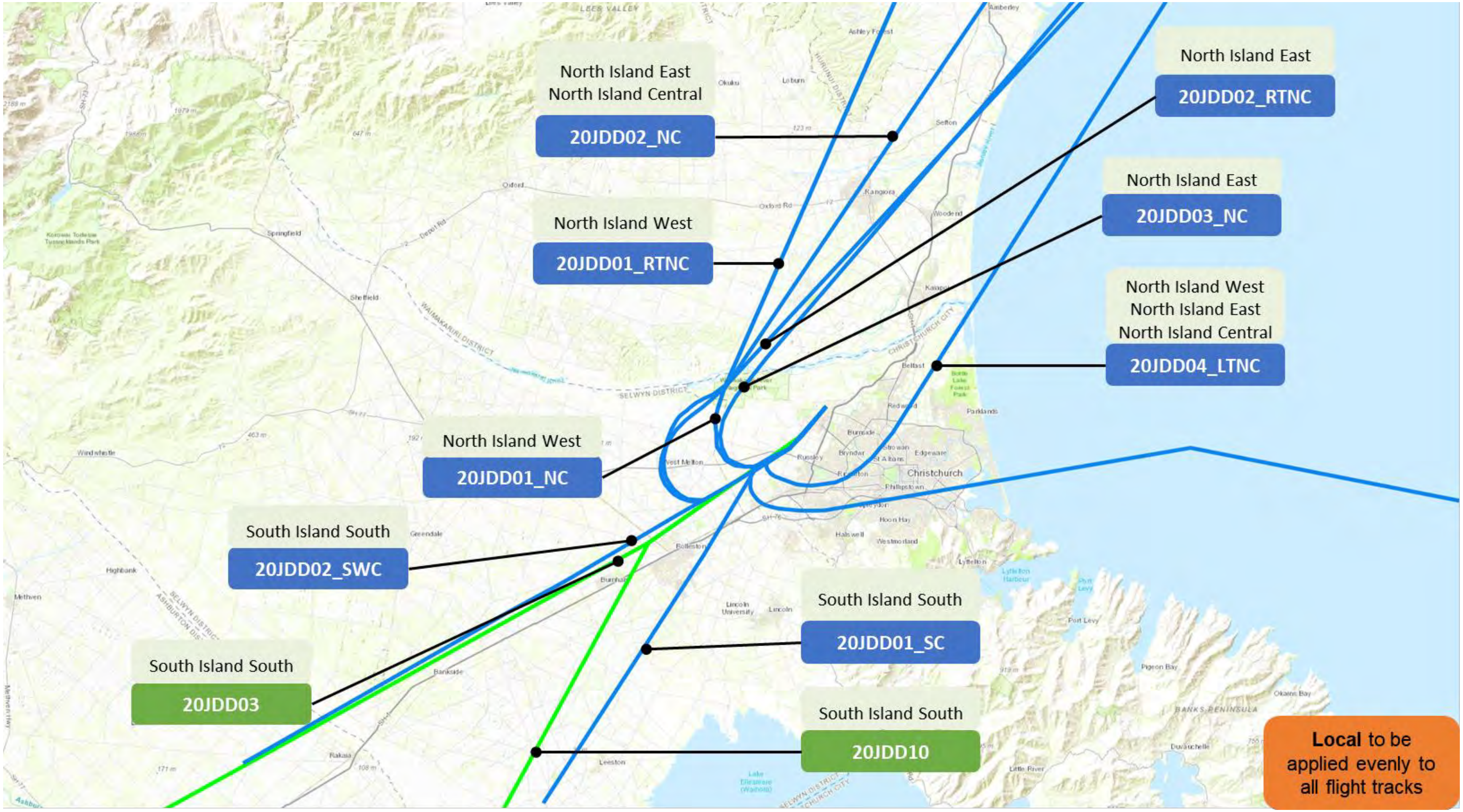


Figure 05-27 Runway 20 Jet Domestic Departures

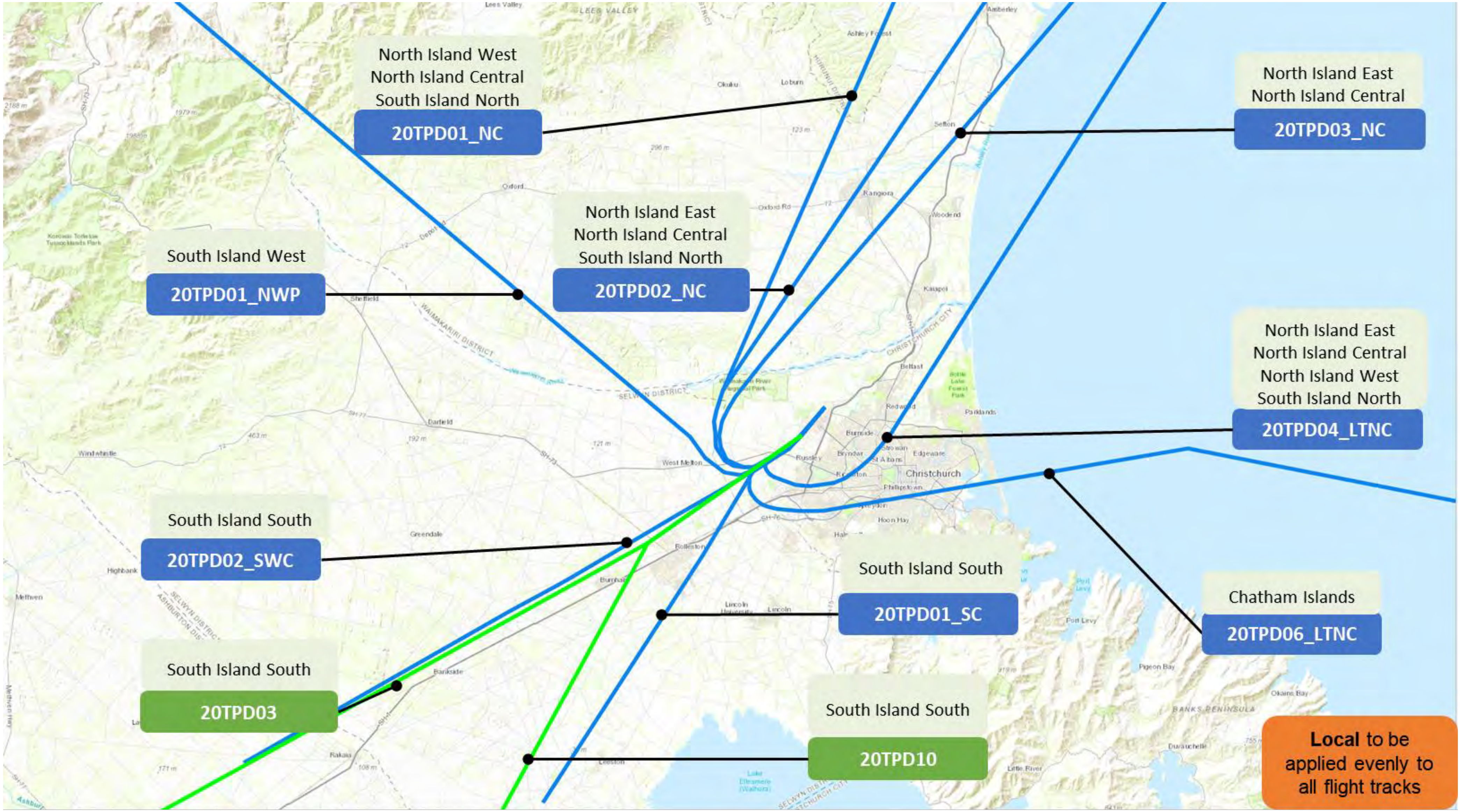


Figure 05-28 Runway 20 TP Domestic Departures

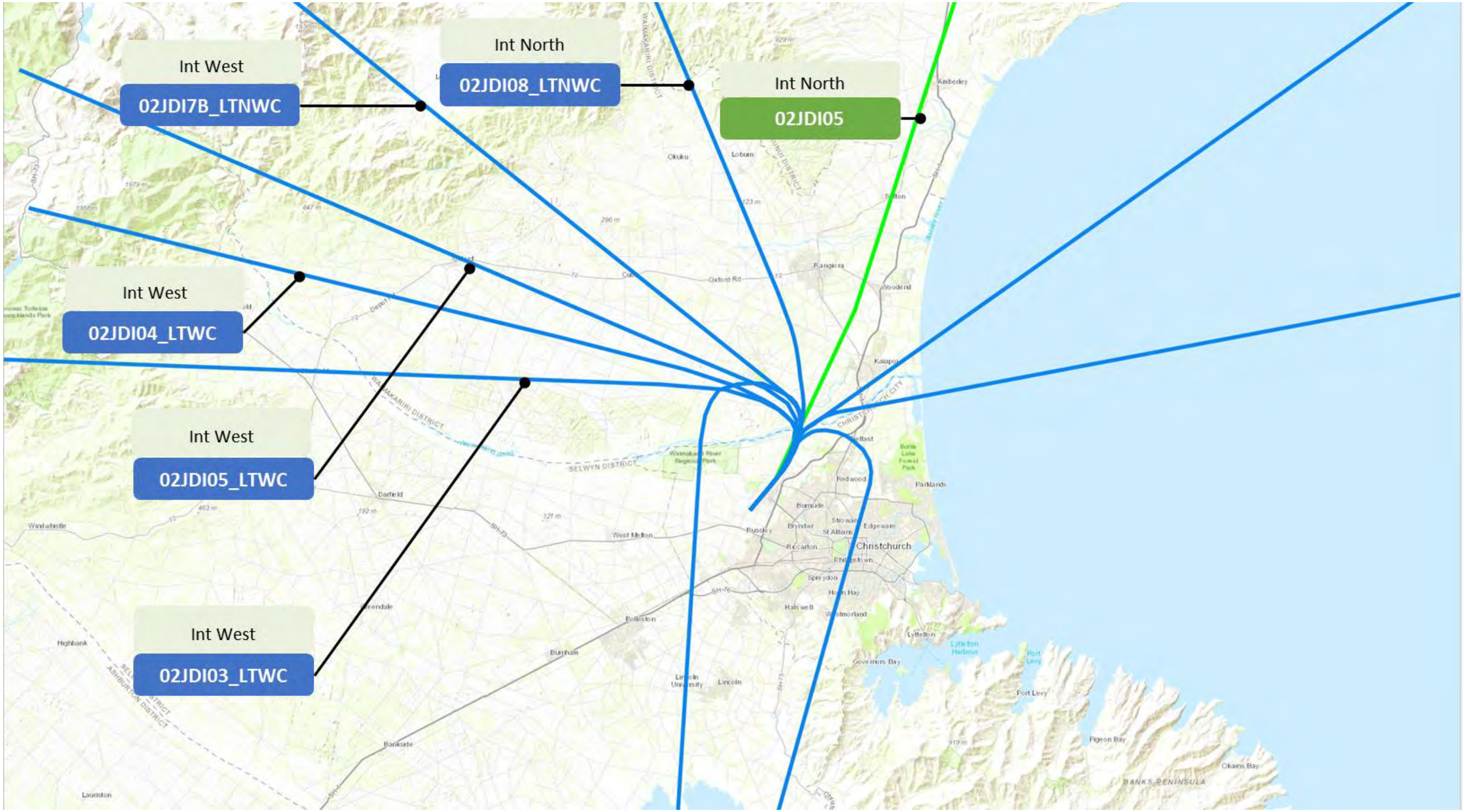


Figure 05-29 Runway 02 Jet International Departures

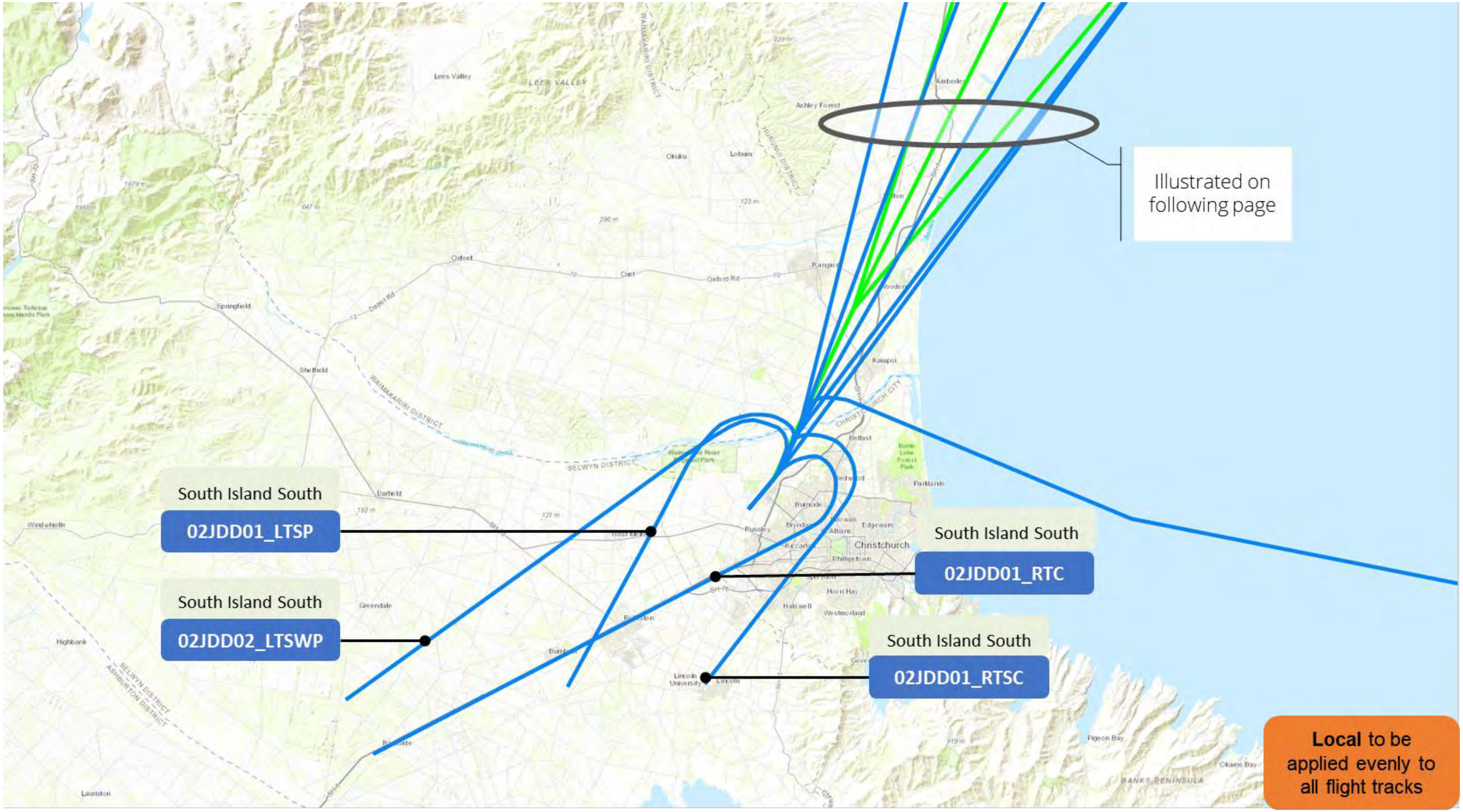


Figure 05-30 Runway 02 Jet Domestic departures

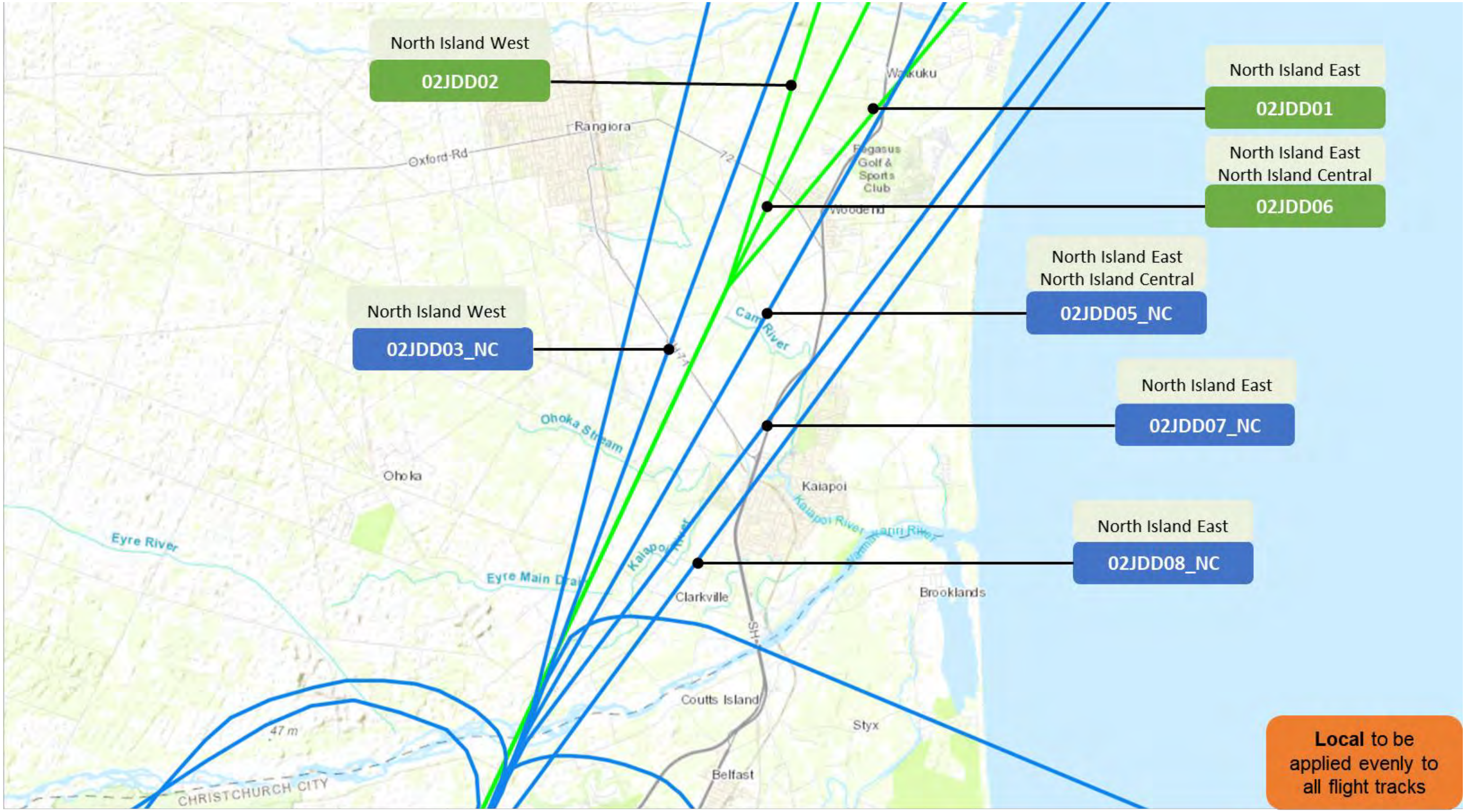


Figure 05-31 Runway 02 Jet Domestic Departures

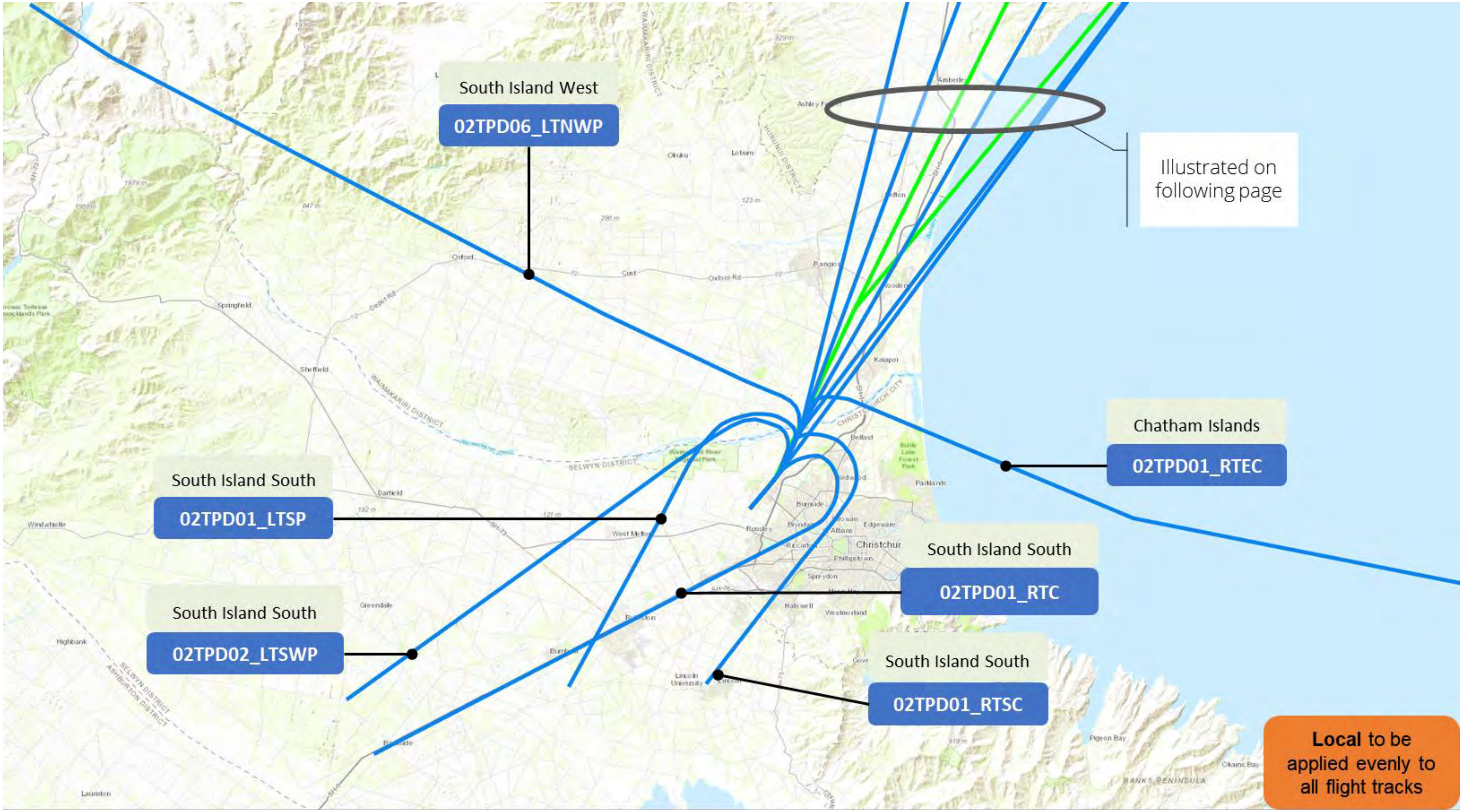


Figure 05-32 Runway 02 TP Domestic Departures

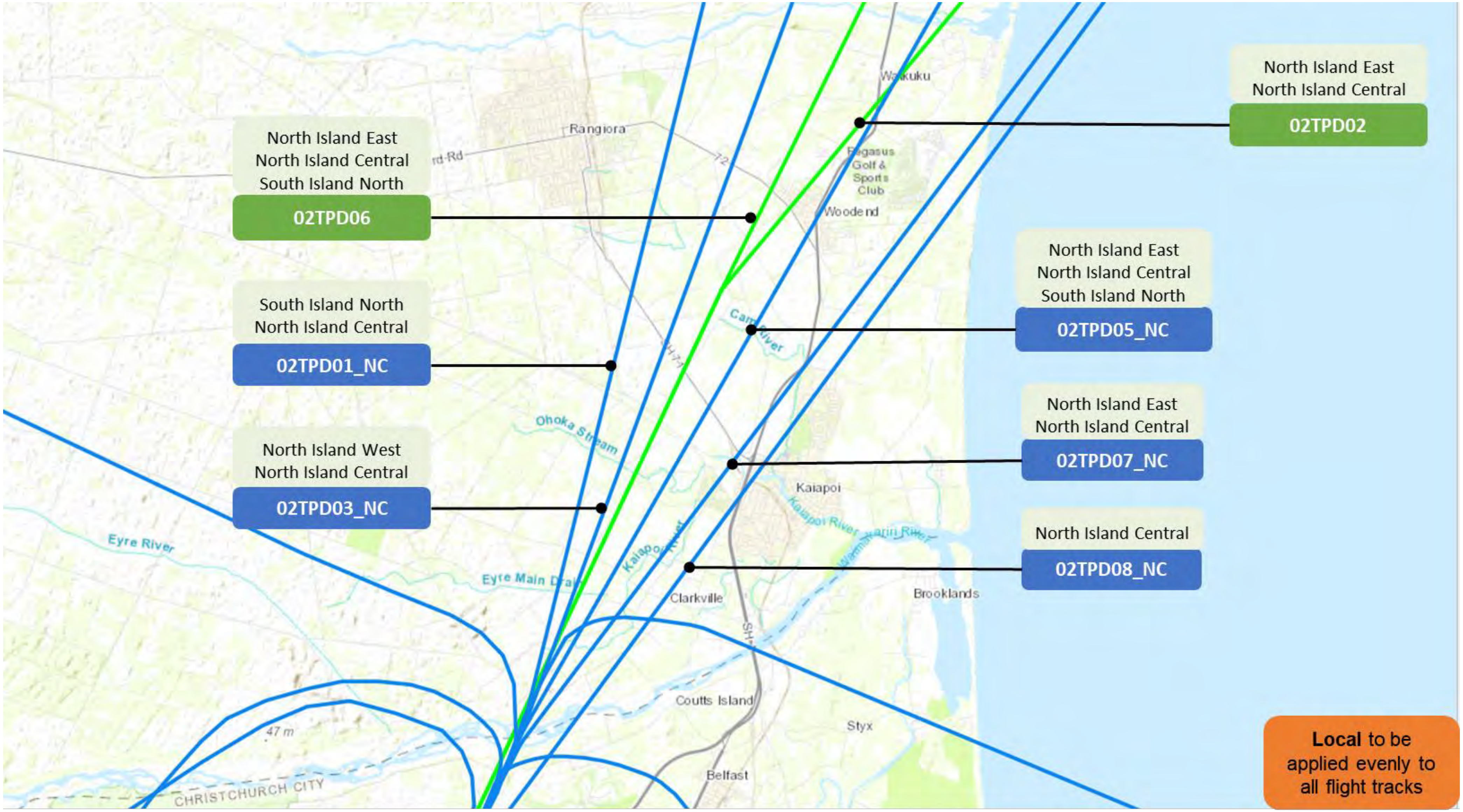


Figure 05-33 Runway 02 TP Domestic Departures

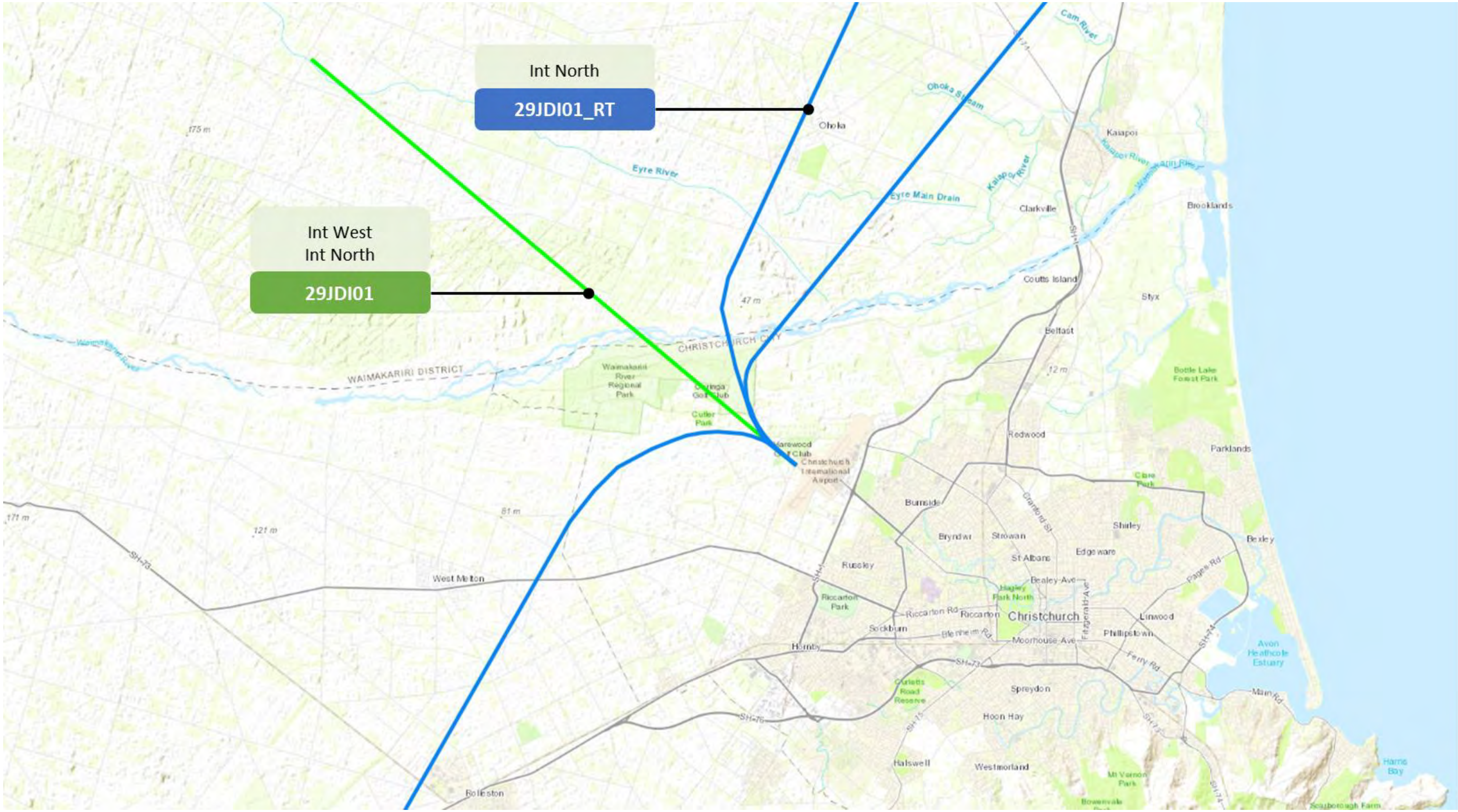


Figure 05-34 Runway 29 Jet International Departures

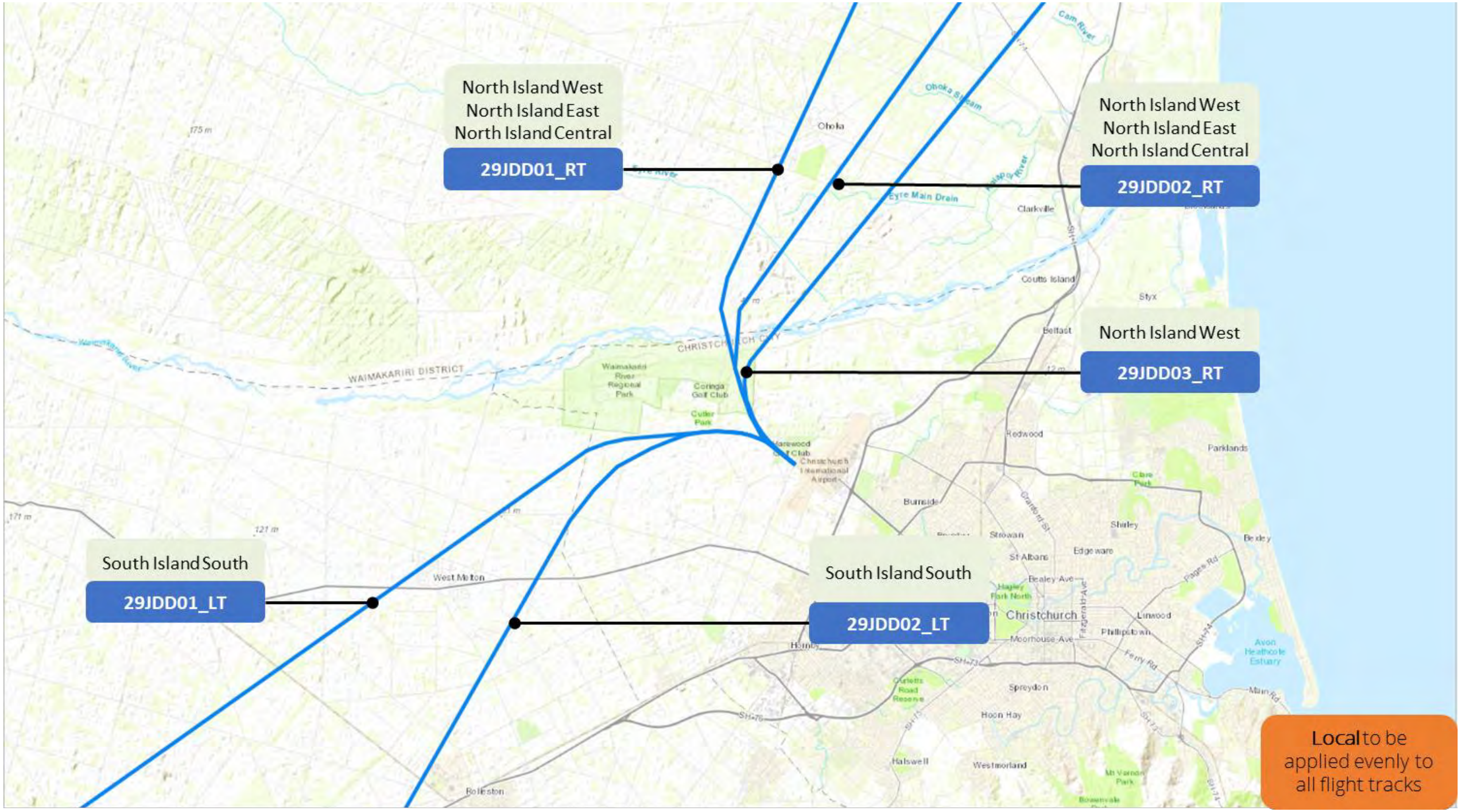


Figure 05-35 Runway 29 Jet Domestic Departures

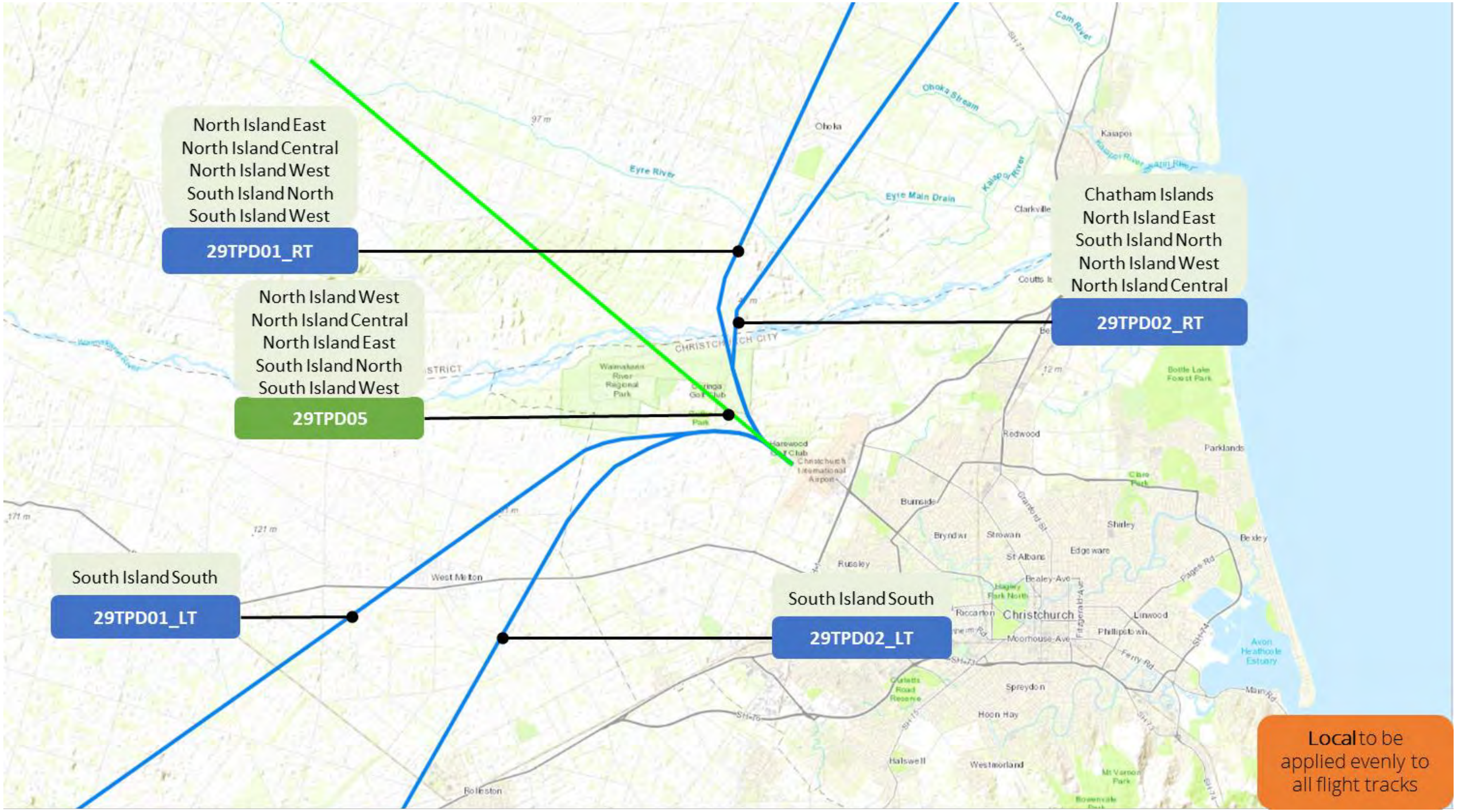


Figure 05-36 Runway 29 TP Domestic Departures

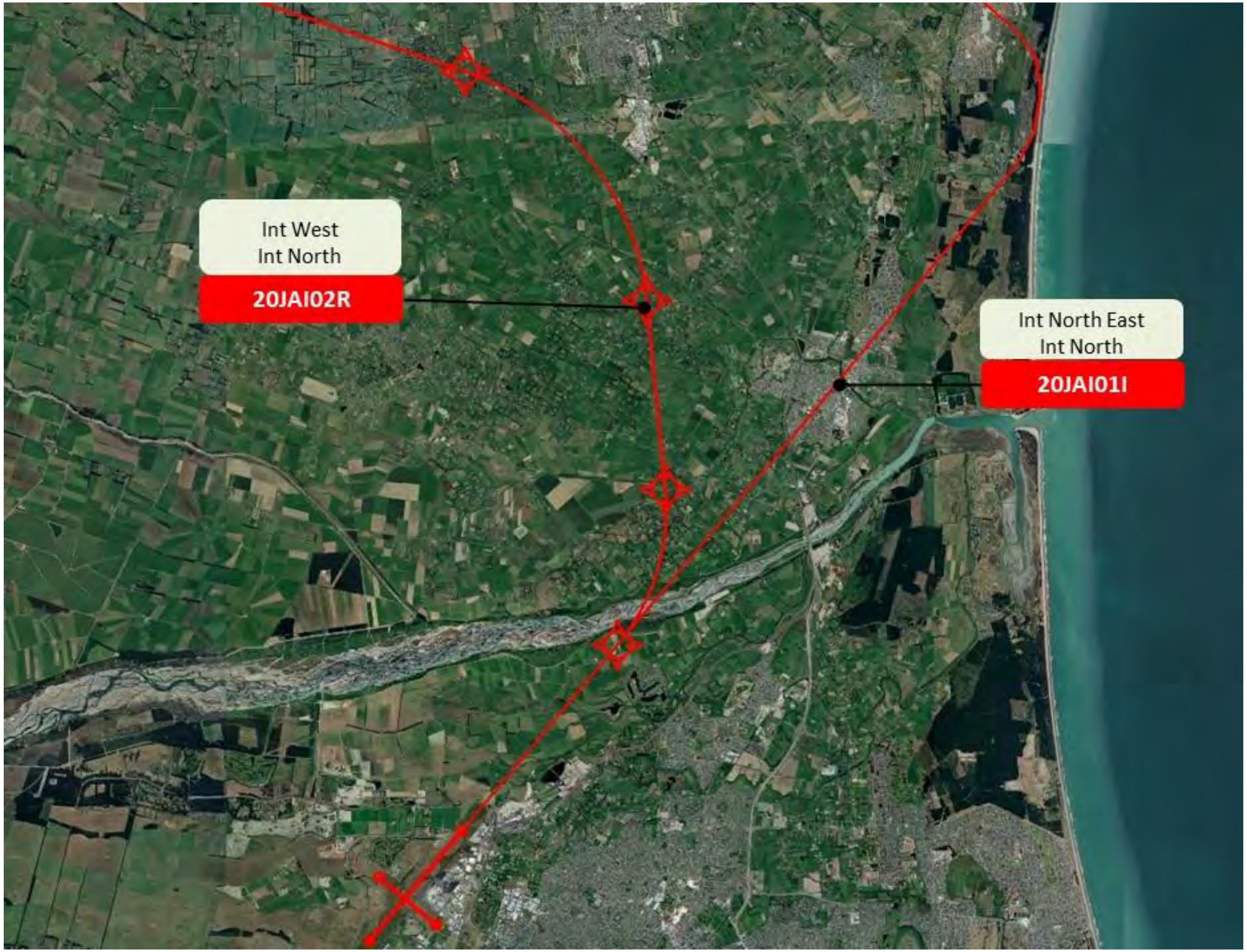


Figure 05-37 Runway 20 Jet International Arrivals

Figure 05-38 Runway 20 Jet Domestic Arrivals

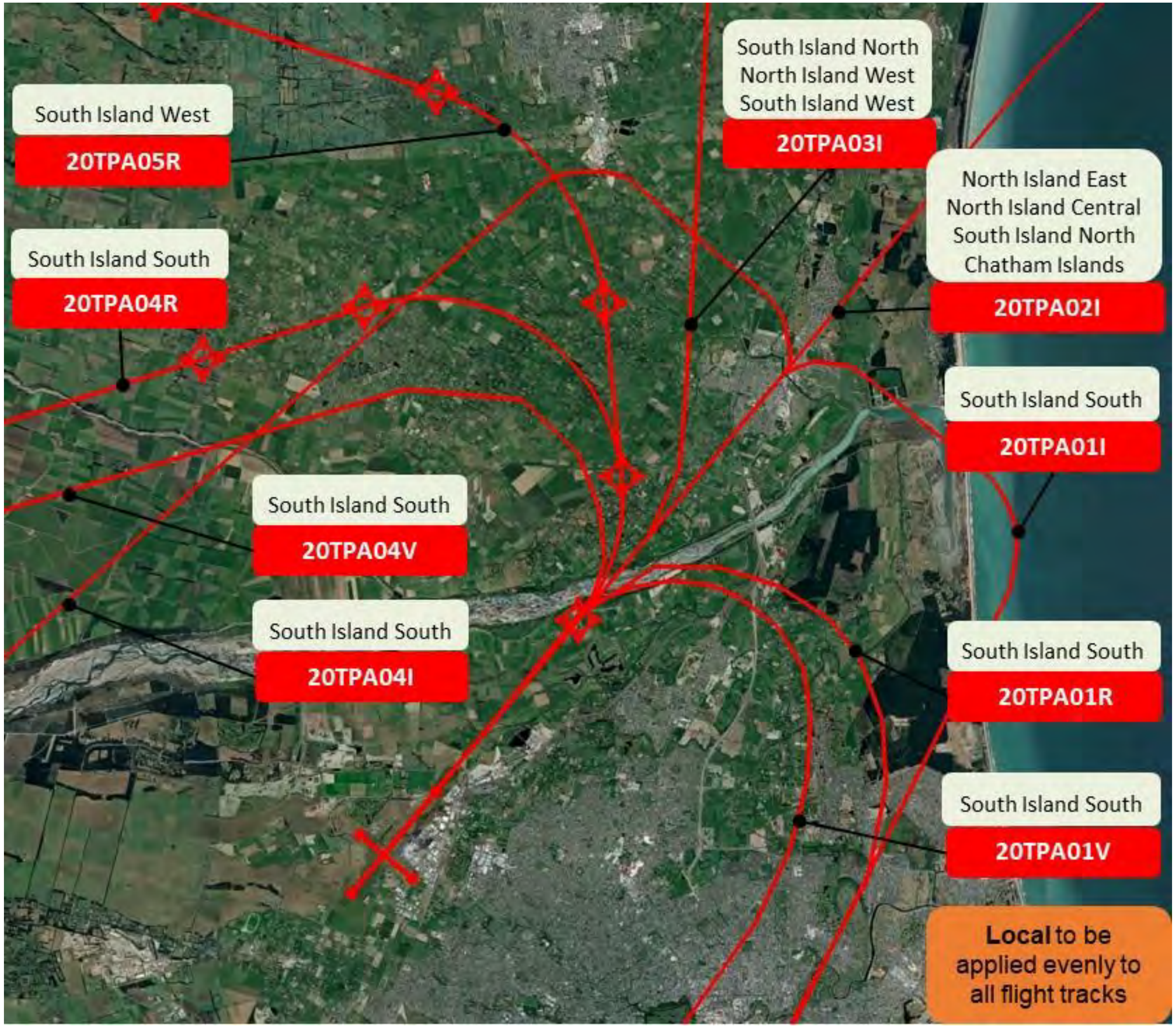


Figure 05-39 Runway 20 TP Domestic Arrivals

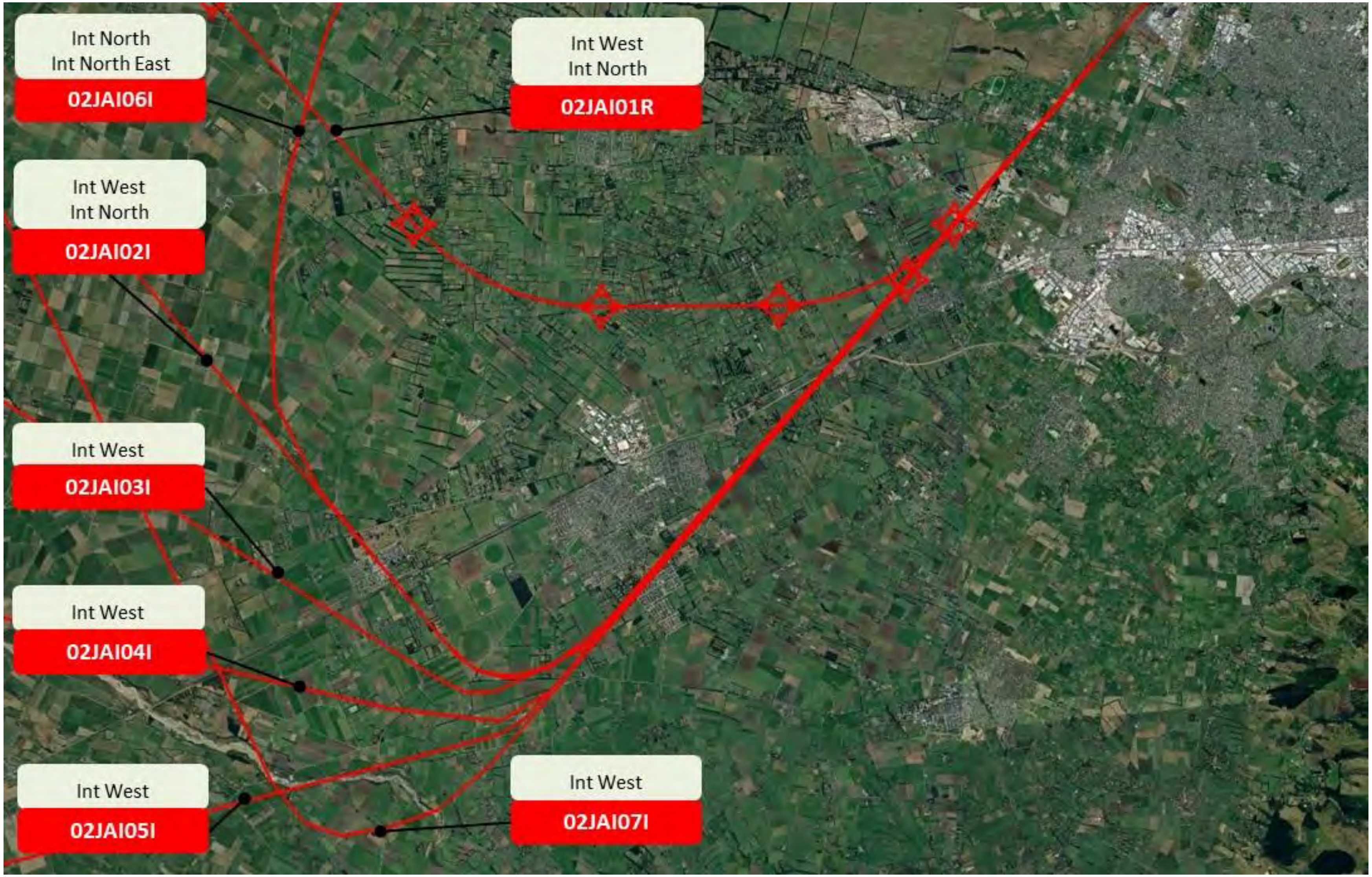


Figure 05-40 Runway 02 Jet International Arrivals

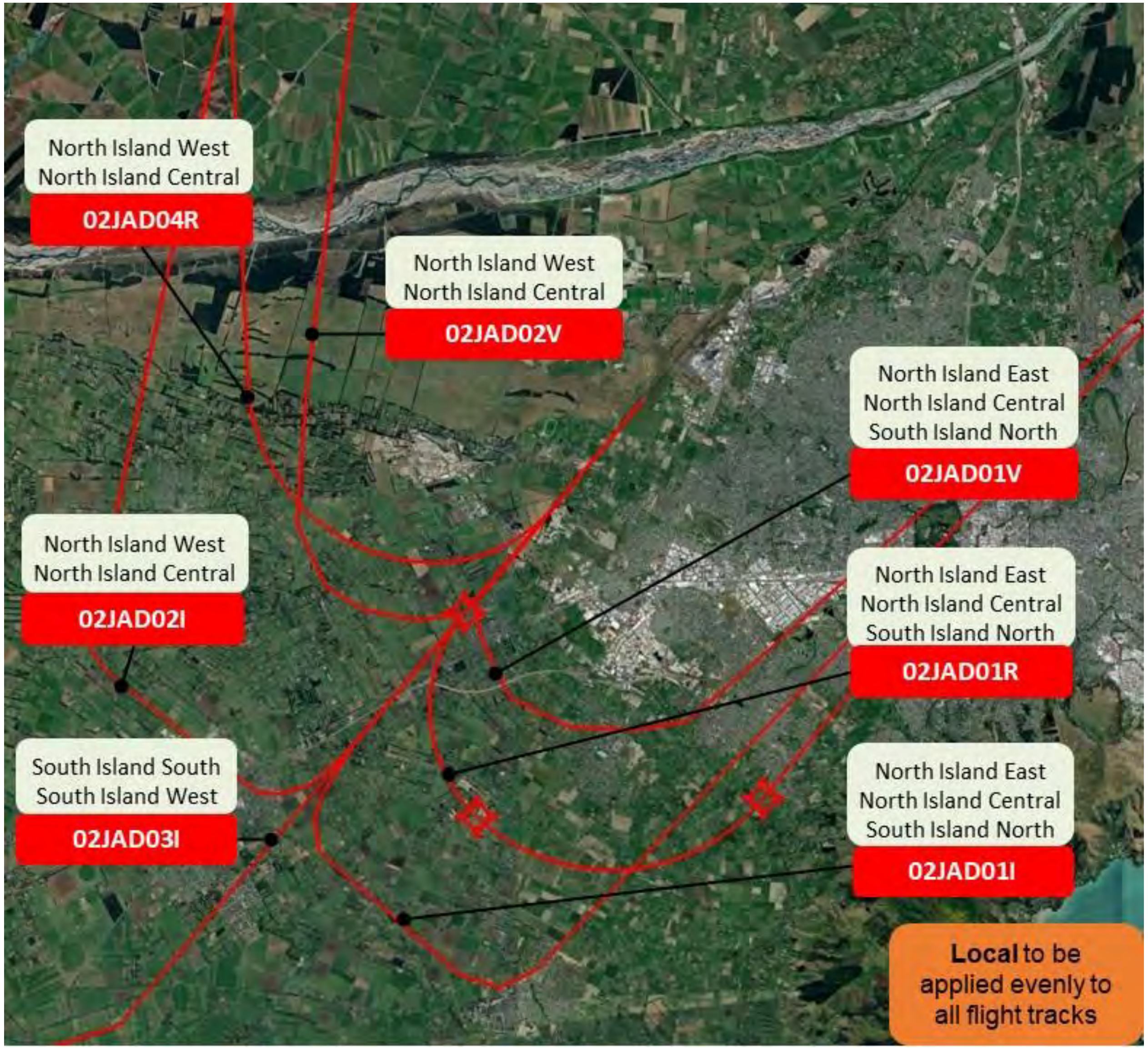


Figure 05-41 Runway 02 Jet Domestic Arrivals

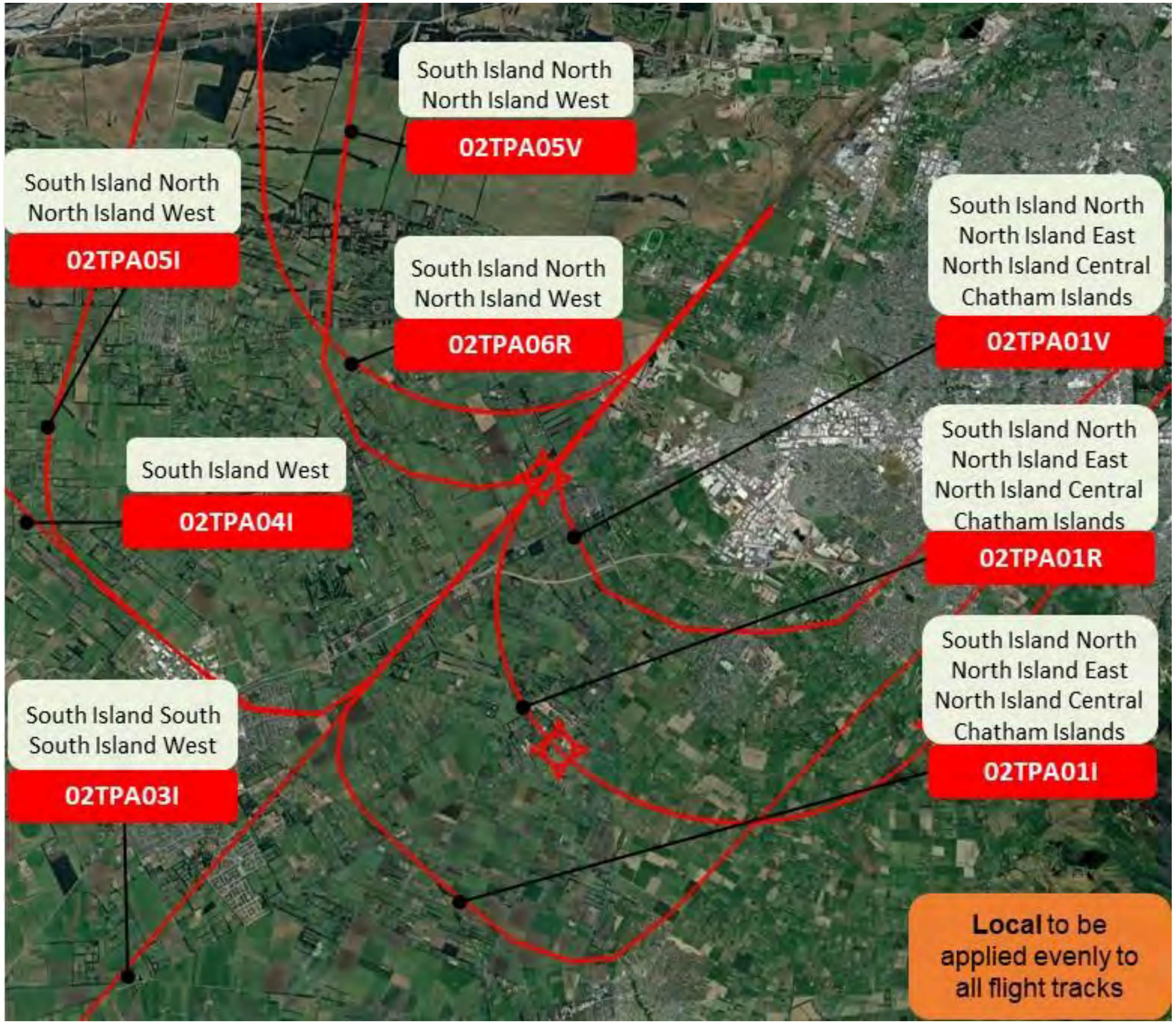


Figure 05-42 Runway 02 TP Domestic Arrivals

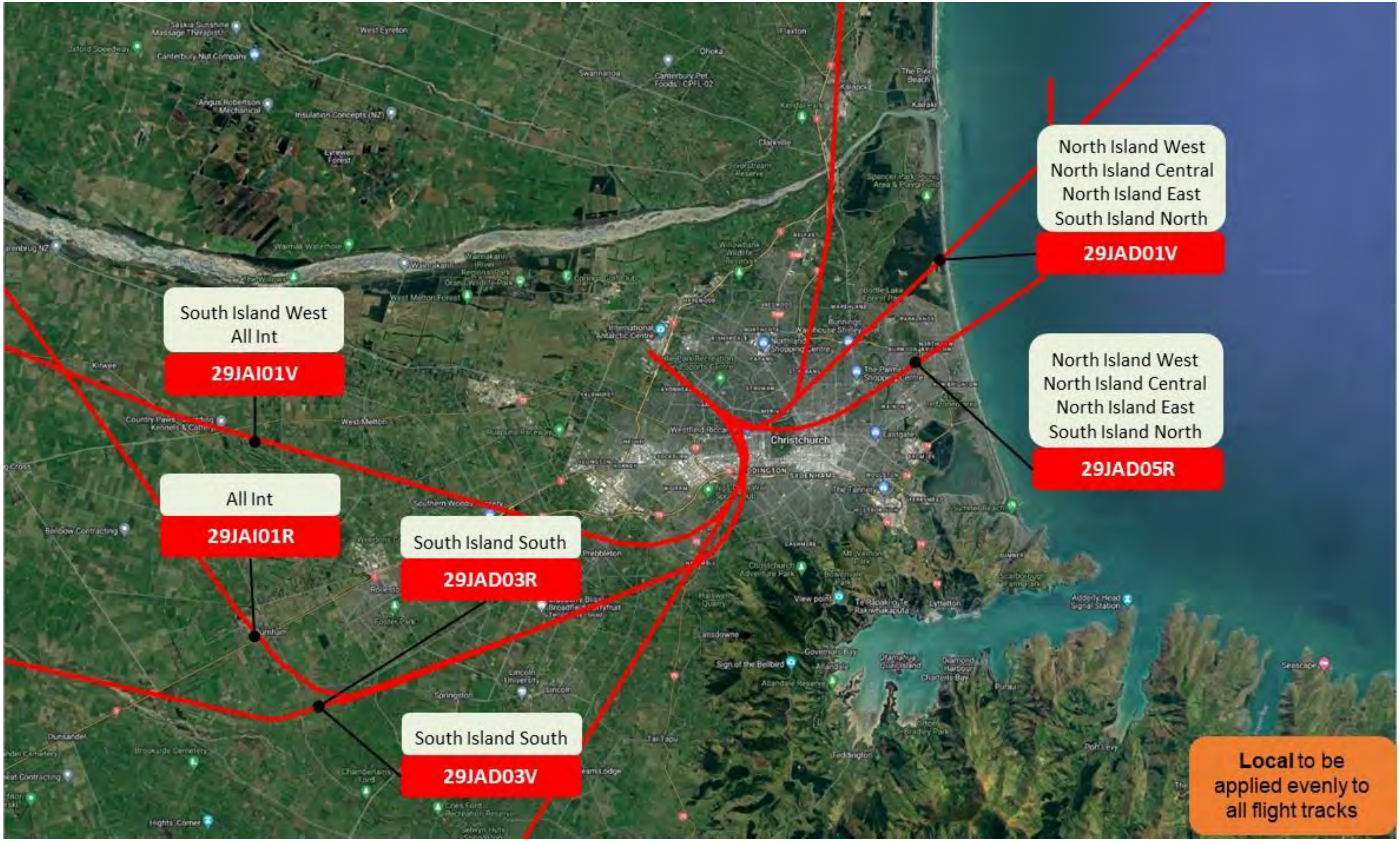


Figure 05-43 Runway 29 Jet Arrivals

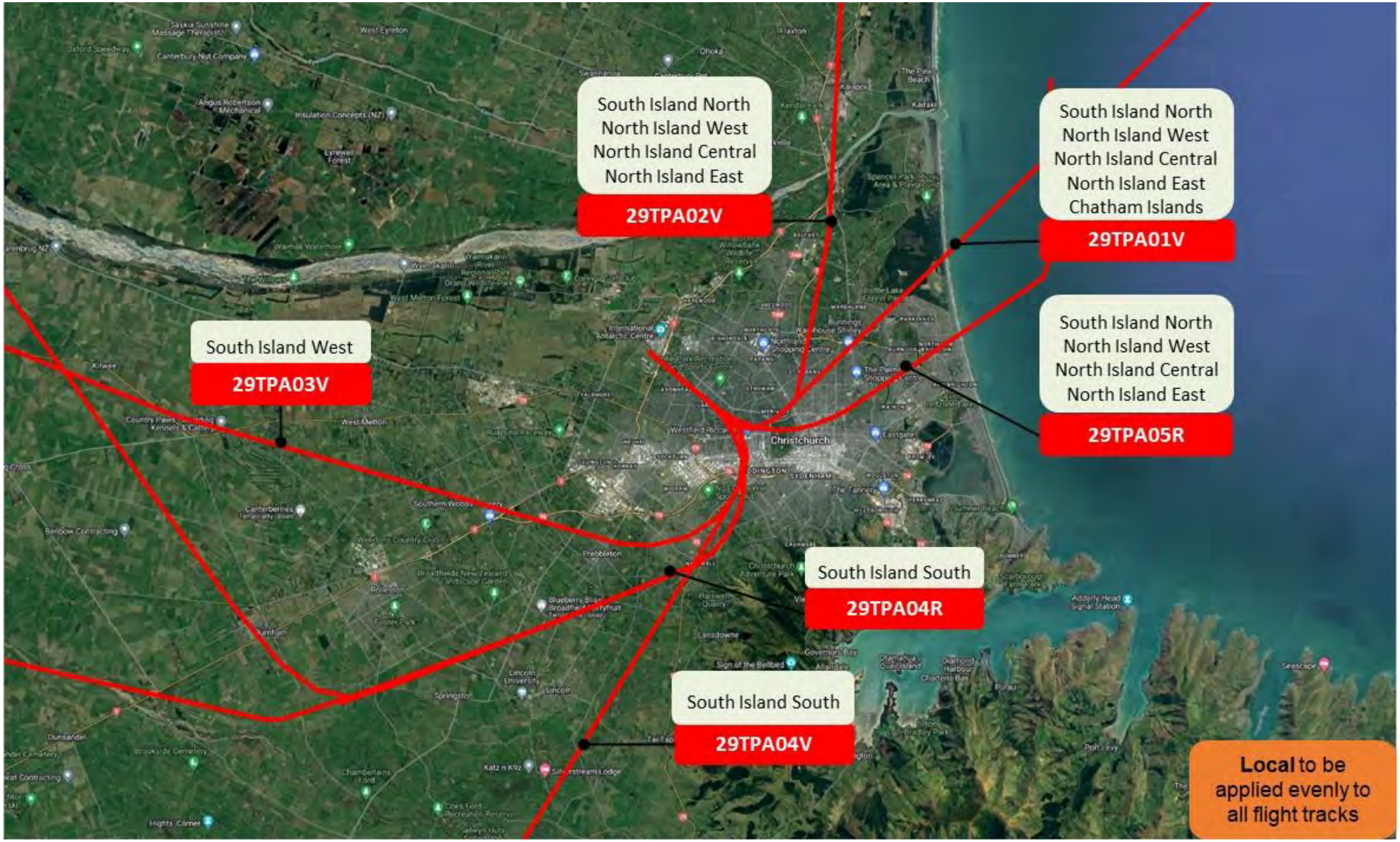


Figure 05-44 Runway 29 TP Arrivals

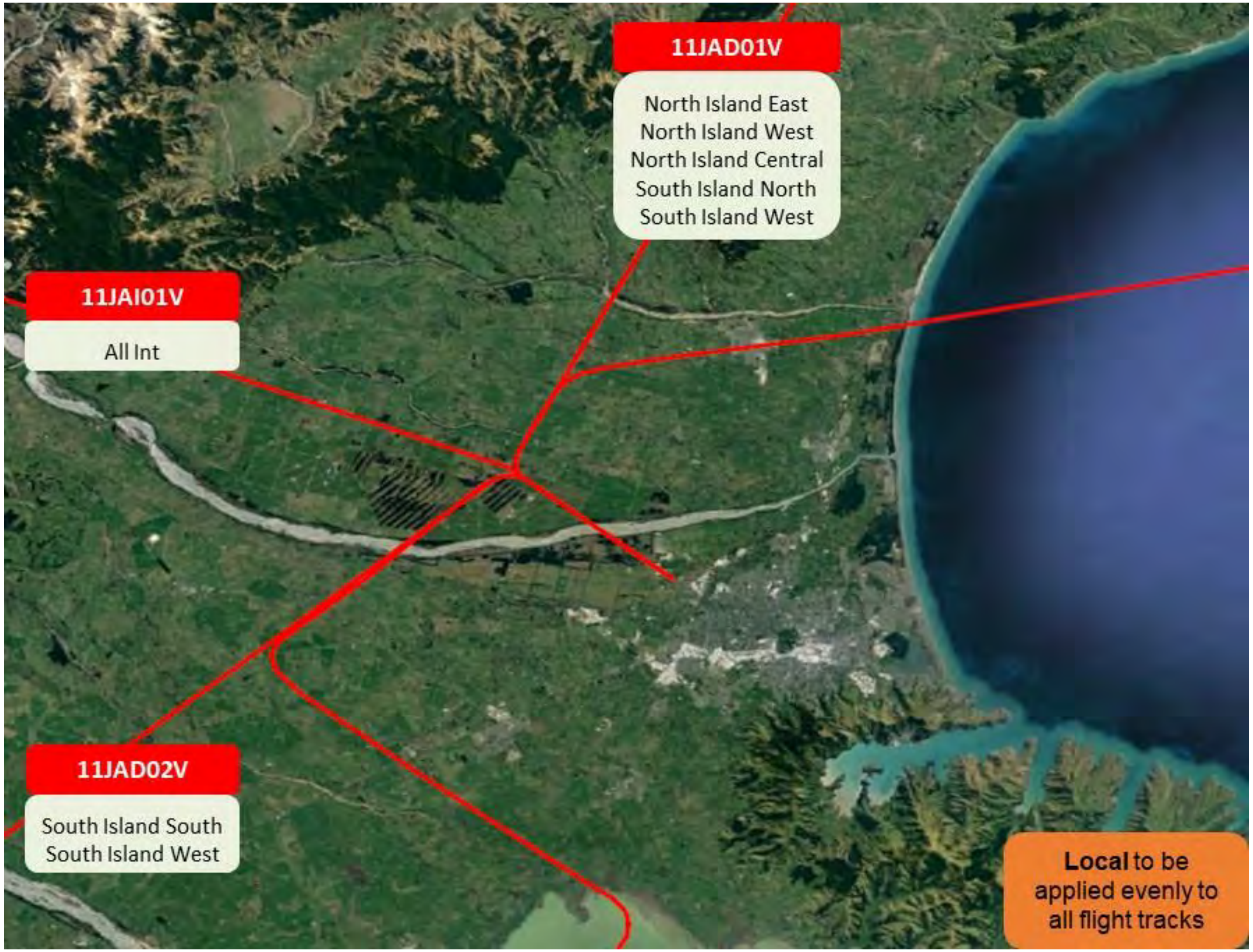


Figure 05-45 Runway 11 Jet Arrivals

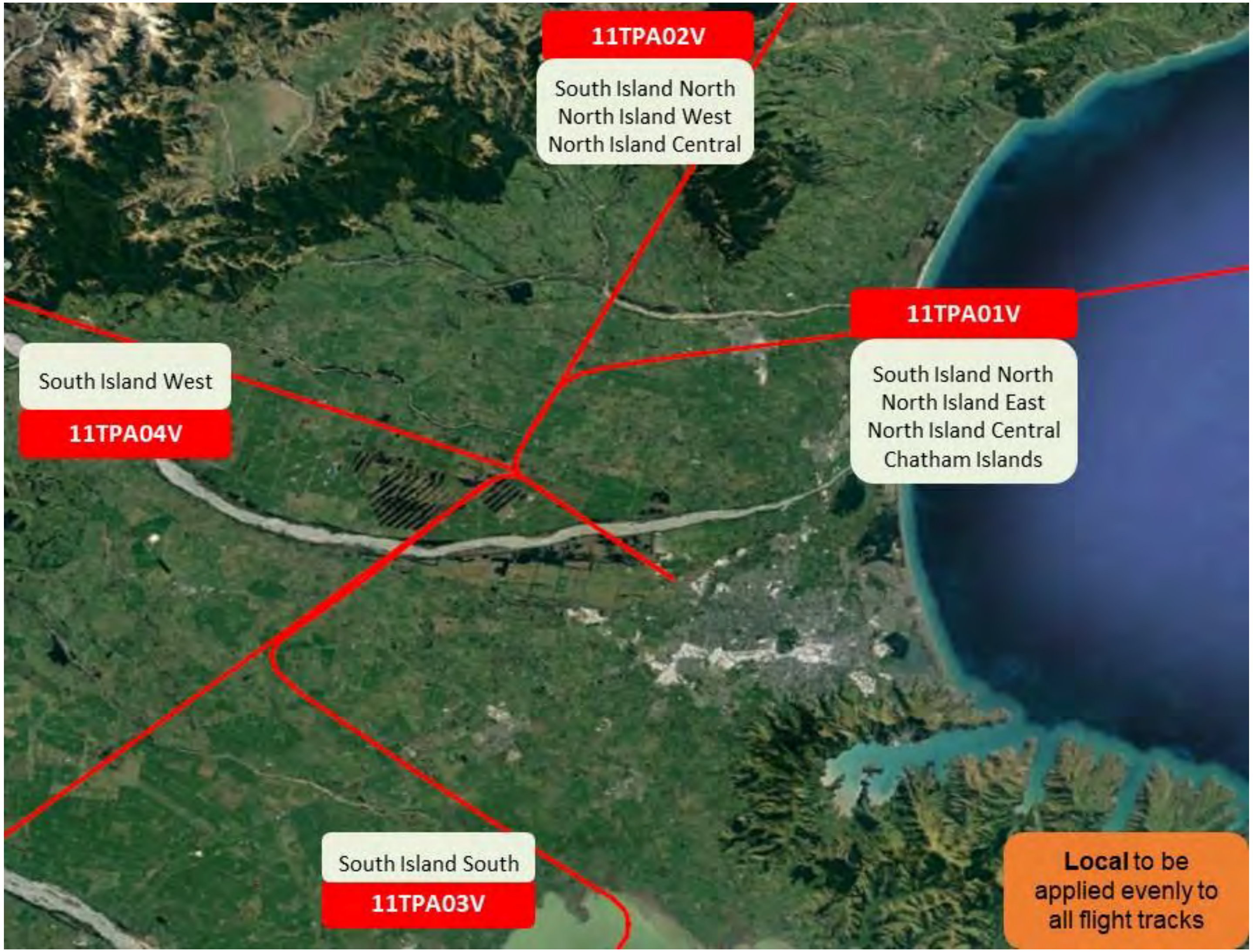


Figure 05-46 Runway 11 TP Arrivals

Helicopter Flight Tracks: Backbone and Allocation

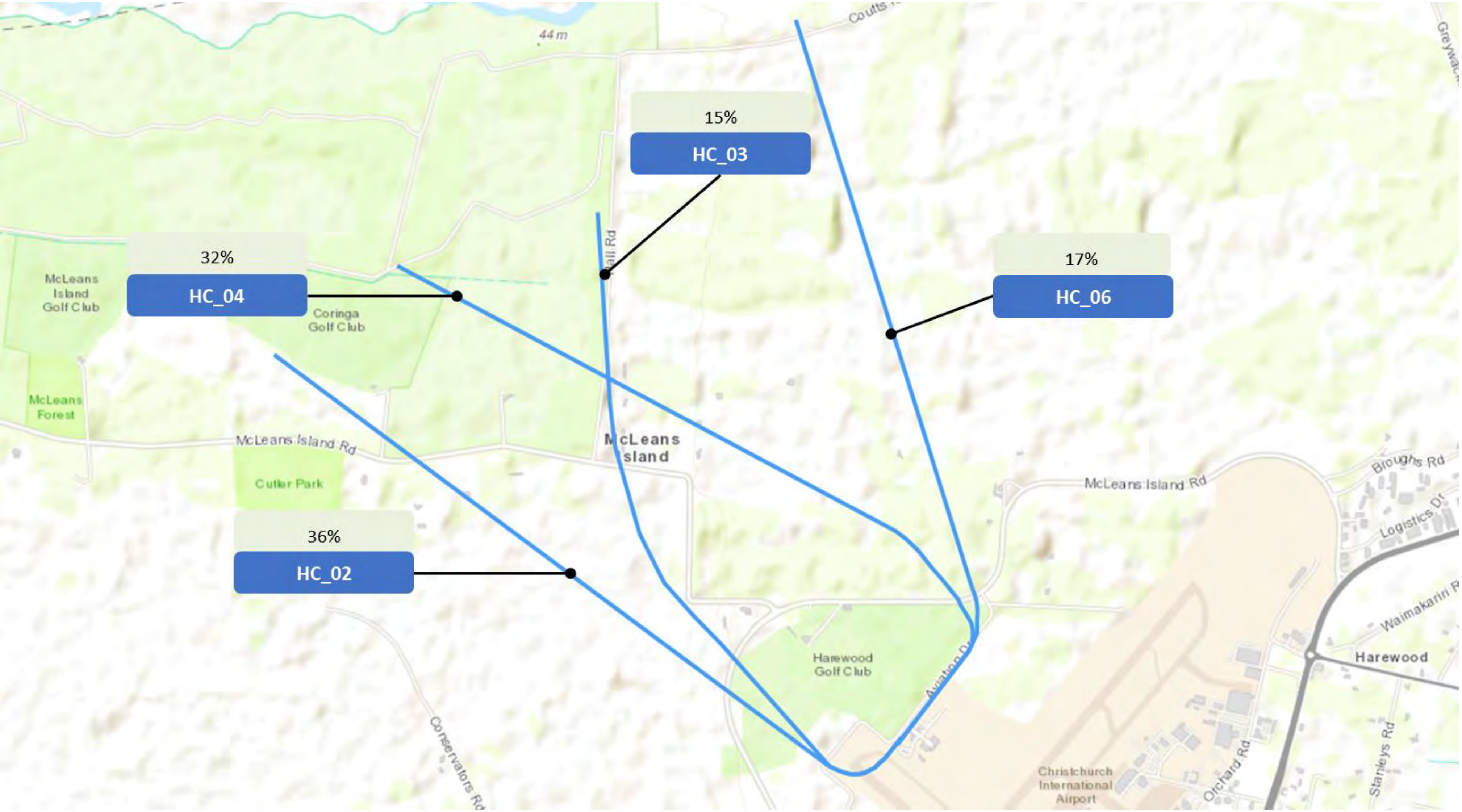


Figure 05-47 Helicopter Arrivals and Departures

Figure 05-48 GCH Arrival and Departures

06. Appendix

Scheduled Departure Flight Track Allocation Splits

Region	Jet Track	% Split
Antarctica	02JDI01_LTSC	40%
	02JDI01_RTSC	60%
North America	02JDI01_NEC	88%
	02JDI02_NEC	12%
Pacific Islands East	02DJI05	100%
Pacific Islands North	02JDI08_LTNWC	30%
	02DJI05	70%
East Asia	02JDI05_LTWC	100%
North East Asia	02JDI7B_LTNWC	100%
Middle East	02JDI03_LTWC	100%
Western Australia	02JDI03_LTWC	100%
Trans-Tasman	02JDI03_LTWC	17%
	02JDI04_LTWC	13%
	02JDI05_LTWC	26%
	02JDI07B_LTNWC	44%
Auckland	02JDD03_NC	32%
	02JDD02	68%
Wellington	02JDD01	16%
	02JDD08_NC	84%
Queenstown	02JDD02_LTSWP	94%
	02JDD01_RTC	6%
Chatham Islands	02JDD01_RTEC	100%
Dunedin	02JDD01_LTSP	69%
	02JDD01_RTSC	31%
Invercargill	02JDD01_LTSP	76%
	02JDD01_RTSC	24%
Napier	02JDD06	29%
	02JDD05_NC	71%
Nelson	02JDD01_NC	100%
Palmerston North	02JDD01	6%
	02JDD07_NC	94%
Hamilton	02JDD03_NC	100%

Table 06-1 Runway 02 Jet Allocation Departures

Region	Turboprop Track	% Split
Antarctica	02TPDI01_LTSC	25%
	02TPDI01_RTSC	75%
Wellington	02TPD02	13%
	02TPD07_NC	87%
Queenstown	02TPD02_LTSWP	94%
	02TPD01_RTC	6%
Chatham Islands	02TPD01_RTEC	100%
Dunedin	02TPD01_LTSP	69%
	02TPD01_RTSC	31%
Invercargill	02TPD01_LTSP	76%
	02TPD01_RTSC	24%
Napier	02TPD06	29%
	02TPD05_NC	71%
Nelson	02TPD01_NC	100%
Palmerston North	02TPD06	30%
	02TPD05_NC	70%
Hamilton	02TPD03_NC	100%
Blenheim	02TPD06	26%
	02TPD05_NC	74%
New Plymouth	02TPD03_NC	100%
Rotorua	02TPD06	25%
	02TPD05_NC	75%
Tauranga	02TPD06	29%
	02TPD05_NC	71%
Hokitika	02TPD06_LTNWP	100%
Other South Regional	02TPD02_LTSWP	94%
	02TPD01_RTC	6%
Other North Regional	02TPD02	14%
	02TPD06	15%
	02TPD01_NC	14%
	02TPD03_NC	14%
	02TPD05_NC	15%
	02TPD07_NC	14%
	02TPD08_NC	14%

Table 06-2 Runway 02 TP Allocation Departures

Jet		
Region	Track	% Split
North America	20JDI02_RTNEC	77%
	20JDI05_LTNEC	23%
Pacific Islands East	20JDI03_NC	53%
	20JDI01_NC	47%
Pacific Islands North	20JDI01_RTNWC	22%
	20JDI01_NC	78%
East Asia	20JDI02_NP	100%
North East Asia	20JDI02_NP	100%
Middle East	20JDI01_WC	100%
Western Australia	20JDI01_WC	100%
Trans-Tasman	20JDI01_WC	21%
	20JDI02_WC	46%
	20JDI02_NP	33%
Antarctica	20JDI02_SC	100%
Auckland	20JDD01_NC	85%
	20JDD04_LTNC	5%
	20JDD01_RTNC	10%
Wellington	20JDD03_NC	68%
	20JDD04_LTNC	25%
	20JDD02_RTNC	7%
Queenstown	20JDD02_SWC	27%
	20JDD03	73%
Chatham Islands	20JDD06_LTNC	100%
Dunedin	20JDD10	6%
	20JDD01_SC	94%
Invercargill	20JDD10	10%
	20JDD01_SC	90%
Napier	20JDD04_LTNC	18%
	20JDD02_NC	82%
Nelson	20JDD01_NC	100%
Palmerston North	20JDD03_NC	100%
Hamilton	20JDD04_LTNC	10%
	20JDD01_NC	90%

Table 06-3 Runway 20 Jet Allocation Departures

Turboprop		
Region	Track	% Split
Antarctica	20TPDI02_SC	100%
Wellington	20TPD04_LTNC	19%
	20TPD03_NC	81%
Queenstown	20TPD03	100%
Chatham Islands	20TPD06_LTNC	100%
Dunedin	20TPD10	6%
	20TPD01_SC	94%
Invercargill	20TPD10	10%
	20TPD01_SC	90%
Napier	20TPD04_LTNC	18%
	20TPD02_NC	82%
Nelson	20TPD01_NC	100%
Palmerston North	20TPD04_LTNC	14%
	20TPD02_NC	86%
Hamilton	20TPD04_LTNC	10%
	20TPD01_NC	90%
Blenheim	20TPD04_LTNC	20%
	20TPD02_NC	80%
New Plymouth	20TPD04_LTNC	7%
	20TPD01_NC	93%
Rotorua	20TPD04_LTNC	14%
	20TPD02_NC	86%
Tauranga	20TPD04_LTNC	11%
	20TPD02_NC	89%
Hokitika	20TPD01_NWP	100%
Other South Regional	20TPD02_SWC	22%
	20TPD03	78%
Other North Regional	20TPD01_NC	25%
	20TPD02_NC	25%
	20TPD03_NC	25%
	20TPD04_LTNC	25%

Table 06-4 Runway 20 TP Allocation Departures

Jet		
Region	**Track**	**% Split**
Antarctica	29JDI02_LT	100%
North America	29JDI03_RT	100%
Pacific Islands East	29JDI03_RT	100%
Pacific Islands North	29JDI01_RT	100%
East Asia	29JDI01	100%
North East Asia	29JDI01	100%
Middle East	29JDI01	100%
Western Australia	29JDI01	100%
Trans-Tasman	29JDI01	100%
Auckland	29JDD01_RT	95%
	29JDD03_RT	5%
Wellington	29JDD01_RT	8%
	29JDD03_RT	92%
Queenstown	29JDD01_LT	100%
Chatham Islands	29JDD02_RT	100%
Dunedin	29JDD02_LT	100%
Invercargill	29JDD01_LT	23%
	29JDD02_LT	77%
Napier	29JDD01_RT	35%
	29JDD02_RT	65%
Nelson	29JDD01_RT	90%
	29JDD02_RT	10%
Palmerston North	29JDD01_RT	29%
	29JDD02_RT	71%
Hamilton	29JDD01_RT	96%
	29JDD02_RT	4%

Table 06-5 Runway 29 Jet Allocations Departures

Turboprop		
Region	**Track**	**% Split**
Antarctica	29TPDI02_LT	100%
Wellington	29TPD01_RT	29%
	29TPD02_RT	71%
Queenstown	29TPD01_LT	100%
Chatham Islands	29TPD02_RT	100%
Dunedin	29TPD02_LT	100%
Invercargill	29TPD01_LT	23%
	29TPD02_LT	77%
Napier	29TPD01_RT	35%
	29TPD02_RT	65%
Nelson	29TPD01_RT	90%
	29TPD02_RT	10%
Palmerston North	29TPD01_RT	29%
	29TPD02_RT	71%
Hamilton	29TPD01_RT	96%
	29TPD02_RT	4%
Blenheim	29TPD01_RT	47%
	29TPD02_RT	53%
New Plymouth	29TPD01_RT	71%
	29TPD02_RT	29%
Rotorua	29TPD01_RT	88%
	29TPD02_RT	12%
Tauranga	29TPD01_RT	88%
	29TPD02_RT	12%
Hokitika	20TPD05	71%
	29TPD01_RT	29%
Other North Regional	20TPD05	34%
	29TPD01_RT	33%
	29TPD02_RT	33%
Other South Regional	29TPD01_LT	100%

Table 06-6 Runway 29 TP Allocations Departures

Scheduled Arrival Flight Track Allocation Splits

	Route & Aircraft		Runway 02																					
			International - Jet							Domestic - Jet							Domestic - Turboprop							
Region	AC_Cat	Region_AC	02JAI01R	02JAI02I	02JAI03I	02JAI04I	02JAI05I	02JAI06I	02JAI07I	02JAD01I	02JAD01R	02JAD01V	02JAD02I	02JAD02V	02JAD03I	02JAD04R	02TPA01I	02TPA01R	02TP01V	02TP03I	02TP04I	02TP05I	02TP05V	02TP06R
Auckland	LNB	Dom_Auckland_LNB											10%	5%		85%								
Auckland	MNB	Dom_Auckland_SWB											10%	5%		85%								
Auckland	MWB	Dom_Auckland_MWB											70%			30%								
Auckland	SWB	Dom_Auckland_SWB											70%			30%								
Wellington	LTP	Dom_Wellington_LTP															20%	75%	5%					
Wellington	MNB	Dom_Wellington_MNB								10%	85%	5%												
East Asia	LWB	Int_East Asia_LWB	30%	70%																				
East Asia	MWB	Int_East Asia_MWB	30%	70%																				
India	MWB	Int_India_MWB																						
Middle East	VLWB	Int_Middle East_VLWB	0%						100%															
North America	MWB	Int_North America_MWB	30%					70%																
Hawaii	SWB	Int_Hawaii_SWB																						
North East Asia	MWB	Int_North East Asia_MWB	30%	70%																				
Pacific Islands East	MNB	Int_Pacific Islands East_MNB	85%					15%																
Pacific Islands North	LNB	Int_Pacific Islands North_LNB	85%					15%																
Pacific Islands North	MNB	Int_Pacific Islands North_MNB	85%					15%																
South East Asia	MWB	Int_South East Asia_MWB																						
Trans-Tasman	LNB	Int_Trans-Tasman_LNB	90%	3%	4.1%	2.9%																		
Trans-Tasman	LWB	Int_Trans-Tasman_LWB	30%	21%	29%	20%																		
Trans-Tasman	SWB	Int_Trans-Tasman_SWB	30%	21%	29%	20%																		
Western Australia	LNB	Int_Western Australia_LNB	85%				15%																	
Blenheim	STP	Reg_Blenheim_STP															20%	75%	5%					
Blenheim	VSTP	Reg_Blenheim_VSTP															20%	75%	5%					
Chatham Islands	MTP	Reg_Chatham Islands_MTP															20%	75%	5%					
Chatham Islands	MNB	Reg_Chatham Islands_MNB															10%	85%	5%					
Dunedin	LTP	Reg_Dunedin_LTP																		100%				
Dunedin	MNB	Reg_Dunedin_MNB													100%									
Hamilton	LTP	Reg_Hamilton_LTP																				20%	5%	75%
Hamilton	MNB	Reg_Hamilton_MNB																				10%	5%	85%
Hokitika	LTP	Reg_Hokitika_LTP																			100%			
Hokitika	MTP	Reg_Hokitika_MTP																			100%			
Invercargill	LTP	Reg_Invercargill_LTP																		100%				
Invercargill	MNB	Reg_Invercargill_MNB													100%									
Napier	LTP	Reg_Napier_LTP															20%	75%	5%					
Napier	MNB	Reg_Napier_MNB															10%	85%	5%					
Nelson	LTP	Reg_Nelson_LTP																				20%	5%	75%
Nelson	MNB	Reg_Nelson_MNB																				10%	5%	85%
New Plymouth	LTP	Reg_New Plymouth_LTP																				20%	5%	75%
Other North Regional	MTP	Reg_Other North Regional_MTP															20%	75%	5%					
Other South Regional	VSTP	Reg_Other South Regional_VSTP																		100%				
Palmerston North	LTP	Reg_Palmerston North_LTP															20%	75%	5%					
Palmerston North	MNB	Reg_Palmerston North_MNB															10%	85%	5%					
Queenstown	LTP	Reg_Queenstown_LTP																		100%				
Queenstown	MNB	Reg_Queenstown_MNB													100%									
Rotorua	LTP	Reg_Rotorua_LTP															20%	75%	5%					
Rotorua	MNB	Reg_Rotorua_MNB																						
Tauranga	MNB	Reg_Tauranga_MNB																						
Tauranga	LTP	Reg_Tauranga_LTP															20%	75%	5%					

Table 06-7 Runway 02 Jet and TP Allocations Arrivals

Route & Aircraft			Runway 11						
			Int - Jet	Dom - Jet		Dom - Turboprop			
Region	AC_Cat	Region_AC	11JAI01V	11JAD01V	11JAD02V	11TPA01V	11TPA02V	11TPA03V	11TPA04V
Auckland	LNB	Dom_Auckland_LNB		100%					
Auckland	MNB	Dom_Auckland_SWB		100%					
Auckland	MWB	Dom_Auckland_MWB		100%					
Auckland	SWB	Dom_Auckland_SWB		100%					
Wellington	LTP	Dom_Wellington_LTP				100%			
Wellington	MNB	Dom_Wellington_MNB		100%					
East Asia	LWB	Int_East Asia_LWB	RWY 02/20						
East Asia	MWB	Int_East Asia_MWB	100%						
India	MWB	Int_India_MWB							
Middle East	VLWB	Int_Middle East_VLWB	RWY 02/20						
North America	MWB	Int_North America_MWB	100%						
Hawaii	SWB	Int_Hawaii_SWB							
North East Asia	MWB	Int_North East Asia_MWB	100%						
Pacific Islands East	MNB	Int_Pacific Islands East_MNB	100%						
Pacific Islands North	LNB	Int_Pacific Islands North_LNB	100%						
Pacific Islands North	MNB	Int_Pacific Islands North_MNB	100%						
South East Asia	MWB	Int_South East Asia_MWB							
Trans-Tasman	LNB	Int_Trans-Tasman_LNB	100%						
Trans-Tasman	LWB	Int_Trans-Tasman_LWB	RWY 02/20						
Trans-Tasman	SWB	Int_Trans-Tasman_SWB	100%						
Western Australia	LNB	Int_Western Australia_LNB	100%						
Blenheim	STP	Reg_Blenheim_STP				100%			
Blenheim	VSTP	Reg_Blenheim_VSTP				100%			
Chatham Islands	MTP	Reg_Chatham Islands_MTP				100%			
Chatham Islands	MNB	Reg_Chatham Islands_MNB				100%			
Dunedin	LTP	Reg_Dunedin_LTP						100%	
Dunedin	MNB	Reg_Dunedin_MNB						100%	
Hamilton	LTP	Reg_Hamilton_LTP					100%		
Hamilton	MNB	Reg_Hamilton_MNB					100%		
Hokitika	LTP	Reg_Hokitika_LTP							100%
Hokitika	MTP	Reg_Hokitika_MTP							100%
Invercargill	LTP	Reg_Invercargill_LTP						100%	
Invercargill	MNB	Reg_Invercargill_MNB						100%	
Napier	LTP	Reg_Napier_LTP				100%			
Napier	MNB	Reg_Napier_MNB				100%			
Nelson	LTP	Reg_Nelson_LTP					100%		
Nelson	MNB	Reg_Nelson_MNB					100%		
New Plymouth	LTP	Reg_New Plymouth_LTP					100%		
Other North Regional	MTP	Reg_Other North Regional_MTP				100%			
Other South Regional	VSTP	Reg_Other South Regional_VSTP						100%	
Palmerston North	LTP	Reg_Palmerston North_LTP				100%			
Palmerston North	MNB	Reg_Palmerston North_MNB				100%			
Queenstown	LTP	Reg_Queenstown_LTP						100%	
Queenstown	MNB	Reg_Queenstown_MNB			100%				
Rotorua	LTP	Reg_Rotorua_LTP				100%			
Rotorua	MNB	Reg_Rotorua_MNB							
Tauranga	MNB	Reg_Tauranga_MNB							
Tauranga	LTP	Reg_Tauranga_LTP				100%			

Table 06-8 Runway 11 Jet and TP Allocations Arrivals

Route & Aircraft			Runway 20																
			Int - Jet		Domestic - Jet						Domestic - Turboprop								
Region	AC_Cat	Region_AC	20JAI01I	20JAI02R	20JAD01I	20JAD02I	20JAD03I	200JAD03R	20JAD04V	20JAD05V	20TPA01I	20TPA01R	20TPA01V	20TPA02I	20TPA03I	20TPA04I	20TPA04R	20TPA04V	20TPA05R
Auckland	LNB	Dom_Auckland_LNB				90%			10%										
Auckland	MNB	Dom_Auckland_SWB				90%			10%										
Auckland	MWB	Dom_Auckland_MWB				100%			0%										
Auckland	SWB	Dom_Auckland_SWB				100%			0%										
Wellington	LTP	Dom_Wellington_LTP												100%					
Wellington	MNB	Dom_Wellington_MNB			90%				10%										
East Asia	LWB	Int_East Asia_LWB	90%	10%															
East Asia	MWB	Int_East Asia_MWB	90%	10%															
India	MWB	Int_India_MWB																	
Middle East	VLWB	Int_Middle East_VLWB	90%	10%															
North America	MWB	Int_North America_MWB	90%	10%															
Hawaii	SWB	Int_Hawaii_SWB																	
North East Asia	MWB	Int_North East Asia_MWB	90%	10%															
Pacific Islands East	MNB	Int_Pacific Islands East_MNB	90%	10%															
Pacific Islands North	LNB	Int_Pacific Islands North_LNB	90%	10%															
Pacific Islands North	MNB	Int_Pacific Islands North_MNB	90%	10%															
South East Asia	MWB	Int_South East Asia_MWB																	
Trans-Tasman	LNB	Int_Trans-Tasman_LNB	90%	10%															
Trans-Tasman	LWB	Int_Trans-Tasman_LWB	90%	10%															
Trans-Tasman	SWB	Int_Trans-Tasman_SWB	90%	10%															
Western Australia	LNB	Int_Western Australia_LNB	90%	10%															
Blenheim	STP	Reg_Blenheim_STP												100%					
Blenheim	VSTP	Reg_Blenheim_VSTP												100%					
Chatham Islands	MTP	Reg_Chatham Islands_MTP												100%					
Chatham Islands	MNB	Reg_Chatham Islands_MNB												100%					
Dunedin	LTP	Reg_Dunedin_LTP									60%	35%	5%						
Dunedin	MNB	Reg_Dunedin_MNB									80%	10%	10%						
Hamilton	LTP	Reg_Hamilton_LTP													100%				
Hamilton	MNB	Reg_Hamilton_MNB													100%				
Hokitika	LTP	Reg_Hokitika_LTP													65%				35%
Hokitika	MTP	Reg_Hokitika_MTP													65%				35%
Invercargill	LTP	Reg_Invercargill_LTP										35%				60%		5%	
Invercargill	MNB	Reg_Invercargill_MNB									80%	10%	10%						
Napier	LTP	Reg_Napier_LTP												100%					
Napier	MNB	Reg_Napier_MNB												100%					
Nelson	LTP	Reg_Nelson_LTP													100%				
Nelson	MNB	Reg_Nelson_MNB													100%				
New Plymouth	LTP	Reg_New Plymouth_LTP													100%				
Other North Regional	MTP	Reg_Other North Regional_MTP												100%					
Other South Regional	VSTP	Reg_Other South Regional_VSTP														95%		5%	
Palmerston North	LTP	Reg_Palmerston North_LTP												100%					
Palmerston North	MNB	Reg_Palmerston North_MNB												100%					
Queenstown	LTP	Reg_Queenstown_LTP														60%	35%	5%	
Queenstown	MNB	Reg_Queenstown_MNB					10%	85%		5%									
Rotorua	LTP	Reg_Rotorua_LTP												100%					
Rotorua	MNB	Reg_Rotorua_MNB																	
Tauranga	MNB	Reg_Tauranga_MNB																	
Tauranga	LTP	Reg_Tauranga_LTP												100%					

Table 06-9 Runway 20 Jet and TP Allocations Arrivals

Route & Aircraft			Runway 29											
			Int- Jet		Domestic - Jet				Domestic - Turboprop					
Region	AC_Cat	Region_AC	29JAI01R	29JAI01V	29JAD01V	29JAD03R	29JAD03V	29JAD05R	29TPA01V	29TPA02V	29TPA03V	29TPA04R	29TPA04V	29TPA05R
Auckland	LNB	Dom_Auckland_LNB			20%			80%						
Auckland	MNB	Dom_Auckland_SWB			20%			80%						
Auckland	MWB	Dom_Auckland_MWB			20%			80%						
Auckland	SWB	Dom_Auckland_SWB			20%			80%						
Wellington	LTP	Dom_Wellington_LTP							20%					80%
Wellington	MNB	Dom_Wellington_MNB			20%			80%						
East Asia	LWB	Int_East Asia_LWB	RWY 02/20	RWY 02/20										
East Asia	MWB	Int_East Asia_MWB	80%	20%										
India	MWB	Int_India_MWB												
Middle East	VLWB	Int_Middle East_VLWB	RWY 02/20	RWY 02/20										
North America	MWB	Int_North America_MWB	80%	20%										
Hawaii	SWB	Int_Hawaii_SWB												
North East Asia	MWB	Int_North East Asia_MWB	80%	20%										
Pacific Islands East	MNB	Int_Pacific Islands East_MNB	80%	20%										
Pacific Islands North	LNB	Int_Pacific Islands North_LNB	80%	20%										
Pacific Islands North	MNB	Int_Pacific Islands North_MNB	80%	20%										
South East Asia	MWB	Int_South East Asia_MWB												
Trans-Tasman	LNB	Int_Trans-Tasman_LNB	80%	20%										
Trans-Tasman	LWB	Int_Trans-Tasman_LWB	RWY 02/20	RWY 02/20										
Trans-Tasman	SWB	Int_Trans-Tasman_SWB	80%	20%										
Western Australia	LNB	Int_Western Australia_LNB	80%	20%										
Blenheim	STP	Reg_Blenheim_STP							100%					
Blenheim	VSTP	Reg_Blenheim_VSTP							100%					
Chatham Islands	MTP	Reg_Chatham Islands_MTP							100%					
Chatham Islands	MNB	Reg_Chatham Islands_MNB							100%					
Dunedin	LTP	Reg_Dunedin_LTP										80%	20%	
Dunedin	MNB	Reg_Dunedin_MNB										80%	20%	
Hamilton	LTP	Reg_Hamilton_LTP								100%				
Hamilton	MNB	Reg_Hamilton_MNB								100%				
Hokitika	LTP	Reg_Hokitika_LTP									100%			
Hokitika	MTP	Reg_Hokitika_MTP									100%			
Invercargill	LTP	Reg_Invercargill_LTP										80%	20%	
Invercargill	MNB	Reg_Invercargill_MNB										80%	20%	
Napier	LTP	Reg_Napier_LTP							100%					
Napier	MNB	Reg_Napier_MNB							100%					
Nelson	LTP	Reg_Nelson_LTP								100%				
Nelson	MNB	Reg_Nelson_MNB								100%				
New Plymouth	LTP	Reg_New Plymouth_LTP								100%				
Other North Regional	MTP	Reg_Other North Regional_MTP								100%				
Other South Regional	VSTP	Reg_Other South Regional_VSTP										80%	20%	
Palmerston North	LTP	Reg_Palmerston North_LTP							100%					
Palmerston North	MNB	Reg_Palmerston North_MNB							100%					
Queenstown	LTP	Reg_Queenstown_LTP										80%	20%	
Queenstown	MNB	Reg_Queenstown_MNB				80%	20%							
Rotorua	LTP	Reg_Rotorua_LTP							100%					
Rotorua	MNB	Reg_Rotorua_MNB												
Tauranga	MNB	Reg_Tauranga_MNB												
Tauranga	LTP	Reg_Tauranga_LTP							100%					

Table 06-10 Runway 29 Jet and TP Allocations Arrivals

Non-Scheduled Departure Flight Track Allocation Splits

Region	Jet Track	% Split
Int West	20JDI02_NP	33%
	20JDI02_WC	33%
	20JDI01_WC	34%
Int North	20JDI01_RTNWC	50%
	20JDI01_NC	50%
South Island South	20JDD10	25%
	20JDD01_SC	25%
	20JDD03	25%
	20JDD02_SWC	25%
North Island West	20JDD01_RTNC	33%
	20JDD01_NC	33%
	20JDD04_LTNC	34%
North Island East	20JDD02_NC	25%
	20JDD02_RTNC	25%
	20JDD03_NC	25%
	20JDD04_LTNC	25%
North Island Central	20JDD04_LTNC	50%
	20JDD02_NC	50%
Local	20JDD10	9%
	20JDD01_SC	9%
	20JDD03	9%
	20JDD02_SWC	9%
	20JDD01_NC	9%
	20JDD06_LTNC	9%
	20JDD01_RTNC	9%
	20JDD04_LTNC	9%
	20JDD02_NC	9%
	20JDD02_RTNC	9%
	20JDD03_NC	10%

Table 06-11 Runway 20 Jet Allocations Departures

Region	Turboprop Track	% Split
North Island West	20TPD01_NC	50%
	20TPD04_LTNC	50%
North Island Central	20TPD01_NC	25%
	20TPD02_NC	25%
	20TPD04_LTNC	25%
	20TPD03_NC	25%
North Island East	20TPD02_NC	33%
	20TPD03_NC	33%
	20TPD04_LTNC	34%
South Island North	20TPD01_NC	33%
	20TPD02_NC	33%
	20TPD04_LTNC	34%
South Island West	20TPD01_NWP	100%
South Island South	20TPD02_SWC	25%
	20TPD03	25%
	20TPD10	25%
	20TPD01_SC	25%
Chatham Islands	20TPD06_LTNC	100%
Local	20TPD01_NC	10%
	20TPD04_LTNC	10%
	20TPD02_NC	10%
	20TPD03_NC	10%
	20TPD01_NWP	10%
	20TPD02_SWC	10%
	20TPD03	10%
	20TPD10	10%
	20TPD01_SC	10%
	20TPD06_LTNC	10%

Table 06-12 Runway 20 TP Allocations Departures

Jet		
Region	Track	% Split
Int West	02JDI03_LTWC	25%
	02JDI05_LTWC	25%
	02JDI04_LTWC	25%
	02JDI7B_LTNWC	25%
Int North	02JDI08_LTNWC	50%
	02JDI05	50%
South Island South	02JDD01_LTSP	25%
	02JDD02_LTSWP	25%
	02JDD01_RTC	25%
	02JDD01_RTSC	25%
North Island West	02JDD03_NC	50%
	02JDD02	50%
North Island East	02JDD01	20%
	02JDD06	20%
	02JDD05_NC	20%
	02JDD07_NC	20%
	02JDD08_NC	20%
North Island Central	02JDD06	50%
	02JDD05_NC	50%
Local	02JDD01_LTSP	9%
	02JDD02_LTSWP	9%
	02JDD01_RTC	9%
	02JDD01_RTSC	9%
	02JDD03_NC	9%
	02JDD02	9%
	02JDD01	9%
	02JDD06	9%
	02JDD05_NC	9%
	02JDD07_NC	9%
	02JDD08_NC	10%

Table 06-13 Runway 02 Jet Allocations Departures

Turboprop		
Region	Track	% Split
North Island West	02TPD03_NC	100%
North Island Central	02TPD06	14.3%
	02TPD01_NC	14.3%
	02TPD03_NC	14.3%
	02TPD02	14.3%
	02TPD05_NC	14.3%
	02TPD07_NC	14.3%
	02TPD08_NC	14.2%
North Island East	02TPD06	25%
	02TPD02	25%
	02TPD05_NC	25%
	02TPD07_NC	25%
South Island North	02TPD05_NC	33%
	02TPD01_NC	33%
	02TPD06	34%
South Island West	02TPD06_LTNWP	100%
South Island South	02TPD01_LTSP	25%
	02TPD02_LTSWP	25%
	02TPD01_RTC	25%
	02TPD01_RTSC	25%
Chatham Islands	02TPD01_RTEC	100%
Local	02TPD03_NC	7.7%
	02TPD06	7.7%
	02TPD01_NC	7.7%
	02TPD02	7.7%
	02TPD05_NC	7.7%
	02TPD07_NC	7.7%
	02TPD08_NC	7.7%
	02TPD06_LTNWP	7.7%
	02TPD01_LTSP	7.7%
	02TPD02_LTSWP	7.7%
	02TPD01_RTC	7.7%
	02TPD01_RTSC	7.7%
	02TPD01_RTEC	7.6%

Table 06-14 Runway 02 TP Allocations Departures

Jet		
Region	Track	% Split
Int West	29JDI01	100%
Int North	29JDI01	50%
	29JDI01_RT	50%
South Island South	29JDD01_LT	50%
	29JDD02_LT	50%
North Island West	29JDD01_RT	33%
	29JDD02_RT	33%
	29JDD03_RT	34%
North Island East	29JDD01_RT	50%
	29JDD02_RT	50%
North Island Central	29JDD01_RT	50%
	29JDD02_RT	50%
Local	29JDD01_LT	25%
	29JDD02_LT	25%
	29JDD01_RT	25%
	29JDD02_RT	25%

Table 06-15 Runway 29 Jet Allocations Departures

Turboprop		
Region	Track	% Split
North Island West	29TPD01_RT	33%
	29TPD02_RT	33%
	29TPD05	34%
North Island Central	29TPD05	34%
	29TPD01_RT	33%
	29TPD02_RT	33%
North Island East	29TPD01_RT	33%
	29TPD02_RT	33%
	29TPD05	34%
South Island North	29TPD01_RT	33%
	29TPD02_RT	33%
	29TPD05	34%
South Island West	29TPD05	50%
	29TPD01_RT	50%
South Island South	29TPD01_LT	50%
	29TPD02_LT	50%
Chatham Islands	29TPD02_RT	100%
Local	29TPD01_RT	20%
	29TPD02_RT	20%
	29TPD05	20%
	29TPD01_LT	20%
	29TPD02_LT	20%

Table 06-16 Runway 29 TP Allocations Departures

Non-Scheduled Arrivals Flight Track Allocation Splits

Jet		
Region	**Track**	**% Split**
North Island West	20JAD02I	50%
	20JAD04V	50%
North Island Central	20JAD01I	34%
	20JAD02I	33%
	20JAD04V	33%
North Island East	20JAD01I	50%
	20JAD04V	50%
South Island South	20JAD03I	34%
	20JAD03R	33%
	20JAD05V	33%
South Island North	20JAD01I	100%
South Island West	20JAD03I	33%
	20JAD03R	33%
	20JAD05V	34%
Int West	20JAI02R	100%
Int North	20JAI02R	50%
	20JAI01I	50%
Int North East	20JAI01I	100%
Local	20JAD01I	16.7%
	20JAD02I	16.7%
	20JAD03I	16.7%
	20JAD03R	16.7%
	20JAD04V	16.6%
	20JAD05V	16.6%

Table 06-17 Runway 20 Jet Allocations Arrivals

Turboprop		
Region	**Track**	**% Split**
North Island West	20TPA03I	100%
North Island Central	20TPA02I	100%
North Island East	20TPA02I	100%
South Island South	20TPA01I	16.7%
	20TPA01R	16.7%
	20TPA01V	16.7%
	20TPA04I	16.7%
	20TPA04V	16.7%
	20TPA04R	16.7%
South Island North	20TPA03I	50%
	20TPA02I	50%
South Island West	20TPA03I	100%
	20TPA5R	100%
Chatham Islands	20TPA02I	100%
Local	20TPA01I	12.5%
	20TPA01R	12.5%
	20TPA01V	12.5%
	20TPA03I	12.5%
	20TPA04I	12.5%
	20TPA04R	12.5%
	20TPA04V	12.5%
	20TPA05R	12.5%

Table 06-18 Runway 20 TP Allocations Arrivals

Jet		
Region	Track	% Split
North Island West	02JAD02V	33%
	02JAD04R	33%
	02JAD02I	34%
North Island Central	02JAD02V	16.6%
	02JAD04R	16.6%
	02JAD02I	16.7%
	02JAD01I	16.7%
	02JAD01R	16.7%
	02JAD01V	16.7%
North Island East	02JAD01V	34%
	02JAD01R	33%
	02JAD01I	33%
South Island South	02JAD03I	100%
South Island North	02JAD01I	33%
	02JAD01R	33%
	02JAD01V	34%
South Island West	02JAD3I	100%
Local	02JAD01I	15%
	02JAD01R	15%
	02JAD01V	14%
	02JAD02I	14%
	02JAD02V	14%
	02JAD03I	14%
	02JAD04R	14%
Int West	02JAI01R	16.7%
	02JAI02I	16.7%
	02JAI03I	16.7%
	02JAI04I	16.7%
	02JAI05I	16.6%
	02JAI07I	16.6%
Int North	02JAI01R	34%
	02JAI02I	33%
	02JAI06I	33%
Int North East	02JAI6I	100%

Table 06-19 Runway 02 Jet Allocations Arrivals

Turboprop		
Region	Track	% Split
North Island West	02TPA05I	34%
	02TPA05V	33%
	02TPA06R	33%
North Island Central	02TPA01V	34%
	02TPA01R	33%
	02TPA01I	33%
North Island East	02TPA01V	34%
	02TPA01R	33%
	02TPA01I	33%
South Island South	02TPA03I	100%
South Island North	02TPA01I	16.7%
	02TPA01R	16.7%
	02TPA01V	16.7%
	02TPA06R	16.6%
	02TPA05V	16.6%
	02TPA05I	16.7%
South Island West	02TPA03I	50%
	02TPA04I	50%
Chatham Islands	02TPA01I	34%
	02TPA01R	33%
	02TPA01V	33%
Local	02TPA03I	12.5%
	02TPA04I	12.5%
	02TPA05I	12.5%
	02TPA06R	12.5%
	02TPA05V	12.5%
	02TPA01V	12.5%
	02TPA01R	12.5%
	02TPA01I	12.5%
Int West*	02JAI01R	16.7%
	02JAI02I	16.7%
	02JAI03I	16.7%
	02JAI04I	16.7%
	02JAI05I	16.7%
	02JAI07I	16.7%

Table 06-20 Runway 02 TP Allocations Arrivals

*Int West Turboprop allocation is for Military allocation; military was not modelled.

Jet		
Region	**Track**	**% Split**
North Island West	29JAD05R	50%
	29JAD01V	50%
North Island Central	29JAD05R	50%
	29JAD01V	50%
North Island East	29JAD05R	50%
	29JAD01V	50%
South Island South	29JAD03R	50%
	29JAD03V	50%
South Island North	29JAD01V	50%
	29JAD05R	50%
South Island West	29JAI01V	100%
Local	29JAD03V	20%
	29JAD03R	20%
	29JAD05R	20%
	29JAD01V	20%
	29JAI1V	20%
Int North	29JAI1R	50%
	29JAI01V	50%
Int North East	29JAI1R	50%
	29JAI01V	50%
Int West	29JAI1R	50%
	29JAI01V	50%

Table 06-21 Runway 29 Jet Allocations Arrivals

Turboprop		
Region	**Track**	**% Split**
North Island West	29TPA01V	33%
	29TPA02V	34%
	29TPA05R	33%
North Island Central	29TPA02V	34%
	29TPA01V	33%
	29TPA05R	33%
North Island East	29TPA02V	34%
	29TPA01V	33%
	29TPA05R	33%
South Island South	29TPA04V	50%
	29TPA04R	50%
South Island North	29TPA01V	33%
	29TPA02V	34%
	29TPA05R	33%
South Island West	29TPA03V	100%
Chatham Islands	29TPA01V	100%
Local	29TPA04V	16.6%
	29TPA04R	16.7%
	29TPA03V	16.7%
	29TPA02V	16.7%
	29TPA01V	16.7%
	29TPA05R	16.6%

Runway 29 TP Allocations Arrivals

Jet		
Region	Track	% Split
North Island West	11JAD01V	100%
North Island Central	11JAD01V	100%
North Island East	11JAD01V	100%
South Island South	11JAD02V	100%
South Island North	11JAD01V	100%
South Island West	11JAD2V	50%
	11JAD01V	50%
Int North	11JAD01V	100%
Int North East	11JAD01V	100%
Int West	11JAD01V	100%
Local	11JAD01V	34%
	11JAD02V	33%
	11JAD01V	33%

Table 06-22 Runway 11 Jet Allocations Arrivals

Turboprop		
Region	Track	% Split
North Island West	11TPA02V	100%
North Island Central	11TPA01V	50%
	11TPA02V	50%
North Island East	11TPA01V	100%
South Island South	11TPA03V	100%
South Island North	11TPA01V	50%
	11TPA02V	50%
South Island West	11TPA04V	100%
Chatham Islands	11TPA01V	100%
Local	11TPA03V	25%
	11TPA04V	25%
	11TPA02V	25%
	11TPA01V	25%

Table 06-23 Runway 11 TP Allocation Arrivals

5 CHRISTCHURCH RECONTOURING NOISE MODELLING REPORT

MARSHALL DAY Acoustics

MARSHALL DAY Acoustics

CHRISTCHURCH RECONTOURING
VOLUME 5: NOISE MODELLING REPORT

Report No.004 | 4 May 2023

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	VOLUME 5: NOISE MODELLING REPORT
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1.0 INTRODUCTION

1.1 Purpose

Christchurch International Airport Limited (CIAL) is seeking to update the current Operative Plan Noise Contours that are incorporated into the Canterbury Regional Policy Statement (CRPS) and District Plans. Marshall Day Acoustics (MDA) has been engaged, along with Airbiz to prepare a set of updated noise contours for Christchurch International Airport (CIA) for inclusion in the CRPS and District Plans. Five technical reports (Volume 1 through Volume 5) detail the various assumptions and methodologies applied to prepare the updated noise contours. This report is Volume 5, the noise modelling technical report.

The new noise contours are referred to throughout this report as the 'Updated Noise Contours' and are based on ultimate runway capacity. Two options for the Updated Noise Contours have been prepared, the Outer Envelope and the Annual Average options. The two options are described in more detail in Section 3.0 and Section 7.0. This report does not include an assessment or recommendation on which option should be adopted.

The purpose of this report is to document the assumptions, methodology and inputs used in the preparation of the Updated Noise Contours and the outcomes of this work. A previous report[1] detailed the sensitivity study undertaken to test the influence of several factors on the size and shape of the noise contours and presented a preliminary set of Updated Noise Contours. That preliminary modelling has been reviewed by a Peer Review Panel appointed by Environment Canterbury. The modelling detailed in this report includes revisions based on feedback from the Peer Review Panel as well as updated information from Airways Corporation NZ regarding flight tracks and runway capacity. These revisions reflect changes in aircraft movement numbers at ultimate runway capacity, revisions to the aircraft fleet assumptions and changes to departure flight tracks. Details of the peer review process and changes to the preliminary modelling are described in Volume 1: Executive Summary Report.

The background and details of the ultimate runway capacity schedules and the definition of flight paths and allocation of traffic to these flight paths is provided in other volumes. Where appropriate, outcomes from these reports are referred to in this report.

This report does not discuss the land use planning rules associated with the various contours and is not an assessment of noise effects. This will be the subject of a separate report.

1.2 Background

The current Operative Plan Noise Contours were modelled by MDA in 2007 following an agreement by a group of aviation and noise experts on methodology and aircraft procedures to be used in the noise modelling. The final outcome was the 'Expert Panel Report' (dated 31 January 2008) which outlined the assumptions and methodologies used, the set of noise contours produced by MDA and recommendations on how the contours should be used.

Policy 6.3.11 (3) in the Regional Policy Statement dictates review of the noise contours after 10 years. The Expert Panel Report also recommends that "the noise contours be remodelled every ten years".

Since 2008 the aircraft fleet mix has changed, new aircraft types have been introduced along with new flight procedures. For these reasons, it was deemed necessary for the noise contours to be updated and MDA was engaged by CIAL to commence the remodelling process in 2018.

The following parties have been involved with the technical aspects of this project:

- Marshall Day Acoustics (MDA) – noise modelling and measurements for model calibration

[1] Christchurch Recontouring Noise Modelling Report 11 May 2022

- Airbiz – aviation consulting – ultimate capacity, air traffic demand projections, and flight tracks
- Airways Corporation NZ (Airways NZ)– information about flight track and flight procedure design
- Christchurch International Airport Limited (CIAL) in consultation with airlines has provided information regarding scheduling of aircraft movements and fleet mix.

1.3 Sources of Input Data

Table 1 details the sources of the data inputs used for the noise modelling.

Table 1: Sources of Input Data

Information	Source
Runway endpoints, elevations, widths & thresholds	CIAL. Elevations from AIP
Runway usage splits and peaking factors	MDA analysis of historical runway usage from CIAL/Airways NZ data
Helipad locations	CIAL. Elevations from AIP.
Flight track locations	Airways NZ as documented by Airbiz in Volume 4: Flight Tracks Report
Flight track allocation	Airways NZ as documented by Airbiz in Volume 4: Flight Tracks Report
Taxiing (tracks and user profiles)	MDA assumptions
Terrain	Shuttle Radar Topography Mission (SRTM) from NASA
Met data	Monthly average temperature, humidity and wind speed data from NIWA’s National Climate Database (accessed through CliFlo).
Annual aircraft schedules	Volume 3 – Air Traffic Projection Report
Aircraft categories and types	Volume 3 – Air Traffic Projection Report
Climate change assumptions	Deloitte report and NIWA
Runway maintenance assumptions	CIAL based on historical runway maintenance shift information

1.4 Noise Modelling Software

The Updated Noise Contours presented in this report have been modelled using the Aviation Environmental Design Tool (AEDT) software program produced by the Federal Aviation Administration (FAA) in the United States. The AEDT models aircraft performance in space and time to predict noise levels on the ground. The AEDT replaces the Integrated Noise Model (INM) Version 7d as the FAA-approved modelling tool for the future. The INM, which was used to model the Operative Plan Noise Contours, is no longer supported and will not receive updates of new aircraft types and profiles in the future. The Updated Noise Contours have been calculated in AEDT version 3e, the latest version available as of March 2023.

2.0 NEW ZEALAND STANDARD NZS 6805

In 1992, the Standards Association of New Zealand published New Zealand Standard NZS 6805:1992 "*Airport Noise Management and Land Use Planning*" (NZS 6805, or The Standard) with a view to providing a consistent approach to noise planning around New Zealand airports. The Standard was finalised after several years of preparation and consultation and in 1991 formed the consensus of many different groups including the Ministry of Transport, the Department of Health, Airline representatives, Local Authorities, residents action groups, acoustic consultants and others including CIAL.

The Standard uses the "Noise Boundary" concept as a mechanism for local authorities to:

- "Establish compatible land use planning" around an airport; and
- "Set noise limits for the management of aircraft noise at airports"

The Noise Boundary concept involves fixing an Outer Control Boundary (OCB) and a smaller, much closer Airnoise Boundary (ANB) around the airport. Inside the ANB, new noise sensitive uses (including residential) are prohibited. Between the ANB and the OCB new noise sensitive uses should also ideally be prohibited (and of those that are built, all should be provided with sound insulation). The ANB is also nominated as the location for future noise monitoring of compliance with a 65 dB L_{dn} limit.

The Standard is based on the Day/Night Sound Level (L_{dn}) which uses the cumulative 'noise energy' that is produced by all flights during a typical day with a 10-decibel penalty applied to night flights. L_{dn} is used extensively in New Zealand and overseas for airport noise assessment, and it has been found to correlate well with community response to aircraft noise.

The location of the ANB is then based upon the projected 65 dB L_{dn} contour, and the location of the OCB is generally based on the projected 55 dB L_{dn} contour. The Standard does however state in paragraph 1.4.3.8 that the local authority may show "the contours in a position further from or closer to the airport, if it considers it more reasonable to do so in the special circumstances of the case". The Canterbury Regional Council, and therefore Christchurch, Waimakariri and Selwyn Councils use the 50 dB L_{dn} contour for the location of the OCB.

The Standard recommends that the ANB and OCB are generally based on noise over a three-month period (or such other period as agreed). Airports in New Zealand mostly use a three-month average with Auckland Airport using an annual average.

The Standard also recommends planning and management procedures be based on predicted noise contours (L_{dn}) for a future level of airport activity. The Standard (clause 1.4.3.1) recommends that a "minimum of a 10-year period be used as the basis of the projected contours." It is important for a major international airport to plan for a period significantly longer than 10 years. For Christchurch Airport the contours are based on ultimate runway capacity.

Clause 1.1.5(c) recommends consideration of the noise from individual maximum noise events for night-time operations, and this is normally achieved by plotting the arrival and departure 95 dB L_{AE} contours from the noisiest frequent night-time aircraft. If the 95 dB L_{AE} contour extends beyond the 65 dB L_{dn} then a composite of both contours forms the ANB. For Christchurch Airport the ANB used for land use planning is a composite of the 65 dB L_{dn} contour and the single event 95 dB L_{AE} contour from an individual aircraft event.

3.0 OVERVIEW OF UPDATED NOISE CONTOUR OPTIONS

This report presents two options for the Updated Noise Contours which are based on different approaches to modelling the runway usage at CIA. Section 5.4 describes the runway usage in detail but in summary the two options are:

- The **Outer Envelope Noise Contours** (composite of three-month worst case runway usage for four wind directions)
- The **Annual Average Noise Contours** (annual average runway usage)

The Outer Envelope is a composite of four scenarios which represent the highest runway usage on each runway over a three-month period. We refer to these as the four **runway bias scenarios**. The highest runway usage is determined from a review of historic runway usage at CIA. The outer extent of these four noise contours overlaid, is taken to form the final Outer Envelope noise contour used for planning purposes.

The Annual Average is a single noise contour run to represent noise over an entire calendar year instead of the busiest three months for each runway end.

NZS 6805 recommends that noise contours are based on noise over a three-month period (or such other period as agreed)[2]. If the three-month period is used for the noise contouring, then compliance would be based on three monthly monitoring, and it is important that Christchurch Airport can comply in any given three-month period – including any unusual runway usage due to unusual wind conditions.

We do not provide an assessment or recommendation on which of the options should be adopted. We consider both options are valid approaches with respect to aircraft noise modelling and NZS 6805:1992. The decision regarding which option to implement will likely involve other town planning considerations beyond our expertise.

3.1 Comparison with the Operative Plan Noise Contours

The modelling inputs for the Updated Noise Contours differ from the Operative Plan Noise Contours in a number of aspects. The Operative Contours were based on a different flight schedule, fleet mix, flight paths and used the INM modelling software rather than AEDT. The Operative Noise Contours were based on an annual average usage of runways 02 and 20 and a highest three-month usage of Runways 29 and 11. A summary of the major differences is given below:

Model Inputs	Operative Plan Noise Contours	Updated Noise Contours
Movement Numbers	175k scheduled passenger 5 freight flights per week	201k scheduled passenger aircraft 15k freight aircraft 20k FBO/small comm, airline/MRO) (Antarctic/military/govt excluded) 28k Helicopters
Fleet mix	Older aircraft	Newer aircraft (A320 Neos etc) but more wide bodies
Runway Configuration	Current RWY 02/20 length. Extension on RW11/29	Runway extensions on 02/20 and 11/29
Flight Tracks	Conventional tracks (no DMAPS or RNP)	New technology including DMAPS for departures and RNP arrivals
Taxiing	Not included	Included
Model version	INM v7.0	AEDT v3e

[2] Clause 1.4.1.2 - New Zealand Standard NZS 6805:1992 "Airport Noise Management and Land Use Planning"

Of the various changes tabled above, the updated flight tracks cause the largest change to the shape of the noise contours. The tracks used for the Operative Plan Noise Contours did not include RNP or DMAPS flight tracks and included arrivals and departures that were predominantly straight. Comparisons of the flight tracks used for the Operative Contours and the Updated Contours is provided in Volume 4: Flight Track Report.

The change in aircraft fleet and forecast would also affect the size of the contours. Modern aircraft are generally quieter than older models however the updated fleet has a higher proportion of wide-body jets and a lower proportion of narrow-body jets than what was modelled for the Operative Plan Noise Contours. Very large wide-body jets are also included such as the Airbus A380, which were not included in the Operative Plan Noise Contours.

A comparison of the mapped Operative and Updated Noise Contours is provided in Appendix P.

4.0 MODELLING INPUTS - PHYSICAL

The extent and shape of noise contours are influenced by many factors such as airport elevation, runway geometry, flight track geometry, aircraft types, movement numbers, runway utilisation, flight track utilisation, origins/destinations, and the day/night split of aircraft movements.

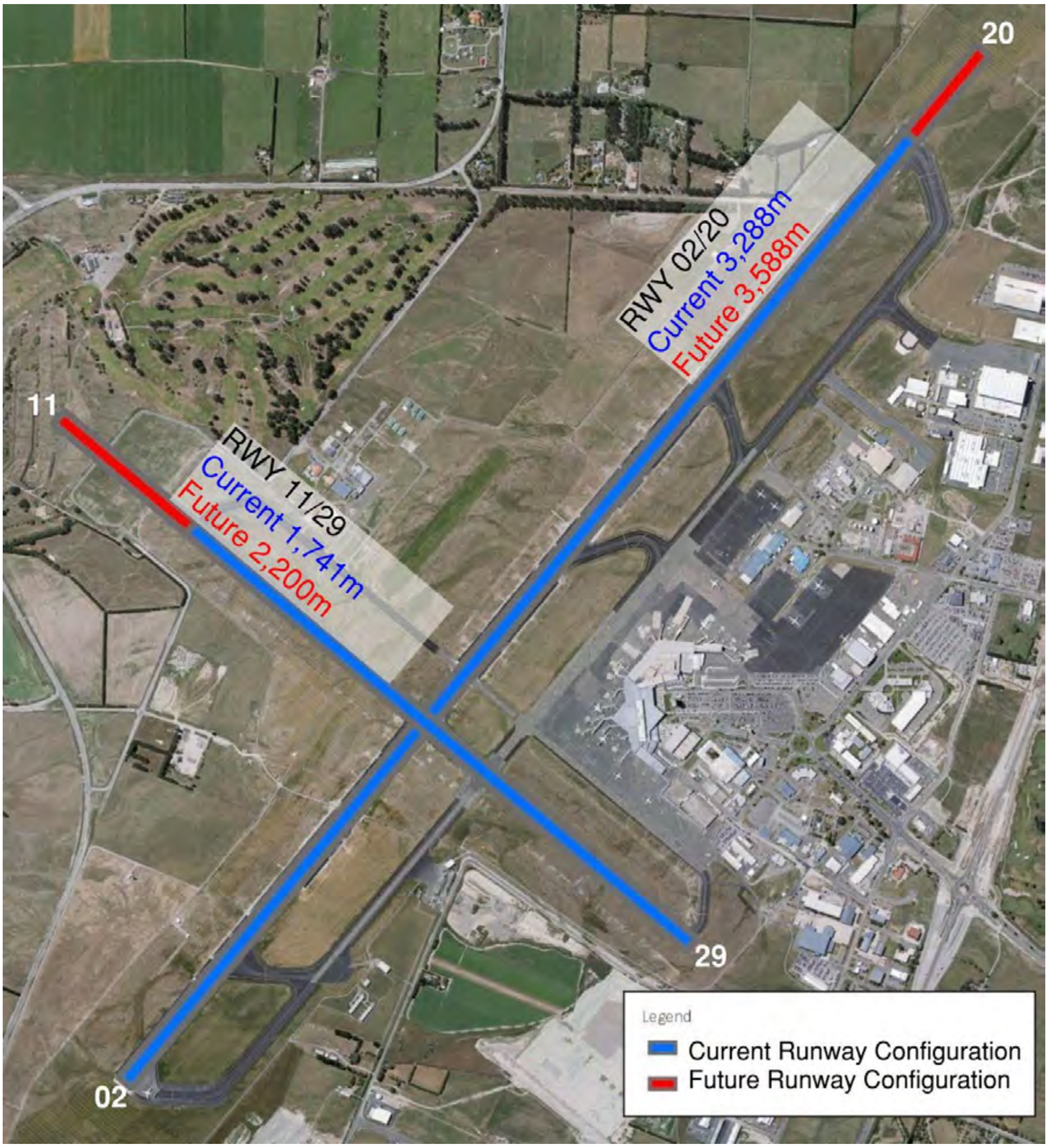
This section summarises the physical inputs to the noise model such as runway endpoints, flight tracks and meteorological data. Section 5.0 describes the operational inputs such as the aircraft movement schedule and assumptions which relate to how the aircraft movements are allocated to specific runways, tracks, aircraft types and flight profiles. Section 6.0 describes the calibration of the noise model.

4.1 Runway Configuration

A diagram explaining the runway vectors and take-off and landing directions at CIA is provided in the Glossary of Terminology in Appendix A. CIA has four operational runways, two on the main runway and two on the shorter crosswind runway.

A future runway configuration has been used to calculate the Updated Noise Contours. The future runway configuration includes extensions on Runways 11 and 20 as per the airport master plan as shown in Figure 1. It is assumed that the extended runways would be operational before ultimate runway capacity occurs. Appendix B1 and B2 list the runway endpoint coordinates and lengths.

Figure 1: Future Runway Configuration for Updated Noise Contours



Source: CIAL

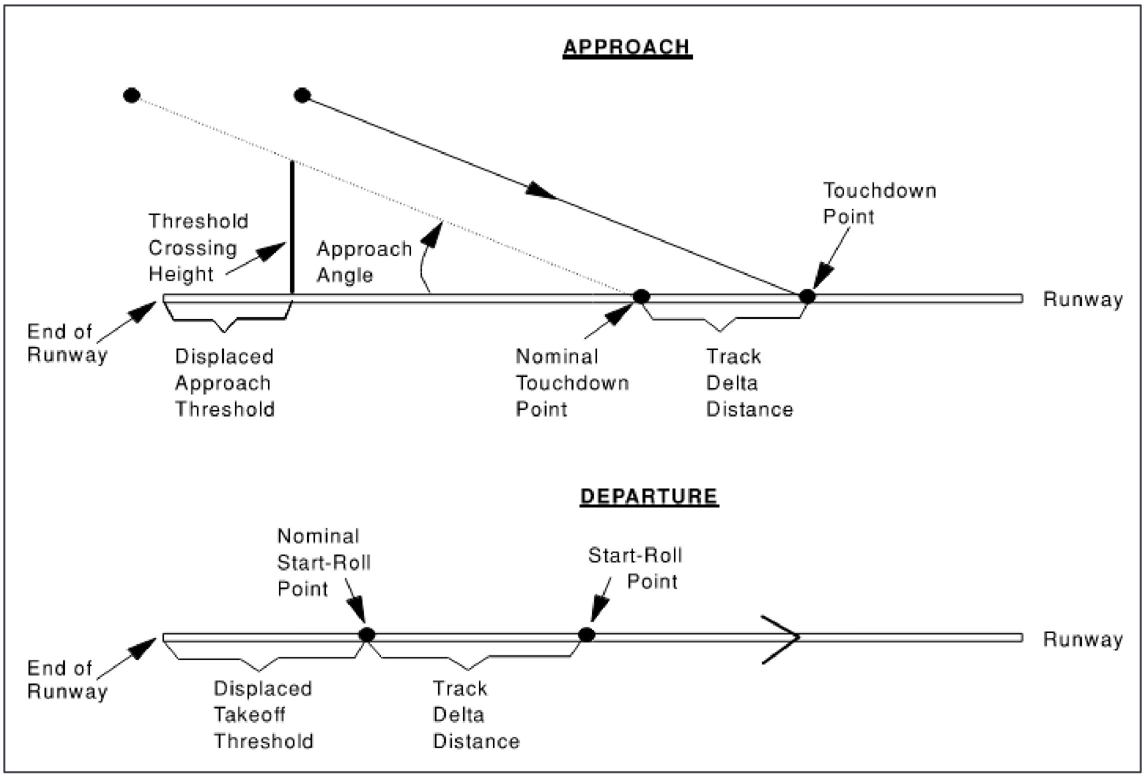
4.2 Displaced Thresholds

The runway endpoints define the end of the runway surface, but this is not necessarily where all aircraft commence take-off or touchdown. These locations should be defined in the noise model as they affect the modelled aircraft altitude and other flight profile parameters further away from the runway. CIAL has advised where different aircraft types commence take-off under the current configuration.

The location on the runway where aircraft start accelerating for a take-off is termed the 'start of roll' position. This is entered into the noise model as a distance from the runway endpoint termed the 'displaced take-off threshold' as shown in Figure 2.

The landing threshold is marked on a runway as a row of white lines. In the noise model, the location of the landing threshold is entered as a distance from the runway endpoint and termed the 'displaced approach threshold' also shown in Figure 2. The default settings in the model, set aircraft at 50 ft above the landing threshold on a 3 degree approach angle to touchdown.

Figure 2: Displaced Take-off and Approach Thresholds



Source: INM Version 7 User Manual

For the Updated Noise Contours, the approach thresholds for all runways are approximately 6 m from the end of the runway including the extensions. The default settings of 50 ft threshold crossing height and 3 degree approach angle are appropriate for the CIA situation and have been applied for the Updated Noise Contours.

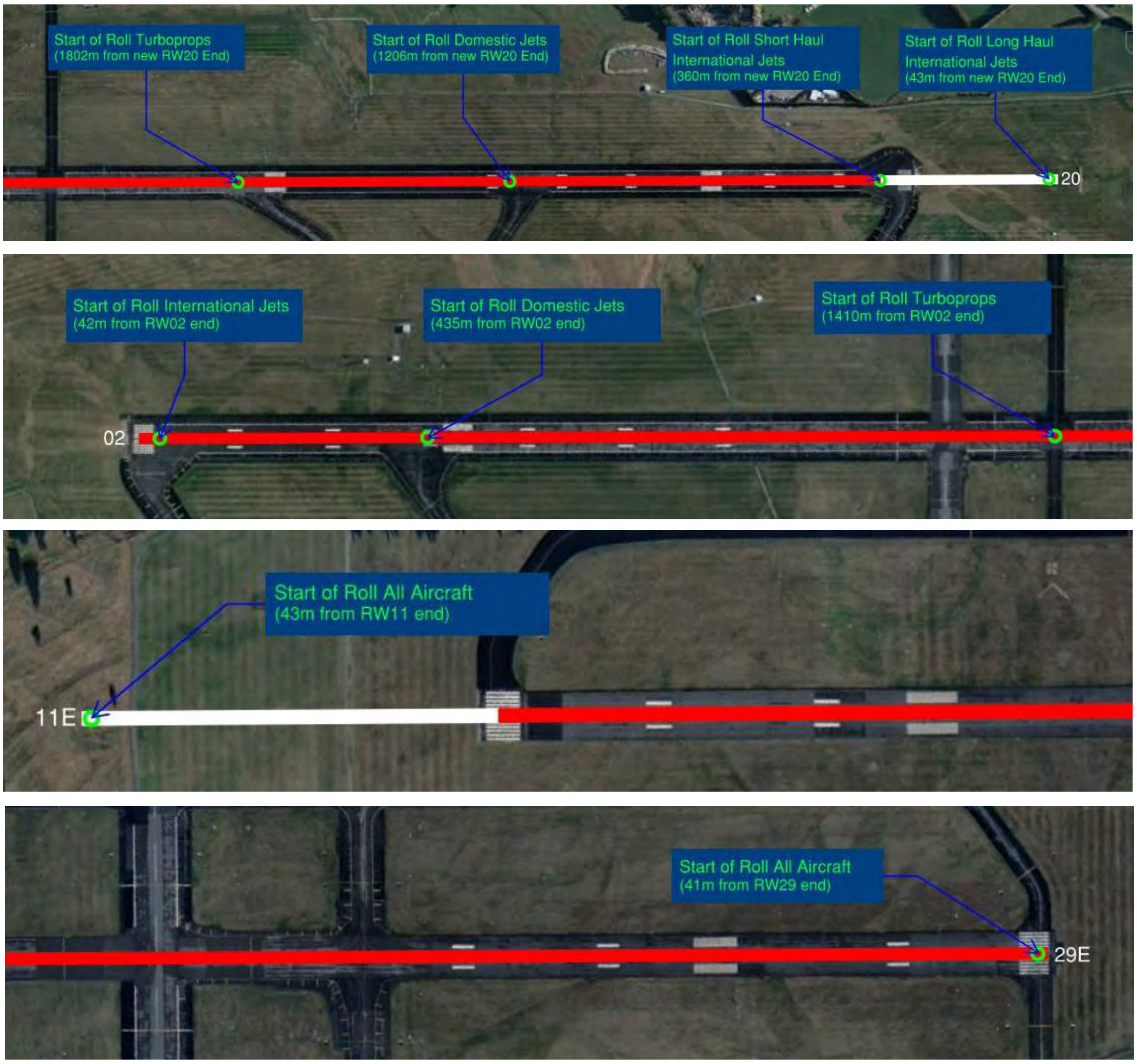
CIAL has advised that under the current runway configuration the start of roll location on the main runway (02/20) varies depending on the aircraft size and route. Smaller aircraft on shorter routes require less runway than larger aircraft on longer routes therefore turbo-props and domestic jets commence take-off partway along the runway to save time and fuel on unnecessary taxiing. For the future runway configuration, the same start of roll positions as currently used have been assumed for all aircraft except wide body aircraft on long haul routes. For Runway 20 departures, wide body aircraft on long haul routes are modelled using the full length of the extended runway.

To account for the different start of roll positions in the noise model, we have entered four separate runways for the main runway (02/20). One runway each for long haul international jets, short haul international jets, domestic jets and turboprops. Figure 3 shows the start of roll locations used for each aircraft group in the noise model.

For Runway 29 the start of roll position is the same for all aircraft. The start of roll position for Runway 11 departures would move with the runway extension, however there are no Runway 11 departures included in the noise model.

The runway naming convention and displaced threshold details for the noise model are listed in Appendix B4.

Figure 3: Runway Departure Thresholds or the "Start of Roll" Distance



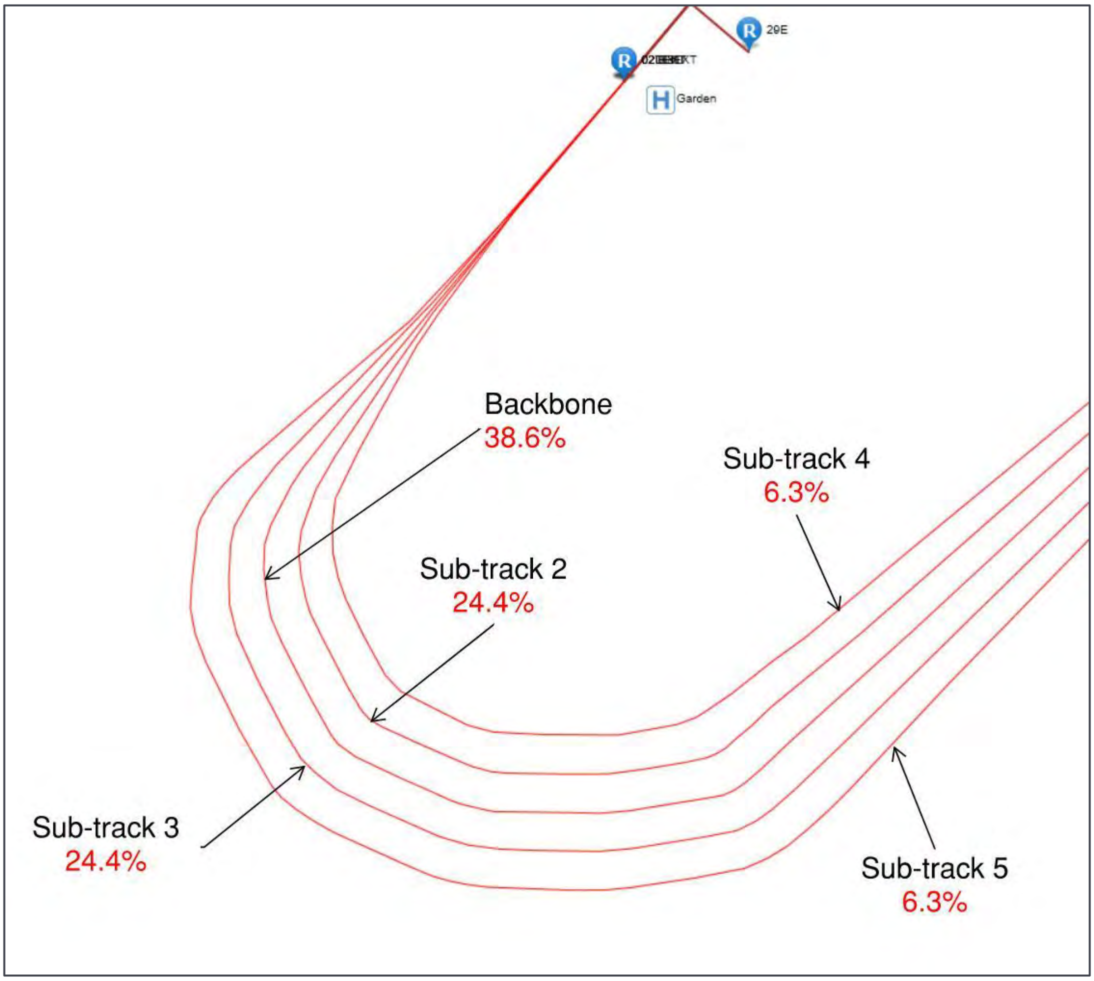
4.3 Flight Tracks

The aircraft flight tracks used for the Updated Noise Contour model are described in Volume 4: Flight Tracks Report prepared by Airbiz. MDA received the digital files for the flight tracks illustrated in Volume 4. We used these files as the basis for generating flight tracks in the AEDT model. We also used radar data provided by Airways to guide the spread of the flight tracks in the model to better represent the variation in actual flight paths flown.

Flight tracks in AEDT are two dimensional, 'ground tracks' (mapped in plan view at ground level). The aircraft altitude, speed and engine thrust at any point along a flight track are defined in the flight profiles available as standard options in the AEDT model. The flight profiles are discussed further in Section 5.7.

Flight tracks can be entered into the model as a single line, meaning that 100% of aircraft allocated to that track are modelled as flying along that line. Alternatively, a track can be dispersed to better represent the natural spread of flight paths that occurs in practice. A dispersed flight track comprises a 'backbone track' (the main flight track) and an even number of 'sub-tracks' at set distances away from the backbone track as shown in Figure 4. AEDT allows a total of 3, 5, 7 or 9 dispersed tracks including the backbone.

Figure 4: Dispersed Flight Track in AEDT



The distance between the backbone and each sub-track must be defined by the modeller at each point along the backbone track. There are standard settings in AEDT for allocating aircraft across dispersed tracks which concentrates more aircraft movements on the backbone and progressively fewer on the outer sub-tracks as shown in Figure 4. Table 2 lists the standard dispersion for 5 and 7 sub-tracks, these standard dispersion settings are based on a normal/Gaussian distribution.

For the Updated Noise Contours, all arrival and departure tracks have been dispersed except for the RNP arrival tracks. The following sections describe in more detail how the arrival and departure tracks have been entered into the model.

Table 2: AEDT dispersed track allocation for 5 and 7 sub-tracks

			Splits over Five Sub-tracks			
	Sub-track 4	**Sub-track 2**	**Backbone**	**Sub-track 3**	**Sub-track 5**	
	6.3%	24.4%	38.6%	24.4%	6.3%	
			Splits over Seven Sub-tracks			
Sub-track 6	**Sub-track 4**	**Sub-track 2**	**Backbone**	**Sub-track 3**	**Sub-track 5**	**Sub-track 7**
3.1%	10.6%	22.2%	28.2%	22.2%	10.6%	3.1%

4.3.1 Arrival Flight Tracks

There are three different types of arrival tracks included in the Updated Noise Contour model:

- RNP — Published procedures with high degree of precision
- Instrument/RNAV — Published procedures with moderate degree of precision
- Visual — Manual procedures with low degree of precision

The types of arrival tracks vary in the degree of precision with which they are flown, with RNP being the most accurate and visual being the least precise.

The amount of traffic using each type of arrival track in the model has been defined by Airbiz and is related to the aircraft size and the location the aircraft is arriving from (i.e. route flown). The arrival track type allocations are listed in Volume 4: Flight Tracks Report. Not all arrival track types are available for each runway so when compiling input data for the model, if an arrival track type was not available, we have reallocated those movements to other available track types. For example, there is no RNP track available for aircraft from Auckland landing on Runway 20, therefore we have allocated these to the instrument arrival track instead.

The modelled arrival tracks are based on the Volume 4 arrival backbone tracks and dispersed in AEDT as follows:

- RNP arrival tracks are not dispersed as radar data demonstrates that RNP arrivals are flown with a high degree of precision such that a single backbone track in the model is appropriate.
- Instrument/RNAV arrival tracks are dispersed in accordance with radar data.
- Visual arrivals are dispersed in accordance with radar data.

The radar data was provided by Airways. The dates of the radar data used for reference are listed in Appendix P. For some tracks there is limited radar data therefore we have applied the advice from Airways regarding generic track spread near fly-by waypoints as follows:

- On straights 0.1 NM either side of the backbone
- On turns 0.5 NM either side of the backbone

A total of five dispersed tracks including the backbone has been used in the model and the standard dispersion percentages applied (refer Table 2). The modelled arrival flight tracks are shown in Appendix S1.

4.3.2 Departure Flight Tracks

The departure flight tracks used for the Updated Noise Contour model are based on an analysis of 'flown flight tracks' carried out by Airbiz using a year's worth of radar data which is detailed in Volume 4: Flight Tracks Report. Airbiz provided digital files of the backbone tracks and outer extents of the track spread for applying dispersion in the model.

For some tracks there is limited radar data therefore we have applied the advice from Airways regarding generic track spread near fly-by waypoints as follows:

- On straights 0.1 NM either side of the backbone
- On turns 0.5 NM either side of the backbone

For departure tracks a total of either five or seven dispersed tracks[3] including the backbone has been used in the model and the standard dispersion percentages applied (refer Table 2).

[3] Depending on the extent of the radar spread

Some of the departure tracks have a large spread with sharp turns which is not practicable to disperse using the standard AEDT sub-tracks. For these tracks, we applied an alternative method by creating five or seven separate backbone tracks in the model. This method allows for a smooth track on the tight turns close to the airport whilst remaining faithful to the extent tracks issued by Airbiz and therefore the spread of the track as a whole. Each backbone has been given a percentage weighting in accordance with the standard weightings applied to dispersed tracks in AEDT (refer Table 2). The modelled departure flight tracks are shown in Appendix S2.

4.4 Taxiing

Fixed wing aircraft taxiing operations have been included in the noise modelling. One of the purposes of the New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"* is:

> *"to ensure communities living close to the airport are properly protected from the effects of aircraft noise whilst recognising the need to be able to operate an airport efficiently"*

Taxiing is an aircraft noise source that is essential for aircraft operations at an airport and can adversely affect communities. Therefore, we consider that taxiing falls within the intended purpose of the Standard and should be included in noise contours. While taxiing has only a small effect on the noise contours at Christchurch Airport, it is now industry best practice to include taxiing in noise contours in New Zealand.

Although there is no specific function to model noise from fixed-wing taxiing within the AEDT, it is possible to model taxiing effectively with user-defined procedures and 'overflight tracks'. This is the method recommended in the user manual for the INM software and the same process can be applied in AEDT. To simplify the process, we have used three aircraft types to represent taxiing for all jet and turbo-prop aircraft as follows:

- Airbus A359 – used for all wide-body jets
- Airbus A20N – used for all narrow body jets
- ATR 72-500 – used for all turbo-prop aircraft

Taxiing of unscheduled light turbo-props and piston engine aircraft is not included in the model as these would have a negligible effect on the contours at Christchurch.

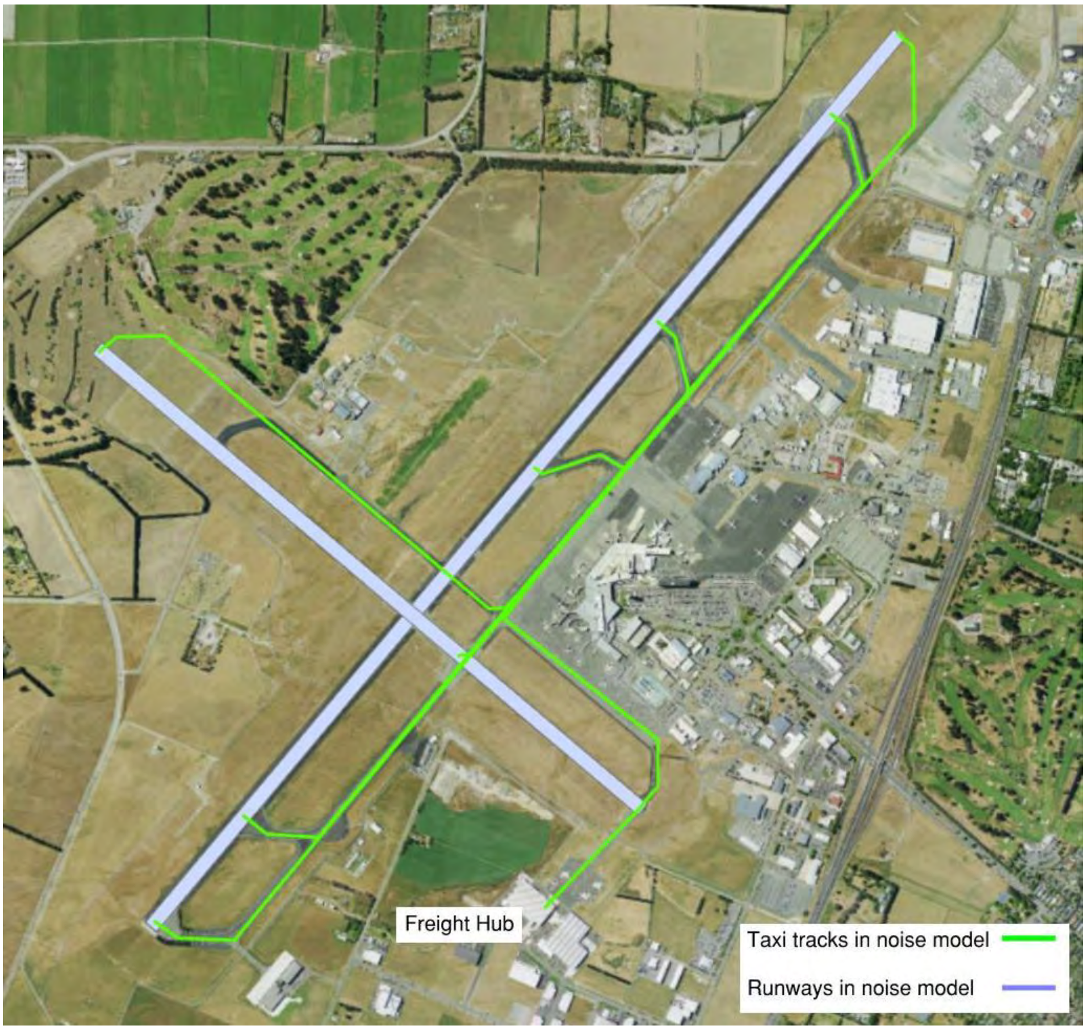
Taxi tracks have been entered into the model as overflight tracks along the taxiways between the airport terminal and each of the various start of roll positions. Arriving aircraft would use these tracks in reverse therefore modelling arriving and departing aircraft on a single track is reasonable for the purpose of noise predictions. In the model, each aircraft movement is assigned to the taxi track corresponding to the runway used for take-off or landing.

An additional taxi track runs between the end of Runway 29 and the freight hub located to the south. All freight aircraft are modelled on this taxi track as well as the taxi track corresponding to the runway used for take-off or landing. Figure 5 shows the taxi tracks used in the noise model.

Aircraft flight profiles for the three representative taxiing aircraft types have been entered as user defined profiles in the AEDT. The details of these profiles are listed in Appendix K.

We have previously measured taxiing of wide body and narrow body jets at other sites and found that the model generally overpredicts noise from taxiing. We have reassessed the results based on the AEDT predictions for CIA and adjusted the number taxiing movements in the Updated Noise Contours model by a factor equivalent to the overprediction in decibels. This is effectively calibrating the model to best reflect measurement data. The applied calibration factors are listed in Appendix K.

Figure 5: Taxi Tracks



4.5 Helipads and Helicopter Flight Tracks

Helicopter movements other than military and rescue, are included in the Updated Noise Contours. There are two main helipad locations at CIA. These have been named after the commercial operators based at each helipad, Heli-Centre and Garden City.

Appendix B3 lists the helipad coordinates and elevations provided for the Garden City and Heli Centre helipads. Figure 6 shows the helipad locations.

Helicopter flight tracks to and from each helipad are defined in Volume 4: Flight Tracks Report. We have entered these into the noise model and applied dispersion based on available radar data. Each track is dispersed into 5 sub-tracks and the AEDT default dispersion percentages applied.

Helicopter taxiing does not occur for the commercial helicopter operations (Garden City Helicopters and Heli-Centre) as they take-off directly from the helipads.

Figure 6: Helipad Locations

4.6 Terrain

It is important to include terrain data in the noise modelling as it influences how sound propagates from source to receiver. Terrain data was sourced from the Shuttle Radar Topographic Mission (SRTM) captured by the National Aeronautics and Space Administration (NASA). The data has a resolution of 3 arc seconds (approximately 90 metres at the equator). It comes in a GeoTIFF format and is then post-processed and converted to a 3tx format suitable for import into the noise model.

4.7 Meteorological Data & Atmospheric Absorption

Atmospheric Absorption Settings

Meteorological conditions influence the atmospheric absorption of noise over distance and the performance of aircraft. AEDT allows details of the meteorological conditions (temperature, pressure, humidity headwind) to be input into the noise model. These details can then be used to modify the noise outputs to represent how noise would propagate over distance in various atmospheric conditions.

There are three different methods described below that can be used to allow for atmospheric absorption, one which assumes a generic atmospheric absorption and two which account for the study-specific atmosphere that is specified.

- Unadjusted (SAE-AIR-1845 atmosphere): uses the inherent atmospheric absorption according to SAE-AIR-1845. Noise data is unadjusted for study-specific atmospherics.

- SAE-ARP-866A: noise data is adjusted for user-defined temperature and relative humidity values according to the methods specified in SAE-ARP-866A.
- SAE-ARP-5534: noise data is adjusted for user-defined temperature, relative humidity, and atmospheric pressure values according to the methods specified in SAE-ARP-5534

The atmospheric absorption module used for the Updated Noise Contours was SAE ARP 5534. SAE ARP 5534 is a more recent module which replaces SAE ARP 866A.

Meteorological Data

The meteorological conditions (temperature, pressure, humidity, headwind) input into the noise model varied between the Annual Average and Outer Envelope Updated Noise Contours.

Meteorological data was sourced from the National Climate Database which contains weather data captured by the National Institute of Water and Atmospheric Research (NIWA). The dataset contains the monthly average values for temperature, pressure, humidity and wind speed. Data from the "Christchurch Aero" station #4843 was used.

For the Outer Envelope Noise Contour, October-December was used to represent the busy three-month period of interest as this historically is the busiest three-month period for aircraft operations in the calendar year. The met data for this period over the past 10 years from 2009 to 2019 was analysed and the resultant values are given in Appendix L.

For the Annual Average Updated Noise Contours the met data for each year from 1996-2016 was analysed and averaged and the resultant values are given in Appendix L.

4.8 Climate Change

Climate change has the potential to influence the size and shape of the noise contours in two main ways. Firstly, climate change may alter the incidence of a certain wind direction which would in turn change runway usage splits. Secondly, changes to temperature and humidity may alter the propagation of sound, as sound travels faster in hotter/more humid conditions.

A NIWA report[4] details climate simulations that were undertaken for the Intergovernmental Panel on Climate change (IPCC). The simulations predict that the frequency of extremely windy days in Canterbury by 2090 is likely to increase by up to 10 per cent. Changing weather patterns will lead to an increase in the frequency of north-west winds over Canterbury, particularly in winter and spring. Increased north-west winds would cause an increase in the use of Runway 29 which is used in those wind conditions, rather than the main runway. The simulations also predicted an increase in temperature of 3 degrees by 2090.

Deloitte also prepared a report[5] for Christchurch Airport on the effects of climate change in Christchurch. This reported slightly lower increases in temperature and windy days. The mean temperature was predicted to increase by about 1 degree in 2040 and 3 degrees in 2090. Extremely windy days were predicted to increase by between 2 and 10 percent by 2090 with an increase in the frequency of westerly winds.

The influence of climate change on the calculated noise contours has been considered in the noise modelling by increasing the Runway 29 usage by a factor of 1.10. This represents a future 10% increase in north westerly winds due to climate change. An equivalent adjustment has been made to reduce usage of Runway 02/20 to balance out the increase in Runway 29 usage.

[4] Climate Change Projections for New Zealand Atmospheric projections based on simulations undertaken for the IPCC 5th Assessment 2nd edition, 2018

[5] Deloitte Report – Christchurch International Airport Physical Climate Modelling – 18 June 2021

4.9 Noise Contour Calculation Grid Settings and Smoothing

The AEDT uses algorithms to calculate the noise level received at individual grid points at 4 ft above ground level and then interpolates noise contours between these grid points.

There are two types of grid settings available in AEDT, fixed grids and dynamic grids. Fixed grids calculate the noise at receptor points within a specified area at a defined grid spacing. Dynamic grids start with a small grid at a central point and move outwards until a certain noise level is reached.

A fixed grid was used to calculate the Updated Noise Contours in the AEDT as the taxiing operations are input as overflights which cannot be calculated using a dynamic grid in AEDT. The grid spacing applied was 0.05 NM for the 50 and 55 dB L_{dn} contours. A smaller grid spacing of 0.01 NM was required for the 65 dB L_{dn} and 95 dB L_{AE} contours to produce a smoother output.

All the calculated contours required smoothing to improve the irregular curvature of the lines produced by the grid calculations. The smoothing process was done with ArcGIS Pro using the tool 'Smooth Polygon'. The following smoothing parameters were applied:

Smoothing algorithm: Polynomial Approximation with Exponential Kernel (PAEK)

Tolerance (50 and 55 L_{dn} contours): 0.002 degrees (lat/long)

Tolerance (65 L_{dn} and LAE contours): 0.001 degrees (lat/long)

5.0 MODELLING INPUTS – OPERATIONAL

To calculate aircraft noise contours we input aircraft movements for an 'average day' over an assessment period. The average day of aircraft operations is defined by the average number of aircraft movements occurring in 24 hours by aircraft type, operation, route, time of day, runway used and flight track.

For the Updated Noise Contours we have used the future 12 month aircraft movement schedule from Volume 3 – Air Traffic Projection Report to derive the average day of movements by aircraft category, operation, route and time of day.

Aircraft types have been defined by a fleet allocation provided by Airbiz.

Runway utilisation for the average day has been determined by analysing historical runway utilisation data. There are five different average day runway usage scenarios used for the Updated Noise Contours.

Flight track allocation for the average day has been defined based on Volume 4: Flight Tracks Report as described in Section 4.3 of this report. This section of the report details the operational inputs to the noise model including aircraft types, movements schedules and runway utilisation.

The sensitivity study summarised in our preliminary noise modelling report[6] tested various input options to help identify which inputs to include in the Updated Noise Contours. The outcome of this study and a subsequent review by the Environment Canterbury appointed Peer Review Panel is that the Updated Noise Contours will include the following assumptions:

- Include freight, FBO/small commercial, airline/MRO (excludes Antarctic, military, government)
- Include helicopters (excludes military and rescue helicopters)
- Include taxiing of larger aircraft on the ground to and from runways

[6] Christchurch Recontouring Noise Modelling Report 11 May 2022

- 201k scheduled passenger aircraft movements at runway capacity (as opposed to 175k in the Operative Plan assumptions)
- 10% more usage of Runway 29 to account for climate change
- Calibration of noise model using flight profiles and stage lengths based on local noise monitoring
- Runway maintenance diversion of aircraft from main to cross-runway during limited days and hours of main runway closure (for Annual Average only)

5.1 Aircraft Movement Schedule

Airport noise contours in New Zealand are based on future aircraft movements. NZS6805 recommends a minimum of 10 years is used for the projection. For high density, mature international airports, international industry practice favours ultimate runway capacity. The justification, methodology and calculation of the ultimate runway capacity at Christchurch Airport for noise contour modelling purposes is described in detail in Volume 2 – Ultimate Runway Capacity Report.

One ultimate runway capacity movement schedule has been provided for the noise modelling and is described below. This is referred to as the "Average Daily Movement Tables" in Volume 3 – Air Traffic Projection Report.

The ultimate runway capacity schedule represents ultimate runway capacity at approximately 201k scheduled passenger aircraft movements (244k fixed wing movements with 35k helicopter movement). The number of Fixed Based Operator (FBO)/small commercial movements in this schedule is significantly reduced as these are displaced by a larger number of scheduled passenger movements.

In the Air Traffic Projection Report it has been assumed that as the Airport approaches ultimate runway capacity, scheduled passenger aircraft movements would be given preference as available runway slots become constrained. Consequently, it has been assumed that in the long term all general aviation traffic and 50% of the FBO and small commercial traffic would be displaced and relocate to other aerodromes as other commercial traffic movements put constraints on available airport infrastructure and airspace.

Volume 3 – Air Traffic Projection Report includes discussion about the implications of the COVID-19 pandemic on the forecasts on which the schedules used for noise modelling are based.

The aircraft movement schedule broken down into separate traffic segments is summarised in Table 3 below.

Table 3: Annual Aircraft Movement Schedules by Market Segment

Traffic Segment	Movement Numbers
Scheduled Passenger	200,683
Freight	15,227
Airline/MRO	5,244
FBO/Small Commercial	14,515
Antarctic/Military/Government	8,207
Helicopters	35,007

Source: Volume 3 – Air Traffic Projection Report

The modelled aircraft movements included in the Updated Noise Contours are shown in Table 4. Antarctic, government, and military movements (including military helicopters) and rescue helicopters have been excluded.

Table 4: Modelled Aircraft Movements by Market Segment

Traffic Segment	Movement Numbers
Included	
Scheduled Passenger	200,683
Freight	15,227
Airline/MRO[1]	5,244
FBO/Small Commercial[2]	14,515
Helicopters	27,945
Not Included	
Antarctic/Military/Government	8,207
Rescue Helicopter	6,842
General Aviation	-

Note 1: MRO (Maintenance Repair Overhaul)
Note 2: FBO (Fixed Base Operator)/Small Commercial

CIA must be able to facilitate military and government aircraft movements at all times. Military and government movements are often in response to natural disasters or emergencies and as such the Airport has limited ability to schedule, predict or manage when these movements will be required. Military and government movements are excluded or managed separately at a number of New Zealand Airports. Generally, they comprise a small number of movements and do not have a large impact on the noise contours.

Antarctic movements have been excluded from the contours, as CIAL has limited ability to schedule, predict or manage when these Antarctic movements will occur. Antarctic movements are also unique to the "Antarctic Season" (Spring / Summer) which is limited in duration and driven by weather conditions in Antarctica.

There is a rescue helicopter base at Christchurch Airport. The projected activity of rescue helicopters was forecast as its own category within the helicopter forecast (6,842 annual movements). These movements have been excluded from the noise modelling as it is not appropriate to restrict emergency operations. This is the accepted approach throughout New Zealand.

5.2 Busy Three-Month Peaking Factor

The aircraft movement schedules described in Section 5.1 contain flight numbers for an entire year. If a noise contour calculation represents the busiest three-months, we factor up the annual movement numbers to represent the 'busy three month' period. This is termed applying a peaking factor.

For example, if we have a hypothetical 100k movements per year, that equates to 274 for an average day (divide by 365). If the busiest three-months had 27k movements, this equates to 294 movements for an average day (divide by 91). The 'peaking factor' in this case is 'busiest/annual' i.e., 294/274 = 1.07.

We did not apply peaking factors for the Annual Average Updated Noise Contour as these represent noise emissions over an entire year.

For the Outer Envelope Updated Noise Contour option we used the peaking factors given in Table 5 based on analysis of aircraft movement data from 1999-2019[7] for all aircraft operations (scheduled, freight FBO/small commercial, airline/MRO, Antarctic,). These are the worst-case peaking factors for the summer months (Oct-Dec) from 1999-2019. October to December was chosen this time as this is generally the busiest three-month period in the calendar year.

We have split the peaking factor analysis into 4 categories, helicopters, scheduled, freight, and a category which includes FBO/small commercial, airline/MRO. The peaking factors for each category are given below and graphs are given in Appendix N.

Table 5: Peaking Factors – Updated Noise Contours

	Peaking Factor	Occurred
Scheduled	1.07	Oct-Dec 1999
Freight	1.08	Oct-Dec 2002
Airline/MRO FBO/Small Commercial	1.31	Oct-Dec 2015
Helicopters	1.50	Oct-Dec 2016

5.3 Aircraft Types and Substitutions

The aircraft movement schedule used for the noise modelling (from 'Volume 3 – Air Traffic Projection Report') sets out aircraft movements based on route and aircraft category[8]. A fleet schedule has also been provided by Airbiz that lists the aircraft types to be included in each category and the percentage allocation of each aircraft type.

We have selected corresponding aircraft types in the AEDT. In most cases the corresponding aircraft type is available in the model however for some aircraft a representative proxy has been selected. For one turbo-prop aircraft a proxy has been used despite the corresponding aircraft being available in the model. This is a result of the model calibration exercise described in Section 6.0.

A summary of the aircraft types defined by Airbiz and the selected AEDT aircraft types used for the Updated Noise Contours is provided in Appendix D.

5.4 Runway Utilisation

A diagram explaining the runway vectors and take-off and landing directions at Christchurch Airport is provided in the Glossary of Terminology in Appendix A.

Christchurch International Airport has four operational runways, two on the main runway and two on the shorter crosswind runway as follows:

- Runway 02 where aircraft land and take-off into a northly wind.
- Runway 20 where aircraft land and take-off into a southerly wind.

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[7] Gap in the data from 2008-2013. Freight data only available from 2000-2007. Helicopter data only available from 2015-2019.

[8] Broad aircraft categories related to seating capacity and range capability.

- Runway 29 where aircraft land and take-off into a north-westerly wind.
- Runway 11 where aircraft land and take-off into a south-easterly wind.

In general, each of these runways is used during the given wind direction. The 02 and 20 runways are the runways used most regularly, with runways 11 and 29 being used in strong crosswind conditions. Departures on runway 11 are extremely rare due to the desire to avoid departing aircraft flying over populated urban areas and for a number of operational reasons, including the short length of the cross-runway. We have assumed there are no departures on runway 11 in the Updated Noise Contours.

For noise modelling purposes, the 'runway usage split' is the proportion of aircraft using each of the four runway ends over the assessment period (12 months or 3 months). We have analysed the historical runway usage data from 1999 to 2019 to determine the average 12 month and busiest 3-month runway usage splits to inform the inputs for the Updated Noise Contours.

Our analysis showed that due to the variable wind patterns in Christchurch, the runway usage in any given three-month period varies significantly. Modelling noise contours for a single 3-month snapshot of runway usage would not adequately represent the extent of the noise impacts at different times of the year and would mean probable exceedance of the noise limit during alternative wind conditions. In response to this problem, we have calculated two different versions of the Updated Noise Contours by applying different runway usage approaches as follows:

Outer Envelope This approach takes account of the worst case 3-month runway usage for each runway by calculating four separate scenarios and taking the outer extent of these contours.

Annual Average This approach avoids the variation in 3-month wind patterns by applying the annual average runway usage.

The following sections describe the runway usage splits used for the Outer Envelope and Annual Average noise contour calculations.

5.4.1 Outer Envelope Runway Utilisation

The Outer Envelope is a composite of four scenarios which represent the highest usage on each runway over a three-month period. We refer to these as the four **runway bias scenarios**.

The results of our data analysis showed the highest recorded usage for each runway from 1999 to 2019 was as follows:

- Runway 02 71% January – March 2019
- Runway 20 50% May – July 2006
- Runway 11 2.5% February – April 2016
- Runway 29 13% September – November 2006

For the RW29 bias scenario, the worst case RW29 usage of 13%, was increased to 14.3% to account for potential climate change effects on increasing the prevalence of north-westerly wind patterns[9]. To balance out the increase on RW29, the usage on RW02 and RW20 was reduced equally for this scenario.

Table 6 lists the four sets of runway usage splits used for each of the modelled runway bias scenarios for the Outer Envelope noise contour.

[9] Refer to Section 4.8

Table 6: Runway Usage Splits Modelled for Each Runway Bias Scenario

Runway Bias Scenario	Runway 02	Runway 20	Runway 11	Runway 29	Total
RW02 bias	**71%**	24.5%	0.5%	4%	100%
RW20 bias	49%	**50%**	0%	1%	100%
RW11 bias	69%	23%	**2.5%**	5.5%	100%
RW29 bias[10]	55.35%	30.35%	0%	**14.3%**	100%

More detailed runway splits are given in Appendix C including separate runway splits for arrivals and departures and for some wide body jets that cannot use the cross-runway. A breakdown of the modelled aircraft movements by aircraft type and allocated runway for each runway bias scenario is listed in Appendix F through Appendix I.

Although these runway splits represent the highest recorded usage on each runway, similar runway splits have been observed in other months/years and the numbers in Table 4 do not represent outliers in the data.

5.4.2 Annual Average Runway Utilisation

The Annual Average runway splits were determined by calculating the 12 month runway splits for each calendar year from 1999 to 2019 and then calculating the average 12 month split on each runway. The results are shown in Table 7.

Table 7: Historical 12 Month Average Runway Splits

Runway 02	Runway 20	Runway 11	Runway 29	Total
58.5%	36.7%	0.3%	4.5%	100%

For the modelling the RW29 usage was increased to 4.95% to account for potential climate change effects increasing the prevalence of north-westerly wind patterns[11]. To balance out the increase on RW29, the usage on RW02 and RW20 was reduced equally. Table 8 shows the Annual Average runway splits applied in the noise model including separate runway splits for arrivals and departures and for wide body jets that cannot use the cross-runway. Runway maintenance is also accounted for in the Annual Average scenario and is described in more detail in Section 5.4.4.

Table 8: Runway Usage Splits for Annual Average Updated Noise Contour

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	58.275%	36.475%	0.300%	4.950%	100%
Narrow-body jet & turboprop departures	58.275%	36.475%	-	5.250%	100%
Wide-body jet arrivals & departures (that cannot use the crosswind runway)	61.0%	39.0%	-	-	100%

[10] Adjusted for climate change by increasing RW29 and decreasing RW02 and RW20

[11] Refer to Section 4.8

A breakdown of the modelled aircraft movements by aircraft type and allocated runway is listed in Appendix E.

There is variability in the runway splits year on year which could make the noise contours larger on one end of the runway than what we have modelled here. We have looked at historical data and generally the variability would only result in a 2 decibel change in the noise contours on a given runway end. We recommend including a 2-decibel tolerance in the noise rules to allow for abnormal runway splits in future.

5.4.3 Aircraft Allocation to Crosswind Runway

For all modelled scenarios, all aircraft have been allocated to use the main and cross-runway apart from the following wide body aircraft types which cannot operationally use the cross-runway.

- Airbus A380
- Airbus A350-900
- Airbus A350-1000
- Boeing 777-900
- Boeing 777-800
- Boeing 787-10

5.4.4 Runway Maintenance

Runway maintenance occurs at night on the main runway on a small proportion of days per year. On the nights when runway maintenance occurs jets that would normally use the main runway must use the cross-runway which increases the extent of the noise contour on this runway.

Analysis of historical periods of routine annual runway maintenance show 14 nights of runway maintenance can occur in a year. These are generally concentrated over the busy three month summer period. For these nights all aircraft (excluding wide body jets) use the cross-runway.

For the Annual Average noise contours, runway maintenance occurring on 14 nights over 12 months is included by shifting night-time movements to the cross-runway for these days.

For the Outer Envelope noise contours, the impact of allowing for 14 nights of runway maintenance over three months expands the cross-runway contour significantly. Given that the RW29 bias scenario for the Outer Envelope already accounts for the worst case three month RW29 usage (three times the annual average usage), and given that runway maintenance has isolated and short term impacts, we have not included runway maintenance in the Outer Envelope noise contours and recommend adding it as an exclusion within the noise compliance rules.

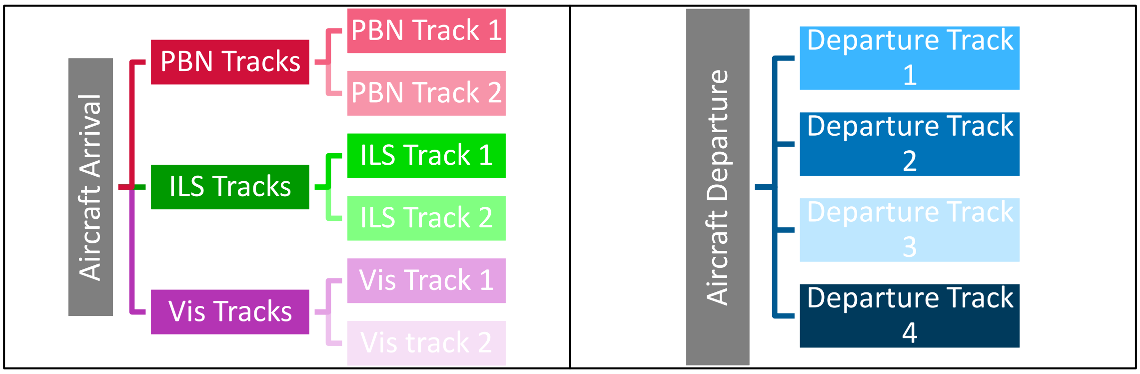
Runway maintenance for larger capital works projects such as future construction of the runway extensions has not been included as they are large scale infrequent runway capital construction events that are not appropriate to be included in the noise contours. These runway capital construction events are proposed to be covered off as an exclusion within the noise compliance rules.

5.5 Flight Track Allocation

Aircraft movements have been assigned to flight tracks in accordance with the allocations set out in Volume 4: Flight Track Report. For departure tracks, there is one step to the track allocation process. Tracks are assigned according to the aircraft type (jet or turbo-prop), route flown and percentage allocation across the available tracks set out in Volume 4.

For arrivals, there are two steps to the process. First, aircraft are assigned a type of arrival track (RNP, ILS/RNAV or Visual) based on the aircraft category and runway used. Then arrival tracks are assigned for each type of arrival according to the aircraft type (jet or turbo-prop), route flown and percentage allocation across the available tracks. Figure 7 illustrates the track allocation processes.

Figure 7: Track Allocations



5.6 Departure Stage Lengths

The origins and destinations provided in the aircraft movement schedule were used to calculate the departure stage lengths for the noise model. A stage length represents the distance a departing aircraft is travelling. In the noise model, the departure flight profiles (climb rate, thrust settings and speed) vary for different stage lengths. Longer stage lengths generally mean a heavier take-off weight due to increased fuel load and hence a shallower climb rate with a resulting increase in noise received on the ground.

Common stage lengths by region are:

- Stage Length 1 – Domestic NZ
- Stage Length 3 and 4 – Australia/Pacific
- Stage Length 5 – Western Australia
- Stage Length 6 – Hawaii
- Stage Length 7, 8 and 9 – America/Europe/Middle East/Asia

Appendix O gives the stage lengths used for each destination.

Some aircraft types in AEDT do not have stages 8 or 9 available. In these cases, where the selected representative aircraft may be a proxy for an aircraft with a greater range, or where an airline may use this aircraft on a route with reduced payload, the next closest stage length is used. Arrivals all have a nominal stage length of 1.

In some cases longer stage lengths have been used for the purpose of calibrating the noise model against measurement data. This process is described further in Section 6.0.

5.7 Aircraft Flight Profiles

The AEDT includes defined flight profiles (altitude, thrust, speed) for arrivals and departures for each aircraft type.

For jet departures there are generally three defined profiles available (Standard, ICAO A and ICAO B) and one for turbo-props (Standard) although there can be fewer or greater available depending on aircraft type. The model adjusts the departure profiles according to the departure stage length. For the Updated Noise Contours we have applied the Standard departure profiles[12] with the stage length

[12] The Standard departure profiles are generally representative for the CIA situation.

corresponding to destination unless our calibration exercise identified an alternative profile and stage length was appropriate (refer Section 6.0)

For arrivals there is generally one flight profile available (Standard). The Standard arrival altitude profile uses a step down or level segment approach which models segments of level flight at set altitudes separated by descending segments. From approximately 9.4 nautical miles from touchdown, the Standard altitude profile is a continuous descent on a 3 degree angle. The continuous descent on the final segment is an appropriate altitude profile for all arrival types into CIA (RNP, ILS and visual). Beyond 9.4 NM from the airport, it is less critical whether the AEDT profiles are representative because the noise contours are not influenced at this distance. Therefore, the Standard AEDT arrival profiles using stage length 1 have been used for the Updated Noise Contours.

5.8 Helicopters

The aircraft movement schedule provided by Airbiz includes helicopters. We have excluded rescue helicopters (BK117) and military helicopters listed in this schedule. The helicopter types in the schedule and the corresponding AEDT helicopter types used in the model are listed in Appendix E2. Not all the helicopter types are available in AEDT so for those that are not, substitutes were chosen based on helicopter size and engine specification.

The helicopter movements from the schedule were allocated to flight tracks in accordance with Volume 4: Flight Track Report. The allocations are listed in Appendix E1. For the Outer Envelope contours a busy three-month peaking factor of 1.5 was applied to helicopter movements (refer Section 5.2).

For helicopters, the Standard flight profiles in AEDT were applied and no calibration adjustments were made. A review of helicopter radar data carried out by Airbiz confirmed the Standard profiles are reasonably representative. The origin/destination of helicopters is domestic so a stage length of 1 was assumed for all movements.

6.0 CALIBRATION OF NOISE MODEL

As with any modelling software, there can be a difference between what is modelled and what is measured on the ground. In our experience, sometimes modelled noise levels for a particular aircraft operation do not match well when compared with in-field measurements. It is best practise in New Zealand to verify a noise model with measurements and adjust the inputs or assumptions to better match with the measured noise levels.

The purpose of the calibration exercise is to correct, as far as practicable, any substantial underprediction that may impact on CIAL's ability to comply with the noise contours or any substantial overprediction that may result in the contours being unreasonably over-stated.

There are several ways to 'calibrate' the noise model. An aircraft can be modelled using a different aircraft type if this aligns more closely with the measurements and other general characteristic of the aircraft and flight procedures are similar. Departing aircraft can also be calibrated by altering the departure profiles and stage lengths. For jet departures Standard, ICAO A and ICAO B profiles are generally available in the model. For turbo-prop aircraft, only Standard departure profiles are available. The stage length defines the distance the aircraft will travel and hence the likely take-off weight which can affect the departure flight profile. In general, the greater the stage length, the higher the noise levels near the airport. Where field measurements indicate the model underpredicts noise for a certain aircraft departure, the stage length can be increased in the model to calibrate the modelled noise with the measured noise. For arrivals, there are fewer options for calibration adjustment.

For the Christchurch Airport recontouring project we have carried out a model verification and calibration process using the available measurement data. We have analysed a large body of aircraft noise measurement data from Auckland and Christchurch Airports and compared the modelled predictions with the average measured level of individual aircraft operations using the sound exposure level L_{AE}.

The measurement data is from five different monitoring points (three from Auckland and two from Christchurch) and includes thousands of measured noise events each correlated to the aircraft type, operation and destination/origin. Where there is a notable difference between the measured and modelled L_{AE} values, (e.g. > 2 dB or more than one standard deviation from the mean measured L_{AE}), we have considered options for calibrating the model to improve the accuracy relative to the field data. Mostly this involved different flight profiles and stage lengths for departures. An alternative aircraft type has only been recommended for one case where the model substantially underpredicts. In summary, we have applied three calibration measures:

1. Increasing the stage length for some departures
2. Using the ICAO A departure profile rather than the Standard profile for some departures
3. Using a substitute aircraft type for one turbo-prop aircraft (DH8C) that the model significantly underpredicts.

For arrivals, our analysis generally found that the modelled L_{AE} based on standard settings compared well with the measurement data (except the DH8C). No adjustments are recommended where the standard modelling settings match the measurement data within an acceptable tolerance (generally within one standard deviation of the mean measured L_{AE}).

A summary of the calibration adjustments for each aircraft type in the Updated Noise Contours is provided in Appendix M.

7.0 UPDATED NOISE CONTOURS

7.1 Two Options for the Updated Noise Contours

This report presents two valid options to be used for the 'Updated Noise Contours' which are:

- The Outer Envelope future noise contours (Outer Envelope)
- The Annual Average future noise contours (Annual Average)

The Outer Envelope is a composite of four scenarios which represent the busiest three-months of runway utilisation on each runway end. The outer perimeter of these four noise contours at each decibel level defines the Outer Envelope contour. For this option, the aircraft movements have also been adjusted by a busy-three month peaking factor.

The Annual Average is a single noise contour (not a composite) to represent the noise exposure over an entire calendar year instead of the busiest three months (i.e. no peaking factor applied). The runway utilisation applied for this option is the historical annual average.

Appendix P3 shows the individual 50 dB L_{dn} contours of the four contour runs that make up the Outer Envelope. Appendix P1 (and Figure 8 below) shows the composite of these as the Outer Envelope noise contours. Appendix P2 (and Figure 9 below) shows the Annual Average noise contours.

Either of the two options (Outer Envelope or Annual Average) could be used by the planning authorities for the Updated Noise Contours. NZS 6805:1992 recommends that noise contours are generally based on noise over a three-month period (or such other period as agreed). Airports in New Zealand mostly use a three-month average with Auckland Airport using an annual average. We consider both options are valid methods of calculating noise contours to achieve the objectives of NZS 6805. The associated rules related to measuring and monitoring compliance will differ depending on which option is selected.

In the context of identifying and managing noise effects, the question is whether a 3 month or 12 month noise exposure is the appropriate period to assess. In our view, there is no clear-cut answer. Most of the research regarding aircraft noise annoyance is based on residents' perception of noise over a 12-month period. Given that three months is a reasonably sustained period, the research based on 12 months may also be applicable to a 3 month exposure. The overall outcome for residents over a longer timeframe would depend on the degree of respite outside the busy three-month period.

In summary, we have calculated two options for the Updated Noise Contours. This report does not consider the land use planning or compliance monitoring rules associated with the contours and is not an assessment of noise effects. Nor does this report include an assessment or recommendation on which of the two options should be adopted.

Figure 8: Outer Envelope Updated Noise Contours

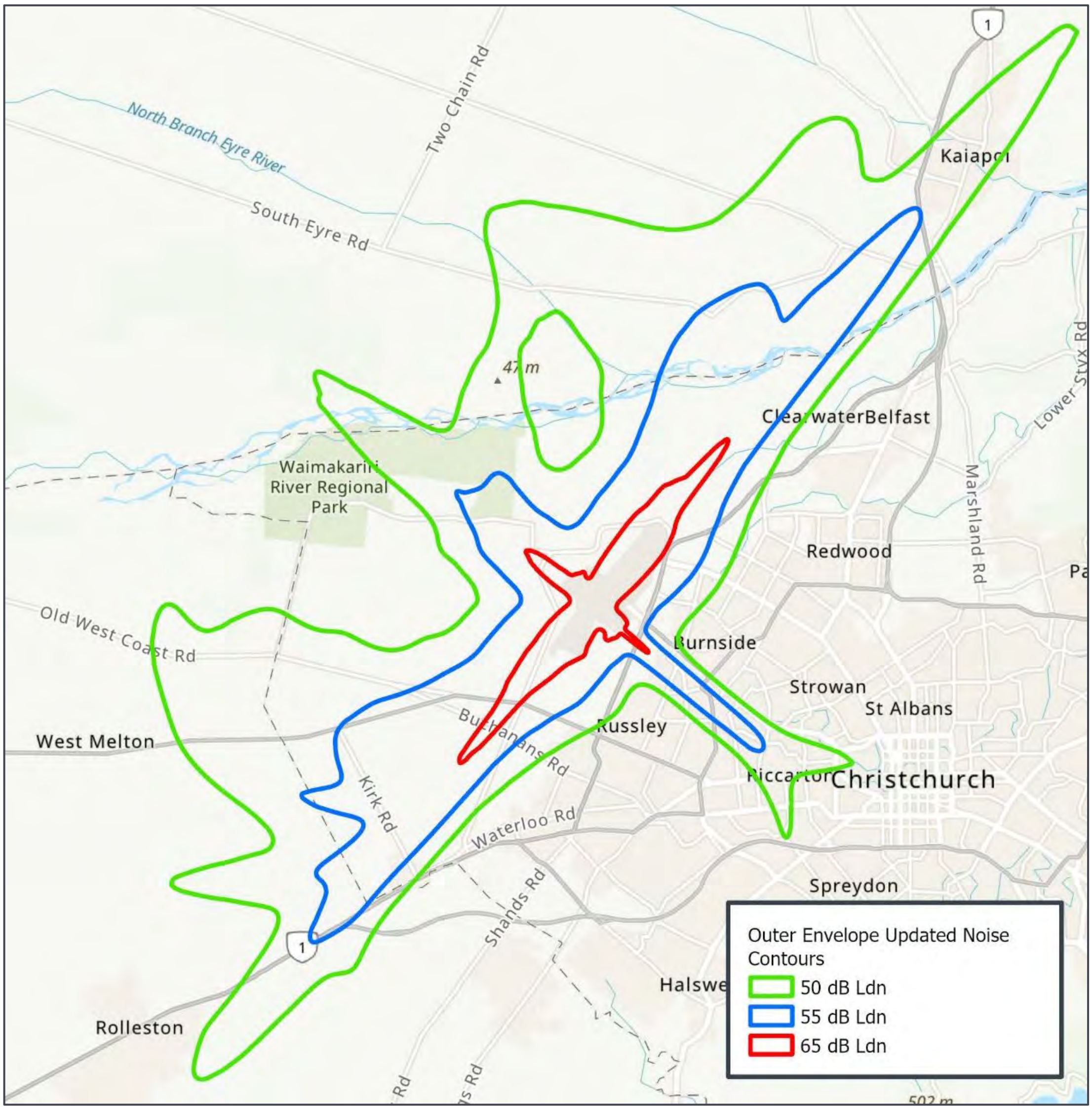
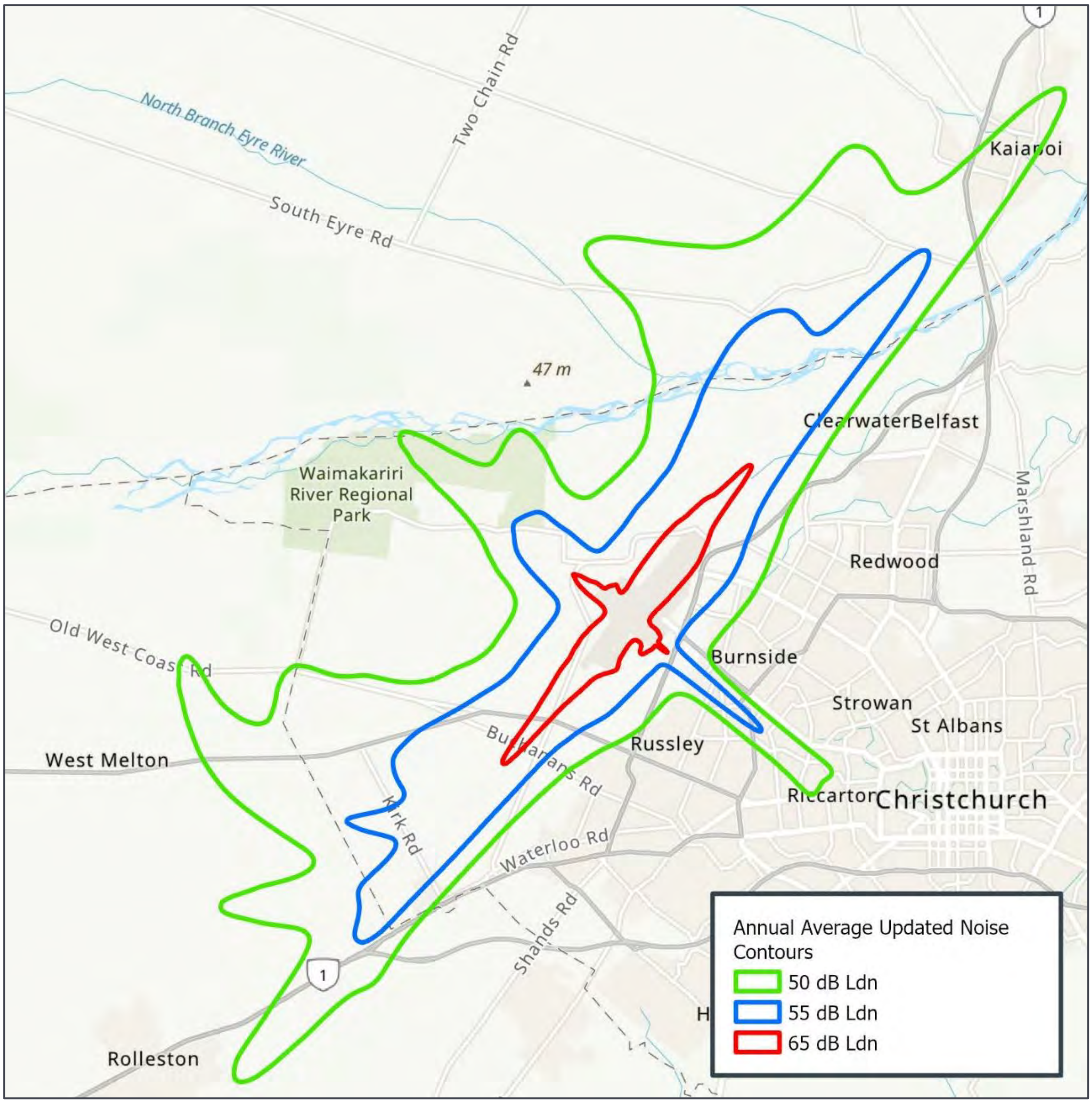


Figure 9: Annual Average Updated Noise Contours

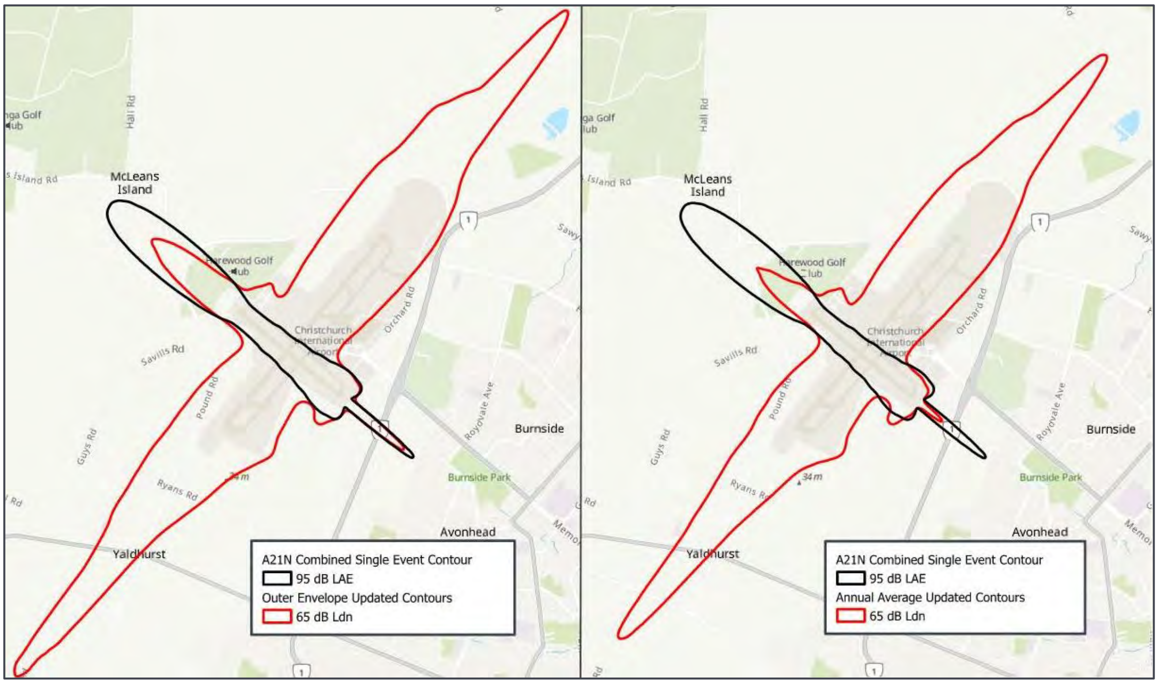


7.2 Air Noise Boundary (L_{dn} 65 + 95 dB L_{AE})

The Operative Plan Air Noise Boundary **(ANB)** is a composite noise contour made up of the 65 dB L_{dn} noise contour and the single event 95 dB L_{AE} contour of the noisiest aircraft operating frequently at night-time. The single event 95 dB L_{AE} contour is used to manage sleep disturbance at night.

We have calculated the 95 dB L_{AE} contours for jet aircraft operating at night in the Updated Noise Contour model. For the main runway (02/20), the 95 dB L_{AE} contours do not extend beyond the 65 dB L_{dn} contours for both the Annual Average and Outer Envelope options. For the cross-runway, the 95 dB L_{AE} contours for jet departures and arrivals on Runway 29 do extend outside the 65 dB L_{dn} contours. The largest single event contour on Runway 29 belongs to the A21N departure and arrival on Trans-Tasman routes. Figure 10 shows the extent of these contours relative to the 65 dB L_{dn} for the Outer Envelope and Annual Average options. The Updated Air Noise Boundary for each option would be defined by the outer extent of L_{dn} and L_{AE} contours. Appendix R shows the Updated Air Noise Boundaries compared with the Operative Plan Air Noise Boundary.

Figure 10: Updated Noise Contours 65 dB L_{dn} and 95 dB L_{AE} for A21N on Runway 29



APPENDIX A GLOSSARY OF TERMINOLOGY

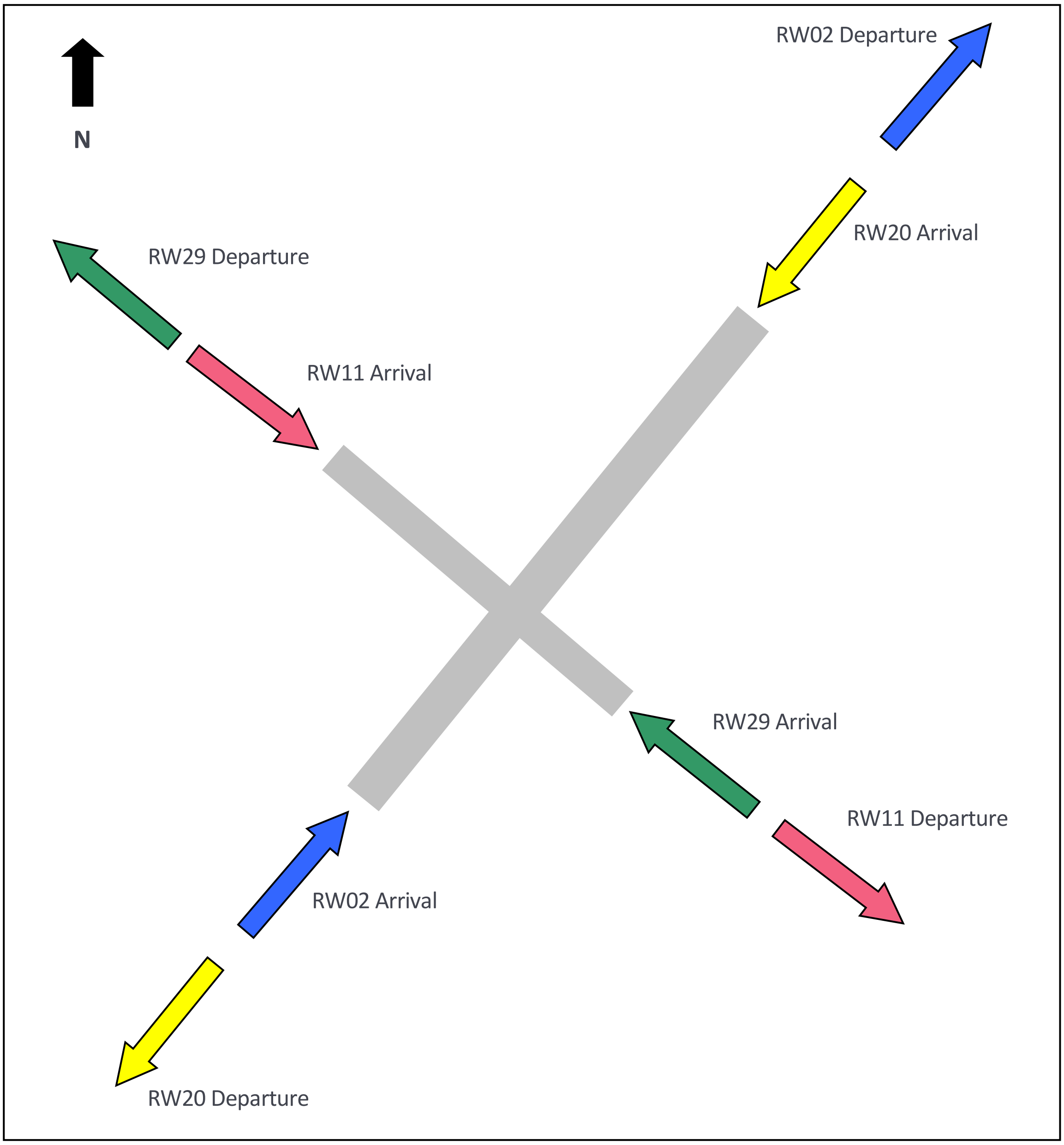
Name	Description
AEDT	Aviation Environmental Design Tool. A proprietary noise model created by the FAA used to calculate noise contours around an airport (replacement of the INM).
AIP	Aeronautical Information Publication New Zealand. Contains aeronautical information essential to air navigation in New Zealand.
Airways New Zealand	The sole Air Traffic Service provider in New Zealand.
CIA	Christchurch International Airport
CIAL	Christchurch International Airport Limited
Cliflo	The web system that provides access to New Zealand's National Climate Database.
Continuous Descent Approach	An aircraft operating technique in which an arriving aircraft descends from an optimal position with minimum thrust and avoids level flight.
Cross-runway	Refers collectively to Runway 11 and Runway 29.
CRPS	Canterbury Regional Policy Statement.
Current Runway Configuration	Refers to the currently existing main and cross-runway. Doesn’t include any proposed extensions.
Daytime	Assumed to be from 7 am to 10 pm.
dB	Decibel. The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 mPa i.e. dB = 20 x log(P/Pr)
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear.
Displaced Approach Threshold	Distance from the end of the runway to the threshold-crossing point or “piano keys”. The “piano keys” are usually near the end of the runway
Expert Panel Report	Prepared in 2008 and outlines the assumptions and methodologies used to prepare the Operative Plan Noise Contours
FAA	The Federal Aviation Administration in the United States. The developer of the INM and the AEDT noise models.
FBO	Fixed Based Operators

Name	Description
Flight operations input (opsflt)	The input into the noise model containing the aircraft operations broken down by runway, track, aircraft type, profile, stage length and time of day.
Future Fleet	Refers to the fleet mix provided by Airbiz in the future. Includes new generation aircraft.
Future Runway Configuration	Refers to the envisaged future main and cross-runway. Includes proposed extensions to runway 11 and 20.
ILS Approach	Instrument Landing System Approach. A type of approach that uses a precision runway approach aid based on two radio beams that provide vertical and horizontal guidance.
INM	The FAA's Integrated Noise Model. A proprietary noise model used to calculate noise contours around an airport.
IPCC	Intergovernmental Panel on Climate Change
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
L_{dn}	The day-night noise level which is calculated from the 24-hour L_{Aeq} with a 10-dB penalty applied to the night-time (2200-0700 hours) L_{Aeq}.
Main Runway	Refers collectively to Runway 02 and Runway 20.
MDA	Marshall Day Acoustics.
NASA	The National Aeronautics and Space Administration.
MRO	Maintenance, Repair, Overhaul
National Climate Database	Database of weather and climate measurements in New Zealand. Collated by NIWA.
Night-time	Assumed to be from 10 pm to 7 am.
NIWA	National Institute of Water and Atmospheric Research
Noise	A sound that is unwanted by or distracting to the receiver.
Noise Model	A programme used to model aircraft noise to produce the noise contours. The INM and the AEDT are types of noise model.
NZS 6805:1992	New Zealand Standard NZS 6805:1992 *"Airport Noise Management and Land Use Planning"*
Operative Plan Noise Contours	The Noise Contours Currently in the Canterbury Regional Policy Statement and Christchurch, Selwyn and Waimakariri District Plans.

Name	Description
RNP	Performance-Based Navigation. Encompasses a shift from ground-based navigation aids emitting signals to aircraft receivers, to 'in-aircraft' systems that receive satellite signals from sources such as the Global Positioning System (GPS).
RNP Approach	Required Navigation Performance Approach. Is a type of RNP approach that allows an aircraft to fly a specific track between two 3-dimensionally defined points in space.
Runway 02	Runway 02 is the main runway with aircraft landing and taking off in a northerly direction (heading 020 degrees magnetic)
Runway 11	Runway 11 is the cross-runway with aircraft landing and taking off in an easterly direction (heading 110 degrees magnetic)
Runway 20	Runway 20 is the main runway with aircraft landing and taking off in a southerly direction (heading 200 degrees magnetic)
Runway 29	Runway 29 is the cross-runway with aircraft landing and taking off in a westerly direction (heading 290 degrees magnetic)
SAE-AIR-1845	SAE-AIR-1845:1986 "Procedure for the Calculation of Airplane Noise in the Vicinity of Airports".
SAE-APR-866A	SAE-ARP-866A:1975 "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise"
SAE-ARP -5534	SAE-ARP-5534:2013 "Application of Pure Tone Atmospheric Absorption Losses to One-Third Octave Band Data"
SEL or L_{AE}	Sound Exposure Level. The sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
Sensitivity Run	Several runs taken to isolate the effect of certain inputs and assumptions to the noise contours such as fleet changes or changes to flight tracks.
SRTM	Shuttle Radar Topography Mission. Is an international research effort that obtained digital elevation models on a near-global scale, to generate a high-resolution digital topographic database of Earth.
Start of Roll (or Displaced Take-off Threshold)	Distance from the physical end of the runway to the average position of noise-producing engines at the start of take-off roll

Name	Description
Step Down Approach	An aircraft operating technique in which an aircraft descends via a series of steps. This involves level fly segments and periods of descent. Continuous descent approach is slowly replacing step down approach as they are quieter and more efficient.
Updated Noise Contours	The updated noise contours to replace the Operative Plan Noise Contours, modelled by CIAL's experts and to be peer reviewed by a panel of experts before confirmation.
Visual Approach	An approach when either part or all an instrument approach procedure is not completed, and the approach is executed with visual reference to the terrain.

Christchurch International Airport Runway Vectors and Movement Directions



APPENDIX B RUNWAY AND HELIPAD COORDINATES

B1 Runways

Runway Endpoint	Coordinates (WGS84 Lat/Long)	Elevation (m/ft)	Width (m/ft)
02	-43.497614 / 172.522113	38m / 123ft	44m / 145ft
20	-43.474966 / 172.548293	28m / 93ft	44m / 145ft
11	-43.484272 / 172.524408	35m / 115ft	44m / 145ft
29	-43.494366 / 172.540878	29m / 95ft	44m / 145ft
20 (Extended)	-43.472899 / 172.550679	28m / 93ft	44m / 145ft
11 (Extended)	-43.481605 / 172.520059	35m / 115ft	44m / 145ft

Source: Christchurch Airport

B2 Runway Lengths

	Current Runway Configuration Length (m)	Future Runway Configuration Length (m)
Runway 02/20	3,288 m	3,588 m
Runway 11/29	1,741 m	2,200 m

Source: Christchurch Airport

B3 Helipads

Helipad	Coordinates (Lat/Long)	Elevation (m/ft)
Garden City	-43.499619 / 172.527755	32 m / 105ft
Heli-Centre	-43.482834 / 172.527901	38 m / 123ft

Source: Christchurch Airport

B4 Runway Displaced Thresholds in Noise Model

Runway End Name	Aircraft/Route	Landing Threshold	Take-off Threshold
02TEXT	Turbo-props	6 m /20 ft	1410 m /4626 ft
20TEXT	Turbo-props	7 m /23 ft	1802 m /5912 ft
02DEXT	Domestic jets	6 m /20 ft	435 m /1427 ft
20DEXT	Domestic jets	7 m /23 ft	1206 m /3956 ft
02IEXT	Short haul international	6 m /20 ft	42 m /138 ft
20IEXT	Short haul international	7 m /23 ft	360 m /1180 ft
02ILHEXT	Long haul international	6 m /20 ft	42 m /138 ft
20ILHEXT	Long haul international	7 m /23 ft	43 m /141 ft
11	All	7 m /23 ft	43 m /141 ft
29	All	5 m /16 ft	41 m /135 ft

APPENDIX C RUNWAY SPLITS – UPDATED NOISE CONTOURS

C1 Runway Splits – Highest Usage of Runway 02

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	71.0%	24.5%	0.50%	4.0%	100%
Narrow-body jet & turboprop departures	71.0%	24.5%	-	4.5%	100%
Wide-body jet arrivals & departures *(that can't use the cross-runway)*	74%	26%	-	-	100%

C2 Runway Splits – Highest Usage of Runway 20

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	49.0%	50.0%	0%	1.0%	100%
Narrow-body jet & turboprop departures	49.0%	50.0%	-	1.0%	100%
Wide-body jet arrivals & departures *(that can't use the cross-runway)*	49%	51%	-	-	

C3 Runway Splits – Highest Usage of Runway 11

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	69.0%	23.0%	2.50%	5.50%	100%
Narrow-body jet & turboprop departures	69.0%	23.0%	-	8.00%	100%
Wide-body jet arrivals & departures *(that can't use the cross-runway)*	75.0%	25.0%			100%

C4 Runway Splits – Highest Usage of Runway 29

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	55.35%	30.35%	0%	14.30%	100%
Narrow-body jet & turboprop departures	55.35%	30.35%	-	14.30%	100%
Wide-body jet arrivals & departures *(that can't use the cross-runway)*	64.0%	36.0%			100%

C5 Runway Splits– Historical Annual Average Adjusted for Climate Change Factor

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow-body jet & turboprop arrivals	58.275%	36.475%	0.300%	4.950%	100%
Narrow-body jet & turboprop departures	58.275%	36.475%	-	5.250%	100%
Wide-body jet arrivals & departures *(that can't use the cross-runway)*	61.0%	39.0%			100%

APPENDIX D AIRCRAFT TYPES

D1 Aircraft Types – Scheduled and Freight

Aircraft Category	Future Fleet Aircraft Type	AEDT Aircraft Type ANP ID	AEDT Equipment ID
Very Large Wide-Body Jet	Airbus A380 (A388)	A380-861	2462
Large Wide-Body Jet	Boeing 777900 (B779)	A350-941	5308
	Airbus A350-1000	A350-941	5308
Medium Wide-Body Jet	Airbus A350 (A359)	A350-941	6200
	Boeing 777800 (B778)	A350-941	5308
	Boeing 787900 (B789)	7879	6439
	Boeing 787-10 (B781)	7879	5308
	Boeing 777-200F (B772F)	777200	3925
Small Wide-Body Jet	Boeing 797700 (B797)	7878R	6435
	Boeing 787800 (B788)	7878R	6435
Large Narrow-Body Jet	Airbus A321 Neo (A21N)	A321-232	5978
Medium Narrow-Body Jet	Airbus A320 Neo (A20N)	A320-271N	5975
	Boeing 737 Max (B38M)	7378MAX	6172
Large Turboprop	ATR-72 (AT76)	ATR72-212A	1671
	DHC-8-300 (DH8C)	ATR72-212A	1671
Medium Turboprop	DHC-8-300 (DH8C)	ATR72-212A	1671
Small Turboprop	Generic Small Turboprop	GASEPF (Pilatus TProp)	1532
Very Small Turboprop	Pilatus PC-12 (PC12)	CNA208	1489

D2 Aircraft Types – FBO/small commercial, airline/MRO

Aircraft Category	Future Fleet Aircraft Type	AEDT Aircraft Type ANP ID	AEDT Equipment ID
Heavy Two Engine Jet	Boeing 787900 (B789)	7879	6439
Medium Jet	Airbus A320 (A320)	A320-232	1019
Medium Two Engine Turboprop	ATR-72 (AT76)	ATR72-212A	1671
Light Multi-Engine Turboprop	Beech 200 Super King Air (BE20)	C12	3189
Light Single Engine Turboprop	Cessna 208 (C208)	CNA208	2106
Light Multi Engine Piston	Piper PA31 (PA31)	PA31	6225
Light Single Engine Piston	Cessna 185 (C185)	CNA182	6271

APPENDIX E MODELLED AIRCRAFT MOVEMENTS ANNUAL AVERAGE - AVERAGE DAY

E1 Scheduled Passenger Aircraft Arrivals – Annual Average

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	15.29	0.08	9.57	1.30	1.38	0.01	0.86	0.22
A21N	26.41	0.14	16.53	2.24	7.04	0.04	4.41	1.10
A351	2.75		1.76		1.13		0.72	
A359	0.99		0.63		0.07		0.04	
A388	1.10		0.70		0.00		0.00	
AT76	60.50	0.31	37.87	5.14	4.42	0.02	2.76	0.69
B38M	0.38	0.00	0.24	0.03	0.06	0.00	0.04	0.01
B778	2.63		1.68		0.07		0.04	
B779	2.75		1.76		1.13		0.72	
B781	0.99		0.63		0.07		0.04	
B788	2.58	0.01	1.61	0.22	2.20	0.01	1.37	0.34
B789	2.52	0.01	1.57	0.21	0.07	0.00	0.04	0.01
B797	14.56	0.07	9.12	1.24	2.20	0.01	1.37	0.34
DHC830	1.67	0.01	1.04	0.14	0.00	0.00	0.00	0.00
Small TP	1.92	0.01	1.20	0.16	0.00	0.00	0.00	0.00
PC12	3.23	0.02	2.02	0.27	0.00	0.00	0.00	0.00
Total	**140.25**	**0.66**	**87.94**	**10.96**	**19.84**	**0.09**	**12.45**	**2.71**

E2 Scheduled Passenger Aircraft Departures – Annual Average

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	15.29		9.57	1.38	1.38		0.86	0.22
A21N	26.41		16.53	2.38	7.04		4.41	1.14
A351	2.75		1.76		1.13		0.72	
A359	0.99		0.63		0.07		0.04	
A388	1.10		0.70		0.00		0.00	
AT76	60.50		37.87	5.45	4.42		2.76	0.71
B38M	0.38		0.24	0.03	0.06		0.04	0.01
B778	2.63		1.68		0.07		0.04	
B779	2.75		1.76		1.13		0.72	
B781	0.99		0.63		0.07		0.04	
B788	2.58		1.61	0.23	2.20		1.37	0.35
B789	2.52		1.57	0.23	0.07		0.04	0.01
B797	14.56		9.12	1.31	2.20		1.37	0.35
DHC830	1.67		1.04	0.15	0.00		0.00	0.00
Small TP	1.92		1.20	0.17	0.00		0.00	0.00
PC12	3.23		2.02	0.29	0.00		0.00	0.00
Total	**140.25**	**0.00**	**87.94**	**11.63**	**19.84**	**0.00**	**12.45**	**2.80**

E3 Non-Scheduled Fixed Wing Aircraft Arrivals – Annual Average

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.147	0.006	0.718	0.097	3.546	0.019	2.219	0.554
A21N	0.331	0.002	0.207	0.028	0.142	0.001	0.089	0.022
A320	1.922	0.010	1.203	0.163	0.556	0.003	0.348	0.087
A359	0.091		0.058		0.115		0.074	
AT76	3.129	0.016	1.959	0.266	0.289	0.002	0.181	0.045
B38M	1.147	0.006	0.718	0.097	3.546	0.019	2.219	0.554
B772F	0.094		0.060		0.119		0.076	
B788	0.168	0.001	0.105	0.014	0.766	0.004	0.479	0.120
B789	0.124	0.001	0.078	0.011	0.124	0.001	0.078	0.011
BEC200	7.720	0.040	4.832	0.656	0.579	0.003	0.363	0.091
CNA185	0.555	0.003	0.347	0.047	0.000	0.000	0.000	0.000
CNA208	0.488	0.003	0.305	0.041	0.006	0.000	0.004	0.001
PA31	0.420	0.002	0.263	0.036	0.024	0.000	0.015	0.004
PC12	0.112	0.001	0.070	0.010	0.323	0.002	0.202	0.050
Total	**17.45**	**0.09**	**10.92**	**1.47**	**10.14**	**0.05**	**6.35**	**1.54**

E4 Non-Scheduled Fixed Wing Aircraft Departures – Annual Average

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.147		0.718	0.103	3.546		2.219	0.573
A21N	0.331		0.207	0.030	0.142		0.089	0.023
A320	1.922		1.203	0.173	0.556		0.348	0.090
A359	0.091		0.058		0.115		0.074	
AT76	3.129		1.959	0.282	0.289		0.181	0.047
B38M	1.147		0.718	0.103	3.546		2.219	0.573
B772F	0.094		0.060		0.119		0.076	
B788	0.168		0.105	0.015	0.766		0.479	0.124
B789	0.124		0.078	0.011	0.124		0.078	0.011
BEC200	7.720		4.832	0.695	0.579		0.363	0.094
CNA185	0.555		0.347	0.050	0.000		0.000	0.000
CNA208	0.488		0.305	0.044	0.006		0.004	0.001
PA31	0.420		0.263	0.038	0.024		0.015	0.004
PC12	0.112		0.070	0.010	0.323		0.202	0.052
Total	**17.45**	**0.00**	**10.92**	**1.56**	**10.14**	**0.00**	**6.35**	**1.59**

APPENDIX F MODELLED AIRCRAFT MOVEMENTS RUNWAY 02 BIAS - AVERAGE DAY

F1 Scheduled Passenger Aircraft Arrivals – RW02 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	18.63	0.13	6.43	1.05	1.75	0.01	0.60	0.10
A21N	32.18	0.23	11.10	1.81	8.94	0.06	3.08	0.50
A351	3.33		1.17		1.38		0.48	
A359	1.20		0.42		0.09		0.03	
A388	1.33		0.47		0.00		0.00	
AT76	73.71	0.52	25.43	4.15	5.61	0.04	1.93	0.32
B38M	0.46	0.00	0.16	0.03	0.08	0.00	0.03	0.00
B778	3.19		1.12		0.09		0.03	
B779	3.33		1.17		1.38		0.48	
B781	1.20		0.42		0.09		0.03	
B788	3.14	0.02	1.08	0.18	2.79	0.02	0.96	0.16
B789	3.07	0.02	1.06	0.17	0.08	0.00	0.03	0.00
B797	17.74	0.12	6.12	1.00	2.79	0.02	0.96	0.16
DHC830	2.03	0.01	0.70	0.11	0.00	0.00	0.00	0.00
Small TP	2.33	0.02	0.81	0.13	0.00	0.00	0.00	0.00
PC12	3.94	0.03	1.36	0.22	0.00	0.00	0.00	0.00
Total	**170.82**	**1.11**	**59.03**	**8.86**	**25.04**	**0.16**	**8.66**	**1.24**

F2 Scheduled Passenger Aircraft Departures – RW02 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	18.63		6.43	1.18	1.75		0.60	0.11
A21N	32.18		11.10	2.04	8.94		3.08	0.57
A351	3.33		1.17		1.38		0.48	
A359	1.20		0.42		0.09		0.03	
A388	1.33		0.47		0.00		0.00	
AT76	73.71		25.43	4.67	5.61		1.93	0.36
B38M	0.46		0.16	0.03	0.08		0.03	0.01
B778	3.19		1.12		0.09		0.03	
B779	3.33		1.17		1.38		0.48	
B781	1.20		0.42		0.09		0.03	
B788	3.14		1.08	0.20	2.79		0.96	0.18
B789	3.07		1.06	0.19	0.08		0.03	0.01
B797	17.74		6.12	1.12	2.79		0.96	0.18
DHC830	2.03		0.70	0.13	0.00		0.00	0.00
Small TP	2.33		0.81	0.15	0.00		0.00	0.00
PC12	3.94		1.36	0.25	0.00		0.00	0.00
Total	**170.82**	**0.00**	**59.03**	**9.97**	**25.04**	**0.00**	**8.66**	**1.40**

F3 Non-Scheduled Fixed Wing Aircraft Arrivals – RW02 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.397	0.010	0.482	0.079	4.500	0.032	1.553	0.254
A21N	0.404	0.003	0.139	0.023	0.181	0.001	0.062	0.010
A320	2.342	0.016	0.808	0.132	0.706	0.005	0.244	0.040
A359	0.110		0.039		0.140		0.049	
AT76	3.813	0.027	1.316	0.215	0.367	0.003	0.127	0.021
B38M	1.397	0.010	0.482	0.079	4.500	0.032	1.553	0.254
B772F	0.114		0.040		0.144		0.051	
B788	0.205	0.001	0.071	0.012	0.972	0.007	0.335	0.055
B789	0.152	0.001	0.052	0.009	0.151	0.001	0.052	0.009
BEC200	9.406	0.066	3.246	0.530	0.735	0.005	0.254	0.041
CNA185	0.676	0.005	0.233	0.038	0.000	0.000	0.000	0.000
CNA208	0.594	0.004	0.205	0.033	0.008	0.000	0.003	0.000
PA31	0.512	0.004	0.177	0.029	0.030	0.000	0.010	0.002
PC12	0.137	0.001	0.047	0.008	0.410	0.003	0.141	0.023
Total	**21.26**	**0.15**	**7.34**	**1.19**	**12.84**	**0.09**	**4.43**	**0.71**

F4 Non-Scheduled Fixed Wing Aircraft Departures – RW02 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.397		0.482	0.089	4.500		1.553	0.285
A21N	0.404		0.139	0.026	0.181		0.062	0.011
A320	2.342		0.808	0.148	0.706		0.244	0.045
A359	0.110		0.039		0.140		0.049	
AT76	3.813		1.316	0.242	0.367		0.127	0.023
B38M	1.397		0.482	0.089	4.500		1.553	0.285
B772F	0.114		0.040		0.144		0.051	
B788	0.205		0.071	0.013	0.972		0.335	0.062
B789	0.152		0.052	0.010	0.151		0.052	0.010
BEC200	9.406		3.246	0.596	0.735		0.254	0.047
CNA185	0.676		0.233	0.043	0.000		0.000	0.000
CNA208	0.594		0.205	0.038	0.008		0.003	0.001
PA31	0.512		0.177	0.032	0.030		0.010	0.002
PC12	0.137		0.047	0.009	0.410		0.141	0.026
Total	**21.26**	**0.00**	**7.34**	**1.33**	**12.84**	**0.00**	**4.43**	**0.80**

APPENDIX G MODELLED AIRCRAFT MOVEMENTS RUNWAY 11 BIAS - AVERAGE DAY

G1 Scheduled Passenger Aircraft Arrivals – RW11 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	18.10	0.66	6.03	1.44	1.70	0.06	0.57	0.14
A21N	31.27	1.13	10.42	2.49	8.69	0.31	2.90	0.69
A351	3.38		1.13		1.39		0.46	
A359	1.21		0.40		0.09		0.03	
A388	1.35		0.45		0.00		0.00	
AT76	71.63	2.60	23.88	5.71	5.45	0.20	1.82	0.43
B38M	0.45	0.02	0.15	0.04	0.08	0.00	0.03	0.01
B778	3.24		1.08		0.09		0.03	
B779	3.38		1.13		1.39		0.46	
B781	1.21		0.40		0.09		0.03	
B788	3.05	0.11	1.02	0.24	2.71	0.10	0.90	0.22
B789	2.98	0.11	0.99	0.24	0.08	0.00	0.03	0.01
B797	17.24	0.62	5.75	1.37	2.71	0.10	0.90	0.22
DHC830	1.98	0.07	0.66	0.16	0.00	0.00	0.00	0.00
Small TP	2.27	0.08	0.76	0.18	0.00	0.00	0.00	0.00
PC12	3.83	0.14	1.28	0.31	0.00	0.00	0.00	0.00
Total	**166.58**	**5.54**	**55.53**	**12.18**	**24.46**	**0.78**	**8.15**	**1.71**

G2 Scheduled Passenger Aircraft Departures – RW11 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	18.10		6.03	2.10	1.70		0.57	0.20
A21N	31.27		10.42	3.63	8.69		2.90	1.01
A351	3.38		1.13		1.39		0.46	
A359	1.21		0.40		0.09		0.03	
A388	1.35		0.45		0.00		0.00	
AT76	71.63		23.88	8.30	5.45		1.82	0.63
B38M	0.45		0.15	0.05	0.08		0.03	0.01
B778	3.24		1.08		0.09		0.03	
B779	3.38		1.13		1.39		0.46	
B781	1.21		0.40		0.09		0.03	
B788	3.05		1.02	0.35	2.71		0.90	0.31
B789	2.98		0.99	0.35	0.08		0.03	0.01
B797	17.24		5.75	2.00	2.71		0.90	0.31
DHC830	1.98		0.66	0.23	0.00		0.00	0.00
Small TP	2.27		0.76	0.26	0.00		0.00	0.00
PC12	3.83		1.28	0.44	0.00		0.00	0.00
Total	**166.58**	**0.00**	**55.53**	**17.72**	**24.46**	**0.00**	**8.15**	**2.48**

G3 Non-Scheduled Fixed Wing Aircraft Arrivals – RW11 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	1.36	0.05	0.45	0.11	4.37	0.16	1.46	0.35
A21N	0.39	0.01	0.13	0.03	0.18	0.01	0.06	0.01
A320	2.28	0.08	0.76	0.18	0.69	0.02	0.23	0.05
A359	0.11		0.04		0.14		0.05	
AT76	3.71	0.13	1.24	0.30	0.36	0.01	0.12	0.03
B38M	1.36	0.05	0.45	0.11	4.37	0.16	1.46	0.35
B772F	0.12		0.04		0.15		0.05	
B788	0.20	0.01	0.07	0.02	0.94	0.03	0.31	0.08
B789	0.15	0.01	0.05	0.01	0.15	0.01	0.05	0.01
BEC200	9.14	0.33	3.05	0.73	0.71	0.03	0.24	0.06
CNA185	0.66	0.02	0.22	0.05	0.00	0.00	0.00	0.00
CNA208	0.58	0.02	0.19	0.05	0.01	0.00	0.00	0.00
PA31	0.50	0.02	0.17	0.04	0.03	0.00	0.01	0.00
PC12	0.13	0.00	0.04	0.01	0.40	0.01	0.13	0.03
Total	**20.67**	**0.74**	**6.89**	**1.63**	**12.49**	**0.44**	**4.16**	**0.97**

G4 Non-Scheduled Fixed Wing Aircraft Departures – RW11 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.36		0.45	0.16	4.37		1.46	0.51
A21N	0.39		0.13	0.05	0.18		0.06	0.02
A320	2.28		0.76	0.26	0.69		0.23	0.08
A359	0.11		0.04		0.14		0.05	
AT76	3.71		1.24	0.43	0.36		0.12	0.04
B38M	1.36		0.45	0.16	4.37		1.46	0.51
B772F	0.12		0.04		0.15		0.05	
B788	0.20		0.07	0.02	0.94		0.31	0.11
B789	0.15		0.05	0.02	0.15		0.05	0.02
BEC200	9.14		3.05	1.06	0.71		0.24	0.08
CNA185	0.66		0.22	0.08	0.00		0.00	0.00
CNA208	0.58		0.19	0.07	0.01		0.00	0.00
PA31	0.50		0.17	0.06	0.03		0.01	0.00
PC12	0.13		0.04	0.02	0.40		0.13	0.05
Total	**20.67**	**0.00**	**6.89**	**2.37**	**12.49**	**0.00**	**4.16**	**1.42**

APPENDIX H MODELLED AIRCRAFT MOVEMENTS RUNWAY 20 BIAS - AVERAGE DAY

H1 Scheduled Passenger Aircraft Arrivals – RW20 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	12.86	0.00	13.12	0.26	1.21	0.00	1.23	0.02
A21N	22.21	0.00	22.66	0.45	6.17	0.00	6.30	0.13
A351	2.21		2.30		0.91		0.95	
A359	0.79		0.83		0.06		0.06	
A388	0.88		0.92		0.00		0.00	
AT76	50.87	0.00	51.91	1.04	3.87	0.00	3.95	0.08
B38M	0.32	0.00	0.33	0.01	0.06	0.00	0.06	0.00
B778	2.12		2.20		0.06		0.06	
B779	2.21		2.30		0.91		0.95	
B781	0.79		0.83		0.06		0.06	
B788	2.17	0.00	2.21	0.04	1.92	0.00	1.96	0.04
B789	2.12	0.00	2.16	0.04	0.06	0.00	0.06	0.00
B797	12.25	0.00	12.50	0.25	1.92	0.00	1.96	0.04
DHC830	1.40	0.00	1.43	0.03	0.00	0.00	0.00	0.00
Small TP	1.61	0.00	1.64	0.03	0.00	0.00	0.00	0.00
PC12	2.72	0.00	2.78	0.06	0.00	0.00	0.00	0.00
Total	**117.51**	**0.00**	**120.09**	**2.21**	**17.19**	**0.00**	**17.59**	**0.31**

H2 Scheduled Passenger Aircraft Departures – RW20 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	12.86		13.12	0.26	1.21		1.23	0.02
A21N	22.21		22.66	0.45	6.17		6.30	0.13
A351	2.21		2.30		0.91		0.95	
A359	0.79		0.83		0.06		0.06	
A388	0.88		0.92		0.00		0.00	
AT76	50.87		51.91	1.04	3.87		3.95	0.08
B38M	0.32		0.33	0.01	0.06		0.06	0.00
B778	2.12		2.20		0.06		0.06	
B779	2.21		2.30		0.91		0.95	
B781	0.79		0.83		0.06		0.06	
B788	2.17		2.21	0.04	1.92		1.96	0.04
B789	2.12		2.16	0.04	0.06		0.06	0.00
B797	12.25		12.50	0.25	1.92		1.96	0.04
DHC830	1.40		1.43	0.03	0.00		0.00	0.00
Small TP	1.61		1.64	0.03	0.00		0.00	0.00
PC12	2.72		2.78	0.06	0.00		0.00	0.00
Total	**117.51**	**0.00**	**120.09**	**2.21**	**17.19**	**0.00**	**17.59**	**0.31**

H3 Non-Scheduled Fixed Wing Aircraft Arrivals – RW20 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	0.96	0.00	0.98	0.02	3.11	0.00	3.17	0.06
A21N	0.28	0.00	0.28	0.01	0.12	0.00	0.13	0.00
A320	1.62	0.00	1.65	0.03	0.49	0.00	0.50	0.01
A359	0.07		0.08		0.09		0.10	
AT76	2.63	0.00	2.68	0.05	0.25	0.00	0.26	0.01
B38M	0.96	0.00	0.98	0.02	3.11	0.00	3.17	0.06
B772F	0.08		0.08		0.10		0.10	
B788	0.14	0.00	0.14	0.00	0.67	0.00	0.68	0.01
B789	0.10	0.00	0.11	0.00	0.10	0.00	0.11	0.00
BEC200	6.49	0.00	6.62	0.13	0.51	0.00	0.52	0.01
CNA185	0.47	0.00	0.48	0.01	0.00	0.00	0.00	0.00
CNA208	0.41	0.00	0.42	0.01	0.01	0.00	0.01	0.00
PA31	0.35	0.00	0.36	0.01	0.02	0.00	0.02	0.00
PC12	0.09	0.00	0.10	0.00	0.28	0.00	0.29	0.01
Total	14.67	0.00	14.97	0.30	8.86	0.00	9.04	0.18

H4 Non-Scheduled Fixed Wing Aircraft Departures – RW20 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	0.96		0.98	0.02	3.11		3.17	0.06
A21N	0.28		0.28	0.01	0.12		0.13	0.00
A320	1.62		1.65	0.03	0.49		0.50	0.01
A359	0.07		0.08		0.09		0.10	
AT76	2.63		2.68	0.05	0.25		0.26	0.01
B38M	0.96		0.98	0.02	3.11		3.17	0.06
B772F	0.08		0.08		0.10		0.10	
B788	0.14		0.14	0.00	0.67		0.68	0.01
B789	0.10		0.11	0.00	0.10		0.11	0.00
BEC200	6.49		6.62	0.13	0.51		0.52	0.01
CNA185	0.47		0.48	0.01	0.00		0.00	0.00
CNA208	0.41		0.42	0.01	0.01		0.01	0.00
PA31	0.35		0.36	0.01	0.02		0.02	0.00
PC12	0.09		0.10	0.00	0.28		0.29	0.01
Total	14.67	0.00	14.97	0.30	8.86	0.00	9.04	0.18

APPENDIX I MODELLED AIRCRAFT MOVEMENTS RUNWAY 29 BIAS - AVERAGE DAY

I1 Scheduled Passenger Aircraft Arrivals – RW29 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	14.52	0.00	7.96	3.75	1.36	0.00	0.75	0.35
A21N	25.08	0.00	13.75	6.48	6.97	0.00	3.82	1.80
A351	2.88		1.62		1.19		0.67	
A359	1.04		0.58		0.07		0.04	
A388	1.15		0.65		0.00		0.00	
AT76	57.46	0.00	31.51	14.85	4.37	0.00	2.40	1.13
B38M	0.36	0.00	0.20	0.09	0.06	0.00	0.03	0.02
B778	2.76		1.55		0.07		0.04	
B779	2.88		1.62		1.19		0.67	
B781	1.04		0.58		0.07		0.04	
B788	2.45	0.00	1.34	0.63	2.17	0.00	1.19	0.56
B789	2.39	0.00	1.31	0.62	0.06	0.00	0.03	0.02
B797	13.83	0.00	7.58	3.57	2.17	0.00	1.19	0.56
DHC830	1.58	0.00	0.87	0.41	0.00	0.00	0.00	0.00
Small TP	1.82	0.00	1.00	0.47	0.00	0.00	0.00	0.00
PC12	3.07	0.00	1.68	0.79	0.00	0.00	0.00	0.00
Total	**134.33**	**0.00**	**73.82**	**31.67**	**19.77**	**0.00**	**10.88**	**4.44**

I2 Scheduled Passenger Aircraft Departures – RW29 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	14.52		7.96	3.75	1.36		0.75	0.35
A21N	25.08		13.75	6.48	6.97		3.82	1.80
A351	2.88		1.62		1.19		0.67	
A359	1.04		0.58		0.07		0.04	
A388	1.15		0.65		0.00		0.00	
AT76	57.46		31.51	14.85	4.37		2.40	1.13
B38M	0.36		0.20	0.09	0.06		0.03	0.02
B778	2.76		1.55		0.07		0.04	
B779	2.88		1.62		1.19		0.67	
B781	1.04		0.58		0.07		0.04	
B788	2.45		1.34	0.63	2.17		1.19	0.56
B789	2.39		1.31	0.62	0.06		0.03	0.02
B797	13.83		7.58	3.57	2.17		1.19	0.56
DHC830	1.58		0.87	0.41	0.00		0.00	0.00
Small TP	1.82		1.00	0.47	0.00		0.00	0.00
PC12	3.07		1.68	0.79	0.00		0.00	0.00
Total	**134.33**	**0.00**	**73.82**	**31.67**	**19.77**	**0.00**	**10.88**	**4.44**

I3 Non-Scheduled Fixed Wing Aircraft Arrivals – RW29 Bias

	Daytime Arrivals by Runway				Night-time Arrivals by Runway			
Aircraft	**02**	**11**	**20**	**29**	**02**	**11**	**20**	**29**
A20N	1.09	0.00	0.60	0.28	3.51	0.00	1.92	0.91
A21N	0.31	0.00	0.17	0.08	0.14	0.00	0.08	0.04
A320	1.83	0.00	1.00	0.47	0.55	0.00	0.30	0.14
A359	0.10		0.05		0.12		0.07	
AT76	2.97	0.00	1.63	0.77	0.29	0.00	0.16	0.07
B38M	1.09	0.00	0.60	0.28	3.51	0.00	1.92	0.91
B772F	0.10		0.06		0.12		0.07	
B788	0.16	0.00	0.09	0.04	0.76	0.00	0.42	0.20
B789	0.12	0.00	0.06	0.03	0.12	0.00	0.06	0.03
BEC200	7.33	0.00	4.02	1.89	0.57	0.00	0.31	0.15
CNA185	0.53	0.00	0.29	0.14	0.00	0.00	0.00	0.00
CNA208	0.46	0.00	0.25	0.12	0.01	0.00	0.00	0.00
PA31	0.40	0.00	0.22	0.10	0.02	0.00	0.01	0.01
PC12	0.11	0.00	0.06	0.03	0.32	0.00	0.18	0.08
Total	**16.59**	**0.00**	**9.10**	**4.24**	**10.04**	**0.00**	**5.51**	**2.53**

I4 Non-Scheduled Fixed Wing Aircraft Departures – RW29 Bias

	Daytime Departures by Runway				Night-time Departures by Runway			
Aircraft	02	11	20	29	02	11	20	29
A20N	1.089		0.597	0.281	3.508		1.924	0.906
A21N	0.315		0.173	0.081	0.141		0.077	0.036
A320	1.826		1.001	0.472	0.550		0.302	0.142
A359	0.095		0.054		0.121		0.068	
AT76	2.972		1.630	0.768	0.286		0.157	0.074
B38M	1.089		0.597	0.281	3.508		1.924	0.906
B772F	0.098		0.055		0.125		0.070	
B788	0.160		0.088	0.041	0.758		0.416	0.196
B789	0.118		0.065	0.031	0.118		0.065	0.030
BEC200	7.332		4.021	1.894	0.573		0.314	0.148
CNA185	0.527		0.289	0.136	0.000		0.000	0.000
CNA208	0.463		0.254	0.120	0.006		0.003	0.002
PA31	0.399		0.219	0.103	0.023		0.013	0.006
PC12	0.107		0.058	0.028	0.320		0.175	0.083
Total	**16.59**	**0.00**	**9.10**	**4.24**	**10.04**	**0.00**	**5.51**	**2.53**

APPENDIX J HELICOPTER TRACKS AND MODELS

J1 Helicopter Track Splits

Helipad	Operation	Track ID	Percentage Use
CENTRE	A and D	HC_02	36%
CENTRE	A and D	HC_03	15%
CENTRE	A and D	HC_04	32%
CENTRE	A and D	HC_06	17%
GARDEN	A and D	GCHA_01	47%
GARDEN	A and D	GCHA_02	53%

Source: Airbiz Volume 4

J2 Helicopter Types Included in the Updated Noise Contours

Helicopter	AEDT Aircraft Type (Airframe Model)	AEDT Equipment ID
Eurocopter AS350	Aerospatiale SA-350D Astar (AS-350)	3810
Eurocopter EC120	Eurocopter EC120	4117
Robinson R22	Robinson R22B	3807
Robinson R44	Robinson R44 Raven	3161
Bell 206	Bell 206 JetRanger	26
Guimbal Cabri G2	Robinson R22B	3807
Hughes 269	Schweizer S269D/330	4100
MD 500	Hughes 500D	30

APPENDIX K TAXIING INFORMATION

Aircraft Type	Engine Height	Speed (kt)	Thrust (Pounds)	Mode
Wide Body Jets (A359)	9.9 ft	25 kt	8000 lb	Approach
Narrow Body Jets (A2N0)	6.5 ft	25 kt	3000 lb	Approach
Turboprops (ATR72-500)	10.9 ft	25 kt	750 lb	Approach

Calibration Adjustment to Jet Taxiing Movement Numbers

Aircraft Type	Overprediction	Factor Applied to Decrease Movements
Wide Body Jets (A359)	5 dB	0.316
Narrow Body Jets (A2N0)	10 dB	0.1

APPENDIX L METEOROLOGICAL DATA

L1 Meteorological Settings – Updated Noise Contours

	For Outer Envelope **Busy three-month Oct-Dec**	**For Annual Average** **Average Calendar Year**
Temperature	14 C / 57 F	12 C / 54 F
Pressure	1012 mbar	1014 mbar
Humidity	75%	82%
Dew Point		
Headwind	9 kn	8 kn

Source: National Climate database by NIWA

MARSHALL DAY Acoustics

APPENDIX M CALIBRATION

M1 Calibration Applied by Adjusting Stage Length and Profile

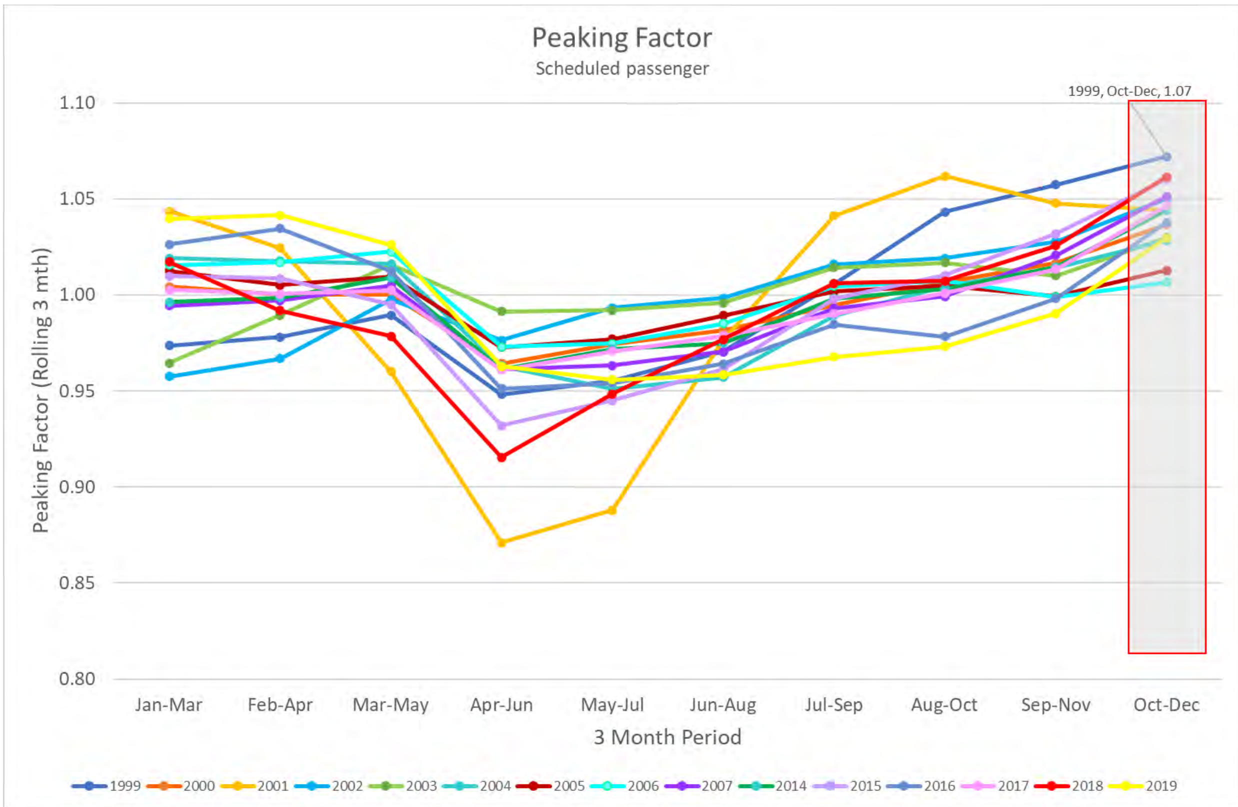
					Forecast Stage Length								
Forecast AC	**ANP ID**	**AirframeModel**	**EngineCode**	**EquipId**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A388	A380-861	Airbus A380-800 Series	9EA001	2462									STND 8
B788	7878R	Boeing 787-8 Dreamliner	12RR063	6435	STND 1		STND 7					STND 8	STND 8
B789	7879	Boeing 787-9 Dreamliner	02P23RR131	6439	STND 1		ICAO A 5					STND 8	STND 8
A359	A350-941	Airbus A350-900 series	01P18RR124	6200			ICAO A 7					STND 8	STND 8
A21N	A321-232	Airbus A321-NEO	01P18PW157	5978	ICAO A 3		ICAO A 4	ICAO A 5	ICAO A 6				
A20N	A320-271N	Airbus A320_NEO	01P18PW153	5975	STND 5			STND 5					
A320	A320-232	Airbus A320-200 Series	1IA003	1019	STND 4		STND 4	STND 4					
B38M	7378MAX	Boeing 737-8	01P20CM135	6172	STND 4			STND 6					
B797	7878R	Boeing 787-8 Dreamliner	12RR063	6435	STND 1		STND 2						
B778	A350-941	Airbus A350-1000 Series	18RR080	5308	STND 1							STND 8	STND 8
B779	A350-941	Airbus A350-1000 Series	18RR080	5308			STND 3					STND 8	
B772 freight	777200	Boeing 777 Freighter	01P21GE216	3925			STND 4					STND 9	
AT76	ATR72-212A	ATR 72-500	PW127F	1671	STND 3								
DH8C	ATR72-212A	ATR 72-500	PW127F	1671	STND 3								
B781	7879	Boeing 787-10 Dreamliner	17GE179	5317	STND 1							STND 8	STND 8
A351	A350-941	Airbus A350-1000 Series	18RR080	5308	STND 1							STND 8	STND 8
PC12	CNA208	Pilatus PC-12	PT67B	1489	STND 1								
PA31	PA31	Piper PA46 (Piston)	TIO540	6225	STND 1								
C185	CNA182	Cessna Skywagon	IO360	6271	STND 1								
C208	CNA208	Cessna 208 Caravan	PT6A14	2106	STND 1								
BE20	C12	Raytheon Super King Air 200	PT6A41	3189	NOISEMAP 1								
GASEPF	GASEPF	Pilatus Turbo Trainer PC-9	PT6A62	1532	STND 1								

text	Default inputs (no calibration adjustment recommended)
text	Adjustment to departure profile based on measurement results
text	Adjustment to departure profile based on adjustment recommended for other stage lengths or for future aircraft
	Blue means uncalibrated so using STND profiles

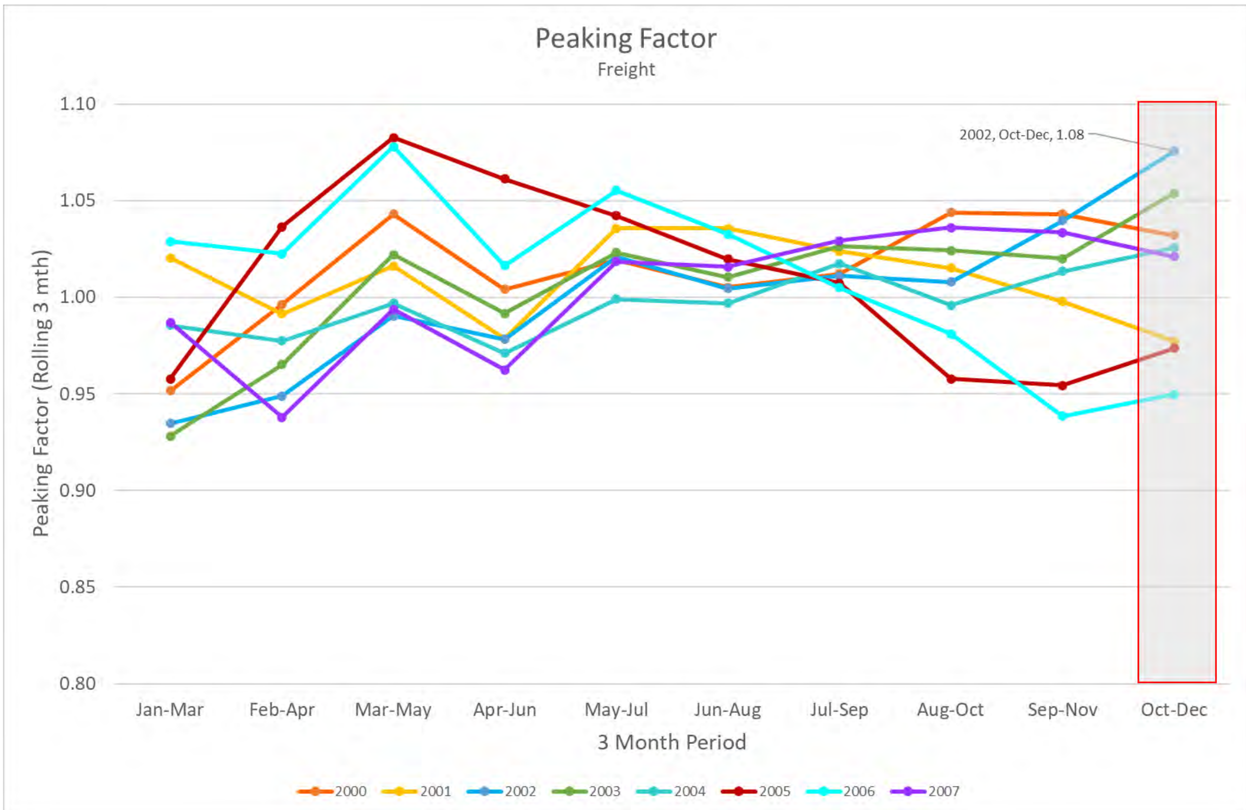
For B797 using STND profiles with stage length - 1

APPENDIX N PEAKING FACTOR GRAPHS

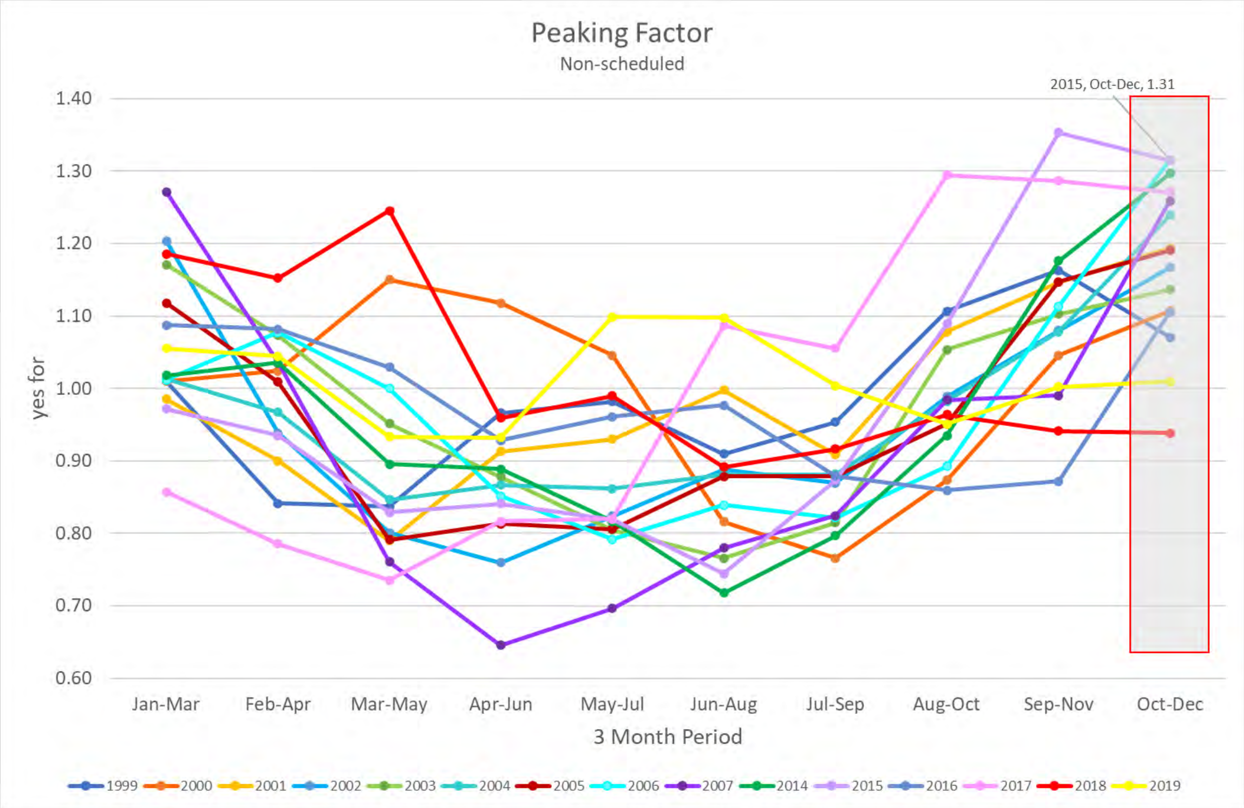
N1 Scheduled Passenger



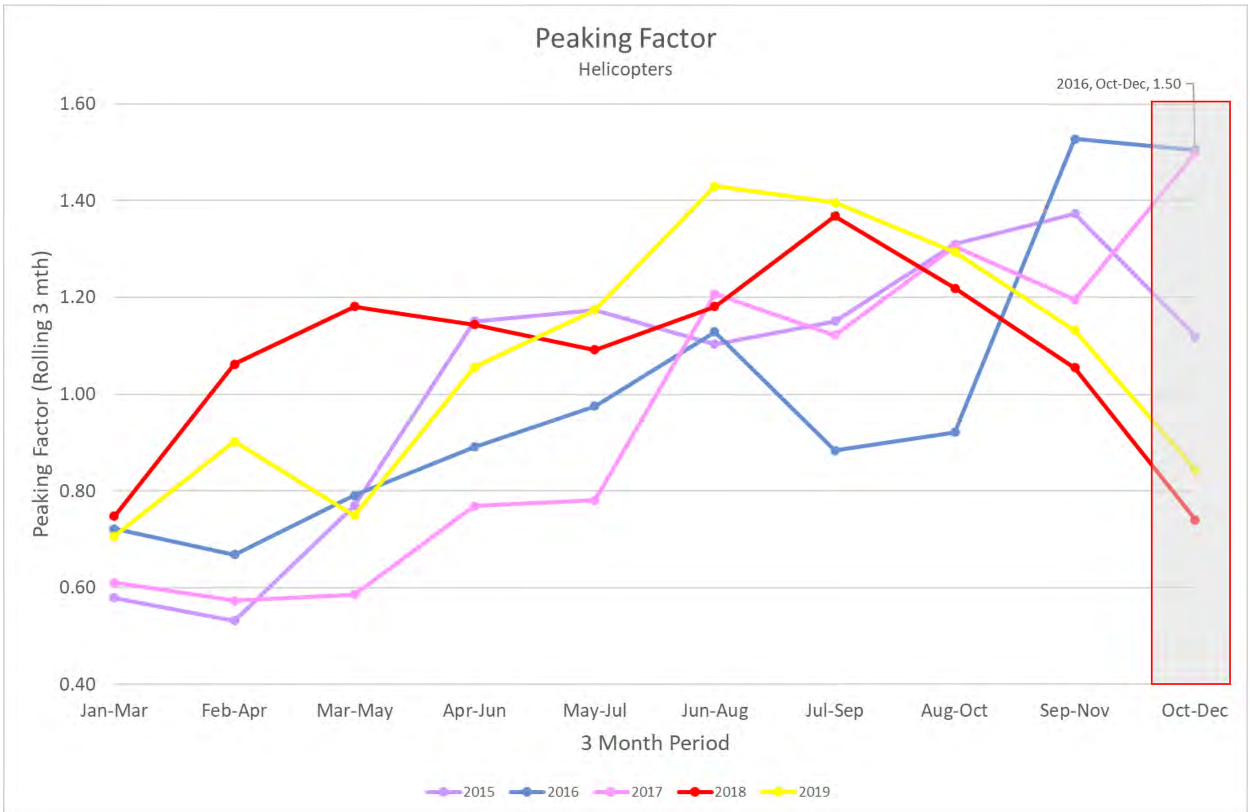
N2 Freight



N3 FBO/small commercial, airline/MRO, Antarctic, military and government



N4 Helicopters



APPENDIX O STAGE LENGTHS BY DESTINATION

O1 Scheduled/Freight

Region	Stage Length
North America	9
Hawaii	6
Pacific Islands East	4
Pacific Islands North	4
South East Asia	7
East Asia	8
North East Asia	8
India	9
Middle East	9
Western Australia	5
Trans-Tasman	3
Auckland	1
Blenheim	1
Chatham Islands	1
Dunedin	1
Hamilton	1
Hokitika	1
Invercargill	1
Napier	1
Nelson	1
New Plymouth	1
Palmerston North	1
Queenstown	1
Rotorua	1
Tauranga	1
Wellington	1
Other North Regional	1
Other South Regional	1
Other West Regional	1

O2 FBO/small commercial, airline/MRO, Antarctic, military and government

Region	Stage Length
Int North	4
Int North East	8
Int West	4
Local	1
North Island Central	1
North Island East	1
North Island West	1
South Island North	1
South Island South	1
South Island West	1

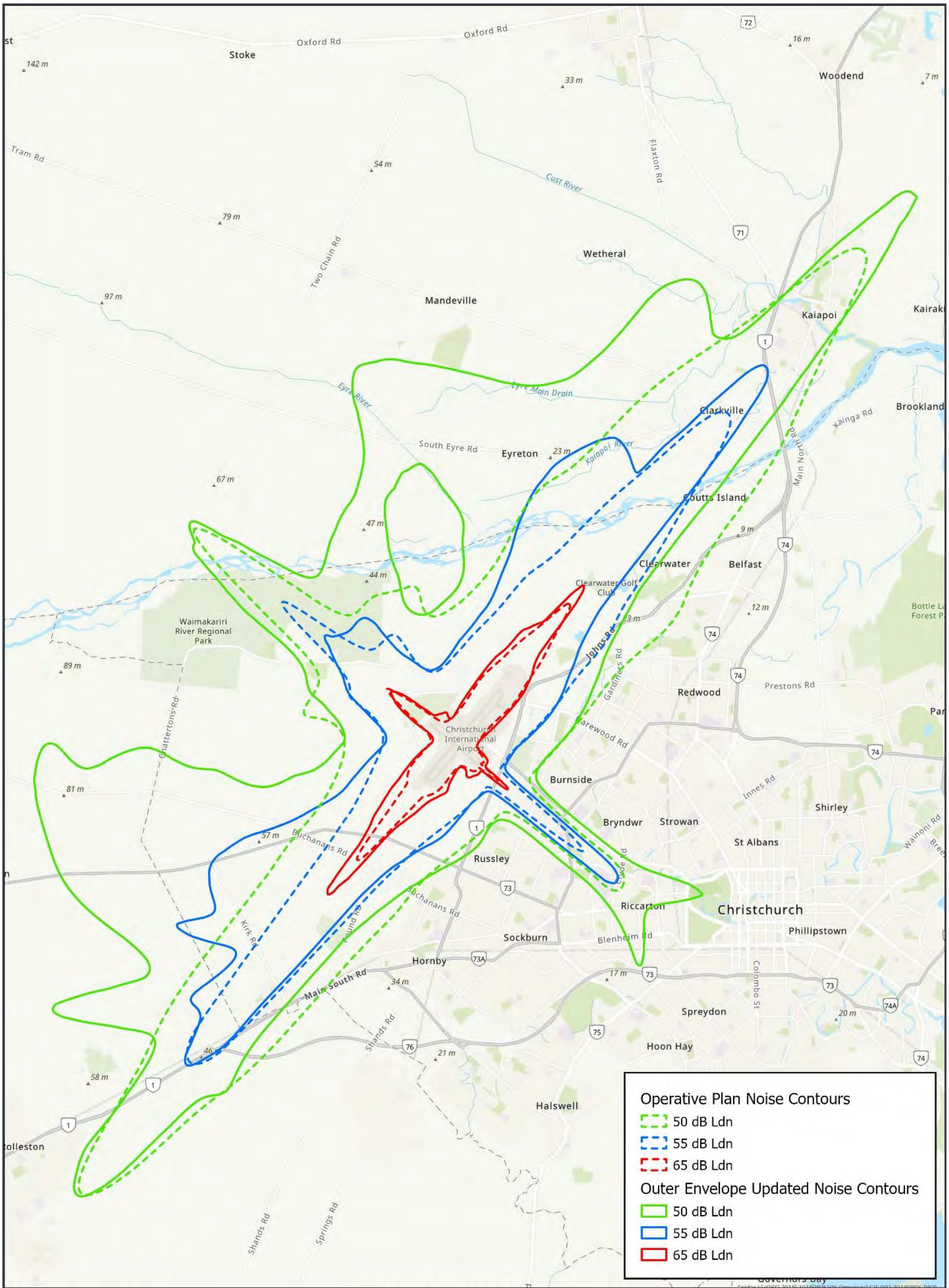
APPENDIX P RADAR DATA REFERENCED FOR FLIGHT TRACK DISPERSION

P1 Radar Data Dates

Operation	Runway	Dates
Arrivals	02	14 May 2021, 6 Oct 2019
	20	14 Apr 2021, 3 Oct 2019
	11	Radar data not used
	29	4 Apr 2021, Feb 2017
Departures	02	Airbiz assessment of flown flight tracks Dec 2021 – Nov 2022
	20	Airbiz assessment of flown flight tracks Dec 2021 – Nov 2022
	29	Airbiz assessment of flown flight tracks Dec 2021 – Nov 2022
Helicopters	All	Sep 2022

APPENDIX Q UPDATED NOISE CONTOURS

Q1 Outer Envelope Noise Contours

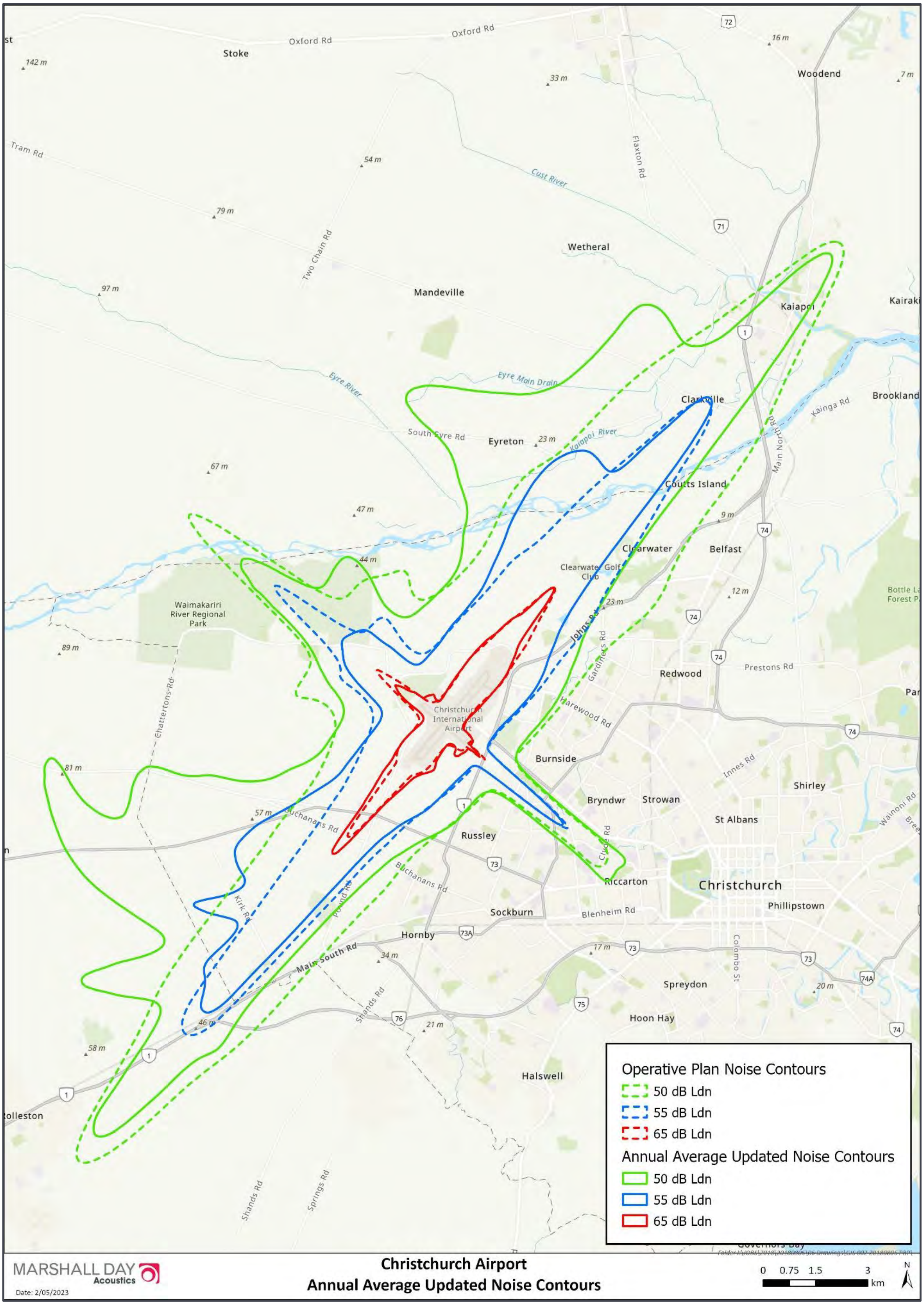


MARSHALL DAY Acoustics
Date: 2/05/2023

Christchurch Airport
Outer Envelope Updated Noise Contours

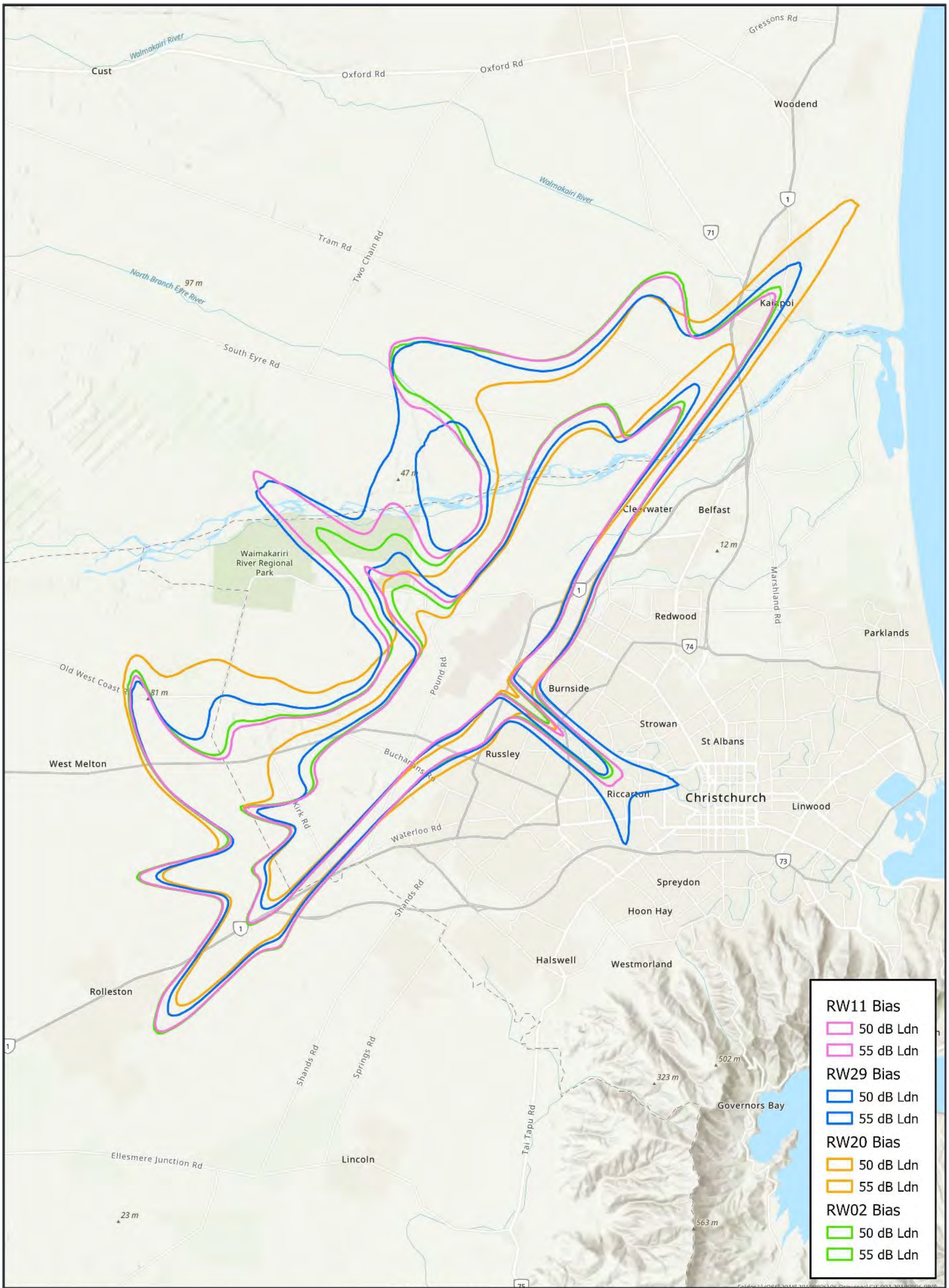
0 0.75 1.5 3 km

Q2 Annual Average Noise Contours



Q3 Highest Usage Each Runway End

These are the four noise contours that make up the Outer Envelope.



MARSHALL DAY Acoustics

Date: 2/05/2023

Christchurch Airport
Outer Envelope Four Runway Bias Noise Contours

0 1.25 2.5 5 km

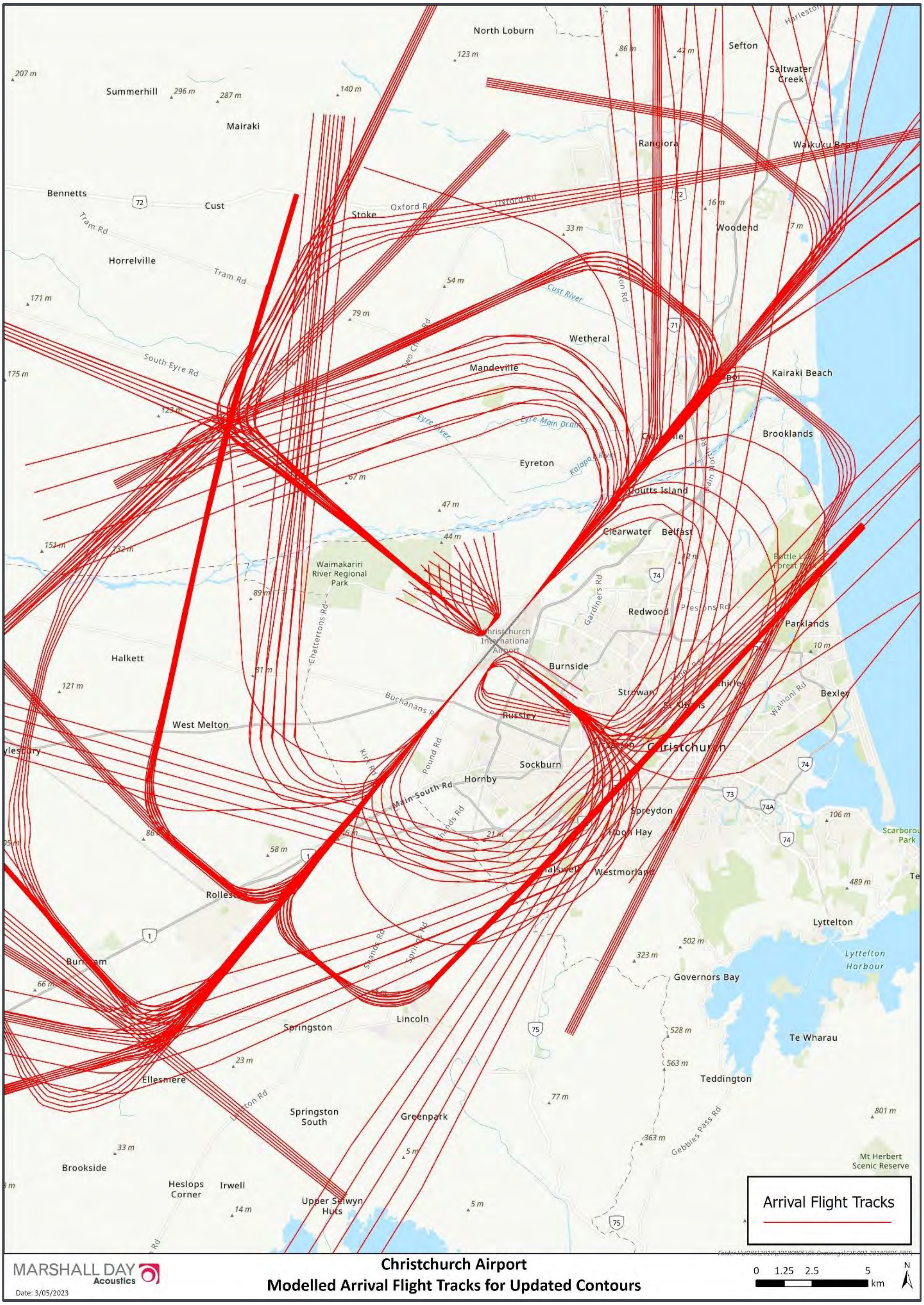
APPENDIX R AIR NOISE BOUNDARY & 95 DB L_{AE} CONTOURS

R1 Air Noise Boundary Outer Envelope Option

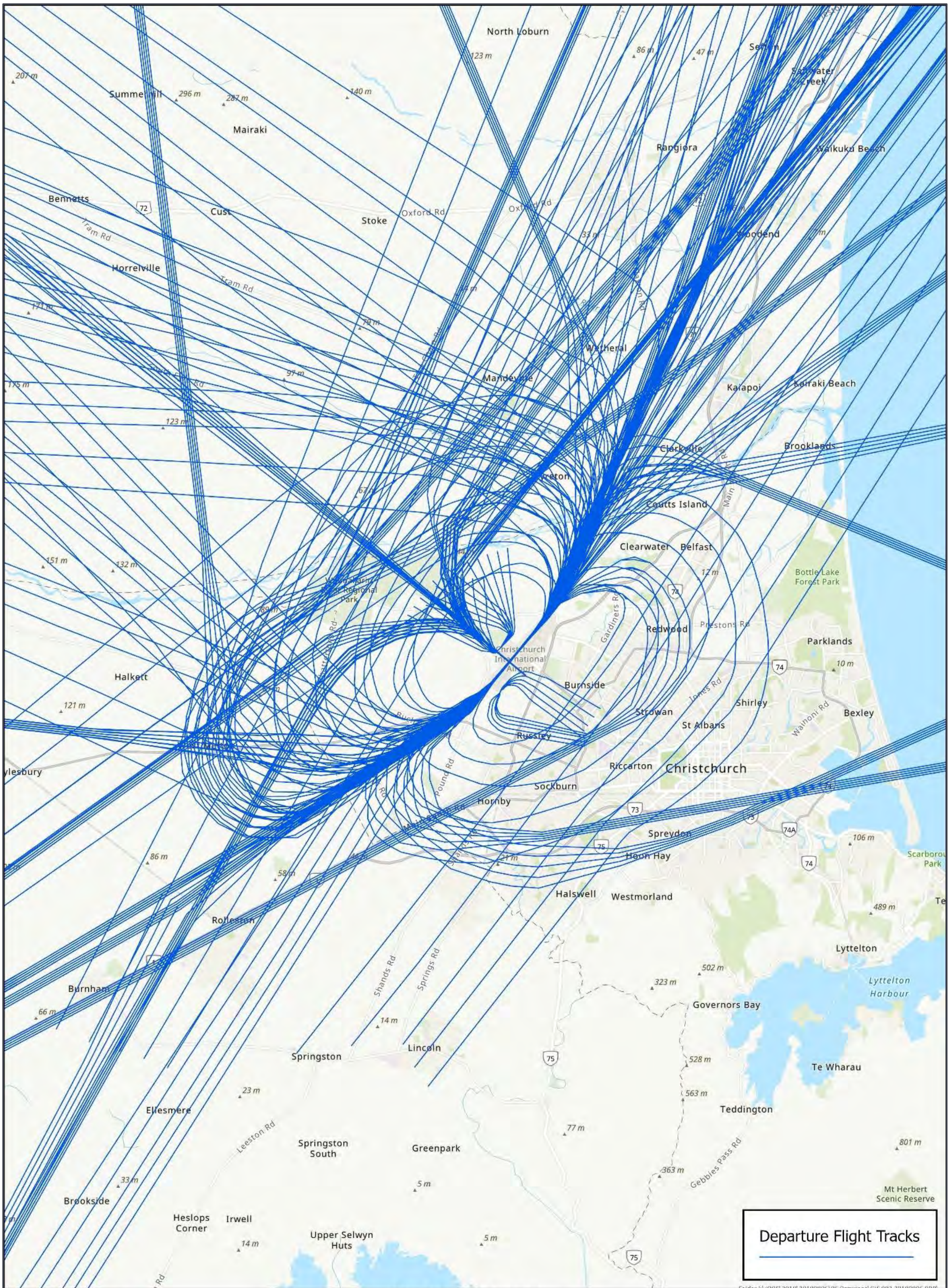
R2 Airnoise Boundary Annual Average Option

APPENDIX S MODELLED FLIGHT TRACKS FOR UPDATED NOISE CONTOURS

S1 Modelled Arrival Flight Tracks



S2 Modelled Departure Flight Tracks



MARSHALL DAY Acoustics

Date: 4/05/2023

Christchurch Airport
Modelled Departure Flight Tracks for Updated Contours

0 1.25 2.5 5 km

Thank YOU

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