2021 CHRISTCHURCH INTERNATIONAL AIRPORT EXPERT UPDATE OF THE OPERATIVE PLAN NOISE CONTOURS

FOR REVIEW BY ENVIRONMENT CANTERBURY'S INDEPENDENT EXPERT PANEL

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CONTENTS

CHRISTCHURCH AIRPORT

Fact SHEETS

- Introduction to Aircraft Noise
- Introduction to Air Traffic Management and Air Traffic Control

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INTRODUCTION TO AIRCRAFT NOISE

1. Planning in the vicinity of airports

Airports are essential for transporting people and goods. They are an intergenerational asset which connects 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 the Airport, 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 enable airport operations to continue to support and benefit communities. 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.

INTRODUCTION TO AIRCRAFT NOISE

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 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 the 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. Aircraft noise is usually assessed by looking at the average noise exposure on a typical day (to account for fluctuations as aircraft come and go).

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). 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. New Zealand Standard NZS 6805: 1992 Airport Noise Management and Land Use Planning recommends using noise contours and guides this process.

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

Christchurch Airport's Operative Plan Noise Contours were confirmed in 2008. They are now due to be re-modelled. An independent panel of experts reviews and confirms the modelling inputs, assumptions, and outcomes.

The shape and size of Christchurch Airport's Operative Plan Noise Contours is 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;
- Ultimate runway capacity;
- Air traffic, including future international and domestic routes and fleet mix;
- 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.

INTRODUCTION TO AIRCRAFT NOISE

5. Regular updates

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 Operative Plan Noise Contours for Christchurch Airport are now due for an update. CIAL's experts have completed a rigorous modelling exercise to produce Updated Noise Contours and this work is provided to Environment Canterbury for peer review by a panel of independent experts. Once this process is complete the Updated Noise Contours can be used for planning documents in Canterbury.

6. 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 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 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.

The New Zealand Standard NZS 6805: 1992 Airport Noise Management and Land Use Planning 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.

KEY INPUTS INTO THE NOISE CONTOUR MODELLING

7. Long term planning using ultimate runway capacity

Modelling is based on the ultimate runway capacity of the airport – that is, the busiest that the 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). 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 the 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 30 to 40 years into the future. But the point is that it will be reached and should be anticipated in planning documents.

8. Aircraft fleet

The overall makeup and mix of the fleet of aircraft using the 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 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 to improve accuracy of the noise modelling.

9. 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.

INTRODUCTION TO AIRCRAFT NOISE

The modelling for the 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 the 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.

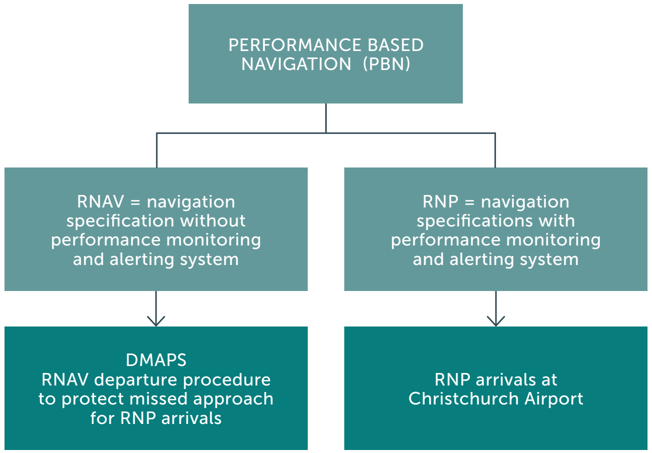
10. Flight paths and precise navigation

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 change 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 the airport straight on, but flight path design and procedures changes from time to time. Since 2018, aircraft have been turning earlier on their approach - 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.



11. 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 northeast and southwest) is used the majority of the time in prevailing wind conditions. When there are crosswind north-westerly wind conditions, the crosswind runway is used instead. 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. In order to model the overall noise environment, the contours have to account for the split between the proportion of usage on each runway.

12. 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 accounted for in the model.

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

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 Air Traffic Control (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.

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

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 which requires denser air routes and creates higher demands on safety and efficiency in terms of aircraft fuel burn, emissions, noise impact, and maximising airspace and runway capacity.

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

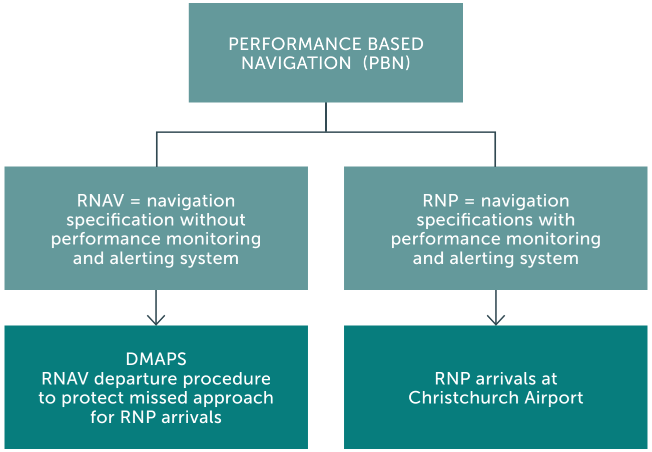
3. Performance-Based Navigation (PBN)

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 a number of 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 NZ 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) 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]

When PBN procedures were introduced at Christchurch International Airport via the RNP arrivals and 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 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%20Impl.%20from%20Industry%20perspective.pdf

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

4. Required Navigation Performance Arrivals at Christchurch Airport

Advanced PBN procedures with CAA Authorisation Required (RNP AR) have been introduced to shorten flightpaths and reduce flight time, fuel burn and CO2 emissions for suitably capable aircraft arriving into Christchurch (most jets and some turboprops).

5. Divergent Missed Approach Protection System at Christchurch Airport

Divergent Missed Approach Protection System (DMAPS) is an innovative system that has been introduced at Christchurch. 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
- 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.[3]

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.

Standard Instrument Departures (SIDS), Standard Instrument Arrivals (STARS)

Standard Instrument Departures (SIDs) and Standard Instrument Arrivals (STARs) provide a safe and efficient way of prescribing a large amount of information through procedure design. 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.[4]

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 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.

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

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

INTRODUCTION TO AIR TRAFFIC MANAGEMENT AND AIR TRAFFIC CONTROL

ACRONYMS

A-RNP	Advanced RNP (PBN specification)
ATC	Air traffic control
ATM	Air traffic management
CNS/ATM	Communications, navigation and surveillance / air traffic management
DME	Distance measuring equipment (radio navigation aid)
FMS	Flight management system
GPS	Global positioning system
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
ILS	Instrument landing system
NAVAID	Navigation(al) aid
NDB	Non-directional (radio) beacon
PBN	Performance-based navigation
RNAV	Area navigation
RNP	Required navigation performance
RNP AR	RNP authorisation required (approach)
VFR	Visual flight rules
VOR	Very high frequency omni-directional range (radio beacon)

1

Executive SUMMARY

- 2021 Modelling Update Process

GLOSSARY

The below glossary of terms is common to all of the reports in this package.

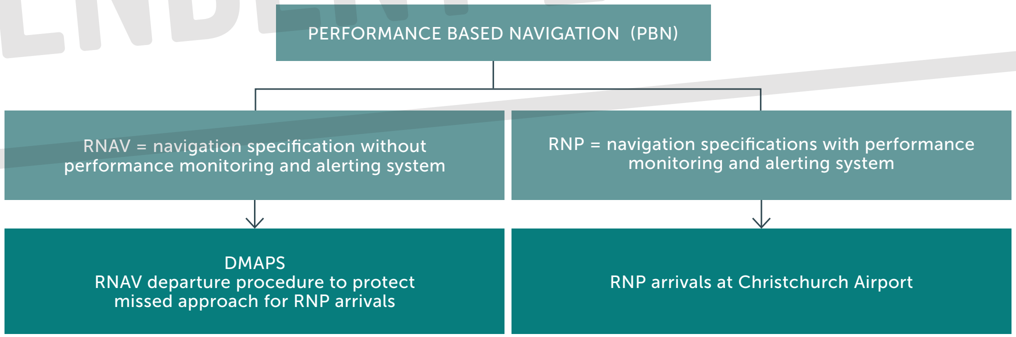
Term	Description
AANC	Annual Aircraft Noise Contour. Prepared annually to determine compliance with the 65dB Ldn Air Noise Compliance Contour.
AEDT	Aviation Environmental Design Tool. A proprietary noise model created by the FAA used to calculate noise contours around an airport (replacement of the INM).
AIP	Aeronautical Information Publication New Zealand. Contains aeronautical information essential to air navigation in New Zealand.
Airways New Zealand (Airways)	The sole Air Traffic Service provider in New Zealand.
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.
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.
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. Doesn't include any proposed extensions.
Daytime	The hours between 7am to 10pm (as per NZS6805:1992).
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)

GLOSSARY

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. This landing point may be permanently or temporarily displaced further down the runway for operational or noise abatement reasons
DMAPS	Divergent Missed Approach Protection System. Departure tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control which enhance safe separation of planes, increased capacity, efficiency and predictability
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.
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 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 (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 that could operate into Christchurch Airport by airlines 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 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 rather than relying on visual landing aids (lights on the side of a runway) to execute a landing.
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
LAmax	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

GLOSSARY

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.
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 between 10 pm to 7am (as per NZS6805:1992).
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.
Noise Model	A programme 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 6805:1992	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.
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).



GLOSSARY

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 aircraft.

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.

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 020 degrees magnetic)

Runway 11
Runway 11 is the crosswind 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 crosswind 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 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 takeoffs are taking place on the other runway. It is enabled by extending the 02/20 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.

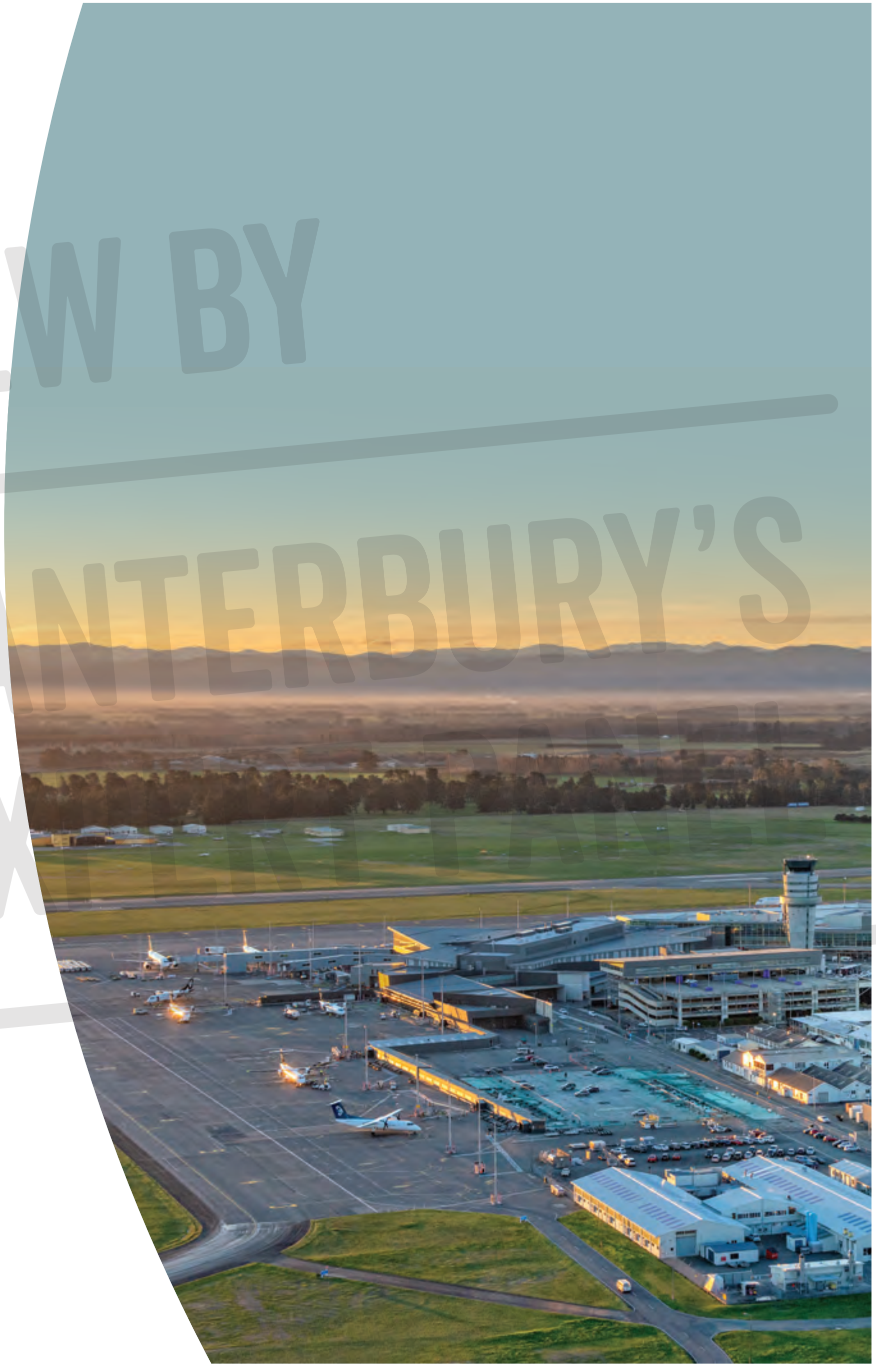
GLOSSARY

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.

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.



INTRODUCTION TO NOISE CONTOUR REMODELLING

1 This report introduces the background and context for the remodelling of the Christchurch International Airport (the Airport / CIA) air noise contours.

2 This report is part of a suite of documents which explain the inputs, assumptions, and outcomes of the remodelling process for peer review by an independent expert panel:

2.1 Volume 1 (this report) introduces the process and reasons for remodelling the Airport's noise contours, and provides an overview of the inputs, assumptions and outcomes of the work to date;

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 the airport;

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

3 Technical input into this project has been provided by:

3.1 Marshall Day Acoustics – noise modelling and measurements for model calibration;

3.2 Airbiz – aviation consulting – ultimate runway capacity, air traffic projections, and flight tracks;

3.3 Airways – flight track information and flight procedure design.

3.4 Christchurch International Airport Limited (CIAL) in consultation with airlines has provided information regarding air traffic demand, scheduling of aircraft movements and fleet mix and runway extension plans in the 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 NZ 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 the airport or under the 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 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 to plan out 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 experienced on the ground – the airport's noise 'footprint'.

9 New Zealand Standard NZS 6805: 1992 Airport Noise Management and Land Use Planning (NZS6805) guides the noise contour modelling process and the associated land use planning and airport noise compliance rules.

10 The Operative Noise Contours and Updated Noise Contours for CIA are based upon what the aircraft noise would be when the Airport is operating at ultimate runway capacity. NZS6805 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 (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 then subject to periodic updates.

Aircraft noise

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

12 There are different types of fixed wing aircraft using the Airport – commercial passenger aircraft, freight aircraft, the aircraft used by the International Antarctic Centre, general aviation, and military or other government aircraft.

INTRODUCTION TO NOISE CONTOUR REMODELLING

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). There are also helicopters, (rotary wing aircraft). Rotary wing aircraft have quite different operating and noise characteristics from fixed wing aircraft.

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

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

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

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

13.4 Terrain surrounding the airport;

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

14 Aircraft are constantly arriving and departing from the Airport – so noise comes and goes throughout the day and night (Christchurch International Airport operates 24/7). The impact of one aircraft is markedly different to the cumulative impact of many aircraft. Aircraft noise is therefore assessed by looking at the average noise exposure on a typical day (to account for fluctuations as aircraft come and go).

Aircraft noise: units of measurement and Ldn metric

15 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 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 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.

16 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 minute.

17 NZS6805 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 and the sound environment at night being quieter, so intrusion from aircraft noise is more noticeable.

Reason for remodelling the Noise Contours

18 There have been noise contours for Christchurch International Airport shown in planning documents since 1994. The first noise contours were updated in 2008 (to produce the Operative Plan Noise Contours which are in the current plans). This remodelling process to produce the Updated Noise Contours will be the third update.

19 Over time, aviation industry practices and airport operations change and evolve. It is appropriate 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.

20 An expert panel reviewed and confirmed the inputs and assumptions for the Operative Plan Noise Contours in January 2008. That expert panel recommended that the Operative Plan Noise Contours be remodelled every 10 years.

21 Canterbury Regional Policy Statement (CRPS) Policy 6.3.11 requires that, prior to a review of Chapter 6 of the CRPS, the Regional Council may request CIAL to undertake a remodelling of the Noise Contours. CIAL received a formal request from Environment Canterbury, pursuant to Policy 6.3.11, on 1 September 2021.

22 The CRPS requires 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

INTRODUCTION TO NOISE CONTOUR REMODELLING

- 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 the Canterbury Regional Council in the form of a comprehensive report along with an executive summary or summary report.

23 This suite of documents explains the remodelling that has been done by CIAL's experts and hands that work over to the Regional Council for the purpose of peer review of the modelling inputs, assumptions and outcomes by the independent panel of airport noise experts.

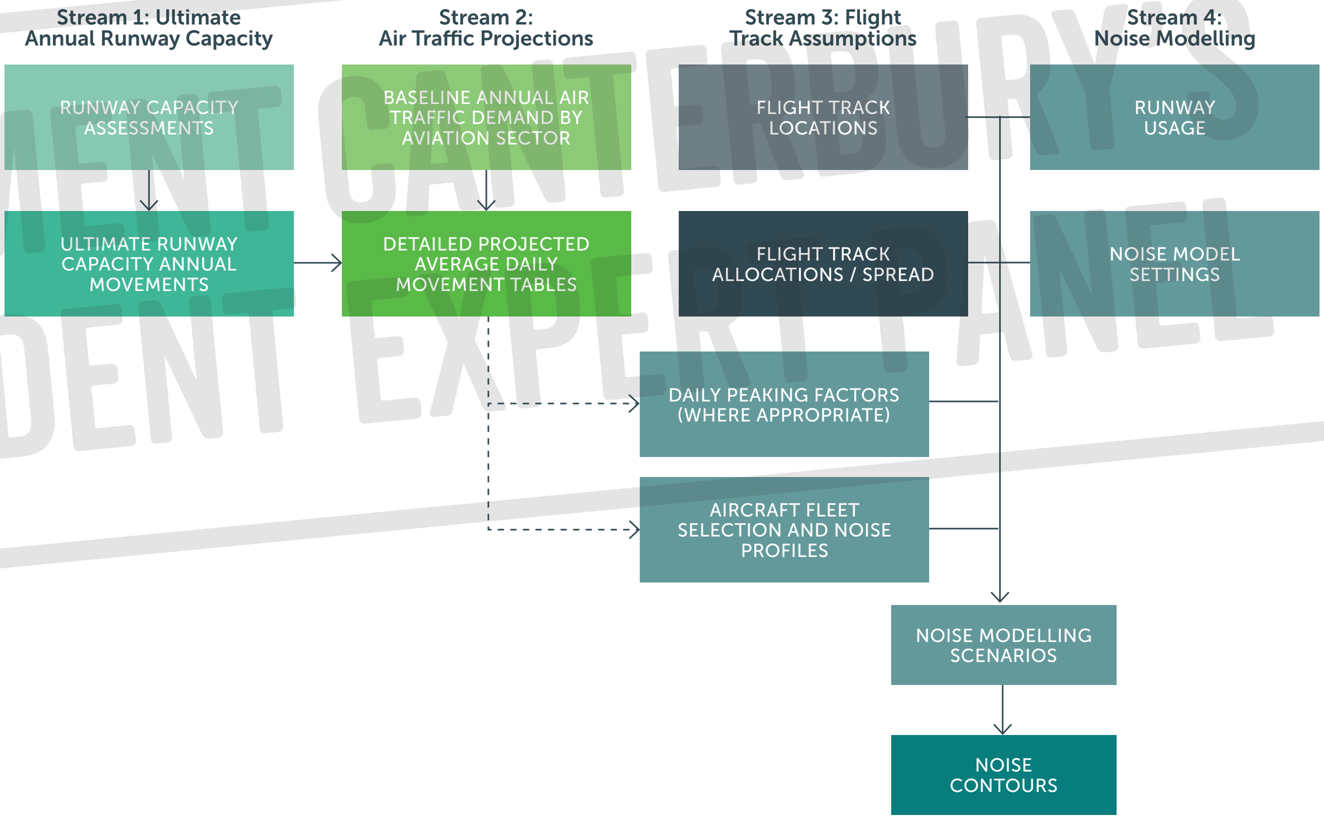
Overview of process to date

24 In anticipation of a formal request from the Regional Council expected ten years after the Operative Plan Noise Contours were prepared, CIAL began the process of commissioning experts to remodel the Operative Plan Noise Contours in 2018. This work was partially completed when the covid-19 pandemic occurred in March 2020, temporarily halting progress. The project recommenced in 2021.

25 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 Updated Noise Contours. Airways (the air navigation service provider for New Zealand) 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.

26 On 1 September 2021 the Regional Council formally requested that CIAL remodel the Operative Plan Noise Contour and provide the modelling inputs, assumptions, and outputs to ECan to be peer reviewed by an independent expert panel, as required by the CRPS.

2021 Modelling Update Process: Expertise and Inputs



INTRODUCTION TO NOISE CONTOUR REMODELLING

Operative Plan Noise Contours

27 The Operative Plan Noise Contours were completed in 2008. The Operative Plan Noise Contours were peer reviewed by a panel of experts convened as part of an Environment Court process.

28 The expert panel agreed that those Operative Plan Noise Contours were to be modelled based on the following inputs and assumptions (in summary):

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

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

28.3 Only commercial passenger aircraft movements and a nominal allocation of freight movements (5 per week) were modelled – other movements such as actual freight movements, general aviation, Antarctic, helicopters, and military were not included in the modelling;

28.4 The future extension of runway 11/29 (the crosswind runway) was accounted for;

28.5 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 (11/29) at particular times of the year. The number of movements on those runway ends was scaled up in the model.

28.6 The A380 and B747-400 aircraft noise profile built into the model was replaced with the B777-300 noise profile in the modelled fleet mix;

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

29 Several of the above assumptions and inputs into the Operative Plan Noise Contours need updating. This is explained in the section below.

Updated Noise Contours – Modelling Process

30 CIAL's experts have undertaken modelling to produce Updated Noise Contours.

31 The Updated Noise Contours are a different shape and size than the Operative Plan Noise Contours. This reflects changes in aviation practices and operations since 2008, and also reflects refinements made in the assumptions. The overall outcome is the contours generally shift slightly to the west.

Model used

32 Two software packages from the Federal Aviation Administration (FAA) in the USA have been used in noise modelling for this project. The sensitivity runs were produced using the Integrated Noise Model (INM) and the Updated Noise Contours were produced using the Aviation Environmental Design Tool (AEDT) – a software package that has now replaced the INM.

33 NZS6805 states that the model to be used for the noise contour is "the FAA Integrated Noise Model or other appropriate models".

34 The INM was used for the sensitivity runs as at the time the calculation times in INM were much faster than the earlier versions of AEDT and more efficient for doing multiple runs. The calculation time issue has been improved in later versions of the AEDT and this is why it has thus been used for the final version of the Updated Noise Contours. For reference, both noise software packages use the same underlying algorithms to calculate noise levels and thus produce the same noise contour outputs. This is discussed further in Volume 5, which contains a comparison of the Updated Noise Contours modelled in INM and in AEDT – the contours are the same.

35 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 assumption better match with the measured noise levels. There are several ways to 'calibrate' the noise model. The ways in which the noise model was calibrated are detailed in Volume 5.

INTRODUCTION TO NOISE CONTOUR REMODELLING

Modelling approach

36 To determine the influence of the various factors on the noise contours at the 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 Operative Plan Noise Contours.

37 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. The sensitivity runs which were undertaken are discussed in Volume 5.

38 Once the final set of appropriate model inputs and assumptions was determined, based on advice from experts of various disciplines, the Updated Noise Contours were produced.

Summary of inputs and assumptions used for Updated Noise Contours

39 The Updated Noise Contours include the following assumptions, which CIAL's experts have determined reflect the most realistic noise footprint for Airport operations based on current information:

39.1 Includes up to date flight tracks, spread, and allocation based on discussions with Airways;

39.2 Accounts for current fleet mix and future fleet mix advised by airlines;

39.3 Includes DMAPS and RNP flight paths;

39.4 Includes commercial passenger aircraft, dedicated freight aircraft, helicopters, other commercial aviation but excludes Antarctic, military and government aircraft;

39.5 Includes taxiing of aircraft on the ground to and from runway entries and exits;

39.6 Assumes ultimate runway capacity of 200,000 commercial passenger aircraft movements;

39.7 Assumes 10% more usage of crosswind runway to account for climate change alteration of prevailing annual average meteorological conditions;

39.8 Includes updated calibration of actual aircraft noise profiles based on acoustic measurements, and accounts for both current and future likely fleet mix;

39.9 Accounts for runway maintenance diverting aircraft from main to crosswind runway for specific times of the day and days of the year based on historic records.

Discussion of modelling inputs and assumptions

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

41 The key modelling inputs that affect the shape and size of the noise contours are flight paths, runway usage, total movements when the Airport reaches ultimate runway capacity, and freight movements.

42 Airport noise contours in New Zealand are based on future aircraft movements. NZS6805 recommends a minimum of 10 years 'time horizon is used for the projection. For CIA, the approach approved by the expert panel in 2008 and followed in the updated modelling is to input an assumption of aircraft movements when the runways and other infrastructure at the Airport is operating at **ultimate runway capacity**. 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 Volume 2.

43 Ultimate runway capacity is based on the scheduled commercial passenger aircraft movements. Other movements such as freight or general aviation movements will fit around commercial passenger arrivals and departures (as even at capacity there will be peak times – other types of aircraft movements would be scheduled for available remaining slots outside of peak times).

44 The Updated Noise Contours are modelled based on ultimate runway capacity at CIA of 200,000 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 the Airport is still moving towards ultimate runway capacity, there will be a number of general aviation aircraft using the airspace which will eventually be displaced to other airfields as scheduled commercial

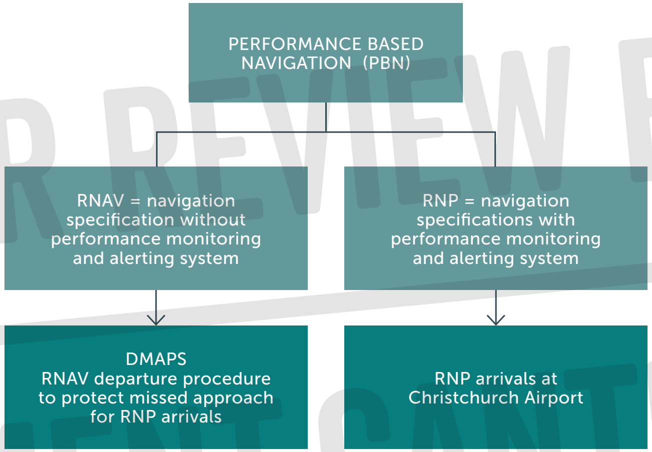
INTRODUCTION TO NOISE CONTOUR REMODELLING

passenger flights and freight flights increase. Ultimate runway capacity and air traffic projection calculations and assumptions are discussed in detail in Volume 2 and 3.

45 Significant, once-in-a-generation changes to **flight paths** (also called flight tracks) have been implemented in the last few years – to enable improvements in safety, move flight paths away from populated urban areas, improve fuel efficiency, carbon efficiency and flight time. Two of these changes have an effect on the shape of the Updated Noise Contours:

45.1 In 2018 Airways adopted Required Navigation Performance (RNP) for some arriving aircraft. This procedure involves an onboard computer taking control of the aircraft at approximately 15 nautical miles (NM) 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.

45.2 In 2020, Airways introduced Divergent Missed Approach Protection System (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 the airport and increasing the size to the west (the aircraft, and therefore the noise contours, move away from the city).



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

47 A parameter that has an influence on both the shape and size of the noise contours is the **runway usage or runway splits**:

47.1 CIA 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).

47.2 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. If the wind is blowing north-west then aircraft will be directed to the crosswind runway, for safety purposes. The crosswind runway is also used while maintenance is done to the main runway.

47.3 The noise footprint of an aircraft on arrival is significantly different in shape to that of a departure. In addition, 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.

47.4 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.

47.5 As described above, the Operative Plan Noise Contour assumed average usage splits of 52%/31% for Runway ends 02/20. Increased use of the crosswind runway is accounted for by scaling up the number of movements on runway ends 11/29 in accordance with the heaviest 3 months usage.

47.6 Actual data of average runway usage for the period 1999-2019 does not support the assumptions of runway splits made by the expert panel. Over that 20 year period, the average usage of runway ends 02/20 is 59% and 36% of flights (respectively).

47.7 The average annual usage of the crosswind runway ends 11/29 is 0.3% and 5% respectively. However in seasonal north-westerly conditions the usage of the crosswind runway increases significantly when examined over a 3 month period. In the heaviest 3 months for runway 11/29 in the 20 year period, 13% of flights used runway 29 and 2.5% of flights used runway 11.

INTRODUCTION TO NOISE CONTOUR REMODELLING

47.8 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.

47.9 Volume 5 discusses the way that the modelling has accounted for actual recorded proportions of runway use in the 20 year period for which data is available, and the approach used to account for the increase use of the crosswind runway which occurs on a seasonal basis.

48 The **types of aircraft movements** which have been included in the modelling of the Updated Noise Contours is largely the same as that for the Operative Noise Contours. The Updated Noise Contours include commercial passenger aircraft movements, freight movements, flights associated airline maintenance, other commercial aviation (fixed-base operators and small commercial operators) and helicopter movements. Demand for freight flights has changed since earlier modelling in 2008. There are now dedicated freight flights at the Airport which were not operating in 2008 (freight at that time was loaded into passenger aircraft, but demand has now increased such that specific freight flights are operating).

49 The Updated Noise Contours exclude Antarctic, military and government movements. Christchurch International 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.

50 Antarctic movements have been excluded from these runs. 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.

51 It has been assumed that as the 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.

52 Another change in the input parameters compared to the Operative Plan Noise Contours is the modelled aircraft type or **fleet mix**. Airbiz and CIAL have had discussions with the main airline operators at CIA 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.

53 The modelling software has inbuilt **noise profiles for representative aircraft models**. These noise profiles have been used in the modelling to represent the current and future fleet mix. Noise profiles have been calibrated. The modelling accounts for aircraft that are already flying, or are anticipated to be introduced into fleets of airlines most likely to be using the Airport - such as the Airbus A320 Neo, Boeing 737max and Boeing 797 (this particular aircraft is still on the drawing board but its introduction into the global fleet is expected to be imminent as a replacement to the Boeing 767 - which has ceased production). The modelling does not attempt to speculate on the noise profile or potential use of any aircraft models that are in developmental phases.

54 Other inputs related to airport operations are included in the modelling. The Updated Noise Contours model the effect of future **runway extensions** which are shown in the airport Master Plan for both the crosswind and main runways in the medium term. 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 jets that would normally use the main runway must use the crosswind runway which increases the extent of the noise contour on this runway.

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

55.1 NIWA predicts that the frequency of north-westerly winds will increase due to climate change, which will increase use of the crosswind runway;

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

INTRODUCTION TO NOISE CONTOUR REMODELLING

56 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

57 The suite of documents prepared by CIAL's experts puts forward two options for modelling the Updated Noise Contour for the expert panel's consideration (these two modelling options are discussed in detail in Volume 5):

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

57.2 a final contour based on the annual average runway usage.

58 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.

59 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.

60 NZS6805 suggests that this busy three-month period "or such other period as is agreed" is used to prepare noise contours. NZS6805 therefore provides flexibility to adopt the approach most appropriate to each airport based on specific context.

61 Both the Outer Envelope and Annual Average options are technically valid methods of calculating noise contours. Both of these methods are used at various airports in New Zealand. The two options are therefore provided for the independent panel of experts' consideration and decision.

Conclusion

62 The above provides an overview of the remodelling process, reason for undertaking the remodelling work, comparison and history of the Operative Plan Noise Contours, key inputs and assumptions, and approach to modelling the Updated Noise Contours for expert panel review.

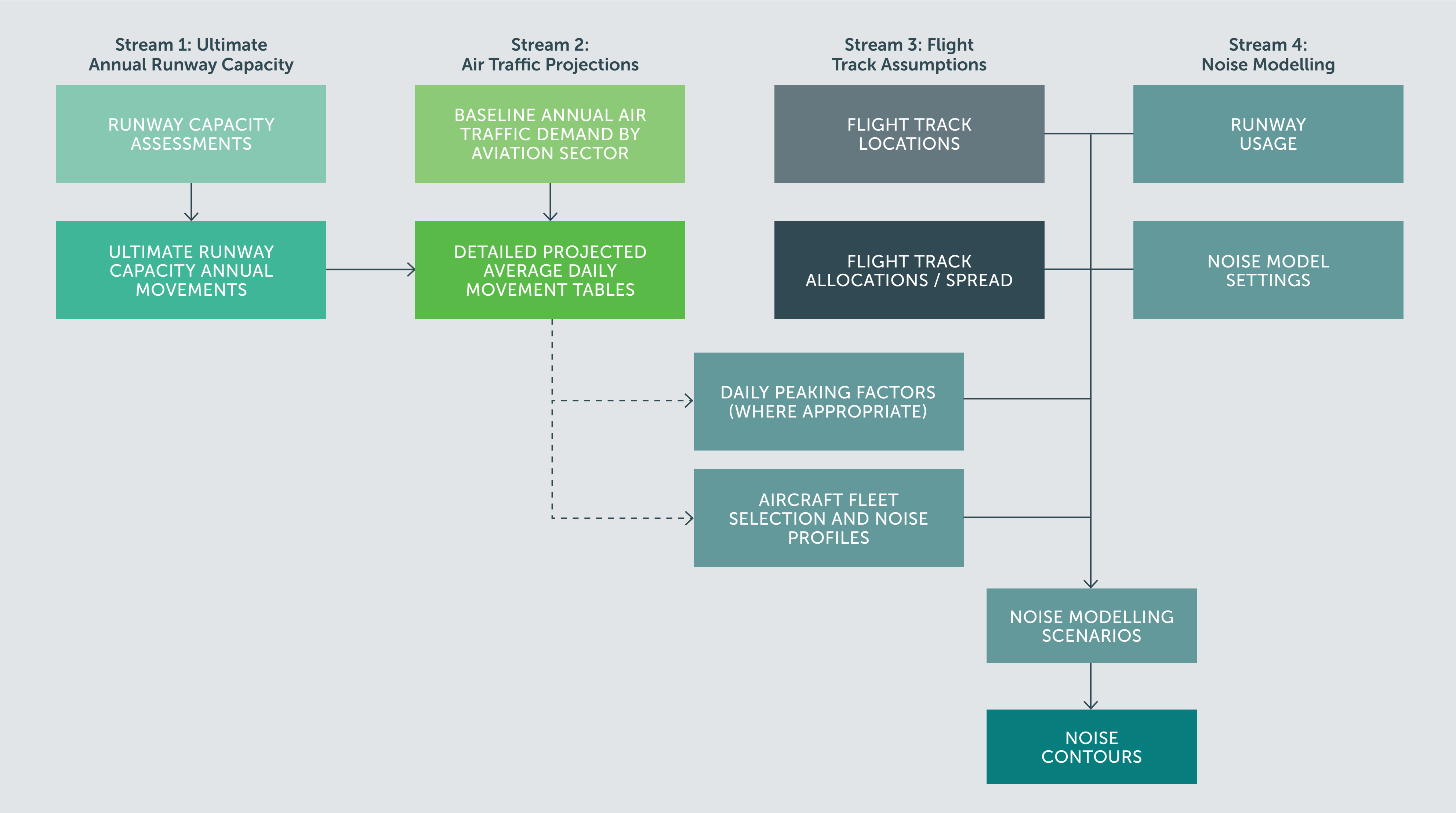
63 Please refer to the accompanying technical documents for further detail:

63.1 **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 tracks, aircraft fleet mix, air traffic projections, and ultimate runway capacity of the airport;

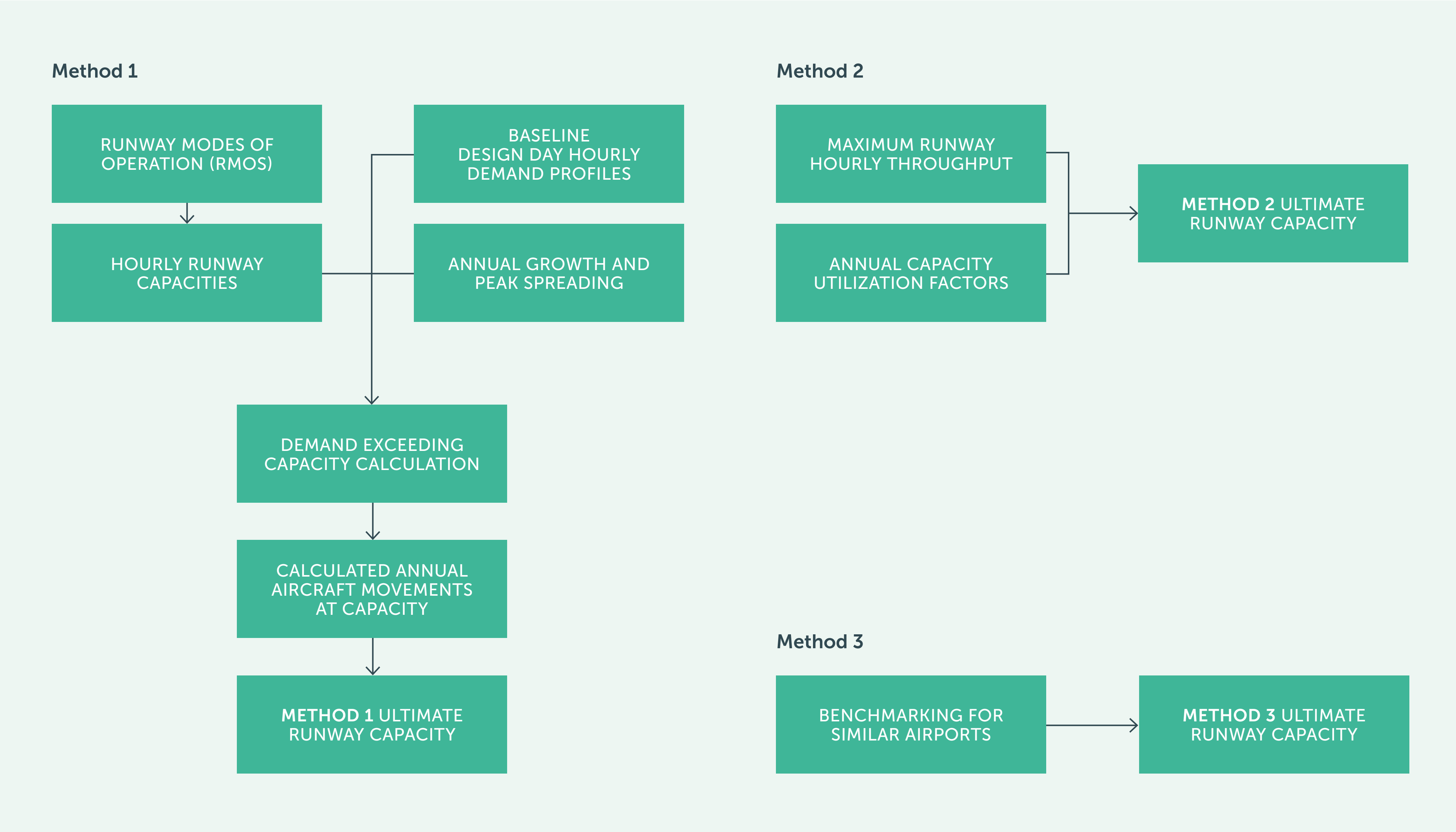
63.2 **Volume 5** has been prepared by expert acoustics consultants with experience in aircraft noise. This report explains: the acoustic inputs and assumptions, the modelling methods used, the sensitivity analysis which has been undertaken, and the modelling outcomes.

2021 MODELLING UPDATE PROCESS

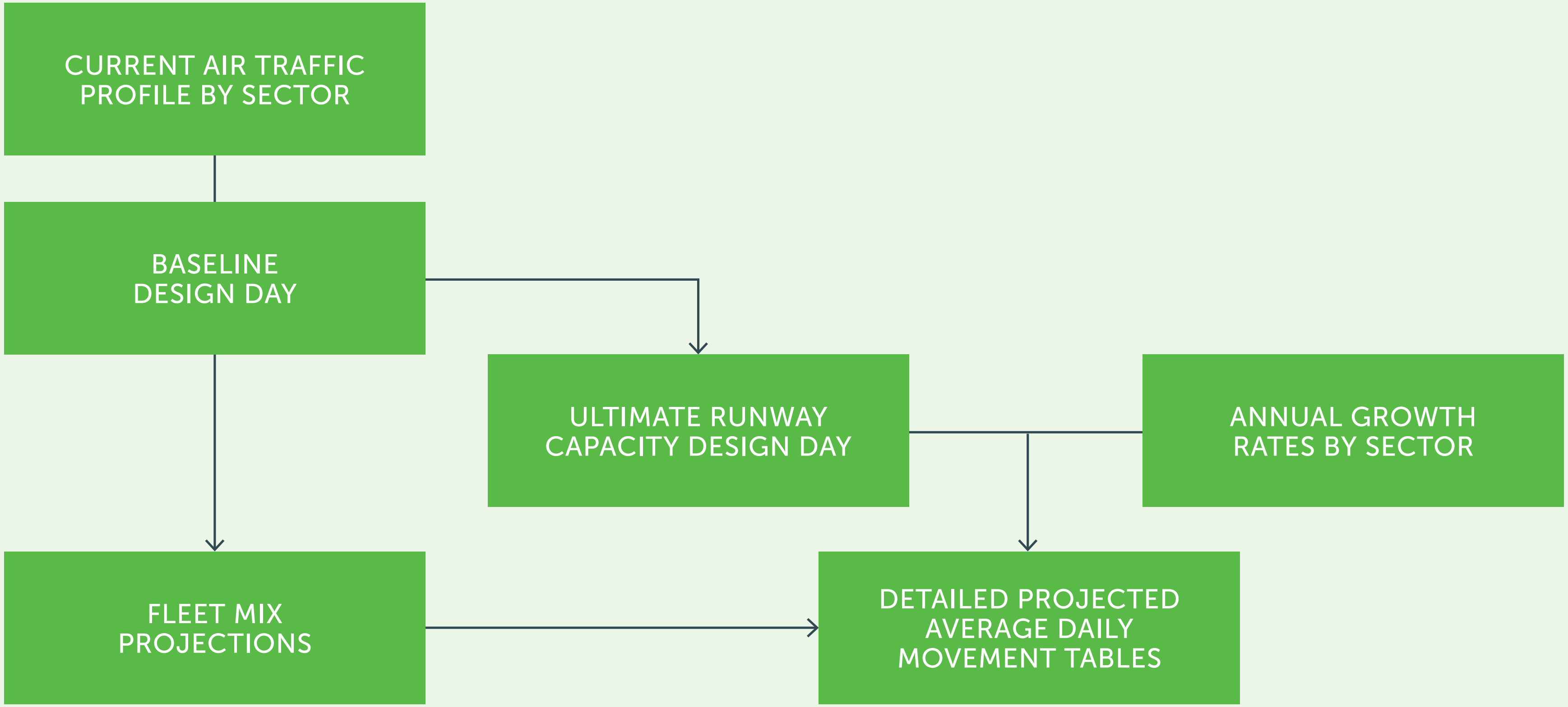
EXPERTISE AND INPUTS



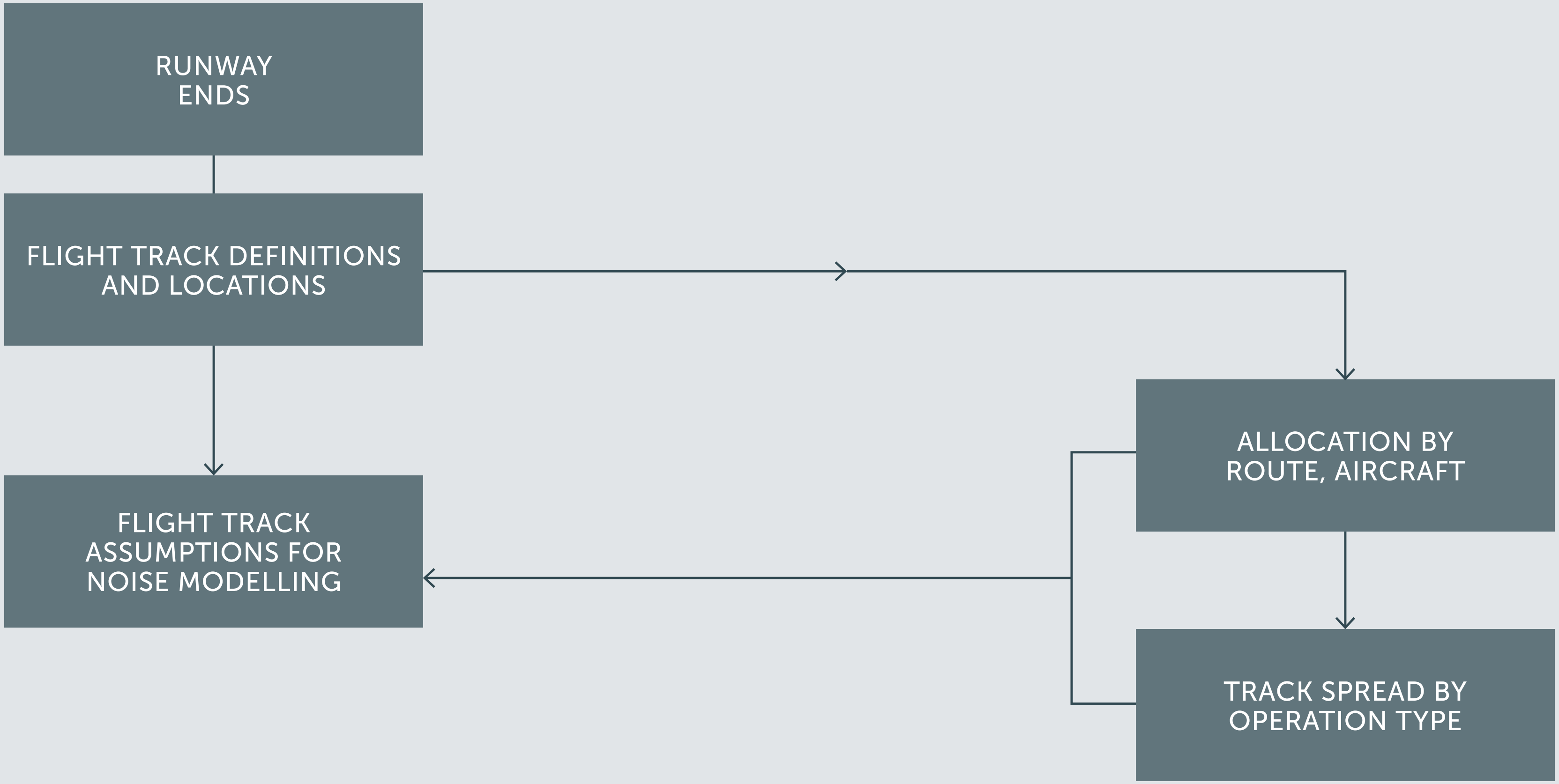
STREAM 1: ULTIMATE ANNUAL RUNWAY CAPACITY



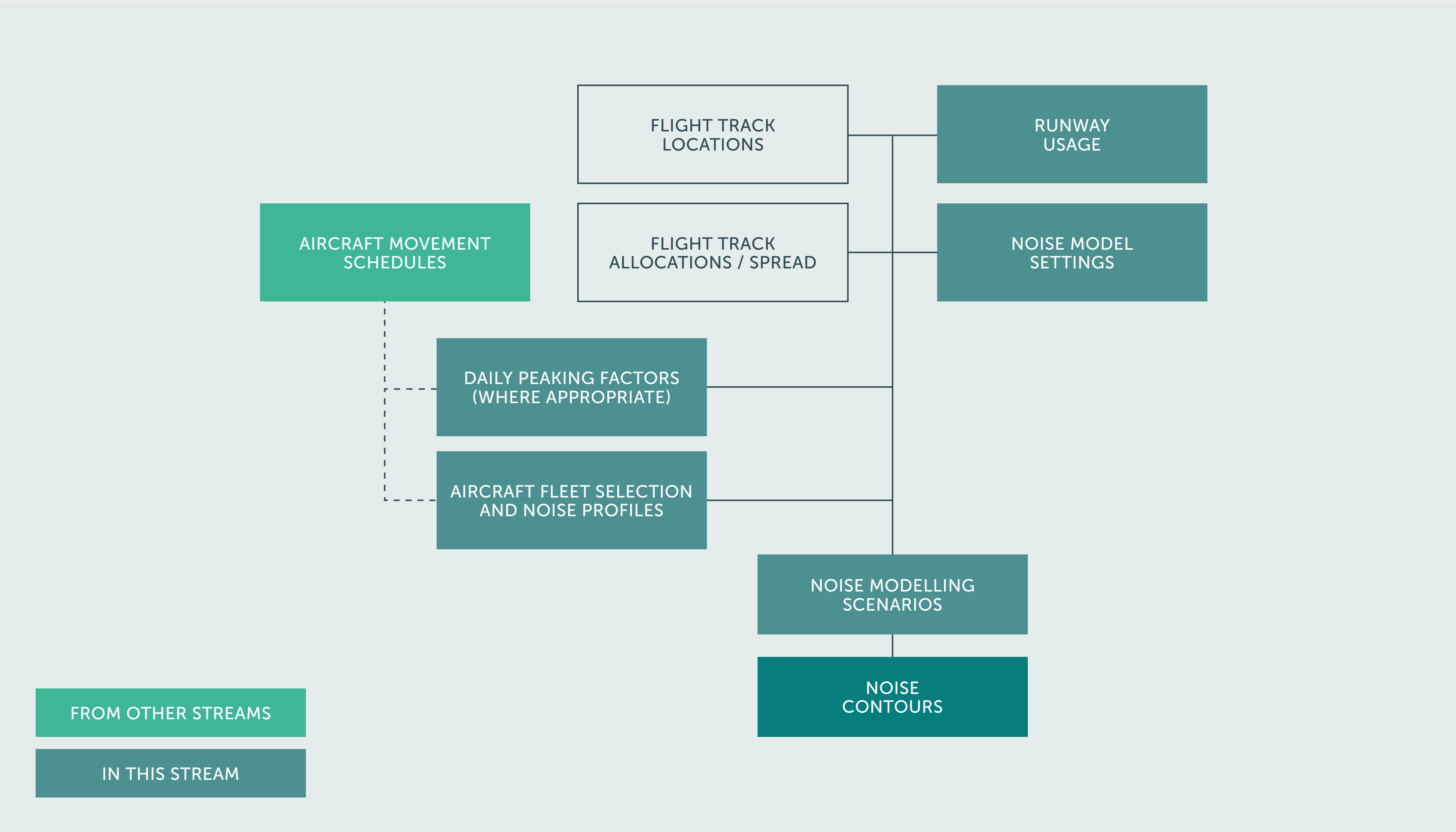
STREAM 2: AIR TRAFFIC PROJECTIONS



STREAM 3: FLIGHT TRACK ASSUMPTIONS



STREAM 4: NOISE MODELLING



2

Christchurch Airport

ULTIMATE RUNWAY CAPACITY

AIRBIZ

Christchurch Airport
Aircraft Noise Contours Update
Ultimate Runway Capacity Report

27th October 2021

Version	Ref	Date issued
1	203b	08/03/2019
2	203c	13/12/2019
3	203d	27/09/2021
4	203e	27/09/2021
5	203f	4/10/2021
6	203g	21/10/2021
7	203h	27/10/2021

Contents

1. 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 figure chosen 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 movements per hour

2. Estimate ultimate runway capacity using a bespoke runway capacity model, based on the above hourly capacity throughputs and a scaled up design day movement profile with some future peak spreading. Helicopters, Antarctic, Freight and GA movements would be in addition.

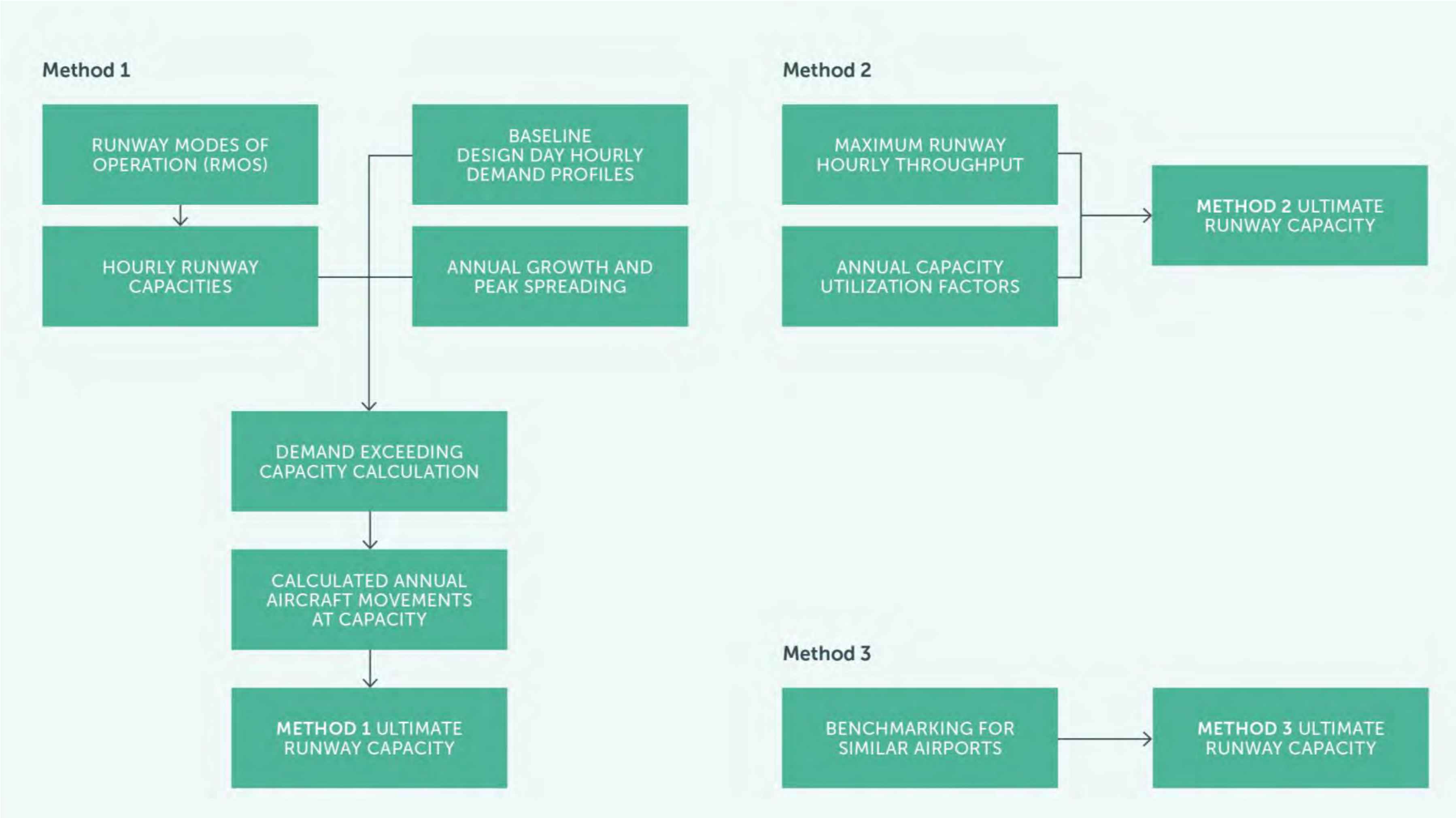
3. Using a second independent methodology to derive ultimate runway capacity based on peaking factors.

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 completed 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 in 2021, CIAL had updated passenger forecasts which considered scenarios for air traffic recovery in the short, medium and long term. At the detail level these were the same as pre-COVID, just that for it was assumed that it would take longer to reach any future projected traffic level. 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.

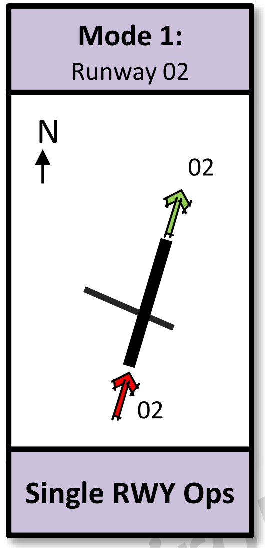
1. Methodology

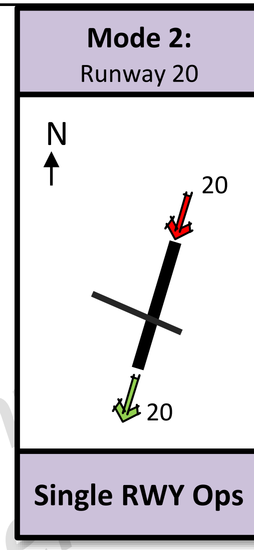


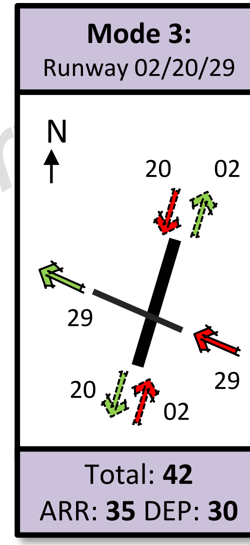
2. Runway Modes of Operation (RMOs) – Current Airfield

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

These RMO figures assume the current Christchurch Airport airfield layout and 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 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.

2. Runway Modes of Operation (RMOs) – Extended Runways

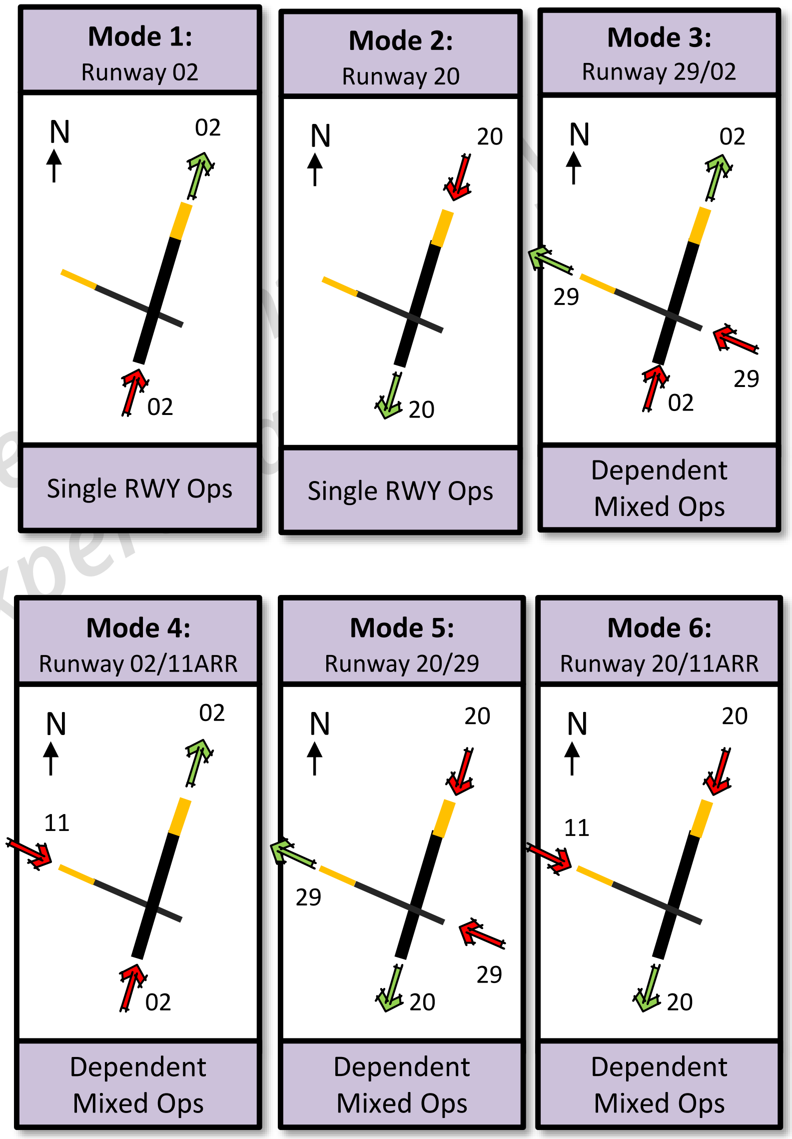
Airways made the following additional comments on RMOs:

- All turboprops can do intersection departures on RWY 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 TWY 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 opposite. They assume the following:

- Extended runways as shown in orange.
- DMAPS procedures with 15° divergence on departures and missed approach (implemented March 2020)

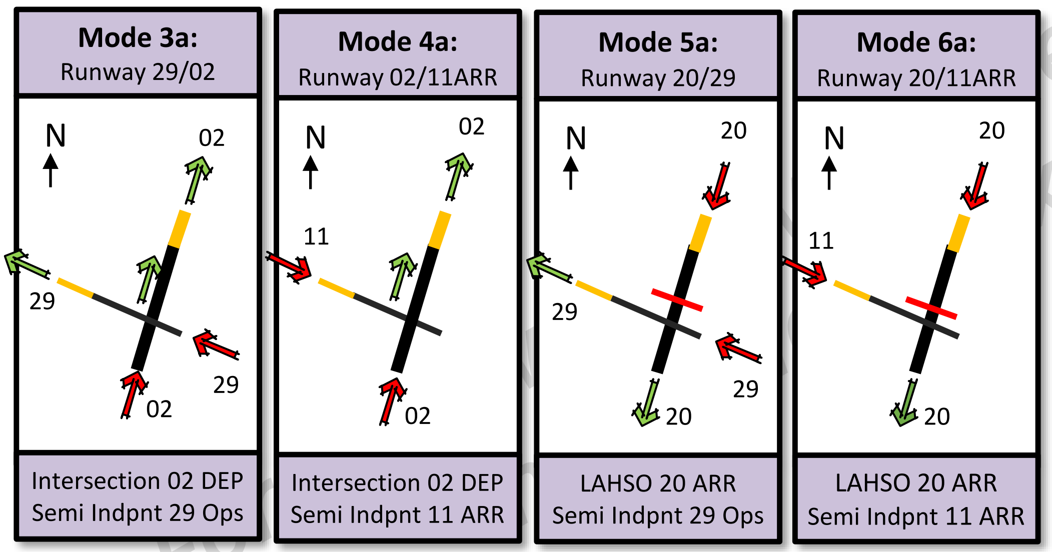
Airways advised that DMAPS with 15° divergence on departure and for missed approach allow fine weather capacity throughput to be maintained even in poor weather conditions. Further detail of flight tracks can be found in Volume 4 – Flight Track Assumptions.



2. Runway Modes of Operation (RMOs) – Extended Runways

Runway Modes of Operations (RMOs) for SIMOPS and LAHSO facilitated by future runway extensions are shown below. Airways consider that they 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 considered further the ultimate runway capacity assessments.

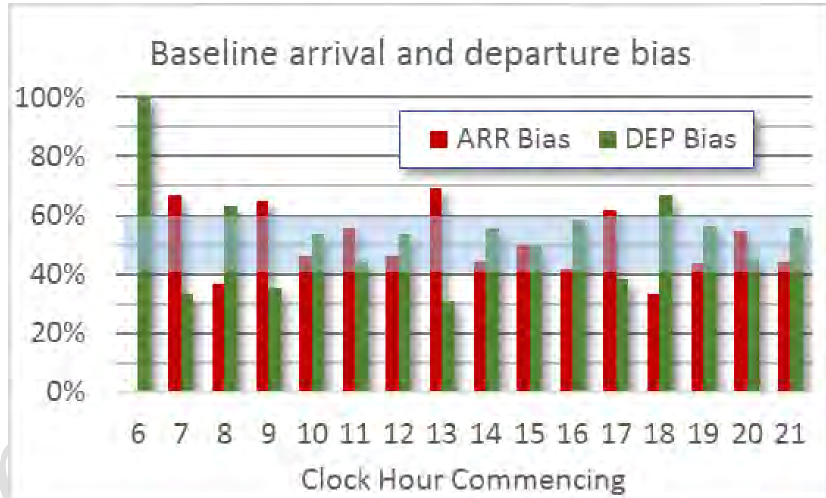
The Airways comments relating to these modes are documented in more detail the Appendix 2.



Other Runway Modes with runway extensions considered by Airways to not be operationally viable.

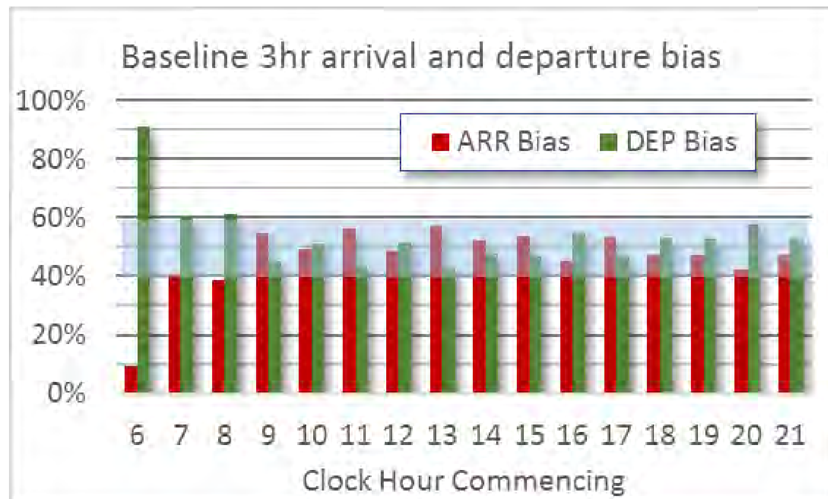
3. Hourly Runway Capacities

Indicative capacities for each of 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 simulates 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 opposite. 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 each RMO 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.

3. Hourly Runway Capacities

The analytical model used to assess the ultimate annual capacity compares projected demand versus hourly capacities for a design day. The tables show the assumed one hour (peak) and three hour (sustained) hourly runway capacities for the following two scenarios.

Scenario 1 is RMOs 1 & 2 (Single 02/20 Runway Operations) **with** DMAPS in **poor** weather conditions.

Scenario 2 is Future RMOs 1 & 2 (Single 02/20 Runway Operations) **with** DMAPS in **good** weather conditions. This allows a 20% increase in hourly capacity compared to scenario 1.

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.

Scenario 1 – 1 hour peak

Arr %	Dep %	Bias Code	Arrival Capacity	Departure Capacity	Total Capacity
90%-100%	0%-10%	1	36	2	36
60%-90%	10%-40%	2	29	10	39
40%-60%	40%-60%	3	21	21	42
10%-40%	60%-90%	4	9	28	37
0%-10%	90%-100%	5	2	34	34

Scenario 1 – 3 hour peak

Arr %	Dep %	Bias Code	Arrival Capacity	Departure Capacity	Total Capacity
90%-100%	0%-10%	1	108	6	108
60%-90%	10%-40%	2	87	30	117
40%-60%	40%-60%	3	63	63	126
10%-40%	60%-90%	4	27	84	111
0%-10%	90%-100%	5	6	102	102

Scenario 2 – 1 hour peak

Arr %	Dep %	Bias Code	Arrival Capacity	Departure Capacity	Total Capacity
90%-100%	0%-10%	1	37	2	37
60%-90%	10%-40%	2	30	11	40
40%-60%	40%-60%	3	22	22	43
10%-40%	60%-90%	4	10	29	38
0%-10%	90%-100%	5	2	35	35

Scenario 2 – 3 hour peak

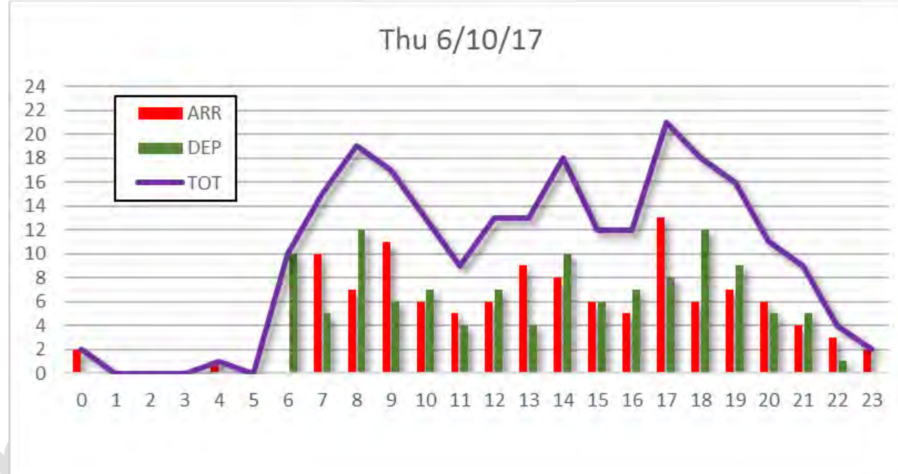
Arr %	Dep %	Bias Code	Arrival Capacity	Departure Capacity	Total Capacity
90%-100%	0%-10%	1	111	6	111
60%-90%	10%-40%	2	90	33	120
40%-60%	40%-60%	3	66	66	129
10%-40%	60%-90%	4	30	87	114
0%-10%	90%-100%	5	6	105	105

4. Annual Projection and Daily Profile

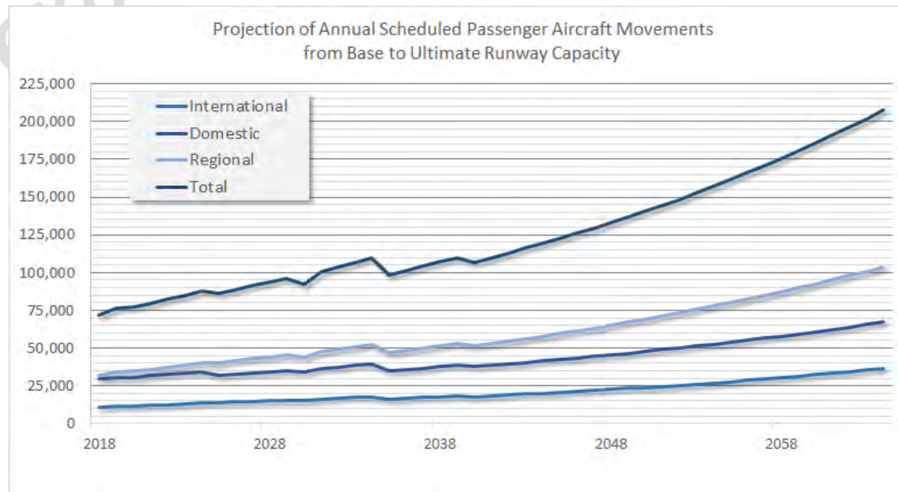
The daily scheduled passenger aircraft movement profile by clock hour tabulated below and plotted opposite was extracted from the selected design day (6/10/2017).

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 opposite bottom right. More details of Air Traffic Projections can be found in Volume 3.



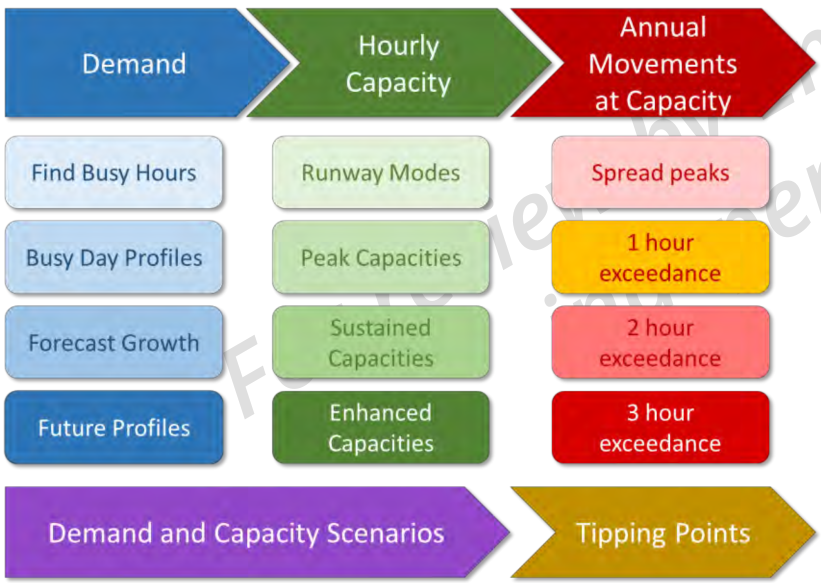
CH	ARR	DEP	TOT
0	2		2
1			0
2			0
3			0
4	1		1
5			0
6		10	10
7	10	5	15
8	7	12	19
9	11	6	17
10	6	7	13
11	5	4	9
12	6	7	13
13	9	4	13
14	8	10	18
15	6	6	12
16	5	7	12
17	13	8	21
18	6	12	18
19	7	9	16
20	6	5	11
21	4	5	9
22	3	1	4
23	2		2
	117	118	235



5. Ultimate 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 (see p7 above)
4. Scenarios 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 exceedance for one or two hours across the day.



Scenarios are based on arrivals, departures or total capacity; peak 1 or sustained (3-hour) peak; can also use multiple forecasts (high, medium, low).

Peak at Capacity

Move peak overflow to shoulder

Shoulder reach capacity

Reaches Capacity

Scenario	Base	+5 years	+10	+15	+20	+25	+30	+35	+40
1									
2									

6. Ultimate Annual Runway Capacity

The model dashboard below shows a heat map for when demand approaches various capacity criteria on a Design Day (typically around a day ranked the 95th percentile).

The “trigger” column is coded for arrivals/departures or overall capacity. The model “scenarios” are for single runway 02 or 20 capacities (as listed previously) and for the “central” annual aircraft movement forecast. Scenario 3 was tested against a 3 hour sustained capacity.

The colours have been set to change when the hourly capacity is exceeded by more than 2 movements per hour (e.g. for 42 mvts/hour capacity, only alert when demand hits 44). For one instance across the day, colour is yellow, pink for 2 instances and red for 3 instances.

Hourly Tolerance	2	AC mvt > capacity

Daily Hours Over Capacity	
0	
1	>=1
2	>=2
3	>=3

Scenario 2 reaches when the annual scheduled passenger forecast traffic is around **175,500 annual movements.**

When scenario 3 is tested against an extended 3-hours demand approaches (assumed RDSM or slot control) its capacity is pushed up to around **190,000 annual movements.**

Scenario 2 & 3 (1 hour) ↓ (175,500) ↓ Scenario 3 (3 hours) (190,000)

Run	Operational Trigger (Arr/Dep/Total)	Capacity Scenario	Demand Peak (hrs)	Growth																							175,500			190,000							
1	A	1	1	Central							1	1	1	1	1	1	2	2	2	2	2	3	3	3	4	4	4	5	6	6	7	7	7	7	12	12	12
2	D	1	1	Central	1	1	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	4	5	7	7	7	7	10	10	10	11	11	11	12	12	13
3	T	1	1	Central											1	1	1	3	3	4	4	5	6	6	6	6	7	7	7	9	9	10	12	12	12	13	14
4	A	2	1	Central							1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	5	5	5	6	6
5	D	2	1	Central				1		1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	4	6	7	7	7	7	7	7	8	8	8
6	T	2	1	Central															1	1	2	2	3	3	3	3	4	5	5	5	5	7	7	7	7	7	8
7	A	3	1	Central											1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	4	5	5	6
8	D	3	1	Central									1	1	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	6	7	7	7	7	7	7	7
9	T	3	1	Central																1	1	2	2	3	3	3	3	5	5	5	5	6	7	7	7	7	8
10	A	3	3	Central														1	1	1	1	1	1	1	1	1	2	2	2	3	3	3	6	8	8	9	9
11	D	3	3	Central																						1	1	1	2	3	4	4	4	6	6	6	6
12	T	3	3	Central																							1	1	1	3	4	5	5	5	8	9	10

7. Daily Profile at Capacity

The model output chart opposite shows the **hourly** demand (arrival/ departure/ overall) with corresponding capacities for **175,000** annual movements for Scenario 2. 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 42. The demand profile is very peaking, hence the "trigger" (previous page) is set above the 42 movements. This also considers potential for peak spreading or delays in single hours pushing movements to subsequent hours.

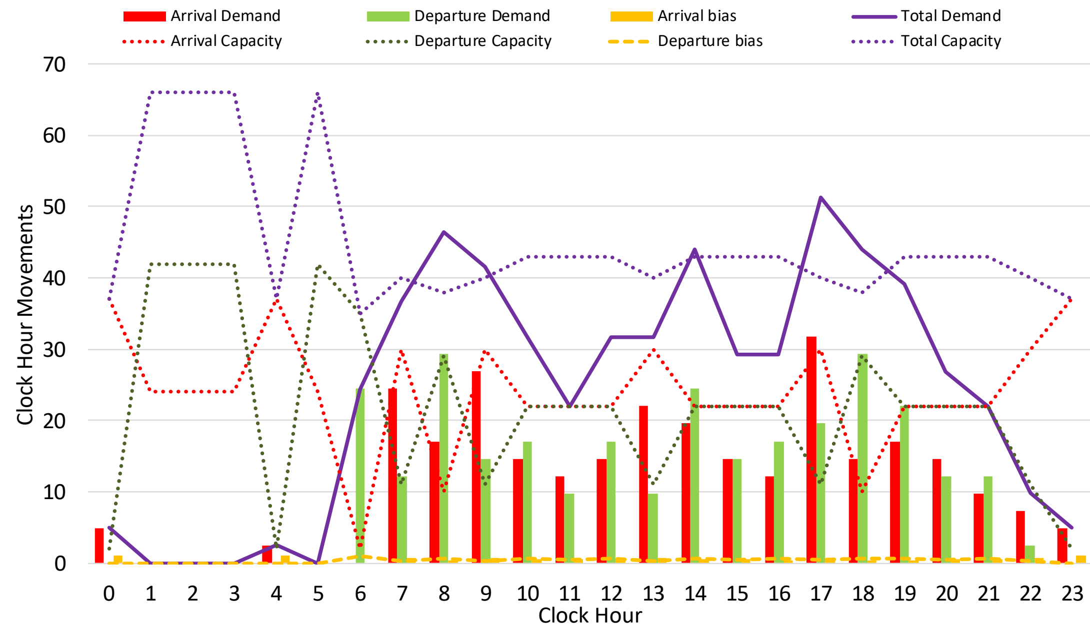
At this level of demand of around 175,000 annual scheduled passenger aircraft movement, there are occasional exceedances of total, arrival and departure capacities. The "design day" is a typical busy day at around 95th percentile in terms of daily traffic. There is still some room for peak spreading across the day and across the year, but there will be delays and the runway system should be considered "at capacity".

Demand
175,000

Scenario
2

Hour Period
1

Growth
Central



Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Arrival Demand	5	0	0	0	2	0	0	24	17	27	15	12	15	22	20	15	12	32	15	17	15	10	7	5
Departure Demand	0	0	0	0	0	0	24	12	29	15	17	10	17	10	24	15	17	20	29	22	12	12	2	0
Total Demand	5	0	0	0	2	0	24	37	46	42	32	22	32	32	44	29	29	51	44	39	27	22	10	5
Arrival Capacity	37	24	24	24	37	24	2	30	10	30	22	22	22	30	22	22	22	30	10	22	22	22	30	37
Departure Capacity	2	42	42	42	2	42	35	11	29	11	22	22	22	11	22	22	22	11	29	22	22	22	11	2
Total Capacity	37	66	66	66	37	66	35	40	38	40	43	43	43	40	43	43	43	40	38	43	43	43	40	37
Arrival bias	100%				100%		0%	67%	37%	65%	46%	56%	46%	69%	44%	50%	42%	62%	33%	44%	55%	44%	75%	100%
Departure bias	0%				0%		100%	33%	63%	35%	54%	44%	54%	31%	56%	50%	58%	38%	67%	56%	45%	56%	25%	0%

7. Daily Profile at Capacity

Scenario number changed from 3 to 2

The model output chart opposite shows the **3-hourly** demand (arrival/ departure/ overall) with corresponding sustained capacities of **200,000** annual scheduled passenger aircraft movements (Scenario 2). These vary depending if the hourly traffic is balanced or arrival or departure biased.

The sustained capacities have been conservatively set at 95% of single hour (peak) capacities.

This shows that at the traffic level of 200,000 annual scheduled passenger movements (when single hour capacity has multiple exceedances) there is room across the day for further peak spreading, and accommodating freight and unscheduled movements.

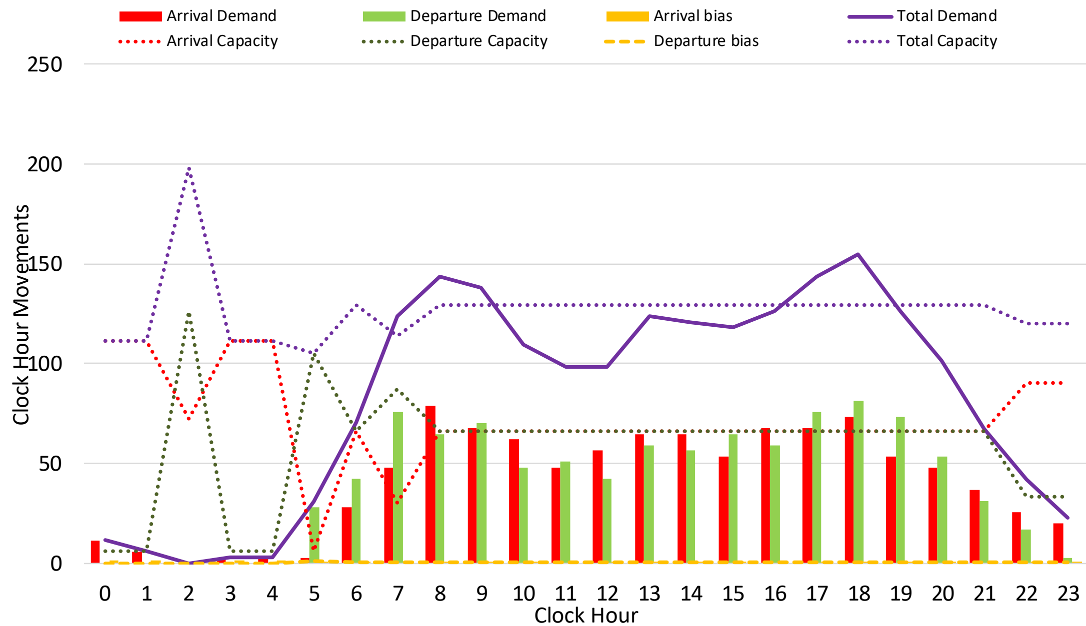
While the heat map shows red starting at 190,000 movements, this extended view on the daily profile shows that peak spreading could extend to 200,000 movements.

Demand
200,000

Scenario
2

Hour Period
3

Growth
Central



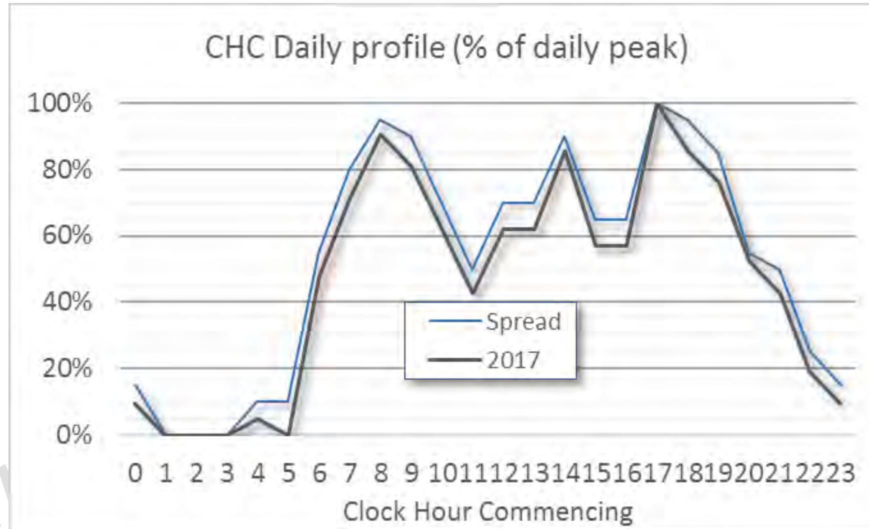
Operation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Arrival Demand	11	6	0	3	3	3	28	48	79	67	62	48	56	65	65	53	67	67	73	53	48	37	25	20
Departure Demand	0	0	0	0	0	28	42	76	65	70	48	51	42	59	56	65	59	76	82	73	53	31	17	3
Total Demand	11	6	0	3	3	31	70	124	143	138	110	98	98	124	121	118	126	143	155	126	101	67	42	22
Arrival Capacity	111	111	72	111	111	6	66	30	66	66	66	66	66	66	66	66	66	66	66	66	66	66	90	90
Departure Capacity	6	6	126	6	6	105	66	87	66	66	66	66	66	66	66	66	66	66	66	66	66	66	33	33
Total Capacity	111	111	198	111	111	105	129	114	129	129	129	129	129	129	129	129	129	129	129	129	129	129	120	120
Arrival bias	100%	100%		100%	100%	9%	40%	39%	55%	49%	56%	49%	57%	52%	53%	45%	53%	47%	47%	42%	47%	54%	60%	88%
Departure bias	0%	0%		0%	0%	91%	60%	61%	45%	51%	44%	51%	43%	48%	47%	55%	47%	53%	53%	58%	53%	46%	40%	13%

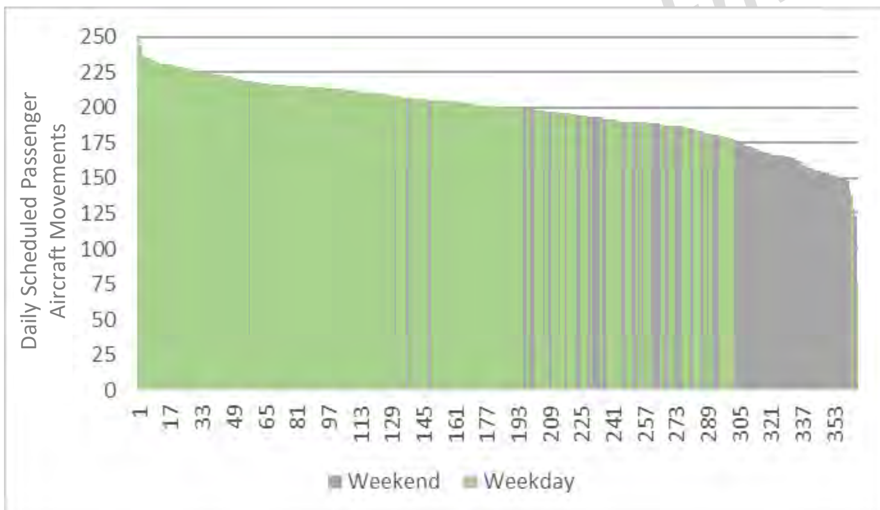
8. Peak Spreading Factor

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





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%**

8. Peak Spreading Factor

The current notional busy hour capacity (all movements) for a single runway at Christchurch is 42 hourly movements. 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).

Marginally adjusted these up for the future projection of a single runway capacity gives an annual capacity around 178,000 annual movements and 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	42					21	Current		
Utilisation	55%				WD1	46%			
Daily	554				WD1	232			
Busy Weekday peaking	92%	Ave	510			89%	207	Ave	
Weekday to Weekend	87%	Ave	482			**84%**	174	Ave	
Busy Weekend peaking	90%	Ave	434			**86%**	203	WE1	
Weekdays	260		132,612				53,820		
Weekends	104		45,146				18,096		
			177,758				71,916		
Convert to 365	100.27%		**177,500**				**72,500**		

9. Benchmarking

Taking the runway peak hourly capacity hypothetically assuming it is maintained for 24 hours a day, 365 days a year gives 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 capacity of their current runway systems is shown below and the current Christchurch ratio of around 40% for scheduled passenger aircraft movements. Using an annual average peaking factor of 52% and some further peak spreading over the design day (as shown previously), gives a projected runway capacity of around 192,500 annual scheduled passenger aircraft movements, assuming a maximum hourly capacity of 42 movements. Varying this gives a range between 165,000 and 225,000 annual 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	42	21	45	50	80	57	50	85	50
Maximum annual 24/7	367,920	183,960	394,200	438,000	700,800	499,320	438,000	744,600	438,000
Annual capacity	192,500	72,500	172,765	215,000	350,000	240,000	130,000	475,000	285,000
Peaking factor	52%	39%	**44%**	**49%**	**50%**	**48%**	**30%**	**64%**	**65%**

10. Conclusion

Assessed Ultimate Annual Runway Capacity

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

Based on the results, this was assessed as between 160,000 and 200,000 annual **scheduled passenger** aircraft movements.

This is based on a notional single runway peak throughput of 42 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. GA movements are assumed to have relocated to another aerodrome as this airport approaches capacity.

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.

10. Conclusion

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) Base Case with scheduled passenger movements around capacity of 175,000 annual movements
(b) A capacity of 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.

10. Conclusion

(a) Base Case

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 Mvts	Annual Aircraft	Cumulative
Scheduled Passenger	201,983	**201,983**
Freight	11,476	213,459
Airline/MRO	5,228	218,687
FBO/Small Commercial	19,992	**238,679**
Antarctic/Military/Govt	6,098	244,777
Helicopter	29,042	29,042

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

200,000 Scheduled Mvts	Annual Aicraft	Cumulative
Scheduled Passenger	201,983	**201,983**
Freight	11,476	213,459
Airline/MRO	5,228	218,687
FBO/Small Commercial (1)	9,996	**228,683**
Antarctic/Military/Govt	6,098	234,781
Helicopter	29,042	29,042

Note (1) Reduced by 50%

RMO CAPACITIES FROM AIRWAYS

APPENDIX 1

RUNWAY MODES OF OPERATION BEFORE RUNWAY EXTENSIONS

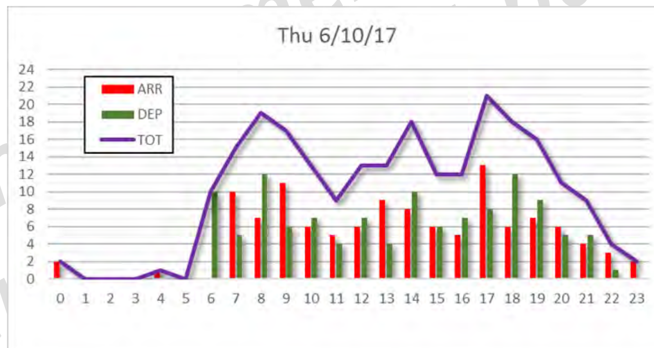
MODE 01

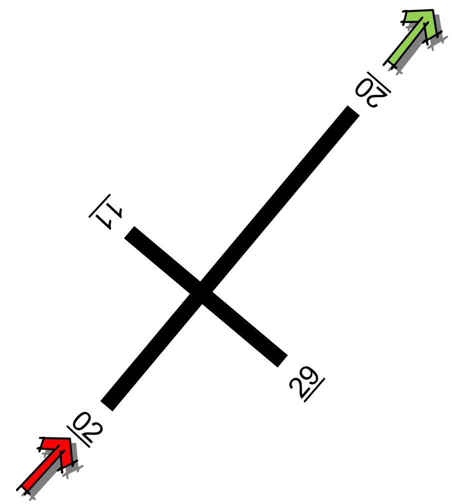
Single Runway 02	NE/E wind: 50% to 60% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period or DRY condition
Noise abatement	No preferred direction

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

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	36	0	36
60-90%	10-40%	29	10	39
40-60%	40-60%	21	21	42
10-40%	60-90%	9	28	37
0-10%	90-100%	0*	30	30





Note: capacities are based on the assumption of no taxiway limitations

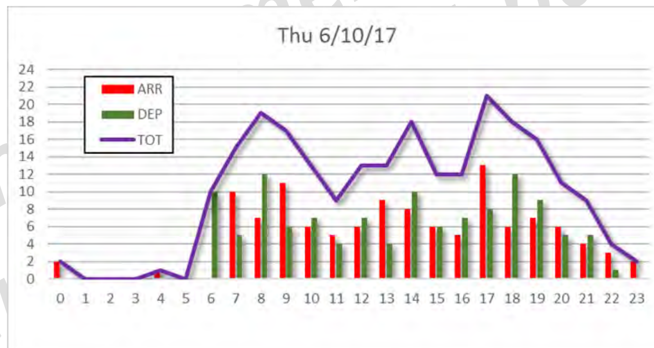
MODE 02

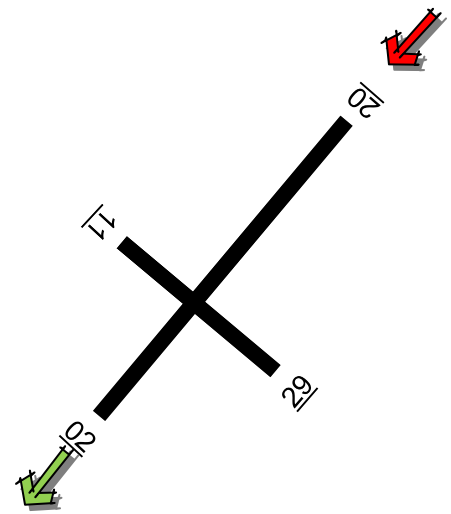
Single Runway 20	SW wind: 30% - 40% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Noise abatement	No preferred direction

Arrivals	**20**
Departures	**20**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	36	0	36
60-90%	10-40%	29	10	39
40-60%	40-60%	21	21	42
10-40%	60-90%	9	28	37
0-10%	90-100%	0*	30	30





Note: capacities are based on the assumption of no taxiway limitations

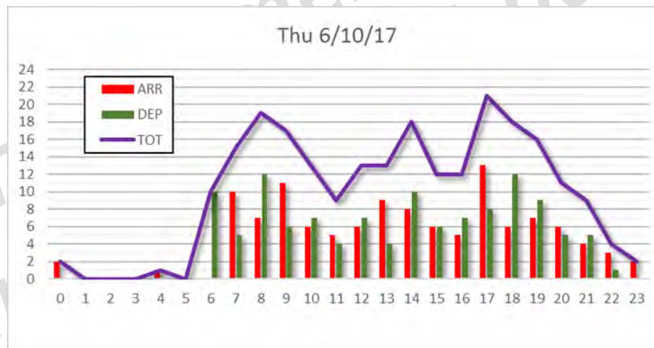
MODE 03

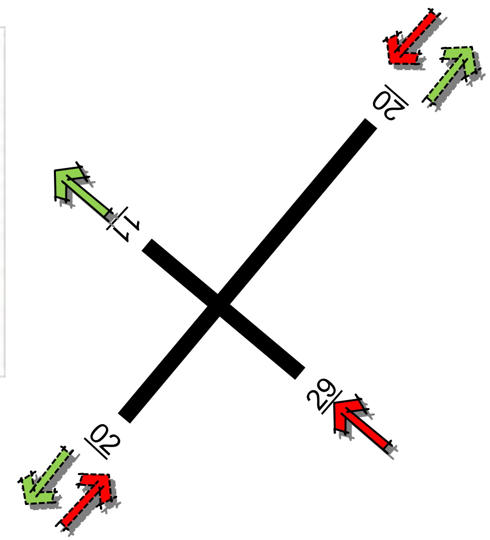
Runway 29 plus /02 or /20	NW/W wind: 10% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 29
Mode 3 is only used when crosswind is greater than 15kts on RWY 02. *RWY 29 generally used only by domestic NB Jets & TP. International Jets to use RWY 02/20 depending on X-wind limits. The selection of 02 or 20 in conjunction with RWY 29 will depend on wind direction.*	

Arrivals	***02/20, 29***
Departures	***02/20, 29***

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	36	0	36
60-90%	10-40%	29	10	39
40-60%	40-60%	21	21	42
10-40%	60-90%	9	28	37
0-10%	90-100%	0*	30	30





Note: capacities are based on the assumption of no taxiway limitations

RUNWAY MODES OF OPERATION WITH RUNWAY EXTENSIONS

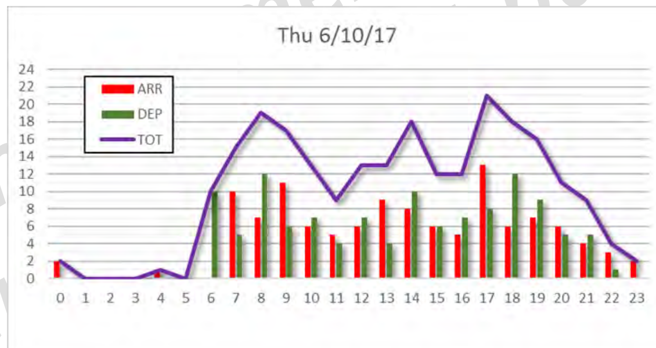
MODE 01

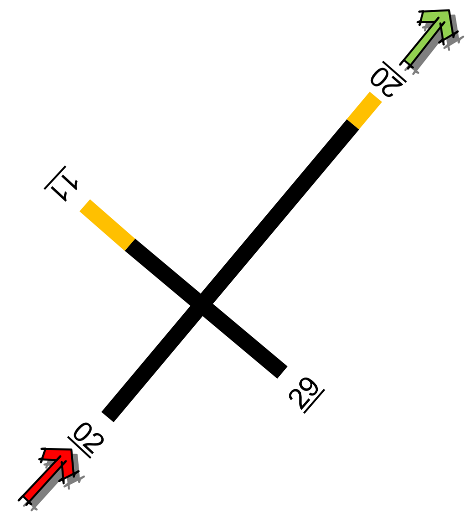
Single Runway 02	NE/E wind: 50% to 60% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period or DRY condition
Noise abatement	No preferred direction
Extension to main runway does not increase capacity, RoT same as current. With DMAPs (15/15) with 15º divergence on Departure and Missed Approach fine weather throughput to be maintained in poor weather conditions.	

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

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





Note: capacities are based on the assumption of no taxiway limitations

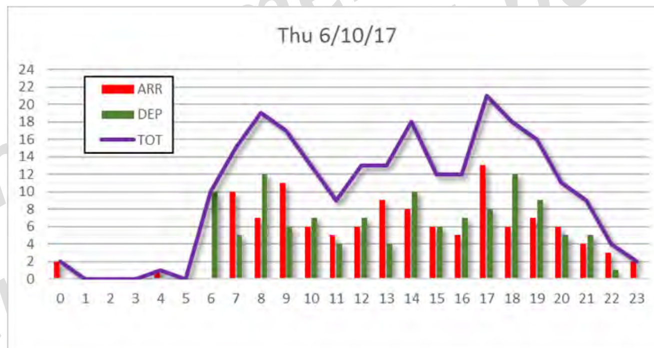
MODE 02

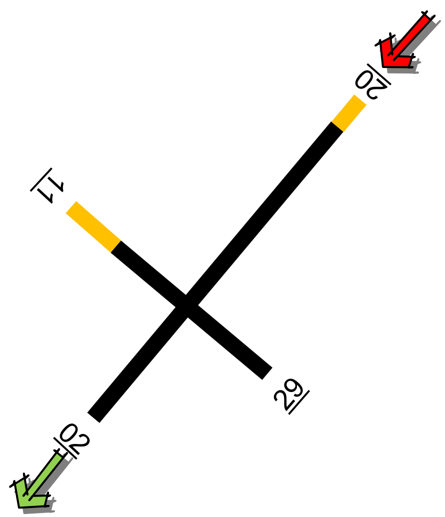
Single Runway 20	SW wind: 30% - 40% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Noise abatement	No preferred direction
Extension to main runway does not increase capacity, RoT same as current. *With DMAPs (15/15) with 15º divergence on Departure and Missed Approach fine weather throughput to be maintained in poor weather conditions.*	

Arrivals	**20**
Departures	**20**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





Note: capacities are based on the assumption of no taxiway limitations

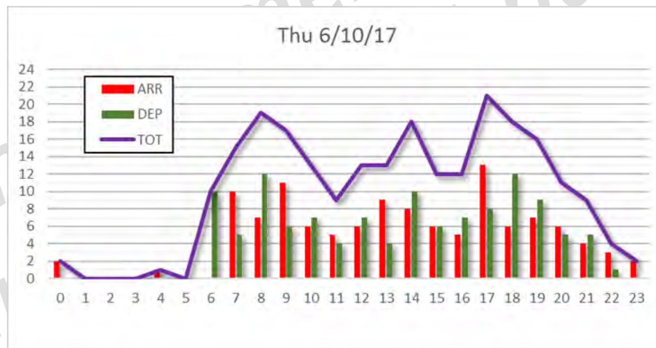
MODE 03

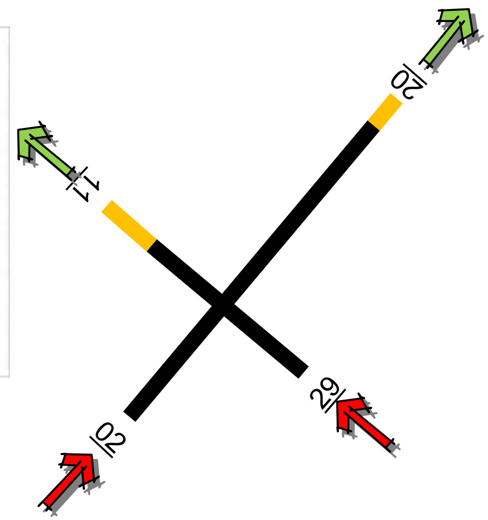
Runways 02/29	NW/W wind: 10% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 29
RWY 29 generally used only by NB Jets & TP. International Jets to use RWY 02/20 depending on X-wind limits. The selection of 02 or 20 in conjunction with RWY 29 will depend on wind direction. Trans-Tasman NB and MWB jets could use RWY 29 in dry conditions. *Extension to main runway does not increase capacity, RoT same as current.*	

Arrivals	**02, 29**
Departures	**02, 29**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





If the extension to RWY 11/29 led to increased use of RWY 29 by internationals, this could lead to reduction in capacity due to internationals generally flying IFR, so they would all require the RNP and be spread out further than aircraft flying visually.

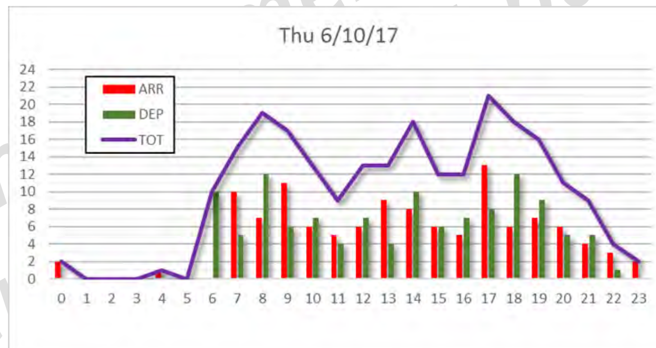
Note: capacities are based on the assumption of no taxiway limitations

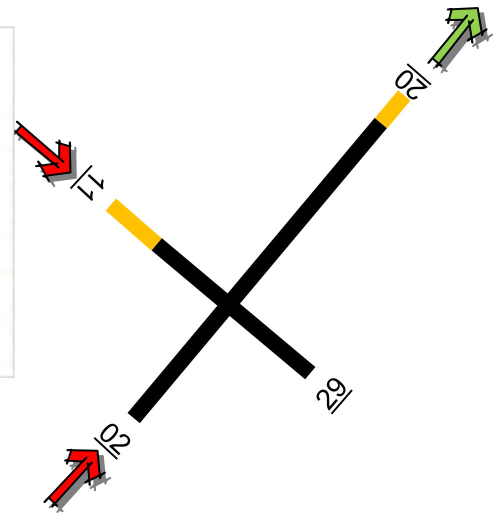
Runway 02 with /11 ARR	**NE/E wind: 50% to 60% of the time**
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 02
RWY 11 generally used only by NB Jets & TP. International Jets to use RWY 02/20 depending on X-wind limits. The selection of 02 or 20 in conjunction with RWY 11 will depend on wind direction. Trans-Tasman NB and MWB jets could use RWY 11 in dry conditions. Extension to main runway does not increase capacity, RoT same as current.	

Arrivals	**02, 11**
Departures	**02**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





If the extension to RWY 11/29 led to increased use of RWY 29 by internationals, this could lead to reduction in capacity due to internationals generally flying IFR, so they would all require the RNP and be spread out further than aircraft flying visually.

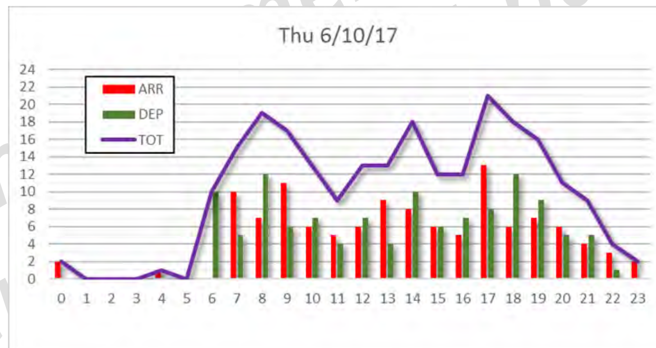
MODE 05

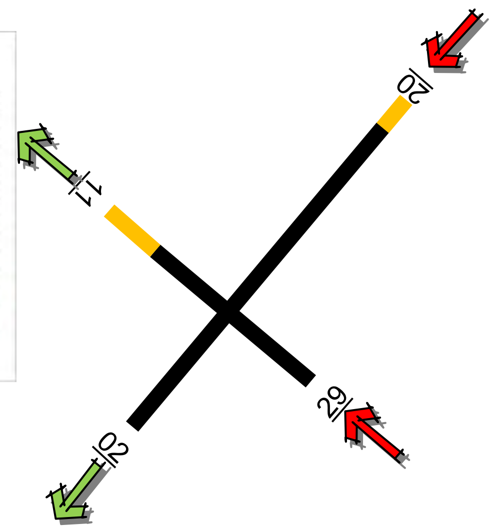
Runways 20/29	**NW/W wind: 10% of the time**
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 29
Mode 5 only used when crosswind on RWY 20 exceeds 15kts. RWY 29 generally used only by NB Jets & TP. International Jets to use RWY 02/20 depending on X-wind limits.	

Arrivals	**20, 29**
Departures	**20, 29**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





Note: capacities are based on the assumption of no taxiway limitations

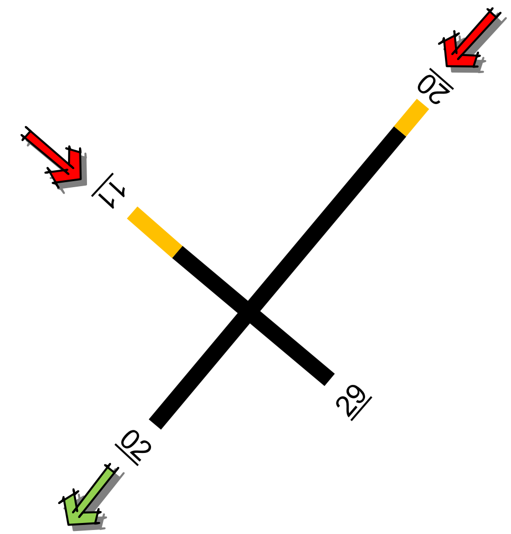
MODE 06

Runway 20/11 ARR	SW wind: 30% - 40% of the time
Downwind tolerance:	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 20
Only use if specific request from TP to use RWY 11 ARR in low traffic.	

Arrivals	**20, 11**
Departures	**20**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35



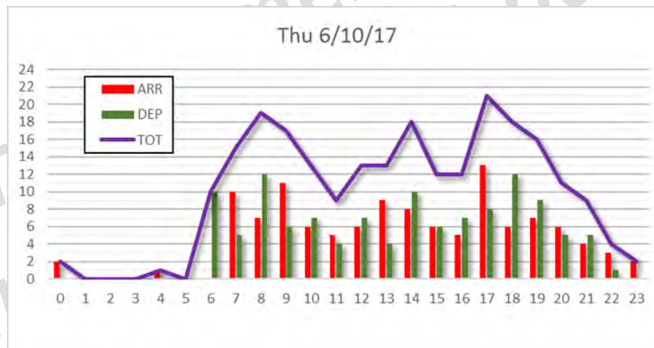
Runway 02/29 SIMOPS	NW/W wind: 10% of the time
Downwind tolerance	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 29
RWY 02 Intersection departures available where appropriate. Semi Independent operations on RWY 29.	

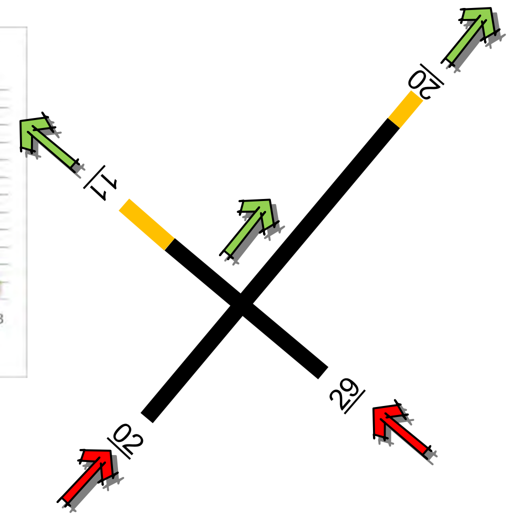
Arrivals	**02, 29**
Departures	**02* , 29**

02* = *intersection departure*

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





Complexity in ground operations could limit capacity, such as head to heads conflict between RWY 29 arrivals and RWY 02 intersection departure queue.

Note: capacities are based on the assumption of no taxiway limitations

MODE 04a

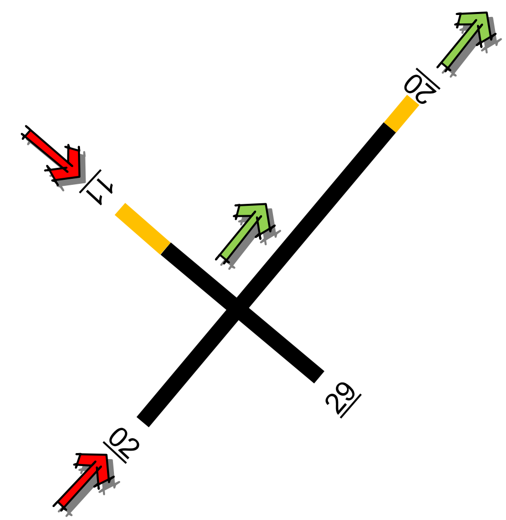
Runway 02/11 ARR	NE/E wind: 50% to 60% of the time (40% of conditions)
Downwind tolerance:	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 02
Only use RWY 11 if specific request from TP to use RWY 11 ARR in low traffic. *Intersection departures off RWY 02. Semi independent operations on RWY 11*	

Arrivals	**02, 11**
Departures	**02***

02* = *intersection departure*

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35

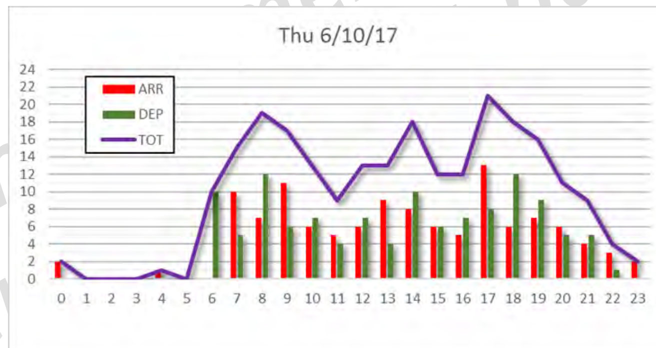


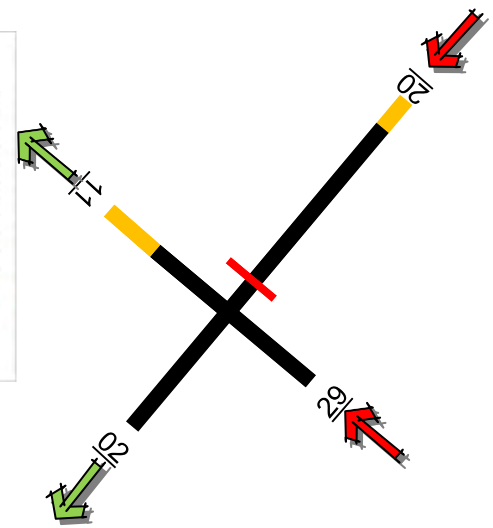
Runway 20/29 LAHSO	NW/W wind: 10% of the time
Downwind tolerance:	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 29
Used when RWY 2- crosswind exceeds 15kts. LAHSO on RWY 20 (DRY only), semi independent operations on RWY 29.	

Arrivals	**20 (LAHSO), 29**
Departures	**02, 29**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35





Note: capacities are based on the assumption of no taxiway limitations

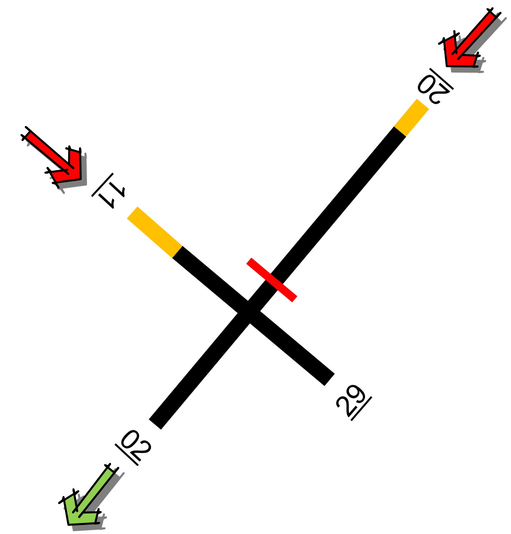
MODE 06a

Runway 20/11 ARR	SW wind: 30% - 40% of the time
Downwind tolerance:	0 knots during busy period or WET condition 5 knots during non-busy period on DRY condition
Preferred direction	RWY 20
Only use if specific request from TP to use RWY 11 ARR in low traffic. LAHSO on RWY 20, semi independent operations on RWY 11.	

Arrivals	**20 (LAHSO), 11**
Departures	**20**

1 HOUR CAPACITY – Fine Weather

Arr	Dep	Arr	Dep	Total
90-100%	0-10%	37	0	37
60-90%	10-40%	30	11	40
40-60%	40-60%	22	22	43
10-40%	60-90%	10	29	38
0-10%	90-100%	0	35	35



OTHER RMOS COMMENTS FROM AIRWAYS

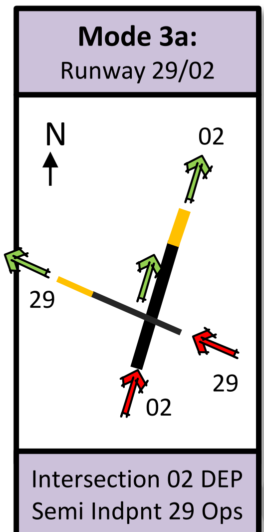
APPENDIX 2

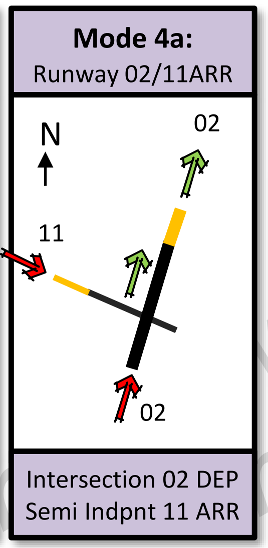
Other RMOs: SIMOPS | Airways comments

The figures shown below are future Runway Modes of Operations (RMOs) for SIMOPS that were considered by Airways to not provide additional capacity and were therefore not taken forward in the assessment of the ultimate annual capacity.

When assessed they also assumed the extended runways and DMAPS. However according to Airways, further ground infrastructure constrains and some airspace constraints would not allow efficient SIMOPS operations. Such modes would therefore not provide any additional capacity to the dependent Mixed Operations presented in the main body of the report. Those constraints are illustrated on the Master Plan figure extract below:

Future Runway Modes (SIMOPS) considered by Airways to not be operationally viable:



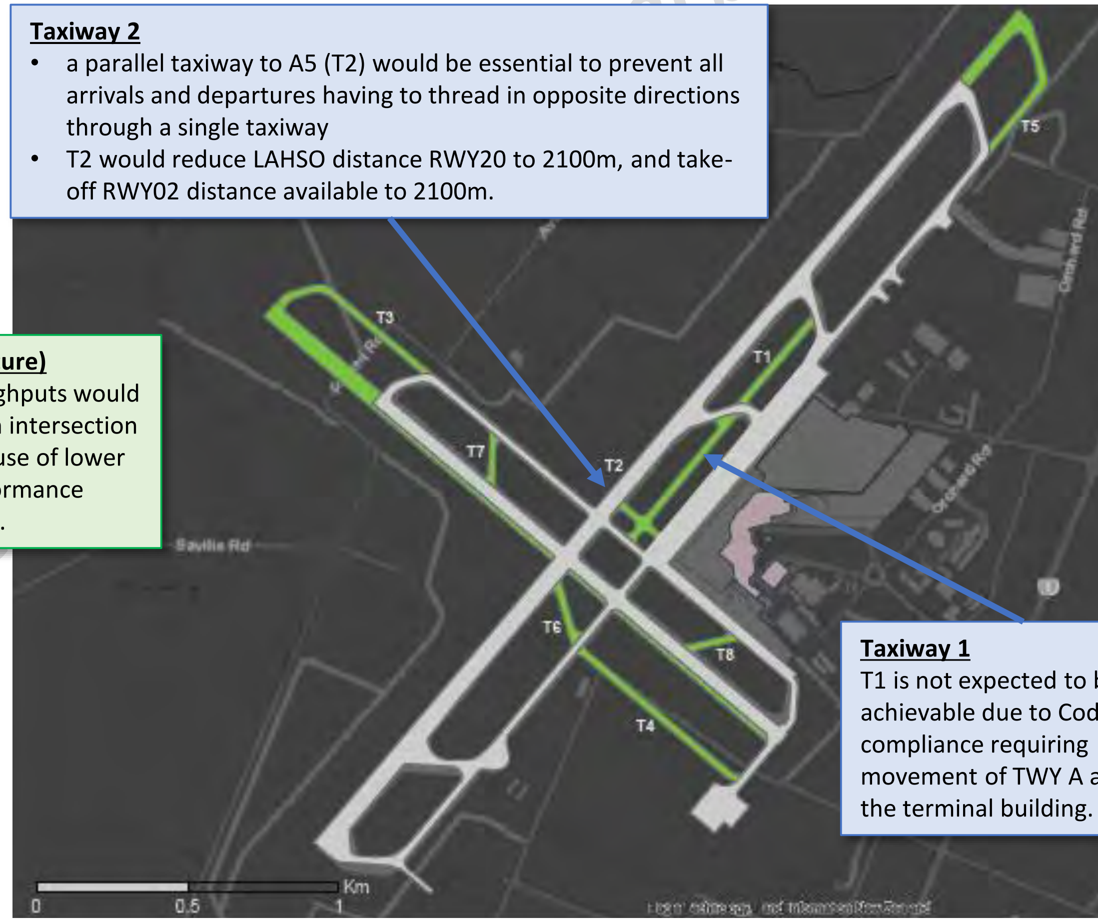


Airspace (Arrival)
Aircraft separation minima standards on arrival would struggle to go less than 5nm because of variability factor between aircraft.

Airspace (Departure)
Departure throughputs would not increase with intersection departures because of lower turboprops performance compared to jets.

Taxiway 2

- a parallel taxiway to A5 (T2) would be essential to prevent all arrivals and departures having to thread in opposite directions through a single taxiway
- T2 would reduce LAHSO distance RWY20 to 2100m, and take-off RWY02 distance available to 2100m.



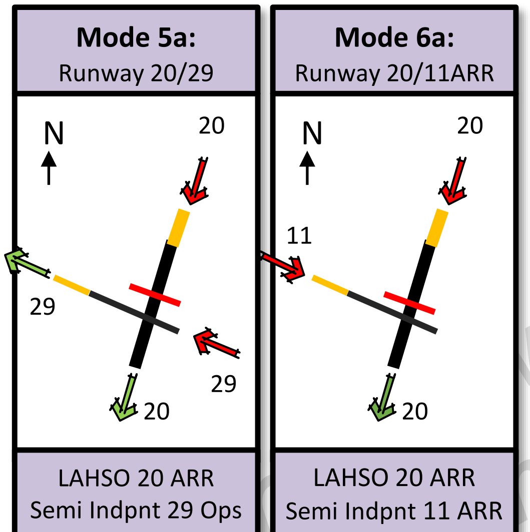
Taxiway 1
T1 is not expected to be achievable due to Code F compliance requiring movement of TWY A abeam the terminal building.

Other RMOs: LAHSO | Airways comments

The figures shown below are future Runway Modes of Operations (RMOs) for LAHSO that were considered by Airways to not provide additional capacity and were therefore not taken forward in the assessment of the ultimate annual capacity.

When assessed they also assumed the extended runways and DMAPS. However according to Airways, further ground infrastructure constrains and some airspace constraints would not allow efficient LAHSO operations. Such modes would therefore not provide any additional capacity to the dependent Mixed Operations presented in the main body of the report. Those constraints are illustrated on the Master Plan figure extract below:

Future Runway Modes (LAHSO) considered by Airways to not be operationally viable:

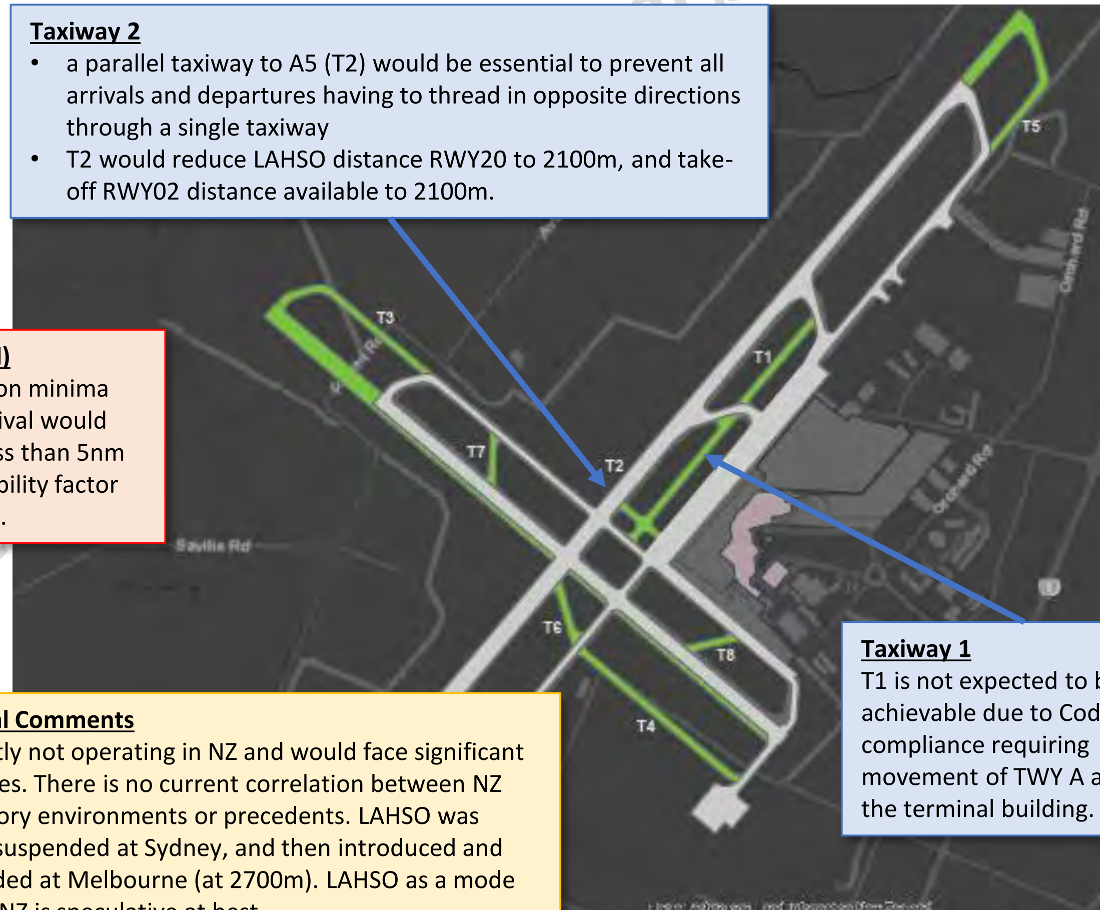


Airspace (Departure)
Departure throughputs would not increase with intersection departures because of lower turboprops performance compared to jets.

Airspace (Arrival)
Aircraft separation minima standards on arrival would struggle to go less than 5nm because of variability factor between aircraft.

Taxiway 2

- a parallel taxiway to A5 (T2) would be essential to prevent all arrivals and departures having to thread in opposite directions through a single taxiway
- T2 would reduce LAHSO distance RWY20 to 2100m, and take-off RWY02 distance available to 2100m.



Taxiway 1
T1 is not expected to be achievable due to Code F compliance requiring movement of TWY A abeam the terminal building.

LAHSO – General Comments
LAHSO is currently not operating in NZ and would face significant regulatory hurdles. There is no current correlation between NZ and AUS regulatory environments or precedents. LAHSO was introduced and suspended at Sydney, and then introduced and recently suspended at Melbourne (at 2700m). LAHSO as a mode of operations in NZ is speculative at best.

3

Christchurch Airport
AIR TRAFFIC PROJECTIONS

AIRWAYS
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AIRBIZ

Table of Contents

01. Introduction

1. Objective

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 to prepare 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.

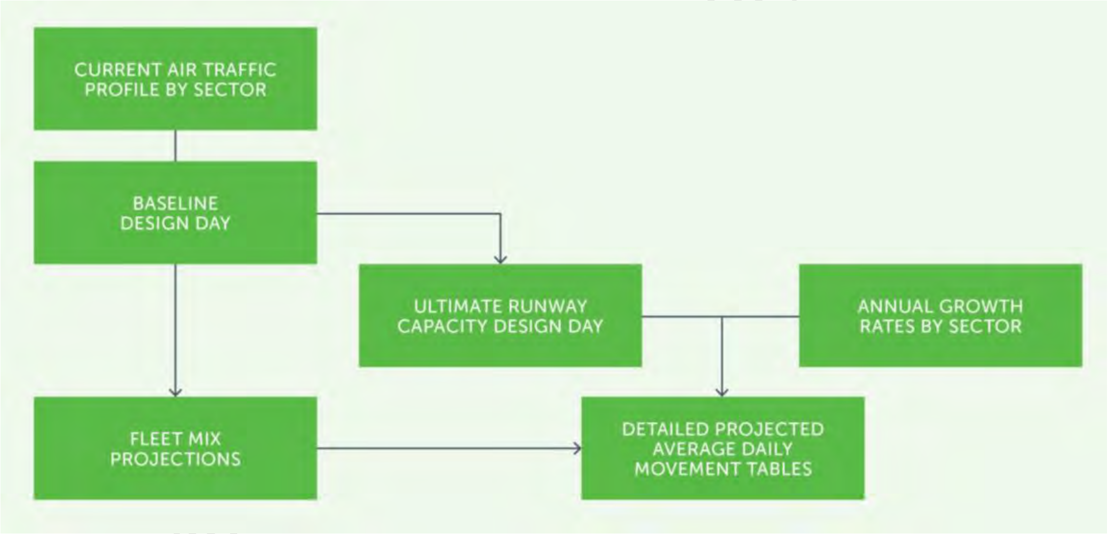
For the noise model, the aircraft movement traffic projections required aircraft type (by agreed categories), arrival/departure, origin/destination (by region, to determine departure stage length, runway and track allocation) and clock hour (to determine day/night weighting).

02. Methodology

1. Overall Methodology

The methodology is illustrated in the flow chart and includes:

- Profiling of current air traffic
- Determining relationships between annual traffic, monthly volumes and a design day (for capacity assessment) split by sector (International, Domestic and Regional) and region within a sector.
- Using a long-term projection of passenger growth for main geographical regions, including extrapolation to "ultimate runway capacity"
- An aircraft movement projection of air traffic demand scenarios for noise modelling.



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

a. Commercial 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).

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

2. Traffic Profiling

Using historic records, aircraft movements were profiled according to:

- Sectors
- Regions
- Aircraft categories
- Daily scheduled passenger movements
- Day/Night
- Daily profiles.

The profiling also looked at current and future fleet mix considering:

- Aircraft categories
- Seats
- Airfield performance
- Route.

3. Demand Projections

In the case of commercial scheduled flights future demand was generated by:

- Annual passenger growth by regions
- Assumed average seats, load factors
- Annual aircraft movement projections
- Design day for capacity analysis
- Daily profiles for noise modelling.

In the case of other categories future demand was generated by:

- Annual growth rates
- Annual aircraft movement projections
- Design day for capacity analysis
- Daily profiles for noise modelling.

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, and 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.

03. Fleet Projections

CIAL prepared fleet projections in a template format for putting in the demand model.

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 testing sensitivity. 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 A320 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 aligning aircraft movements to annual passengers through typical seating configurations and load factors. For noise modelling a different aircraft model 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.

International

Category	Typical Usage	Current Ave Seats based on	Future Avg 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%

Domestic

Category	Typical Usage	Current Ave Seats based on	Future Avg 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)	Main trunk routes at peak times		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	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		New aircraft design
Very Small Turboprop (VSTP)	2nd tier airline regional routes	S8 PC12	No change

Assumed average seats for International and domestic current and future fleets are shown below.

		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 passenger, 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. Sometime referred to as the "middle of the market" (MoM) concept, it would 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 Airbiz A321neoXLR already available for order, although this is a single-aisle model. With post-COVID 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.

04. Demand Profile

1. International Route Map

1. Introduction

CIAL prepared daily demand profiles for use in the runway capacity calculations and a future design day "schedule" to be used in noise modelling. Two notional horizons were selected for noise modelling:

- Commercial scheduled flights in FY2035 – representing a scenario of highest demand before the extension of the main Runway 02/20.
- All categories at ultimate runway capacity (as described in Volume 2 – Ultimate Runway Capacity)

CIAL regularly prepares long term (20 year) annual passenger forecasts for business and other planning purposes. The forecasts are for international, domestic trunk and regional sectors. The forecasts were further broken down to regions for each of these sectors and were based on distance and direction, both of which are required for noise modelling. The forecast growth rates by sector/region accounts for differential long-term growth rate projections.

2. Regions

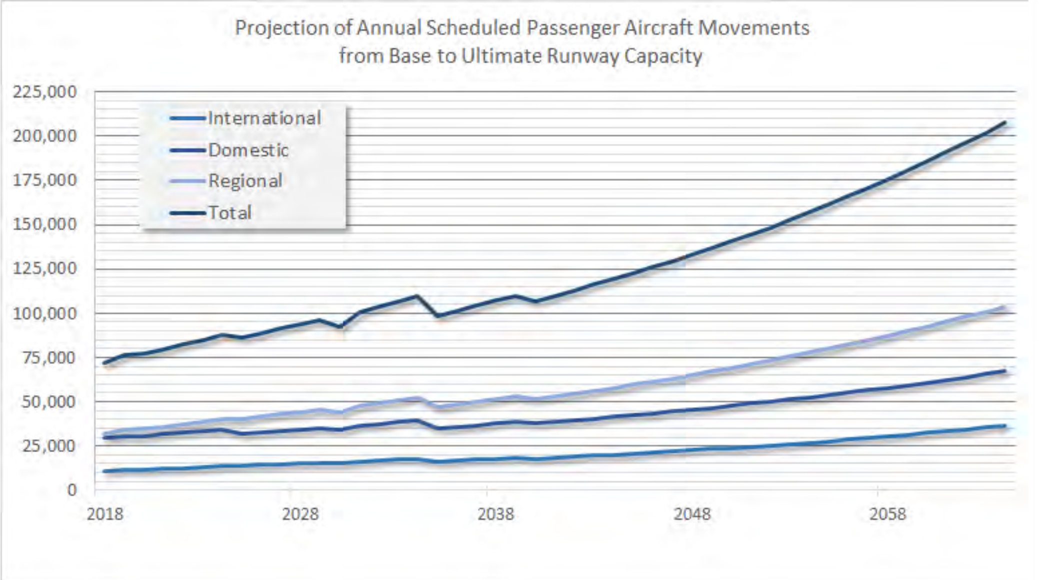
2. Domestic Route Map

The regions are tabulated below:

International	Domestic Trunk	Regional
North America	Auckland	Hamilton
Hawaii	Wellington	Tauranga
Pacific Islands East		Rotorua
Pacific Islands North		Napier
Southeast Asia		New Plymouth
East Asia		Palmerston North
Northeast Asia		Nelson
India		Blenheim
Middle East		Hokitika
Western Australia		Dunedin
Trans-Tasman		Queenstown
		Invercargill
		Chatham Islands
		Other North Regional
		Other South Regional
		Other West Regional

3. Annual Air Traffic Demand

CIAL annual passenger projections based on CIAL growth rates for each sector (international, domestic and regional) were converted to aircraft movement projections based on the assumed load factors and projected fleet seating capacity for each separate sector. The resulting scheduled passenger aircraft movement trend lines and composition out to ultimate runway capacity are shown below.



4. Projected Design Day Schedules

The annual aircraft movement projection was translated into design day profile of (unlinked) arrivals and departures. This could then be scaled up using analytical models to generate a design day ultimate capacity estimate and clock hour profile of runway arrivals/departures. It provides the detail for modelling for each flight in the "schedule":

- clock hour (for day/night weighting)
- aircraft category/type (to be translated into representative aircraft for noise model)
- origin/destination region (for assignment to runway/track depending on runway mode of operation and stage length for departure profile).

The resulting output provided to MDA for noise modelling can be found in the Appendices in the form of tables of the annual average daily aircraft movements. The projections were provided for 2035 (commercial scheduled passenger aircraft movements only, for noise contours before runway extensions)) and at ultimate runway capacity.

5. Pre – and Post-COVID Air Traffic Demand

The air traffic demand studies were completed 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 in 2021, CIAL had updated passenger projections which considered scenarios for air traffic recovery the short, medium and long term. At the detail level these updated projections were the same as the pre-COVID projections, just that for a projected traffic level it would be reached by some 5 years further out when considering COVID-recovery trajectories.

As this recontouring study is based on the Ultimate Runway Capacity of the airport, this does not impact the air traffic demand assumptions or noise modelling.

05. Annual Aircraft Movement Projection

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 potential impact of climate change on future drivers of passenger demand and the future relationship between those drivers and the resulting passenger demand is uncertain. One possible outcome is that the future demand may be suppressed. The actual growth rates that occur in the future would affect the timing but not the actual level of demand adopted for noise modelling which is based on notional ultimate runway capacity assessments.

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

- **a.** Commercial 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).

Discussion of which categories of aircraft movements are included in the noise contours and the rationale are discussed in Volume 5 – Noise Modelling.

2. Scheduled Passenger Aircraft

Commercial 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.

Passenger Demand

Passenger traffic was divided into the following main groupings: domestic, international outbound residents and international inbound visitors, by origin and destination rather than segment. These were broken down into domestic and global regions (e.g. Europe, China, North America etc.).

Specific future growth rates were applied for each market based on research and knowledge of the markets. Several sources were used to validate growth rates, including historic trends and forecasts from MBIE, Boeing and Airbus.

GDP and population are key factors for domestic and international outbound growth. Forecast GDP and population growth have been used to moderate growth for these segments. Markets were then divided into routes and regions flown to/from Christchurch.

Route development experienced at larger airports in New Zealand and Australia were used to determine probable future routes to be operated at Christchurch.

Demand projections assumed that growth is unconstrained by airport facilities, curfews or regulation.

The table below shows historic (1998 to 2018) and projected Average Annual Growth Rates (2020 – beyond 2055).

Historic		**Long Term Projected**	
Region	**Growth Rate**	**Region**	**Growth Rate**
International	3.2%	International	3.2%
Domestic/Regional	3.1%	Domestic Main Trunk (AKL, WLG)	2.6%
		Regional	3.1%
Total	**3.2%**	**Total:**	**3.0%**

Passenger Aircraft Movement Demand

The passenger aircraft projection was derived from the passenger demand using assumed load factor estimates to determine total seat capacity required to carry projected passengers for each route/region.

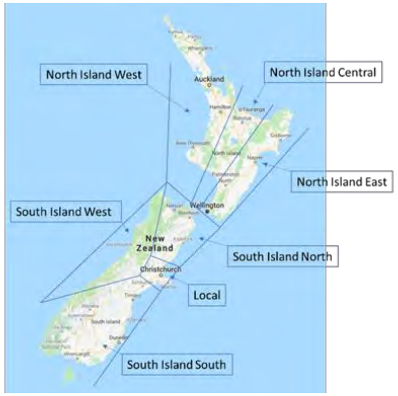
The number of aircraft movements required to fulfil the projected seat numbers was determined by the average seat capacity of aircraft flying on each route.

Future Fleet Mix: Key Assumptions

Progressively as routes grow airlines will operate higher seat capacity aircraft, increasing average seats per movement. 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. New aircraft in the 19/20 seat, and 250 seat seating capacity categories will become available within the next 10 years.

Non-Scheduled Domestic Aircraft Movement Regions



3. 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.

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.

4. Freight

In the last 10 years, freight capacity through Christchurch Airport by volume increased by an average of 3% per annum – likely stimulated by 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.

Limited competition is envisaged for freight services to the South Island due to Christchurch being positioned at the centre of the island, making transport from road to the regions possible within hours.

The 3% growth in overall volume capacity has been continued for the period of the projections, which translates into 2% average annual growth in aircraft movement as average aircraft size gradually increases, reducing the total number of aircraft required to move the same amount of freight.

New Asian and Trans-Tasman freight services have been introduced later in the projection, based on similar services introduced at Auckland Airport as freight demand increased.

5. Helicopters

Helicopters operations at Christchurch Airport are unlike those at other New Zealand airport, with 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 the 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.

Rescue Helicopters

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.

Commercial

This group includes agricultural, logistical and training movements. Flight training could be relocated to Rangiora/West Melton 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.

Tourism

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

<u>Military</u>

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

6. General Aviation

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

No growth has been projected for general aviation (GA) 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 this traffic transition to alternative airfields as other commercial traffic movements put constraints on available airport infrastructure and airspace. Therefore GA 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

1. FY2035 (scheduled passenger flights only, interim contours for checking noise contours before the future extension of runway as envisaged in the airport master plan),
2. Projection by traffic segment for a notional runway capacity of 175,000 scheduled passenger aircraft movements (other aircraft operations accommodated across the day at times of lower demand), this scenario matching the Expert Panel runway capacity assumption
3. An alternative annual runway capacity of 200,000 scheduled passenger aircraft movements (refer Volume 2 – Ultimate Runway Capacity) 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 FY2035

Source:
12609w105m CHC Forecast Model - MDA (No PF)

Sector	Region	AC_Cat	Region_AC	2035 ARR Day	2035 ARR Night	2035 DEP Day	2035 DEP Night
Int	North America	MWB	Int_North America_MWB	0.4	0.0	0.4	0.0
Int	Pacific Islands East	MNB	Int_Pacific Islands East_MNB	0.0	0.0	0.0	0.0
Int	Pacific Islands North	MNB	Int_Pacific Islands North_MNB	0.4	0.1	0.4	0.1
Int	East Asia	LWB	Int_East Asia_LWB	0.8	0.1	0.8	0.1
Int	East Asia	MWB	Int_East Asia_MWB	2.0	0.2	2.0	0.2
Int	North East Asia	MWB	Int_North East Asia_MWB	0.7	0.0	0.7	0.0
Int	Middle East	VLWB	Int_Middle East_VLWB	0.8	0.0	0.8	0.0
Int	Western Australia	LNB	Int_Western Australia_LNB	0.3	0.0	0.3	0.0
Int	Trans-Tasman	LWB	Int_Trans-Tasman_LWB	0.9	0.8	0.9	0.8
Int	Trans-Tasman	SWB	Int_Trans-Tasman_SWB	1.3	1.1	1.3	1.1
Int	Trans-Tasman	LNB	Int_Trans-Tasman_LNB	4.3	3.8	4.3	3.8
Int	Trans-Tasman	MNB	Int_Trans-Tasman_MNB	2.2	1.9	2.2	1.9
Dom	Auckland	MWB	Dom_Auckland_MWB	1.2	0.0	1.2	0.0
Dom	Auckland	SWB	Dom_Auckland_SWB	3.0	0.0	3.0	0.0
Dom	Auckland	LNB	Dom_Auckland_LNB	16.6	1.1	16.6	1.1
Dom	Auckland	MNB	Dom_Auckland_MNB	7.2	0.5	7.2	0.5
Reg	Hamilton	LTP	Reg_Hamilton_LTP	5.3	0.0	5.3	0.0
Reg	Tauranga	LTP	Reg_Tauranga_LTP	2.9	0.0	2.9	0.0
Reg	Tauranga	MTP	Reg_Tauranga_MTP	0.7	0.0	0.7	0.0
Reg	Rotorua	LTP	Reg_Rotorua_LTP	3.5	0.0	3.5	0.0
Reg	Napier	LTP	Reg_Napier_LTP	4.0	0.0	4.0	0.0
Reg	New Plymouth	LTP	Reg_New Plymouth_LTP	1.8	0.0	1.8	0.0
Reg	New Plymouth	MTP	Reg_New Plymouth_MTP	0.6	0.0	0.6	0.0
Reg	Palmerston North	LTP	Reg_Palmerston North_LTP	5.6	0.0	5.6	0.0
Dom	Wellington	MNB	Dom_Wellington_MNB	6.1	0.3	6.1	0.3
Dom	Wellington	LTP	Dom_Wellington_LTP	11.8	0.5	11.8	0.5
Reg	Nelson	LTP	Reg_Nelson_LTP	3.4	0.3	3.4	0.3
Reg	Nelson	MTP	Reg_Nelson_MTP	6.3	0.5	6.3	0.5
Reg	Blenheim	STP	Reg_Blenheim_STP	1.2	0.0	1.2	0.0
Reg	Blenheim	VSTP	Reg_Blenheim_VSTP	0.8	0.0	0.8	0.0
Reg	Hokitika	LTP	Reg_Hokitika_LTP	1.1	0.0	1.1	0.0
Reg	Hokitika	MTP	Reg_Hokitika_MTP	0.7	0.0	0.7	0.0
Reg	Dunedin	LTP	Reg_Dunedin_LTP	8.7	0.6	8.7	0.6
Reg	Queenstown	MNB	Reg_Queenstown_MNB	2.1	0.2	2.1	0.2
Reg	Queenstown	LTP	Reg_Queenstown_LTP	2.1	0.2	2.1	0.2
Reg	Invercargill	LTP	Reg_Invercargill_LTP	8.6	0.5	8.6	0.5
Reg	Chatham Islands	MTP	Reg_Chatham Islands_MTP	0.1	0.0	0.1	0.0
Reg	Other North Regional	MTP	Reg_Other North Regional_MTP	0.9	0.0	0.9	0.0
Reg	Other South Regional	VSTP	Reg_Other South Regional_VSTP	2.0	0.0	2.0	0.0

Scheduled Passenger Flights 175,000

Source:

12609w105m CHC Forecast Model - MDA (No PF)

Sector	Region	AC_Cat	Region_AC	175,000 ARR Day	175,000 ARR Night	175,000 DEP Day	175,000 DEP Night
Int	North America	MWB	Int_North America_MWB	0.7	0.0	0.7	0.0
Int	Pacific Islands East	MNB	Int_Pacific Islands East_MNB	0.1	0.1	0.1	0.1
Int	Pacific Islands North	LNB	Int_Pacific Islands North_LNB	0.1	0.0	0.1	0.0
Int	Pacific Islands North	MNB	Int_Pacific Islands North_MNB	0.7	0.1	0.7	0.1
Int	East Asia	LWB	Int_East Asia_LWB	2.4	0.3	2.4	0.3
Int	East Asia	MWB	Int_East Asia_MWB	3.5	0.4	3.5	0.4
Int	North East Asia	MWB	Int_North East Asia_MWB	1.6	0.0	1.6	0.0
Int	Middle East	VLWB	Int_Middle East_VLWB	1.3	0.0	1.3	0.0
Int	Western Australia	LNB	Int_Western Australia_LNB	0.6	0.0	0.6	0.0
Int	Trans-Tasman	LWB	Int_Trans-Tasman_LWB	1.6	1.4	1.6	1.4
Int	Trans-Tasman	SWB	Int_Trans-Tasman_SWB	2.4	2.1	2.4	2.1
Int	Trans-Tasman	LNB	Int_Trans-Tasman_LNB	11.9	10.6	11.9	10.6
Dom	Auckland	MWB	Dom_Auckland_MWB	2.8	0.0	2.8	0.0
Dom	Auckland	SWB	Dom_Auckland_SWB	8.3	0.0	8.3	0.0
Dom	Auckland	LNB	Dom_Auckland_LNB	38.1	3.6	38.1	3.6
Dom	Auckland	MNB	Dom_Auckland_MNB	2.5	0.2	2.5	0.2
Reg	Hamilton	LTP	Reg_Hamilton_LTP	9.8	0.5	9.8	0.5
Reg	Tauranga	LTP	Reg_Tauranga_LTP	6.3	0.2	6.3	0.2
Reg	Rotorua	LTP	Reg_Rotorua_LTP	6.6	0.2	6.6	0.2
Reg	Napier	LTP	Reg_Napier_LTP	7.4	0.3	7.4	0.3
Reg	New Plymouth	LTP	Reg_New Plymouth_LTP	4.3	0.0	4.3	0.0
Reg	Palmerston North	LTP	Reg_Palmerston North_LTP	10.3	0.5	10.3	0.5
Dom	Wellington	MNB	Dom_Wellington_MNB	8.5	0.6	8.5	0.6
Dom	Wellington	LTP	Dom_Wellington_LTP	13.8	1.0	13.8	1.0
Reg	Nelson	LTP	Reg_Nelson_LTP	14.6	1.3	14.6	1.3
Reg	Blenheim	STP	Reg_Blenheim_STP	2.7	0.0	2.7	0.0
Reg	Blenheim	VSTP	Reg_Blenheim_VSTP	0.7	0.0	0.7	0.0
Reg	Hokitika	LTP	Reg_Hokitika_LTP	2.6	0.0	2.6	0.0
Reg	Hokitika	MTP	Reg_Hokitika_MTP	0.6	0.0	0.6	0.0
Reg	Dunedin	LTP	Reg_Dunedin_LTP	16.8	1.3	16.8	1.3
Reg	Queenstown	MNB	Reg_Queenstown_MNB	4.1	0.5	4.1	0.5
Reg	Queenstown	LTP	Reg_Queenstown_LTP	4.1	0.5	4.1	0.5
Reg	Invercargill	LTP	Reg_Invercargill_LTP	16.6	1.2	16.6	1.2
Reg	Chatham Islands	MTP	Reg_Chatham Islands_MTP	0.3	0.0	0.3	0.0
Reg	Other North Regional	MTP	Reg_Other North Regional_MTP	1.7	0.0	1.7	0.0
Reg	Other South Regional	VSTP	Reg_Other South Regional_VSTP	3.9	0.0	3.9	0.0

Non-Scheduled Commercial, Military, Government and Antarctic Flights 175,000

Source:
12609w113g CHC Forecast Model Non-scheduled - MDA (No PF)

				175,000	175,000	175,000	175,000
				ARR	ARR	DEP	DEP
Type	Region	Aircraft Type	Region_AC	Day	Night	Day	Night
Airline/MRO	Local	Medium Two Engine Turboprop	Airline/MRO_Local_Medium Two Engine Turboprop	0.8	0.0	0.8	0.0
Airline/MRO	Local	Medium Jet	Airline/MRO_Local_Medium Jet	0.1	0.0	0.1	0.0
Airline/MRO	South Island North	Light Single Engine Turboprop	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	Airline/MRO_South Island North_Medium Two Engine Turboprop	0.5	0.0	0.5	0.0
Airline/MRO	South Island South	Medium Two Engine Turboprop	Airline/MRO_South Island South_Medium Two Engine Turboprop	0.6	0.0	0.6	0.0
Airline/MRO	South Island South	Medium Jet	Airline/MRO_South Island South_Medium Jet	0.4	0.0	0.4	0.0
Airline/MRO	North Island Central	Medium Two Engine Turboprop	Airline/MRO_North Island Central_Medium Two Engine Turboprop	0.1	0.0	0.1	0.0
Airline/MRO	North Island East	Medium Two Engine Turboprop	Airline/MRO_North Island East_Medium Two Engine Turboprop	0.7	0.1	0.7	0.1
Airline/MRO	North Island East	Medium Jet	Airline/MRO_North Island East_Medium Jet	0.3	0.1	0.3	0.1
Airline/MRO	North Island West	Medium Two Engine Turboprop	Airline/MRO_North Island West_Medium Two Engine Turboprop	0.4	0.0	0.4	0.0
Airline/MRO	North Island West	Medium Jet	Airline/MRO_North Island West_Medium Jet	0.6	0.1	0.6	0.1
Airline/MRO	North Island West	Heavy Two Engine Jet	Airline/MRO_North Island West_Heavy Two Engine Jet	0.1	0.0	0.1	0.0
Airline/MRO	Int West	Medium Jet	Airline/MRO_Int West_Medium Jet	0.5	0.5	0.5	0.5
Airline/MRO	Int North	Medium Jet	Airline/MRO_Int North_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Light Single Engine Piston	Antarctic/Military/Govt_Local_Light Single Engine Piston	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	Local	Light Single Engine Turboprop	Antarctic/Military/Govt_Local_Light Single Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	Local	Light Multi Engine Turboprop	Antarctic/Military/Govt_Local_Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Medium Four Engine Turboprop	Antarctic/Military/Govt_Local_Medium Four Engine Turboprop	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	Local	Medium Jet	Antarctic/Military/Govt_Local_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Heavy Four Engine Jet	Antarctic/Military/Govt_Local_Heavy Four Engine Jet	0.3	0.1	0.3	0.1
Antarctic/Military/Govt	South Island North	Light Multi Engine Turboprop	Antarctic/Military/Govt_South Island North_Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	South Island North	Medium Four Engine Turboprop	Antarctic/Military/Govt_South Island North_Medium Four Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	South Island North	Medium Jet	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	Antarctic/Military/Govt_South Island South_Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	South Island South	Medium Four Engine Turboprop	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	Antarctic/Military/Govt_North Island Central_Light Single Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island Central	Light Multi Engine Turboprop	Antarctic/Military/Govt_North Island Central_Light Multi Engine Turboprop	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	North Island Central	Medium Four Engine Turboprop	Antarctic/Military/Govt_North Island Central_Medium Four Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island Central	Medium Jet	Antarctic/Military/Govt_North Island Central_Medium Jet	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	North Island East	Light Multi Engine Turboprop	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	Antarctic/Military/Govt_North Island East_Medium Four Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island East	Medium Jet	Antarctic/Military/Govt_North Island East_Medium Jet	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island West	Medium Four Engine Turboprop	Antarctic/Military/Govt_North Island West_Medium Four Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island West	Medium Jet	Antarctic/Military/Govt_North Island West_Medium Jet	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	Antarctica	Medium Four Engine Turboprop	Antarctic/Military/Govt_Antarctica_Medium Four Engine Turboprop	0.8	0.4	1.1	0.1
Antarctic/Military/Govt	Antarctica	Medium Jet	Antarctic/Military/Govt_Antarctica_Medium Jet	0.1	0.0	0.2	0.0
Antarctic/Military/Govt	Antarctica	Heavy Four Engine Jet	Antarctic/Military/Govt_Antarctica_Heavy Four Engine Jet	0.5	0.2	0.7	0.0
Antarctic/Military/Govt	Int West	Medium Four Engine Turboprop	Antarctic/Military/Govt_Int West_Medium Four Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int West	Medium Jet	Antarctic/Military/Govt_Int West_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int West	Heavy Four Engine Jet	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	Antarctic/Military/Govt_Int North East_Medium Jet	0.0	0.0	0.0	0.0
Antarctic/Military/Govt	Int North East	Heavy Four Engine Jet	Antarctic/Military/Govt_Int North East_Heavy Four Engine Jet	0.2	0.0	0.2	0.0

Non-Scheduled Commercial, Military, Government and Antarctic Flights 175,000 continued

Source:
12609w113g CHC Forecast Model Non-scheduled - MDA (No PF)

Type	Region	Aircraft Type	Region_AC	175,000 ARR Day	175,000 ARR Night	175,000 DEP Day	175,000 DEP Night
FBO/Small Commercial	Local	Light Single Engine Piston	FBO/Small Commercial_Local_Light Single Engine Piston	1.1	0.0	1.1	0.0
FBO/Small Commercial	Local	Light Multi Engine Turboprop	FBO/Small Commercial_Local_Light Multi Engine Turboprop	0.6	0.0	0.6	0.0
FBO/Small Commercial	South Island North	Light Multi Engine Turboprop	FBO/Small Commercial_South Island North_Light Multi Engine Turboprop	5.5	0.3	5.5	0.3
FBO/Small Commercial	South Island North	Medium Two Engine Turboprop	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	FBO/Small Commercial_South Island South_Light Multi Engine Piston	0.9	0.1	0.9	0.1
FBO/Small Commercial	South Island South	Light Single Engine Turboprop	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	FBO/Small Commercial_South Island South_Light Multi Engine Turboprop	2.6	0.3	2.6	0.3
FBO/Small Commercial	South Island West	Light Multi Engine Turboprop	FBO/Small Commercial_South Island West_Light Multi Engine Turboprop	3.9	0.3	3.9	0.3
FBO/Small Commercial	Chatham Islands	Light Multi Engine Turboprop	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	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	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	FBO/Small Commercial_North Island East_Light Single Engine Turboprop	0.3	0.0	0.3	0.0
FBO/Small Commercial	North Island East	Light Multi Engine Turboprop	FBO/Small Commercial_North Island East_Light Multi Engine Turboprop	1.3	0.1	1.3	0.1
FBO/Small Commercial	North Island East	Medium Two Engine Turboprop	FBO/Small Commercial_North Island East_Medium Two Engine Turboprop	0.9	0.1	0.9	0.1
FBO/Small Commercial	North Island East	Medium Jet	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	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	FBO/Small Commercial_North Island West_Light Multi Engine Turboprop	1.3	0.2	1.3	0.2
FBO/Small Commercial	North Island West	Medium Two Engine Turboprop	FBO/Small Commercial_North Island West_Medium Two Engine Turboprop	1.1	0.1	1.1	0.1
FBO/Small Commercial	North Island West	Medium Jet	FBO/Small Commercial_North Island West_Medium Jet	0.3	0.0	0.3	0.0
FBO/Small Commercial	Int West	Medium Jet	FBO/Small Commercial_Int West_Medium Jet	0.5	0.1	0.5	0.1

Freight 175,000

Source:
12609w112e CHC Forecast Model Cargo - MDA (no PF)

Sector	Region	AC_Ca	Region_AC	175,000 ARR Day	175,000 ARR Night	175,000 DEP Day	175,000 DEP Night
Int	East Asia	MWB	Int_East Asia_MWB	0.1	0.2	0.1	0.2
Int	Trans-Tasman	MWB	Int_Trans-Tasman_MWB	0.2	0.2	0.2	0.2
Int	Trans-Tasman	SWB	Int_Trans-Tasman_SWB	0.2	0.4	0.2	0.4
Int	Trans-Tasman	LNB	Int_Trans-Tasman_LNB	0.3	0.2	0.3	0.2
Dom	Auckland	SWB	Dom_Auckland_SWB	0.0	0.6	0.0	0.6
Dom	Auckland	LNB	Dom_Auckland_LNB	0.1	0.0	0.1	0.0
Dom	Auckland	MNB	Dom_Auckland_MNB	1.4	5.5	1.4	5.5
Reg	Palmerston North	MNB	Reg_Palmerston North_MNB	1.0	2.4	1.0	2.4
Reg	Palmerston North	VSTP	Reg_Palmerston North_VSTP	0.2	0.6	0.2	0.6

Helicopters 175,000

Source:
12609w115e CHC Forecast Model Helicopter - MDA (no PF)

Airport Area	Aircraft Group	Region_AC	175,000 ARR Day	175,000 ARR Night	175,000 DEP Day	175,000 DEP Night
GCH Aviation	A109	GCH Aviation_A109	6.8	0.8	6.8	0.8
GCH Aviation	AS50	GCH Aviation_AS50	0.9	0.1	0.9	0.1
GCH Aviation	EC20	GCH Aviation_EC20	2.7	0.0	2.7	0.0
GCH Aviation	R44	GCH Aviation_R44	1.7	0.0	1.7	0.0
GCH Aviation	R22	GCH Aviation_R22	2.8	0.0	2.8	0.0
HeliCentre	A109	HeliCentre_A109	0.0	0.0	0.0	0.0
HeliCentre	EC20	HeliCentre_EC20	3.9	0.0	3.9	0.0
HeliCentre	AS50	HeliCentre_AS50	3.5	0.0	3.5	0.0
HeliCentre	B06	HeliCentre_B06	1.5	0.0	1.5	0.0
HeliCentre	MD52	HeliCentre_MD52	2.4	0.1	2.4	0.1
HeliCentre	R44	HeliCentre_R44	2.1	0.0	2.1	0.0
HeliCentre	R22	HeliCentre_R22	0.6	0.1	0.6	0.1
HeliCentre	H269	HeliCentre_H269	0.5	0.0	0.5	0.0
HeliCentre	G2CA	HeliCentre_G2CA	5.9	0.1	5.9	0.1
Military Apron	NH90	Military Apron_NH90	0.0	0.0	0.0	0.0
Military Apron	H2	Military Apron_H2	0.0	0.0	0.0	0.0
Military Apron	A109	Military Apron_A109	0.1	0.0	0.1	0.0

Scheduled Passenger Flights 200,000

Source:
12609w105m CHC Forecast Model - MDA (No PF)

Sector	Region	AC_Cat	Region_AC	200,000 ARR Day	200,000 ARR Night	200,000 DEP Day	200,000 DEP Night
Int	North America	MWB	Int_North America_MWB	0.8		0.8	
Int	Pacific Islands East	MNB	Int_Pacific Islands East_MNB	0.1	0.1	0.1	0.1
Int	Pacific Islands North	LNB	Int_Pacific Islands North_LNB	0.1	0.0	0.1	0.0
Int	Pacific Islands North	MNB	Int_Pacific Islands North_MNB	0.8	0.1	0.8	0.1
Int	East Asia	LWB	Int_East Asia_LWB	2.9	0.4	2.9	0.4
Int	East Asia	MWB	Int_East Asia_MWB	4.3	0.5	4.3	0.5
Int	North East Asia	MWB	Int_North East Asia_MWB	1.9		1.9	
Int	Middle East	VLWB	Int_Middle East_VLWB	1.5		1.5	
Int	Western Australia	LNB	Int_Western Australia_LNB	0.7		0.7	
Int	Trans-Tasman	LWB	Int_Trans-Tasman_LWB	1.8	1.6	1.8	1.6
Int	Trans-Tasman	SWB	Int_Trans-Tasman_SWB	2.8	2.5	2.8	2.5
Int	Trans-Tasman	LNB	Int_Trans-Tasman_LNB	13.8	12.3	13.8	12.3
Dom	Auckland	MWB	Dom_Auckland_MWB	3.2		3.2	
Dom	Auckland	SWB	Dom_Auckland_SWB	9.7		9.7	
Dom	Auckland	LNB	Dom_Auckland_LNB	43.7	4.7	43.7	4.7
Dom	Auckland	MNB	Dom_Auckland_MNB	2.9	0.3	2.9	0.3
Reg	Hamilton	LTP	Reg_Hamilton_LTP	11.2	0.7	11.2	0.7
Reg	Tauranga	LTP	Reg_Tauranga_LTP	7.3	0.2	7.3	0.2
Reg	Rotorua	LTP	Reg_Rotorua_LTP	7.5	0.3	7.5	0.3
Reg	Napier	LTP	Reg_Napier_LTP	8.5	0.4	8.5	0.4
Reg	New Plymouth	LTP	Reg_New Plymouth_LTP	5.0		5.0	
Reg	Palmerston North	LTP	Reg_Palmerston North_LTP	11.9	0.6	11.9	0.6
Dom	Wellington	MNB	Dom_Wellington_MNB	9.0	0.7	9.0	0.7
Dom	Wellington	LTP	Dom_Wellington_LTP	14.7	1.1	14.7	1.1
Reg	Nelson	LTP	Reg_Nelson_LTP	16.7	1.6	16.7	1.6
Reg	Blenheim	STP	Reg_Blenheim_STP	3.2		3.2	
Reg	Blenheim	VSTP	Reg_Blenheim_VSTP	0.8		0.8	
Reg	Hokitika	LTP	Reg_Hokitika_LTP	3.0		3.0	
Reg	Hokitika	MTP	Reg_Hokitika_MTP	0.7		0.7	
Reg	Dunedin	LTP	Reg_Dunedin_LTP	19.4	1.5	19.4	1.5
Reg	Queenstown	MNB	Reg_Queenstown_MNB	4.7	0.5	4.7	0.5
Reg	Queenstown	LTP	Reg_Queenstown_LTP	4.7	0.5	4.7	0.5
Reg	Invercargill	LTP	Reg_Invercargill_LTP	19.2	1.4	19.2	1.4
Reg	Chatham Islands	MTP	Reg_Chatham Islands_MTP	0.3		0.3	
Reg	Other North Regional	MTP	Reg_Other North Regional_MTP	2.0		2.0	
Reg	Other South Regional	VSTP	Reg_Other South Regional_VSTP	4.6		4.6	

Non-Scheduled Commercial, Military, Government and Antarctic Flights 200,000

Source:
12609w113g CHC Forecast Model Non-scheduled - MDA (No PF)

Type	Region	Aircraft Type	Region_AC	200,000 ARR Day	200,000 ARR Night	200,000 DEP Day	200,000 DEP Night
Airline/MRO	Local	Medium Two Engine Turboprop	Airline/MRO_Local_Medium Two Engine Turboprop	0.9	0.0	0.9	0.0
Airline/MRO	Local	Medium Jet	Airline/MRO_Local_Medium Jet	0.2	0.0	0.2	0.0
Airline/MRO	South Island North	Light Single Engine Turboprop	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	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	Airline/MRO_South Island South_Medium Two Engine Turboprop	0.7	0.0	0.7	0.0
Airline/MRO	South Island South	Medium Jet	Airline/MRO_South Island South_Medium Jet	0.4	0.0	0.4	0.0
Airline/MRO	North Island Central	Medium Two Engine Turboprop	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	Airline/MRO_North Island East_Medium Two Engine Turboprop	0.9	0.2	0.9	0.2
Airline/MRO	North Island East	Medium Jet	Airline/MRO_North Island East_Medium Jet	0.3	0.1	0.3	0.1
Airline/MRO	North Island West	Medium Two Engine Turboprop	Airline/MRO_North Island West_Medium Two Engine Turboprop	0.5	0.0	0.5	0.0
Airline/MRO	North Island West	Medium Jet	Airline/MRO_North Island West_Medium Jet	0.7	0.1	0.7	0.1
Airline/MRO	North Island West	Heavy Two Engine Jet	Airline/MRO_North Island West_Heavy Two Engine Jet	0.1	0.0	0.1	0.0
Airline/MRO	Int West	Medium Jet	Airline/MRO_Int West_Medium Jet	0.5	0.6	0.5	0.6
Airline/MRO	Int North	Medium Jet	Airline/MRO_Int North_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Light Single Engine Piston	Antarctic/Military/Govt_Local_Light Single Engine Piston	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	Local	Light Single Engine Turboprop	Antarctic/Military/Govt_Local_Light Single Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	Local	Light Multi Engine Turboprop	Antarctic/Military/Govt_Local_Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Medium Four Engine Turboprop	Antarctic/Military/Govt_Local_Medium Four Engine Turboprop	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	Local	Medium Jet	Antarctic/Military/Govt_Local_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Local	Heavy Four Engine Jet	Antarctic/Military/Govt_Local_Heavy Four Engine Jet	0.3	0.1	0.3	0.1
Antarctic/Military/Govt	South Island North	Light Multi Engine Turboprop	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	Antarctic/Military/Govt_South Island North_Medium Four Engine Turboprop	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	South Island North	Medium Jet	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	Antarctic/Military/Govt_South Island South_Light Multi Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	South Island South	Medium Four Engine Turboprop	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	Antarctic/Military/Govt_North Island Central_Light Single Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island Central	Light Multi Engine Turboprop	Antarctic/Military/Govt_North Island Central_Light Multi Engine Turboprop	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	North Island Central	Medium Four Engine Turboprop	Antarctic/Military/Govt_North Island Central_Medium Four Engine Turboprop	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	North Island Central	Medium Jet	Antarctic/Military/Govt_North Island Central_Medium Jet	0.5	0.0	0.5	0.0
Antarctic/Military/Govt	North Island East	Light Multi Engine Turboprop	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	Antarctic/Military/Govt_North Island East_Medium Four Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island East	Medium Jet	Antarctic/Military/Govt_North Island East_Medium Jet	0.4	0.0	0.4	0.0
Antarctic/Military/Govt	North Island West	Medium Four Engine Turboprop	Antarctic/Military/Govt_North Island West_Medium Four Engine Turboprop	0.2	0.0	0.2	0.0
Antarctic/Military/Govt	North Island West	Medium Jet	Antarctic/Military/Govt_North Island West_Medium Jet	0.3	0.0	0.3	0.0
Antarctic/Military/Govt	Antarctica	Medium Four Engine Turboprop	Antarctic/Military/Govt_Antarctica_Medium Four Engine Turboprop	0.9	0.4	1.2	0.1
Antarctic/Military/Govt	Antarctica	Medium Jet	Antarctic/Military/Govt_Antarctica_Medium Jet	0.1	0.1	0.2	0.0
Antarctic/Military/Govt	Antarctica	Heavy Four Engine Jet	Antarctic/Military/Govt_Antarctica_Heavy Four Engine Jet	0.6	0.3	0.8	0.0
Antarctic/Military/Govt	Int West	Medium Four Engine Turboprop	Antarctic/Military/Govt_Int West_Medium Four Engine Turboprop	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int West	Medium Jet	Antarctic/Military/Govt_Int West_Medium Jet	0.1	0.0	0.1	0.0
Antarctic/Military/Govt	Int West	Heavy Four Engine Jet	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	Antarctic/Military/Govt_Int North East_Medium Jet	0.0	0.0	0.0	0.0
Antarctic/Military/Govt	Int North East	Heavy Four Engine Jet	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 200,000 (continued)

Source:
12609w113g CHC Forecast Model Non-scheduled - MDA (No PF)

Type	Region	Aircraft Type	Region_AC	200,000 ARR Day	200,000 ARR Night	200,000 DEP Day	200,000 DEP Night
FBO/Small Commercial	Local	Light Single Engine Piston	FBO/Small Commercial_Local_Light Single Engine Piston	0.7	0.0	0.7	0.0
FBO/Small Commercial	Local	Light Multi Engine Turboprop	FBO/Small Commercial_Local_Light Multi Engine Turboprop	0.4	0.0	0.4	0.0
FBO/Small Commercial	South Island North	Light Multi Engine Turboprop	FBO/Small Commercial_South Island North_Light Multi Engine Turboprop	3.2	0.2	3.2	0.2
FBO/Small Commercial	South Island North	Medium Two Engine Turboprop	FBO/Small Commercial_South Island North_Medium Two Engine Turboprop	0.1	0.0	0.1	0.0
FBO/Small Commercial	South Island South	Light Multi Engine Piston	FBO/Small Commercial_South Island South_Light Multi Engine Piston	0.5	0.0	0.5	0.0
FBO/Small Commercial	South Island South	Light Single Engine Turboprop	FBO/Small Commercial_South Island South_Light Single Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	South Island South	Light Multi Engine Turboprop	FBO/Small Commercial_South Island South_Light Multi Engine Turboprop	1.5	0.2	1.5	0.2
FBO/Small Commercial	South Island West	Light Multi Engine Turboprop	FBO/Small Commercial_South Island West_Light Multi Engine Turboprop	2.2	0.2	2.2	0.2
FBO/Small Commercial	Chatham Islands	Light Multi Engine Turboprop	FBO/Small Commercial_Chatham Islands_Light Multi Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	North Island Central	Light Multi Engine Turboprop	FBO/Small Commercial_North Island Central_Light Multi Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	North Island Central	Medium Jet	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	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	FBO/Small Commercial_North Island East_Light Multi Engine Turboprop	0.7	0.1	0.7	0.1
FBO/Small Commercial	North Island East	Medium Two Engine Turboprop	FBO/Small Commercial_North Island East_Medium Two Engine Turboprop	0.5	0.1	0.5	0.1
FBO/Small Commercial	North Island East	Medium Jet	FBO/Small Commercial_North Island East_Medium Jet	0.2	0.0	0.2	0.0
FBO/Small Commercial	North Island West	Light Single Engine Turboprop	FBO/Small Commercial_North Island West_Light Single Engine Turboprop	0.2	0.0	0.2	0.0
FBO/Small Commercial	North Island West	Light Multi Engine Turboprop	FBO/Small Commercial_North Island West_Light Multi Engine Turboprop	0.8	0.1	0.8	0.1
FBO/Small Commercial	North Island West	Medium Two Engine Turboprop	FBO/Small Commercial_North Island West_Medium Two Engine Turboprop	0.6	0.0	0.6	0.0
FBO/Small Commercial	North Island West	Medium Jet	FBO/Small Commercial_North Island West_Medium Jet	0.2	0.0	0.2	0.0
FBO/Small Commercial	Int West	Medium Jet	FBO/Small Commercial_Int West_Medium Jet	0.3	0.0	0.3	0.0

Freight 200,000

Source:
12609w112e CHC Forecast Model Cargo - MDA (no PF)

Sector	Region	AC_Ca	Region_AC	200,000 ARR Day	200,000 ARR Night	200,000 DEP Day	200,000 DEP Night
Int	East Asia	MWB	Int_East Asia_MWB	0.2	0.3	0.2	0.3
Int	Trans-Tasman	MWB	Int_Trans-Tasman_MWB	0.2	0.2	0.2	0.2
Int	Trans-Tasman	SWB	Int_Trans-Tasman_SWB	0.3	0.4	0.3	0.4
Int	Trans-Tasman	LNB	Int_Trans-Tasman_LNB	0.4	0.2	0.4	0.2
Dom	Auckland	SWB	Dom_Auckland_SWB	0.0	0.7	0.0	0.7
Dom	Auckland	LNB	Dom_Auckland_LNB	0.2	0.0	0.2	0.0
Dom	Auckland	MNB	Dom_Auckland_MNB	1.6	6.2	1.6	6.2
Reg	Palmerston North	MNB	Reg_Palmerston North_MNB	1.2	2.9	1.2	2.9
Reg	Palmerston North	VSTP	Reg_Palmerston North_VSTP	0.2	0.6	0.2	0.6

Helicopters 200,000

Source: 12609w115e CHC Forecast Model Helicopter - MDA (no PF)			200,000 ARR	200,000 ARR	200,000 DEP	200,000 DEP
Airport Area	Aircraft Group	Region_AC	Day	Night	Day	Night
GCH Aviation	A109	GCH Aviation_A109	7.3	0.9	7.3	0.9
GCH Aviation	AS50	GCH Aviation_AS50	0.9	0.1	0.9	0.1
GCH Aviation	EC20	GCH Aviation_EC20	3.0	0.0	3.0	0.0
GCH Aviation	R44	GCH Aviation_R44	1.8	0.0	1.8	0.0
GCH Aviation	R22	GCH Aviation_R22	2.9	0.0	2.9	0.0
HeliCentre	A109	HeliCentre_A109	0.0	0.0	0.0	0.0
HeliCentre	EC20	HeliCentre_EC20	4.4	0.0	4.4	0.0
HeliCentre	AS50	HeliCentre_AS50	3.9	0.0	3.9	0.0
HeliCentre	B06	HeliCentre_B06	1.7	0.0	1.7	0.0
HeliCentre	MD52	HeliCentre_MD52	2.5	0.1	2.5	0.1
HeliCentre	R44	HeliCentre_R44	2.2	0.0	2.2	0.0
HeliCentre	R22	HeliCentre_R22	0.7	0.1	0.7	0.1
HeliCentre	H269	HeliCentre_H269	0.5	0.0	0.5	0.0
HeliCentre	G2CA	HeliCentre_G2CA	6.2	0.1	6.2	0.1
Military Apron	NH90	Military Apron_NH90	0.1	0.0	0.1	0.0
Military Apron	H2	Military Apron_H2	0.1	0.0	0.1	0.0
Military Apron	A109	Military Apron_A109	0.1	0.0	0.1	0.0

Christchurch Airport
FLIGHT TRACK ASSUMPTIONS

2021 CHRISTCHURCH INTERNATIONAL AIRPORT EXPERT UPDATE OF THE OPERATIVE PLAN NOISE CONTOURS
FOR REVIEW BY ENVIRONMENT CANTERBURY'S INDEPENDENT EXPERT PANEL

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Christchurch Airport
Aircraft Noise Contours Update
Flight Track Assumptions Report

27th October 2021

Version	Ref	Date issued
1	200a	14/09/2018
12	200s	30/05/2019
13	200t	25/10/2019
14	200u	13/12/2019
15	200v	06/06/2021
16	200w	11/06/2021
17	200x	29/06/2021
18	200y	06/07/2021
19	200z	29/07/2021
20	200aa	13/08/2021
21	200ab	05/10/2021
22	200ac	12/10/2021
23	200ad	22/10/2021
Final	200ae	27/10/2021

Contents

Introduction

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

The noise contours are based on the requirements and guidelines in the current New Zealand Standard Airport noise management and land use planning (NZS 6805:1992), and with those currently in operation as defined by the Ldn 50 contour at airport ultimate capacity. They also consider the SEL contours for the critical design aircraft for each runway.

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 **flight track assumptions**. The nature of the material being presented, and the technical audience determined the adoption of a highly graphical style.

Other technical support volumes cover the topics:

- air traffic movement projections and fleet mix
- runway capacity and
- aircraft noise modelling.

Introduction

The **flight track assumptions** for use in noise modelling as documented in this report rely on extensive iterative consultation and review with Airways New Zealand, the national Air Navigation Services Provider (ANSP). Supporting reference documents and data used were the published AIP (the most current version at the time) and the radar tracks provided by Airways from their system as KML files. These main flight track assumptions (vertical and lateral location and spread, traffic allocation) as documented in this report can be grouped as follows:

- Approach type splits (Visuals, ILS and RNP)
- Backbone ARR/DEP flight track definition
- Track allocation by aircraft type (Jet vs. Turboprops) and Origin & Destination
- Track spread assumptions
- Altitude profiles for RNP ARR and DEP – including any unique profile at CHC
- Helicopter Tracks

Other arrival and departure aircraft movement splits were allocated by destination to the relevant tracks. Where there were multiple tracks, in the absence of definitive data, for modelling purposes they were assumed to be spread evenly. Where there was an obvious traffic bias to a destination heading, a notional spread between multiple tracks was derived based on relative traffic densities between destinations.

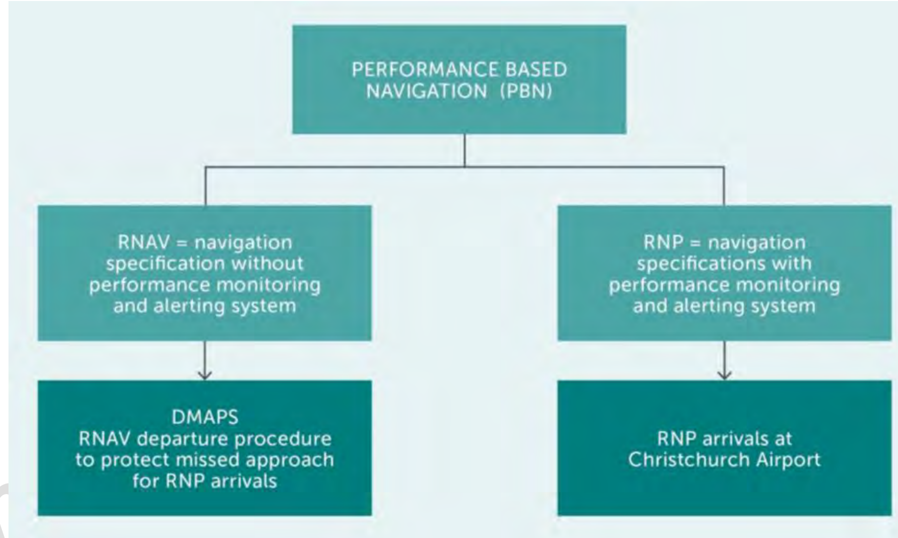
This pack initially compares the Updated Flight Tracks with those in the Operative Plan, highlighting any key differences.

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

An introductory explanation of the various types of procedures such as PBN, RNAV, RNP, ILS etc is provided as part of Volume 1.

Below are some extracts which may be useful references in relation to the Flight Path definitions and diagrams specific to the flight track assumptions for the contour update.

- 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 path, defined by waypoints such as geographic fixes (latitude and longitude) and not necessarily by reference to ground navaids. RNAV specifications describe the basic level of performance. The NZ 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) 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.

Other common terms referenced are: 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).

RNP arrivals at Christchurch Airport

Advanced PBN procedures with CAA Authorisation Required (RNP AR) have been introduced to shorten flightpaths and reduce flight time, fuel burn and CO2 emissions for suitably capable aircraft arriving into Christchurch (most jets and some turboprops).

DMAPs departure tracks at Christchurch Airport

Divergent Missed Approach Protection System (DMAPS) is an innovative system that has also been introduced at Christchurch. DMAPS provides 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.

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 of aircraft fleet mix, relative growth of various sectors – international, domestic, freight etc. In addition there can be changes in ATM/ATC procedures or allocation between say PBN/ILS or Visual tracks as a greater proportion of the aircraft fleet operating at an airport becomes more technologically capable.

During the course of this study there was the implementation of the RNP arrivals and DMAP departures by Airways. 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 2008 EP contours. If there are any future adjustments to flight track assumptions will be incremental and marginal. They should therefore be within the tolerance of the updated noise contours. Future changes to ATM/ATC systems in the very long term are not possible for anyone to predict with any degree of certainty and would be purely speculative.

Recontouring Process

The final flight tracks used are provided in this document. Some of the earlier sensitivity scenarios used those flight track assumptions from 2019, due to the timing of those sensitivity runes. However, the flight tracks now in use are the DMAPS flight tracks and so those tracks are the focus of this report and have been included in the final modelling assumptions for the Updated Noise Contours. All sensitivities included in the final contours were rerun with the 2021 flight track assumptions.

Flight tracks were initially reviewed and agreed with Airways in 2019. As part of the recontouring project, the flight track assumptions were reviewed and updated in 2021 based on the latest available information and consultation with Airways.

The main change identified during the recontouring process was the implementation of DMAPS departure procedures, which came into place in March 2020. The 2019 assumptions were based on proposed procedures provided by Airways. By the time of implementation, these had subsequently changed slightly. For arrivals, consultation with Airways indicated a trend in the reduction of visual arrivals (particularly in turboprops), with more RNP procedures being taken up, so this was reflected in the assumed approach splits. Some other minor changes to arrival tracks were made – these are discussed in more detail later in the report.

TRACK COMPARISON:

OPERATIVE PLAN VS UPDATED TRACKS

Operative Plan vs Updated Tracks

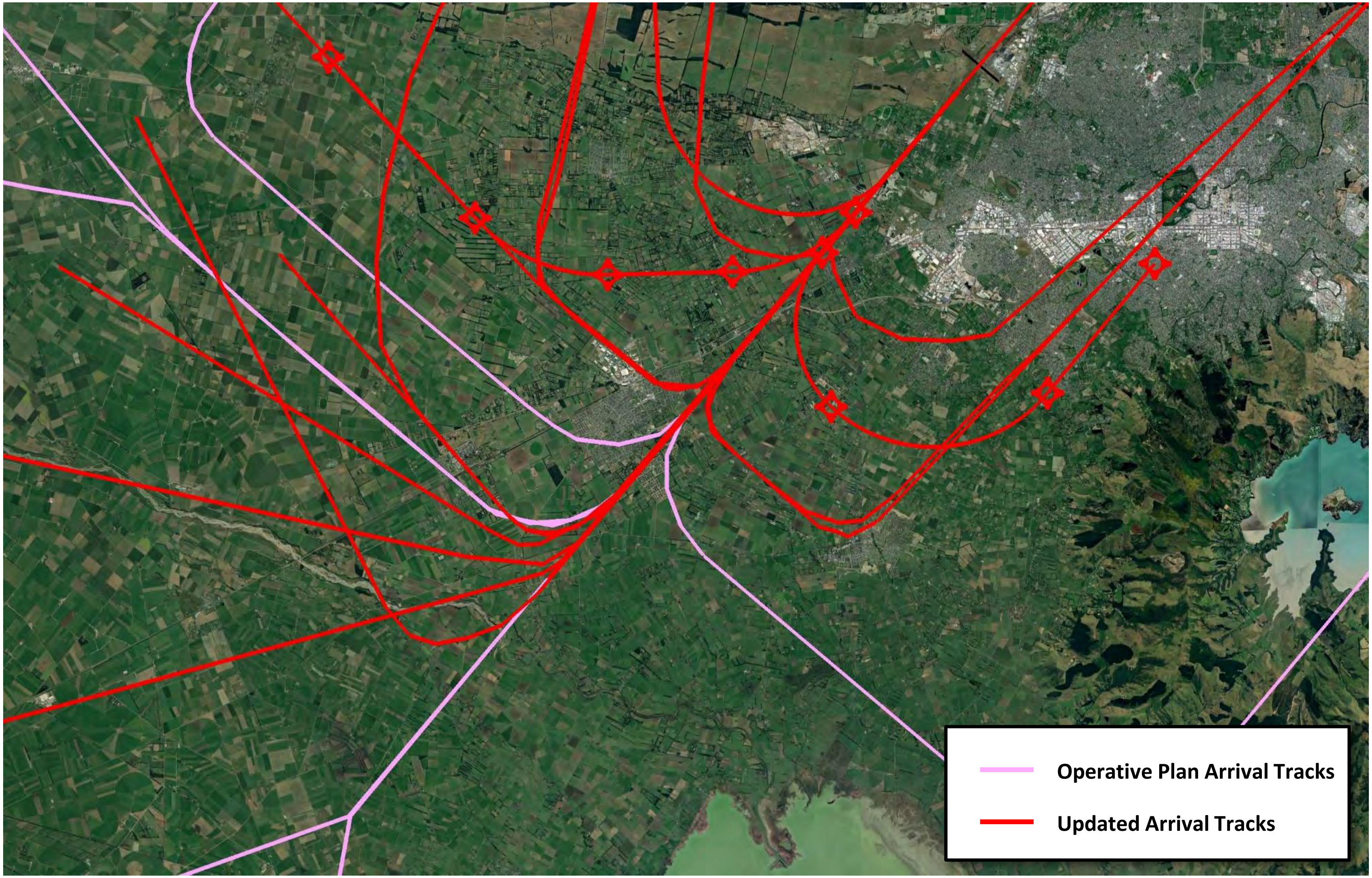
The following slides compare the Operative Plan flight tracks with the Updated flight tracks for the following breakdowns:

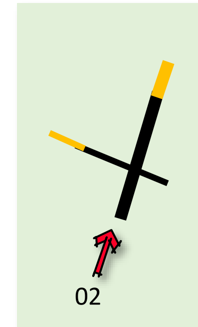
- RWY 02 Arrivals
- RWY 20 Arrivals
- RWY 29 Arrivals
- RWY 11 Arrivals
- RWY 02 Departures
- RWY 20 Departures
- RWY 29 Departures

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 and DMAPS procedures for departures.
RNP arrivals enable shorter final approaches, whilst the DMAPS departures consolidate the traffic onto fewer tracks and diverge from the runway centreline.

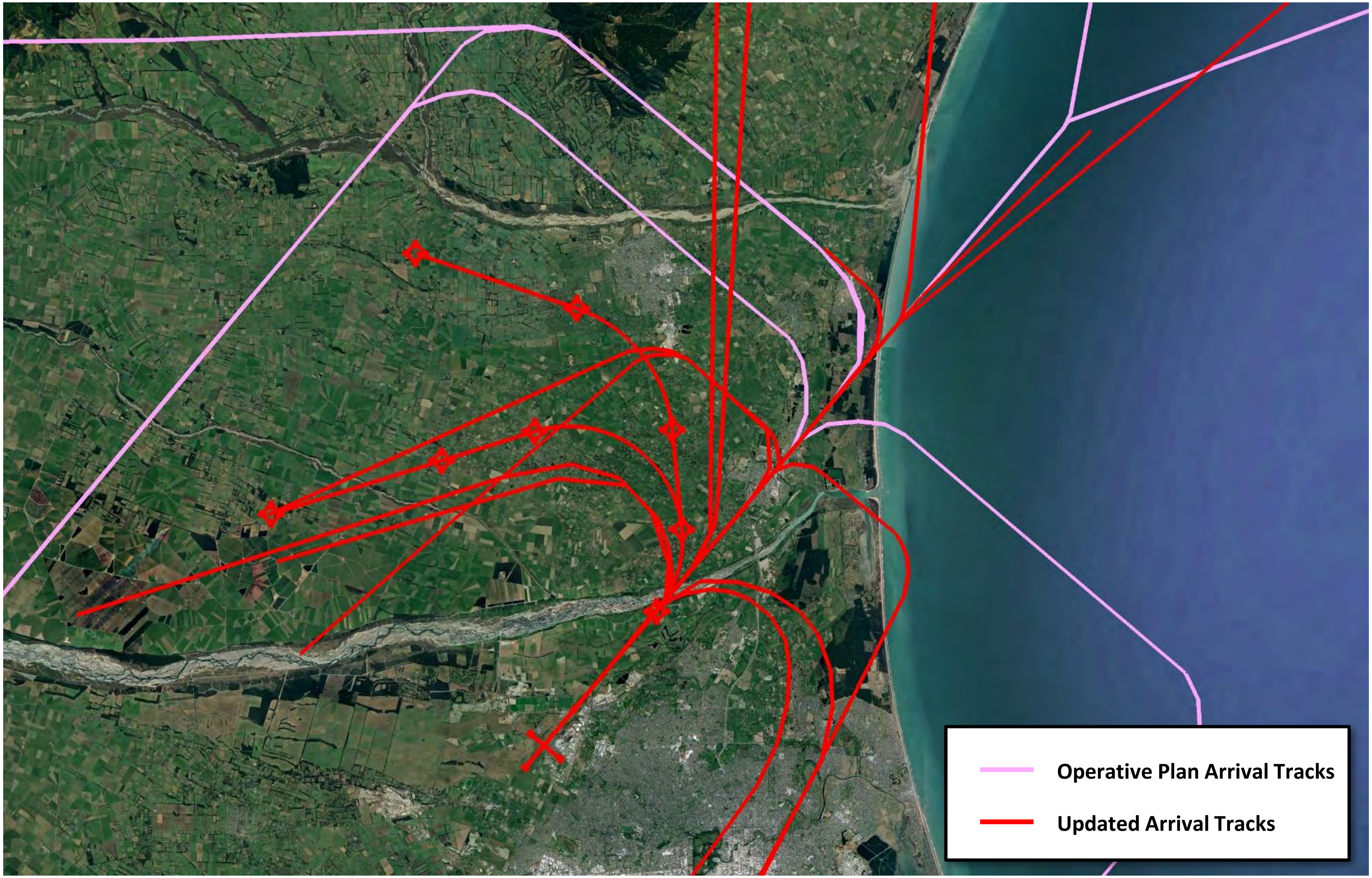
Assumptions on the Updated Flight Tracks are provided later in the pack.

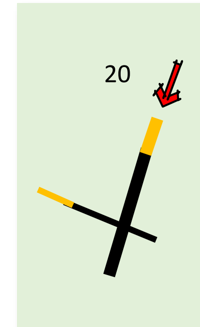
Operative Plan vs Updated Tracks: Runway 02 Arrivals



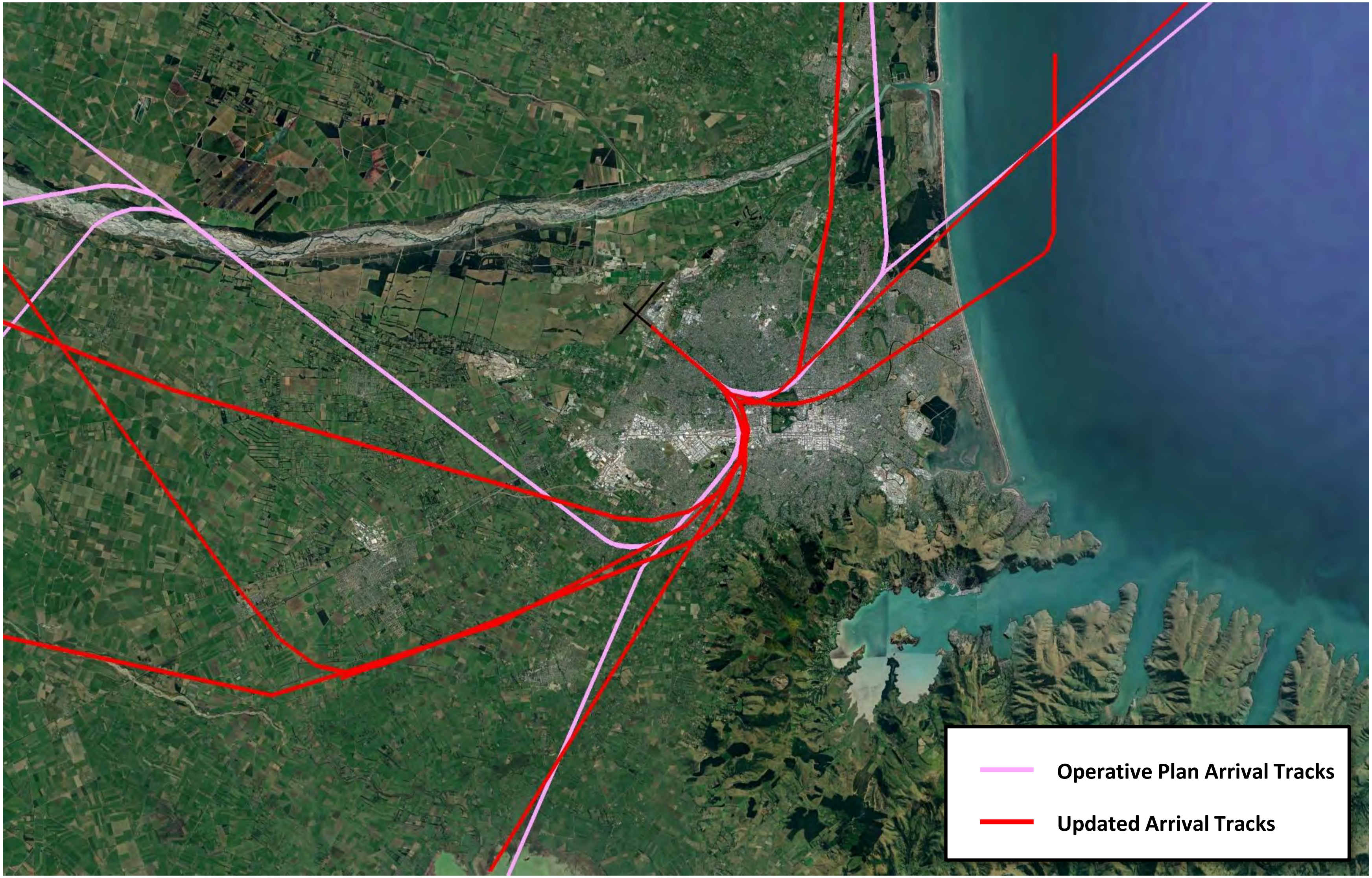


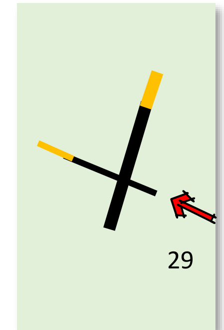
Operative Plan vs Updated Tracks: Runway 20 Arrivals



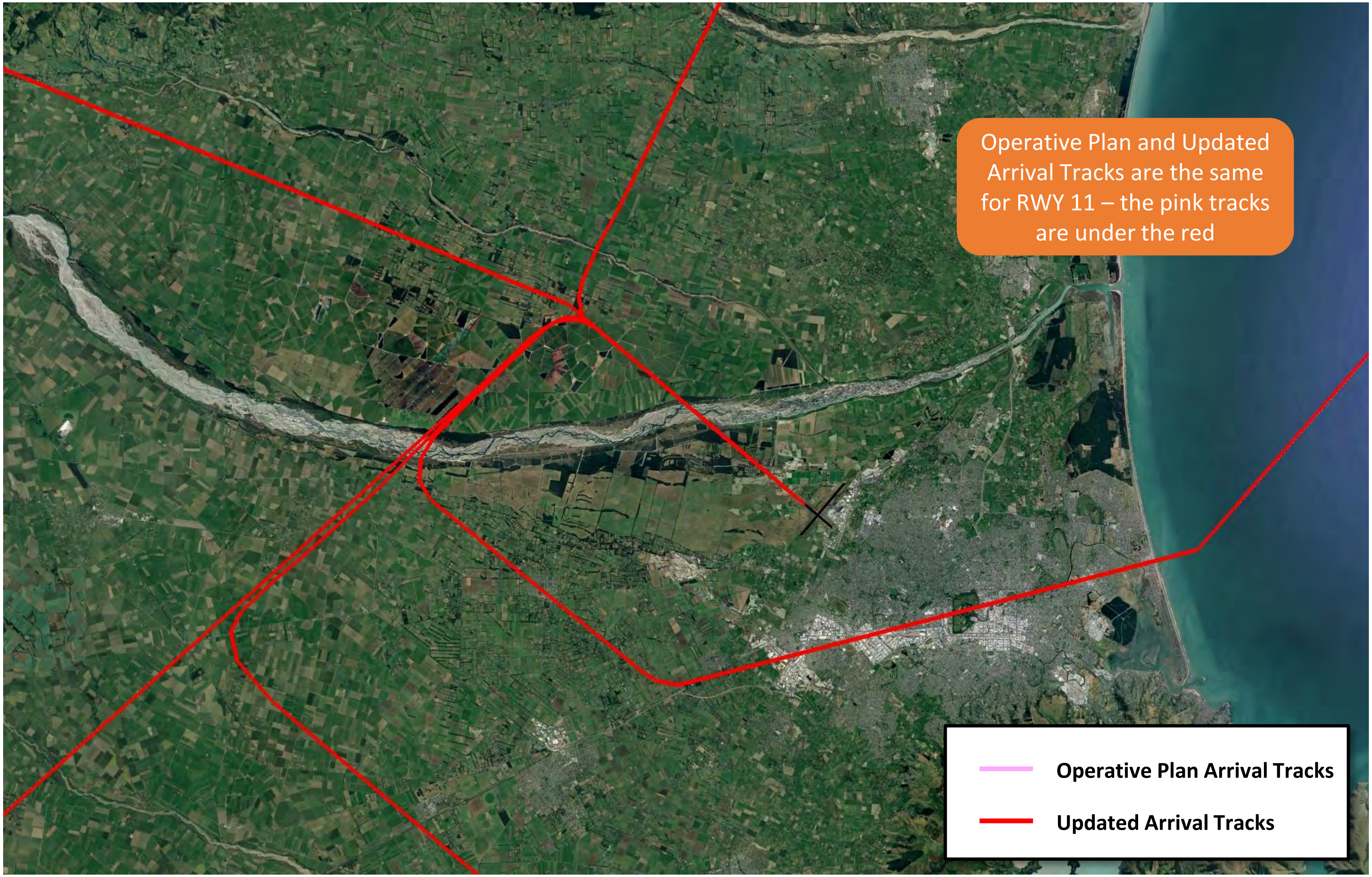


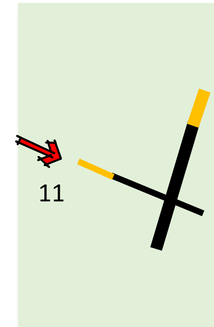
Operative Plan vs Updated Tracks: Runway 29 Arrivals



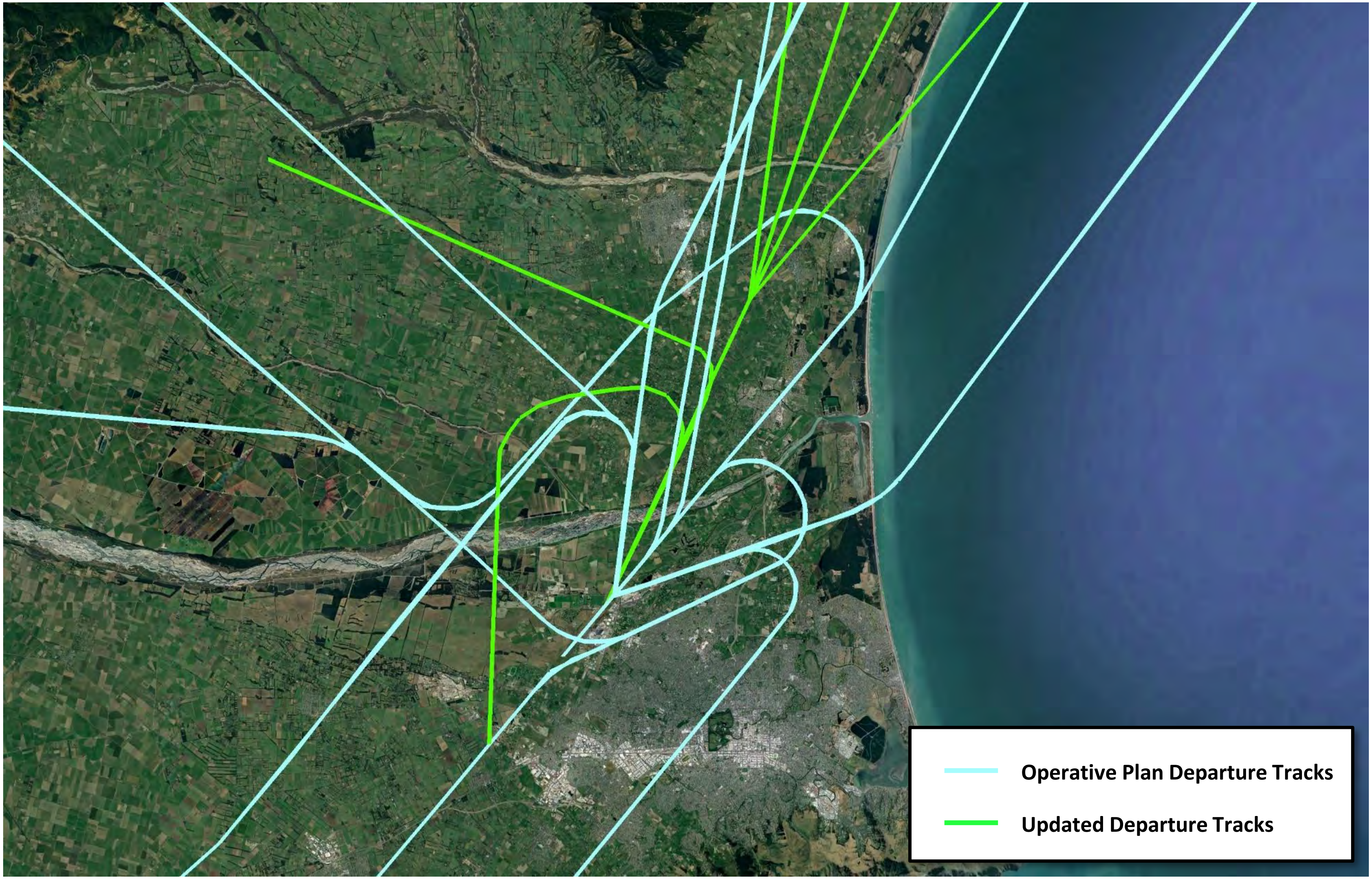


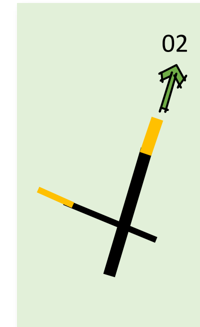
Operative Plan vs Updated Tracks: Runway 11 Arrivals



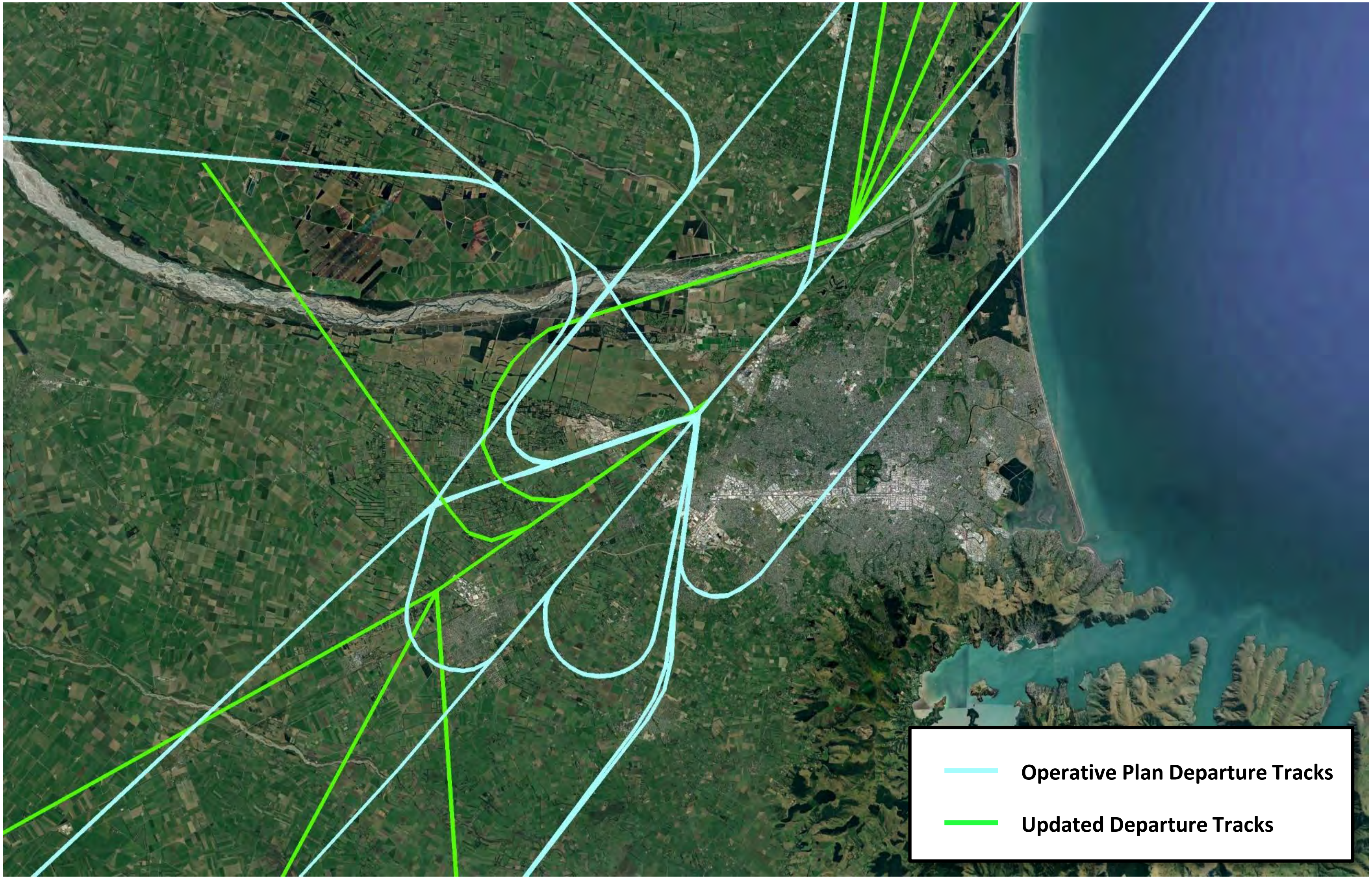


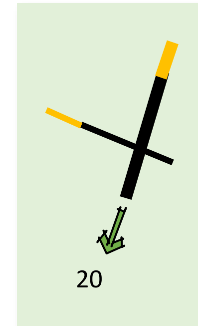
Operative Plan vs Updated Tracks: Runway 02 Departures



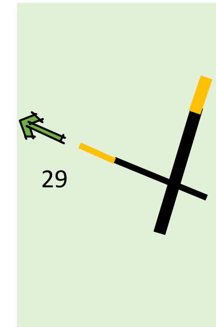


Operative Plan vs Updated Tracks: Runway 20 Departures





Operative Plan vs Updated Tracks: Runway 29 Departures



UPDATED FLIGHT TRACKS:

GENERAL ASSUMPTIONS

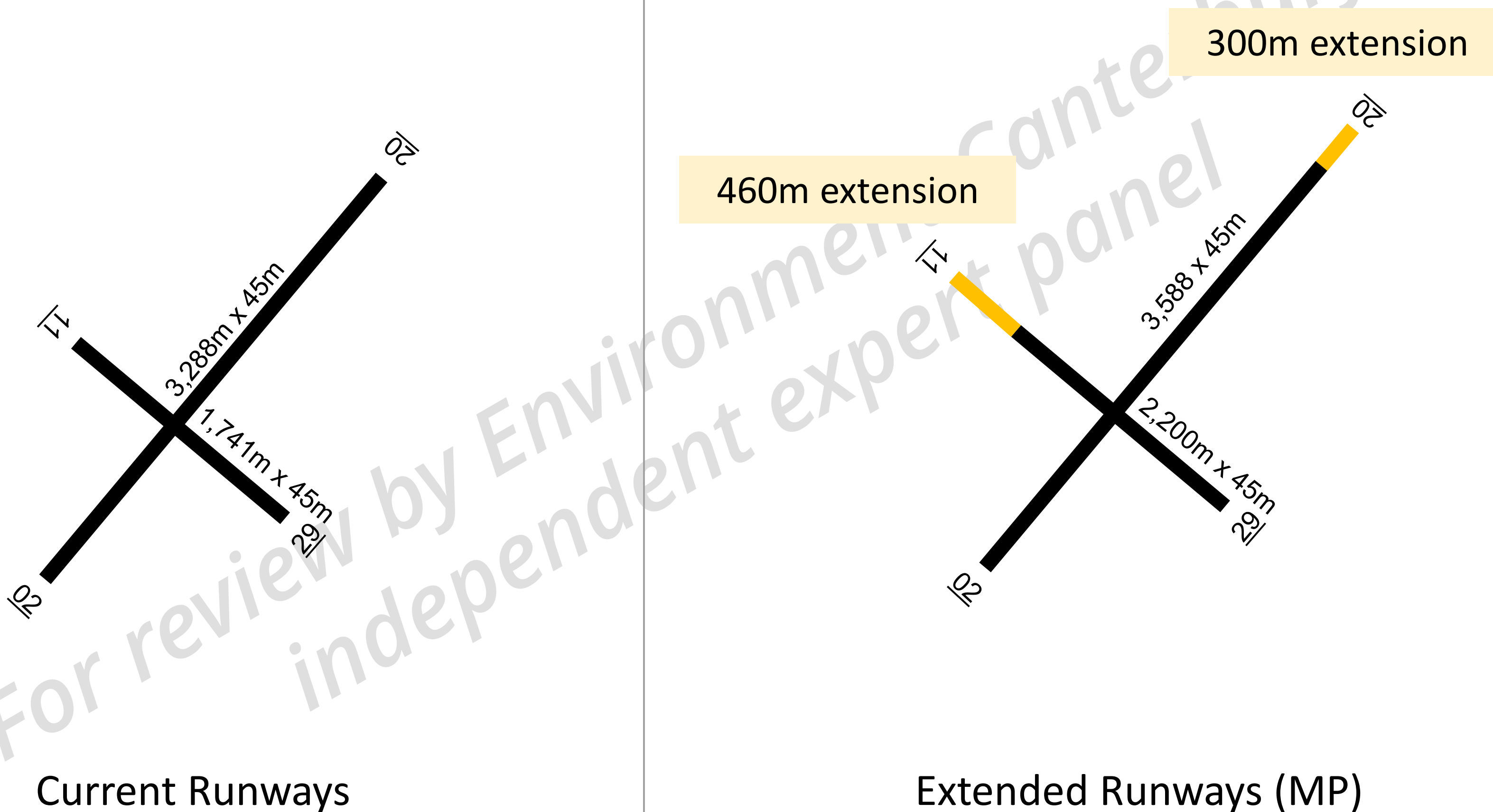
Updated Flight Tracks Introduction

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

1. Runways
    - Current vs Extended Runway Configurations
2. Flight Track Definitions
    - Sources of information
    - Procedure types
    - Adjustments for extended runway
    - Sensitivity scenarios
3. 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
4. Track Spread
    - Fixed wing (RNP arrivals, Non-RNP arrivals, departures)
    - Helicopters
5. Altitude profiles
    - Modelling assumptions boundaries
    - Arrival profiles
    - Departure profiles

MP 2040 - RWY extensions

Shown below are the two runway configurations for the current system and when the runways are extended based on the Masterplan



Flight Tracks Definition

Sources of information & procedure types:

- Arrival tracks are based on radar data and published approaches in the AIP with the following changes:
  - RWY 02/20 arrival Visual tracks were pushed in as indicated by Airways on 20/09/2018
  - RWY 20 arrival Visual tracks were added from Queenstown, Auckland & Wellington, as advised by Airways on 08/06/2021
  - Final approaches for Visual arrivals were extended to 3NM, as advised by Airways on 16/07/2021
  - Other minor adjustments were made based on iterative consultation with Airways
- Departure tracks are based on DMAPS design procedures which were implemented in March 2020. SID tracks were sourced from Airways AIP and guidance was provided by Airways on 27/05/2021 and cancelled SID tracks were based on radar data provided by Airways on 28/05/2021.
- The final update of this document was based on Airways feedback on 16/07/2021.

Adjustments for extended runway:

- 02 departures are pushed as per the same length of the 300m extension to the North
- RWY 11 arrival tracks are pushed out by the length of RWY 11/29 extension of 460m to the West
- RWY 20 arrival tracks are pushed out by the length of RWY 02/20 extension of 300m to the North

Sensitivity Scenarios

- For some sensitivity scenarios, alternative flight tracks were used. This included the “Cancelled SID” scenario and tracks for Military Helicopters in any runs that included military. Since these sensitivity scenarios were not included in the final contour these tracks are not included in this report.

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, RWY02 JET ARRs from Queenstown can only use the ILS track.

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

MWB 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	80%	0%	20%

Turbo props	Runway End	RNP	ILS/RNAV	Visual
Approach Splits	RWY02	75%	20%	5%
	RWY20	35%	60%	5%
	RWY29	80%	0%	20%
	RWY11	60%	0%	40%

Note the Jet acronyms are as follow: LWB – Large Wide Body; MWB – Medium Wide Body; NB – Narrow Body

Track spread assumptions – Fixed wing

The following track spread assumptions were applied for updated flights tracks for fixed wing aircraft. These assumptions were discussed and agreed with Airways and MDA.

Track Spread

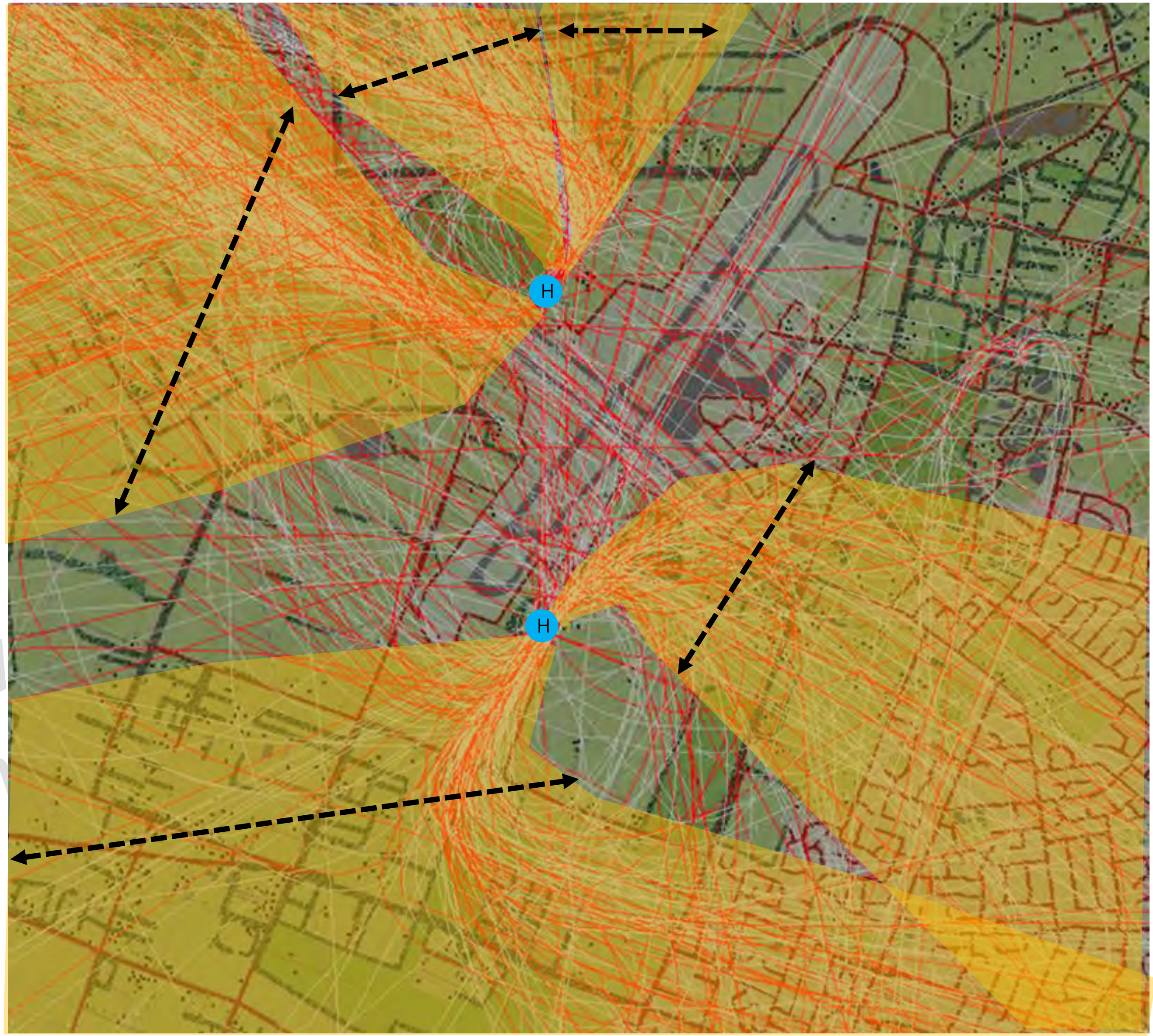
	ARR – RNP	ARR – Non-RNP	DEP
Jet	No spread required (consistent with previous MDA modelling)	As per Radar Data across 5 tracks (when possible)	Applying an assumption that the spread will be half the width as per radar data
Turboprops			

The INM default spread was used as per below :

- 5 tracks spread: backbone track = 38.6% then 24.4% each for next 2 then 6.3% each for the last 2 (used for Non-RNP arrival tracks and departure tracks)

Track spread assumptions - Helicopters

The following helicopter spread assumptions were applied for both arrival and departure helicopter flight paths. The spread assumptions are indicatively based on the provided radar track data from Airways.



The INM default spread was used as per below:

- 5 tracks spread: backbone track = 38.6% then 24.4% each for next 2 then 6.3% each for the last 2

H Helipad

Helicopter dispersion

Altitude Profiles - Modelling assumption boundaries

Shown on the right are the distance range circles around Christchurch Airport.

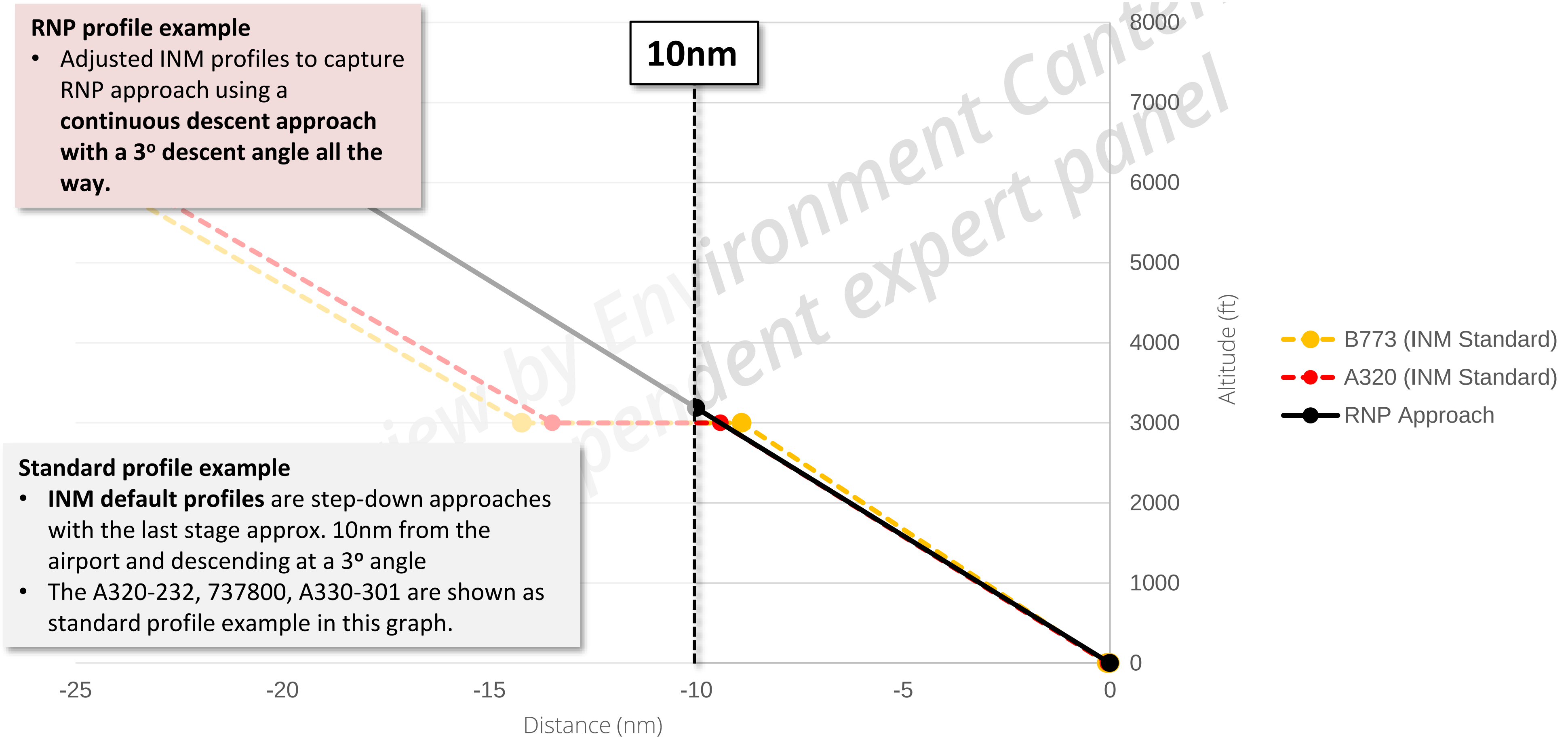
Changes to flight track or altitude profile parameters were changed if they would have an impact on the noise contours.

Based on previous preliminary contours it was assumed that the majority of the contours will be contained **within 10nm**.

Where appropriate, INM default modelling parameters were used.

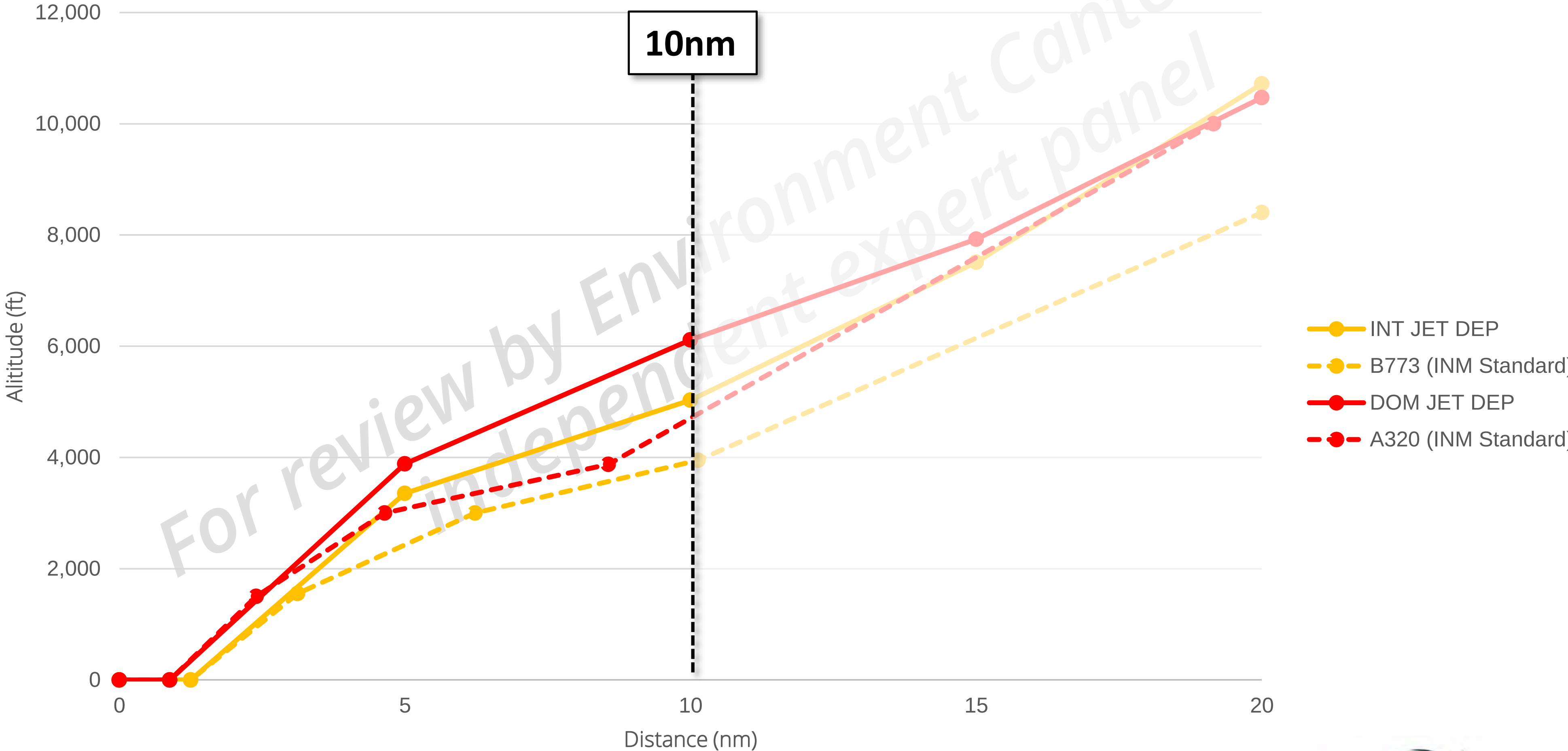
Altitude Profiles comparison – Arrival

There are two types of approach profiles used for arrivals. The first is a step-down approach (see yellow and red profiles in graph) 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 graph). It is possible to add a user defined profile into the noise model to account for a constant descent approach. However, this was not deemed necessary as both the step down and RNP profiles switch to a constant descent profile within 10nm of the runway and the noise contours do not generally extend beyond this.



Altitude Profiles comparison – Departure

The following graph shows typical departure altitude profiles obtained from the radar data of actual flights for International and Domestic Jets, and the INM Standard profiles for representative aircraft types in each of the categories. Since the INM Standard profiles are similar to the typical departure altitude profiles within 10nm, it was not considered necessary to add user defined profile into the noise model for departures.



UPDATED FLIGHT TRACKS:

BACKBONE AND ALLOCATION

Updated Flight Tracks: Backbone and Allocation

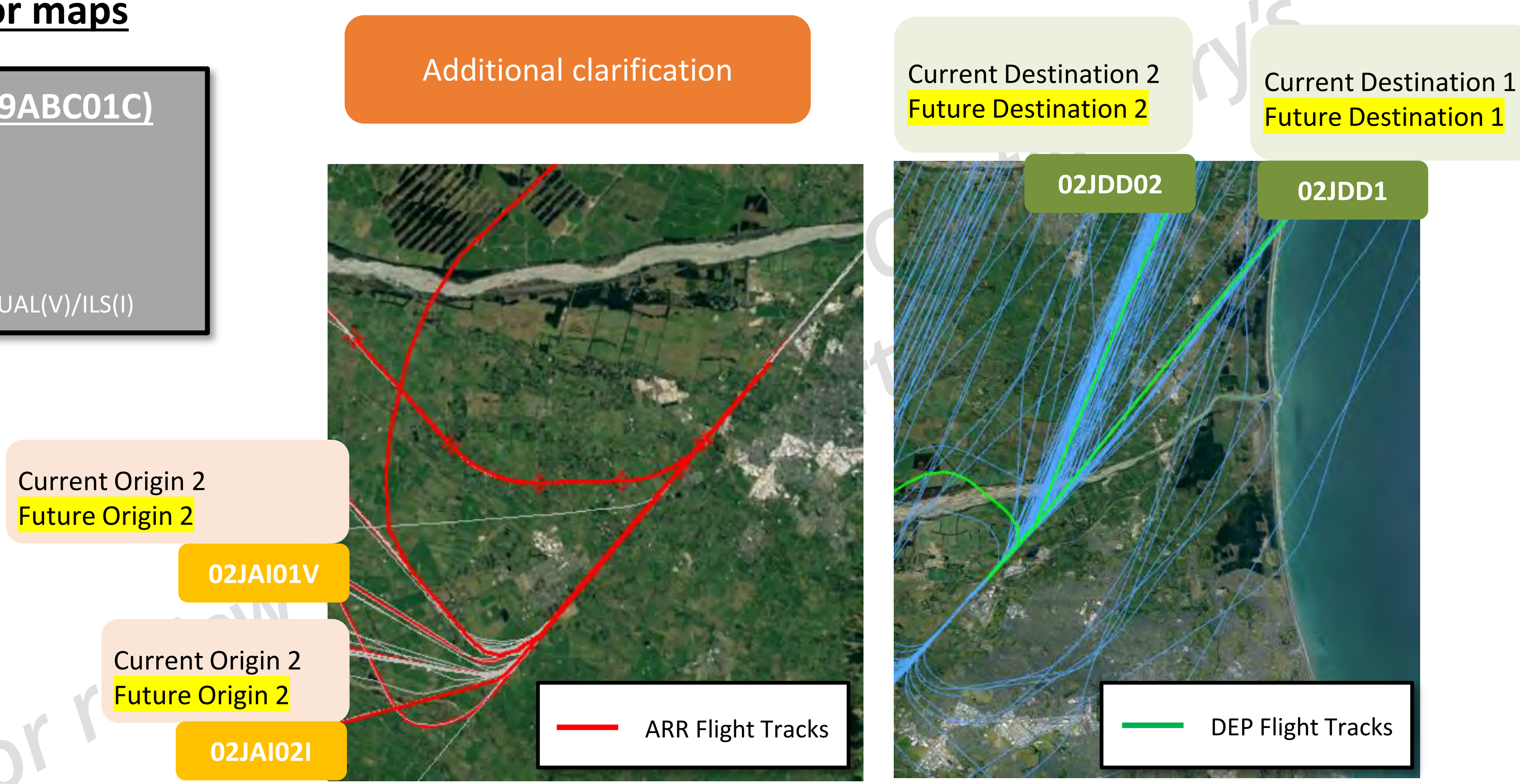
The flight track backbones and respective allocations are provided in this section for the following movement categories:

1. Scheduled Flight Tracks
2. Other Flight Tracks
3. Helicopter Tracks

Updated Flight Tracks: Legend

Legend for maps

Track ID (99ABC01C)
99 is RWY end
A is Jet/TP track
B is ARR/DEP
C is INT/DOM
01 is Track ID
C is RNP(R)/VISUAL(V)/ILS(I)



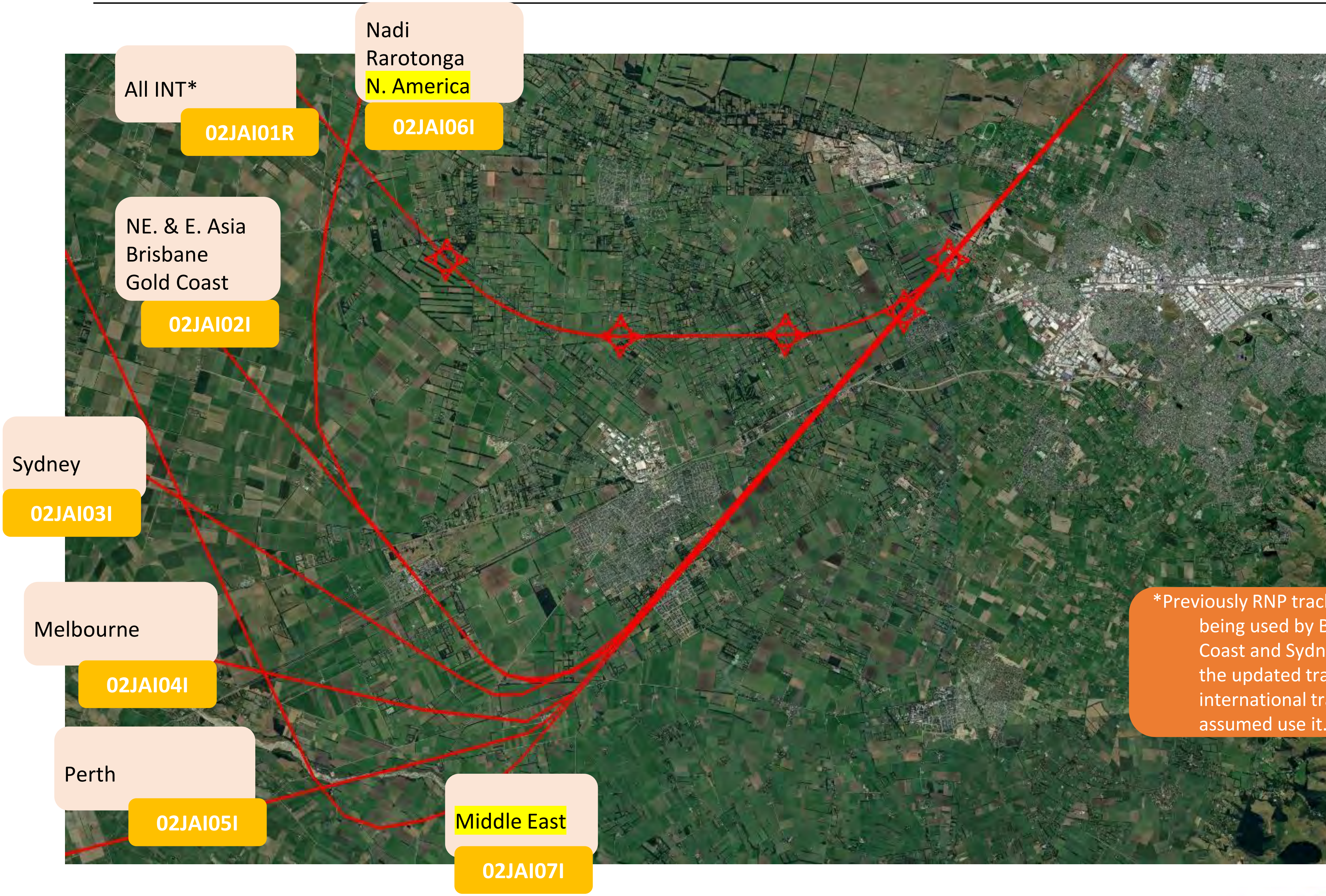
SCHEDULED FLIGHT TRACKS:

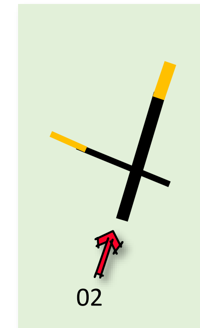
BACKBONE AND ALLOCATION

The arrival flight tracks are based off the second week in July 2017, October 2017, January 2018 and March 2018 radar data track and extensive review by Airways in 2021.

The departure flight tracks are based on current SIDs (as of 11/06/2021), 1 day of actual tracks from April 2021 and May 2021 and extensive review by Airways in 2021.

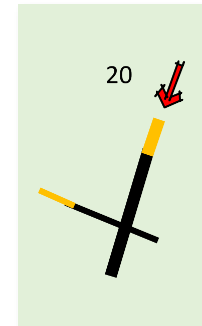
Runway 02 Jet Arrivals – International



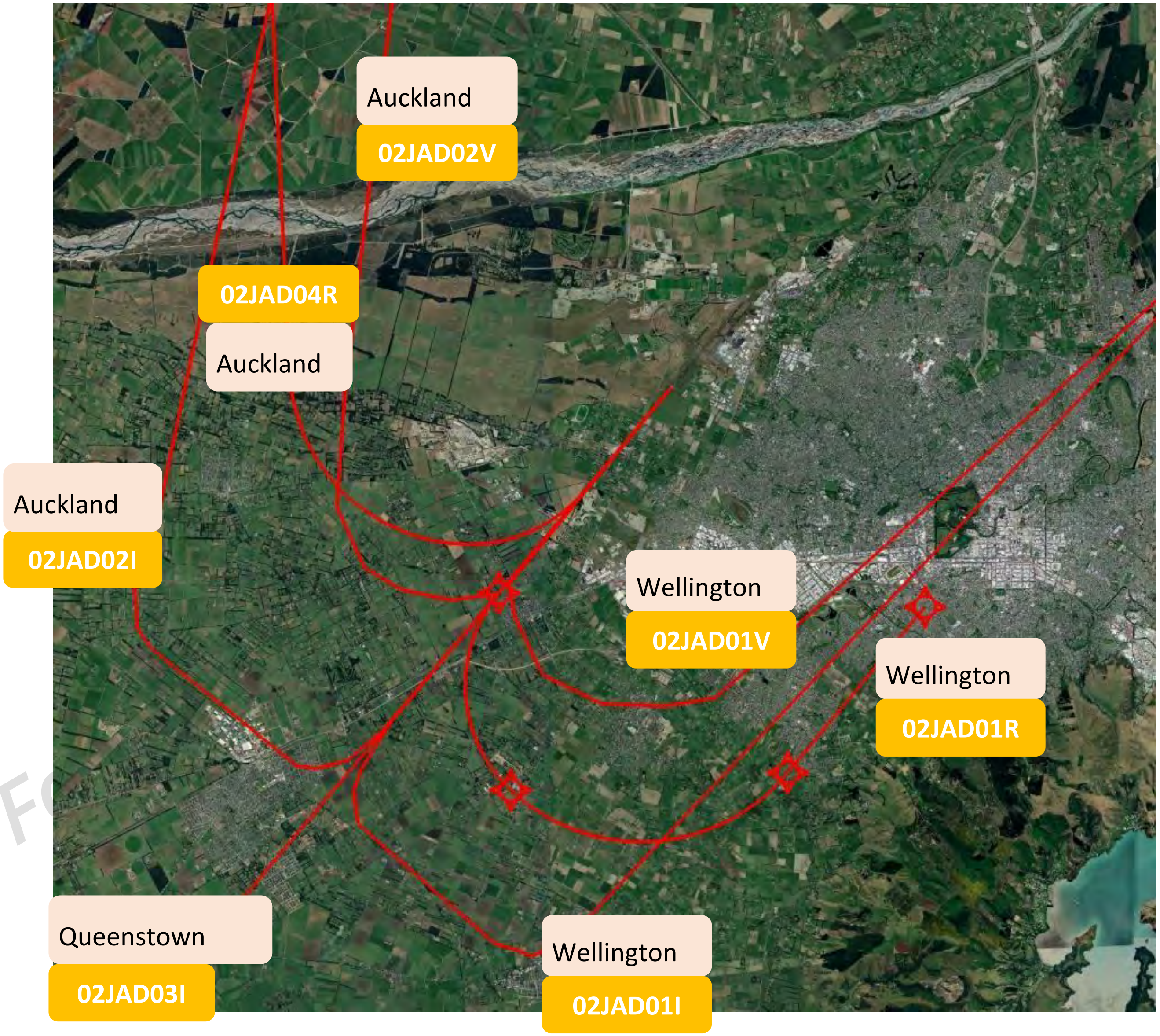


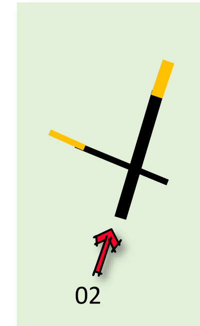
*Previously RNP track 02JAI01R was being used by Brisbane, Gold Coast and Sydney traffic. For the updated tracks all international traffic are assumed use it.

Runway 20 Jet Arrivals – International

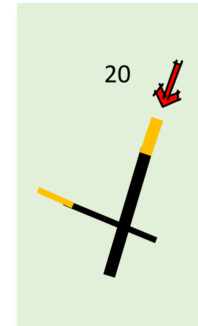


Runway 02 Jet Arrivals – Domestic



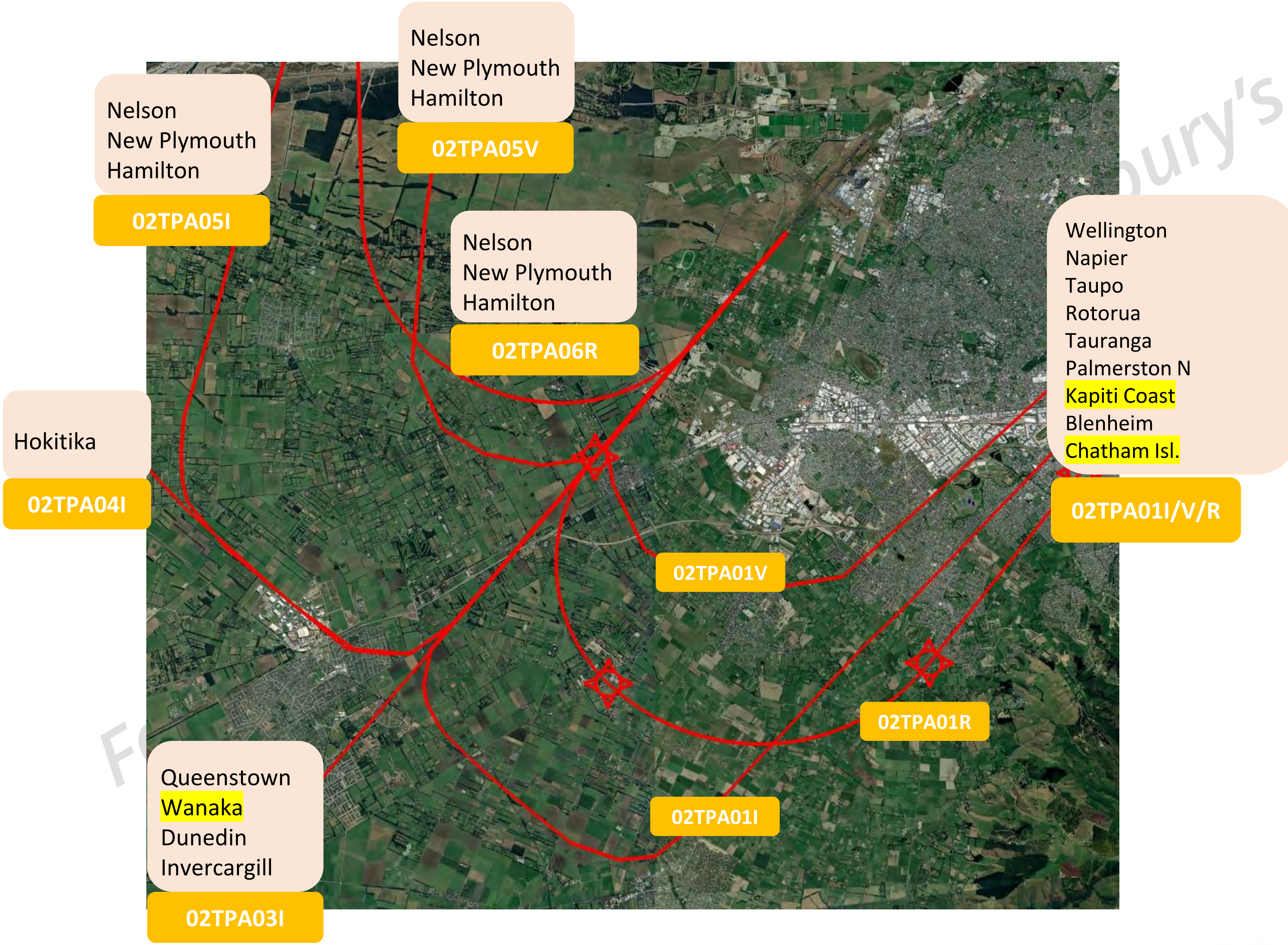


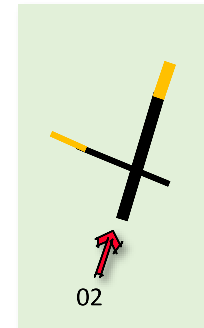
Runway 20 Jet Arrivals – Domestic



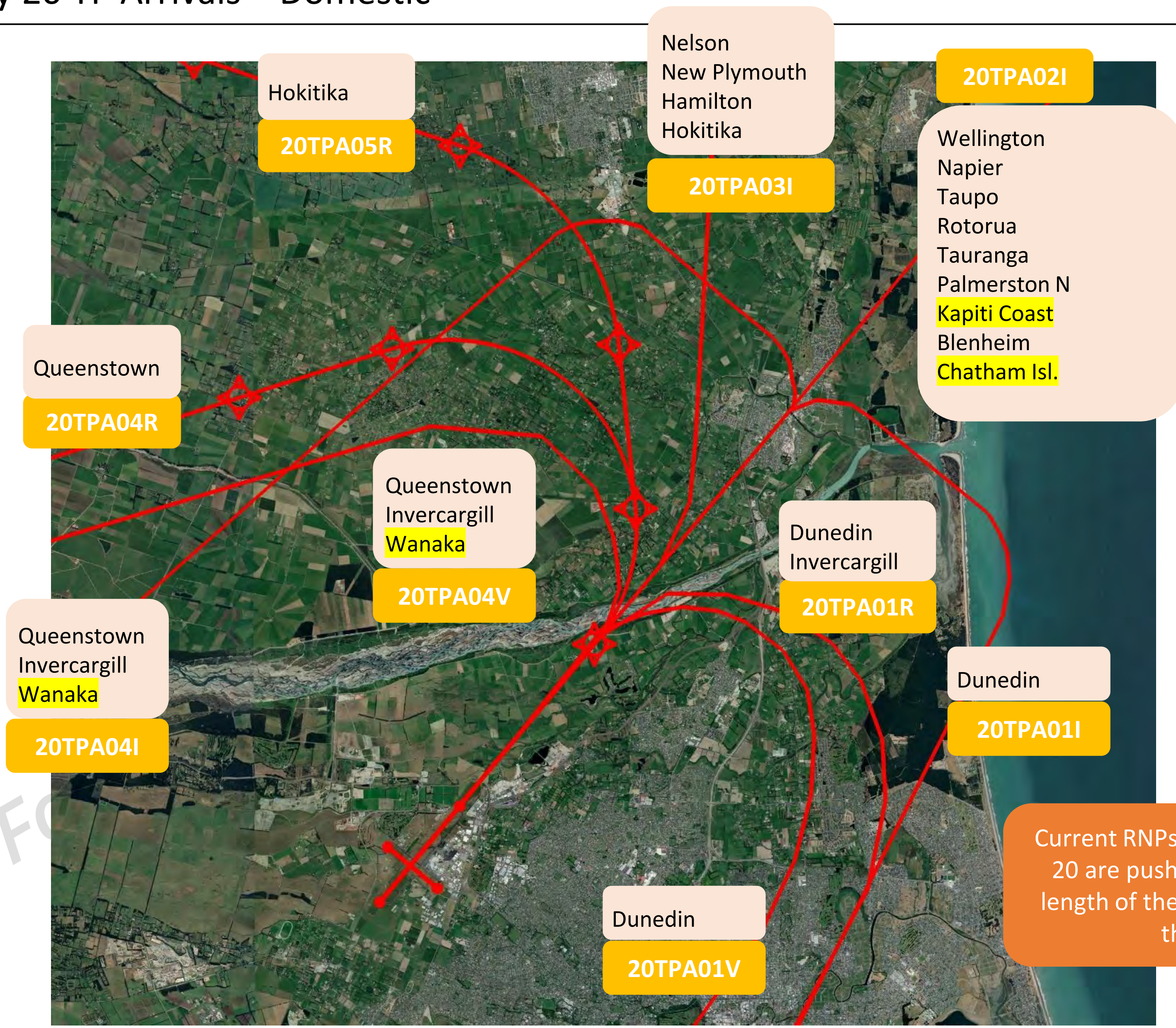
Current RNPs and Visuals for RWY 20 are pushed as per the same length of the 300 m extension to the North.

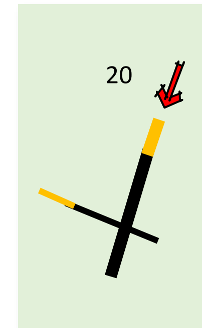
Runway 02 TP Arrivals – Domestic





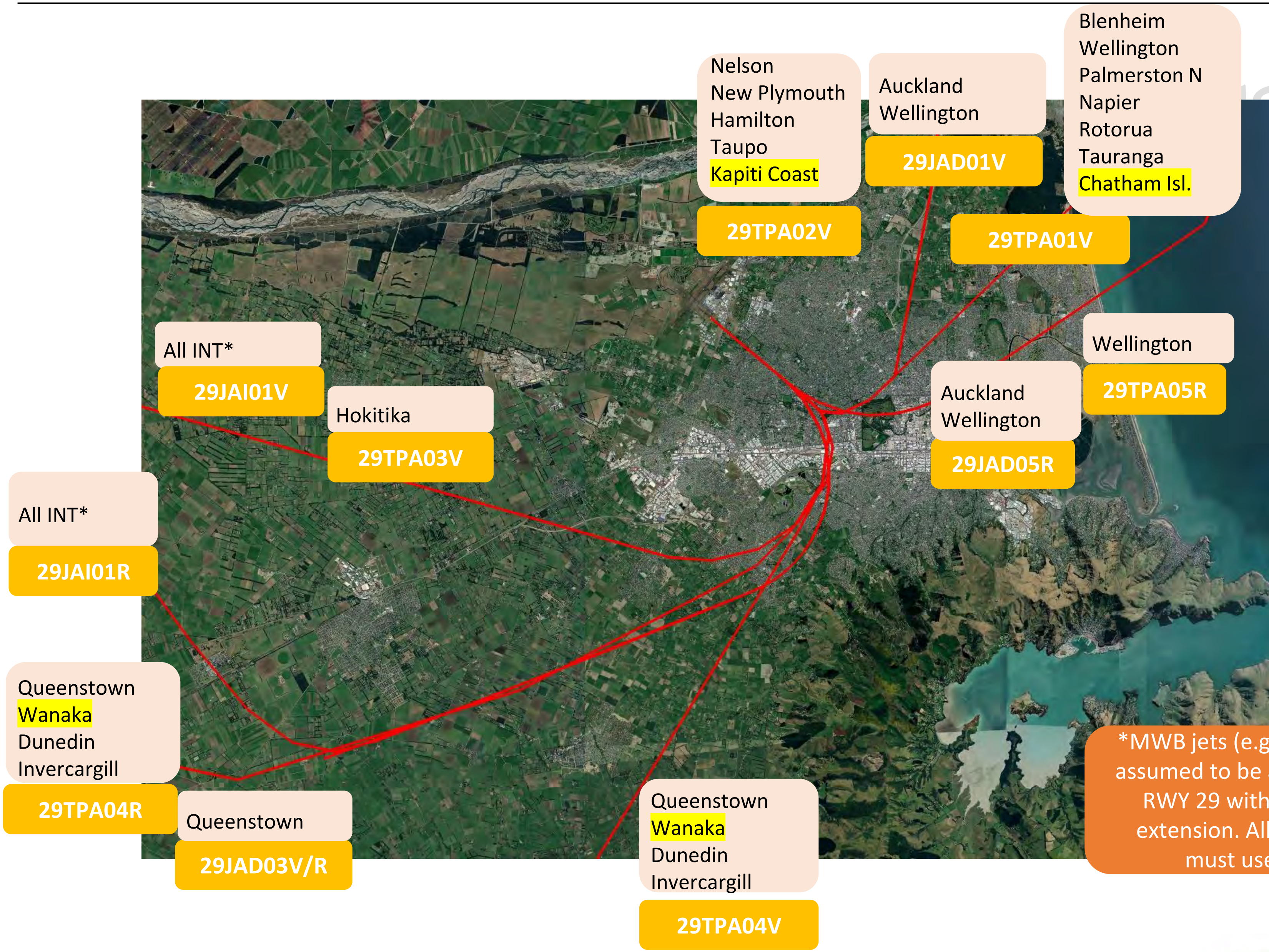
Runway 20 TP Arrivals – Domestic

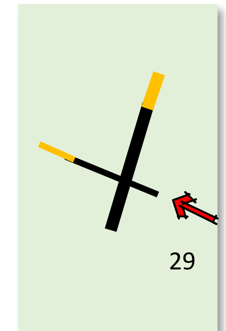




Current RNPs and Visuals for RWY 20 are pushed as per the same length of the 300 m extension to the North.

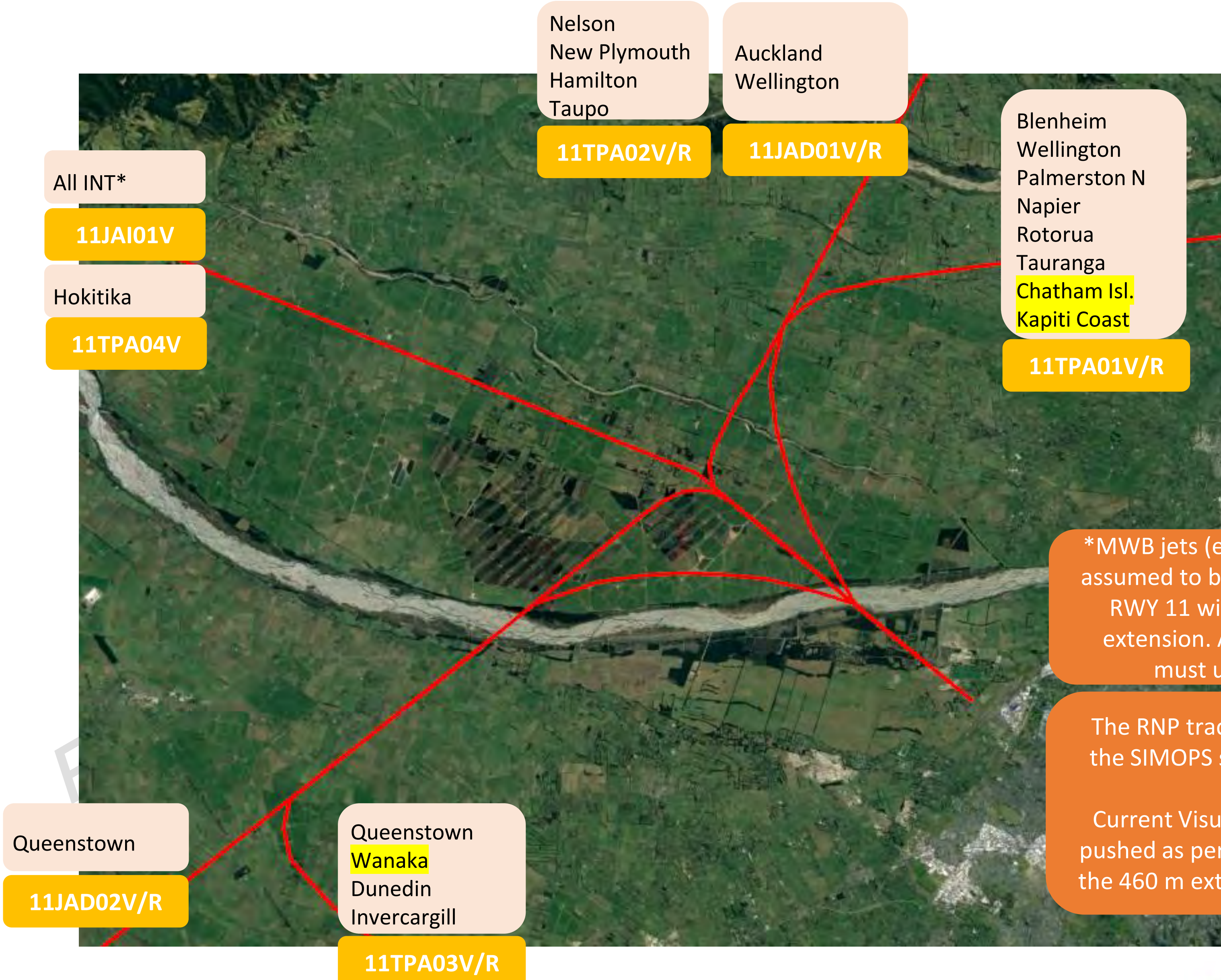
Runway 29 Jet & TP Arrivals

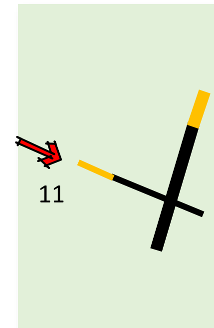




*MWB jets (e.g. 787, 330) are assumed to be able to land on RWY 29 with the runway extension. All other WBJ's must use 02/20.

Runway 11 Jet & TP Arrivals

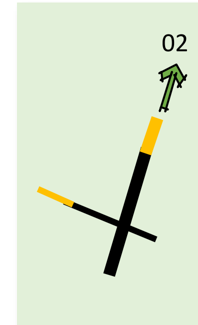




*MWB jets (e.g. 787, 330) are assumed to be able to land on RWY 11 with the runway extension. All other WBJ's must use 02/20.

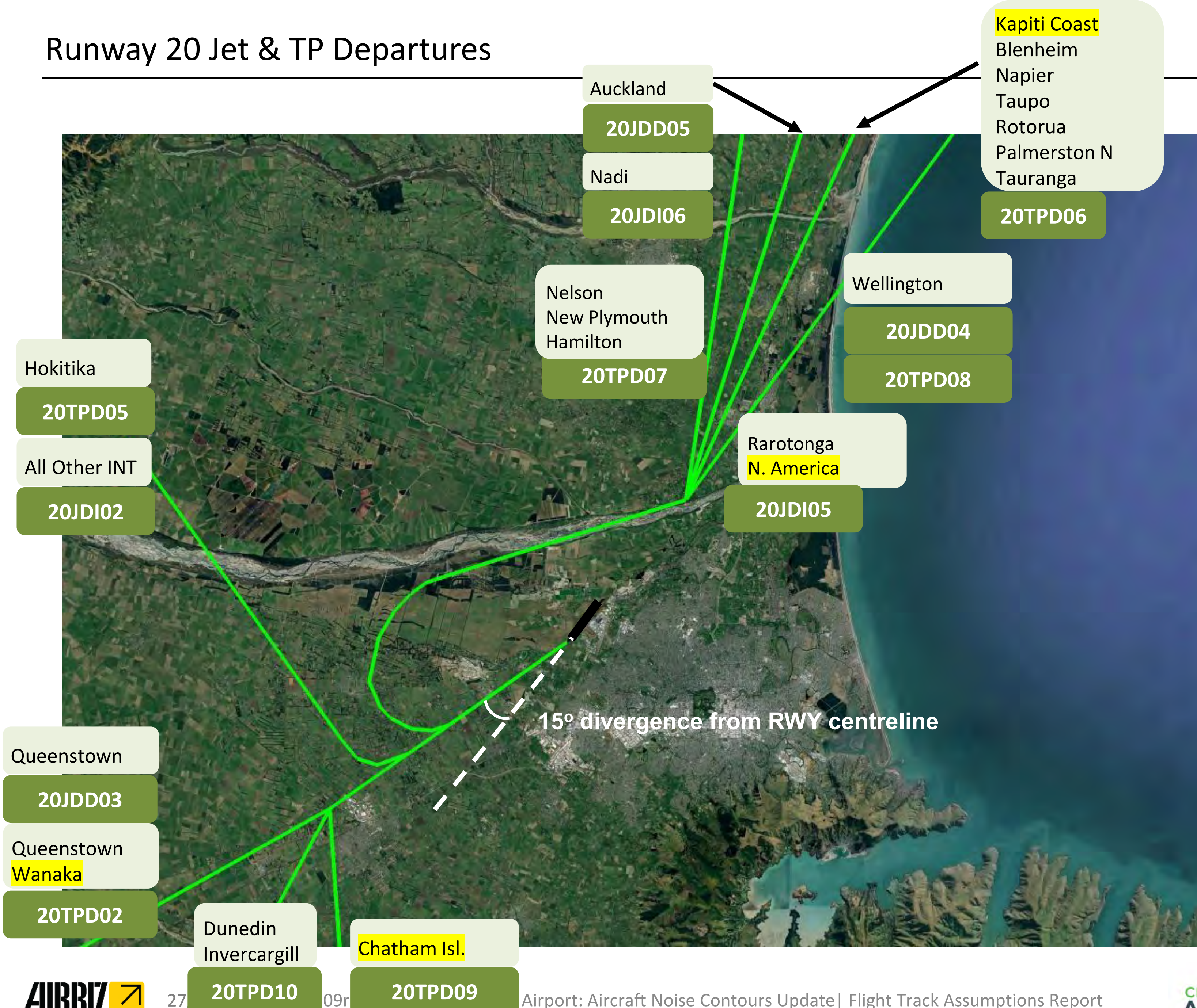
The RNP tracks were added for the SIMOPS sensitivity scenario only.
Current Visuals for RWY 11 are pushed as per the same length of the 460 m extension to the West.

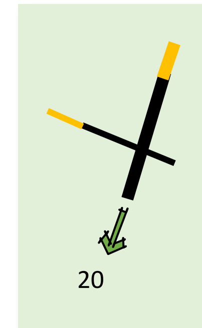
Runway 02 Jet & TP Departures



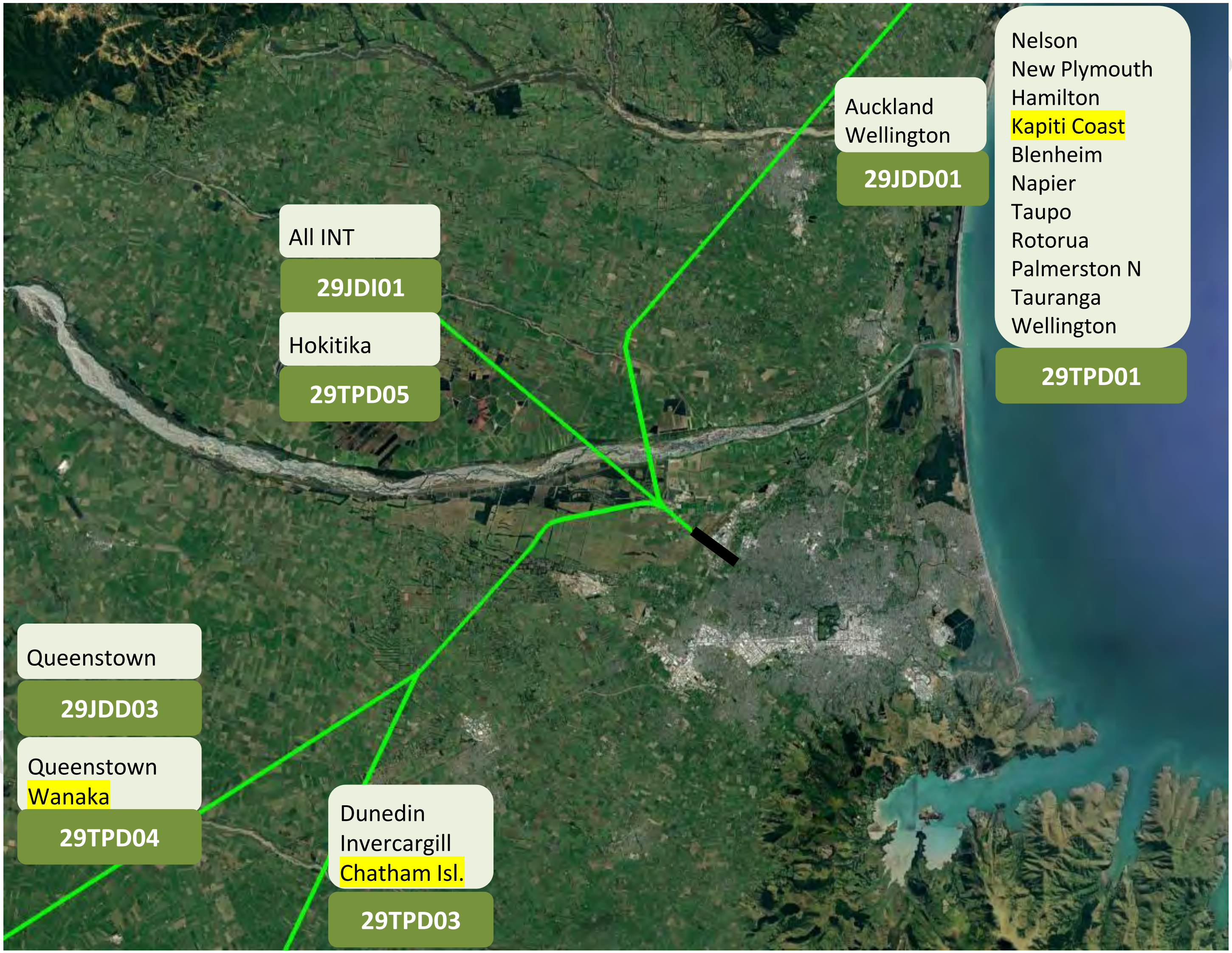
RWY02 DEPS are pushed as per the same length of the 300 m extension to the North.

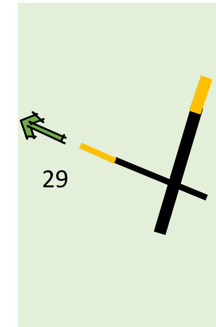
Runway 20 Jet & TP Departures





Runway 29 Jet & TP Departures





OTHER FLIGHT TRACKS:

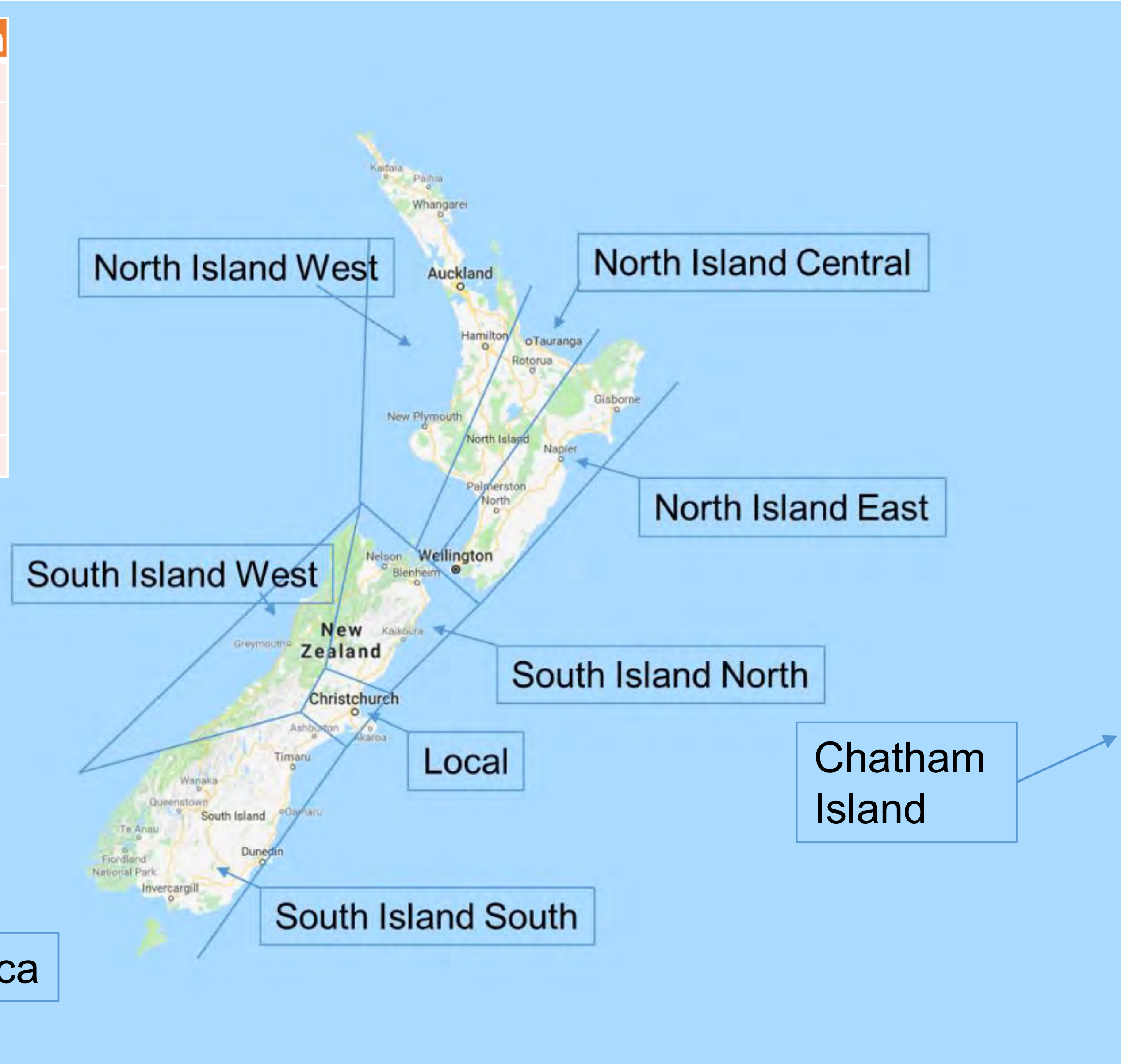
BACKBONE AND ALLOCATION

Other International Aircraft Movement Regions

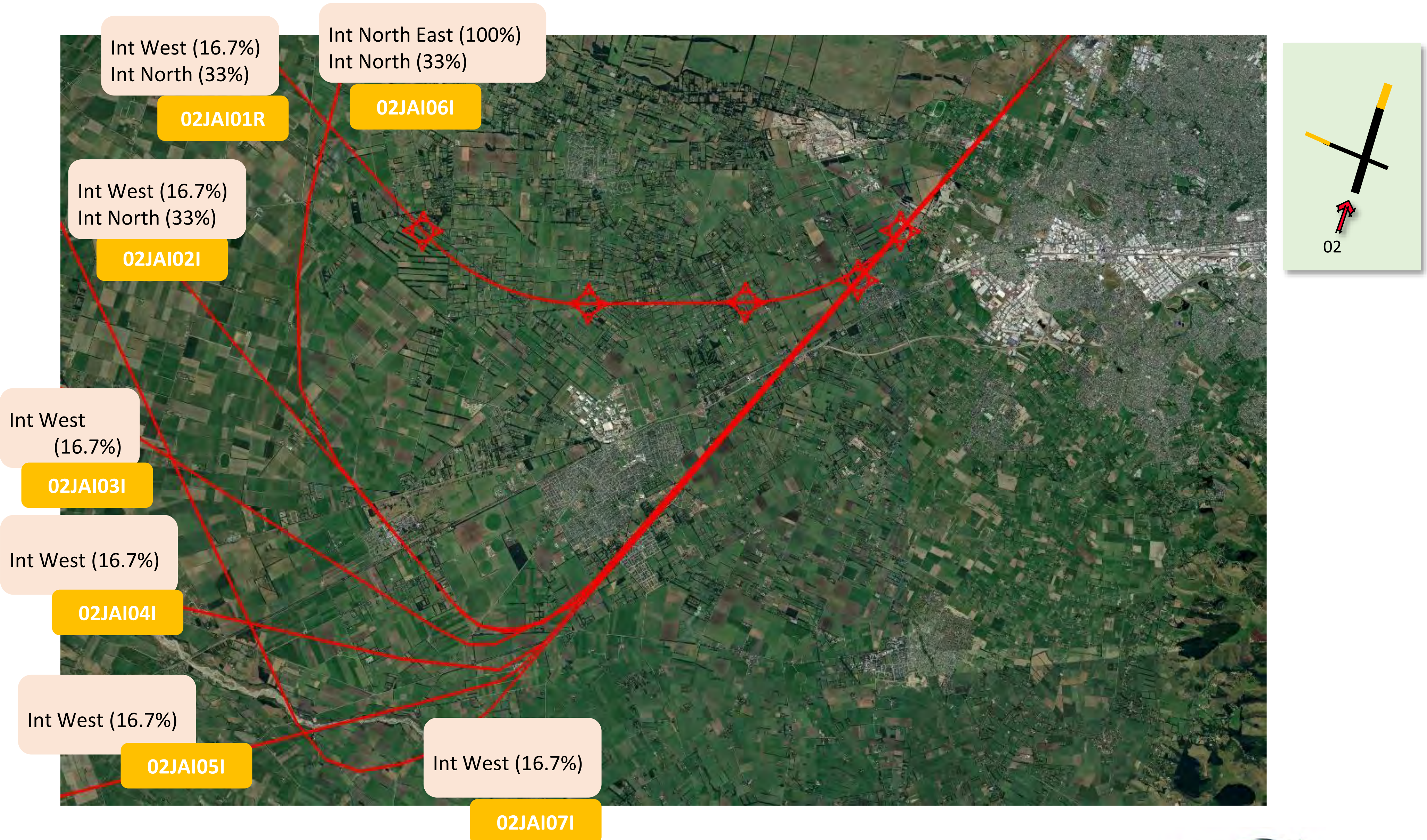
Region	Stage Length	Example O/D
Int West	4	East coast AUS
Int North	4	Fiji
Int North East	8	USA

Other Domestic Aircraft Movement Regions

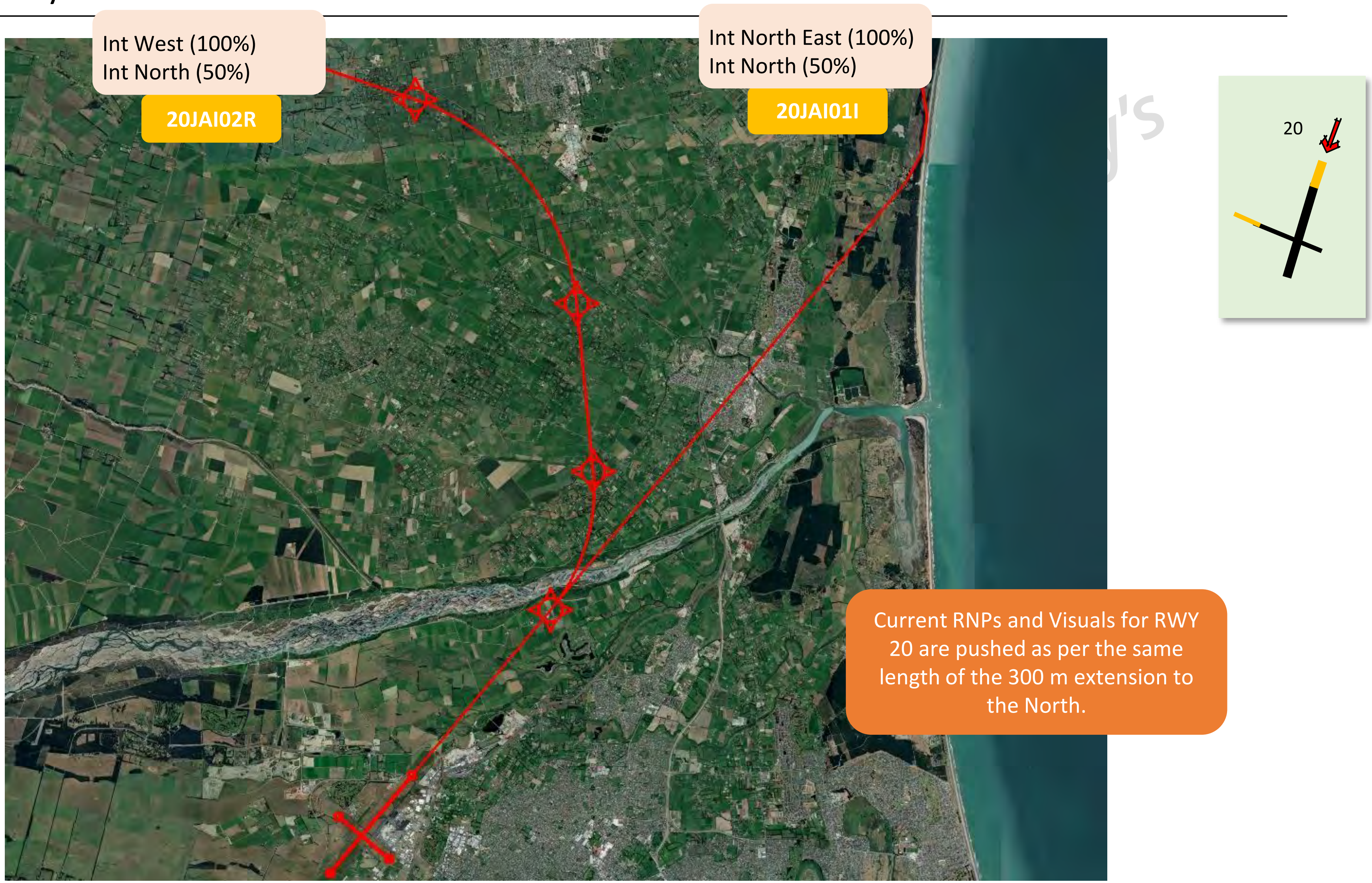
Region	Stage Length
Local	1
South Island North	1
South Island South	1
North Island Central	1
North Island East	1
North Island West	1
South Island West	1
Chatham Islands	1
Antarctica	5



Runway 02 Jet Arrivals – International

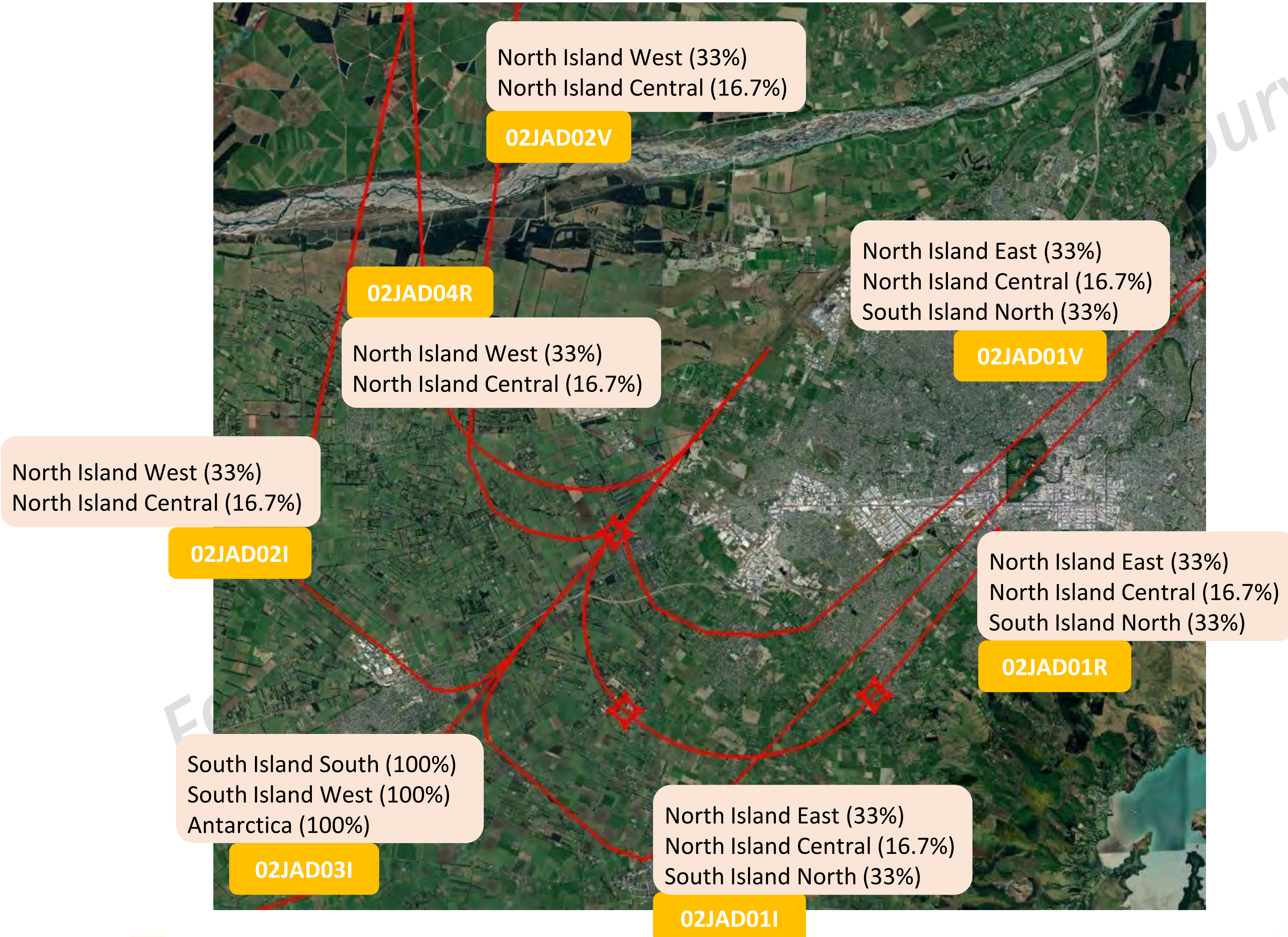


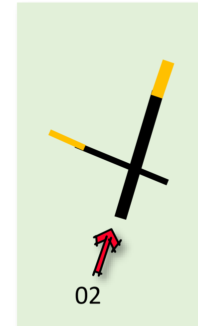
Runway 20 Jet Arrivals – International



Current RNPs and Visuals for RWY 20 are pushed as per the same length of the 300 m extension to the North.

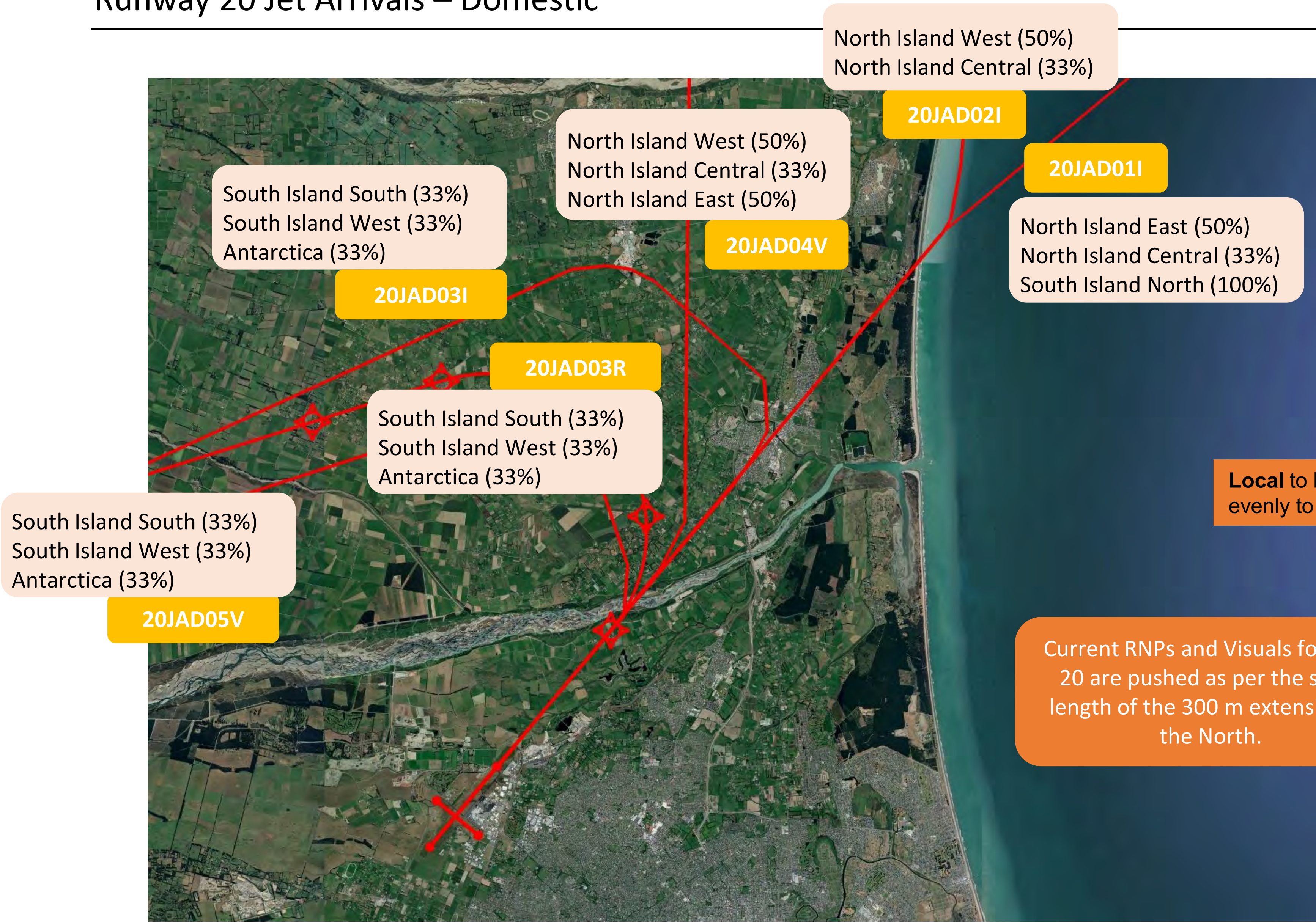
Runway 02 Jet Arrivals – Domestic

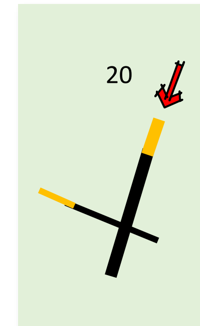




Local to be applied evenly to all flight tracks

Runway 20 Jet Arrivals – Domestic

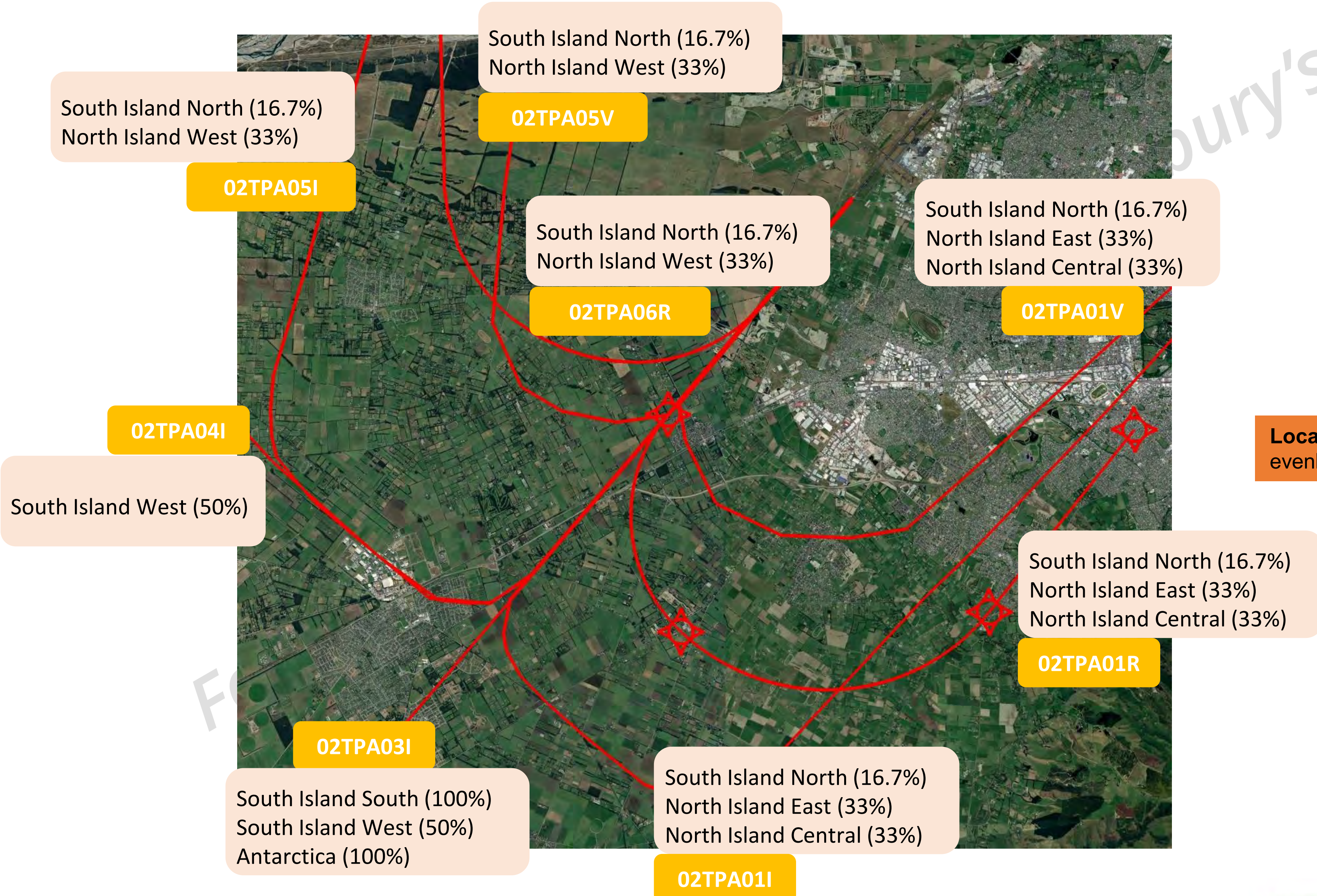


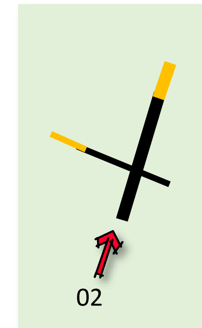


Local to be applied evenly to all flight tracks

Current RNPs and Visuals for RWY 20 are pushed as per the same length of the 300 m extension to the North.

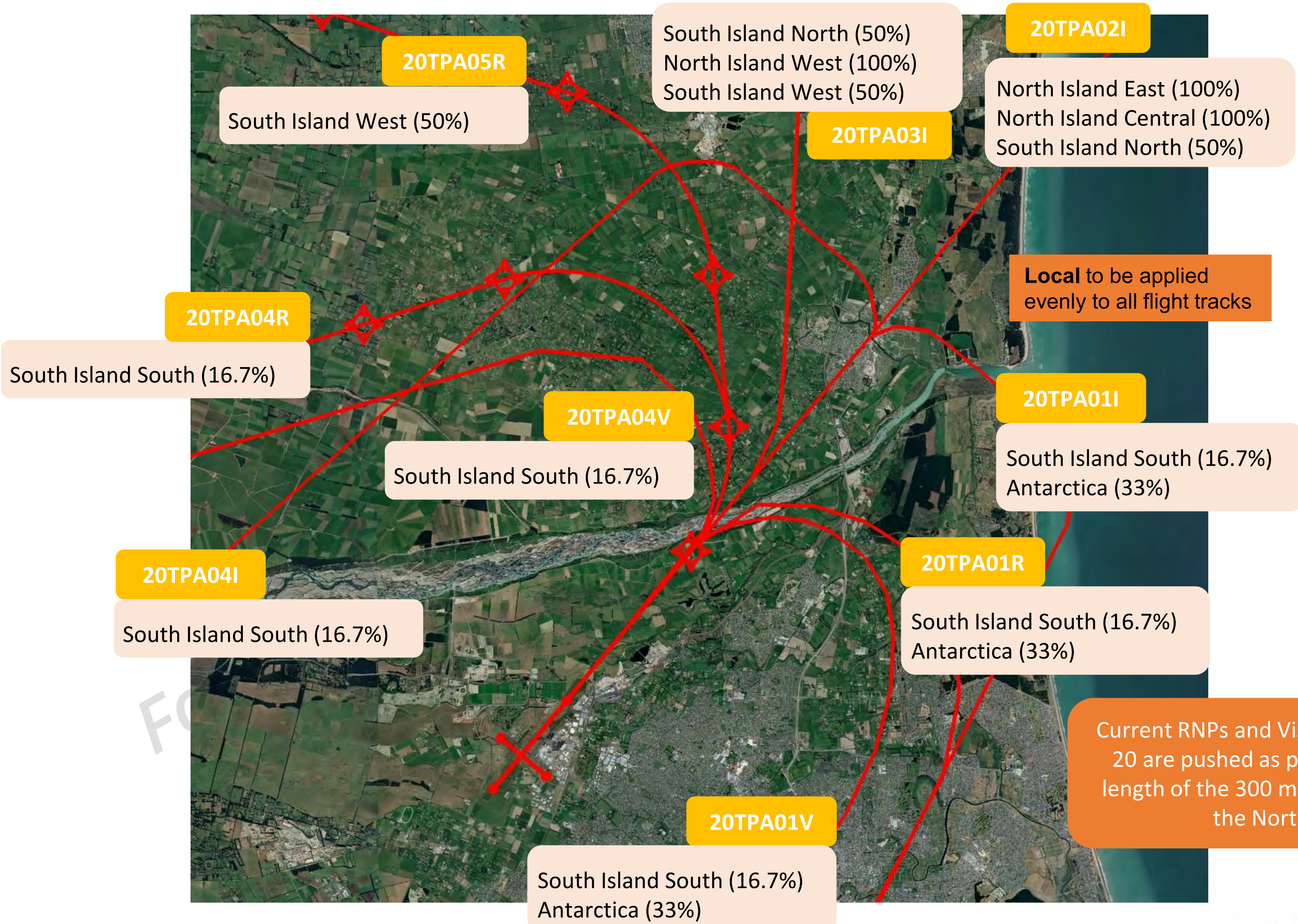
Runway 02 TP Arrivals – Domestic

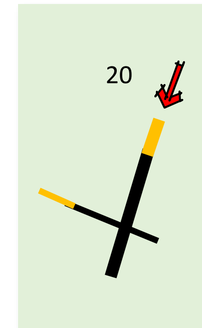




Local to be applied evenly to all flight tracks

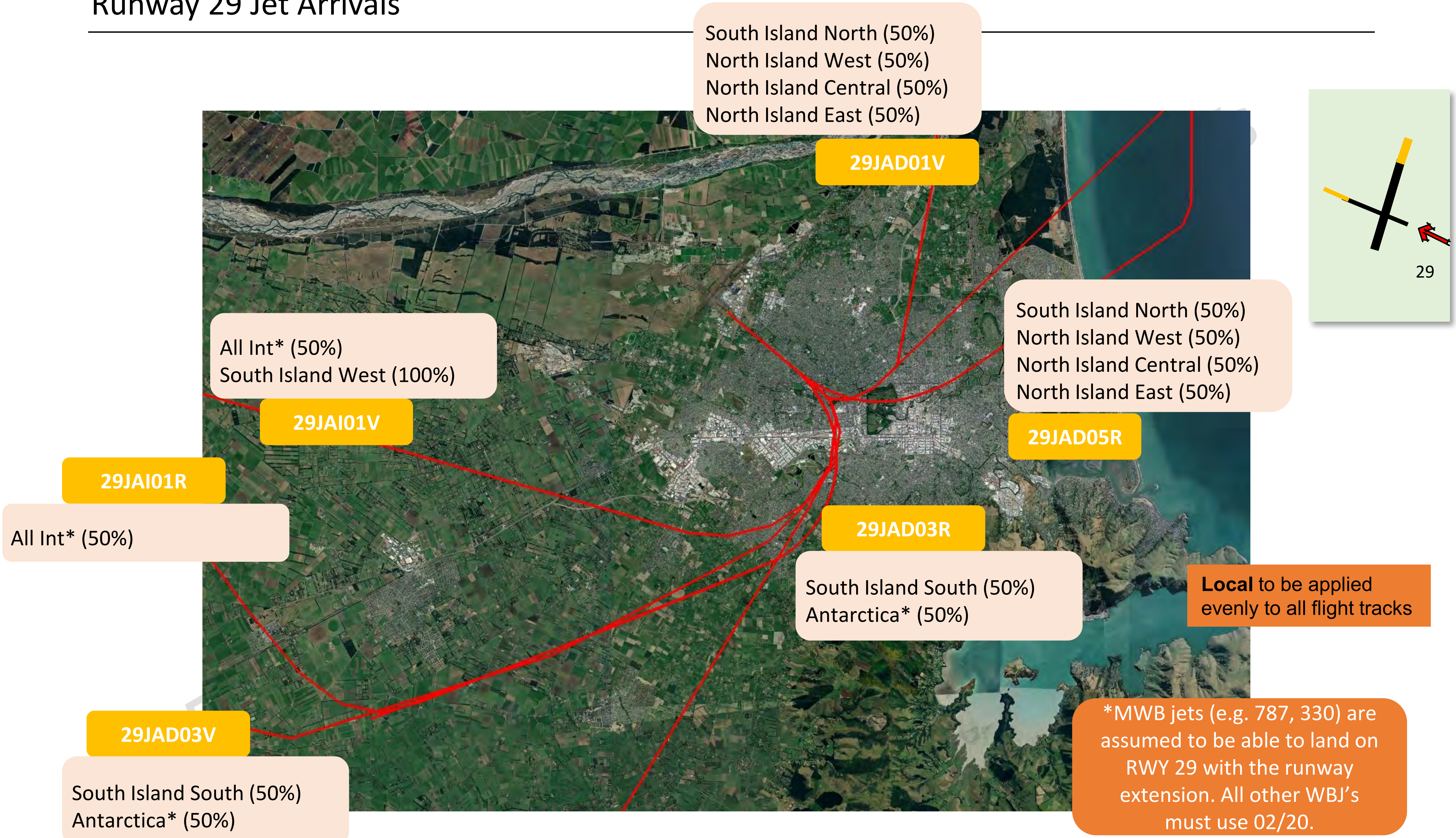
Runway 20 TP Arrivals – Domestic



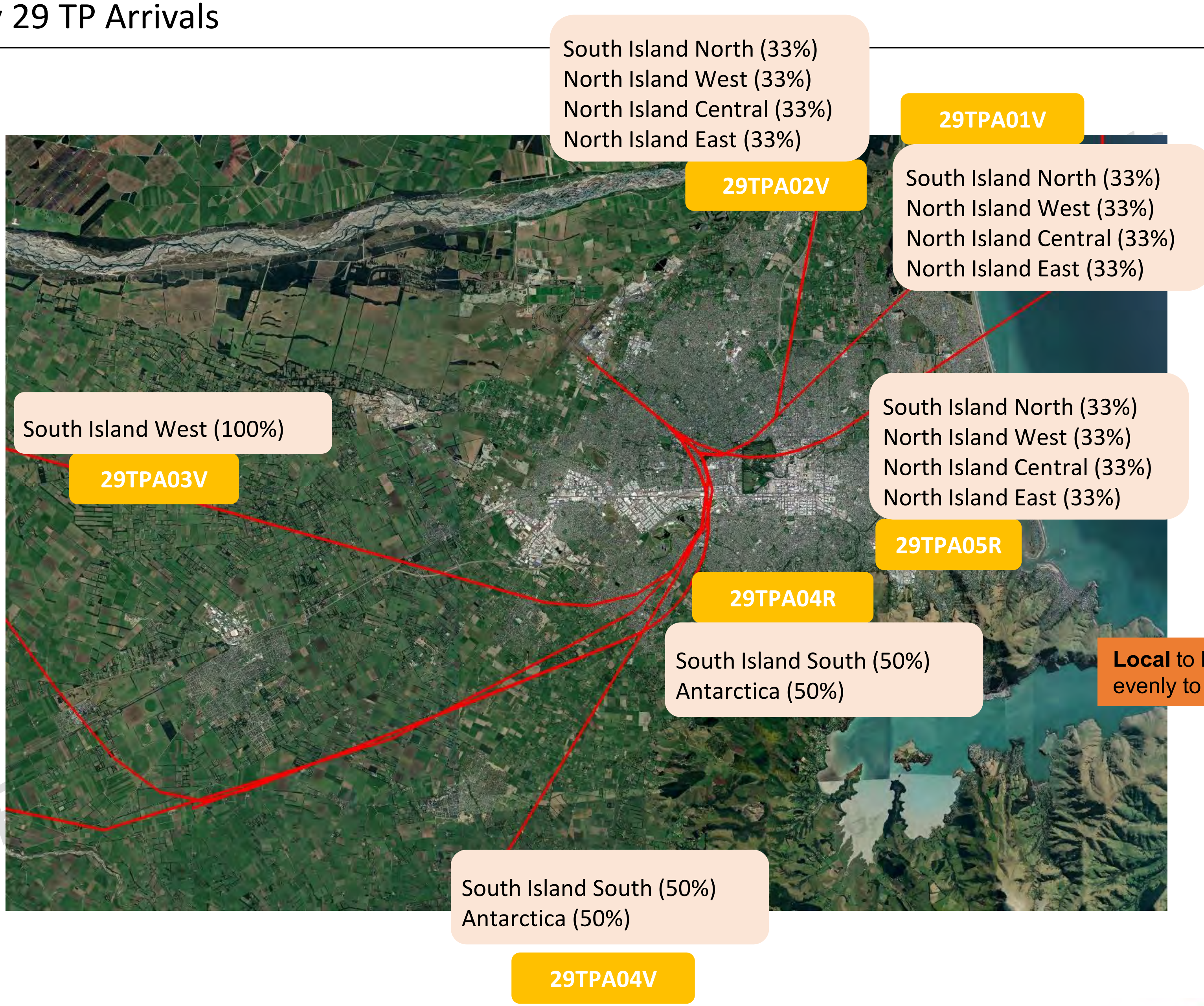


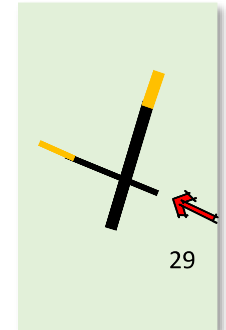
Current RNPs and Visuals for RWY 20 are pushed as per the same length of the 300 m extension to the North.

Runway 29 Jet Arrivals



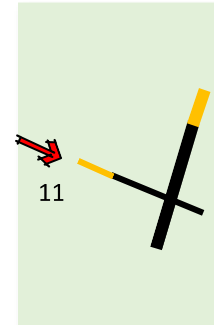
Runway 29 TP Arrivals



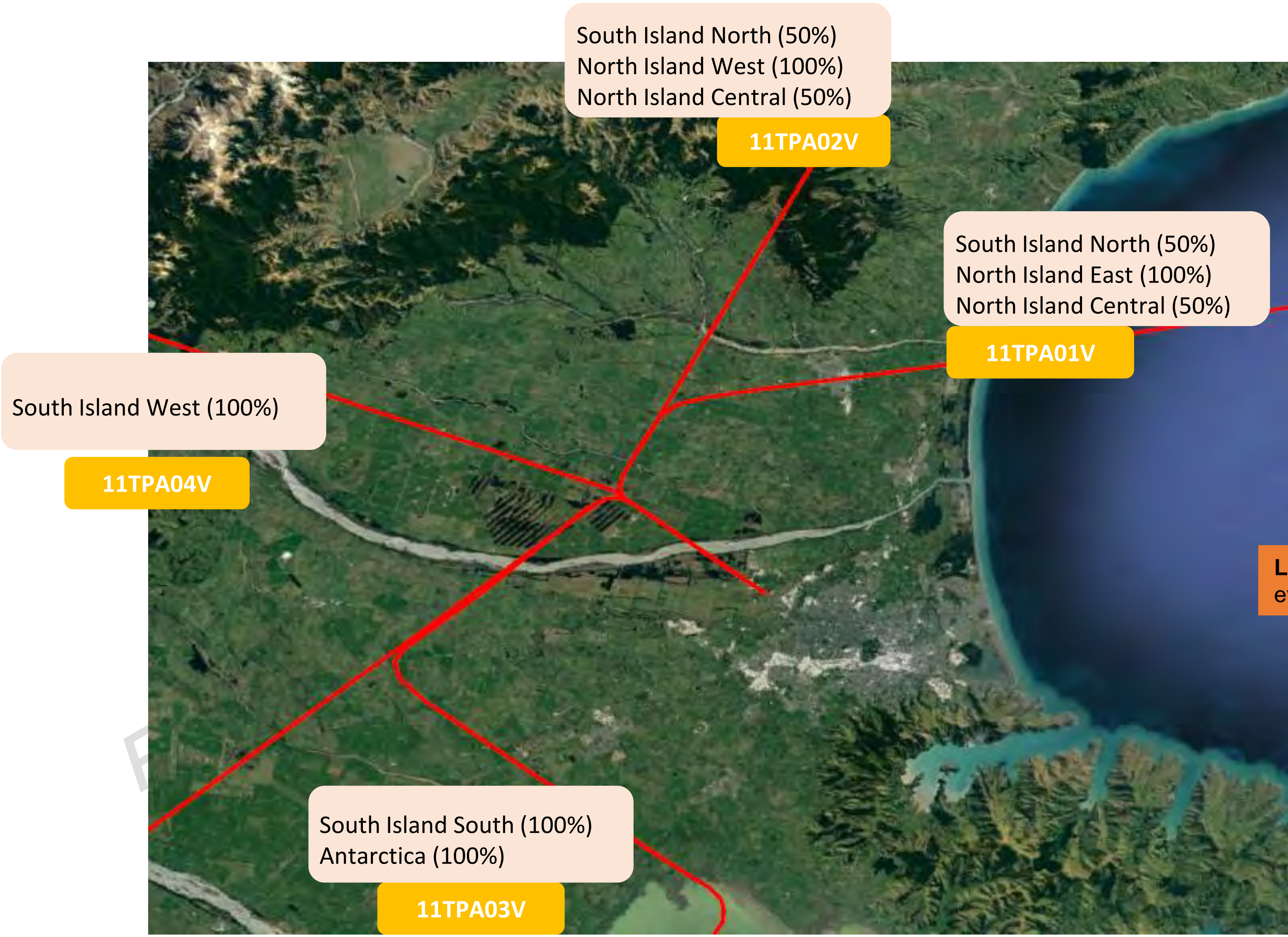


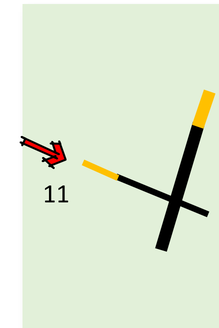
Local to be applied evenly to all flight tracks

Runway 11 Jet Arrivals



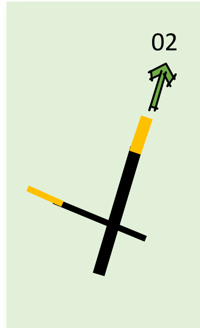
Runway 11 TP Arrivals





Local to be applied evenly to all flight tracks

Runway 02 Jet Departures – International



RWY02 DEPS are pushed as per the same length of the 300 m extension to the North.

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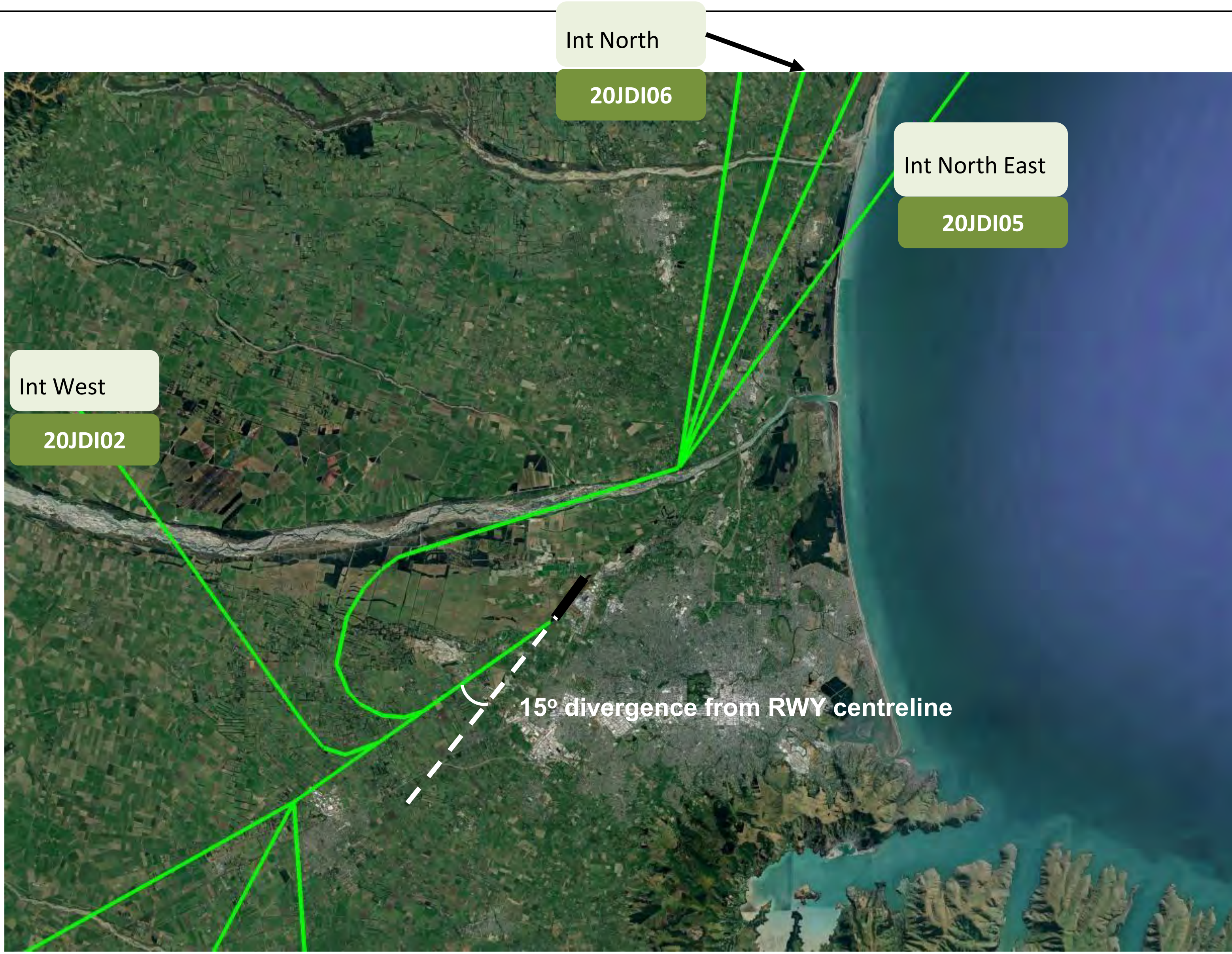
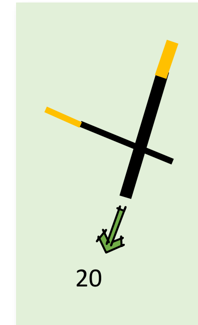
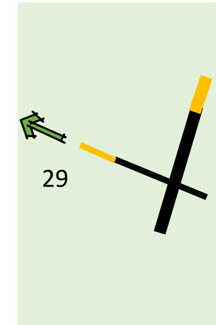
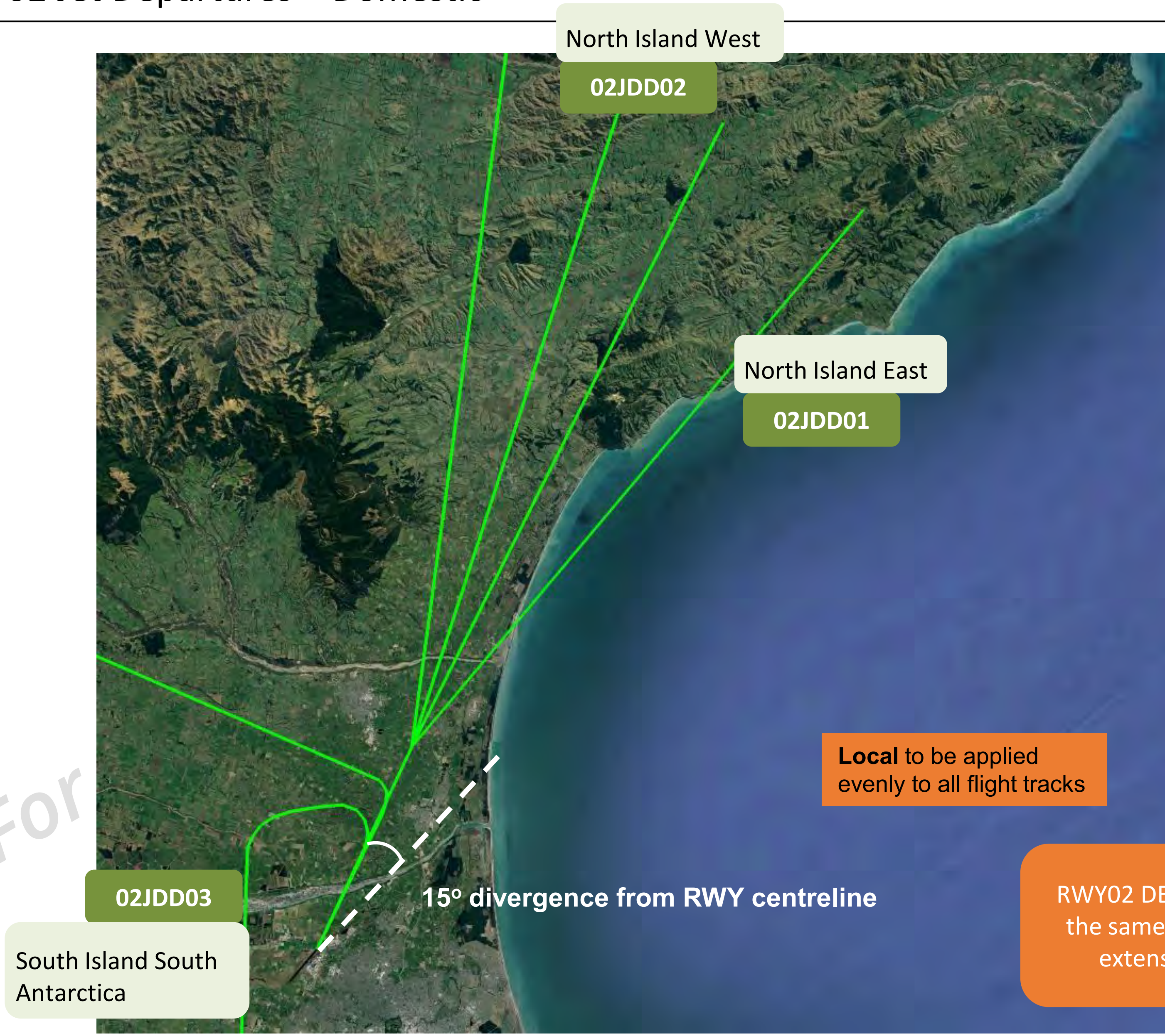


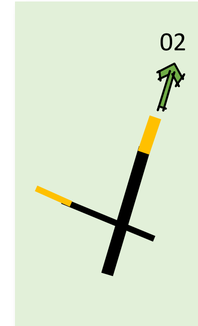


Runway 29 Jet Departures - International



Runway 02 Jet Departures – Domestic





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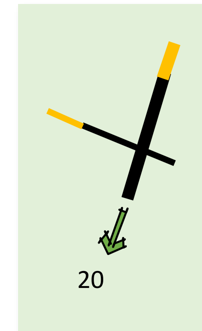
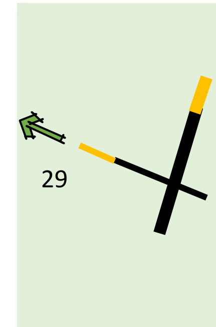
Runway 20 Jet Departures – Domestic



Runway 29 Jet Departures - Domestic



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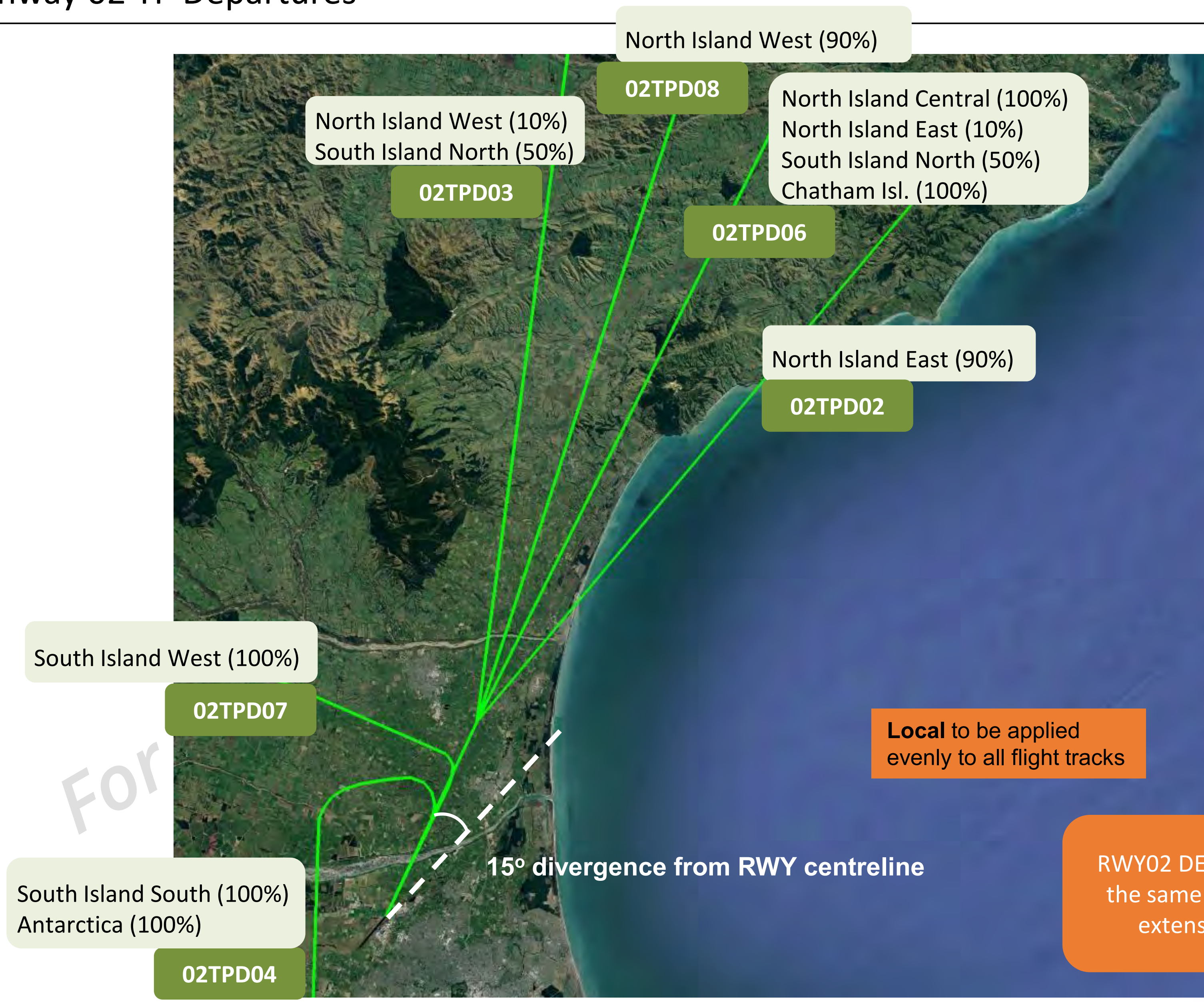

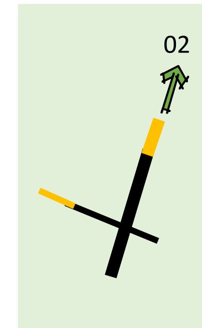

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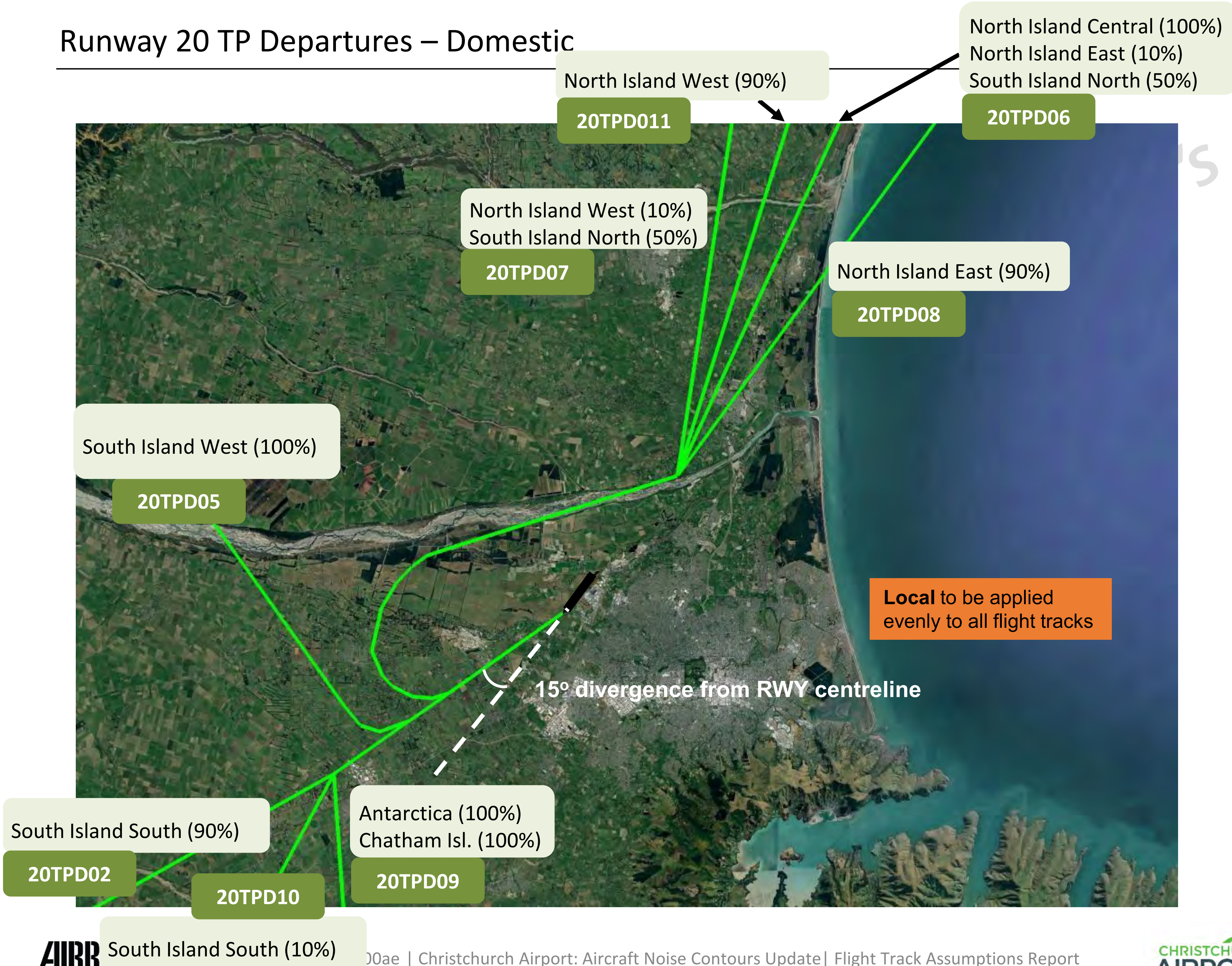
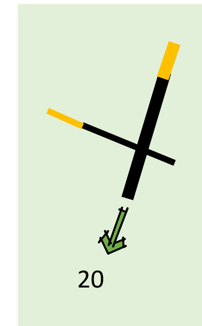
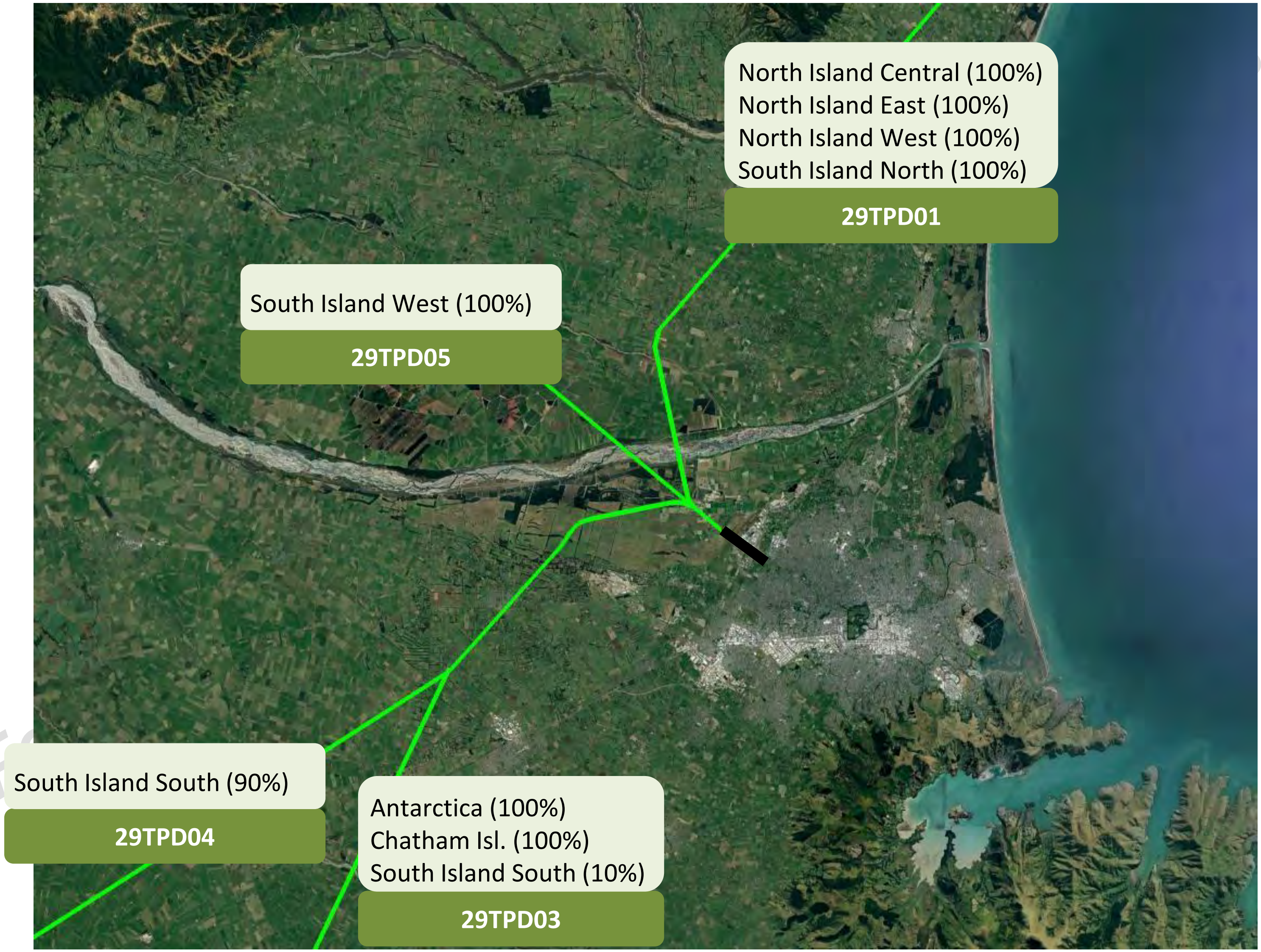
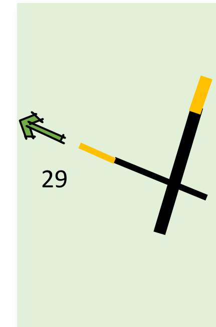
Runway 20 TP Departures – Domestic





Runway 29 TP Departures - Domestic



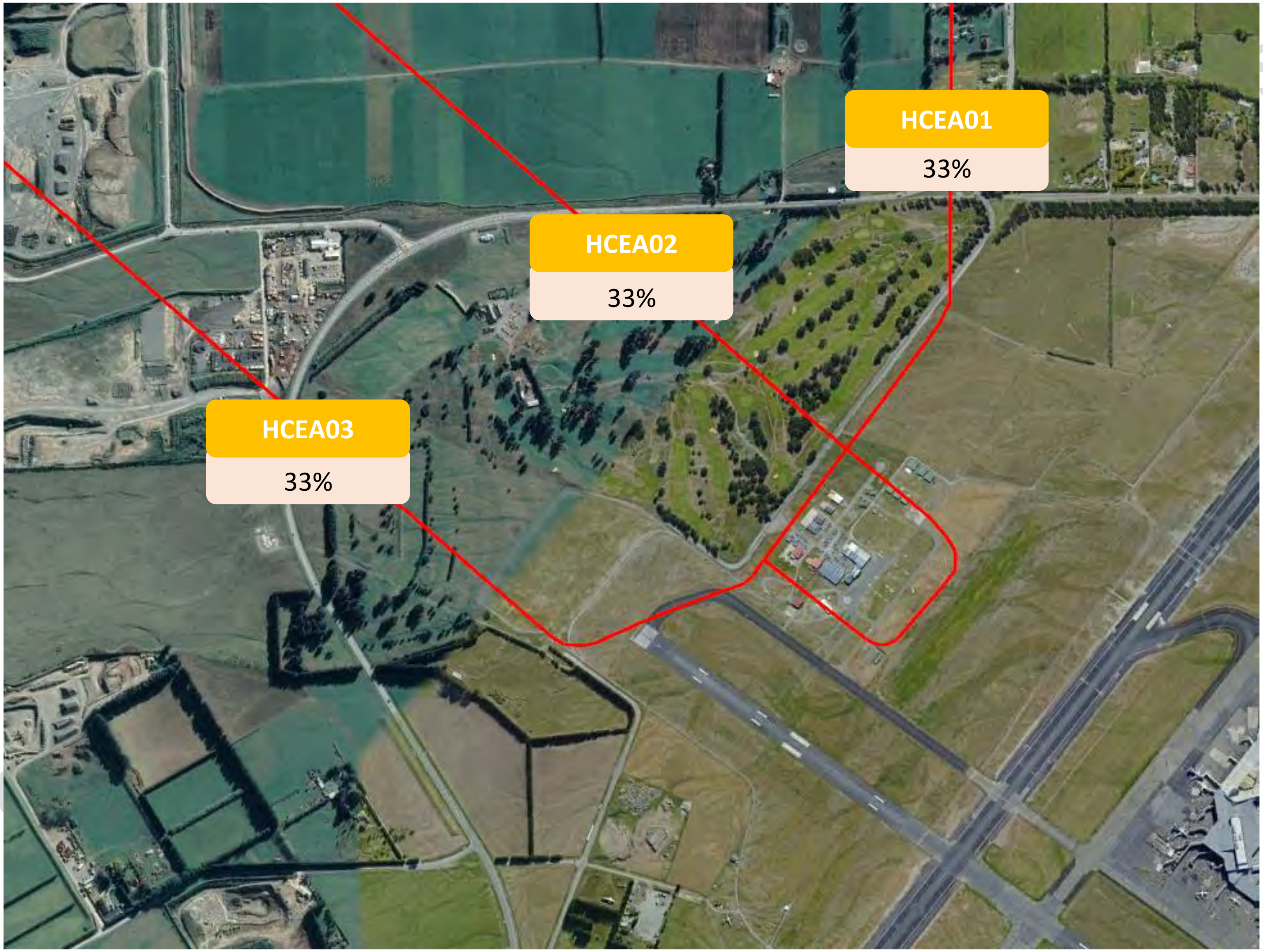


HELICOPTER TRACKS:

BACKBONE AND ALLOCATION

Helipad- Helicentre Departures

Helipad- Helicentre Arrivals



Helipad- Garden City Departures

Helipad- Garden City Arrivals

5

Christchurch Recontouring
NOISE MODELLING REPORT

2021 CHRISTCHURCH INTERNATIONAL AIRPORT EXPERT UPDATE OF THE OPERATIVE PLAN NOISE CONTOURS
FOR REVIEW BY ENVIRONMENT CANTERBURY'S INDEPENDENT EXPERT PANEL

MARSHALL DAY Acoustics

MARSHALL DAY Acoustics

CHRISTCHURCH RECONTOURING NOISE MODELLING REPORT

Report No.001 | 11 May 2022

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Project:	**CHRISTCHURCH AIRPORT RECONTOURING**
Prepared for:	**Christchurch International Airport Ltd** **PO Box 14001** **Christchurch Airport** **Christchurch 8544**
Attention:	**Felicity Blackmore**
Report No.:	**Report No.001**

Document Control

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Final Draft r01	006		6-Oct-21	Laura McNeill	Chris Day
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MARSHALL DAY Acoustics

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose

Christchurch International Airport Limited (CIAL) is seeking to update the 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 and Airways New Zealand to prepare a set of updated noise contours for inclusion in the CRPS and District Plans. The new noise contours are referred to throughout this report as the "Updated Noise Contours" and are based ultimate runway capacity. Two options are provided for the Updated Noise Contours, the busy three-month Outer Envelope and Annual Average. These are described in more detail in Section 6.0.

The purpose of this report is to document the assumptions, methodology and inputs used to inform the preparation of the Updated Noise Contours and the outcomes of this work. This includes details of the sensitivity runs which were used to test the influence of several factors on the size and shape of the noise contours. These sensitivity runs were then used to inform the final inputs and assumptions used to prepare the Updated Noise Contours.

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 forms part of the documentation provided to Council and may also be used to inform a peer review if this is implemented. 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 – noise modelling and measurements for model calibration
- Airbiz – aviation consulting – ultimate capacity, air traffic demand projections, and flight tracks
- Airways – 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

Two software packages from the Federal Aviation Administration (FAA) in the USA have been used in noise modelling for this project. The sensitivity runs were produced using the Integrated Noise Model (INM) and the Updated Noise Contours were produced using the Aviation Environmental Design Tool (AEDT) – a software package that has now replaced the INM.

The INM was used for the sensitivity runs as at the time the run times in INM were much faster than the earlier versions of AEDT and more efficient for doing multiple runs. The run time issue has been improved in later versions of the AEDT and it has been used for the final version of the Updated

Noise Contours. For reference, both software packages use the same underlying algorithms to calculate noise levels and thus produce the same noise contour outputs.

1.3 Terminology

There are several noise contours referred to in this document. This section provides a reference for the names of key noise contours. A complete Glossary of Terminology can be found in Appendix A.

- Operative Plan Noise Contours (also known as the "Expert Panel Noise Contours") - The Noise Contours Currently in the Canterbury Regional Policy Statement and Christchurch, Selwyn and Waimakariri District Plans.
- Noise Contour Sensitivity Runs – Several runs taken to test and isolate the effect of certain changes to the noise contours such as fleet changes or changes to flight tracks to confirm the assumptions and inputs which have the most influence on the extent and shape of the contours
- Updated Noise Contours – The updated noise contours to replace the Operative Plan Noise Contours, to be peer reviewed by a panel of experts before confirmation. There are two options:
    - Option 1 - A busy three-month Outer Envelope of four noise contour runs for the highest usage on each runway end.
    - Option 2 - A single run based on an Annual Average
- Base case – Initial noise contour run with standard inputs which all other sensitivity runs are compared to. Inputs are generally consistent with Operative Plan Noise Contours based on 175k scheduled passenger aircraft movements

1.4 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 end splits and peaking factors	MDA, based on historical analysis of runway usage.
Helipad locations	CIAL. Elevations from AIP. Airways NZ for military apron information
Drone information	From drone operator
Tracks and dispersion	Airways NZ as documented by Airbiz in "Volume 4 – Flight Track Assumptions Report"
Track type and specific track allocation	Airways NZ as documented by Airbiz in "Volume 4 – Flight Track Assumptions 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).
Ultimate runway capacity	Runway mode capacities (Airways), annuals (Airbiz)
Annual aircraft schedules	CIAL, including day/night splits, route and aircraft category splits
Aircraft categories and types	CIAL/Airbiz in doc "12609w109c CHC INM Fleet RevC". MDA in aircraft substitutions.
User-defined aircraft noise profiles - calibration	MDA - based on CIAL monitoring data Appropriate AEDT aircraft types selected by noise calibration
Climate change assumptions	Deloitte report and NIWA
Runway maintenance assumptions	CIAL based on historical runway maintenance shift information

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" 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 forms the consensus of opinion in 1991 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 required, 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 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. At Auckland International Airport the original 1995 contours were based on a projection for the year 2030 (35 years ahead at the time). At Wellington International Airport the projections were based on the ultimate runway capacity. At Christchurch Airport they 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 SEL 95 contours from the noisiest frequent night-time aircraft. If the SEL 95 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 SEL contour from an individual aircraft event.

Land Use Planning can be an effective way to minimise population exposure to noise around airports. Aircraft technology and flight management, although an important component in abating noise, will not be sufficient alone to eliminate or adequately control aircraft noise. Uncontrolled development of noise sensitive uses around an airport can unnecessarily expose additional people to high levels of noise and can constrain, by public pressure as a response to noise, the operation of the airport.

3.0 NOISE MODEL

The Aviation Environmental Design Tool (AEDT) is a software program produced by the Federal Aviation Administration (FAA) in the United States. It 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 is no longer supported and will not receive updates of new aircraft types and profiles in the future.

The INM was used for the sensitivity runs as at the time the run times in INM were much faster than the earlier versions of AEDT and more efficient for doing multiple runs. The run time issue has been rectified in later versions of the AEDT and this is why version 3d of the AEDT software has been used for the Updated Noise Contours.

For reference, both noise models use the same underlying algorithms to calculate noise levels and produce the same noise contour outputs.

3.1 Model Calibration

INM and AEDT both contain a database of the noise profiles of common jet, turboprop aircraft and helicopters that can be used in the noise modelling. If an aircraft model is not available in the AEDT, a substitute aircraft can be selected and modelled as a proxy. Aircraft substitutes can also be used to 'calibrate' aircraft against noise measurements by selecting the aircraft that most closely aligns with measured results (this is discussed in detail in Section 3.1 of this report).

Each aircraft has standard arrival, departure and circuit profiles for altitude, thrust and speed that can be selected. For jet departures STANDARD, ICAO A and ICAO B profiles are generally available. Standard profiles are available for arrivals and turboprop operations. The profiles have different settings for altitude, thrust and speed which influence the calculated noise level and can be used to 'calibrate' the noise model to align more closely with measurements.

There are several ways to 'calibrate' the noise model. You can model an aircraft using another substitute if this aligns more closely with the measurements. For example, we model the Boeing 777200 as a Boeing 777300 in the noise model as the model outputs show that the Boeing 777300 profile in the noise model more closely aligns with our measurement results of the Boeing 777200.

Departing aircraft can also be calibrated by altering the departure profiles and stage lengths. For example, we use the ICAO A departure profile for the Boeing 737800 as this more closely aligns with the measured results than the STANDARD or ICAO B departure profile. For the Boeing 737800 departures calibrate much more closely with longer stage lengths and thus a stage length of 3 is changed to 5 in the noise model to improve the model accuracy.

The selected profiles and aircraft types then modify the noise-power-distance (NPD) curves which enable the noise model to calculate the noise level from that operation as received on the ground. The tracks flown, runway used, and the number of movements is used to calculate the overall noise exposure level.

The time of day is also factored in, which allows for consideration of people being more sensitive to aircraft operations at night (10pm to 7am) with a 10-dB penalty being applied to night flights. This method is defined in NZS 6805 and is the accepted method to account for the increased annoyance at night-time.

4.0 SUMMARY OF NOISE CONTOUR RUNS

4.1 Base Case

There are many factors and aspects of airport operations that can alter the size and shape of the noise contours. The aim of the modelling exercise is to determine which factors and assumptions to include in the noise model which will best reflect and provide for future airport growth.

To determine the influence of the various factors on the noise contours at Christchurch Airport, a Base Case was developed which included standard inputs that could then be altered to explore and isolate model inputs through sensitivity runs.

The Base Case is generally consistent with Operative Plan Noise Contours and is based on 175k scheduled passenger movements but used updated runway splits, flight tracks and fleet mix. The Base Case uses Ultimate Capacity Schedule A which includes 175k scheduled movements. This run does not include freight, FBO/small commercial, airline/MRO, Antarctic, military and government or helicopter movements. The Base Case run uses the Future Runway Configuration (with extensions), RNP arrivals and DMAPS tracks in the modelling.

The Base Case uses the runway splits detailed in Table 4 which are based on the average historical runway splits for November to January with a bias to include more movements on Runways 11/29. These runway splits use the same methodology as the Operative Plan Noise Contours enabling comparison. A busy three-month peaking factor of 6% was included in this run along with taxiing, terrain and calibration based on Auckland Airport and Christchurch Airport noise monitoring data.

4.2 Sensitivity runs

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 us to isolate each factor and better understand the makeup of the contours. A list of the sensitivity runs is given below in Section 5.5.2.

4.3 Updated Noise Contours

Once the final set of appropriate model inputs and assumptions was determined, based on input from experts of various disciplines, the Updated Noise Contours were produced. There are two options for the Updated Noise Contours:

- The Outer Envelope future noise contour (Outer Envelope)
- The Annual Average future noise contour (Annual Average)

The Outer Envelope 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.

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. The historical annual average runway splits are used for this run.

The Standard recommends that noise contours are 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. Both options are valid methods of calculating noise contours and this is discussed further in this report.

4.4 Comparison with the Operative Plan Noise Contours

The Updated Noise Contours differ from the Operative Plan Noise Contours in a number of aspects. The Operative contours included 175k scheduled passenger movements (vs 200k Updated) and included an extension to the cross-runway only (Updated includes a main runway extension). The Operative Contours were based on a different flight schedule, fleet mix, flight paths and used an older version of the INM (version 7.0).

A summary of the major differences is given below:

INM Inputs	Operative Plan Noise Contours	Updated Noise Contours
Movement Numbers	175k scheduled passenger 5 freight flights per week	200k scheduled passenger aircraft 11k freight aircraft 15k FBO/small commercial, airline/MRO) (Antarctic/military/govt excluded) 29k Helicopters/drones
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 straight tracks (no DMAPS or RNP)	New technology including DMAPS for departures and RNP arrivals
Taxiing	Doesn't include	Does include
Model version	INM v7.0	INM v7d & AEDT v3d

Of the various changes tabled above, the new flight tracks cause the largest change to 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 Expert Panel flight paths and Updated Flight Paths is given in 'Volume 4 – flight track assumptions pack' and discussed below in section 5.1.3.

Modern aircraft are generally quieter than older models however the updated fleet has a higher proportion of noisier wide-bodied jets and a lower proportion of narrow-bodied jets than what was modelled for the Operative Plan Noise Contours. Very large wide-bodied jets are also included such as the Airbus A380; - these were not included in the Operative Plan Noise Contours. A comparison of the aircraft schedules used for the Expert Panel and Base case noise contours is given in Appendix M.

5.0 SENSITIVITY RUNS

5.1 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 into aircraft movements. All these factors are included in the noise contour runs that are discussed later in this report. This section summarises inputs that go directly into the noise model and includes physical parameters such as runway endpoints, flight tracks and meteorological data. Section 5.2 and Section 5.3 discuss the aircraft schedules and assumptions which relate to how the aircraft movements are allocated to specific runways, tracks, aircraft types and flight profiles. Section 5.4 discusses calibration of the noise model.

Values are given in imperial and metric units unless otherwise stated. Imperial units are required for the US based INM/AEDT noise models.

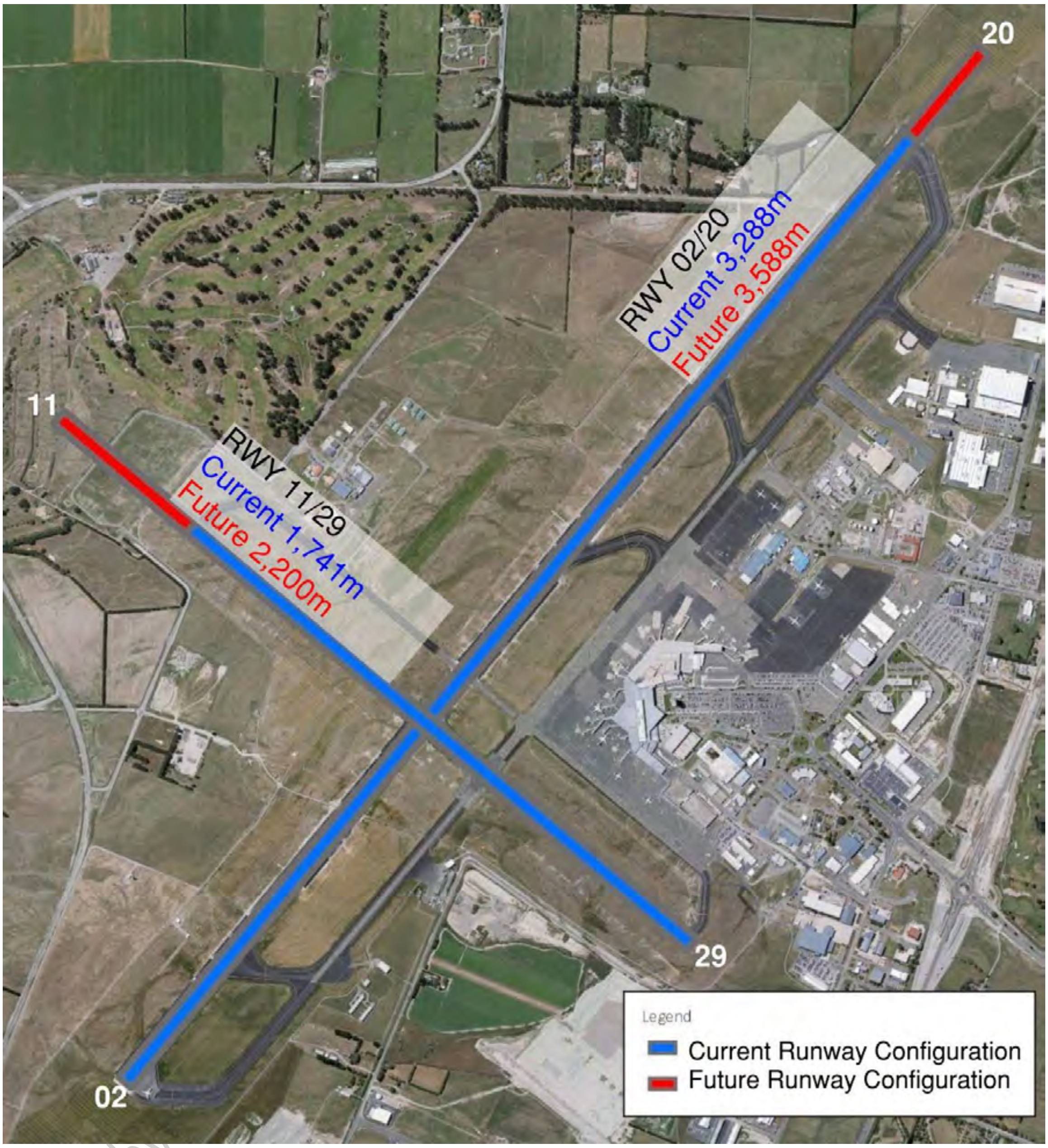
5.1.1 Runway Configurations

Two runway configurations have been input, the 'Current Runway Configuration' and 'Future Runway Configuration'. The Current Runway Configuration includes the runway endpoints, elevations, widths, and thresholds that exist now.

The Future Runway Configuration includes extensions on Runways 11 and 20 as per the airport master plan. It is assumed that the extended runway would be operational well before ultimate runway capacity occurs. Figure 1 shows the runway endpoints, elevations and widths used in the noise modelling. Appendix B1 and B2 give the runway coordinates and lengths.

The Future Runway Configuration was used to calculate the Updated Noise Contours and most sensitivity runs apart from runs 7 and 9 which are before the runway extensions are built.

Figure 1: Runways



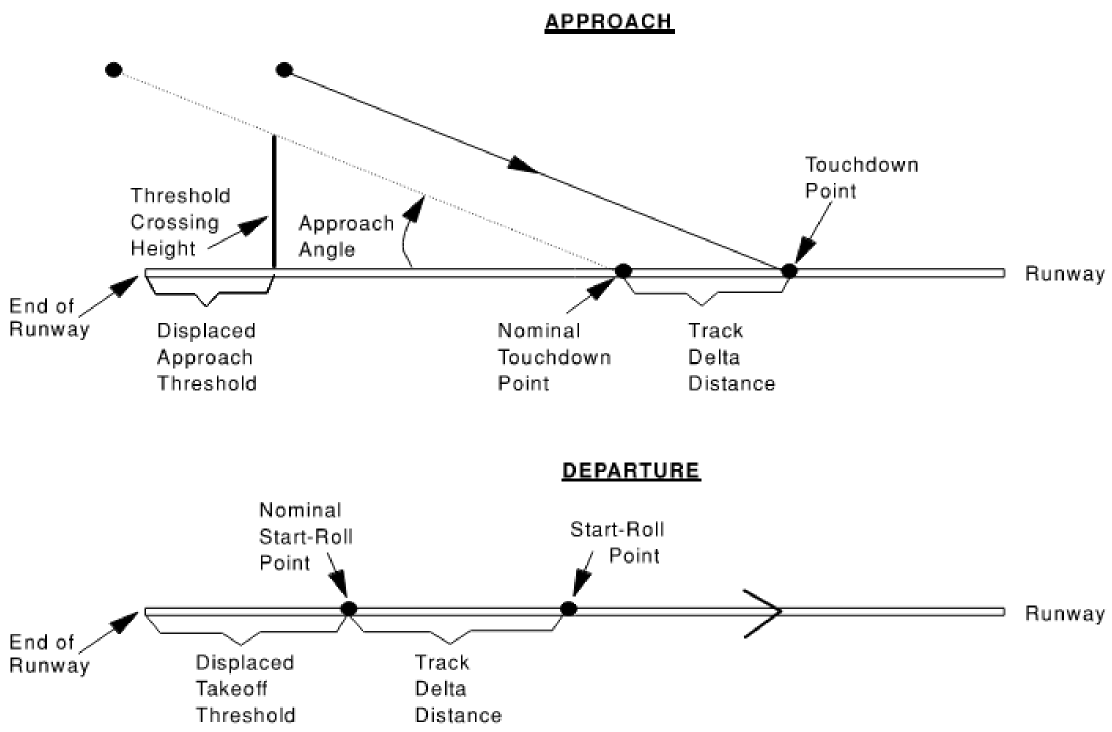
Source: CIAL

5.1.2 Displaced Thresholds

The runway endpoints and widths demarcate the physical size of the runway surface. CIAL has provided us with information on where aircraft depart and arrive on the runway surface which translates to an input named "displaced thresholds" in the Noise Model. Figure 2 shows how displaced thresholds are defined in the Noise Model and descriptions are given below:

- Displaced Approach Threshold: Distance from the end of the runway to the threshold-markings or "piano keys". The "piano keys" are usually near the end of the runway.
- 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

Figure 2: Displaced Take-off and Approach Thresholds



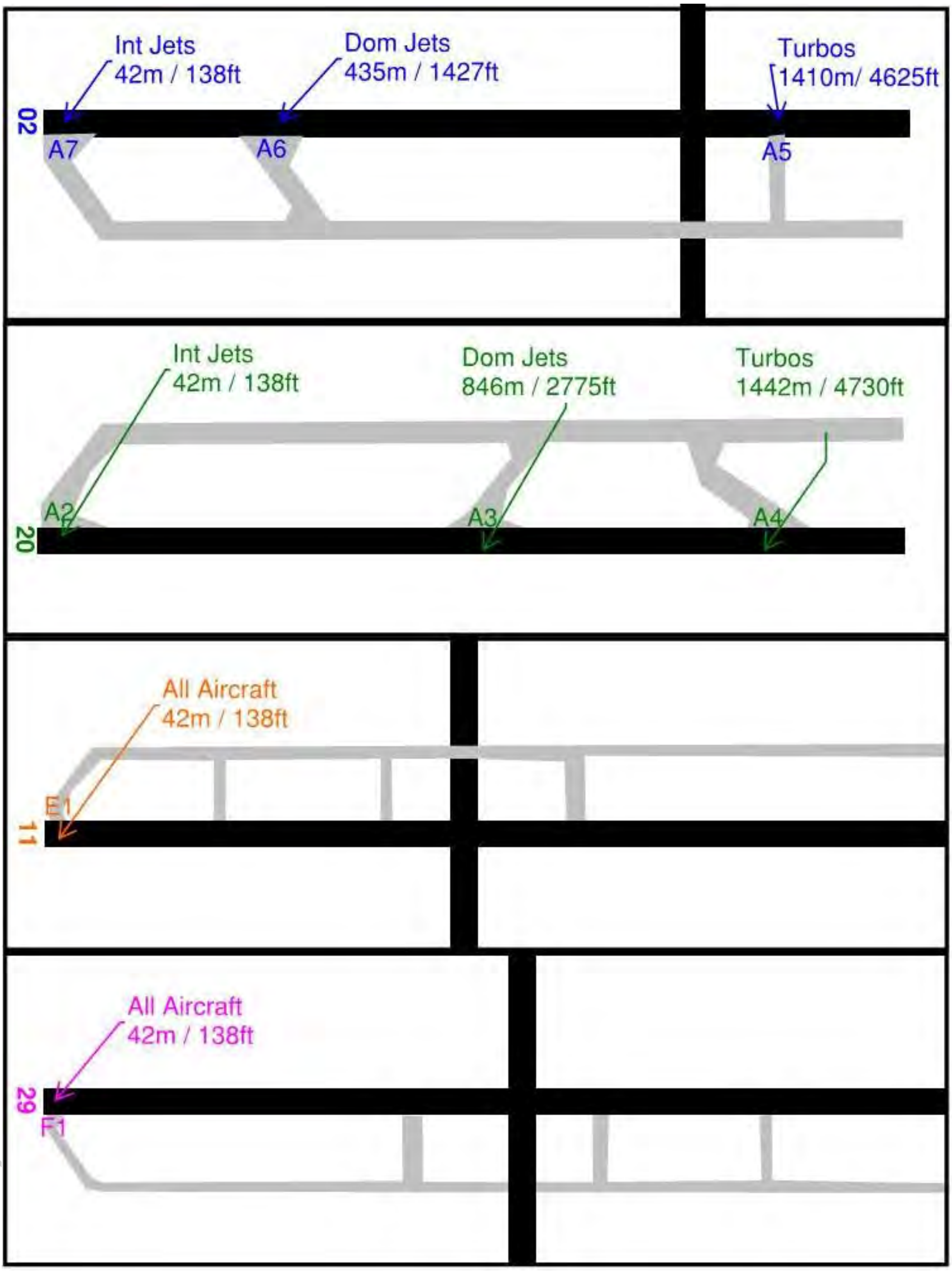
Source: INM Version 7 User Manual

The approach thresholds for all runways are around 6m from the end of the runway. The noise model assumes aircraft cross the threshold markings at 15m (50ft) and touchdown approximately 400m (1300ft) down the runway.

The start of roll has been broken down into international jets, domestic jets and turboprops, as larger aircraft use more of the runway on take-off and thus the start of roll varies. The start of roll for each runway is shown in Figure 3. It is noted that these displaced arrival and departure distances are assumed not to change with the runway extensions and though the names of the taxiways marked may change, the displaced distances have been assumed to be the same for each aircraft category.

Sensitivity run 13 allows for intersection departures on Runway 02 for 30% of domestic narrow-bodied jet departures. The threshold for intersection departures is 100m north of taxiway A5.

Figure 3: Runway Departure Thresholds or the "Start of Roll" Distance (shown on Current Runway Configuration)



5.1.3 Flight Tracks

The flight tracks input into the noise model are detailed in in 'Volume 4 – flight track assumptions pack'. The flight tracks include DMAPS departure tracks (15/15 departures) which came into operation in 2020. DMAPS are departure tracks that turn at approximately a 15-degree angle soon after take-off, instead of flying straight.

The flight tracks also include RNP tracks for arrivals which were implemented in 2018/2019. RNP tracks encompass 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). These tracks generally have less dispersion and spread than the ILS or visual tracks.

A more detailed description of DMAPS departure tracks and RNP approaches can be found in the in 'Volume 4 – flight track assumptions pack'.

The flight tracks evolved slightly during the recontouring project. Some of the earlier sensitivity scenarios used slightly different flight tracks to the final updated flight tracks. We consider the evolution of the flight paths to have no significant effect on the conclusions.

The track dispersion assumptions are given in Appendix E1 and are based on information from the track allocation spreadsheet[1]. The dispersion used was based on the spread seen in the radar tracks and halved to represent less dispersion expected in future. RNP arrivals do not have dispersion.

The percentage of movements assigned to each sub-track are the standard sub-track splits defined in the noise model and varies depending on how many sub-tracks there are. For arrival tracks, the spread is dispersed over five tracks. For the departures, the spread is dispersed over three tracks. The splits for these sub tracks are given in Appendix E2.

5.1.4 Taxiing

Fixed-wing 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 (aircraft use taxiways to move between the runway and the aircraft parking stands) and can adversely affect communities. Therefore, we consider that taxiing falls within the intended purpose of the Standard and should be included in the noise contours.

Early versions of the INM did not facilitate taxiing noise calculations. Although there is still no native function to model fixed-wing taxiing within the AEDT, it is possible to model taxiing effectively with user-defined procedures. 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.

Taxiing operations have been modelled using a user-defined profile in the noise model and overflight procedures.

Three aircraft profiles have been used to represent taxiing across all aircraft types as follows:

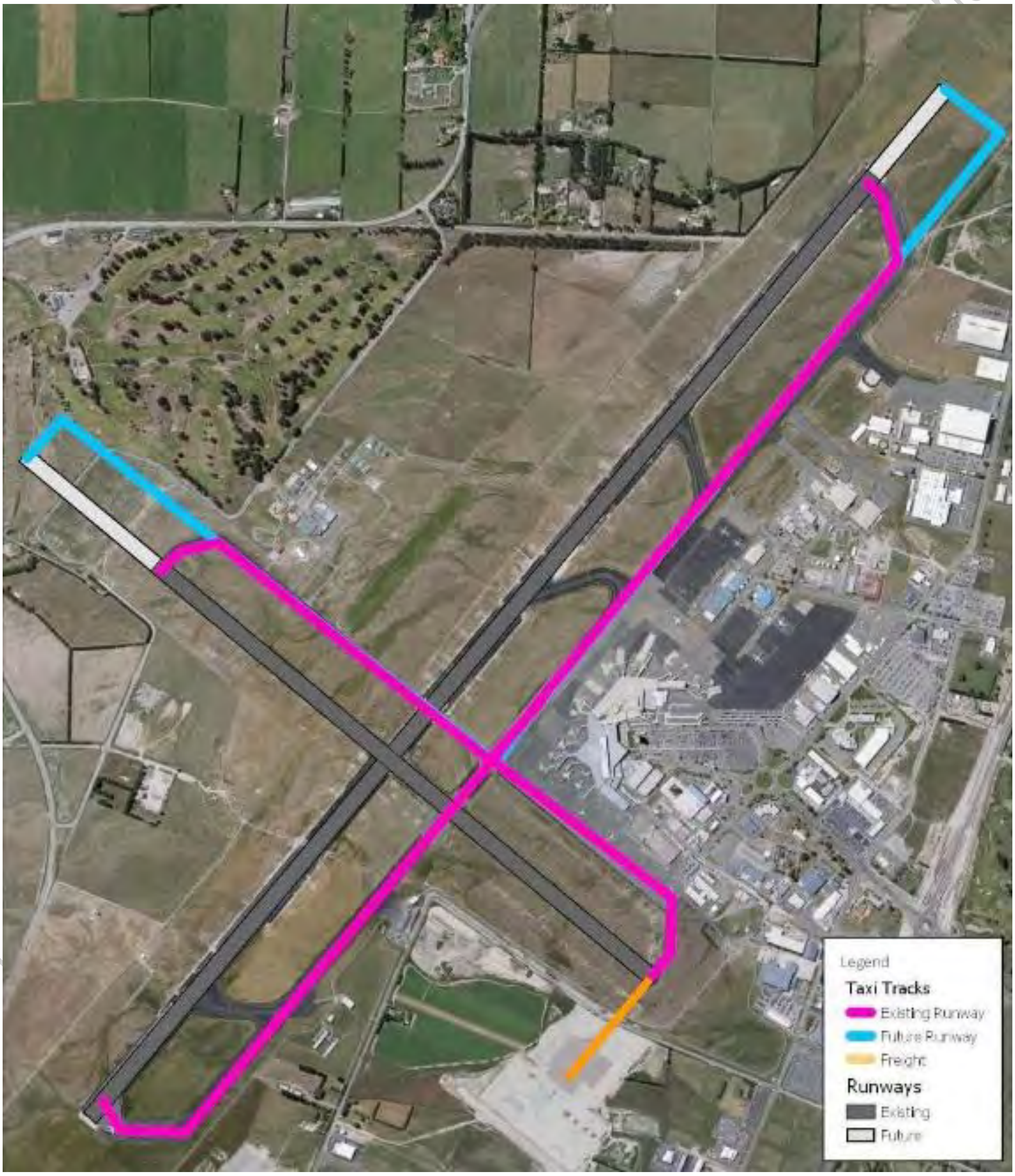
- Boeing 777200 – used for all wide-bodied jets
- Airbus A320 – used for all other jets (737800 used in scenarios where A320s changed to 737)
- ATR 72 (using Dornier 328 as a substitute) – used for all propeller aircraft

[1] 12609w301j CHC Tracks Allocation

The Boeing 777200 and ATR72 taxiing has been verified with measurements and show a good correlation between the measured and modelled values. The Airbus A320 overpredicts in the noise model and thus the movement numbers have been reduced to calibrate the noise levels. The user-defined profiles assume that aircraft are at 10% thrust when taxiing using the approach profile in the noise model. Other assumptions in the profile are given in Appendix H.

The assumed taxi tracks are shown in Figure 4 and originate from the main terminal for scheduled, FBO/small commercial, airline/MRO, Antarctic, military and government aircraft and from the freight hub for freight aircraft. Taxiing tracks for arrivals and departures have been assumed to be the same for simplicity.

Figure 4: Taxi Tracks (pink = Current Taxi Tracks, blue = Updated Taxi Tracks, orange = Freight Taxi Tracks)



5.1.5 Helipads

Appendix B3 shows the helipad coordinates and elevations provided for the Garden City, Heli Centre and military apron helipads along with the arrival and departure locations of military helicopters that depart from the main runway. Figure 5 shows a map of the helipad locations.

Figure 5: Helipads

Helicopter taxiing does not occur for the commercial helicopter operations (Garden City Helicopters and HeliCentre) as they take-off directly from the site. It is understood that taxiing would occur for a small number of military helicopters departing from the main runway surface that would need to taxi from the military apron to the take-off/landing location on the main runway. We have not modelled helicopter taxiing for these operations as they would make no difference to the noise contours. Military helicopters are also not included in the Updated Noise Contours.

5.1.6 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.

5.1.7 Meteorological Data & Atmospheric Absorption

Atmospheric Absorption Settings

Meteorological conditions influence the atmospheric absorption of noise over distance and the performance of aircraft. AEDT and INM both allow 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 AEDT includes access to all three atmospheric absorption calculation methods whereas the INM only includes access to SAE-AIR-1845 and SAE-ARP-866A. The atmospheric absorption module used in the sensitivity runs and in the Updated Noise Contours was SAE ARP 866A. This is the module recommended by the Federal Aviation Administration.

SAE ARP 5534 2013 is a more recent module which is being investigated by the FAA as a replacement of SAE ARP 866A. We understand this investigation has not been completed yet and that SAE ARP 866A should be used as the default until this investigation is completed.

Meteorological Data

The meteorological conditions (temperature, pressure, humidity, headwind) input into the noise model varied between runs. Different data was used for the sensitivity runs and 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.

The three-month periods Nov-Jan, Apr-Jun, Sep-Nov were chosen to represent the busiest periods on each runway (02/20/11/19) based on historical aircraft movement data. The meteorological data from 2009-2019 (ten year) was analysed to determine the historical average temperature, humidity, wind speed and pressure which was then input into the noise model.

Appendix I1 shows the different meteorological conditions used for various sensitivity runs. For most of the sensitivity runs the meteorological data in the first column representing November to January was used as this generally represents the busiest period at the airport. For sensitivity runs 4a, 4b, 4c and 4d the meteorological data specific to each runway end was used. These values are shown in the last three columns.

5.1.8 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[2] 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 the cross-runway 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[3] for Christchurch Airport regarding the effects of climate change in Christchurch. This reported slightly lesser increases in temperature and windy days. The mean temperature was predicted to increase by about 1 degree at 2040 and 3 degrees at 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 through three sensitivity runs. Run 14 and 14a account for the increase in north-westerly winds and cross-runway movements are multiplied by a factor of 1.10 for run 14 and 1.05 for run 14a to represent an increase in north westerly winds due to climate change by 10% and 5% respectively. Run 15 increases the input temperature in the noise model by 3 degrees Celsius.

5.1.9 Contour Grid Settings

The AEDT and INM use algorithms to calculate the noise level received at individual grid points and then interpolate noise contours between these grid points. There are two types of grid settings available in AEDT, regular grids and dynamic grids. Regular grids calculate the noise at receptor points within a specified area at a given grid spacing. Dynamic grids start with a small grid at a central point and move outwards until a certain noise level is reached. Dynamic grids are a replacement of recursive grids used in INM and are generally preferable to linear grids as these methods provide more resolution where it is needed.

A dynamic grid was used to calculate the Updated Noise Contours in the AEDT. For the sensitivity runs in the INM, a recursive grid was used (similar to a dynamic grid). The grid settings for both were:

- Refinement number: 10
  Used to control the size of the smallest contouring grid in dynamic grid processing
- Refine tolerance: 0.1
  The threshold value (in decibels) for the difference between the noise value and the noise value of the linear fit between the neighbouring points. If the absolute value of the difference is above the tolerance, the grid is divided in half (refined) and noise is evaluated at those new (intermediate) points
- Dynamic grid algorithm: Linear INM Legacy
  The algorithm for a first-order fit (the difference between the noise value at a grid point and the noise value of a linear fit between two neighbours of the same grid point)

[2] Climate Change Projections for New Zealand Atmospheric projections based on simulations undertaken for the IPCC 5th Assessment 2nd edition, 2018

[3] Deloitte Report – Christchurch International Airport Physical Climate Modelling – 18 June 2021

5.2 Modelling Inputs - Operational

5.2.1 Aircraft Movement Schedules

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'.

Two ultimate runway capacity movement schedules and one interim schedule have been provided and are described below. These are referred to as the "Average Daily Movement Tables" in 'Volume 3 – Air Traffic Projection Report'.

Interim schedule - represents an interim year before capacity is reached and when the current shorter runways are used with the current fleet mix. It was used to investigate the effect of having the current fleet still running. This included 90k scheduled passenger movements (123k fixed wing movements – no helicopters)

Ultimate Runway Capacity Schedule "A" - this schedule represents ultimate runway capacity at approximately 175k scheduled passenger movements (213k fixed wing movements with 26k helicopter movements).

Ultimate Runway Capacity Schedule "B" - this schedule represents ultimate runway capacity at approximately 200k scheduled passenger aircraft movements (232k fixed wing movements with 29k helicopter movement). It includes half the number of FBO/small commercial movements as these are displaced by a larger number of scheduled passenger movements.

Schedule "A" contains 175k scheduled passenger aircraft movements which was used for the initial sensitivity runs. This aligned with the Expert Panel runway capacity assumption. Schedule "B" contains 200k scheduled passenger aircraft movements as recommended in this update and was used for the Updated Noise Contours. Movement numbers for other traffic segments were also provided for each schedule.

For Schedule "B" it is assumed that as the airport approaches ultimate runway capacity, scheduled passenger aircraft movements would be given preference as available runway slots become constrained. This leads to reducing 50% of the movements available to FBO/small commercial movements to allow additional schedule passenger aircraft movements.

For Schedule "A" preference is not given to scheduled passenger movements and a higher number of FBO/small commercial movements remain, offset by a lower number of scheduled passenger movements. An interim schedule is also provided to model the effect on the noise contours of using the current shorter runway and the current fleet which contains older noisier aircraft models.

'Volume 3 – Air Traffic Projection Report' includes discussion about the pre-COVID forecasts prepared by CIAL in 2019 and update in 2021 with the post-COVID recovery forecasts, on which the schedules used for noise modelling are based.

The aircraft movement schedules were broken down into separate traffic segments as summarised in Table 2 below. These included fixed wing and helicopter/drone movements. For fixed wing we were provided with movement numbers for scheduled passenger, freight and Airline/MRO, FBO/small commercial, Antarctic, government and military movements.

A general aviation schedule was provided but has not been used in any of the runs as it is assumed that as the airport reaches capacity, general aviation movements would be accommodated at another airport.

Sensitivity runs looked at the effect of including certain traffic segments. Sensitivity run #6 included helicopter movements. Sensitivity run #16 included freight and non-scheduled movements.

Table 2: Aircraft Annual Movement Schedules by Market Segment

Annual Movements	Fixed Wing						Helicopters
	Scheduled Passenger	Freight	Airline/MRO	FBO/Small Commercial	Antarctic Military Government	General Aviation	
Interim schedule	98k	5k	3k	12k	5k	Not included	18k
Ultimate Runway Capacity Schedule "A"	175k	10k	5k	18k	5k	Not included	26k
Ultimate Runway Capacity Schedule "B"	200k	11k	5k	10k*	6k	Not included	29k

**Schedule "B" includes half the number of FBO/small commercial movements as these are displaced by a larger number of scheduled passenger movements (as are GA).*

5.2.2 Busy three-months Peaking Factor

The aircraft movement schedules described in Section 5.2.1 contain flight numbers for an entire year. Most of the noise contour runs represent the busiest three-months. Therefore, we must factor up the movement numbers given to represent the 'busy three month' period

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.

For the sensitivity runs we used a peaking factor of 1.06 for all fixed wing movements. This peaking factor was determined by calculating peaking factors for each three-month period between 1999-2017[4]for all aircraft operations (scheduled, freight FBO/small commercial, airline/MRO, Antarctic, military and government) and then choosing the highest peaking factor that occurred in that period. For the sensitivity runs we used the same peaking factor for all fixed wing categories. Peaking factors were not applied to helicopters or drones.

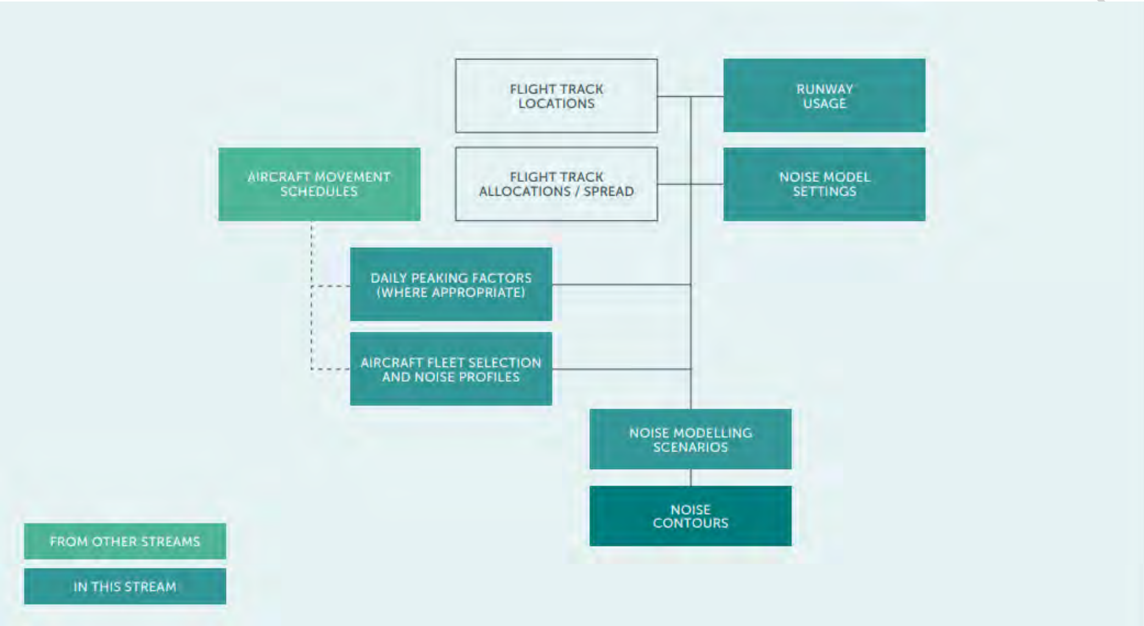
[4] Gap in the data from 2008-2013. Freight data only available from 2000-2007. Helicopter data only available from 2015-2019.

5.3 Modelling Inputs - Allocation of Schedules

This section describes how the aircraft movement schedules (which includes movement numbers by sector, aircraft category and time of day) are allocated to specific runways, tracks, aircraft types and flight profiles.

Figure 6 shows the inputs to the noise modelling. There are often multiple options for each input. For instance, we have multiple runway splits that we have used in the sensitivity runs (see Section 5.3.1). Section 6.2 describes the inputs used for the Updated Noise Contours.

Figure 6: Noise Model Inputs



5.3.1 Runway Usage Splits

This section describes the runway usage splits used for the various noise contour runs – that is, the proportion of traffic which uses each of the four runway ends. The 02 and 20 runways are the runways used most regularly, with runways 11 and 29 being used in strong crosswind conditions. More detailed runway splits are given in Appendix C including separate runway splits for arrivals and departures and for Wide Bodied jets which cannot use the cross-runway.

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. For all scenarios we have assumed that there are no departures on runway 11 as they are extremely rare and thus do not make a difference to the noise contours.

The runway splits given in this and later sections give the overall runway splits assumed and are not broken down into the specific runway splits for different aircraft types or operations. More detailed runway splits are given in Appendix C and reflect the fact that departures have not been allocated to runway 11. It also gives the runway splits for wide bodied jets which cannot use the cross-runway at all.

There are seven different runway splits used for various sensitivity runs. These are described in more detail below:

#1 - Historical Average November to January

We calculated the runway splits for November to January for each year between 1999-2017. The November to January period was chosen as it is generally the busiest period at the airport. The historical average for the November to January is given in Table 3 below. These runway splits were used for Run 3c which considered the effect of not including a bias on the Cross-runway.

Table 3: Historical Average Nov-Jan

Runway 02	Runway 20	Runway 11	Runway 29	Total
60%	33%	1%	6%	100%

#2 - Historical Average November to January + Factoring up Cross-runway Usage

The usage of the cross-runway fluctuates seasonally and is tied to the occurrence of north-westerly wind conditions (most common in the spring and summer months). Higher usage of runway 11/29 increases the noise exposure of the cross-runway. Modelled noise contours need to account appropriately for this seasonal variation which could occur again in future.

Most of the sensitivity runs factor up movements on the cross-runway (as per Table 4) to account for higher usage of Runways 11/29 that can occur seasonally. This methodology was used for the Operative Plan Noise Contours.

The historical average runway usage for Runway 11 and Runway 29 over a three-month period is 1% and 6%, respectively. However, the highest recorded runway usage over a three-month period was 5% and 13% for Runway 11 & 29 respectively. To account for this seasonal increase in cross-runway usage, 5% of total movements were assigned to Runway 11 and 13% to Runway 29 movements. The runway splits for the main runway are left the same.

Table 4: Historical Average Nov-Jan + Cross-runway Movements Factored Up

Runway 02	Runway 20	Runway 11	Runway 29	Total
60%	33%	5%	13%	~~100~~111%

The percentages in Table 4 add up to more than 100% as a result. If we have for example 100k aircraft arrivals, the resultant numbers that use Runway 29 would be 6k for the average runway usage of 6% and 13k for the factored-up runway usage of 13%. The number of movements on Runway 02/20 remains the same. This approach was adopted by the Expert Panel for the Operative Noise Contours.

#3 - Historical Average November to January + Factoring up Cross-runway Usage + Climate Change

Sensitivity run 14 and 14a account for the increase in north-westerly winds and cross-runway usage due to climate change. The movements on the cross-runway are multiplied by a factor of 1.10 for run 14 and 1.05 for run 14a to represent an increase in north westerly winds due to climate change by 10% and 5% respectively. The increase in north-west winds due to climate change is detailed in Section 5.1.8. The runway splits for these sensitivity runs are given in Table 5.

Table 5: Historical Average Nov-Jan + Cross-runway Movements Factored Up + Climate Change

Runway 02	Runway 20	Runway 11	Runway 29	Total
60%	33%	5.5% (10% change) 5.3% (5% change)	14.3% (10% change) 13.7% (5% change)	~~100~~113% 112%

#4 to #7 Highest Runway Usage Each Runway End

We calculated the runway splits for each three-month period from 1999-2017 to find the highest recorded usage of each runway end. We wanted to see how much this differed from the historical average runway splits given above and whether using the highest three-month runway split on each runway end as opposed to the historical three-months average would make a different to the size of the noise contours.

They were as follows.

- Runway 02 – used 72% of the time - November to January 2006
- Runway 20 – used 42% of the time - April to June 2007
- Runway 11 – used 5% of the time - September to November 2011
- Runway 29 – used 13% of the time - September to November 2005

We used the runway splits from these periods to calculate noise contour runs 4a, b, c, d. The runway usage for each period is given below.

Table 6: Highest Usage Each Runway End

Highest Usage of	Runway 02	Runway 20	Runway 11	Runway 29	Total
RW02	**72%**	24%	0%	4%	100%
RW20	53%	**42%**	0%	4%	100%
RW11	37%	54%	**5%**	3%	100%
RW20	57%	30%	0%	**13%**	100%

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 6 do not represent outliers in the data. The exception to this is the usage of 5% on RW11 which was later found to be based on anomalous data in 2011. The 2011 data has been excluded from the reanalysis completed for the Updated Noise Contours as a result.

All aircraft have been allocated to use the main and cross-runway apart from long-haul wide-bodied jets which cannot operationally use the cross-runway.

5.3.2 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 3 moth summer period. For these nights all aircraft (excluding wide body jets) use the cross-runway.

Sensitivity run #21 considers the effect of runway maintenance on the size and shape of the noise contours. It assumes 14 nights out of a three-month period are affected by runway maintenance. For these nights aircraft (excluding wide bodied jets) were moved to the cross-runway.

Runway maintenance for larger capital works projects such as future construction of the runway extensions have 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 in an exclusion.

5.3.3 Flight Track Allocation

The flight track allocation used is described in this section. Flight Tracks were allocated as shown in Figure 7. The track splits used to allocate the broad categories (ILS/Visual/RNP) for arrivals are given in 'Volume 4 – Flight Track assumptions report'. The track splits used to allocate specific tracks for arrivals and departures are also documented here. Helicopter Tracks are discussed in Section 5.3.7.

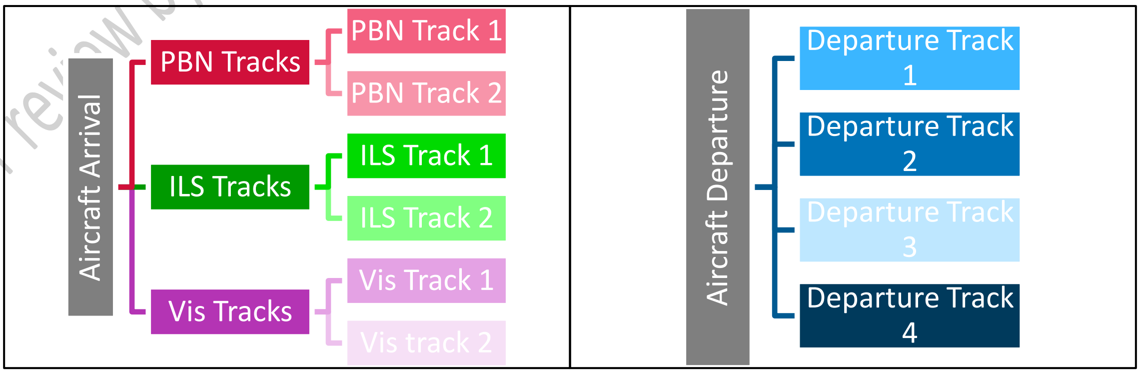
For arrivals, the movements were split out into broad track types which include ILS approaches, visual approaches and RNP approaches and then split into specific tracks. These allocations are summarised in 'Volume 4 – Flight Track assumptions report'.

Departures all fly on the same type of track and thus were split into the specific tracks available. The derivation of these is described in more detail in 'Volume 4 – Flight Track assumptions report'.

The flight tracks evolved slightly during the recontouring project. Some of the earlier sensitivity scenarios used slightly different flight track allocations to the final updated flight tracks. We consider the evolution of the flight paths to have no significant effect on the conclusions.

The track splits used to allocate the broad categories (ILS/Visual/RNP) for arrivals are given in 'Volume 4 – Flight Track assumptions report'. The tracks splits used to allocate specific tracks for arrivals and departures are also documented in 'Volume 4 – Flight Track assumptions report'. Helicopter tracks are discussed in Section 5.3.7.

Figure 7: Track Allocations



5.3.4 Aircraft Types and Substitutions

The aircraft type allocation is described in this section. The modelling considers the current aircraft fleet, and the anticipated future aircraft fleet for users of the airport. The schedules described in 'Volume 3 – Air Traffic Projection Report' provides information structured in broad aircraft categories related to seating capacity and range capability to serve origin/destination airports and with indicative representative aircraft models for these broad categories. A summary of the aircraft types used is given in Appendix F.

Airbiz provided information on what percentage of movements could be assigned to each representative aircraft model for the Current and Future Fleet. The Future Fleet contains aircraft that are anticipated in the future airline fleets such as the Airbus A320 Neo, Boeing 737max and Boeing 797 whilst the Current fleet is aircraft used at the moment. The specific aircraft models are in Appendix L.

The Boeing 797 is intended to be a replacement for the B767 - small wide-body with medium-haul range. Boeing has been doing market testing, prior to commitment to design and build, noting the B767 is no longer in production. More information of the Boeing 797 is included in 'Volume 3 – Air Traffic Projection Report'.

The upgrade of freight aircraft in operators' fleet has historically been slower than the change-over for scheduled airline passenger aircraft, hence the current fleet is used for freight.

5.3.5 Origins and Destinations

The origins and destinations used to allocate the aircraft movement schedules to specific stage lengths is described in this section. The origins and destinations provided in the schedule were used to calculate the stage length to be used in the noise model. A stage length represents the distance a departing aircraft is travelling. Common stage lengths by region are given below:

- 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

The idea behind using stage lengths is that the longer the trip, the heavier the take-off weight due to increased fuel load, the greater time and distance along the flight path before a given altitude is reached (shallower departure profile) and the more noise produced by the aircraft. Appendix N gives the stage lengths used for each destination. Helicopter destinations are in Section 5.3.7.

Some aircraft do not have Stages 8 or 9 available in the noise model reflecting the range limit of the aircraft used. 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.

5.3.6 Aircraft Profiles

The altitude profiles available in the noise model assume a step-down approach with a set altitude, speed and thrust setting. It is also possible to add user-defined profiles to the noise model and this was considered for the RNP tracks which use a continuous descent profile. Investigation of flight tracks revealed that within 10 nautical miles of the airport, both RNP and non-RNP arrivals are on continuous descent and that a user-defined continuous descent profile was not needed.

A comparison of the noise model departure profiles and actual departure profiles at the airport showed the actual departure profiles were similar to those in the noise model. Because of the consistency between the preset profiles in the noise model and real-world results it was decided to use the preset departure profiles in the noise model rather than creating user-defined profiles. This is discussed further in 'Volume 4 – Flight track assumptions report'.

5.3.7 Helicopters

The helipad and flight track allocations are described in this section along with calibration information for helicopters. A schedule was provided with information regarding the number of movements on each helipad by helicopter type and time of day. The movements were split into the specific tracks as shown in Appendix G1.

The schedule also provided helicopter types also shown in Appendix G2. Not all the helicopter models are available in the noise model and for these models substitutes were chosen based on helicopter size and engine specification. These underlined in the table.

Over time MDA has built up a database of helicopter noise measurements. These measurements were compared to the noise model to determine any difference between the measured and modelled noise levels. If any discrepancy was found, the number of movements was factored up or down to alter the resultant noise output to match what was measured.

Appendix J2 shows which out of the eight substitutes used in the noise modelling has measurement information, whether there was a discrepancy between the measured and modelled noise values and what calibration was performed to account for this difference. For helicopter models where no measurement information was available, the default noise outputs in the noise model were assumed and no calibration was performed. The origin/destination of helicopters is domestic and stage lengths of 1 were assumed.

5.3.8 Drones

Potential for use of drones at Christchurch Airport was investigated, but the information available at this time is limited and uncertain. There is also uncertainty around the noise levels of drone operations, we currently do not have any noise measurements. For completeness we have included a sensitivity run (#20) which attempted to model drone movements based on the best information available at the time. However, drone movements have been excluded from the Updated Noise Contours.

A possible future drone schedule was provided which included a range of drone movements from 4 to 120 per day. The worst case of 120 movements per day was used. Appendix B4 shows possible drone take off/landing area coordinates and elevations provided by the drone operator. The movements were modelled on indicative tracks provided by a drone operator.

We do not have measurement information for drones, but we have assumed they are likely to be quieter than helicopters. To provide a conservative approach the drones were modelled in the INM as a Robinson R22, the smallest helicopter in the noise model.

5.4 Calibration of Noise Model

As with any modelling software, there is generally a difference between what is modelled and what is measured on the ground. It is best practise in New Zealand to verify a noise model with measurements and adjust the inputs or assumptions better match with the measured noise levels. There are several ways to 'calibrate' the noise model, these are detailed below.

5.4.1 Noise Measurements

Noise measurements of individual aircraft events were undertaken at Auckland and Christchurch Airports. Auckland Airport has three permanent noise monitors at Puhinui School, the Manukau Velodrome and Prices Road. The noise monitor at the Velodrome is located under the extended runway centreline. The Puhinui School and Prices Road noise monitors are located to the north and south of the extended runway centreline.

Noise data from these monitors for the year 2018 was analysed in a bespoke piece of software. Thirty to forty thousand aircraft noise events were extracted from each noise monitor. Around twenty thousand of these noise events related to specific jet aircraft types in the flight schedule for Christchurch Airport. The remainder were turboprops and other jets which we did not use in our analysis.

Additional data for the Airbus A320neo from 2019 was also added. This aircraft had only just started flying into Auckland Airport in 2018 so the 2019 data was added to bolster the sample size for this specific aircraft.

For Christchurch Airport two temporary noise monitors was deployed from October to December 2019. One was located to the north of the Airport on Shipley's Road. The other was located to the south of the Airport near Ryans Road. Both were underneath the extended runway centreline.

Noise data from these two monitors was analysed in a bespoke piece of software and around five thousand aircraft noise events were extracted from each noise monitor. Around three thousand of these noise events related to the specific jet aircraft types in the flight schedule for Christchurch Airport. The remainder were turboprops and other jets which we did not use in our analysis.

Both the Auckland and Christchurch data was analysed to extract the average SEL at each noise monitor for a specific aircraft type/operation/stage length. For example, an Airbus A320 arrival flying Trans-Tasman with a stage length of 3 or a Boeing 787 departure flying to North America with a stage length of 9. This data was then compared to the modelled noise levels as described in more detail below.

5.4.2 Measured vs Modelled

A comparison was undertaken between the modelled noise level and thousands of noise levels measured on the ground for aircraft operations at Auckland and Christchurch Airports as described above.

The average SEL noise level of operations with a specific aircraft type/operation/stage length combination was calculated from the noise monitoring data and compared with the noise model. This information was used to determine which aircraft were being modelled accurately and which aircraft required use of a substitute to more closely align with the measurements.

For example, we model the Boeing 777200 as a Boeing 777300 in the noise model as the model more closely aligns with our measurement results. Appendix J gives the equivalents used in the noise model for each aircraft model and other calibration details.

Departing aircraft can also be calibrated in the modelling software by altering the departure profiles and stage lengths. For example, we use the ICAO A departure profile for the Boeing

737800 as this more closely aligns with the measured results than the STANDARD or ICAO B departure profiles.

Also, Boeing 737800 departures calibrate much more closely with longer stage lengths and thus a stage length of 3 is changed to 5 in the noise model to improve the model accuracy.

The changes made are summarised in Appendix J. Helicopters were also calibrated in the noise model in a slightly different way. This is discussed in more detail in Section 5.3.7.

For aircraft that do not exist yet, such as the Boeing 797, a similar sized aircraft is chosen. In this case it was the Boeing 787 which is modelled as a Boeing 777200 in INM for departures.

The Boeing 797 is a replacement for the B767. 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.

An example of the various options looked at for the Boeing 787900 calibration is given in Appendix J3. For arrivals the Boeing 787 substitute in INM (7878R) shows good agreement with the measured data. We also investigated the Boeing 777200 substitute (777200), but this was too noisy for arrivals.

For the departures we also investigated the Boeing 787 and 777200 substitutes in INM. In this case the Boeing 787 substitute (7878rR) was too quiet (by about 3dB), and the Boeing 777200 substitute (777200) showed better agreement, so we now model 787 departures as 777200s.

5.5 Noise Contour Runs

There are two valid options for the "Updated Noise Contours". Options one is termed the Outer Envelope and is the outer extent of four scenarios which represent the busiest usage on each runway end to account for seasonal variability. Option 2 is the Annual Average future noise contour and is based on noise emissions for an entire year.

The Standard 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. Both options are valid methods of calculating noise contours.

Several sensitivity runs were undertaken prior to running the Updated Noise Contours to determine the effect of various inputs and assumptions on the noise contours. A "Base Case" noise contour was run first, and the sensitivity runs made alterations to the Base Case to determine the extent of any changes to the noise contours when a specific assumption was changed.

Section 5.5.1 describes the Base Case run in detail in terms of the inputs and assumptions. Section 5.5.2 describes the sensitivity runs undertaken and highlights how each run differs from the Base Case and the resultant influence on the size and shape of the noise contours. It also provides a recommendation for each sensitivity run on whether it should be included in the Updated Noise Contours.

Each sensitivity run includes scheduled passenger aircraft movements for either the interim schedule or one of the ultimate runway capacity schedules. Some sensitivity runs add helicopter or freight movements on top of this. Other runs may alter the runway usage, aircraft types or tracks used or parameters in the noise model such a temperature.

The data inputs used for the Sensitivity Runs are described in more detail in Section 5.5.2. The data inputs used for the Updated Noise Contours are described in more detail in Section 6.0.

5.5.1 Base Case

There are many factors that can alter the size and shape of the noise contours including the tracks and runways used, fleet mix, runway usage and other factors. To determine the influence of these factors on the noise contours at Christchurch Airport, a Base Case was developed which included standard inputs that could then be explored through sensitivity runs. Compared to the Base Case, the sensitivity run would determine the significance of changes in relation to the size and shape of the noise contours. As explained in Section 3.0 the INM has been used to calculate all sensitivity runs with the AEDT used to calculate the Updated Noise Contours.

The Base Case uses the runway capacity assumption of 175k scheduled passenger aircraft movements. This was also used in the Operative Plan Noise Contours. This run does not include freight, FBO/small commercial, airline/MRO, Antarctic, military and government or helicopter movements. The Base Case run uses the Future Runway Configuration (with extensions), Updated Flight Tracks and the Future Fleet (with A320 Neos / 737 max) in the modelling.

The Base Case uses the runway splits detailed in Table 4 which factor up movements on the cross-runway to account for higher usage of Runways 11/29 that can occur seasonally. This is the same methodology as the Operative Plan Noise Contours enabling comparison. A busy three-month peaking factor of 6% was included in this run along with taxiing, terrain and calibration based on noise monitoring data.

5.5.2 Sensitivity Runs

Several Sensitivity Runs were determined for exploration based on the main factors relevant to airport operations and to isolate the various modelling assumptions. A list of Sensitivity Runs was finalised in mid-2019 and has been updated on several occasions to include further runs as required.

A description of each sensitivity run is given below. Table 7 provides a summary of each sensitivity run and how it differs from the Base Case inputs. A column is included for a recommendation on whether the sensitivity run should be included in the Updated Noise Contours. Maps of the different sensitivity runs can be found in Appendix O.

<u>3b – Base Case without DMAPS</u>
This sensitivity run investigates the influence of using straight departure tracks (which were in use in 2019 but have since been replaced with the DMAPS flight paths) in the noise modelling as opposed to the updated tracks used in the Base Case which include DMAPS.

The resultant noise contour is a different shape to the Base Case. A retraction in the noise contour to the north-west and south-west occurs where the DMAPS tracks fly.

<u>3c – Base Case without cross-runway movements factored up</u>
The Operative Plan Noise Contours factored up movements on the cross-runway to account for seasonal bias. This same methodology was used for the Base Case. Run 3c removes this factor resulting in a lesser number of movements on the cross-runway. The resultant noise contour is smaller for the cross-runway.

<u>4a/4b/4c/4d - Highest Usage Each Runway End</u>
These four runs investigate the influence of using the highest recorded runway splits on each runway end (02/20/11/29). It is an alternative method to account for seasonal runway bias and rather than factoring up the movements on the cross-runway (as per Base Case/Operative Plan), the highest recorded usage on runways 11 and 29 are modelled, along with the highest usage on runway 02/20 (which as not accounted for last time). The outer extent of these four noise contours is taken to form the noise contour.

The outer extent of these four noise contours extends beyond the Base Case for the main runway contour. This is because the Base Case did not include a seasonal runway bias for the main runway. For the cross-runway the noise contours are a similar size to the Base Case as a seasonal runway bias was already included by a different method as explained above.

<u>6 – Base Case with Helicopters</u>
The Base Case only includes 175k scheduled passenger movements. This sensitivity run was used to test the influence on the noise contours of adding helicopter movements. The noise contours expand slightly where the tracks intersect with the 50/55 L_{dn} noise contours.

<u>7 – 2018 Schedule scaled up to 2020</u>
This run was a very early run completed before DMAPS came into operation. It investigated the effect of non DMAPS departures on the noise contours. This run is now obsolete as DMAPS are now operational.

<u>8a/8b - Base Case with Airbus A320Neos aircraft replaced by Boeing 737max</u>
Scenarios 8a and 8b were run to investigate the effect of Air New Zealand changing their primary aircraft provider from Airbus to Boeing. This would mean that A320neos could be replaced by Boeing 737max. Scenario 8a investigated the effect of replacing 100% of the fleet and Scenario 8b investigated replacing only 50% of the fleet.

The Boeing 737max is noisier than the Airbus A320Neo and the noise contours expand by 1-3 dB depending on whether 50% or 100% of the fleet is replaced.

8c – Base Case with Airbus A380's replaced by Boeing 777x

This run investigated the effect of international aircraft carriers moving away from use of the Airbus A380 in preference for the Boeing 777x. Scenario 8c investigated the effect of replacing 100% of the fleet.

The Airbus A380 and Boeing 777x are assumed to have a similar noise profile and thus no discernible change was observed in the noise contours.

9 – Interim Schedule run with current airfield and fleet

This run was based on an interim flight schedule and was intended to investigate the extent of an interim noise contour. Although the interim year has a smaller number of aircraft movements forecast than at ultimate runway capacity, it uses the current fleet which is slightly noisier that the future fleet. It was thought that the interim noise contour may be larger in certain areas due to this.

This was not the case and the 65 L_{dn} contour for run #9 sits within the 65 L_{dn} contour for the Base Case.

9b – Runway 11/29 moved south

Run 9b investigated the impact of moving the cross-runway south by 22.5m. This was to provide Code E taxiway separation between Runway 11/29 and Taxiway F which is identified in the masterplan. This change had a minor influence the noise contours.

10 – Base Case with 200k scheduled passenger movements

This run investigated the influence of using 200k scheduled passenger movements instead of 175k. The demand modelling by Airbiz shows that ultimate runway capacity could be reached at anywhere between 175k and 200k movements depending on what methodology is used.

175k was chosen for the Operative Plan noise contours and is also used in the Base Case. Compared to the Base Case, the contours expand by 1-2 dB if 200k scheduled passenger movements are used.

11 – Base Case with tolerance for shifting of RNP tracks

Run 11 was undertaken to investigate whether shifting the defined RNP tracks would alter the noise contours. This was to account for any tweaks to the RNP tracks in future.

One RNP tracks was looked at as an example and it was shifted 1km north then 1km south of the original track. The effect was that the bump in the noise contour caused by that RNP track also shifted.

12 – Base Case with 100% RNP allocation

The Base Case allocates arrivals to ILS, visual and RNP approaches. This is because not all aircraft use RNP approaches currently so ILS and visual approaches are still required. There is a step change worldwide to shift away from visual and ILS approaches to RNP approaches and eventually it is envisaged that almost all aircraft will be equipped to fly RNP approaches.

This run investigates the effect of moving aircraft off visual and ILS approaches and allocating them all to RNP approaches. RNP tracks generally join the extended runway centreline closer to the airport whereas visual and ILS approaches generally join the extended runway centreline earlier meaning they are flying straight for longer.

This causes the spikes in the noise contours from the straight ILS and visual approaches to retract.

13 – Base Case with SIMOPS

With the extension of the main runway, it is possible for some narrow-bodied jets to take-off on Runway 02 from the cross-runway intersection instead of from the end of the runway. These take-offs are called intersection departures and run 13 investigates the effect of 30% of domestic narrow-bodied jets performing these departures. This run had a negligible effect on the noise contours.

14/14a - Base Case with more 11/29 usage to account for climate change

Climate change is predicted to increase the frequency of north-west winds over Canterbury which would cause an increase in the use of the cross-runway. Runs 14 and 14a investigate the effect of increasing the number of movements on the cross-runway to account for this potential change.

The cross-runway movements are multiplied by a factor of 1.10 for run 14 and 1.05 for run 14a to represent an increase in north westerly winds due to climate change by 10% and 5% respectively. This causes a slight increase in the size of the cross-runway noise contour.

15 – Base Case with higher temperature for climate change

Climate change is also predicted to increase temperatures by up to 3 degrees in the future. Run 15 increases the input temperature in INM by 3 degrees to account for this predicted change. This change had no effect on the noise contours.

16 – Base Case with Freight, Airline/MRO, FBO/Small commercial, Antarctic, military and government movements

The Base Case only includes 175k scheduled passenger movements. This sensitivity run was used to test the influence on the noise contours of adding freight, Airline/MRO, FBO/Small commercial, Antarctic, military and government movements. Addition of these movements expands the noise contours by 2-3 dB.

17 – Base Case no taxiing

Taxiing was not included in the Operative Plan noise contour as the noise model did not have the capability to model taxiing at the time. It is now possible to model taxiing in the noise model and it is best practise to do so.

The addition of taxiing had a negligible influence on the noise contour with a slight expansion on the eastern side of the 65 L_{dn} noise contour near the taxiways.

19 – Base Case with updated calibration and noise profiles

As with any modelling software, there is generally a difference between what is modelled and what is measured on the ground. It is best practise in New Zealand to verify a noise model with measurements and adjust the inputs or assumption better match with the measured noise levels. This is called a "calibration".

Section 5.4 explains how we calibrated the noise model. This calibration was not included in the Base Case and run 19 investigates the effect of including it. The calibration causes the noise contours to expand by 0.5dB.

20 – Base Case with Drones

The Base Case only includes 175k scheduled passenger movements. This sensitivity run was used to test the influence on the noise contours of adding possible future drone movements. Based on the available information, drones do not make a large difference to the noise contours, and the contours expand slightly where the tracks intersect with the 50 L_{dn} noise contour.

21 – Base Case with Runway Maintenance
This run investigates accounting for runway maintenance by moving jets that would normally use the main runway to use the cross-runway on nights where maintenance occurs.

This run causes the cross-runway noise contours to expand by 2-3 dB.

22 – Base Case with Cancelled SID's
Sometimes aircraft will request permission from air traffic control to turn early and deviate away from the flight path they are on. These types of departures are called "cancelled SID's" and we have modelled the effect of shifting 50% of departing aircraft onto these tracks and leaving 50% on the conventional designated flight path.

There are three cancelled SID's, one for runway 02 which provides an earlier turn option for those heading south and one for runway 20 and runway 29 which provide an earlier turn option for those heading north.

Moving 50% of aircraft on these specific routes to the cancelled SID's has a negligible effect on the noise contours and changed the shape slightly in areas where the cancelled SID track intersects with the noise contour.

23 – Operative Plan scheduled with Airline/MRO, FBO/Small commercial, Antarctic, military and government movements
The Operative Plan noise contours only included 175k scheduled passenger movements. Many of the other movement categories such as Antarctic and military are excluded from the operative plan noise rules.

This sensitivity run was used to ascertain the extent of the Operative Plan noise contours had Airline/MRO, FBO/Small commercial, Antarctic, military and government movements been included. Including these movements causes the Operative Plan noise contour to expand by 2-3 dB.

24 – Base Case with 200k scheduled movements and Expert Panel Tracks
The Operative Plan noise contours used different tracks to the Base Case. When the Operative Plan noise contours were modelled in 2008 there were no DMAPS or RNP tracks, and the tracks were mainly straight tracks.

This sensitivity run was used to determine the extent of the noise contours if the Operative Plan tracks were used as opposed to the updated tracks.

Comparing to run 10, which also includes 200k movements, the change in the shape of the noise contours is evident with this run having longer oval shaped noise contours.

Table 7: Sensitivity Runs

Run	Run Date	Name	Schedule Used	Runways/Tracks/Fleet Used	Difference to Base Case Inputs	Purpose of Run	Effect on Noise Contours (Compared to Base Case)	Include in Updated Noise Contours
3a	1-May-19	Base Case	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	-	-	-	-
3b	15-May-19	Base Case without DMAPS	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Current tracks (no DMAPS) Future fleet	Uses current tracks without DMAPS departures	Investigate the influence of DMAPS departures on the noise contours	Retraction of north-western and south-western contour tips	No
3c	14-May-19	Base Case without cross-runway movements factored up	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Uses runway splits without the cross-runway movements factored up (see Appendix C1)	Investigate the influence of factoring up the cross-runway movements on the noise contour	Shrinking of noise contour on the cross-runway	No
4a	1-May-19	Runway 02 Highest Usage	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Runway splits from the highest recorded usage of Runway 02 used (see Appendix C4).	Investigate how the busiest Runway 02 usage influences the noise contours	Slight extension to the north, retraction to the south, east and west	Yes
4b	1-May-19	Runway 20 Highest Usage	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Runway splits from the highest recorded usage of Runway 20 used (see Appendix C5).	Investigate how the busiest Runway 20 usage influences the contours	Slight extension to the north and south, retraction to the east and west	Yes
4c	24-Sep-19	Runway 29 Highest Usage	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Runway splits from the highest recorded usage of RUNWAY 29 used (see Appendix C7).	Investigate how the busiest Runway 11 usage influences the contours	Slight retraction north and south, expansion to the east	Yes
4d	24-Sep-19	Runway 11 Highest Usage	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Runway splits from the highest recorded usage of RUNWAY 11 used (see Appendix C6).	Investigate how the busiest Runway 29 usage influences the contours	Slight retraction north and south, expansion to the west	Yes
6	18-Jun-19	Base Case with helicopters	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger Helicopters	Future runway configuration Updated tracks (include DMAPS) Future fleet	Includes helicopters	Investigate how helicopter movements influence the contours	Small deviations on the 50/55 L_{dn} contour where the helicopter tracks cross	Yes
7	13-Jun-19	2018 Schedule Scaled up to 2020 (no DMAPS departures)	2018 (scaled to 2020) Scheduled passenger	Current runway configuration Expert Panel tracks (no DMAPS) Current fleet	2018 AANC schedule scaled to 2020 at 4% growth pa. Uses the Current runway Configuration and Expert Panel Tracks and fleet.	Investigate the likely contours for the 2020 AANC in relation to the Base Case to identify any interim compliance issues.	65 L_{dn} contour different shape due to use of Current Tracks (no DMAPS)	No
8a	1-May-19	Base Case with Airbus A320neos replaced by Boeing 737max	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet (737 sub A320)	Airbus A320neo/A321neo changed to Boeing 737max	Investigate the influence of substituting A320neo for Boeing 737max.	Contours expand by 2-3 dB	No
8b	14-May-19	Base Case with 50% of Airbus A320neos replaced by Boeing 737max	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet (737 sub A320)	50% of Airbus A320neo/A321neo changed to Boeing 737s	Investigate the influence of substituting half of the A320neo for Boeing 737max	Contours expand by 1-2 dB	No
8c	1-May-19	Base Case with A380s replaced by 777xs	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet (777x sub A380)	Airbus A380s changed to Boeing 777Xs	Investigate the influence of substituting half of the A380s for Boeing 777x's.	Negligible change	No

Run	Run Date	Name	Schedule Used	Runways/Tracks/Fleet Used	Difference to Base Case Inputs	Purpose of Run	Effect on Noise Contours (Compared to Base Case)	Include in Updated Noise Contours
8d	1-Aug-19	Base Case with current gen A320s/737s i.e., not Neos or max's	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Current fleet	Current fleet used (no A320 Neos or 737 max)	Investigate the influence of assuming the current fleet (A320s replace A320 Neos etc)	Contours expand by 0.5-1 dB	No
9	18-Jul-19	Interim Schedule run with current airfield and fleet	Interim Scheduled passenger 98k	Current runway configuration Updated tracks (include DMAPS) Current fleet	Used the Current runway Configuration and Current fleet	Investigate an interim scenario using Updated tracks but the Current runway Configuration and fleet. Identify any interim compliance issues.	Contours retract by 1-2 dB	No
9b	22-Jan-20	Runway 11/29 moved south	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration (11/29 shifted south) Updated tracks (include DMAPS) Future fleet	Cross-runway shifted 22.5m south	This modification is to allow for new taxiway separation	Contours shift south by similar distance	No
10	13-May-19	Base Case with 200k scheduled passenger movements	Ultimate Runway Capacity Schedule "B" 200k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Uses 200k scheduled passenger movements instead of 175k	Investigate the influence of a higher number of scheduled passenger aircraft movements at capacity.	Contours expand by 0.5-1dB	Yes
11	14-May-19	Base Case with tolerance for Shifting of RNP Tracks	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	RNP track to south altered to turn earlier/later.	Investigate how changing RNP tracks could influence noise contours if they were updated in future.	Nodes in contour shift to where new track intersects	No
12	1-May-19	Base Case with 100% RNP allocation	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	100% of tracks allocated to RNP from ILS/Visual tracks (where available).	Investigate how using 100% RNP tracks would influence the contours.	Expansion of wings at north-western and south-western end of the contour, shrinking of centreline contour	No
13	13-Jun-19	Base Case with SIMOPS	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	30% of domestic narrow-bodied jet departures use an intersection departure	Investigate whether intersection departures would alter the noise contours.	Negligible change	No
14/14a	1-May-19	Base Case with More 11/29 Usage for Climate Change	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	10%/5% more movements added to Runway 11/29 – (see Appendix C3)	Investigate the influence of increased cross-runway usage due to climate change.	0.5-1dB increase in cross-runway contour	Yes
15	1-May-19	Base Case with Higher Temperature for Climate Change	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	The temperature in INM increased by 3 degrees Celsius	Investigate the influence of a temperature increase on the noise contours due to climate change.	Negligible change	No
16	17-Jul-19	Base Case with freight, FBO/small commercial, airline/MRO, Antarctic, military and government movements	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger Freight, FBO/small commercial, airline/MRO, Antarctic, military and government	Future runway configuration Updated tracks (include DMAPS) Future fleet	Includes freight, FBO/small commercial, airline/MRO, Antarctic, military and government schedule	Investigate the influence of freight, FBO/small commercial, airline/MRO, Antarctic, military and government movements on the noise contours.	Contours expand by 2-3 dB	Yes/No. Exclude Antarctic/military/government
17	24-Sep-19	Base Case no taxiing	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Doesn't include taxiing	Investigate the influence of taxiing on the noise contours.	Negligible expansion on the eastern side of 65 Ldn contour	~~Yes~~No (taxiing to be included)
19	20-Jan-20	Base Case with updated calibration of noise profiles in the noise model	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Includes updated calibration based on measurement from Christchurch and Auckland	Investigate the influence of the new calibration on the noise contours	Contours expand by 0.5 dB	Yes

Run	Run Date	Name	Schedule Used	Runways/Tracks/Fleet Used	Difference to Base Case Inputs	Purpose of Run	Effect on Noise Contours (Compared to Base Case)	Include in Updated Noise Contours
20	1-Jun-21	Base Case with Drones	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger Drones	Future runway configuration Updated tracks (include DMAPS) Future fleet	Includes drones	Investigate the influence of possible future drone noise on the noise contours	Negligible change	No
21	27-Jun-21	Base Case with Runway Maintenance	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS) Future fleet	Includes runway maintenance by moving aircraft at night to the cross-runway to allow for maintenance on the man runway.	Investigate the effect of runway maintenance of the noise contours	Large Change 3-4 dB	Yes/No. Include in the Annual Average, do not include in the Outer Envelope
22	20-Jul-21	Base Case with cancelled SID's	Ultimate Runway Capacity Schedule "A" 175k scheduled passenger	Future runway configuration Updated tracks (include DMAPS and cancelled SID's) Future fleet	Includes use of cancelled SID's	Investigate effects of cancelled SID tracks on the noise contours	Change in shape due to track changes	No
23	26-Aug-21	Operative Plan schedule with freight, FBO/small commercial, airline/MRO, Antarctic, military and government	Expert Panel Schedule Scheduled passenger Freight, FBO/small commercial, airline/MRO, Antarctic, military and government	Expert Panel Runways Expert Panel Tracks Expert Panel Fleet	Adds freight, FBO/small commercial, airline/MRO, Antarctic, military and government aircraft to the original Operative Plan Noise Contours	Investigate the influence of adding freight, FBO/small commercial, airline/MRO, Antarctic, military and government to the Operative Plan noise contours	Contours expand by 2-3 dB	No
24	30 Aug-21	Base Case with 200k scheduled & Operative Plan tracks	Ultimate Runway Capacity Schedule "B" 200k scheduled passenger	Future runway configuration Expert Panel Tracks Future fleet	Uses the expert panel tracks on the 200k scheduled passenger schedule	Investigate the noise contour size/shape using the Expert Panel tracks vs the Updated Tracks	Highlighted Change in contour shape	No

6.0 UPDATED NOISE CONTOURS

6.1 Modelling Inputs

Many of the modelling inputs described in Section 5.0 are used for the Updated Noise Contours. We describe those inputs that have been changed/altered for the Updated Noise Contours in this section.

6.1.1 From Sensitivity Runs

The sensitivity runs summarised in Table 7 identified inputs and assumptions that could be included or excluded in the Updated Noise Contours. The Updated Noise Contours include the following assumptions investigated in the sensitivity runs:

- #16 - Includes freight, FBO/small commercial, airline/MRO (excludes Antarctic, military and government)
- #6 - Includes helicopters (excludes military helicopters)
- #17 - Includes taxiing of aircraft on the ground to and from runways
- #10 – 200k scheduled passenger aircraft movements at runway capacity (as opposed to 175k in the Operative Plan assumptions)
- #14 - 10% more usage on the cross-runway to account for climate change
- #19 - Updated calibration of aircraft noise profiles based on local noise monitoring
- #21 - Runway Maintenance (for Annual Average only) diversion of aircraft from main to cross-runway during limited days and hours of main runway closure
- #23/24/25 - Latest version of Airways NZ flight tracks definition, spread and allocations

6.1.2 Meteorological Data

The meteorological data described in Section 5.1.7 was reanalysed for the Updated Noise Contours to refine our assumptions. For the Outer Envelope Future Noise Contour, October-December was used represent the busy three-month period of interest as this historically is the busiest three-month period 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 I2.

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 I2.

6.1.3 Aircraft Movement Schedules

Ultimate Runway Capacity Schedule "B" is used for the Updated Noise Contours. For Schedule "B" it is assumed that as the airport approaches ultimate runway capacity, scheduled passenger aircraft movements would be given preference as available runway slots become constrained. This leads to reducing 50% of the movements available to FBO/small commercial movements to allow additional schedule passenger aircraft movements.

The movement categories that were included in the Updated Noise Contours are shown in Table 8. Antarctic, government and military movements (including military helicopters) have been excluded from these runs. Christchurch International 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 a large impact on the noise contours.

Antarctic movements have been excluded from these runs, 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.

A general aviation schedule was provided but has not been used in any of the runs as it is assumed that as the airport reaches capacity, general aviation movements (typically aeroclub type recreational activity would be accommodated at another airport.

Table 8: Aircraft Annual Movement Schedules by Market Segment – Schedule "B"

Category	Movement Numbers
Included	
Scheduled Passenger	200k
Freight	11k
Airline/MRO	5k
FBO/Small Commercial	10k
Helicopters	29k
Not Included	
Antarctic/military/government	6k
General Aviation	29k

**Schedule "B" includes half the number of FBO/small commercial movements as these are displaced by a larger number of scheduled passenger movements*

6.1.4 Runway Usage Splits

For the updated Noise Contours, we added 2018 and 2019 to the dataset and reanalysed the runway usage data for October to December rather than November to January as we did for the sensitivity runs.

October to December was chosen as it generally is the busiest three-month period in the 'calendar year'. November to January spans two calendar years which is not technically in keeping with the current noise rules in the Christchurch District Plan

Five different runway splits have been used in the Updated Noise Contours. Four for the Outer Envelope and one for the Annual Average noise contour.

As mentioned in Section 5.3.1, departures on runway 11 are extremely rare and thus we have not included departures on runway 11 in the Outer Envelope or Annual Average noise contours.

Outer Envelope

The Outer Envelope consists of four separate runs accounting for the busiest three-month runway usage recorded on each runway end ~~for the October to December period~~ between 1999 and 2019.

The highest runway usages recorded for this period were:

- Runway 02 – used ~~67~~71% of the time – ~~October to December 2017~~January – March 2019
- Runway 20 – used ~~38~~50% of the time - ~~October to December 2001~~May – July 2006
- Runway 11 – used ~~1.8~~2.5% of the time - ~~October to December 2015~~February – April 2016
- Runway 29 – used ~~11~~13% of the time - ~~October to December 2006~~September – November 2006

The runway usage for each period is given in the following table. For the RW29/11 worst case splits 10% added to movements on the cross-runway to account for potential climate change effects on increasing the prevalence of north-westerly wind patterns.

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 9 do not represent outliers in the data. The RW11 splits are lower that what was modelled for the sensitivity runs (5% vs 2.75 %) as the 5% value is from 2011 which contained anomalous data and was excluded from the final analysis.

Table 9: Highest 3 Month Usage Each Runway End

Highest Usage of	Runway 02	Runway 20	Runway 11	Runway 29	Total
RW02	**71%**	24.5%	0.5%	4%	100%
RW20	49%	**50%**	0%	1%	100%
RW11	69%	23%	**2.75%**	6.05%	101%
RW29~~0~~	56%	31%	0%	**14.3%**	101~~0~~%

Annual Average

The Annual Average Runway Splits were determined by calculating the runway splits for each calendar year from 1999-2019 and then finding the average of these. These are shown in Table 10.

Again, 10% is added to RW19/11 to account for potential climate change effects on increasing the prevalence of north-westerly wind patterns. Runway Maintenance is also Accounted for in this run and is described in more detail in Section 5.3.2.

Table 10: Annual Average Runway Splits

Runway 02	Runway 20	Runway 11	Runway 29	Total
58.5%	36.7%	0.3%	5%	101~~0~~%

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 proposed including a 2-decibel tolerance in the noise rules to allow for abnormal runway splits in future.

<u>Aircraft Allocation</u>

For both options all aircraft have been allocated to use the main and cross-runway apart from the following wide bodied aircraft types which cannot operationally use the cross-runway.

- Airbus A380
- Airbus A350
- Boeing 777900
- Boeing 777800

6.1.5 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 in the busiest three months up to 14 nights of runway maintenance can occur. For these nights all aircraft (excluding wide body jets) use the cross-runway.

For the Annual Average Run runway maintenance is included as it does not make such a large difference to the noise contours the 14 nights of maintenance are spread over a year.

For the Outer Envelope the noise contours on the cross-runway expand significantly. There are two ways of dealing with this effect. Either the contours are enlarged, and this activity is included in the compliance rule. Or alternatively, it could be excluded from the modelling and excluded from the noise compliance rule. At this stage we have not included runway maintenance in the Outer Envelope noise contour and propose adding it as an exclusion within the noise compliance rules.

Runway construction for larger capital works projects such as future construction of the runway extensions have not been included as they are large scale infrequent runway construction e events that are not appropriate to be included in the noise contours. Runway capital works are proposed to be covered off in an exclusion within the noise compliance rules.

6.1.6 Busy three-month Peaking Factor

We did not use peaking factors for the Annual Average Updated Noise Contour as this represent noise over an entire year.

For the Outer Envelope Updated Noise Contour option we used the peaking factors given in Table 11 based on a reanalysis of the data to include 2018 and 2019. 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, Antarctic, military and government. The peaking factors for each category are given below and graphs are given in Appendix K.

Table 11: 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

6.1.7 Updated Flight Tracks and Allocations

The flight tracks evolved slightly during the recontouring project. Some of the earlier sensitivity scenarios used slightly different flight track allocations and flight track trajectories to the updated flight tracks. Sensitivity runs 23/24/25 isolated the influence of these changes in the noise contours and showed minor difference in the shape of the noise contours.

We consider this subtle evolution of the flight paths to have no significant effect on the conclusions.

6.2 Calculated Noise Contours

6.2.1 Two options for the Updated Contours

The final set of noise contours is termed the 'Updated Noise Contours'. Two options are available to be used for the 'Updated Noise Contours':

- 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 activity on each runway end. The outermost contour of these four noise contours is taken in each region to form the final Outer Envelope. The total aircraft movements used in this calculation is also based on the busiest 3 months over the last 20 years.

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

Either of these two options (Outer Envelope or Annual Average) could be used by the planning authorities for the Updated Noise Contours. NZS6805 states that "sound exposure (should be averaged over a three-month period (or such other period as is agreed)" so while the busiest three-month approach is the approach referenced in the Standard, the Standard envisages that, where appropriate looking at the context of a particular airport, an alternative approach could be taken. The approach across New Zealand varies. The original Christchurch Noise Contours (1994) used the Outer Envelope concept based on the busiest three-month concept. The Operative District Plan Noise Contours accounted for seasonal runway bias in a different way by factoring up movements on the crosswind runway. The recently updated Auckland Airport Noise Contours uses the Annual Average concept.

The Outer Envelope has the largest footprint and thus protects the greatest number of people from adverse noise effects by restricting development inside the noise contours. However, most of the research surrounding noise annoyance including community annoyance surveys is based on residents' perception of noise over a 12-month period which suggests that the Annual Average approach would be the best fit for representing these noise levels.

The WHO 2018 aircraft noise guidelines which are based on an amalgamation of a large number of noise annoyance studies internationally and the FAA noise annoyance study which looked at 20 airports in the United States are based on a 12-month period. These studies ask respondents to assess their aircraft noise environment over the past 12 months.

Noise contours produced in the United States are based on an annual average. The United Sates provisions are detailed in FAA Part 150 which states that *"the yearly day-night sound level (Ldn) must be used"*. For Australia it is understood that the noise contours are also generally prepared using an annual average.

The Outer Envelope concept represents the busiest period where residents are exposed to higher levels of noise. However, this is counteracted by the other 9 months of the year, which are included in the Annual Average where noise levels are lower, and residents receive some respite from aircraft noise. Appendix P3 shows the individual 50 dB Ldn 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.

The associated rules related to measuring and monitoring compliance will differ depending on which option is selected. For example, the Annual Average would likely provide for unusual runway usage/winds by way of a tolerance in the rules as opposed for calculating a seasonal bias for each runway end as occurred for the Outer Envelope. This is because the Annual Average runway usage is generally more stable than over three months.

The assessment of noise annoyance is generally determined by 'noise exposure' – the average noise level over a period of time. People will generally accept a higher level of noise for a period of time if they know they will receive a lower level of noise for the remaining period. The period of time this 'averaging' is assessed over (3 months vs 12 months) is a matter of expert opinion.

There are arguments both ways for using either the busiest 3-month Outer Envelope or the Annual Average. We have modelled the contours based on both of these approaches to assist the authorities.

Figure 8: Outer Envelope

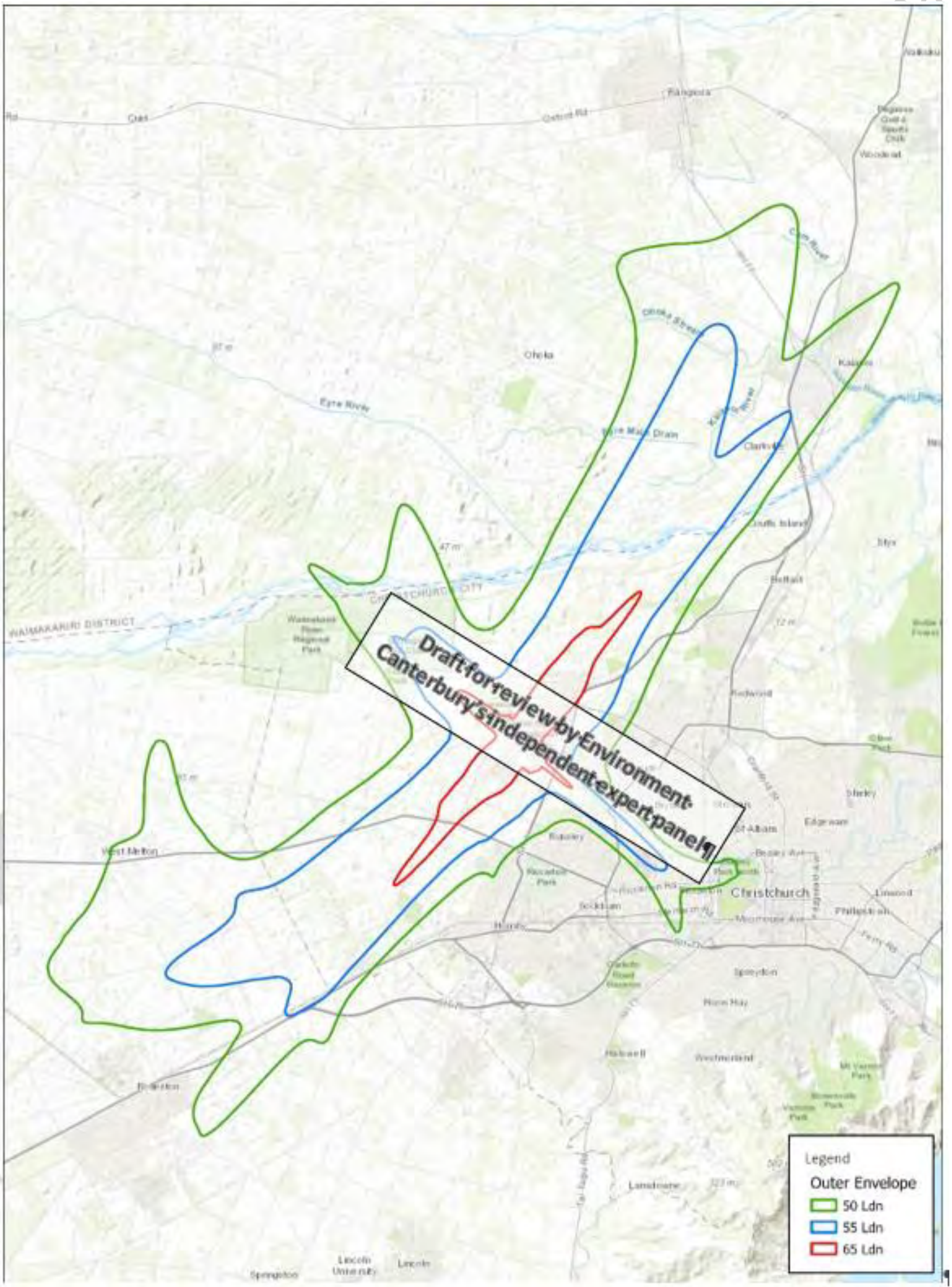
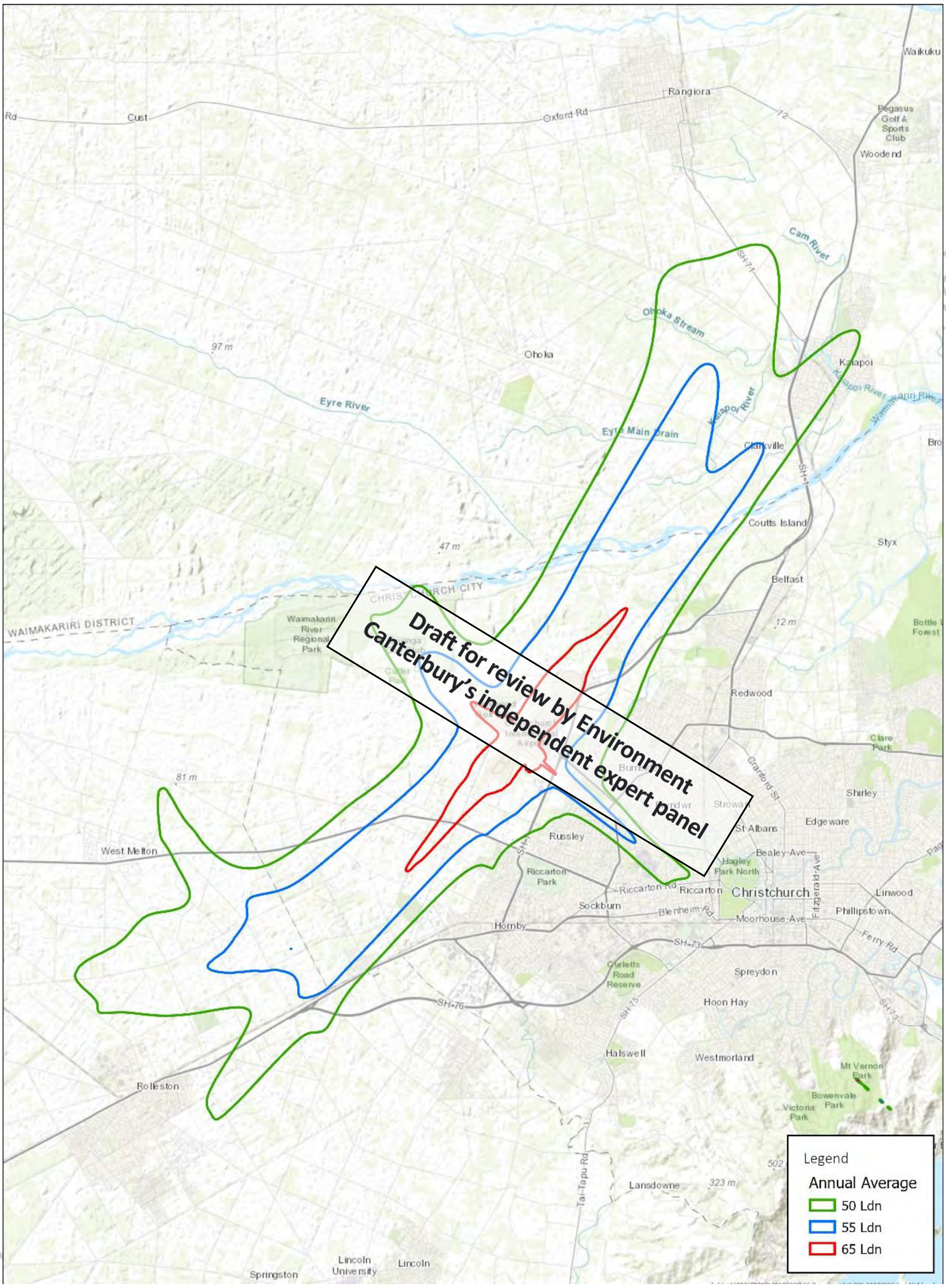


Figure 9: Annual Average



6.2.2 Air Noise Boundary (L_{dn} 65 + SEL 95)

As described in Section 2.0, the 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 SEL contour of the noisiest aircraft used frequently at night-time. This contour is used to avoid sleep disturbance and annoyance at night.

Generally, it is the larger aircraft with the longer stage lengths (for departures) that are noisiest such as the jets. The jets included in the noise modelling are:

Wide bodied jets:

- Airbus A380 (no night flights)
- Boeing 777800/900
- Boeing 777200 (for freight)
- Airbus A350
- Boeing 787
- Boeing 797

Narrow bodied jets

- Boeing 737 max
- Airbus A320 Neo
- Airbus A320 (for freight)

All of the wide-bodied jets fly long haul and have a stage length of 9 apart from the Boeing 797 which only flies Trans-Tasman and has a stage length of 3. Only the Boeing 797 and 787 can use the cross-runway. For departures, the wide-bodied jets are generally louder than the narrow-bodied jets. For arrivals this is also true apart from for the Boeing 737 max which is noisier than the Boeing 787/797.

Based on these aircraft types, our noise measurements and modelling results show that the noisiest aircraft for the main runway is the Boeing 777800/900. For the cross-runway it is the Boeing 737 max for arrivals and the Boeing 787 for departures. The Boeing 787 was chosen for departures on the cross-runway over the Boeing 797 as it has a longer stage length and thus is louder. This was confirmed by plotting SEL95 contours for each aircraft type. The Airbus A380 was not considered as it does not fly at night-time at Christchurch.

The parameters used to model the SEL95 noise contours is given in Table 12 below and the individual arrival and departure SEL95 contours are shown in Appendix Q2. The composite Air Noise Boundary for the Outer Envelope and Annual Average is shown in Figure 10 and Appendix Q1.

The wind speed in the noise model was set to 20 knots for all of these runs to account for the condition that would be present then large aircraft would be using the cross-runway. These noise contours were all modelled in INM.

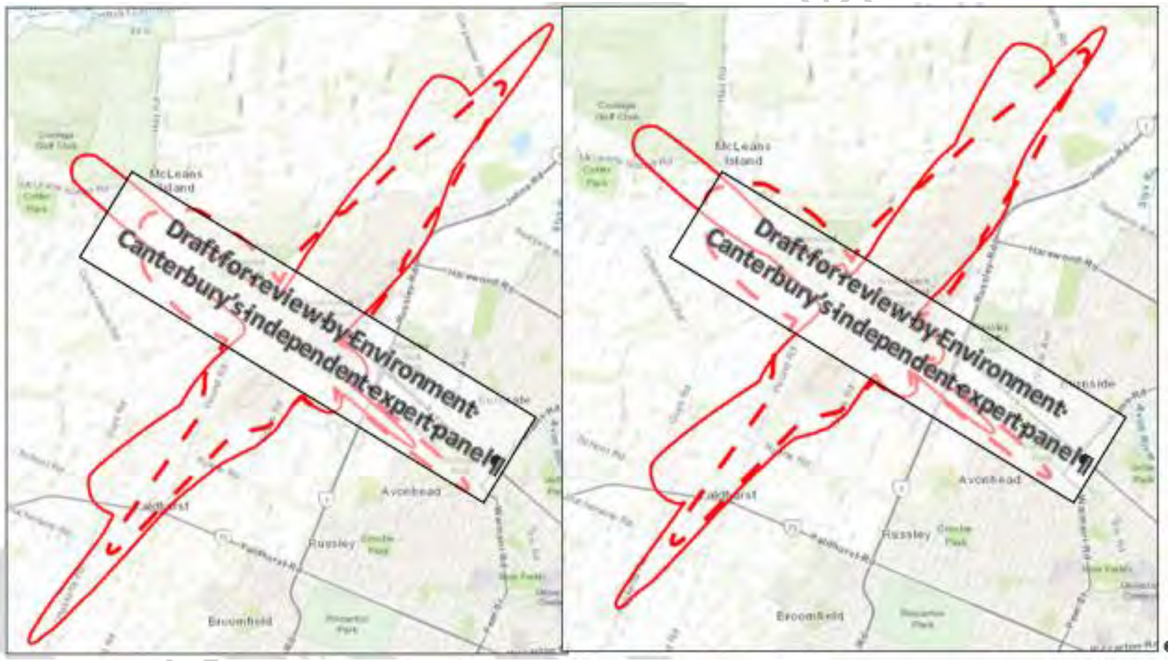
Table 12: Aircraft Operations Included in ASEL95 Contours

Aircraft Type	INM Aircraft*	Op Type	Profile ID	Stage Length	Runway
Boeing 737max Arrival	737800	A	STANDARD	1	Cross-runway
Boeing 787 Departure	777200	D	STANDARD	9	Cross-runway *RW29 only*
Boeing 778/779 Arrival	777300	A	STANDARD	1	Main
Boeing 778/779 Departure	777300	D	ICAO_A	9*	Main

** Due to the calibration some aircraft types are modelled as different substitutions in INM. For example, the 778/779 is modelled as a 773 in INM to ensure a good calibration with measurements.*

** The highest stage length available in the INM for a Boeing 777300 is 7. The stage length of 9 was altered in the noise model to represent this. There is a stage length of 9 available for the 777200 so this did not have to be altered.*

Figure 10: ANB Annual Average (left) and ANB Outer Envelope (right) vs Current ANB (dotted)



APPENDIX A GLOSSARY OF TERMINOLOGY

Name	Description
AANC	Annual Aircraft Noise Contour. Prepared annually to determine compliance with the Air Noise Boundaries.
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.
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 inputs which all other sensitivity runs are compared to.
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 Fleet	Refers to the fleet mix provided by Airbiz that currently exists.
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
DMAPS	Divergent Missed Approach Protection System. Departure tracks that turn at an angle soon after take-off, instead of flying straight and then turning when instructed by Air Traffic Control.
DMAPS Tracks	Refers to the flight tracks currently in use, with RNP procedures in place and DMAPS departures.
No-DMAPS Tracks	Refers to the flight tracks provided by Airbiz which were used prior to 2020. Doesn't include DMAPS departures.
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.
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.
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.
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).
Piano Keys (or Threshold Markings)	A series of parallel, longitudinal, stripes across the width of the runway, commencing at a point approximately 6 metres from the runway end.
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.
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.
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 02/20 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
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.
Steering Committee	Project team including representatives from CIAL, MDA, Airbiz, Airways NZ, Chapman Tripp and Planz Consultants.
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.

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 | Note: For Scenario 9b Runway 11/29 is moved 22.5m south.

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	30m / 98ft
Heli Centre	-43.482834 / 172.527901	30m / 98ft
Military Apron	-43.485556 / 172.546667	31m / 102ft
Runway 20	-43.480223 / 172.542230	28m / 93ft
Runway 02	-43.494155 / 172.526127	38m / 123ft

Source: Christchurch Airport

B4 Drone take off/landing areas

Name	Coordinates (Lat/Long)	Elevation (m/ft)
Magenta	-43.481388/172.530416	34m / 112ft
Green	-43.478480/172.549956	29m / 95ft
Orange	-43.484441/172.542404	32m / 105ft
Purple	--43.494094/172.531317	33m / 108ft
Other	-43.489101/172.532067	32m / 105ft

Source: Drone operator

APPENDIX C RUNWAY SPLITS – SENSITIVITY RUNS

C1 Average Runways Splits Nov-Jan

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	60%	33%	1%	6%	100%
Narrow bodied jet & Turboprop Departures	60%	33%	0%	7%	100%
Wide bodied Jet Arrivals & Departures	65%	35%	-	-	100%

C2 Average Runways Splits Nov-Jan with a Cross-runway Movements Factored Up

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	60%	33%	5%	13%	110%
Narrow bodied jet & Turboprop Departures	60%	33%	0%	18%	110%
Wide bodied Jet Arrivals & Departures	65%	35%	-	-	100%

C3 Average Runways Splits Nov-Jan with a more Movements on Runways 11/29 for Climate Change

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	60%	33%	5.5% (10% change) ~~5.3% (5% change)~~	14.3% (10% change) ~~13.7% (5% change)~~	113%
Narrow bodied jet & Turboprop Departures	60%	33%	0%	19.8% (10% change)	113%
Wide bodied Jet Arrivals & Departures	65%	35%	-	-	100%

C4 Runway Splits Nov-Jan 2006 – Highest Usage of Runway 02 on Record

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	72%	24%	0%	4%	100%
Narrow bodied jet & Turboprop Departures	72%	24%	0%	4%	100%
Wide bodied Jet Arrivals & Departures	75%	25%	-	-	100%

C5 Runway Splits Apr-Jun 2007 – Highest Usage of Runway 20 on Record

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	53%	42%	0%	4%	100%
Narrow bodied jet & Turboprop Departures	53%	42%	0%	4%	100%
Wide bodied Jet Arrivals & Departures	~~65~~56%	44%	-	-	100%

C6 Runway Splits Sep-Nov 2011 – Highest Usage of Runway 11 on Record

	Runway 02	Runway 20	Runway 11	Runway 29	Total
All Arrivals (excludes long-haul wide-bodied jets)	37%	54%	5%	3%	100%
All Departures (excludes long-haul wide-bodied jets)	37%	54%	0%	8%	100%
Long-Haul Wide-Bodied Jets	41%	59%	-	-	

C7 Runway Splits Sep-Nov 2005 – Highest Usage of Runway 29 on Record

	Runway 02	Runway 20	Runway 11	Runway 29	Total
All Arrivals (excludes long-haul wide-bodied jets)	57%	30%	0%	13%	100%
All Departures (excludes long-haul wide-bodied jets)	57%	30%	0%	13%	100%
Long-Haul Wide-Bodied Jets	35%	35%	-	-	

APPENDIX D RUNWAY SPLITS – UPDATED NOISE CONTOURS

D1 Runway Splits ~~Oct-Dec 2001~~ – Highest Usage of Runway 02

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	71%	24.5%	0.5%	4%	100%
Narrow bodied jet & Turboprop Departures	71%	24.5%	-	4.5%	100%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	74%	26%	-	-	100%

D2 Runway Splits ~~Oct-Dec 2001~~ – Highest Usage of Runway 20

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	49%	50%	0%	1%	100%
Jet & Turboprop Departures	49%	50%	-	1%	100%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	49%	51%	-	-	100%

D3 Runway Splits ~~Oct-Dec 2015~~ – Highest Usage of Runway 11

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	69%	23%	2.75%	6.05%	101%
Narrow bodied jet & Turboprop Departures	69%	23%	-	8.80%	101%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	75%	25%			

D4 Runway Splits ~~Oct-Dec 2006~~ – Highest Usage of Runway 29

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	56%	31%	0%	14.3%	101%
Narrow bodied jet & Turboprop Departures	56%	31%	-	14.3%	101%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	64%	36%			

D5 Runway Splits– Historical Annual Average

	Runway 02	Runway 20	Runway 11	Runway 29	Total
Narrow bodied jet & Turboprop Arrivals	58.5%	~~6~~36.7%	0.3%	5%	100.5%
Narrow bodied jet & Turboprop Departures	58.5%	36.7%	-	5.3%	100.5~~3~~%
Wide bodied Jet Arrivals & Departures *(that can't use the cross-runway)*	61%	39%			

APPENDIX E TRACK SPREAD AND DISPERSION

E1 Track Spread

Track Type	Updated Tracks
RNP Arrivals	No spread
Non-RNP Arrivals	Spread Half of what Assumed from Radar Data
Departures	Spread Half of what Assumed from Radar Data

Source: Airbiz

E2 Track Dispersion

Splits over Five Sub tracks				
Subtrack 4	**Subtrack 3**	**Backbone**	**Subtrack 1**	**Subtrack 2**
6.3%	24.4%	38.6%	24.4%	6.3%
Splits over Three Sub tracks				
	Subtrack 2	**Backbone**	**Subtrack 1**	
	15.87%	68.26%	15.87%	

APPENDIX F AIRCRAFT TYPES

F1 Aircraft Types – Scheduled/Freight

Aircraft Type	Aircraft Model	
	Current fleet	**Future Fleet**
Very Large Wide-Bodied Jet	Airbus A380 (A388)	Airbus A380 (A388)
Large Wide-Bodied Jet	Boeing 777200 (B772)	Boeing 777900 (B779)
Medium Wide-Bodied Jet	Airbus A350 (A359) Boeing 777200 (B772) Boeing 787900 (B789)	Airbus A350 (A359) Boeing 777800 (B778) Boeing 787900 (B789)
Small Wide-Bodied Jet	Boeing 777200 (B772) Boeing 787800 (B788)	Boeing 797700 (B797) Boeing 787800 (B788)
Large Narrow-Bodied Jet	Airbus A320 (A320)	Airbus A321 Neo (A21N)
Medium Narrow-Bodied Jet	Airbus A320 (A320) Boeing 737800 (B738)	Airbus A320 Neo (A20N) Boeing 737 Max (B38M)
Large Turboprop	ATR-72 (AT76) -	ATR-72 (AT76) De Havilland Canada DHC-8-300 (DH8C)
Medium Turboprop	De Havilland Canada DHC-8-300 (DH8C)	De Havilland Canada DHC-8-300 (DH8C)
Small Turboprop	Generic Small Turboprop	Generic Small Turboprop
Very Small Turboprop	Pilatus PC-12 (PC12)	Pilatus PC-12 (PC12)

Source: Airbiz

F2 Aircraft Types – FBO/small commercial, airline/MRO, Antarctic, military and government

Aircraft type	Aircraft Model
Heavy Four Engine Jet	Boeing C17 (C17)
Heavy Two Engine Jet	Boeing 787900 (B789)
Medium Jet	Airbus A320 (A320)
Medium Four Engine Turboprop	Lockheed C130 Hercules (C130)
Medium Two Engine Turboprop	ATR-72 (AT76)
Light Multi-Engine Turboprop	Beech 200 Super King Air (BE20)
Light Single Engine Turboprop	Cessna 208 (C208)
Light Multi Engine Piston	Piper PA31 (PA31)
Light Single Engine Piston	Cessna 185 (C185)

Source: Airbiz

APPENDIX G HELICOPTER TRACKS AND MODELS

G1 Helicopter Runway and Track Splits

Helipad	Operation	Track ID	Percentage Use
CENTRE	A	HCEA01	33%
CENTRE	A	HCEA02	33%
CENTRE	A	HCEA03	33%
CENTRE	D	HCED01	33%
CENTRE	D	HCED02	33%
CENTRE	D	HCED03	33%
GARDEN	A	HGCA01	50%
GARDEN	A	HGCA02	50%
GARDEN	D	HGCD01	50%
GARDEN	D	HGCD02	50%
MILAPR	A	HMAA01	10%
MILAPR	A	HMAA02	25%
MILAPR	A	HMAA03	20%
MILAPR	A	HMAA04	30%
HELI20	A	HMAA05	5%
HELI02	A	HMAA06	10%
MILAPR	D	HMAD01	10%
MILAPR	D	HMAD02	25%
MILAPR	D	HMAD03	20%
MILAPR	D	HMAD04	30%
HELI20	D	HMAD05	5%
HELI02	D	HMAD06	10%

Source: Airbiz

G2 Helicopter Types

Helicopter	Substitute in Noise Model Code | Model
Augusta Westland AW109	A109 | Augusta Westland AW109
Eurocopter AS350	SA350D | Eurocopter AS350
Eurocopter EC120	EC30 | Eurocopter EC130
Robinson R22	R22 | Robinson R22
Robinson R44	R44 | Robinson R44
Bell 206	B206L | Bell 206
Guimbal Cabri G2	R44 | Robinson R44
Hughes 269	R22 | Robinson R22
MD 500	EC30 | Eurocopter EC130
NHI Industries NH90	S70 | Sikorsky S-70
Kaman SH-2 Seasprite	S65 | Sikorsky S-65

Source: Airbiz

APPENDIX H TAXIING INFORMATION

Aircraft Type	Engine Height (ft)	Speed (kt)	Thrust (Pounds)	Mode
Wide Bodied Jets (772)	9ft	30kt	9000lb	Approach
Narrow Bodied Jets (A320)	6.4ft	30kt	3000lb	Approach
Or 737800	6.4ft	30kt	3000lb	Approach
Turboprops Dornier 328	10ft	25kt	675lb	Approach

APPENDIX I METEOROLOGICAL DATA

I1 Meteorological Settings – Sensitivity Runs

	Busy three-month Nov-Jan *Used for the base	Runway 20 Busy three-month Apr-Jun	Runway 11 Busy three-month Sep-Nov	Runway 29 Busy three-month Sep-Nov
Temperature	14 C / 57 F	9 C / 49 F	14 C / 57 F	11 C / 52 F
Pressure	1013 HpA / 30 Hg	1015 HpA / 30 Hg	1013 HpA / 30 Hg	1011 HpA / 30 Hg
Humidity	75%	87%	75%	77%
Headwind	4 m/s / 9 kt	3 m/s / 6 kt	4 m/s / 9 kt	4 m/s / 8 kt

Source: National Climate database by NIWA

I2 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 / 54F
Pressure	1012 HpA / 30 Hg	1014 HpA / 30 Hg
Humidity	75%	82%
Headwind	5 m/s / 9kt	4 m/s / 8kt

Source: National Climate database by NIWA

APPENDIX J CALIBRATION

J1 Fixed Wing Calibration

Aircraft	Equivalent	Operation	Actual Stage	Modified Stage	Profile
A20N	A320-232	A	1	1	STANDARD
A20N	A320-211	D	1	3	ICAOA
A20N	A320-211	D	4	3	ICAOA
A21N	A320-232	A	1	1	STANDARD
A21N	A320-211	D	1	3	ICAOA
A21N	A320-211	D	3	3	ICAOA
A21N	A320-211	D	5	3	ICAOA
A320	A320-232	A	1	1	STANDARD
A320	A320-211	D	1	5	ICAOA
A320	A320-211	D	3	5	ICAOA
A320	A320-211	D	4	5	ICAOA
A359	7878R	A	1	1	STANDARD
A359	777200	D	7	7	STANDARD
A359	777200	D	8	8	STANDARD
A388	A380-861	A	1	1	STANDARD
A388	A380-861	D	9	9	STANDARD
B38M	737800	A	1	1	STANDARD
B38M	737800	D	4	6	ICAO_A
B778	777300	A	1	1	STANDARD
B778	777300	D	1	1	ICAO_A
B778	777300	D	8	8	ICAO_A
B778	777300	D	9	9	ICAO_A
B738	737800	A	1	1	STANDARD
B738	737800	D	3	5	ICAO_A
B738	737800	D	4	6	ICAO_A
B772	777300	A	1	1	STANDARD
B772	777300	D	1	1	ICAO_A
B772	777300	D	7	7	ICAO_A
B772	777300	D	8	8	ICAO_A
B779	777300	A	1	1	STANDARD
B779	777300	D	3	3	ICAO_A
B779	777300	D	7	7	ICAO_A
B788	7878R	A	1	1	STANDARD
B788	777200	D	3	3	STANDARD
B789	7878R	A	1	1	STANDARD
B789	777200	D	1	1	STANDARD
B789	777200	D	7	7	STANDARD
B789	777200	D	8	8	STANDARD
B797	7878R	A	1	1	STANDARD
B797	777200	D	1	1	STANDARD

J2 Helicopter Calibration

Helicopter	Measurements Available	Difference Meas vs Mod	Calibration
Augusta Westland AW109	N	-	Assume 0
Eurocopter AS350	Y	0 dB	None required
Eurocopter EC130	Y	10 dB	Divide no. movements by 10
Robinson R22	N	-	Assume 0
Robinson R44	Y	15 dB	Divide no. movements by 30
Bell 206	N	-	None
Sikorsky S-70	N	-	None
Sikorsky S-65	N	-	None

J3 Calibration Example

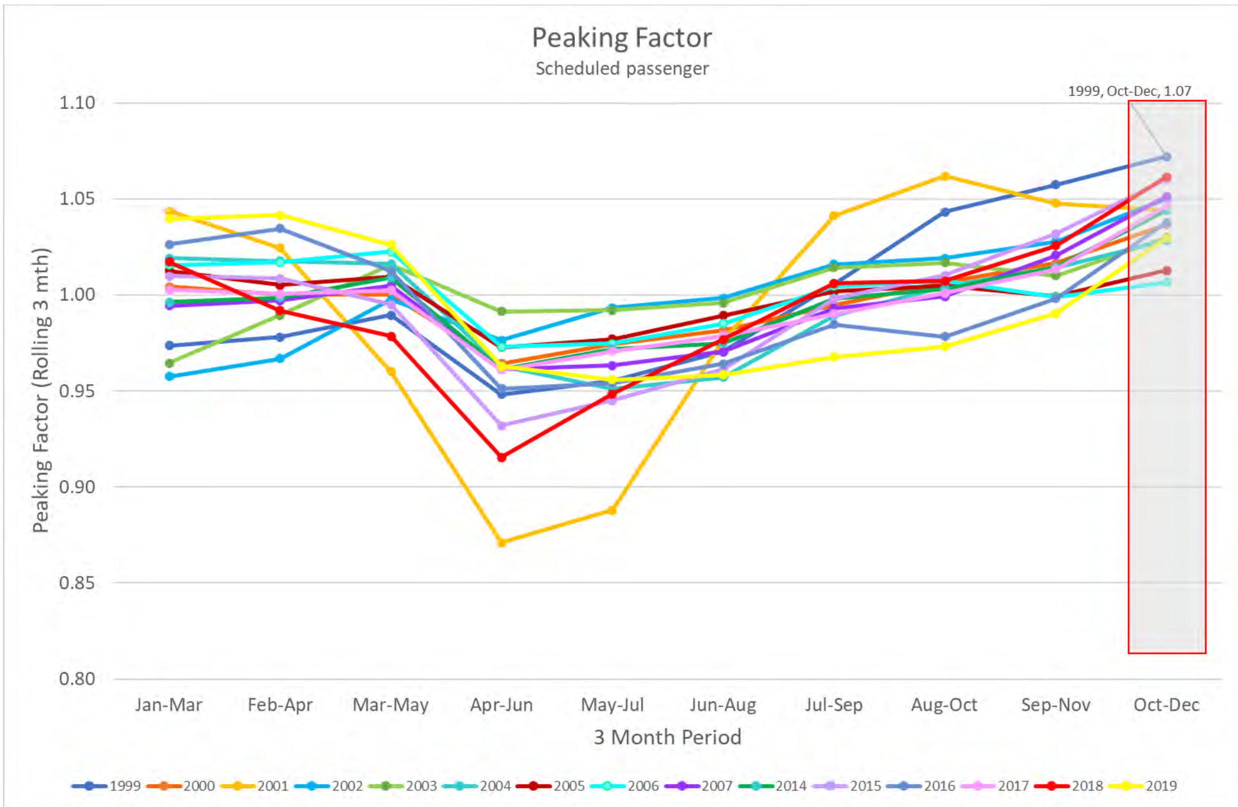
Calibration Example for Boeing 787900

	Aircraft	Op Type	Stage	Profile	Puh	Vel	Pric	Shp	Ste	Chosen
Boeing 787900 Arrival Calibration										
Measured	B789	A	1	N/A	84.7	86.4	83.0	91.1	93.6	
Modelled Opt1	7878R	A	1	STANDARD	83.9	84.5	83.7	92.5	94.2	Y
Modelled Opt2	777200	A	1	STANDARD	86.0	86.4	86.1	95.0	97.1	
Deviation Opt 1	7878R	A	1	STANDARD	-0.8	-1.9	0.7	1.4	0.6	
Deviation Opt 2	777200	A	1	STANDARD	1.3	0.0	3.1	3.9	3.5	
Boeing 787900 Departure Stage 7 Calibration										
Measured	B789	D	7		84.7	84.5	87.0	91.4	94.6	
Modelled Opt 1	7878R	D	7	STANDARD	81.9	80.7	85.4	87.9	90.3	
Modelled Opt 2	7878R	D	7	ICAOA	81.4	80.2	84.6	86.6	90.6	
Modelled Opt 3	7878R	D	7	ICAOB	80.9	79.7	86.3	89.0	91.6	
Modelled Opt 4	777200	D	7	STANDARD	85.0	83.9	88.0	91.0	93.4	Y
Modelled Opt 5	777200	D	7	ICAO_A	84.0	83.1	87.3	90.7	96.5	
Modelled Opt 6	777200	D	7	ICAO_B	83.5	82.6	90.8	93.7	96.6	
Deviation Opt 1	7878R	D	7	STANDARD	-2.8	-3.8	-1.6	-3.5	-4.3	
Deviation Opt 2	7878R	D	7	ICAOA	-3.3	-4.3	-2.4	-4.8	-4.0	
Deviation Opt 3	7878R	D	7	ICAOB	-3.8	-4.8	-0.7	-2.4	-3.0	
Deviation Opt 4	777200	D	7	STANDARD	0.3	-0.6	1.0	-0.4	-1.2	
Deviation Opt 5	777200	D	7	ICAO_A	-0.7	-1.4	0.3	-0.7	1.9	
Deviation Opt 6	777200	D	7	ICAO_B	-1.2	-1.9	3.8	2.3	2.0	

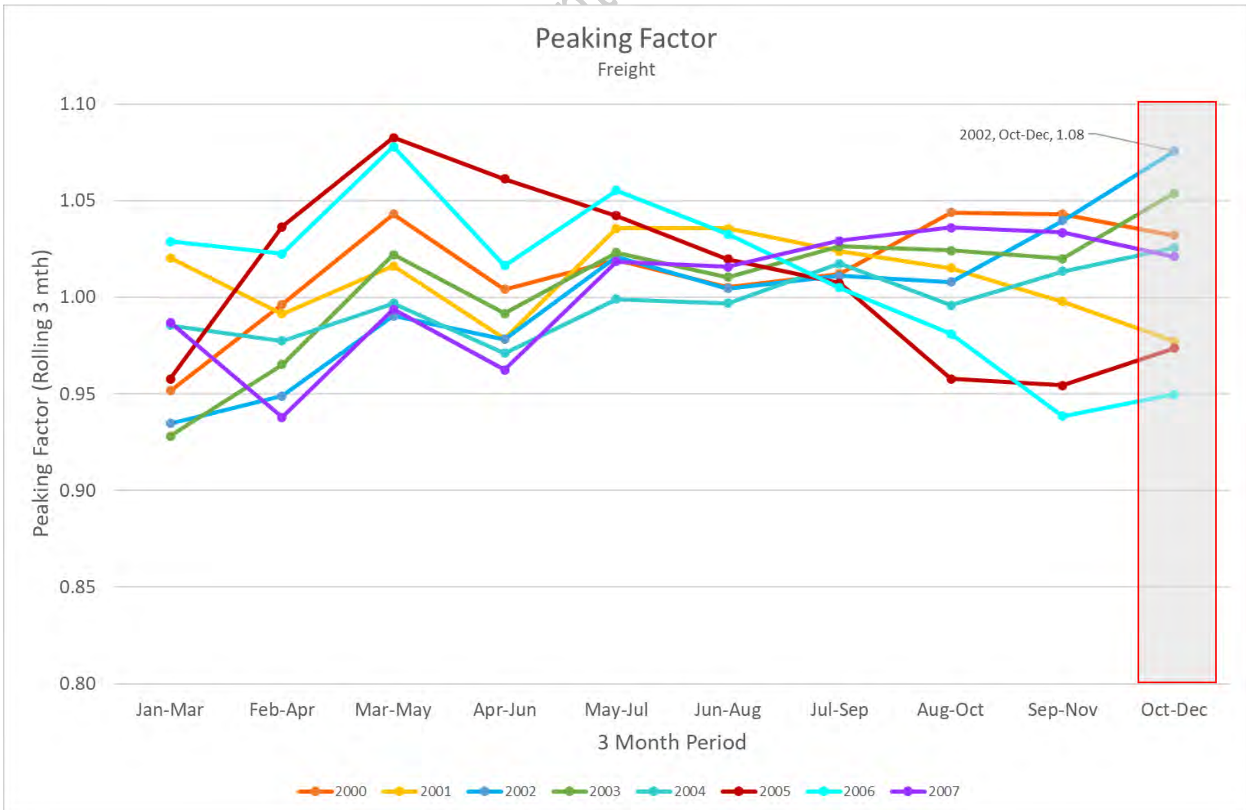
*Puh, Vel and Pri are the Auckland Airport monitoring locations. Shp and Ste are the monitoring locations at Christchurch Airport.

APPENDIX K PEAKING FACTOR GRAPHS

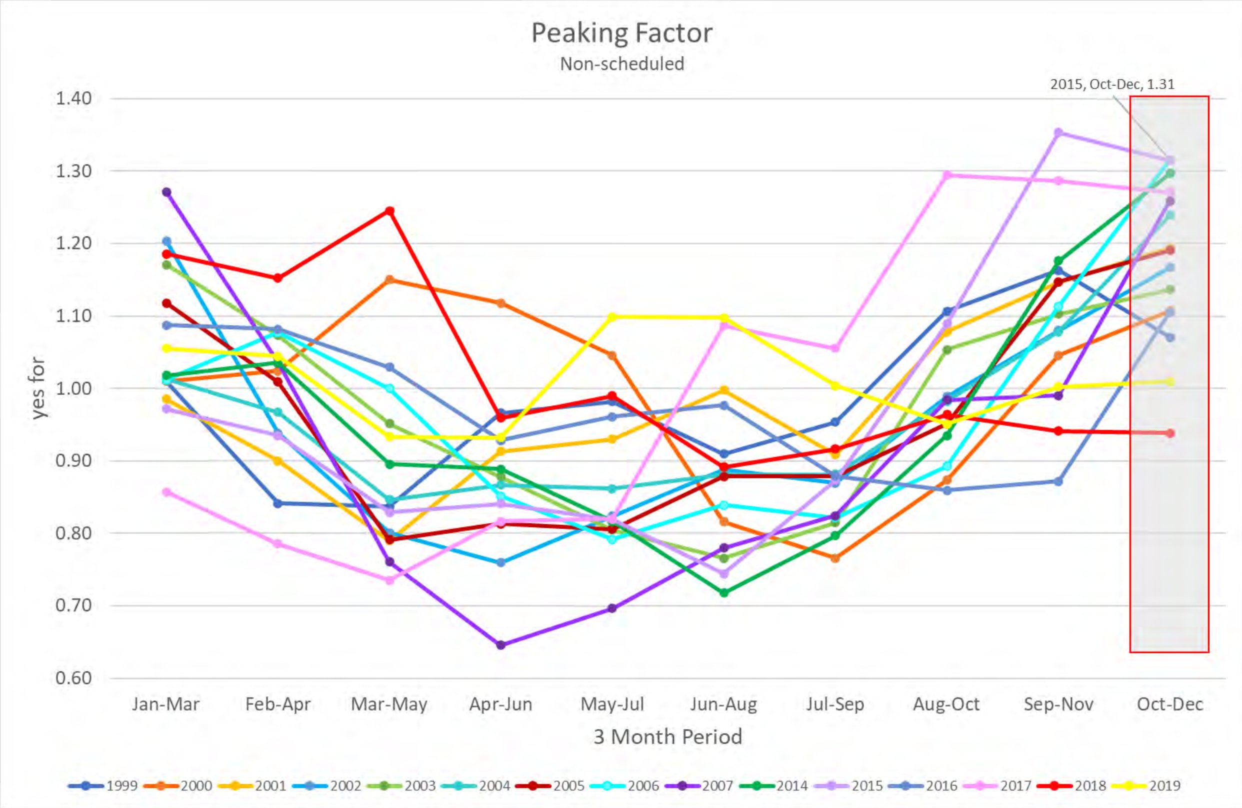
K1 Scheduled Passenger



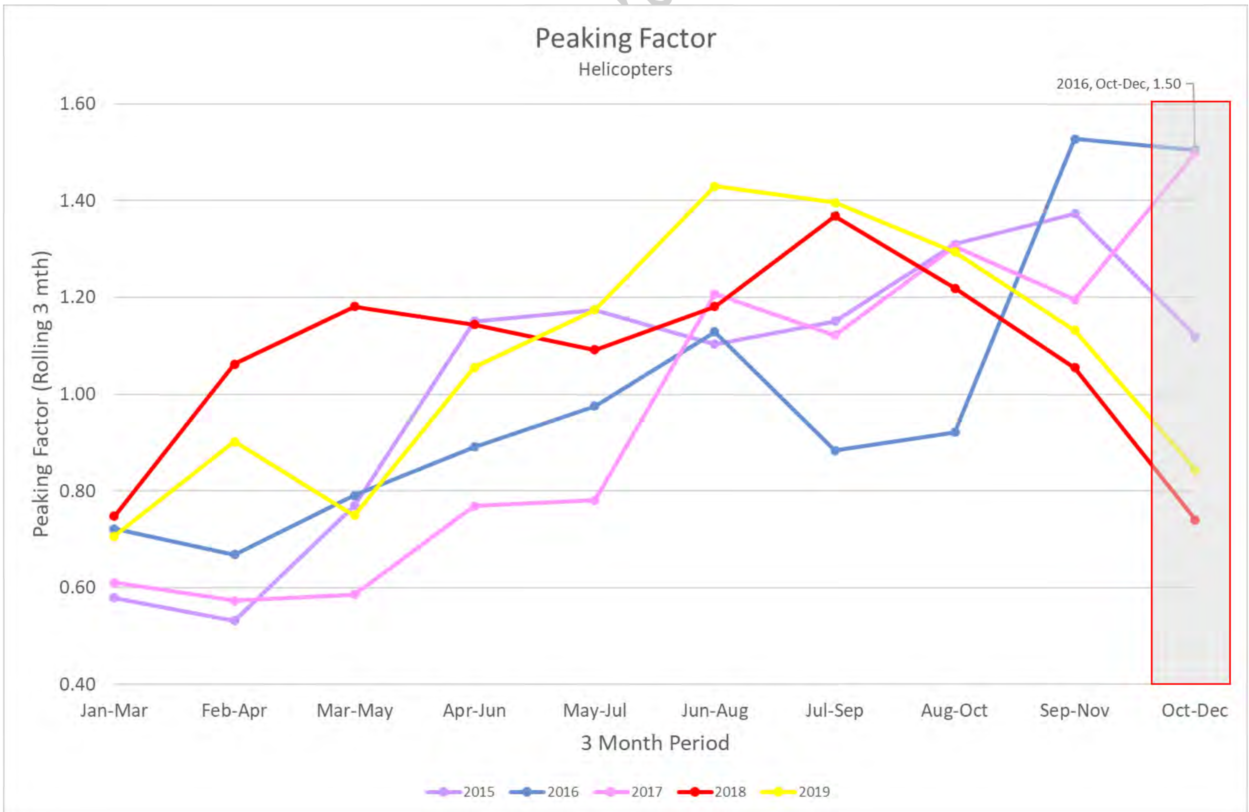
K2 Freight



K3 FBO/small commercial, airline/MRO, Antarctic, military and government



K4 Helicopters



MARSHALL DAY Acoustics

APPENDIX L AIRCRAFT TYPES

L1 Current fleet

Sector	Region	Aircraft Category	Aircraft	INM Equivalent	% Use
Int	North America	VLWB	A388	A380-861	100%
Int	North America	MWB	B772	772USER	34%
Int	North America	MWB	B789	7878R	33%
Int	North America	MWB	A359	A359USER	33%
Int	North America	SWB	B788	7878R	100%
Int	Hawaii	MWB	B772	772USER	34%
Int	Hawaii	MWB	B789	7878R	33%
Int	Hawaii	MWB	A359	A359USER	33%
Int	Hawaii	SWB	B788	7878R	100%
Int	Pacific Islands East	MWB	B772	772USER	34%
Int	Pacific Islands East	MWB	B789	7878R	33%
Int	Pacific Islands East	MWB	A359	A359USER	33%
Int	Pacific Islands East	SWB	B788	7878R	100%
Int	Pacific Islands East	MNB	A320	A320USER	50%
Int	Pacific Islands East	MNB	B738	737800	50%
Int	Pacific Islands North	MWB	B772	772USER	34%
Int	Pacific Islands North	MWB	B789	7878R	33%
Int	Pacific Islands North	MWB	A359	A359USER	33%
Int	Pacific Islands North	SWB	B788	7878R	100%
Int	Pacific Islands North	LNB	A320	A320USER	100%
Int	Pacific Islands North	MNB	A320	A320USER	50%
Int	Pacific Islands North	MNB	B738	737800	50%
Int	South East Asia	VLWB	A388	A380-861	100%
Int	South East Asia	MWB	B772	772USER	34%
Int	South East Asia	MWB	B789	7878R	33%
Int	South East Asia	MWB	A359	A359USER	33%
Int	South East Asia	SWB	B788	7878R	100%
Int	East Asia	VLWB	A388	A380-861	100%
Int	East Asia	LWB	B772	772USER	100%
Int	East Asia	MWB	B772	772USER	34%
Int	East Asia	MWB	B789	7878R	33%
Int	East Asia	MWB	A359	A359USER	33%
Int	East Asia	SWB	B788	7878R	100%
Int	North East Asia	VLWB	A388	A380-861	100%
Int	North East Asia	MWB	B772	772USER	34%
Int	North East Asia	MWB	B789	7878R	33%
Int	North East Asia	MWB	A359	A359USER	33%
Int	North East Asia	SWB	B788	7878R	100%
Int	India	MWB	B772	772USER	34%
Int	India	MWB	B789	7878R	33%
Int	India	MWB	A359	A359USER	33%
Int	India	SWB	B788	7878R	100%
Int	Middle East	VLWB	A388	A380-861	100%

Int	Middle East	MWB	B772	772USER	34%
Int	Middle East	MWB	B789	7878R	33%
Int	Middle East	MWB	A359	A359USER	33%
Int	Middle East	SWB	B788	7878R	100%
Int	Western Australia	MWB	B772	772USER	34%
Int	Western Australia	MWB	B789	7878R	33%
Int	Western Australia	MWB	A359	A359USER	33%
Int	Western Australia	SWB	B788	7878R	100%
Int	Western Australia	LNB	A320	A320USER	100%
Int	Western Australia	MNB	A320	A320USER	50%
Int	Western Australia	MNB	B738	737800	50%
Int	Trans-Tasman	LWB	B772	772USER	100%
Int	Trans-Tasman	SWB	B788	7878R	100%
Int	Trans-Tasman	LNB	A320	A320USER	100%
Int	Trans-Tasman	MNB	A320	A320USER	50%
Int	Trans-Tasman	MNB	B738	737800	50%
Dom	Auckland	MWB	B772	772USER	50%
Dom	Auckland	MWB	B789	7878R	50%
Dom	Auckland	SWB	B788	7878R	100%
Dom	Auckland	LNB	A320	A320USER	100%
Dom	Auckland	MNB	A320	A320USER	100%
Reg	Hamilton	MNB	A320	A320USER	100%
Reg	Hamilton	LTP	AT76	ATR72	100%
Reg	Hamilton	MTP	DH8C	DHC830	100%
Reg	Tauranga	MNB	A320	A320USER	100%
Reg	Tauranga	LTP	AT76	ATR72	100%
Reg	Tauranga	MTP	DH8C	DHC830	100%
Reg	Rotorua	MNB	A320	A320USER	100%
Reg	Rotorua	LTP	AT76	ATR72	100%
Reg	Rotorua	MTP	DH8C	DHC830	100%
Reg	Napier	MNB	A320	A320USER	100%
Reg	Napier	LTP	AT76	ATR72	100%
Reg	Napier	MTP	DH8C	DHC830	100%
Reg	New Plymouth	MNB	A320	A320USER	100%
Reg	New Plymouth	LTP	AT76	ATR72	100%
Reg	New Plymouth	MTP	DH8C	DHC830	100%
Reg	Palmerston North	MNB	A320	A320USER	100%
Reg	Palmerston North	LTP	AT76	ATR72	100%
Reg	Palmerston North	MTP	DH8C	DHC830	100%
Dom	Wellington	MNB	A320	A320USER	100%
Dom	Wellington	LTP	AT76	ATR72	100%
Dom	Wellington	MTP	DH8C	DHC830	100%
Reg	Nelson	MNB	A320	A320USER	100%
Reg	Nelson	LTP	AT76	ATR72	100%
Reg	Nelson	MTP	DH8C	DHC830	100%
Reg	Blenheim	MNB	A320	A320USER	100%
Reg	Blenheim	LTP	AT76	ATR72	100%

Reg	Blenheim	MTP	DH8C	DHC830	100%
Reg	Blenheim	STP	???	GASEPF	100%
Reg	Blenheim	VSTP	PC12	PC12	100%
Reg	Hokitika	MNB	A320	A320USER	100%
Reg	Hokitika	LTP	AT76	ATR72	100%
Reg	Hokitika	MTP	DH8C	DHC830	100%
Reg	Hokitika	VSTP	PC12	PC12	100%
Reg	Dunedin	MNB	A320	A320USER	100%
Reg	Dunedin	LTP	AT76	ATR72	100%
Reg	Dunedin	MTP	DH8C	DHC830	100%
Reg	Queenstown	MNB	A320	A320USER	100%
Reg	Queenstown	LTP	AT76	ATR72	100%
Reg	Queenstown	MTP	DH8C	DHC830	100%
Reg	Invercargill	MNB	A320	A320USER	100%
Reg	Invercargill	LTP	AT76	ATR72	100%
Reg	Invercargill	MTP	DH8C	DHC830	100%
Reg	Chatham Islands	MNB	A320	A320USER	100%
Reg	Chatham Islands	LTP	AT76	ATR72	100%
Reg	Chatham Islands	MTP	DH8C	DHC830	100%
Reg	Chatham Islands	VSTP	PC12	PC12	100%
Reg	Other North Regional	MNB	A320	A320USER	100%
Reg	Other North Regional	LTP	AT76	ATR72	100%
Reg	Other North Regional	MTP	DH8C	DHC830	100%
Reg	Other North Regional	VSTP	PC12	PC12	100%
Reg	Other South Regional	MNB	A320	A320USER	100%
Reg	Other South Regional	LTP	AT76	ATR72	100%
Reg	Other South Regional	MTP	DH8C	DHC830	100%
Reg	Other South Regional	VSTP	PC12	PC12	100%
Reg	Other West Regional	MNB	A320	A320USER	100%
Reg	Other West Regional	LTP	AT76	ATR72	100%
Reg	Other West Regional	MTP	DH8C	DHC830	100%
Reg	Other West Regional	VSTP	PC12	PC12	100%
Int	Trans-Tasman	MWB	B788	7878R	34%
Int	Trans-Tasman	MWB	B789	7878R	33%
Int	Trans-Tasman	MWB	A359	A359USER	33%
Reg	Palmerston North	VSTP	PC12	PC12	100%

L2 Future Fleet

Sector	Region	Aircraft Category	Aircraft	INM Equivalent	% Use
Int	North America	VLWB	A388	A380-861	100%
Int	North America	LWB	B779	779USER	100%
Int	North America	MWB	B789	7878R	34%
Int	North America	MWB	A359	A359USER	33%
Int	North America	MWB	B778	778USER	33%
Int	North America	SWB	B788	7878R	100%
Int	Hawaii	LWB	B779	779USER	100%
Int	Hawaii	MWB	B789	7878R	34%
Int	Hawaii	MWB	A359	A359USER	33%
Int	Hawaii	MWB	B778	778USER	33%
Int	Hawaii	SWB	B788	7878R	50%
Int	Hawaii	SWB	B797	797USER	50%
Int	Pacific Islands East	MWB	B789	7878R	34%
Int	Pacific Islands East	MWB	A359	A359USER	33%
Int	Pacific Islands East	MWB	B778	778USER	33%
Int	Pacific Islands East	SWB	B788	7878R	50%
Int	Pacific Islands East	SWB	B797	797USER	50%
Int	Pacific Islands East	LNB	A21N	A21NUSER	100%
Int	Pacific Islands East	MNB	A20N	A20NUSER	50%
Int	Pacific Islands East	MNB	B38M	B38MUSER	50%
Int	Pacific Islands North	MWB	B789	7878R	34%
Int	Pacific Islands North	MWB	A359	A359USER	33%
Int	Pacific Islands North	MWB	B778	778USER	33%
Int	Pacific Islands North	SWB	B788	7878R	50%
Int	Pacific Islands North	SWB	B797	797USER	50%
Int	Pacific Islands North	LNB	A21N	A21NUSER	100%
Int	Pacific Islands North	MNB	A20N	A20NUSER	50%
Int	Pacific Islands North	MNB	B38M	B38MUSER	50%
Int	South East Asia	VLWB	A388	A380-861	100%
Int	South East Asia	LWB	B779	779USER	100%
Int	South East Asia	MWB	B789	7878R	34%
Int	South East Asia	MWB	A359	A359USER	33%
Int	South East Asia	MWB	B778	778USER	33%
Int	South East Asia	SWB	B788	7878R	50%
Int	South East Asia	SWB	B797	797USER	50%
Int	South East Asia	LNB	A21N	A21NUSER	100%
Int	East Asia	VLWB	A388	A380-861	100%
Int	East Asia	LWB	B779	779USER	100%
Int	East Asia	MWB	B789	7878R	34%
Int	East Asia	MWB	A359	A359USER	33%
Int	East Asia	MWB	B778	778USER	33%
Int	East Asia	SWB	B788	7878R	50%
Int	East Asia	SWB	B797	797USER	50%
Int	East Asia	LNB	A21N	A21NUSER	100%

Int	North East Asia	VLWB	A388	A380-861	100%
Int	North East Asia	LWB	B779	779USER	100%
Int	North East Asia	MWB	B789	7878R	34%
Int	North East Asia	MWB	A359	A359USER	33%
Int	North East Asia	MWB	B778	778USER	33%
Int	North East Asia	SWB	B788	7878R	50%
Int	North East Asia	SWB	B797	797USER	50%
Int	North East Asia	LNB	A21N	A21NUSER	100%
Int	India	LWB	B779	779USER	100%
Int	India	MWB	B789	7878R	34%
Int	India	MWB	A359	A359USER	33%
Int	India	MWB	B778	778USER	33%
Int	India	SWB	B788	7878R	50%
Int	India	SWB	B797	797USER	50%
Int	India	LNB	A21N	A21NUSER	100%
Int	Middle East	VLWB	A388	A380-861	100%
Int	Middle East	LWB	B779	779USER	100%
Int	Middle East	MWB	B789	7878R	34%
Int	Middle East	MWB	A359	A359USER	33%
Int	Middle East	MWB	B778	778USER	33%
Int	Middle East	SWB	B788	7878R	50%
Int	Middle East	SWB	B797	797USER	50%
Int	Middle East	LNB	A21N	A21NUSER	100%
Int	Western Australia	MWB	B789	7878R	34%
Int	Western Australia	MWB	A359	A359USER	33%
Int	Western Australia	MWB	B778	778USER	33%
Int	Western Australia	SWB	B788	7878R	50%
Int	Western Australia	SWB	B797	797USER	50%
Int	Western Australia	LNB	A21N	A21NUSER	100%
Int	Western Australia	MNB	A20N	A20NUSER	50%
Int	Western Australia	MNB	B38M	B38MUSER	50%
Int	Trans-Tasman	LWB	B779	779USER	100%
Int	Trans-Tasman	SWB	B788	7878R	50%
Int	Trans-Tasman	SWB	B797	797USER	50%
Int	Trans-Tasman	LNB	A21N	A21NUSER	100%
Int	Trans-Tasman	MNB	A20N	A20NUSER	50%
Int	Trans-Tasman	MNB	B38M	B38MUSER	50%
Dom	Auckland	MWB	B789	7878R	50%
Dom	Auckland	MWB	B778	778USER	50%
Dom	Auckland	SWB	B797	797USER	100%
Dom	Auckland	LNB	A21N	A21NUSER	100%
Dom	Auckland	MNB	A20N	A20NUSER	100%
Reg	Hamilton	LNB	A21N	A21NUSER	100%
Reg	Hamilton	MNB	A20N	A20NUSER	100%
Reg	Hamilton	LTP	AT76	ATR72	100%
Reg	Hamilton	MTP	DH8C	DHC830	100%
Reg	Tauranga	LNB	A21N	A21NUSER	100%

Reg	Tauranga	MNB	A20N	A20NUSER	100%
Reg	Tauranga	LTP	AT76	ATR72	100%
Reg	Tauranga	MTP	DH8C	DHC830	100%
Reg	Tauranga	STP	???	GASEPF	100%
Reg	Rotorua	MNB	A20N	A20NUSER	100%
Reg	Rotorua	LTP	AT76	ATR72	100%
Reg	Rotorua	LTP	DH8D	DHC830	0%
Reg	Rotorua	MTP	DH8C	DHC830	100%
Reg	Rotorua	STP	???	GASEPF	100%
Reg	Napier	MNB	A20N	A20NUSER	100%
Reg	Napier	LTP	AT76	ATR72	100%
Reg	Napier	MTP	DH8C	DHC830	100%
Reg	Napier	STP	???	GASEPF	100%
Reg	New Plymouth	MNB	A20N	A20NUSER	100%
Reg	New Plymouth	LTP	AT76	ATR72	100%
Reg	New Plymouth	MTP	DH8C	DHC830	100%
Reg	New Plymouth	STP	???	GASEPF	100%
Reg	Palmerston North	MNB	A20N	A20NUSER	100%
Reg	Palmerston North	LTP	AT76	ATR72	100%
Reg	Palmerston North	MTP	DH8C	DHC830	100%
Reg	Palmerston North	STP	???	GASEPF	100%
Dom	Wellington	MNB	A20N	A20NUSER	100%
Dom	Wellington	LTP	AT76	ATR72	100%
Dom	Wellington	MTP	DH8C	DHC830	100%
Dom	Wellington	STP	???	GASEPF	100%
Reg	Nelson	MNB	A20N	A20NUSER	100%
Reg	Nelson	LTP	AT76	ATR72	100%
Reg	Nelson	MTP	DH8C	DHC830	100%
Reg	Nelson	STP	???	GASEPF	100%
Reg	Blenheim	MNB	A20N	A20NUSER	100%
Reg	Blenheim	LTP	AT76	ATR72	100%
Reg	Blenheim	MTP	DH8C	DHC830	100%
Reg	Blenheim	STP	???	GASEPF	100%
Reg	Blenheim	VSTP	PC12	PC12	100%
Reg	Hokitika	MNB	A20N	A20NUSER	100%
Reg	Hokitika	LTP	AT76	ATR72	100%
Reg	Hokitika	MTP	DH8C	DHC830	100%
Reg	Hokitika	STP	???	GASEPF	100%
Reg	Hokitika	VSTP	PC12	PC12	100%
Reg	Dunedin	LNB	A21N	A21NUSER	100%
Reg	Dunedin	MNB	A20N	A20NUSER	100%
Reg	Dunedin	LTP	AT76	ATR72	100%
Reg	Dunedin	MTP	DH8C	DHC830	100%
Reg	Dunedin	STP	???	GASEPF	100%
Reg	Queenstown	LNB	A21N	A21NUSER	100%
Reg	Queenstown	MNB	A20N	A20NUSER	100%
Reg	Queenstown	LTP	AT76	ATR72	100%

Reg	Queenstown	MTP	DH8C	DHC830	100%
Reg	Queenstown	STP	???	GASEPF	100%
Reg	Invercargill	LNB	A21N	A21NUSER	100%
Reg	Invercargill	MNB	A20N	A20NUSER	100%
Reg	Invercargill	LTP	AT76	ATR72	100%
Reg	Invercargill	MTP	DH8C	DHC830	100%
Reg	Invercargill	STP	???	GASEPF	100%
Reg	Chatham Islands	MNB	A20N	A20NUSER	100%
Reg	Chatham Islands	LTP	AT76	ATR72	100%
Reg	Chatham Islands	MTP	DH8C	DHC830	100%
Reg	Chatham Islands	STP	???	GASEPF	100%
Reg	Chatham Islands	VSTP	PC12	PC12	100%
Reg	Other North Regional	MNB	A20N	A20NUSER	100%
Reg	Other North Regional	LTP	AT76	ATR72	100%
Reg	Other North Regional	MTP	DH8C	DHC830	100%
Reg	Other North Regional	STP	???	GASEPF	100%
Reg	Other North Regional	VSTP	PC12	PC12	100%
Reg	Other South Regional	MNB	A20N	A20NUSER	100%
Reg	Other South Regional	LTP	AT76	ATR72	100%
Reg	Other South Regional	MTP	DH8C	DHC830	100%
Reg	Other South Regional	STP	???	GASEPF	100%
Reg	Other South Regional	VSTP	PC12	PC12	100%
Reg	Other West Regional	MNB	A20N	A20NUSER	100%
Reg	Other West Regional	LTP	AT76	ATR72	100%
Reg	Other West Regional	MTP	DH8C	DHC830	100%
Reg	Other West Regional	STP	???	GASEPF	100%
Reg	Other West Regional	VSTP	PC12	PC12	100%

L3 FBO/small commercial, airline/MRO, Antarctic, military and government Fleet

Region	Aircraft Category	Aircraft	INM Equivalent	% Use
Antarctica	Heavy Four Engine Jet	C17	C17	100%
Int North East	Heavy Four Engine Jet	C17	C17	100%
Int West	Heavy Four Engine Jet	C17	C17	100%
North Island West	Heavy Two Engine Jet	B789	7878R	100%
South Island South	Light Multi Engine Piston	PA31	PA31	100%
Chatham Islands	Light Multi Engine Turboprop	BE20	BEC200	100%
Local	Light Multi Engine Turboprop	BE20	BEC200	100%
North Island Central	Light Multi Engine Turboprop	BE20	BEC200	100%
North Island East	Light Multi Engine Turboprop	BE20	BEC200	100%
North Island West	Light Multi Engine Turboprop	BE20	BEC200	100%
South Island North	Light Multi Engine Turboprop	BE20	BEC200	100%
South Island South	Light Multi Engine Turboprop	BE20	BEC200	100%
South Island West	Light Multi Engine Turboprop	BE20	BEC200	100%
Local	Light Single Engine Piston	C185	CNA185	100%
Local	Light Single Engine Turboprop	C208	CNA208	100%
North Island Central	Light Single Engine Turboprop	C208	CNA208	100%
North Island East	Light Single Engine Turboprop	C208	CNA208	100%
North Island West	Light Single Engine Turboprop	C208	CNA208	100%
South Island North	Light Single Engine Turboprop	C208	CNA208	100%
South Island South	Light Single Engine Turboprop	C208	CNA208	100%
Antarctica	Medium Four Engine Turboprop	C130	C130	100%
Int West	Medium Four Engine Turboprop	C130	C130	100%
Local	Medium Four Engine Turboprop	C130	C130	100%
North Island Central	Medium Four Engine Turboprop	C130	C130	100%
North Island East	Medium Four Engine Turboprop	C130	C130	100%
North Island West	Medium Four Engine Turboprop	C130	C130	100%
South Island North	Medium Four Engine Turboprop	C130	C130	100%
Antarctica	Medium Jet	A320	A320USER	100%
Int North	Medium Jet	A320	A320USER	100%
Int North East	Medium Jet	A320	A320USER	100%
Int West	Medium Jet	A320	A320USER	100%
Local	Medium Jet	A320	A320USER	100%
North Island Central	Medium Jet	A320	A320USER	100%
North Island East	Medium Jet	A320	A320USER	100%
North Island West	Medium Jet	A320	A320USER	100%
South Island North	Medium Jet	A320	A320USER	100%
South Island South	Medium Jet	A320	A320USER	100%
Local	Medium Two Engine Turboprop	AT76	ATR72	100%
North Island Central	Medium Two Engine Turboprop	AT76	ATR72	100%

North Island East	Medium Two Engine Turboprop	AT76	ATR72	100%
North Island West	Medium Two Engine Turboprop	AT76	ATR72	100%
South Island North	Medium Two Engine Turboprop	AT76	ATR72	100%
South Island South	Medium Two Engine Turboprop	AT76	ATR72	100%
Local	Heavy Four Engine Jet	C17	C17	100%
South Island South	Medium Four Engine Turboprop	C130	C130	100%

APPENDIX M EXPERT PANEL VS BASE CASE FLIGHT SCHEDULE

M1 Expert Panel

Aircraft	Main Runway (02/20)		Cross-runway	
	Day	Night	Day	Night
		Jets		
Boeing 737700	39	9	3	1
Boeing 737800	58	8	3	0
Boeing 767300	0	1	0	0
Boeing 777200	15	1	1	0
Boeing 777300	3	0	0	0
Boeing A320-211	106	16	6	4
Jet Total	**219**	**36**	**13**	**5**
ATR42	1	0	1	0
De Havilland Canada Dash 8	37	0	32	0
DHC830	42	2	37	2
Hawker Siddley HA 748A	63	0	56	0
Turboprop Total	**143**	**2**	**126**	**2**
Total	**363**	**37**	**139**	**7**

M2 Base Case

INM Equivalent	Main Runway (02/20)		Cross-runway	
	Day	Night	Day	Night
		Jets		
778USER	7	0	0	0
779USER	8	4	0	0
7878RAUSER	5	1	0	0
7878RDUSER	5	1	0	0
797AUSER	10	1	0	0
797DUSER	10	1	0	0
A20NAUSER	15	1	3	0
A20NDUSER	15	1	3	0
A21NAUSER	50	14	10	3
A21NDUSER	50	14	10	3
A359USER	4	0	0	0
A380-861	3	0	0	0
B38MUSER	1	0	0	0
Jet Total	**183**	**40**	**25**	**6**
		Turboprops		
ATR72	223	14	43	3
DHC830	5	0	1	0
GASEPF	5	0	1	0
PC12	9	0	2	0
Turboprop Total	**243**	**14**	**47**	**3**
Total	**426**	**53**	**72**	**9**

APPENDIX N STAGE LENGTHS BY DESTINATION

N1 Scheduled/Freight

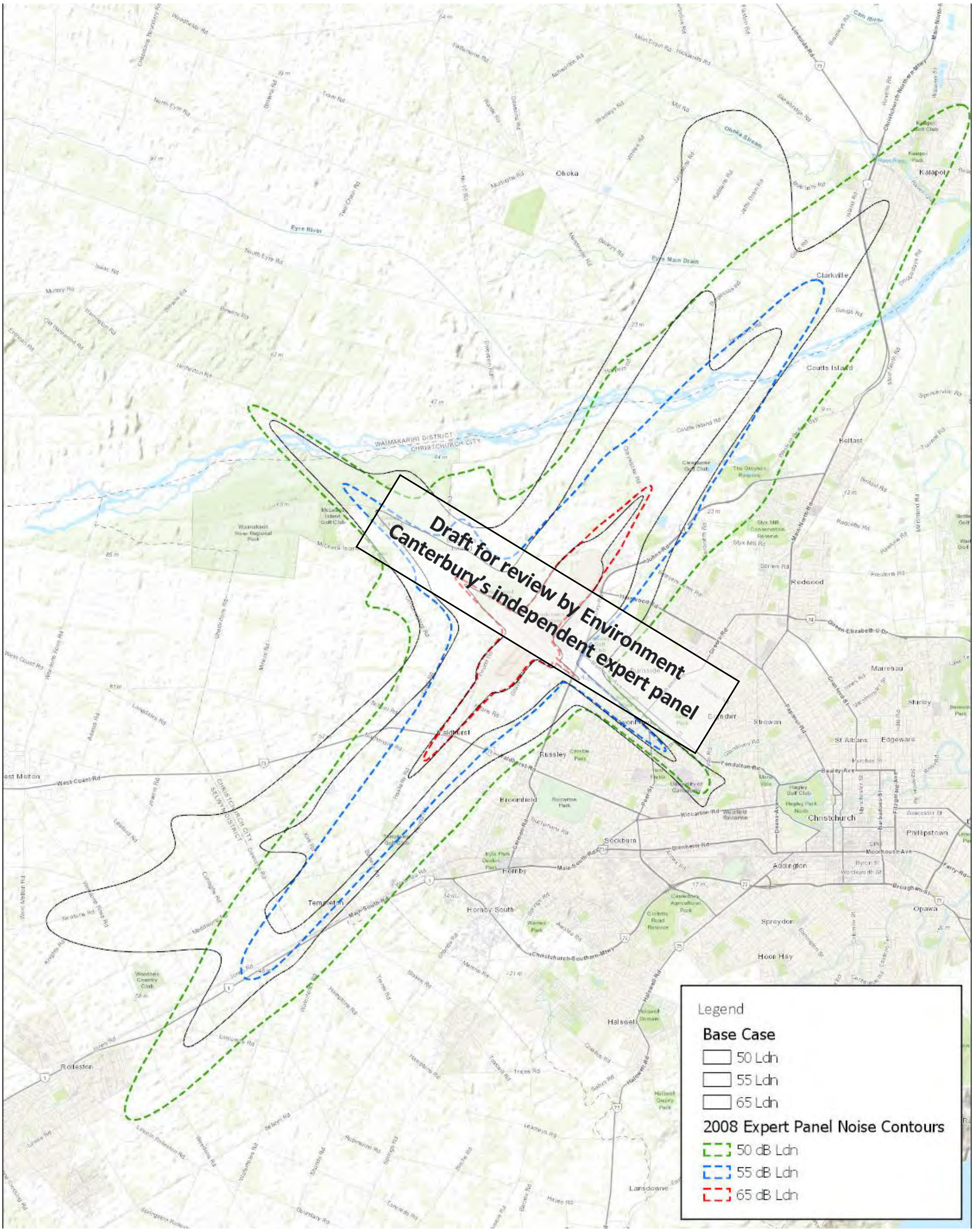
Region	Stage Length
North America	9
Hawaii	6
Pacific Islands East	4
Pacific Islands North	4
South East Asia	7
East Asia	8
North East Asia	8
India	9
Middle East	9
Western Australia	5
Trans-Tasman	3
Auckland	1
Blenheim	1
Chatham Islands	1
Dunedin	1
Hamilton	1
Hokitika	1
Invercargill	1
Napier	1
Nelson	1
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

N2 FBO/small commercial, airline/MRO, Antarctic, military and government

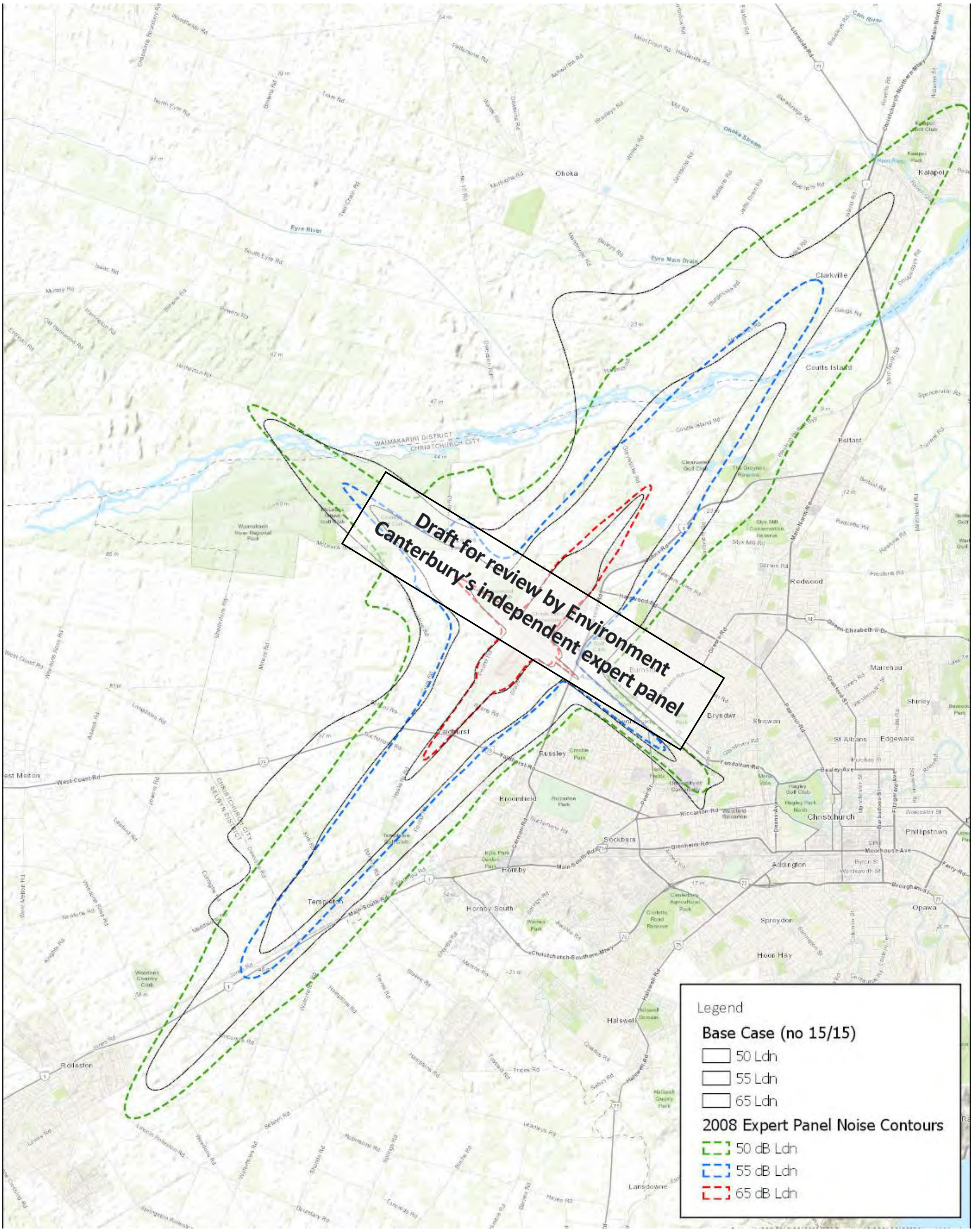
Region	Stage Length
Antarctica	5
Int North	4
Int North East	8
Int West	4
Local	1
North Island Central	1
North Island East	1
North Island West	1
South Island North	1
South Island South	1
South Island West	1

APPENDIX O SENSITIVITY RUN NOISE CONTOURS

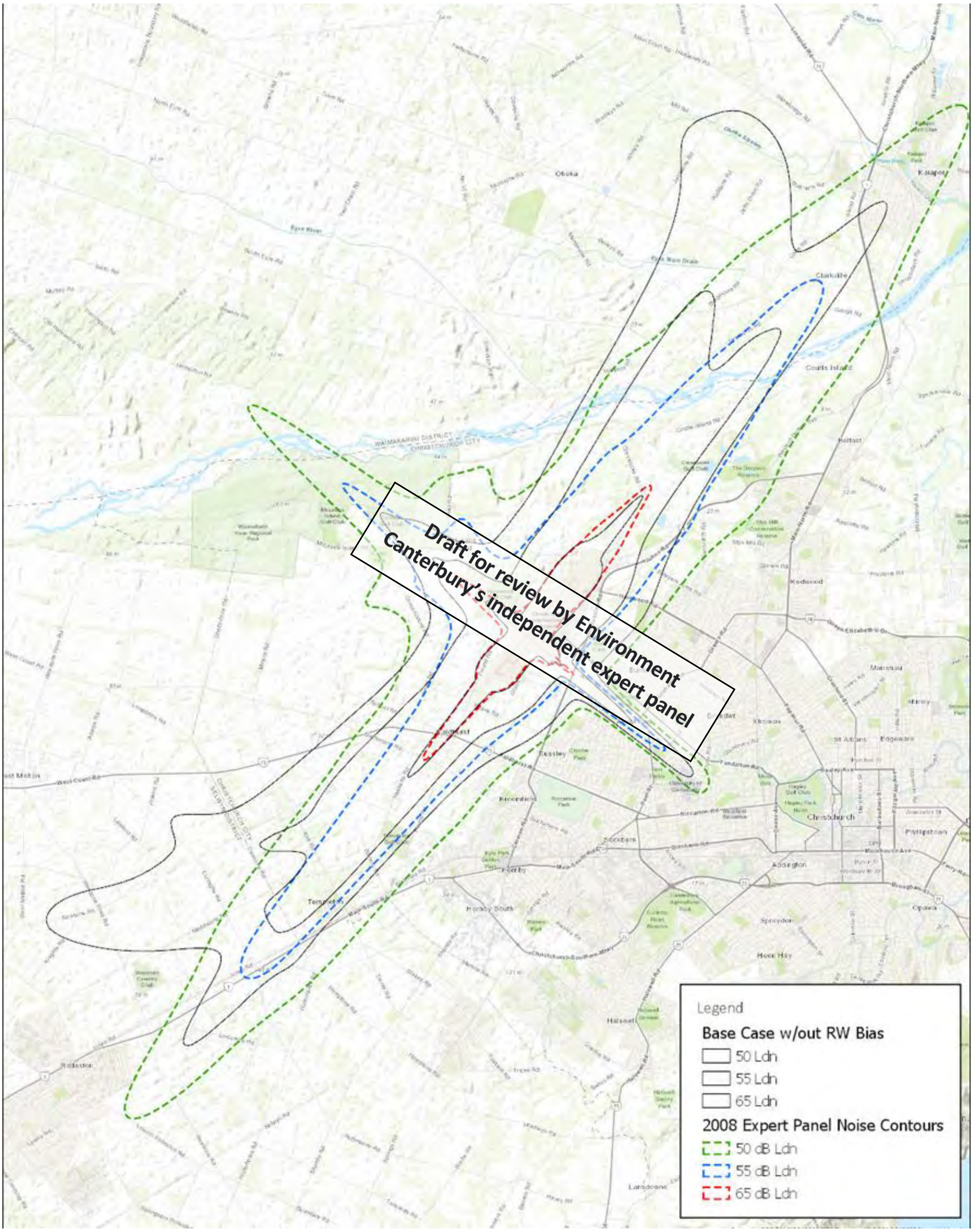
O1 Sensitivity Run 3a - Base Case



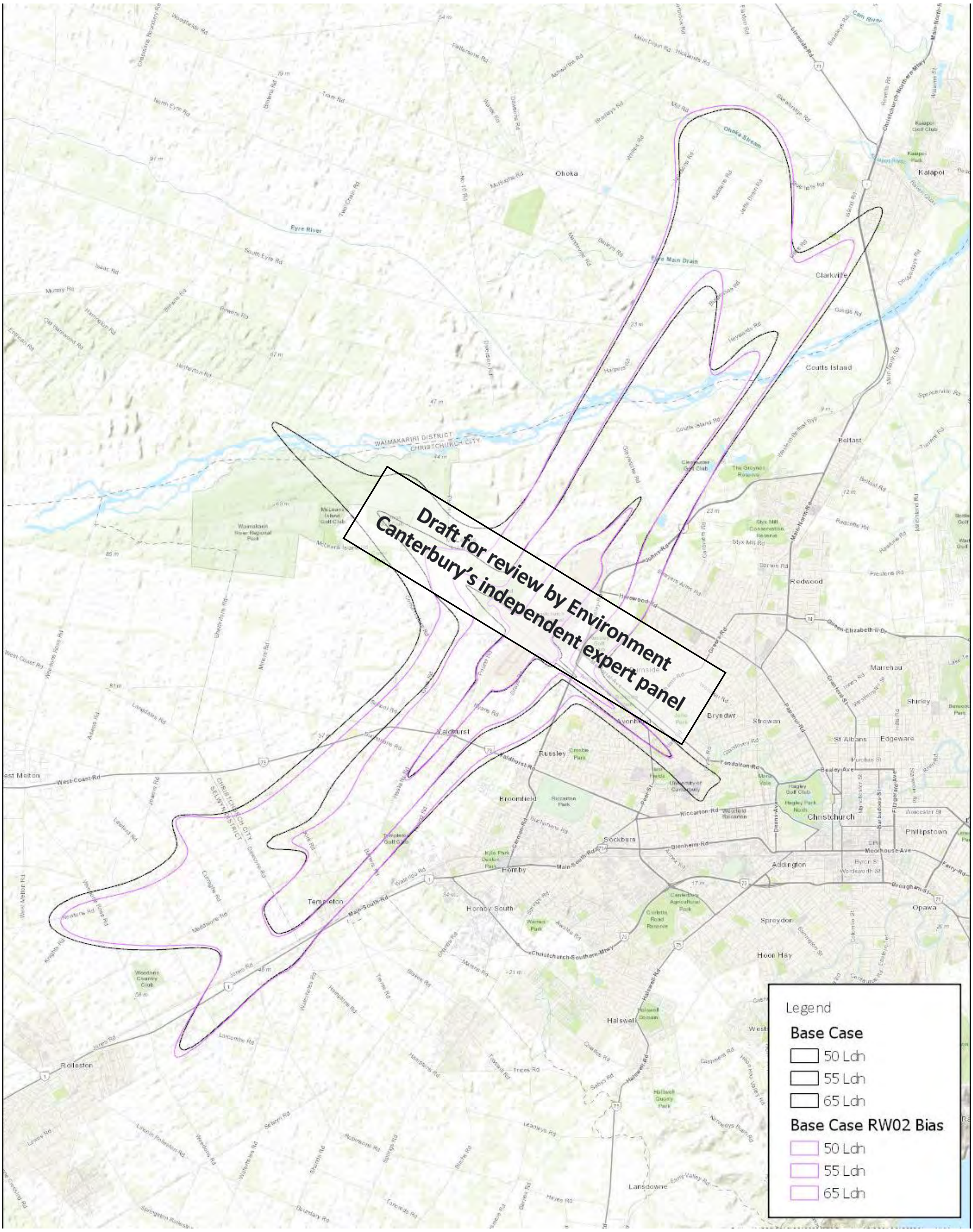
O2 Sensitivity Run 3b - Base Case without DMAPS



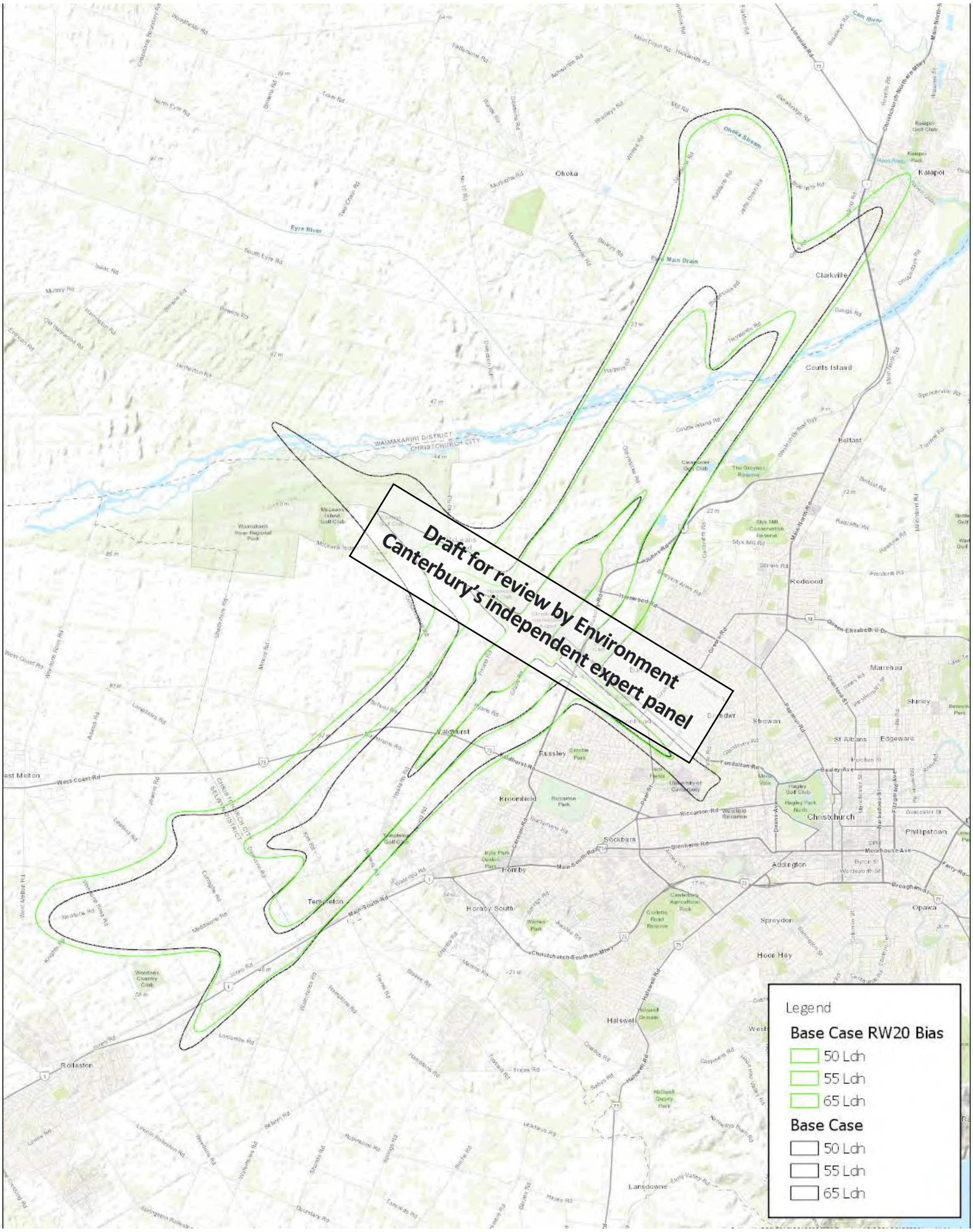
O3 Sensitivity Run 3c - Base Case without cross-runway movements factored up



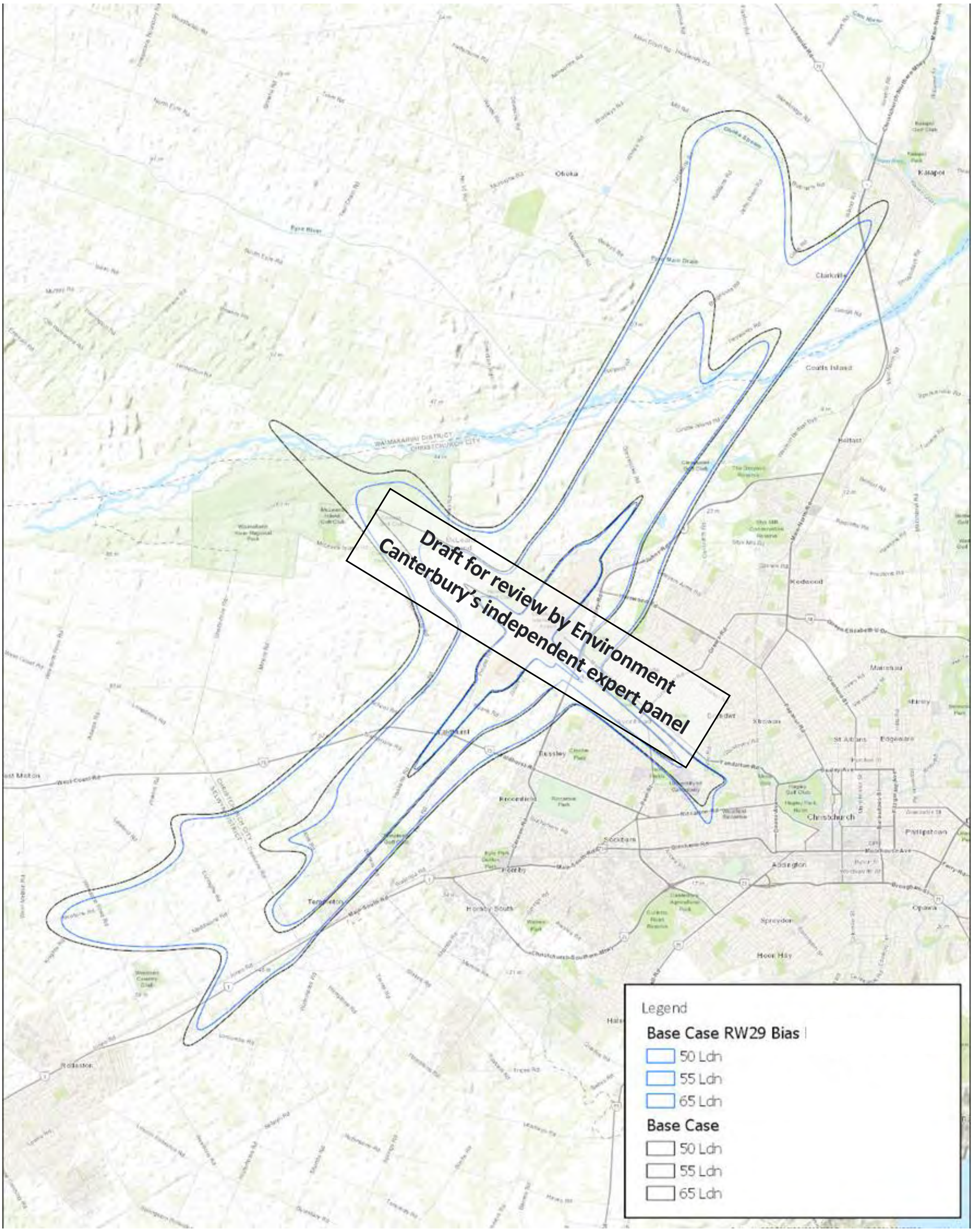
O4 Sensitivity Run 4a - Runway 02 Highest Usage



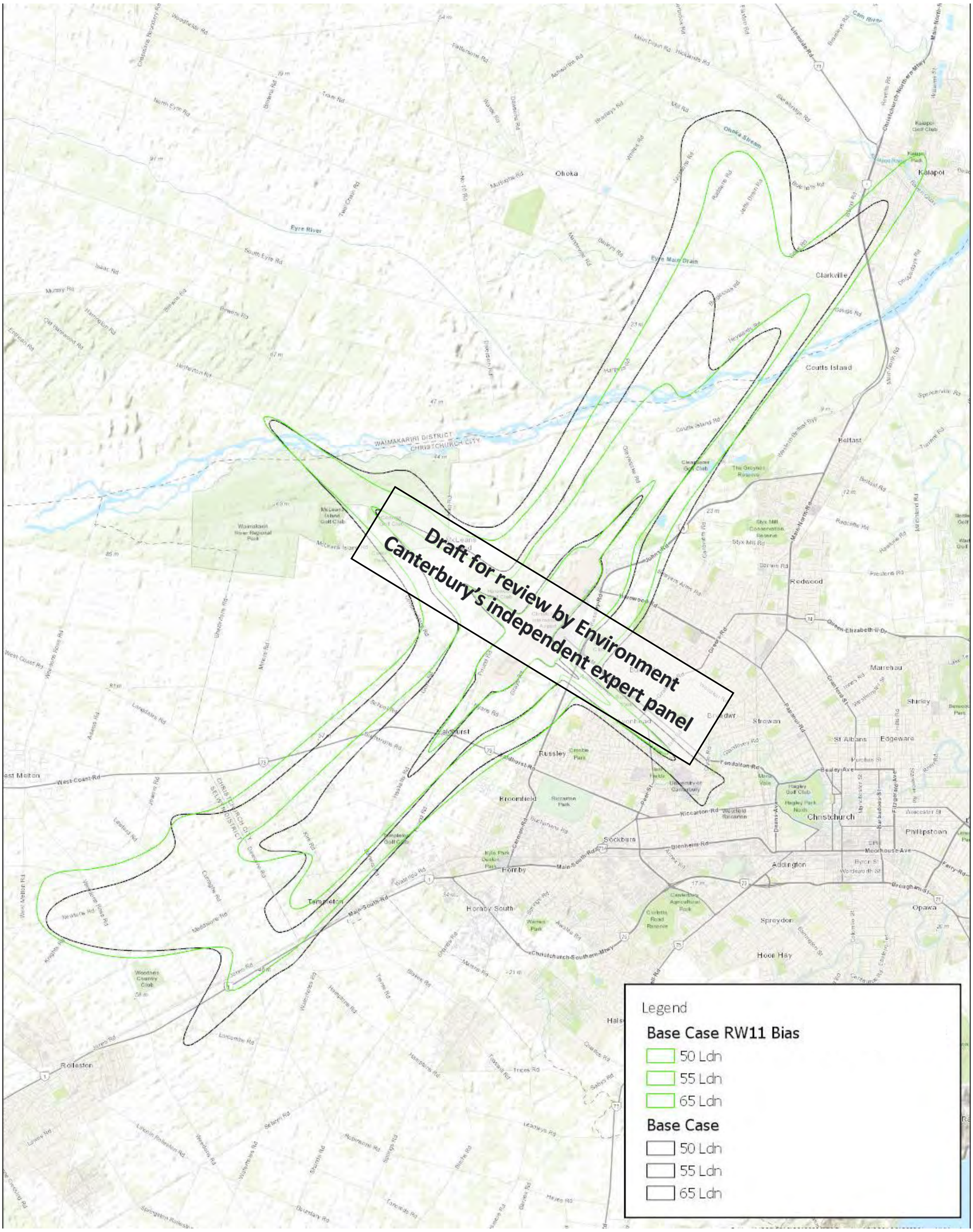
O5 Sensitivity Run 4b - Runway 20 Bias Highest Usage



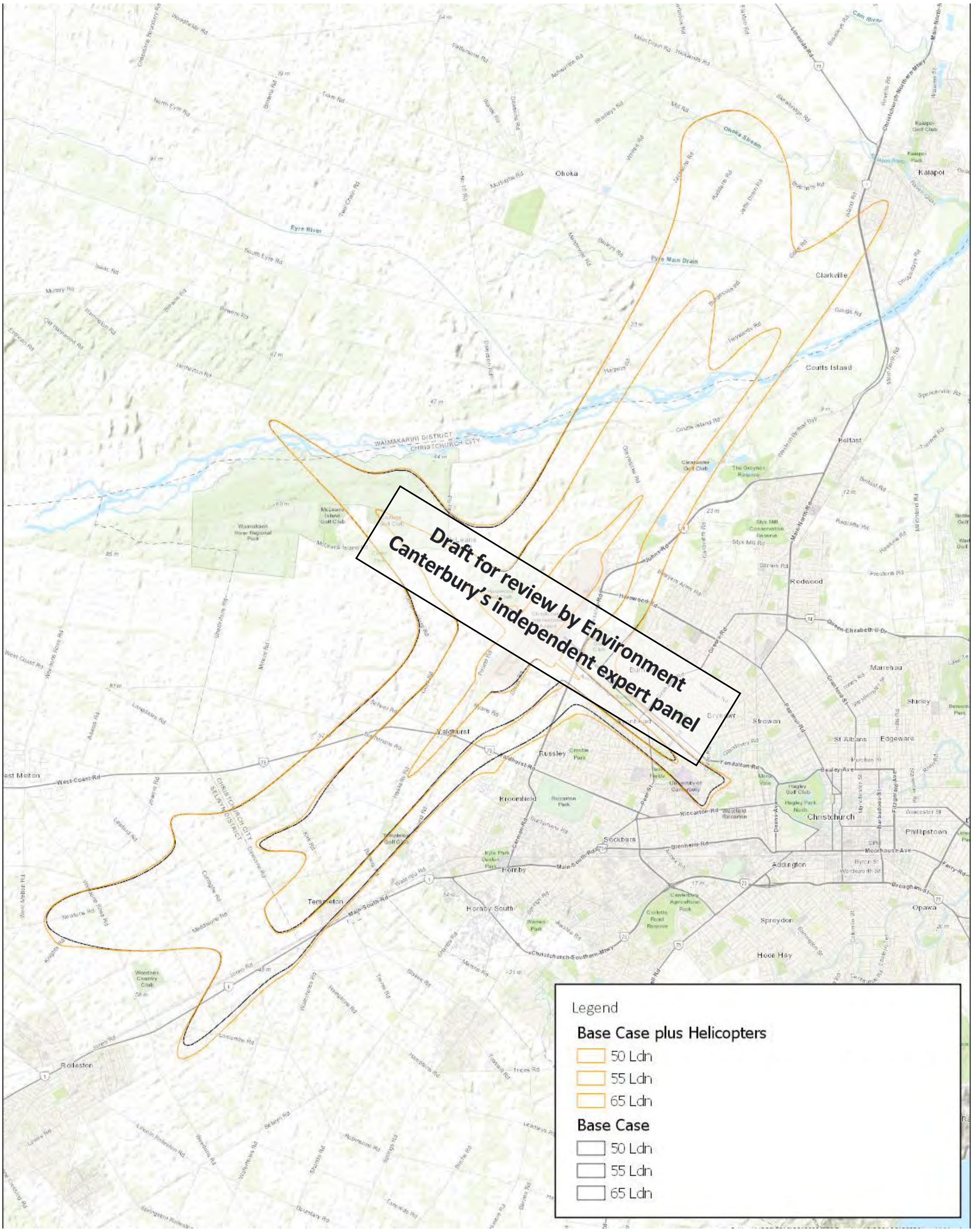
O6 Sensitivity Run 4c - Runway 29 Highest Usage



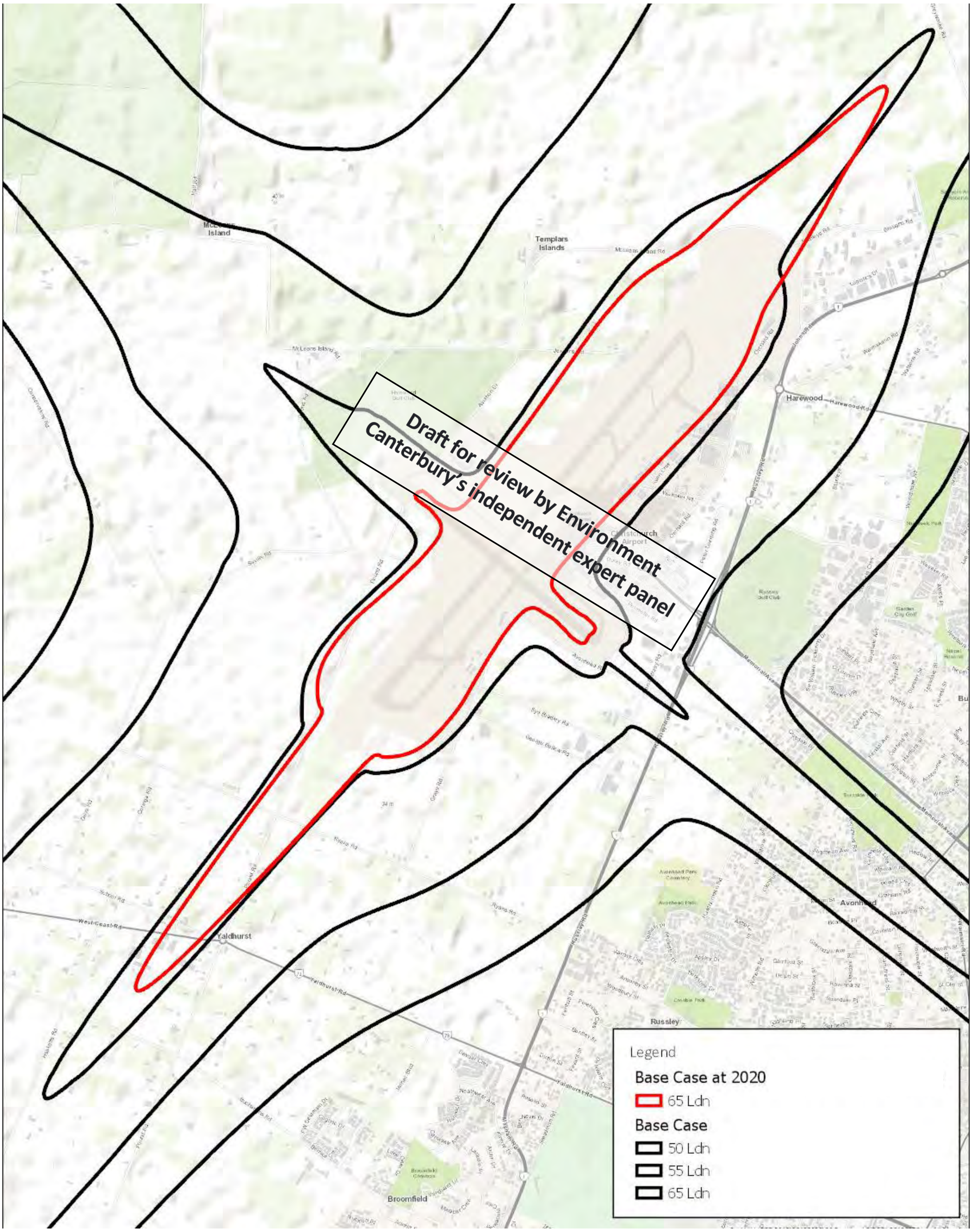
O7 Sensitivity Run 4d - Runway 11 Bias Highest Usage



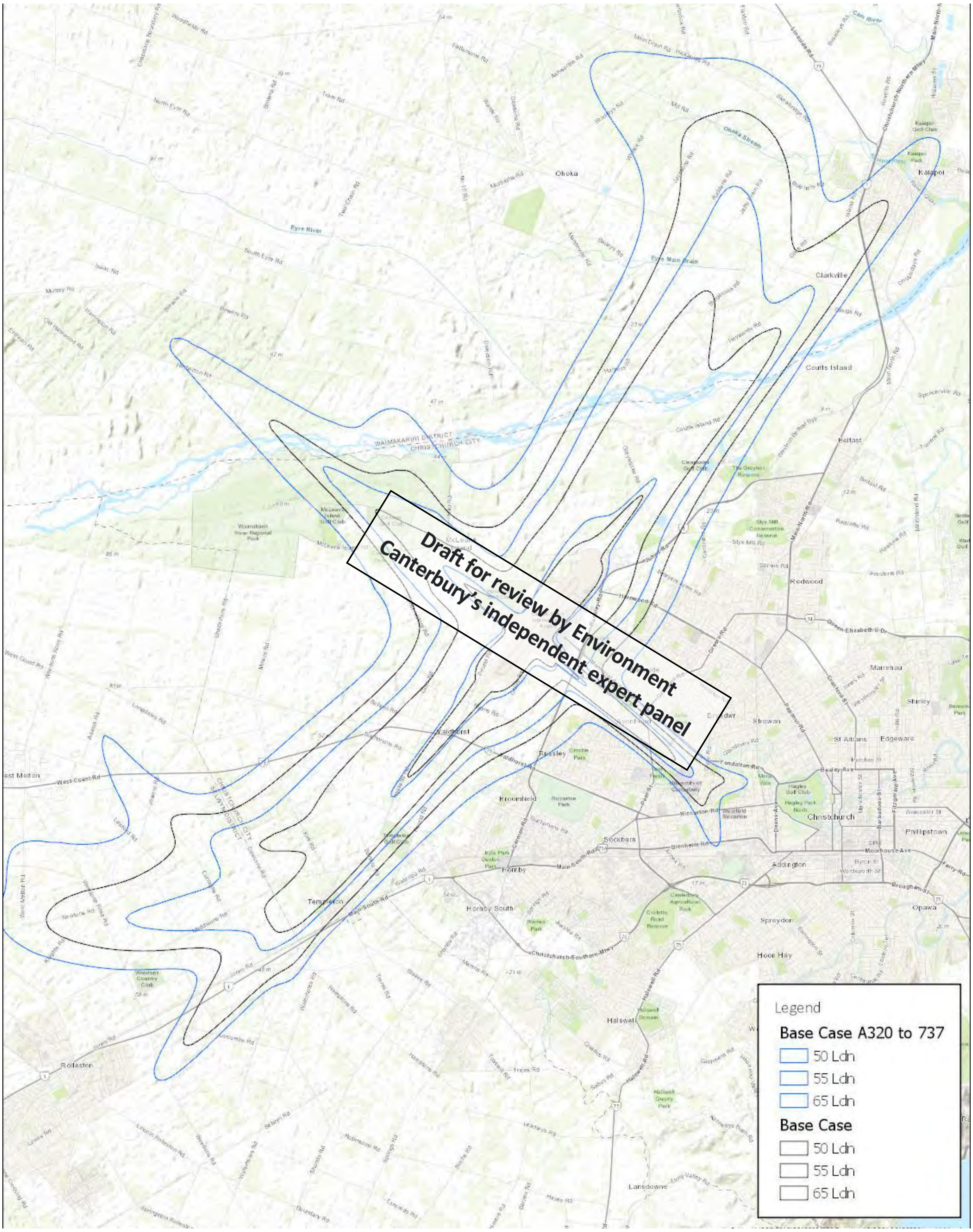
O8 Sensitivity Run 6 - Base Case with helicopters



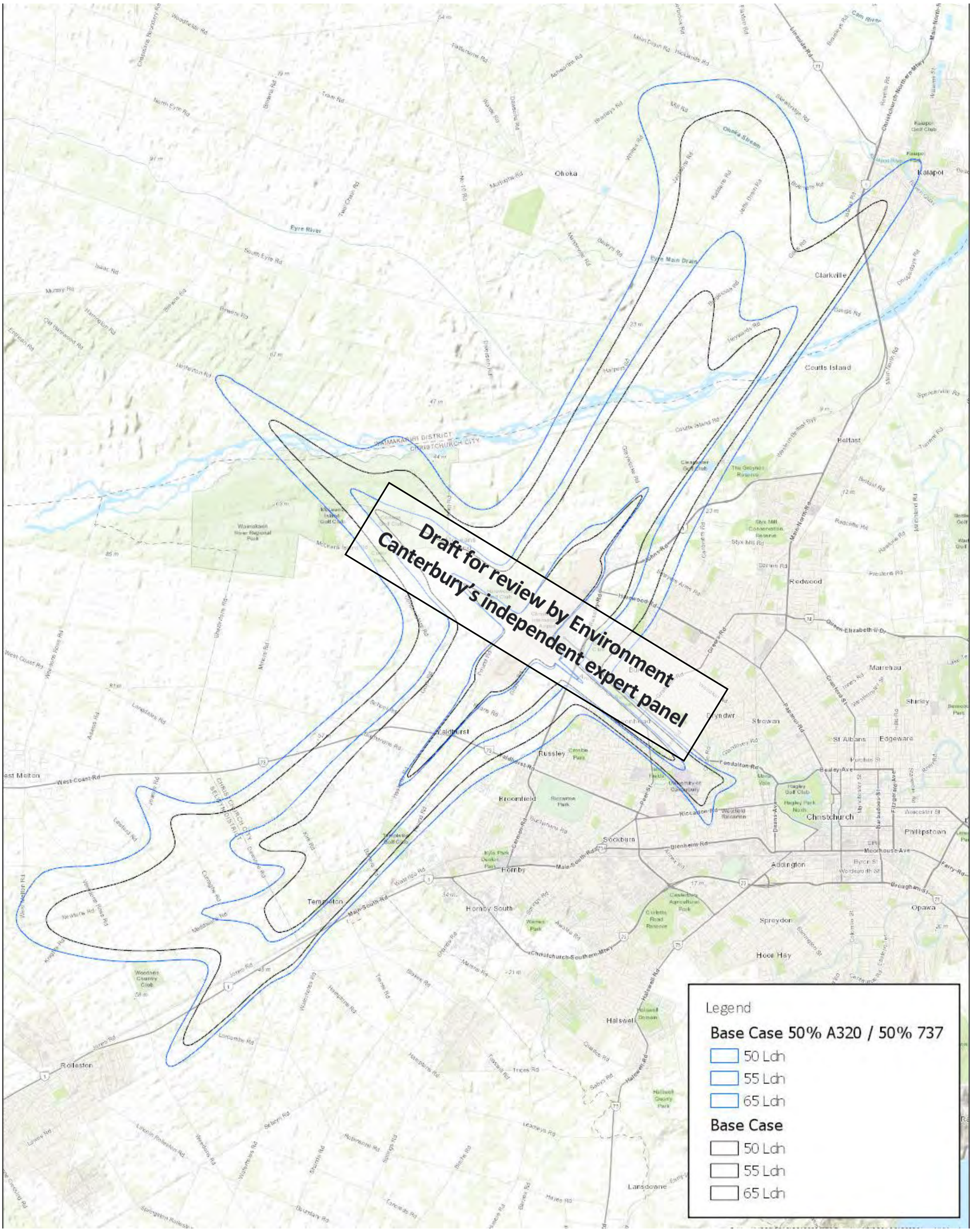
O9 Sensitivity Run 7 - 2018 Schedule Scaled to 2020 (no DMAPS departures)



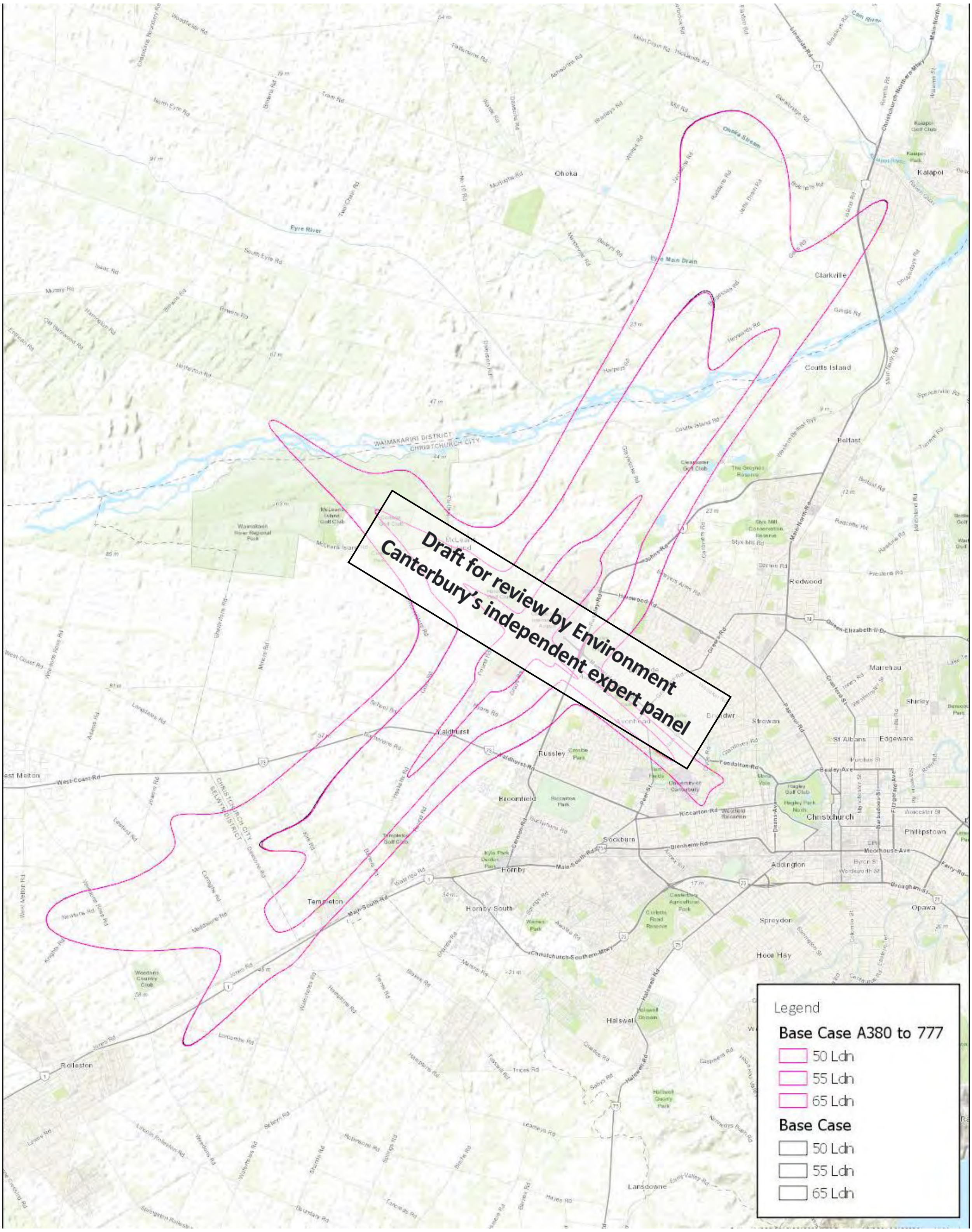
O10 Sensitivity Run 8a - Base Case with Airbus A320neos replaced by Boeing 737max



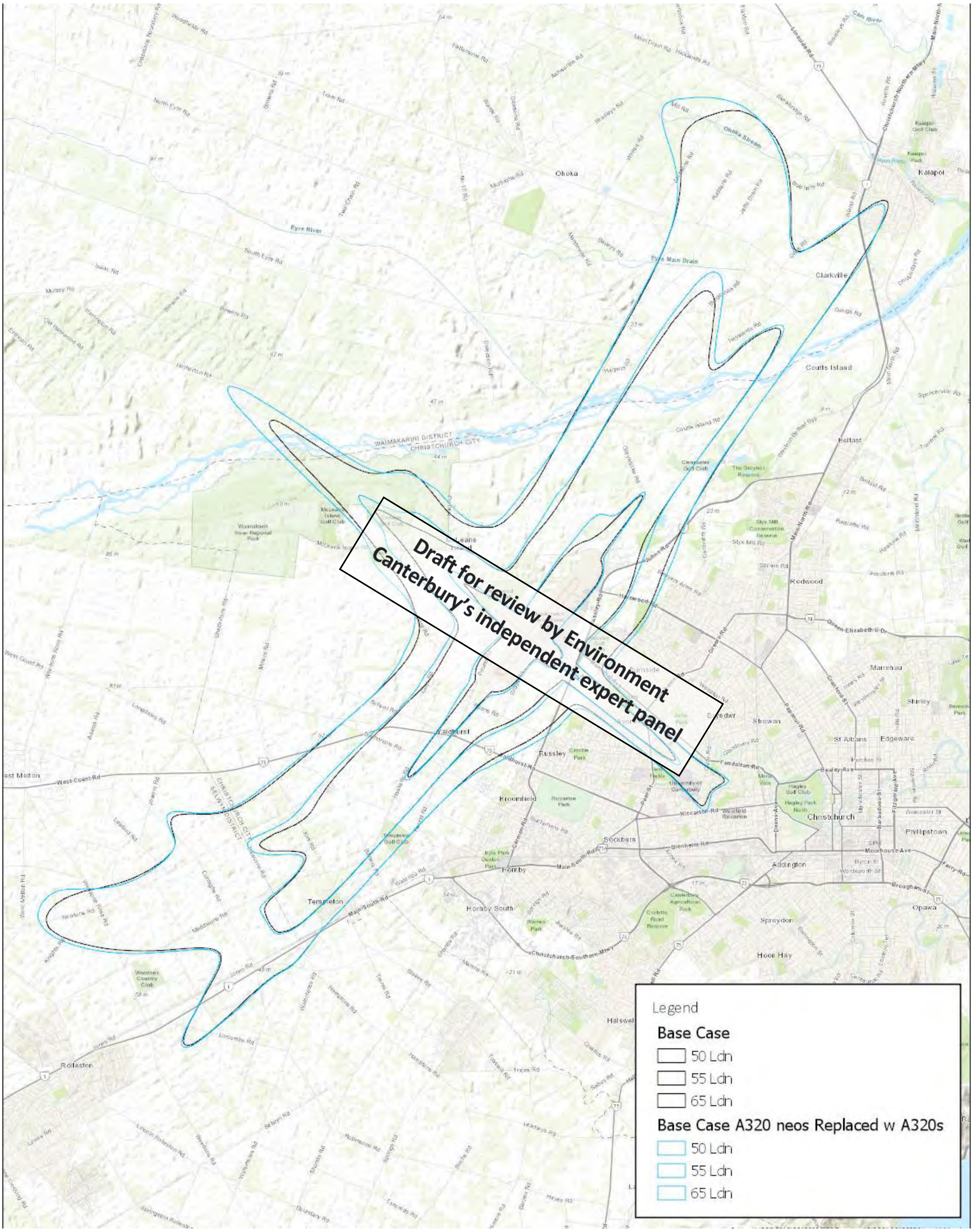
O11 Sensitivity Run 8b - Base Case with 50% of Airbus A320neos replaced by Boeing 737max



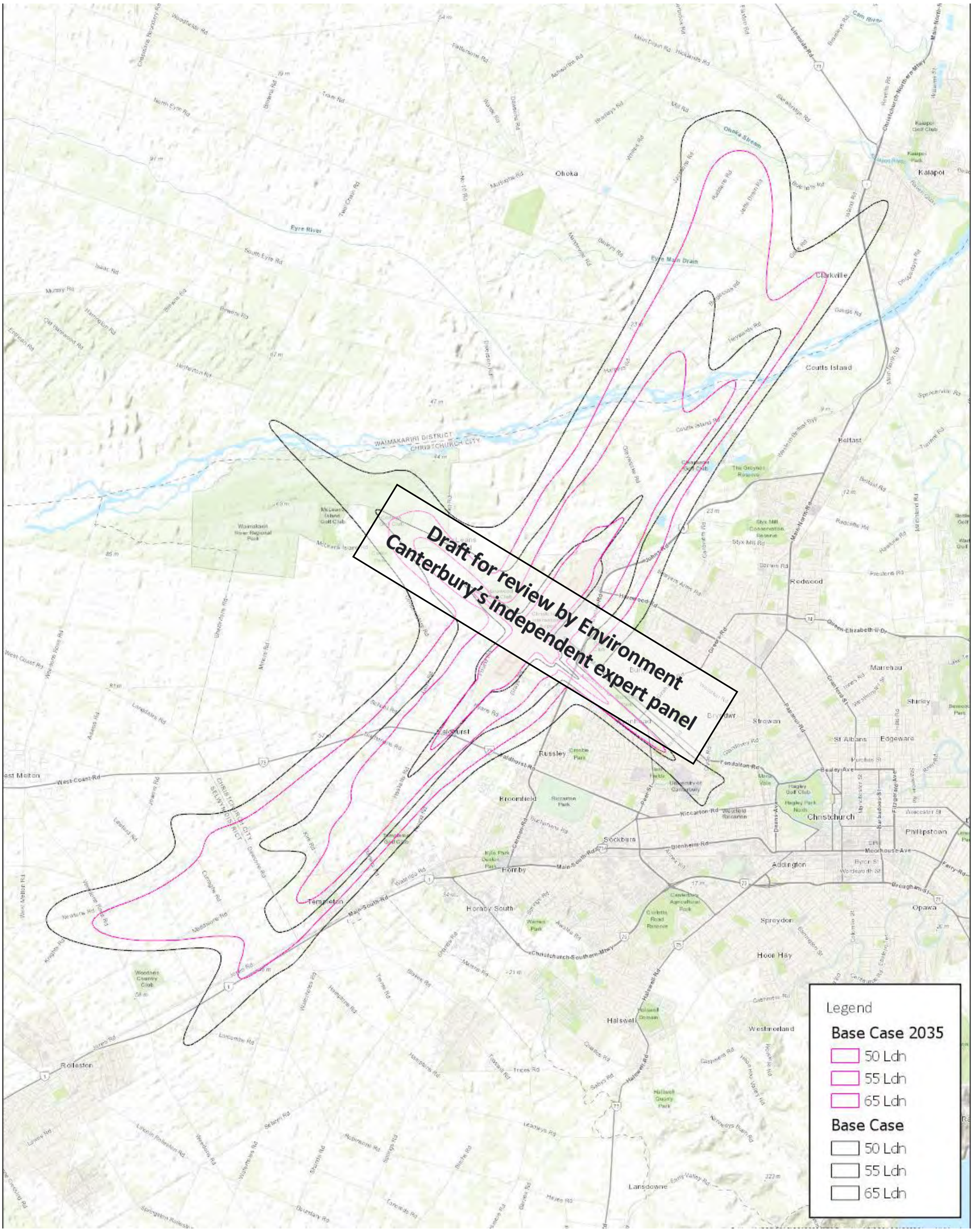
O12 Sensitivity Run 8c - Base Case with A380s replaced by 777xs



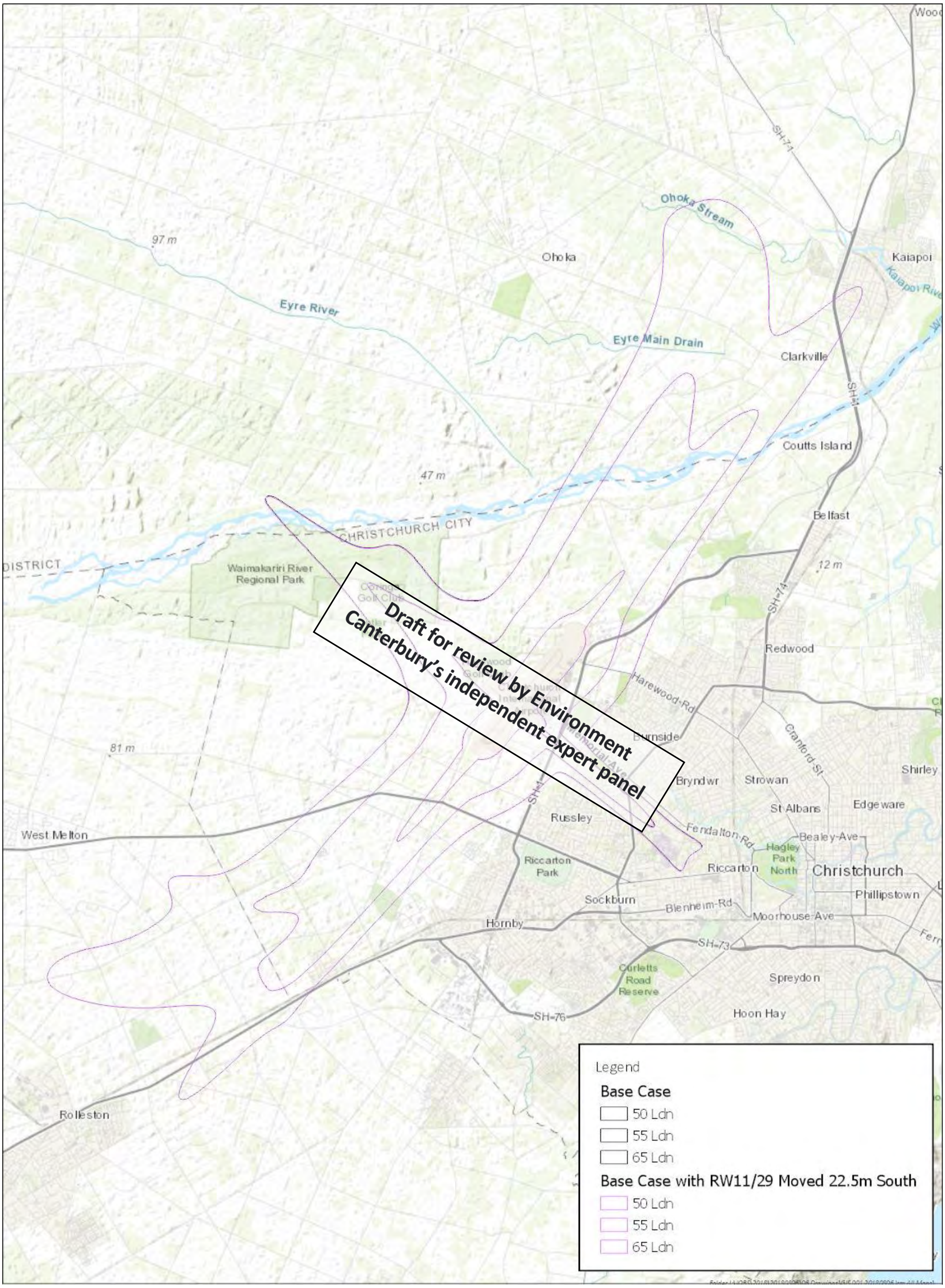
O13 Sensitivity Run 8d - Base Case with current gen A320s/737s i.e., not Neos or maxes



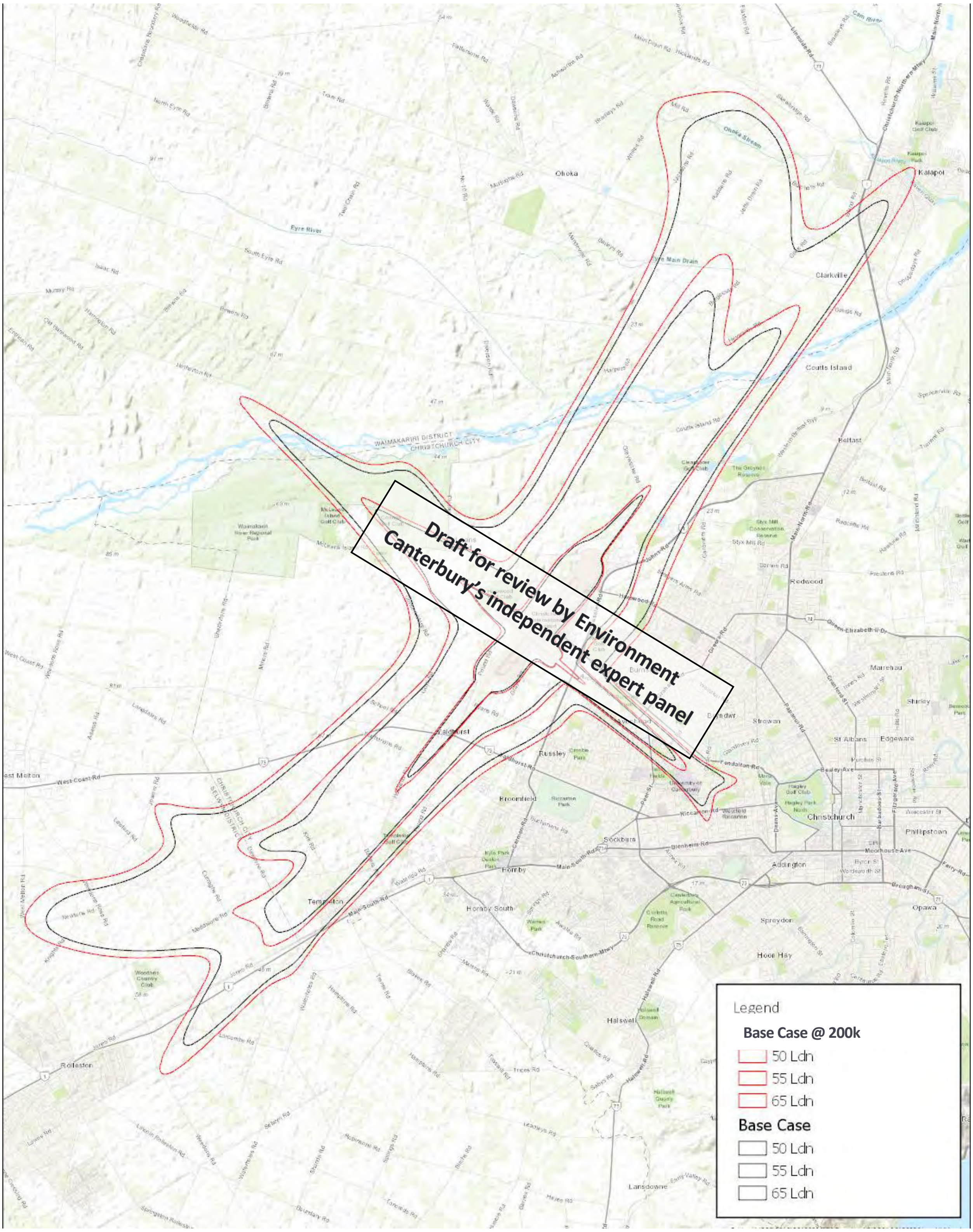
O14 Sensitivity Run 9 – Interim schedule run with current airfield and fleet



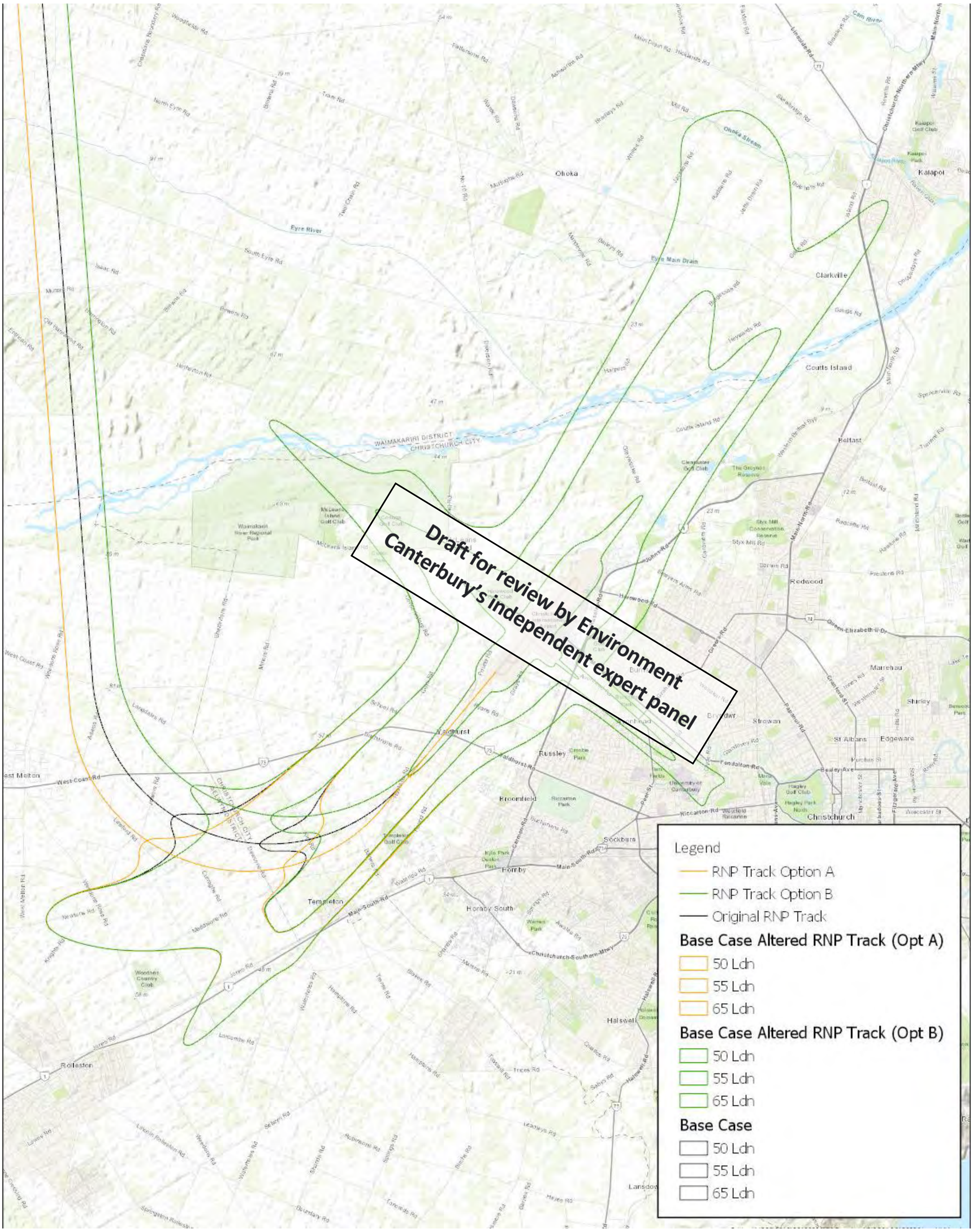
O15 Sensitivity Run 9b - Runway 11/29 Shifts 22.5m South



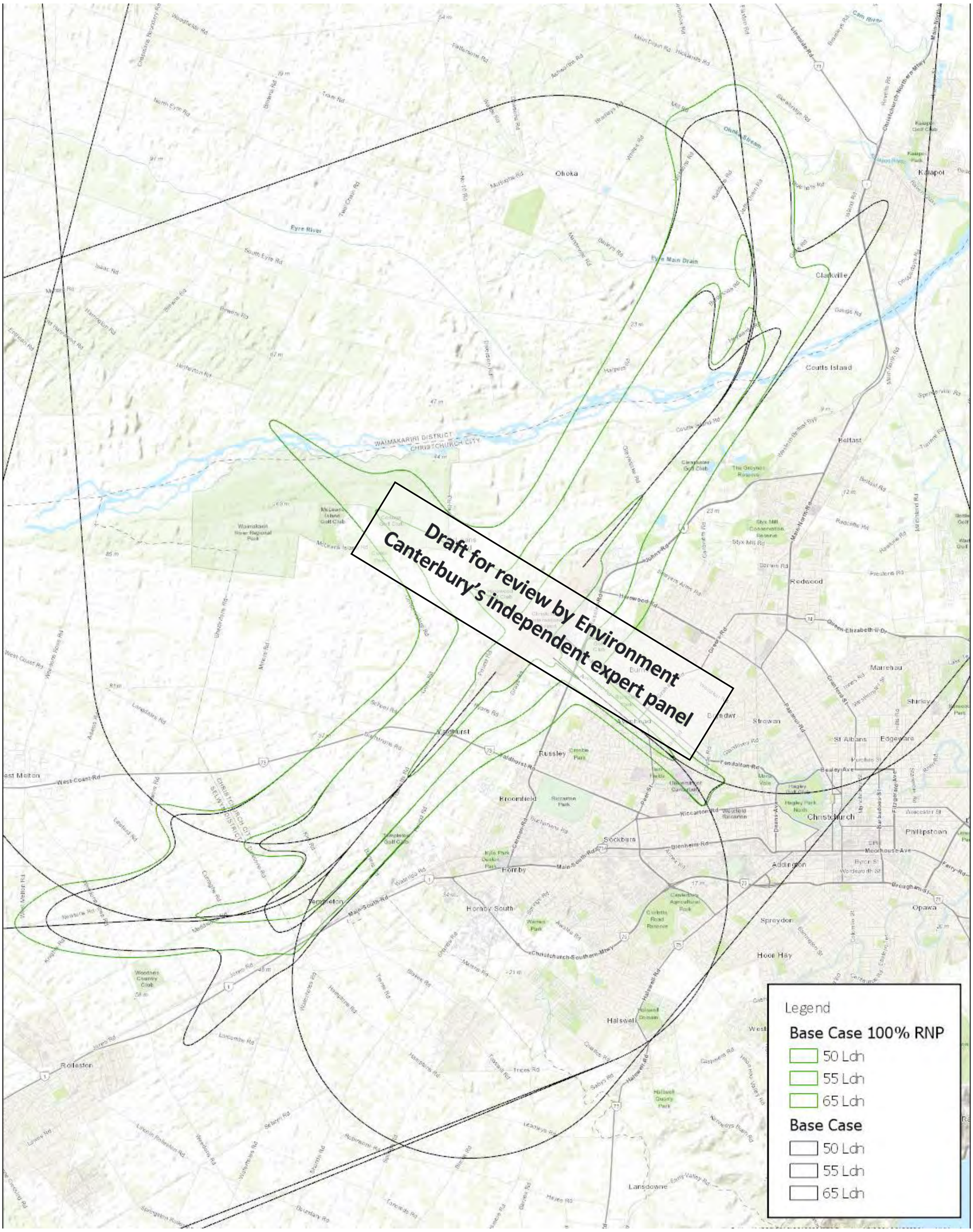
O16 Sensitivity Run 10 - Base Case with 200k scheduled passenger movements



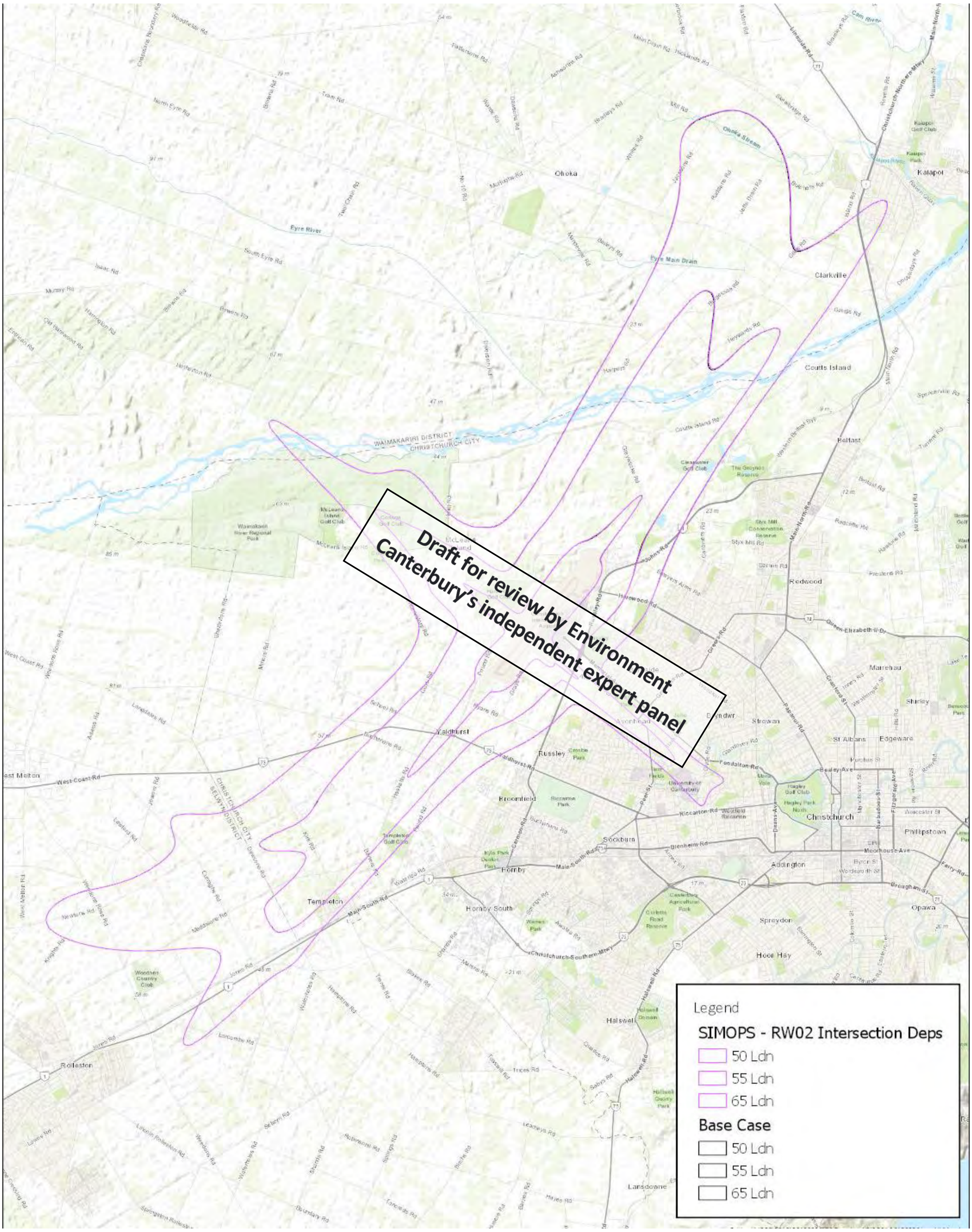
O17 Sensitivity Run 11 - Base Case with tolerance of shifting of RNP tracks



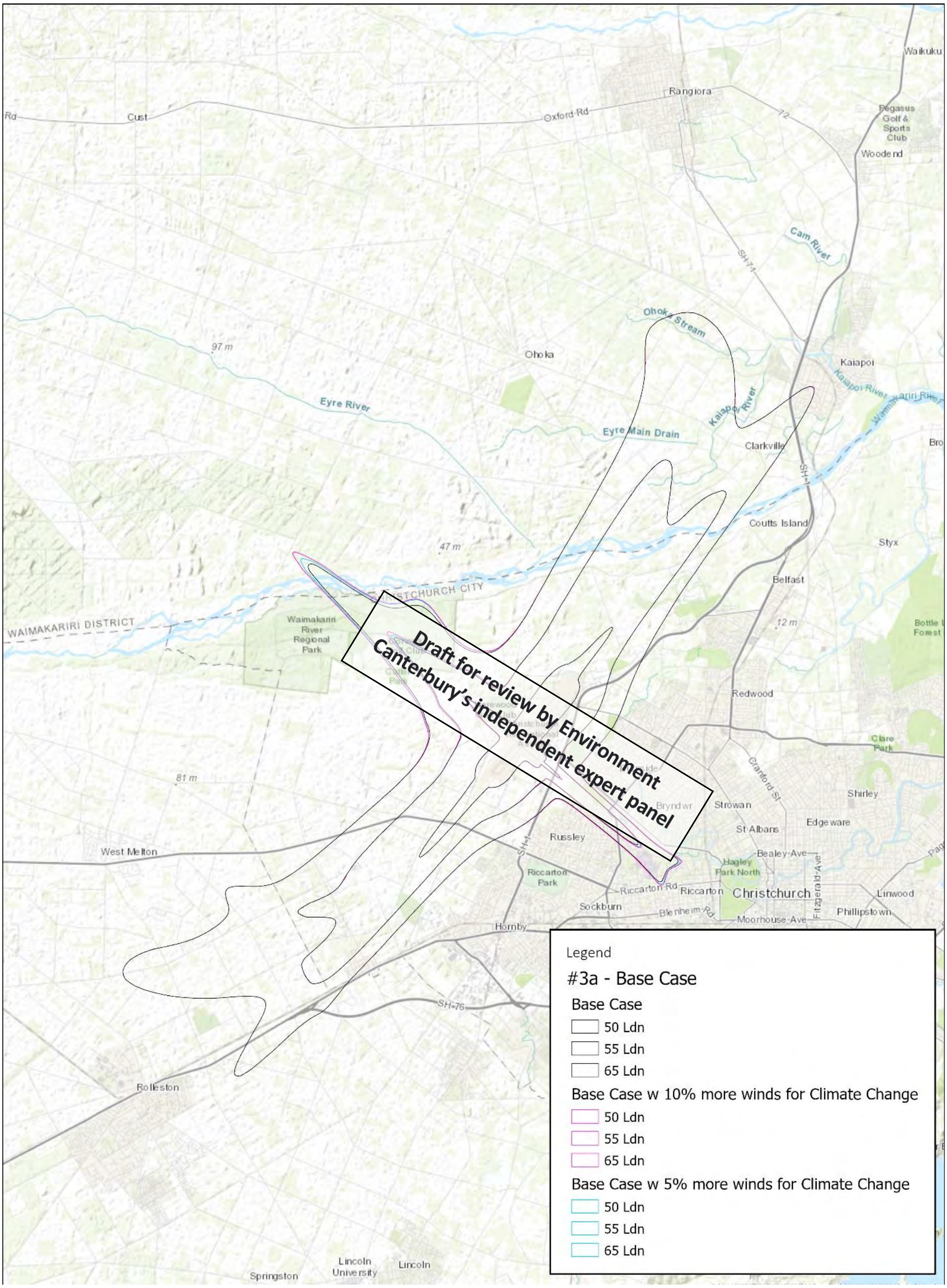
O18 Sensitivity Run 12 - Base Case with 100% RNP Allocation



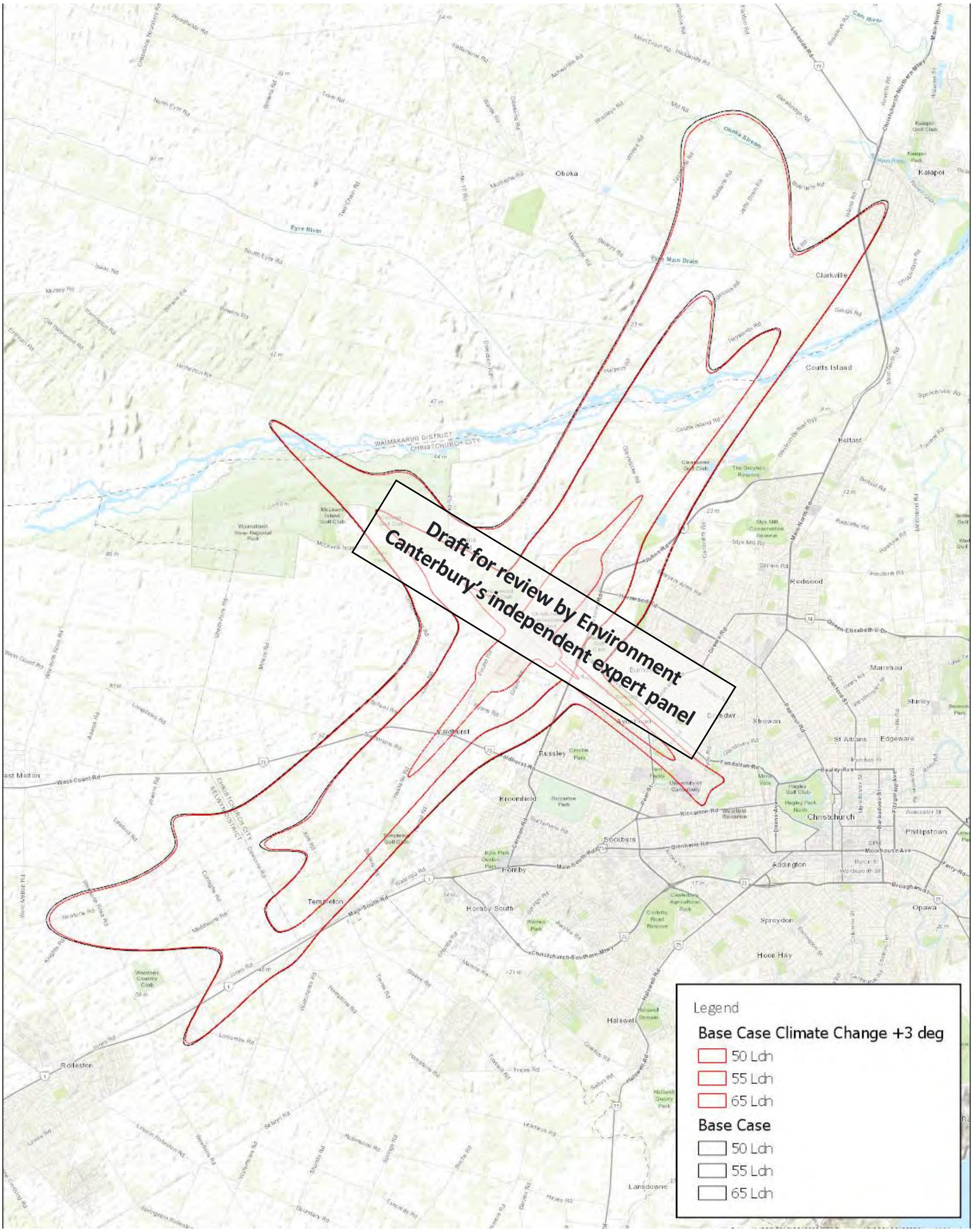
O19 Sensitivity Run 13 - Base Case with SIMOPS



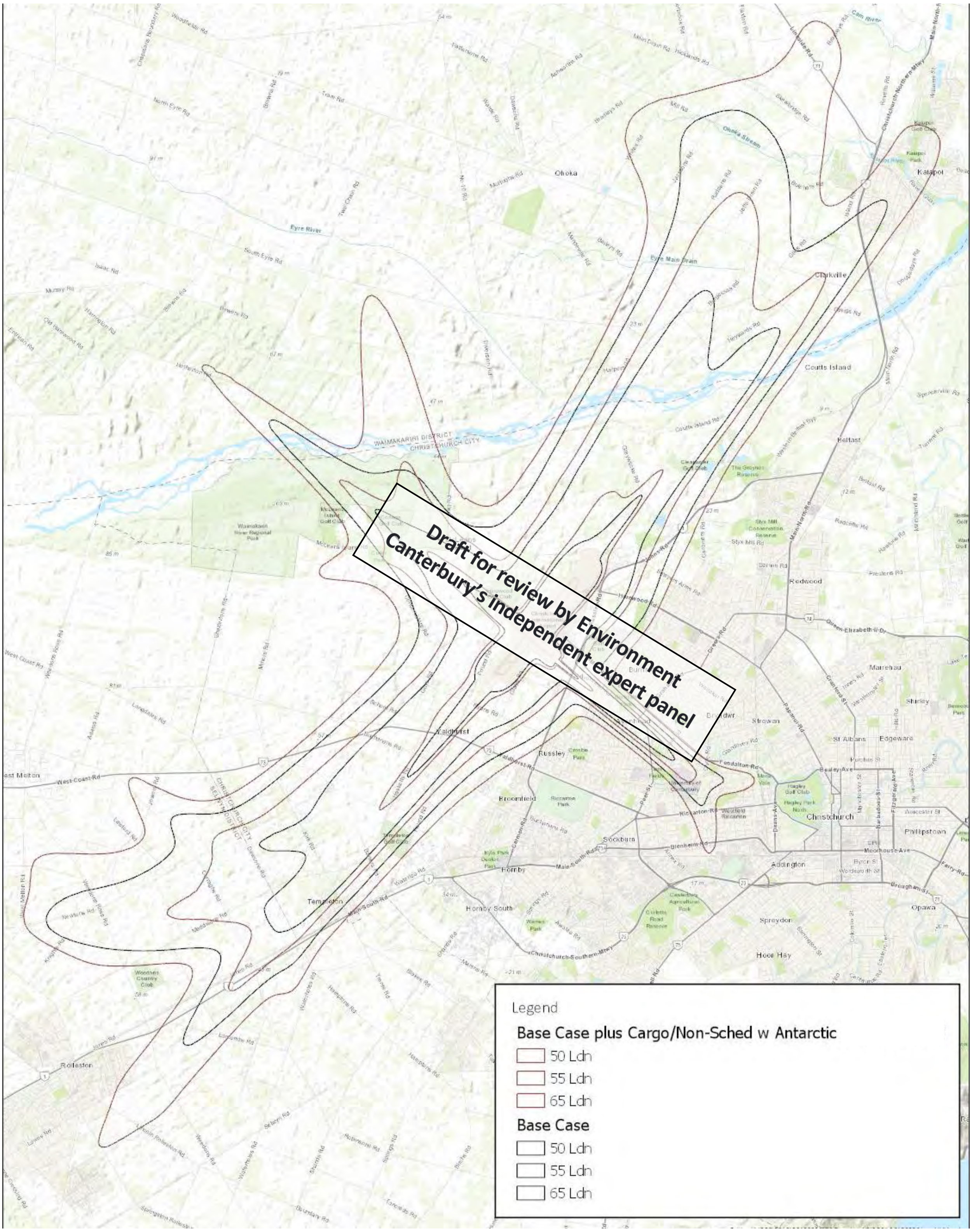
O20 Sensitivity Run 14 - Base Case with More 11/29 Usage for Climate Change



O21 Sensitivity Run 15 - Base Case with Higher Temperature for Climate Change

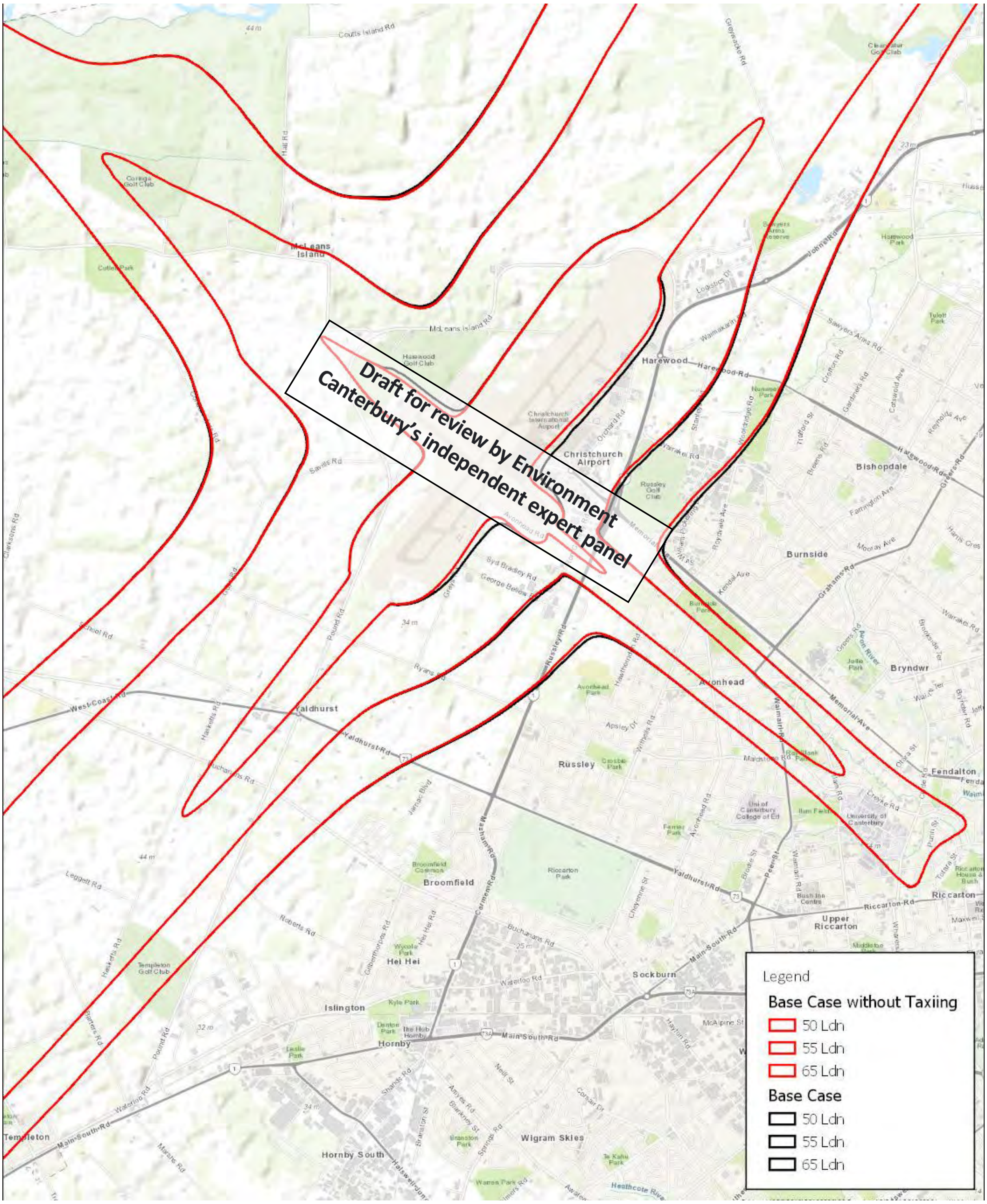


O22 Sensitivity Run 16 - Base Case with Freight, FBO/small commercial, airline/MRO, Antarctic, military and government

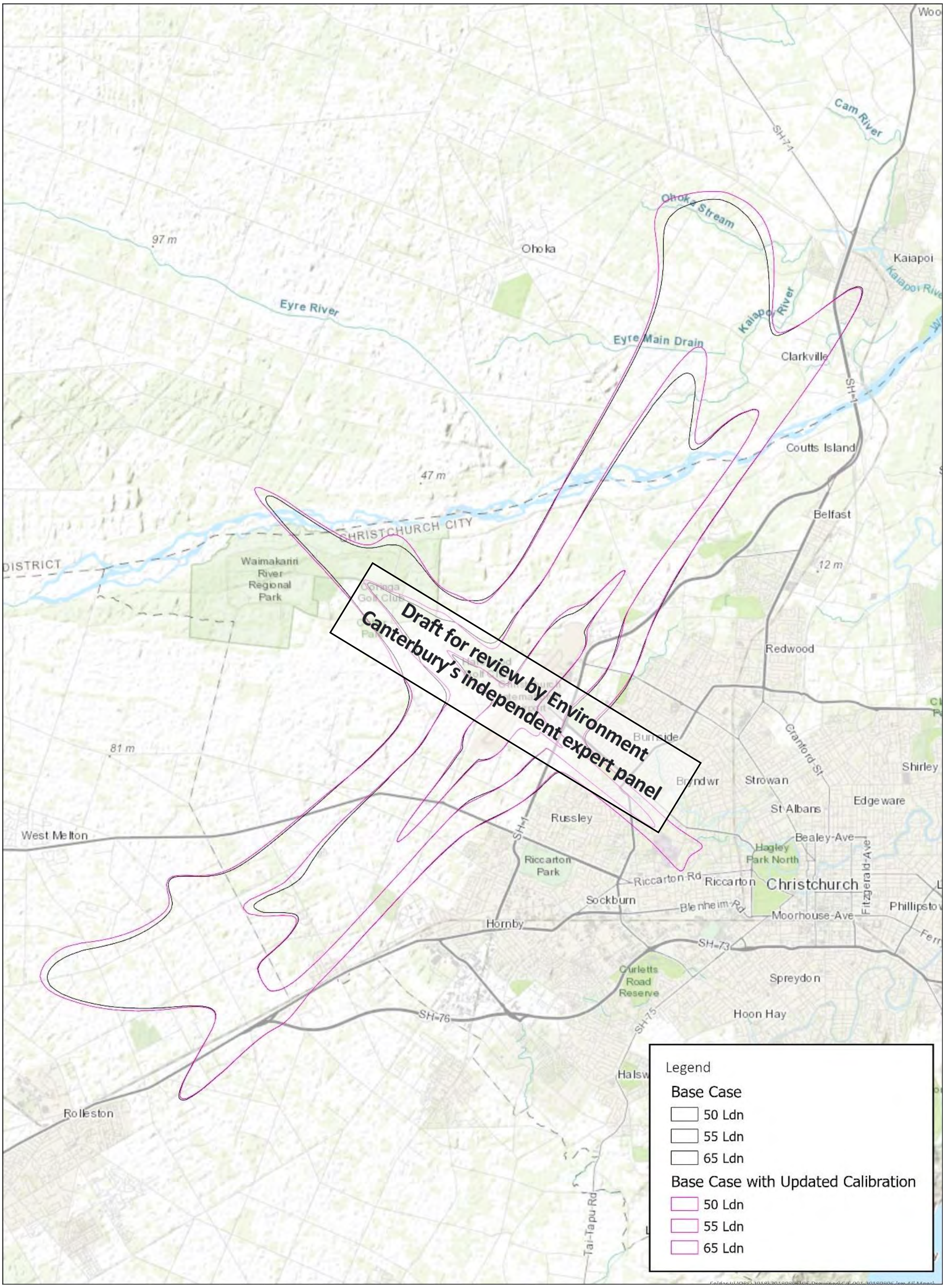


MARSHALL DAY Acoustics

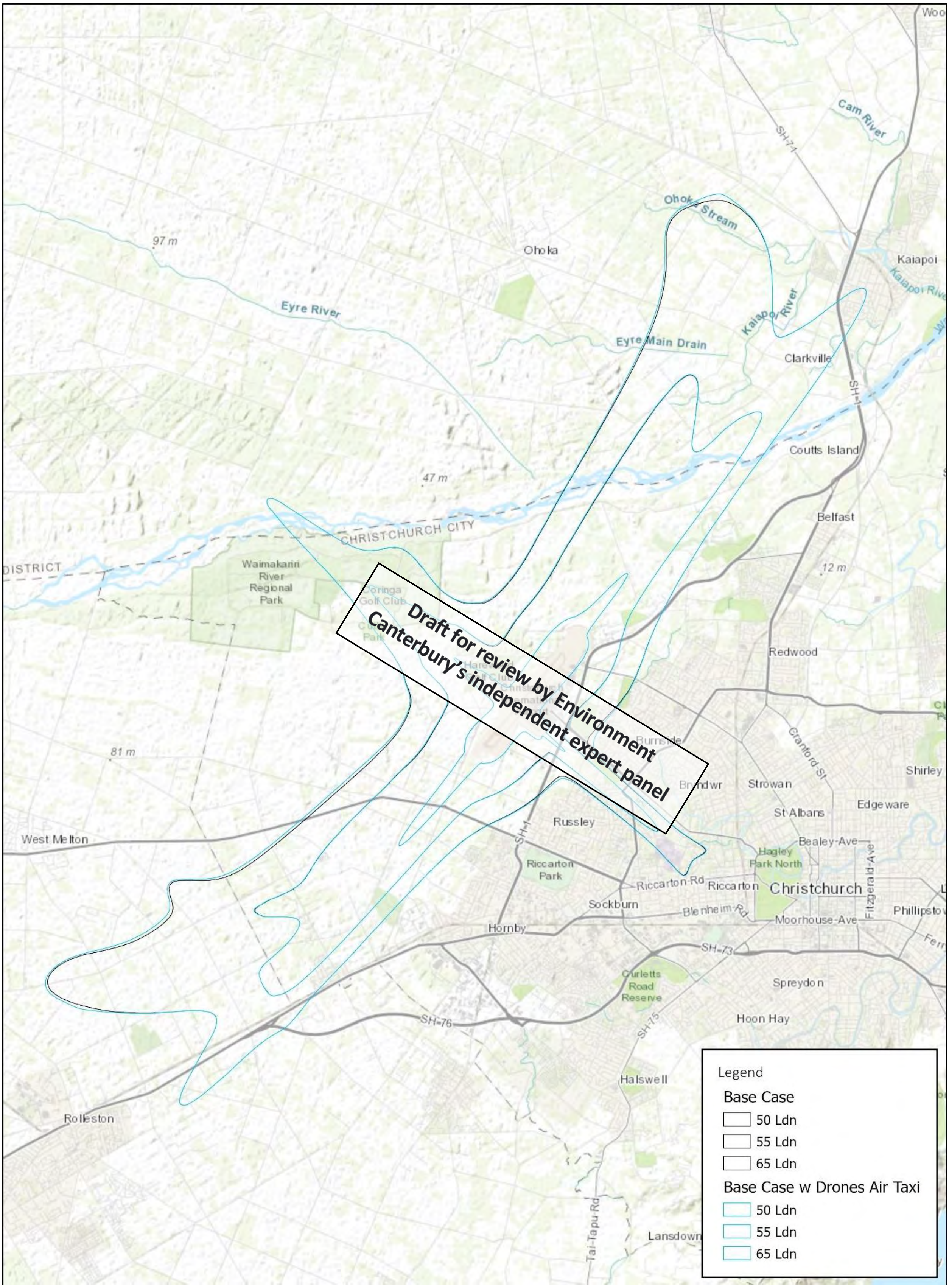
O23 Sensitivity Run 17 - Base Case no taxiing



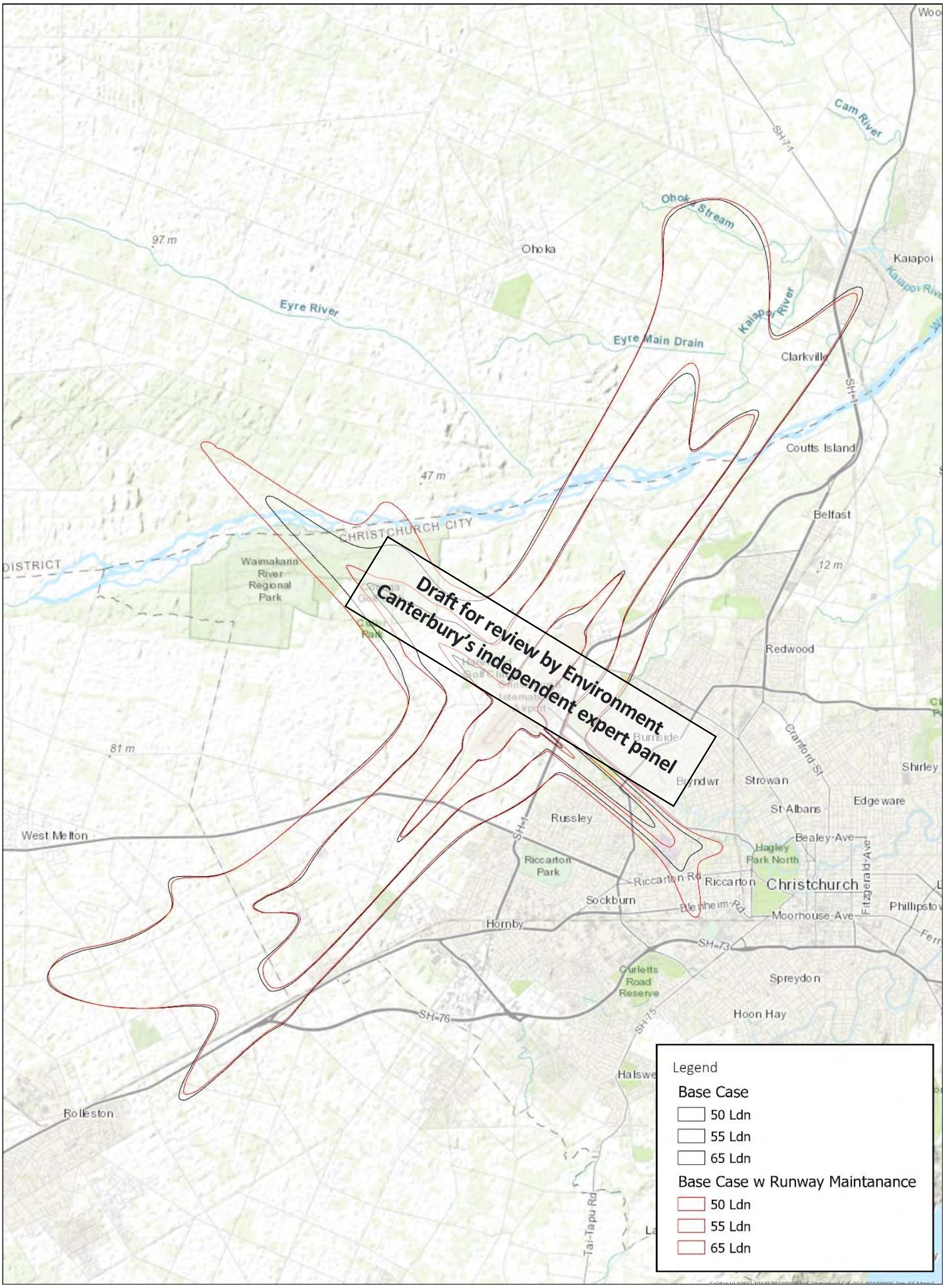
O24 Sensitivity Run 19 - Base Case with Updated Calibration of noise profiles in the noise model



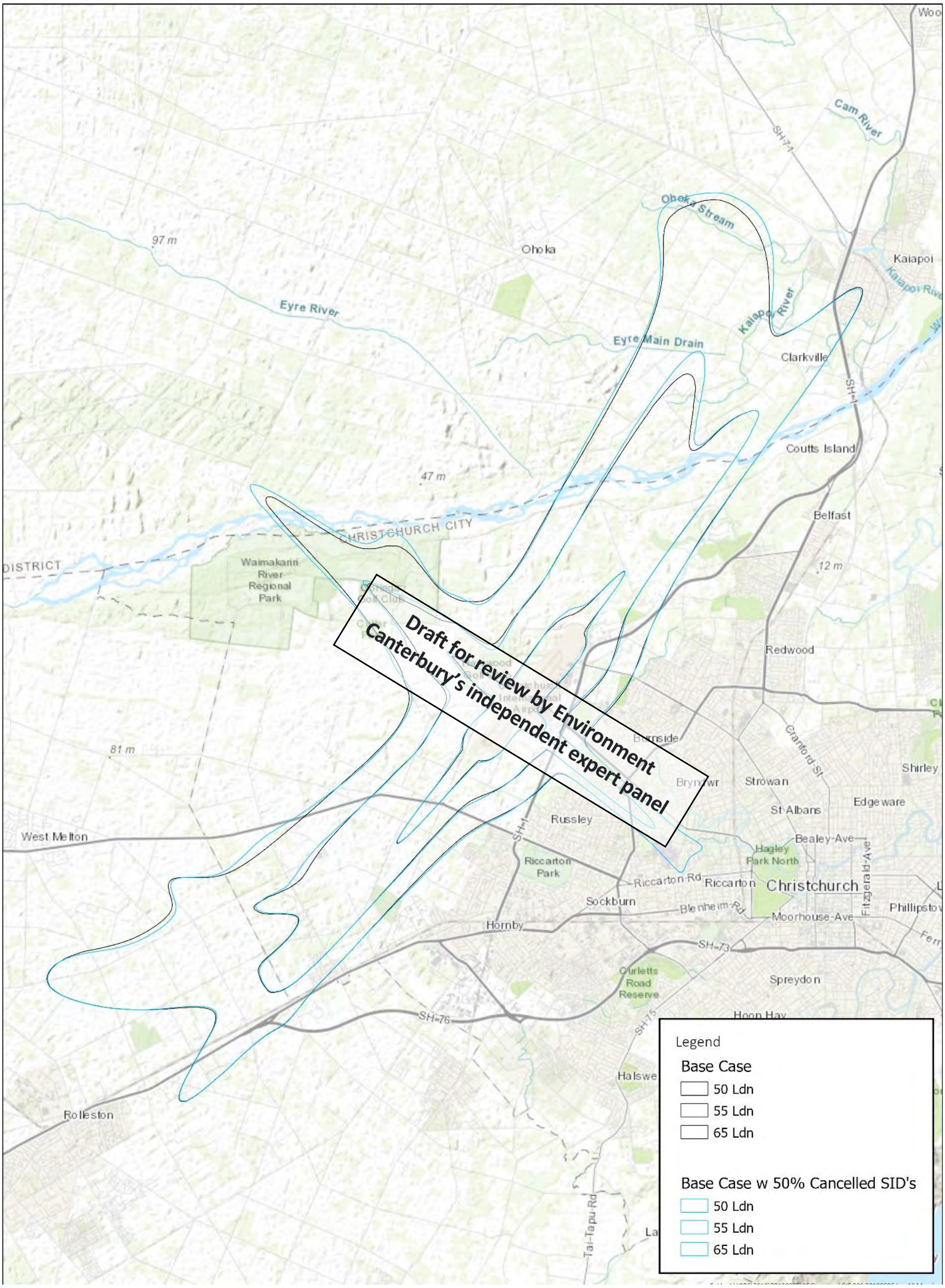
O25 Sensitivity Runs 20 - Base Case with Drones



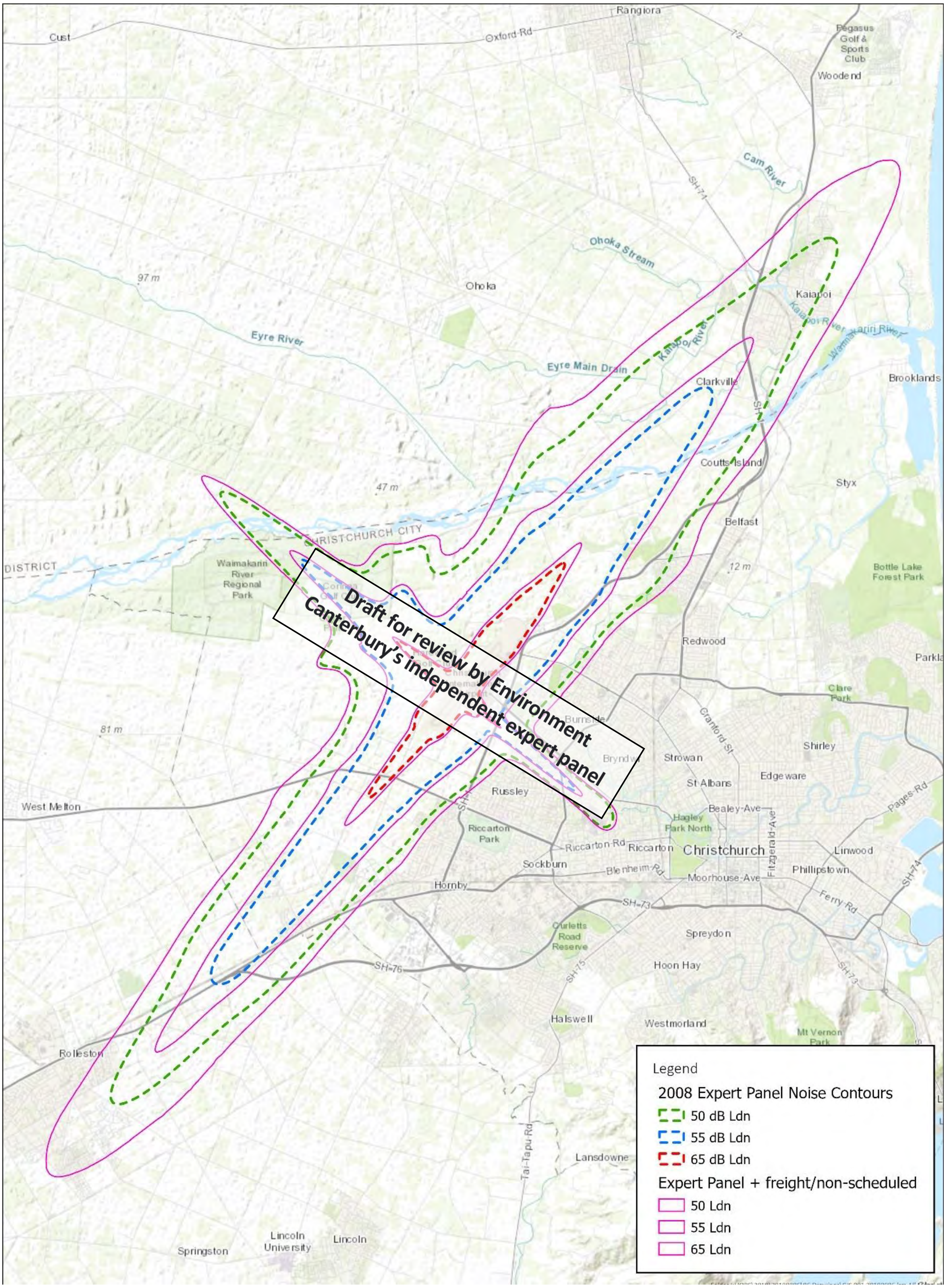
O26 Sensitivity Run 21 - Base Case with Runway Maintenance



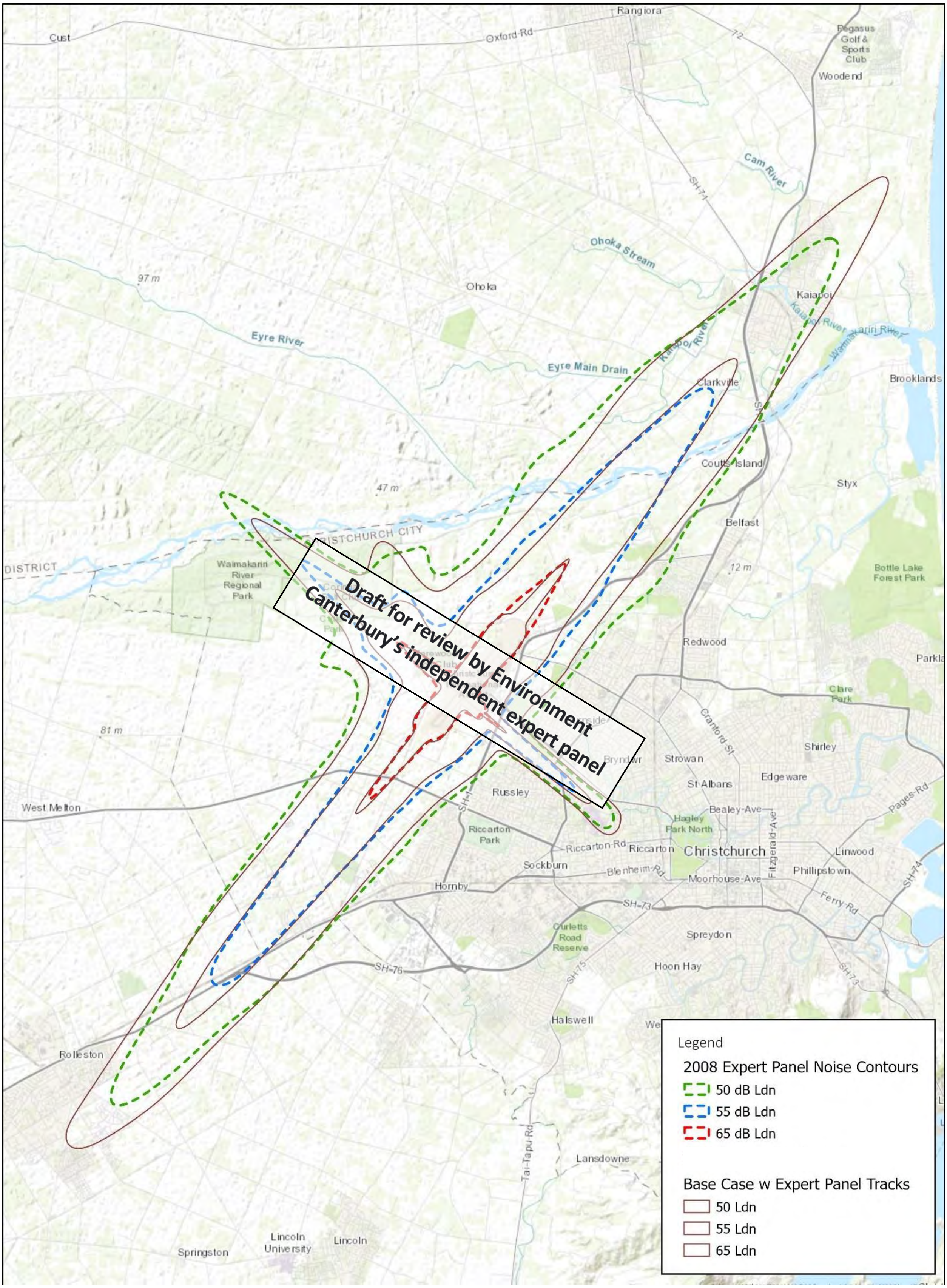
O27 Sensitivity Run 22 – Base Case with Cancelled SID's



O28 Sensitivity Run 23 - Expert Panel schedule with freight, FBO/small commercial, airline/MRO, Antarctic, military and government

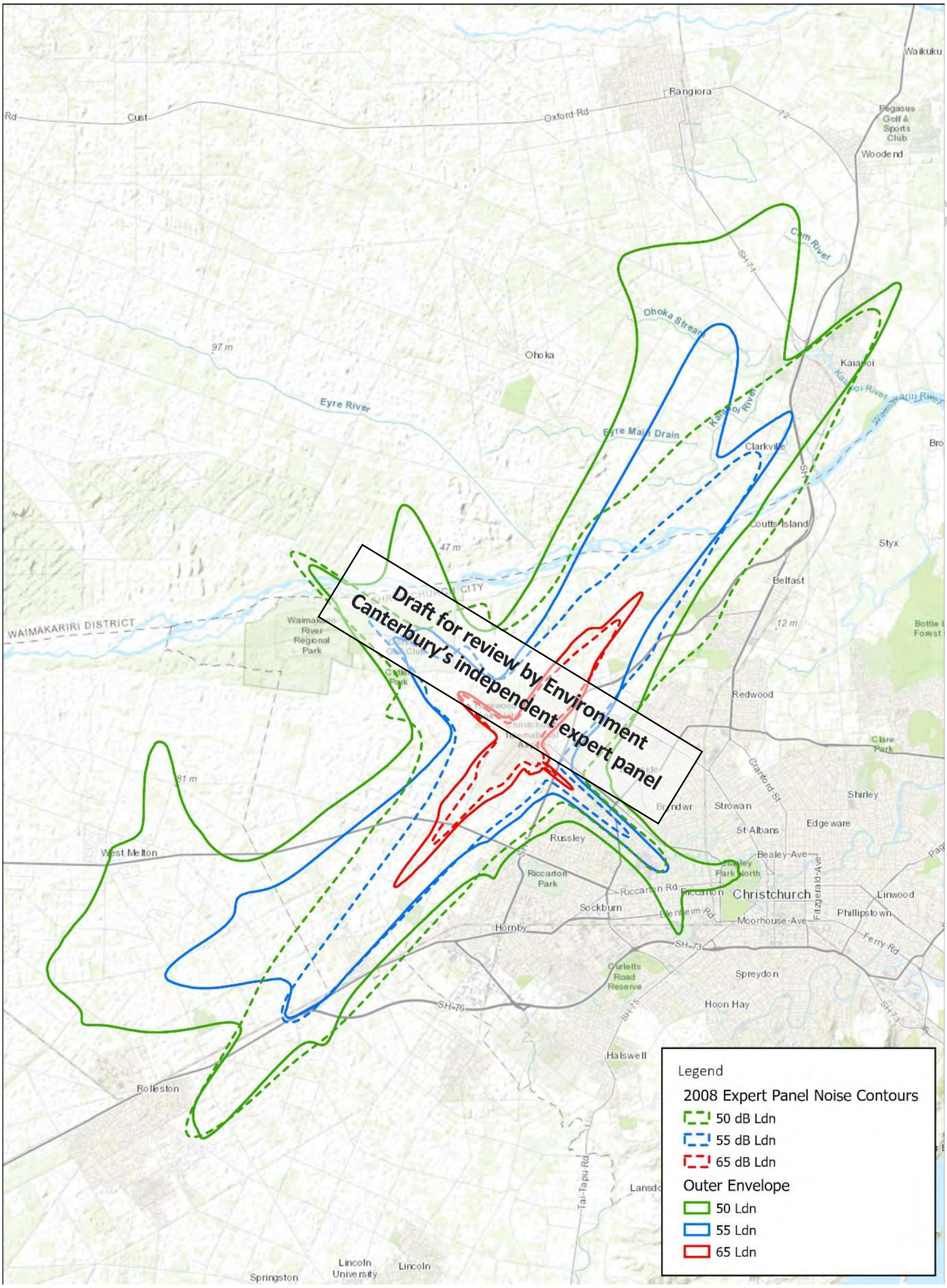


O29 Sensitivity Runs 24 - Base Case with 200k scheduled & Expert Panel Tracks

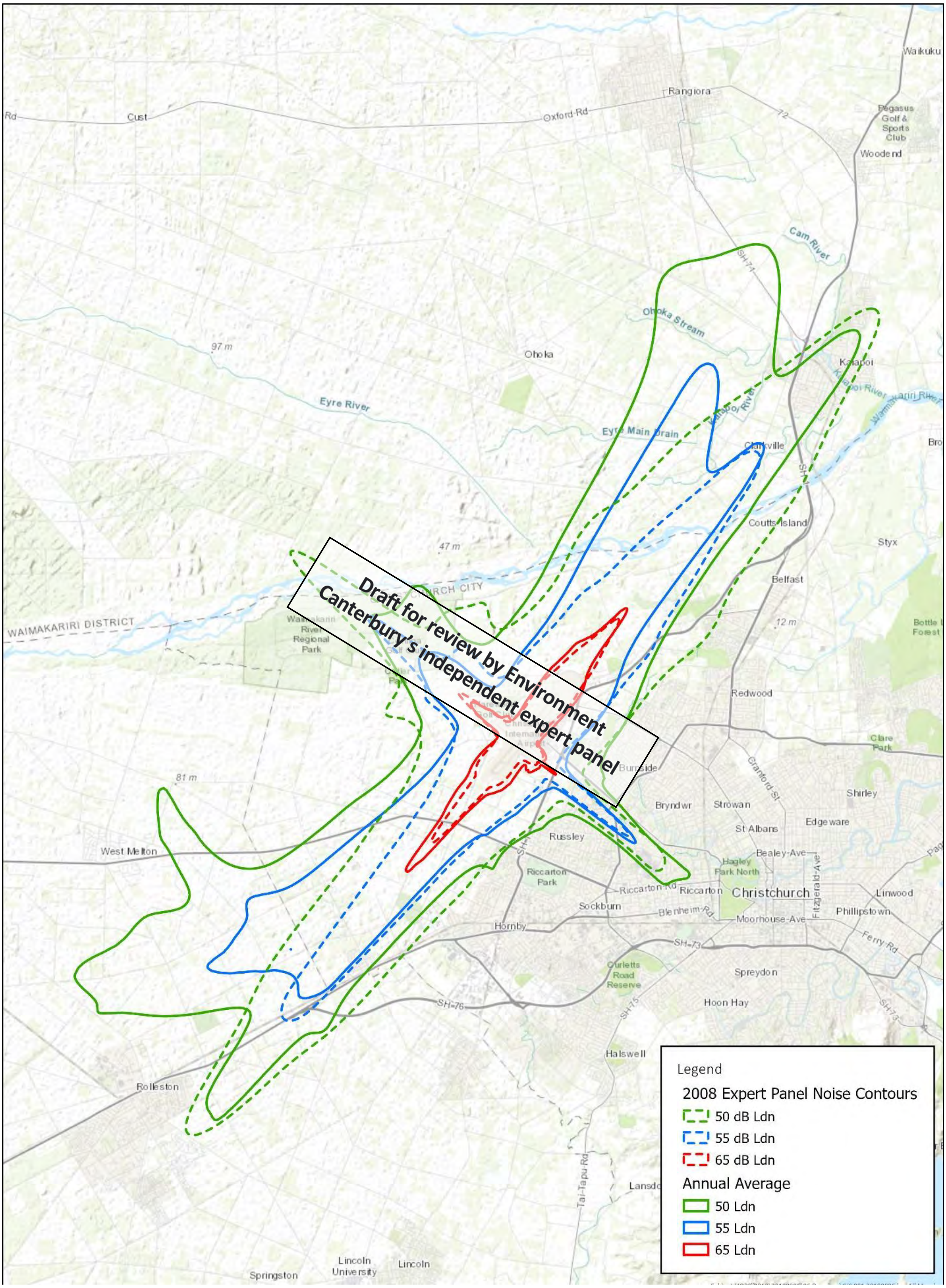


APPENDIX P UPDATED NOISE CONTOURS

P1 Outer Envelope Noise Contours

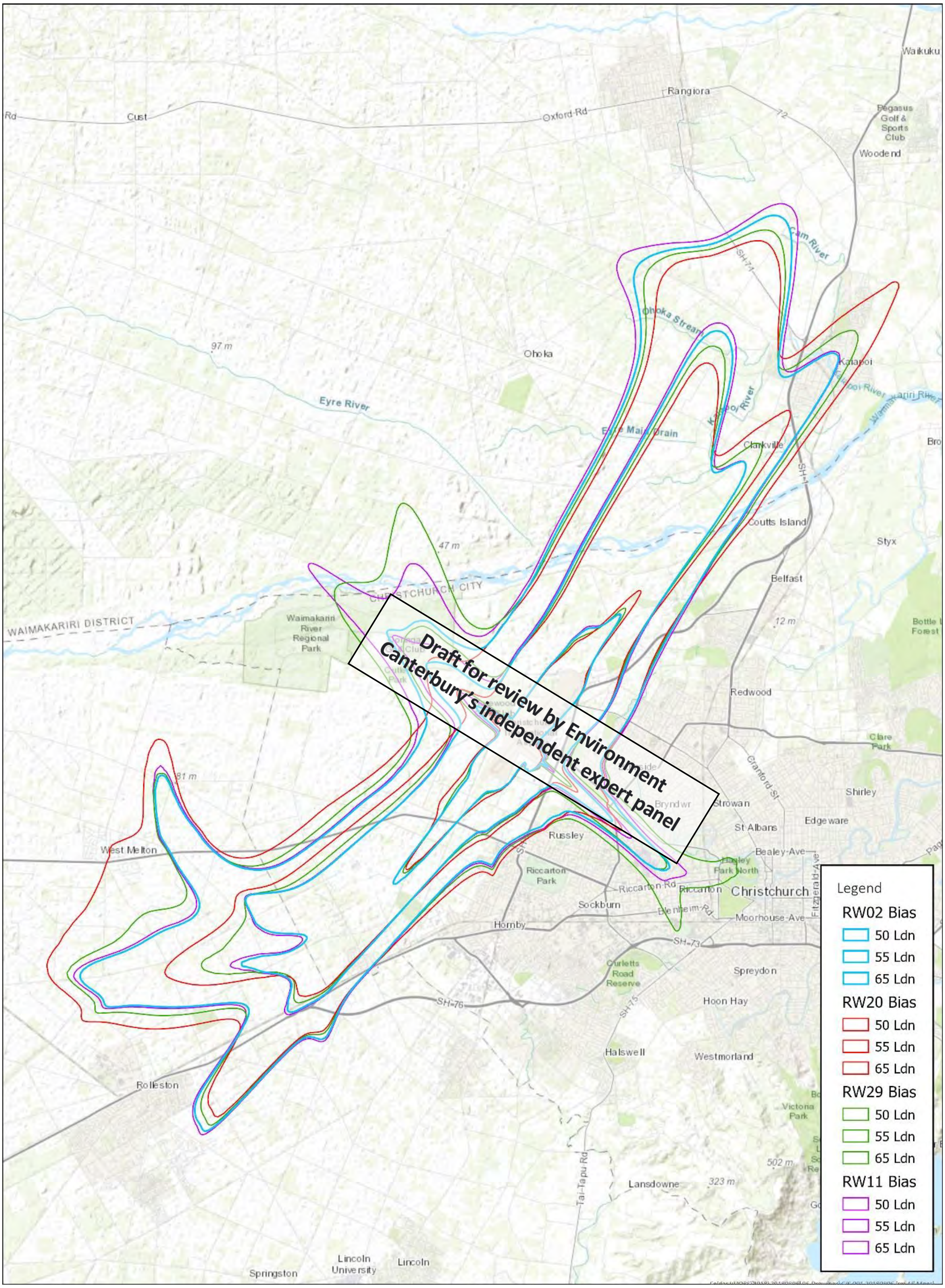


P2 Annual Average Noise Contours



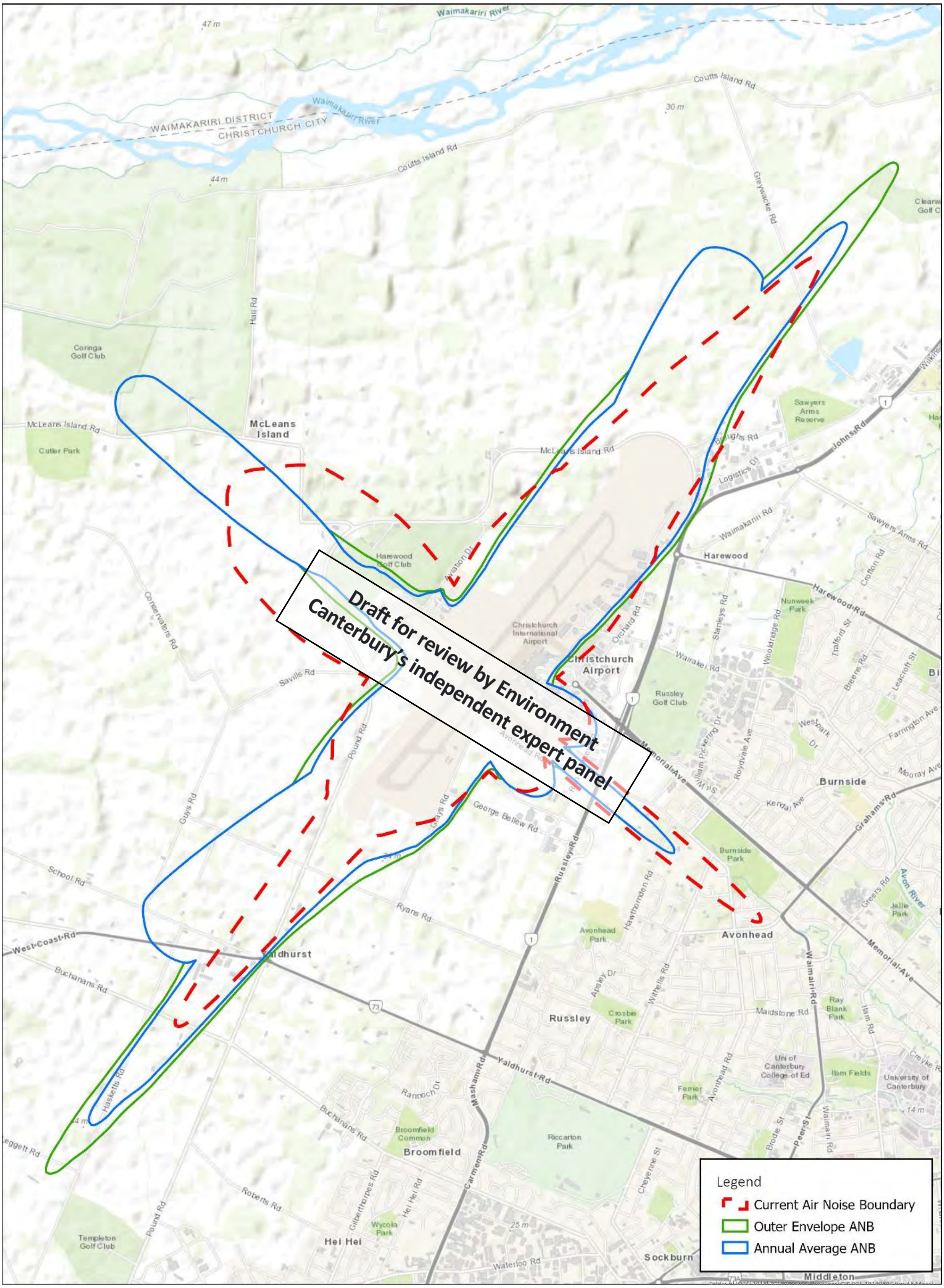
P3 Highest Usage Each Runway End

These are the four noise contours that make up the Outer Envelope



APPENDIX Q AIR NOISE BOUNDARY & SEL95 CONTOURS

Q1 Air Noise Boundary



Q2 Individual SEL95 Contours