Central Otago Airport

Feasibility Phase: Airspace Workstream

Airspace Feasibility and Runway Alignment

SUMMARY REPORT

25 August 2023

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Glossary

Terminology	Description
Air Traffic Control (ATC)	A service provided by ground-based air traffic controllers who direct aircraft on the ground and through a given section of controlled airspace, and can provide advisory services to aircraft in non-controlled airspace.
All Engines Standard Instrument Departure (AESID)	A Standard Instrument Departure (SID) flight procedure designed assuming all engines on the aircraft are operating normally.
Approach (APCH)	The final phase of approach by an aircraft for landing at an airport.
AKL	IATA code for Auckland Airport.
CAANZ	Civil Aviation Authority of New Zealand.
Controlled Airspace	Airspace of defined dimensions within which air traffic control services are provided in accordance with airspace classifications.
dBA	Decibel
Decision Height (DH)	Decision Height (DH) is a specified altitude or height in an approach with vertical guidance at which a Missed Approach must be initiated if the required visual reference to continue the approach has not been established.
Engine Out Standard Instrument Departure (EOSID)	Flight procedures designed for an aircraft to climb safely in the remote event that an engine failure occurs at or soon after take-off. The EOSID should be designed to align as closely as possible with the AESID to assure a smooth transition from a normal departure to an engine out procedure, if required.
Flight path / Flight track	A general term referring to the 2D or 3D pathway that an aircraft will follow within an Instrument Flight Procedure (IFP).

General Aviation (GA)	A term used to refer to the range of aviation operations not included in the definition of scheduled passenger operations or air freight. This may include activities such as private, recreational, sightseeing operations, emergency services (aero medical, search and rescue, fire-fighting), pilot training, surveying and aerial photography, and agricultural aviation services.
Gradient	Vertical angle of slope of a flight path.
Great Circle (Distance)	The shortest pathway (and distance) between two points, tracking on the surface of the globe.
High Intensity Approach Lights (HIAL)	High Intensity Approach Lighting systems are usually installed at the ends of international runways which have Precision Approach procedures, consisting of a longitudinal array of lights that extend a distance beyond the runway end, often on land outside the airport boundary.
International Civil Aviation Organisation (ICAO)	ICAO: International Civil Aviation Organization—a specialized agency of the United Nations that serves the 193 States adhering to the 1944 Convention on International Civil Aviation.
Instrument Flight Procedures (IFPs)	Instrument flight procedures (IFP) are used by aircraft flying in accordance with instrument flight rules and are designed to facilitate safe and efficient aircraft operations.
Instrument Flight Rules	A set of regulations governing all aspects of civil aviation operations under conditions in which flight by outside visual reference is not safe.
Instrument Landing System (ILS)	A precision radio navigation system that provides short-range vertical and horizontal guidance during an approach to land.
Maximum Take-off Weight (MTOW)	The maximum gross weight, due to design or operational limitations, at which an aircraft is permitted to take off.
Missed Approach	A procedure to be followed if an approach to land cannot be continued.
Navigation Specification (NAVSPEC)	A set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept.
Obstacle Clearance Surface (OCS)	Obstacle Clearance Surface (OCS) and VSS (Visual Segment Surface) are design segments of an airport approach procedure, which need to be kept clear of any penetrations by obstacles.

Obstacle Limitation Surface (OLS)	A series of surfaces that define the volume of airspace at and around an aerodrome to be kept free of obstacles in order to permit the intended aircraft operations to be conducted safely and to prevent the aerodrome from becoming unusable by the growth of obstacles around the aerodrome.
Passenger movement	One departure or one arrival by a passenger at an airport.
Performance Based Navigation (PBN)	A framework for defining performance requirements in navigation specifications. PBN framework can be applied to an air traffic route, instrument procedure, or defined airspace. PBN provides a basis for the design and implementation of automated flight paths as well as for airspace design and obstacle clearance.
Runway End Protection Area (REPA)	A REPA is an area defined at each end of a runway where certain land use controls should be established to protect the public (that is people and property on the ground beyond the end of a runway) from the risk of an accident or incident of an aircraft undershooting or overshooting a runway. Land uses recommended to be permitted under REPAs should be activities that do not attract the assembly of a large number of people although this is not intended to be prohibition of the presence of persons or property within such an area.
Runway End Safety Area (RESA)	A cleared and graded area symmetrical about the extended runway centre line and adjacent to and beyond the end of the runway strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway
RNAV (Area Navigation)	A method of instrument flight rules (IFR) navigation that allows an aircraft to choose any course within a network of navigation beacons, rather than navigate directly to and from the beacons.
RNP (Required Navigation Performance)	A family of navigation specifications under Performance Based Navigation (PBN) which permit the operation of aircraft along a precise flight path with a high level of accuracy and the ability to determine aircraft position with both accuracy and integrity.
RNP 0.1 (or 0.2 or 0.3)	An RNP of 0.1 means the aircraft navigation system must be able to calculate its position to within a circle with a radius of one tenth of a nautical mile. RNP-AR (authorisation required) allowing operations below standard RNP 0.3 nautical mile values.
RNP AR (authorisation required)	RNP-AR requires air operations to have authorisation from a civil aviation regulator to operate below standard RNP 0.3 nautical mile values.

Standard Terminal Arrival Route (STAR)	A published flight procedure followed by arriving aircraft connecting between the enroute system and the final Approach segment of arrival.
Standard Instrument Departure (SID)	A published flight procedure followed by departing aircraft connecting between take-off and the enroute system.
Threshold	The designated beginning of one end of a runway.
Turboprop aircraft	An aircraft with turbine engine(s) that drives a propellor for thrust.
Visual Segment Surface (VSS)	VSS (Visual Segment Surface) and Obstacle Clearance Surface (OCS) are design segments of an airport approach procedure, which need to be kept clear of any penetrations by obstacles.

1. Introduction

Christchurch International Airport Limited (CIAL) has purchased approximately 800 hectares of land near Tarras in Central Otago and is undertaking investigations into the opportunity to develop additional airport capacity, referred to as the Central Otago Airport (COA).

Airbiz Aviation Strategies Ltd (Airbiz) has been engaged to assess the feasibility of conducting commercial operations in the airspace surrounding the site and identifying feasible runway location and alignment options. The studies undertaken by Airbiz sit within the Airspace workstream of CIAL's broader project development framework, which is illustrated in Figure 1-1 following.

This report describes the process and presents the findings and evaluation of the feasibility planning studies to confirm the feasibility of conducting commercial operations in the airspace surrounding the site, and to identify the optimum and preferred runway location and alignment.

i. CIAL Objectives

CIAL has identified key objectives that have guided the project, as follows:

Provide additional airport capacity to meet the needs of Central Otago and the lower South Island with associated facilities and infrastructure that:

a. Meets medium- and long-term future demands for convenient and affordable domestic and international air connectivity,
b. Improves the accessibility of aviation services to meet Central Otago's future population growth and distribution patterns,
c. Enhances the vitality of the region's economy which relies on the safe and efficient movement of people and products to and from the region,
d. Is located, developed and operated to:
    i. enable the long-term provision of safe and efficient aviation services to the region while minimising the risk of operational constraint,
    ii. mitigate adverse effects on natural and physical resources, people and communities,
    iii. integrate with the existing state highway network and be readily provided with infrastructure services,
    iv. be resilient to the adverse effects of climate change and natural hazards,
    v. adhere to national and international aviation safety standards and protocols,
e. Enables the transition to low emissions aviation including opportunities for future energy sources,
f. Is developed and operated to provide a positive user experience.

The following Table 1-1 summarises how CIAL's objectives that are relevant to aeronautical planning workstreams have been addressed through the Airbiz engagement on this and previous contributory studies.

ii. CIAL Development Principles

CIAL have set out the following core airport development principles:

- To build trust that CIAL will have regard to the local community and broader stakeholders' interests,
- To secure the necessary regulatory license, and
- To create a commercially, socially, and economically feasible project which is able to deliver on the inter-regional opportunity that exists in Central Otago.

The opportunity is the creation of a greenfield airport which will:

- Be capable of delivering high levels of passenger experiential satisfaction, sustainability outcomes and operational responsiveness for airline customers,
- Be flexible by matching future growth of infrastructure capacity with demand,
- Deliver economic and social opportunities for the region it supports,
- Limit impacts on nearby noise sensitive communities and be compatible with future residential and commercial development in the region, and
- Be designed with a lower carbon future in mind using world class environmental practices.

Figure 1-1: CIAL Project Development Framework

Workstreams

Feasibility	Communications and Engagement	Airspace	Environment	Infrastructure Planning & Design	Surface Access	Regulatory
	Community & Iwi		Land		Public Transport	
Social & Economic Wellbeing Assessment		Airspace & Flight Tracks Design		Airport Development Strategy		Environmental Studies
	Industry (Aviation and others)		Energy		Land Transport	
Demand Modelling		Aircraft Noise		Off-site Infrastructure Requirements		CAA Airport Certification
	Central & Local Government		Carbon		Surface Access Strategy	
Financial & Business		Aeronautical Safeguarding		Airport Master Plan		Central Otago District Council
	Regulatory & Financial		Water		Planning	
Commercial Planning		Meteorological Study		Land Use Plan & Zoning		Otago Regional Council
	Communications Channels		Waste		Design	
Rationale		Aircraft Emissions		Site Planning, Design & Preparation		Waka Kotahi

Table 1-1: Application of CIAL Objectives

CIAL Objectives	Application
Meets medium- and long-term future demands for convenient and affordable domestic and international air connectivity. Improves the accessibility of aviation services to meet Central Otago's future population growth and distribution patterns, Enhances the vitality of the region's economy which relies on the safe and efficient movement of people and products to and from the region, Is located, developed and operated to: • enable the long-term provision of safe and efficient aviation services to the region while minimising the risk of operational constraint, • adhere to national and international aviation safety standards and protocols,	An airport capable of domestic and international operations, catering for: • Code C[1] turboprop aircraft (ATR-72) • Code C jet aircraft (A320, A321, B737) • Code E[2] jet aircraft (A350, B787) • Domestic trunk routes (AKL, WLG, CHC, DUD) • Australia and Pacific Islands routes • Eastern Asia routes. Studies examine site feasibility for a minimum runway length of approximately 2200m, with potential for a maximum length of 3000m. Flight path options have been planned and provisionally designed in compliance with both New Zealand and International aviation rules and requirements.
Is located, developed and operated to: • mitigate adverse effects on natural and physical resources, people and communities, • be resilient to the adverse effects of climate change and natural hazards, Enables the transition to low emissions aviation including opportunities for future energy sources,	Flight path options examine and measure effects such as aircraft noise and visual intrusion on community considerations including population locations, gliding areas, dark sky reserves, etc. Environmental and sustainability principles underpin all aspects of the studies.

[1] Code C is an ICAO categorisation of aircraft by dimensions. Of main relevance to this study is the wingspan for which Code C is between 24m and 36m. This code includes most narrow body (single aisle) passenger aircraft operating in and to New Zealand.

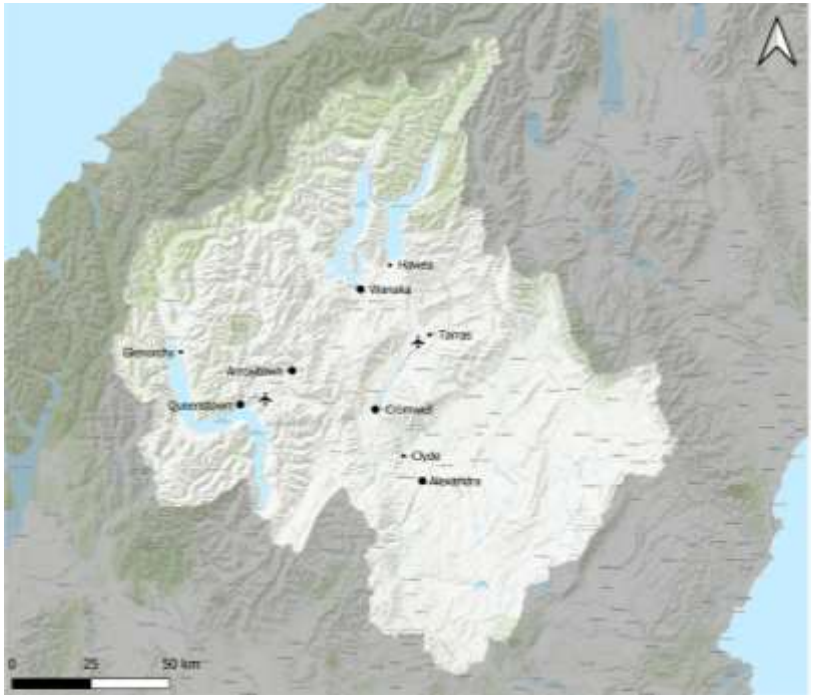
[2] Code E is an ICAO categorisation of aircraft by dimensions. Of main relevance to this study is the wingspan for which Code E is between 52m and 65m. This code includes most wide body (dual aisle) passenger aircraft operating in and to New Zealand, except the A380 (which is Code F).

2. Location, Terrain and Meteorology

i. Location

The proposed airport location is at the approximate centre of the Queenstown Lakes and Central Otago Districts as shown in Figure 2-1.

Figure 2-1: COA Site Location



The proposed site for the airport is broadly triangular in shape and broadly equidistant between three locations, Wanaka/Hawea, Cromwell and Lindis Pass as depicted in Figure 2-2. The airport site is at the convergence of three valleys:

- Hawea (to the northwest),
- Lindis (to the northeast), and
- Dunstan (to the southwest).

Figure 2-2: COA Site Location

ii. Terrain

The surrounding mountain terrain will significantly influence arrival and departure flight paths in and out of the proposed airport. The elevations above sea level of the mountain ranges around the airport are as follows:

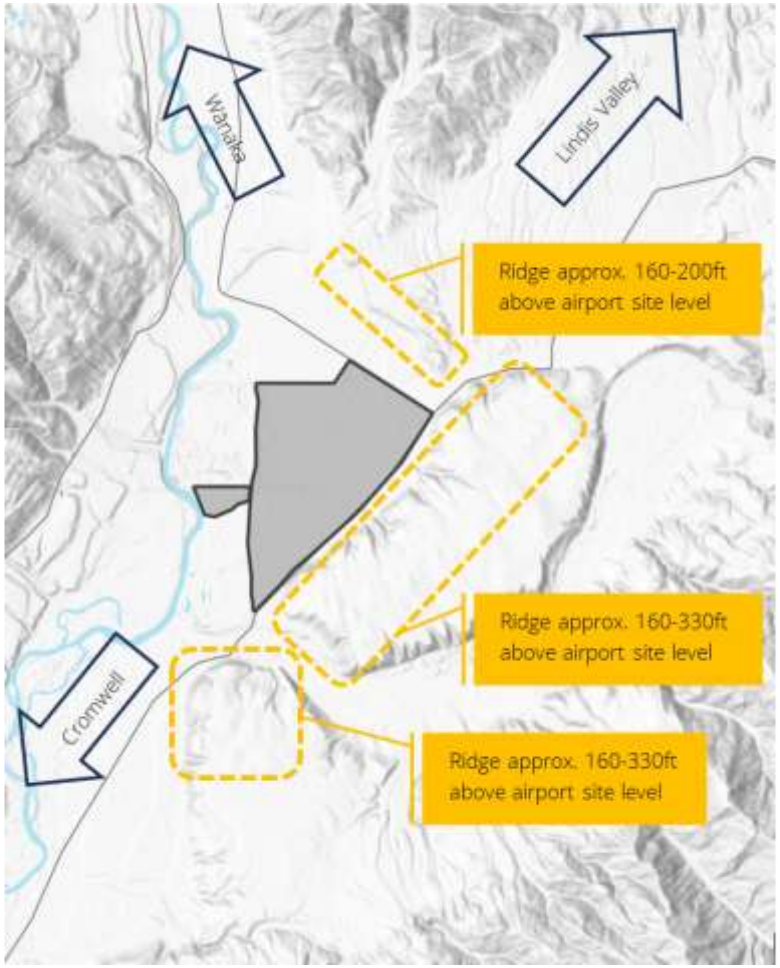
- Over 6,000 ft (1,800m) to the east of the site,
- Over 3,000 ft (900m) to the north of the site,
- Over 6,500 ft (2,000m) at the end of the Lindis Valley,
- Over 5,000 ft (1,500m) to the southeast of the site, and
- Over 4,000 ft (1,200m) to the south of the site.

For context, the airport land elevation is approximately 240m above sea level.

There are significant ridges near the airport site which will influence runway orientation and length. These ridges are generally in three locations as shown in Figure 2-3:

- A ridge (with approximate elevation above the airport site of 160 – 200ft) to the north of the site,
- A ridge (with approximate elevation above the airport site of 160 – 330ft) to the east of the site, and
- A ridge (with approximate elevation above the airport site of 160 – 330ft) to the south of the site.

Figure 2-3: Ridge Terrain near the COA Site



iii. Initial Runway Alignment Options

In 2020-2021 Airbiz prepared a report titled "Runway Alignment and Airspace Pre-Feasibility Study Phase 1", 11 February 2021, which identified there could be two practical runway alignment and airspace planning options and lengths, constrained by site boundaries and adjacent terrain.

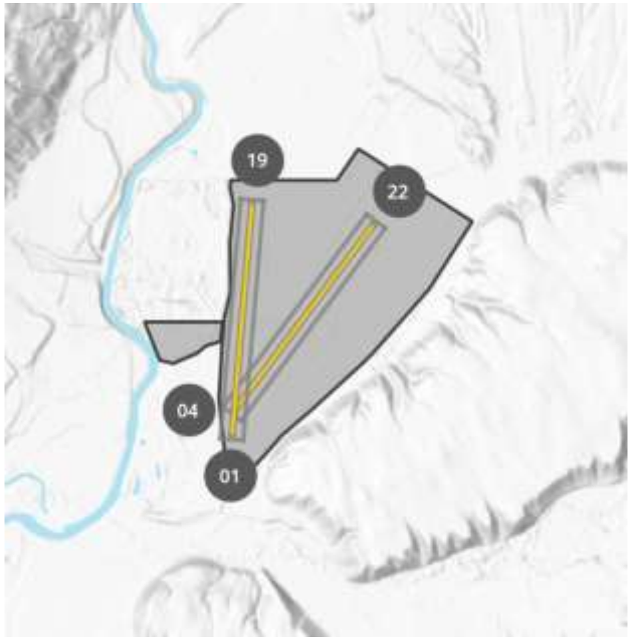
The initial runway alignment options depicted in Figure 2-4 generally referring to approximate compass headings, are 01-19 and 04-22, were identified by CIAL and Airbiz by considering:

- General alignment of valleys and terrain
- Characteristics of the airport site – shape, adjacency and alignment of highways and roads.

For each alignment option, the runway length options under examination are 2200m and 3000m, being generally representative of indicative shortest and longest runway options.

The intention is to select the preferable option and develop just one runway on the airport site, on that alignment.

Figure 2-4: Initial Runway Alignment Options



iv. Meteorology

The consideration of meteorological conditions in the vicinity of the airport site is not within the scope of studies described in this report.

A preliminary assessment the meteorological conditions has been previously undertaken and described in an earlier Airbiz report, "Airspace and Runway Alignment Study, Pre-Feasibility Report, 11 February 2021".

CIAL has since commissioned a weather station to be installed by MetService on the site and this has been providing continuous site-specific data for almost one year (at the time of this report). Further analysis of the meteorology will be undertaken in the near future when a full year of data is available.

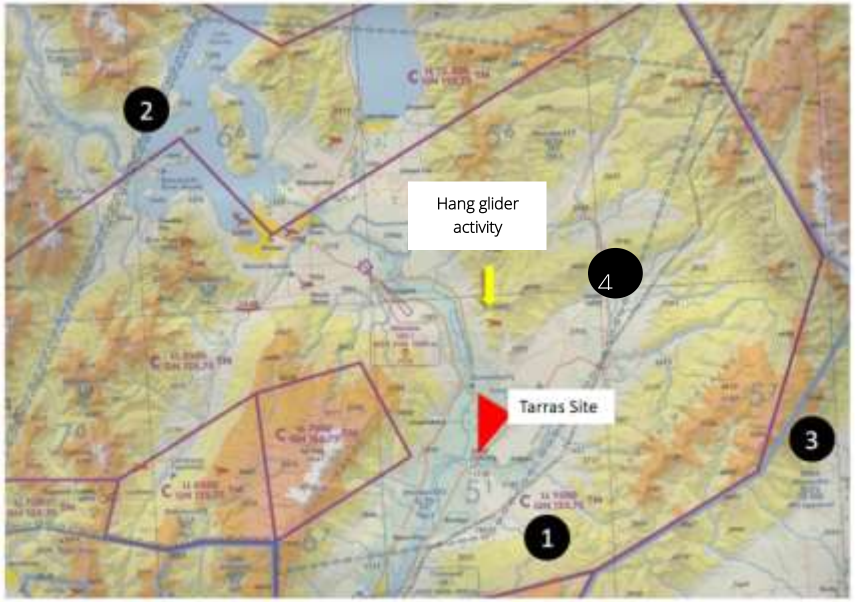
3. Airspace Environment

i. Surrounding Airspace

Figure 3-1 opposite illustrates the existing airspace environment around the COA site.

- Controlled airspace starts at 9500 ft and is Class C (denoted 1)
- The airspace between the surface and 9500ft is uncontrolled and contains a Common Frequency Zone named Wanaka CFZ (denoted 2).
- There is a General Aviation (GA area to the east of the COA site used by Gliding - G953 that makes a section of controlled airspace available as uncontrolled airspace for gliding 13,500ft to FL175 upon air traffic control approval (denoted 3).
- Hang glider/paraglider activity occurs directly to the north of the site – denoted 4 and identified below with a yellow arrow.

Figure 3-1: Existing Airspace



ii. Adjoining Airspace

North:

Due to terrain and limited aircraft operations, airspace to the north is mainly uncontrolled with controlled airspace starting at 13,500ft and then further north at 17,500ft.

East:

Due to terrain and limited aircraft operations, airspace to the east is mainly uncontrolled, with controlled airspace starting at 13,500ft. Glider operations take place south of Omarama and within general aviation areas in controlled airspace identified for glider use.

South:

Due to terrain and limited aircraft operations, airspace to the south is mainly uncontrolled with controlled airspace starting at 13,500ft.

West:

Complex airspace configuration due to terrain and the proximity of Queenstown. Queenstown Airport has multiple inbound and outbound routes and is managed by an air traffic control service provided in a control zone (CTR) and associated control area (CTA).

iii. Existing Air Routes (Enroute)

The adjoining airspace has developed over the last 20 years and adapted to meet the increased needs, primarily of Queenstown Airport (ZQN). The changes have aligned with the introduction of Global Navigation Satellite Systems (GNSS) for navigation under both area navigation (RNAV) and required navigation performance (RNP) using GNSS and aircraft systems.

ZQN has benefited from new GNSS instrument procedures and was world leading in using tailored RNP procedures associated with aircraft performance, equipment and crew training called RNP-AR (authorization required) allowing operations below standard RNP 0.3 nautical mile values.

ZQN now has jet operations for both domestic and international routes using RNP-AR. Wanaka Airport (WKA) has also been enabled with instrument procedures using GNSS.

The area has established domestic routes in the national enroute structure, north and northwest to Christchurch, to the North Island and direct to Auckland:

- Y266 One-way route CHC south to ZQN (amended from north)
- Q787 Two-way route ZQN north that connects to CHC, connects to Nelson (NSN) and to WLG
- Y320 One-way route south to ZQN from waypoint LAKAR east of New Plymouth (NPL) for AKL and northern North Island
- Y569 One-way route north from ZQN to waypoint LOVTA at Westport connects to AKL.

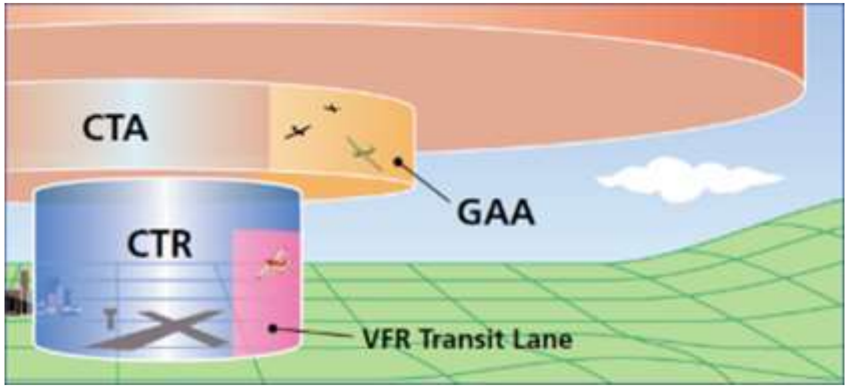
There are routes west to East Coast Australia from Queenstown:

- P753 and P880 are international routes from ZQN VOR/DME.
- L508 is an international route from CHC that crosses north of the proposed site near Franz Josef then heads south to intersect P880 to the west.

iv. Airspace Management

The Director of Civil Aviation manages the designation and classification of airspace under Civil Aviation Rule Part 71. These are generally illustrated in Figure 3-2 below.

Figure 3-2: Airspace Classification Terminologies



The Director of Civil Aviation may require the designation and operation of a Control Area (CTA), a Control Zone (CTR) and an Air Traffic Management Service (ATS).

The consideration of the requirements for airspace management is not within the scope of studies described in this report.

A preliminary assessment of airspace management has been included in an earlier Airbiz report, "Airspace and Runway Alignment Study, Pre-Feasibility Report, 11 February 2021". Further investigation of requirements is expected to be undertaken subsequent to this current report.

v. Other aerodromes and aviation activities

The consideration of the interactions of other aviation activities and operations at and from other aerodromes is not within the scope of studies described in this report.

A preliminary assessment of existing aerodromes, general aviation and Wanaka Airport activity has been previously undertaken and described in an earlier Airbiz report, "Airspace and Runway Alignment Study, Pre-Feasibility Report, 11 February 2021".

Further investigation of the management of interactions will be undertaken subsequent to this current report.

4. Assessment Process

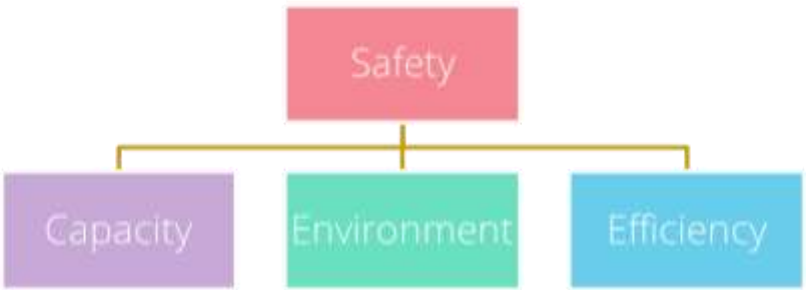
i. Lenses

The process of identifying and designing feasible options for flight paths and IFPs for the proposed airport, and the subsequent evaluation of options to determine the referred runway location/alignment, needs to consider the requirements, impacts and suitability of four criteria, or lenses (the term being applied to depict a manner of viewing the subject material).

These four criteria/lenses for assessment can be expressed as:

- Safety
- Environment
- Efficiency
- Capacity.

Figure 4-1: Assessment Lenses



Safety is the most important consideration. Baseline IFPs and any identified alternatives to Baseline IFPs must be safe and compliant with relevant International and New Zealand Civil Aviation Standards. Safety also refers to the complexity of the air traffic control environment which should ensure that the air traffic controller workload imposed by the IFPs does not result in potentially unsafe outcomes for aircraft operations.

Environment measures noise impacts, visual effects from aircraft overflight (for both communities and sensitive heritage and ecological areas), and carbon emissions.

Efficiency predicts a measure of individual aircraft and overall airspace system performance.

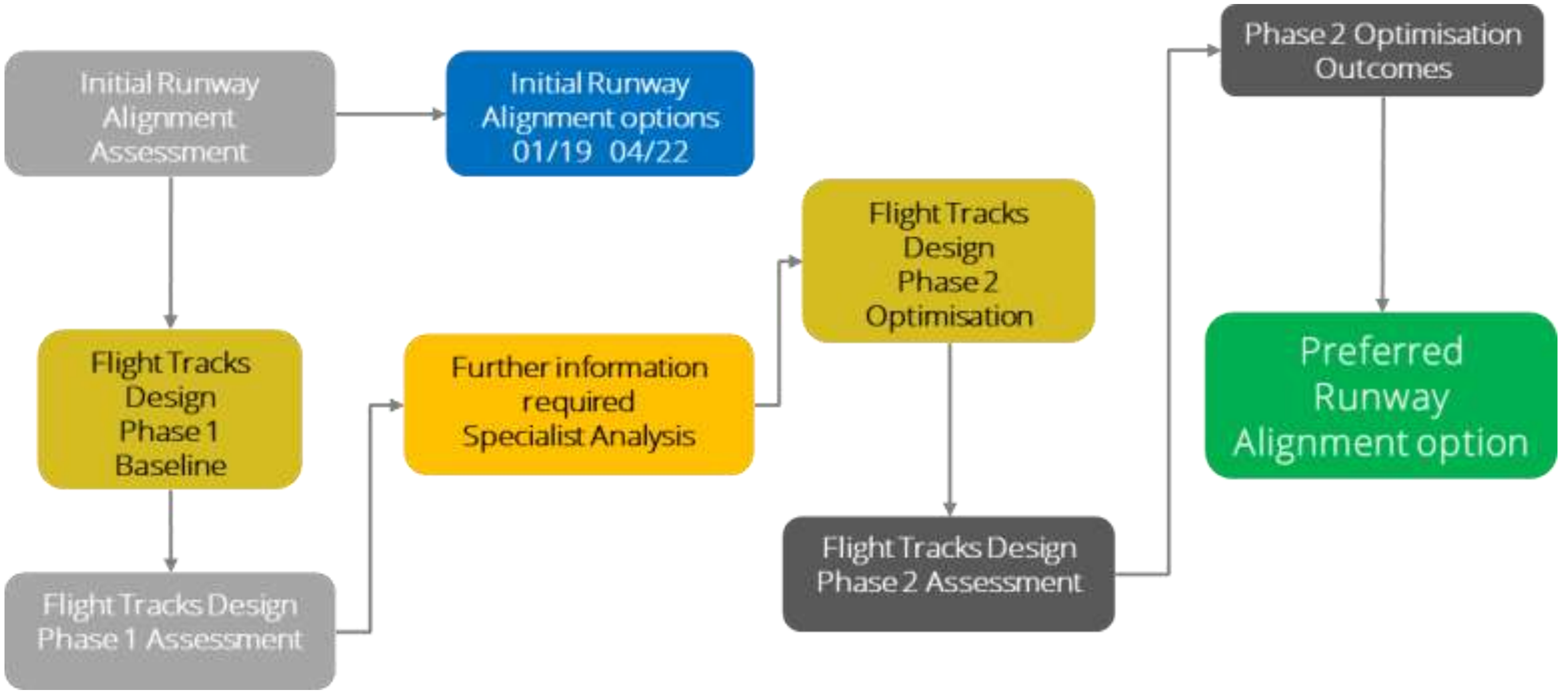
Capacity assesses the ability of the airspace system and procedures to minimise inter-dependencies of flight paths and IFPs to facilitate a consistently processing rate of aircraft arrivals and departures at the airport.

Assessment of each lens cannot be done in isolation. The process is interdependent, starting and ending with Safety. Assessment within each lens which results in a proposal to change part of the original concept design must then undergo assessment within the remaining lenses and be ultimately brought back under Safety for a final assessment.

ii. Process

Figure 4-2 following shows the stepwise process that has been followed for the design, assessment and evaluation of flight paths to resolve a preferred runway alignment.

Figure 4-2: Design and Assessment Process



A key aspect of the process is the staging of the design of flight tracks for each runway alignment option into two phases.

The Phase 1 Baseline stage was specifically tasked with investigating the fundamental feasibility of having safe and compliant airline operations at the proposed airport site, taking account of the obvious terrain context.

Initial high level assessments of aeronautical (aircraft performance) and environmental (aircraft noise and emissions) lenses were made to highlight the nature and scale of potential issues inherent in the Baseline design.

The subsequent Phase 2 Optimisation stage involved a more nuanced approach to the design of flight tracks with deeper considerations of Efficient, Environmental impacts and Capacity lenses.

Together with the Baseline designs, the further Optimised options provide a comprehensive range of alternatives to assess in a multi-criteria analysis and evaluation, with a view to identifying the preferred runway alignment.

iii. Evaluation Process

The assessment process for evaluating the Phase 1 Baseline and Phase 2 Optimised flight tracks has considered measurable and comparable aspects of the tracks for the two candidate runway alignments, organised in the framework of the four lenses described above.

For each evaluation and comparison, a simple empirical evaluation scoring model has been applied, as shown below in Figure 4-3.

Figure 4-3: Evaluation Scoring

Assessment Description	Assessment Score
A **positive** outcome, broadly considered to be compliant, suitable, versatile, acceptable	5
A **reasonable** outcome for which compliance, suitability, versatility and acceptability is anticipated to be achievable	4
A **neutral** outcome for which compliance, suitability, versatility and acceptability is anticipated to be challenging to achieve	3
An **inferior** outcome for which compliance, suitability, versatility and acceptability seems unlikely to be achievable	2
A **negative** outcome for which compliance, suitability, versatility and acceptability is almost certainly not achievable	1

5. Flight Tracks Design

i. Specialist Advisors

Design of initial flight paths and Instrument Flight Procedures (IFPs) for the two options for runway location and alignment has been undertaken by Aeropath Ltd, a provider of Airport and Terminal Area Instrument Flight Procedure Design services in New Zealand, the Pacific and internationally. Aeropath's work has been carried out with overall direction by Airbiz and has comprised two phases:

- Phase 1 Airspace Feasibility, to prepare initial Proof of Concept (POC) flight paths and IFPs for the two initial options for runway location and alignment to serve as 'Baseline' options with initial consideration of regulatory compliance, safety, environment, efficiency, and existing flight paths in the region with the objective of confirming that commercial air operations would be feasible at the proposed airport site for Cat C and D aircraft types, and
- Phase 2 Airspace Options, to identify additional feasible IFP and flight path options based on a deeper assessment of considerations (lenses), particularly environmental, design principles or specific criteria.

Together with the Baseline designs, these further options provide a comprehensive range of alternatives to assess in a multi-criteria analysis and evaluation, with a view to identifying the preferred runway alignment.

In parallel with the Aeropath flight track design work, further specialist analyses have been undertaken, including:

- Terrain mapping in more detail, derived from a regional aerial survey, undertaken by Landpro,
- Meteorology data, derived from site installations of meteorological monitoring and recording systems, installed and operated by Meteorological Services of New Zealand Ltd (MetService)),
- Engine-out performance and analysis, and aircraft take-off payloads assessments, undertaken by Astral (reliant on the detailed terrain data from Landpro),
- Aircraft engine out performance analysis and take-off payloads assessments, prepared by Astral (reliant on the terrain data),
- Airspace capacity issues, principally identification of potential dependencies between arrival and departure flight tracks, assessed by Airbiz,
- Sensitive areas to avoid being overflown, assessed by Enviser and Airbiz (following the completion of Aeropath's Phase 1 flight tracks design),
- Preliminary aircraft noise modelling, assessed by Airbiz,
- Preliminary aircraft emissions modelling, assessed by Airbiz, and
- Preliminary analysis for Obstacle Limitation Surfaces (OLS)[3], initiated by Airbiz, to assess potential implications for land use and development outside the airport boundary arising from the need to assess and control obstacles (refer to Appendix A for more information).

[3] Obstacle Limitation Surfaces (OLS) are defined areas about and above an aerodrome intended for the protection of aircraft in the vicinity of an aerodrome.

ii. Flight Tracks Design: Phase 1 Brief

Objectives

The primary objectives for Aeropath's Phase 1 work were to:

1. Confirm the initial (earlier) assessment that feasible IFPs could be designed (for CAT C and D aircraft),
2. Compare which of the two runway pairs would provide the most advantageous results in terms of both flight safety and operations, and
3. Prepare outputs in a graphical form that facilitates subsequent environmental assessments to be made.

The Phase 1 design work was focussed on the segments of flight operations close to the airport - Standard Instrument Departures (SID)[4] and Approaches (APCH)[5] - with a general appreciation that it would be practical to connect these segments of flights into the existing New Zealand enroute navigation structure, without (yet) designing such connections.

Principles

- Safety and Flyability principles that Aeropath was asked to apply to their Phase 1 design work were to:
- Keep design as simple as possible,
- Place Safety as the primary consideration,
- Be compliant with relevant International and New Zealand Civil Aviation Standards,
- Avoid inherent complexity for the air traffic control environment to ensure that air traffic controller workload imposed by the IFPs does not result in potentially unsafe outcomes for aircraft operations, and
- Use RNAV[6] and/or RNP[7] instead of conventional navigation (at that preliminary stage).

Runway Length Scenarios

Each runway pair was considered at runway length scenarios of 2,200m and 3,000m. Provisional configurations for the 3,000m runway scenarios envisaged:

1. Positioning the southern threshold of runway pair 01/19 from 2,200m to 3,000m, requiring:

- One APCH to RWY 19 and two APCHs to RWY 01, and
- One SID off RWY 01 and two SIDs off RWY 19.

2. Positioning the northern threshold of runway pair 04/22 from 2,200m to 3,000m, requiring:

- One APCH to RWY 04 and two APCHs to RWY 22, and
- One SID off RWY 22 and two SIDs off RWY 04.

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[4] SID = Standard Instrument Departure (see Glossary)

[5] APCH = Approach (see Glossary)

[6] RNAV = Area Navigation, a method of instrument flight rules (IFR) navigation that allows an aircraft to choose any course within a network of navigation beacons, rather than navigate directly to and from the beacons

[7] RNP = Required Navigation Performance (RNP) is a family of navigation specifications under Performance Based Navigation (PBN) which permit the operation of aircraft along a precise flight path with a high level of accuracy and the ability to determine aircraft position with both accuracy and integrity.

Flight Tracks Design: Phase 1 Outputs and Exclusions

The outputs from Phase 1 design of initial Arrival and Departure tracks comprised preliminary designs for:

- Approaches (APCH),
- Missed Approaches, and
- Standard Instrument Departures (SID) for operations with All Engines (AESID),

for each runway direction, for each alignment option.

At the initial Phase 1 stage, the outputs did not consider or produce:

- Options for Standard Arrival Routes (STAR),
- Engine Out departure procedures (EOSID).
- Flight tracks and IFPs for a broader NAVSPEC RNP 0.3 or for approaches other than RNAV, (ILS or similar),
- Enroute connections that demonstrate how routings to/from AKL, WLG, CHC and SYD would be achieved,
- Assessments of procedures and flight paths for turboprop and general aviation aircraft operations at COA,
- Assessment of how Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) operations to/from adjacent aerodromes can be accommodated with COA operations, and
- Assessments, other than very high level, for Capacity, Efficiency and Environmental lenses.

Aeropath's Phase 1 technical material and outputs were presented in a report to CIAL (dated 10 June 2022) prepared by JN Aviation Consulting with guidance and review by MH Aviation and Airbiz.

iii. Flight Tracks Design: Phase 2 Brief

The scope of work and objectives for Aeropath's Phase 2 work was focussed on:

- Design for alternative feasible flight paths and IFPs that offer benefits in respect of consideration of the four lenses, e.g. mitigations to environmental effects on adjacent Socially Sensitive Areas, without degradation of safety and efficiency (such as lateral shift of a flight track if practical to avoid proximity to a Socially Sensitive Area or increased climb gradient for a SID to provide a higher altitude over a Socially Sensitive Area),
- "Filling in" design information not produced in Phase 1,
- Preparing flight tracks to NAVSPEC RNP 0.3 (which is recommended to be considered as part of a complete RNP AR package, providing for greater versatility and less disruptions, accounting for potential issues relating to capabilities of crew, aircraft and airlines, and meteorological variabilities), and
- Integrating AESIDs with the EOSIDs prepared by Astral,
- Efficiently connecting to the established Enroute system, and
- Investigating a third alignment option 05/23 as a variant of 04/22, with the runway shifted eastward on the site and the alignment rotated approximately 10º clockwise to assess whether there might be payload advantages due to lower terrain to the north of the site on that adjusted alignment.

The Phase 2 work by Aeropath has been able to take due account of and has benefited by being able to draw on:

- The more detailed terrain data,
- Engine-out performance and analysis undertaken by Astral, insofar as the Phase 2 optimised SIDs have been designed to follow the EOSID paths up to and as far identified branch points, as described in 5.v, and

- Advice on socially sensitive areas to avoid being overflown, identified by Airbiz in discussion with CIAL.

iv. Aeronautical Performance Framework

Table 5-1 following sets out the target technical performance framework for the Aeropath Phase 1 and Phase 2 work, aimed at producing outcomes that could be expected to be fully workable in the longer term.

For Phase 1, Aeropath conducted their flight track design work applying the most stringent RNP 0.1 and 0.2 NAVSPEC (which effectively enables a "tighter" flight track but is more restrictive on which airlines, aircraft and pilots might be able to fly it).

For Phase 2, the target NAVSPEC of RNP 0.3 was applied, providing for greater versatility and less disruptions, accounting for potential issues relating to capabilities of crew, aircraft and airlines, and meteorological variabilities.

Table 5-1: Instrument Flight Procedures: Performance Framework

Performance Parameter	Target
Navigation Specification (NAVSPEC)[8]	RNP 0.3
Approach gradient	3°
Decision Height	250 feet
Missed Approach gradient	2.5%
Visual Segment Surface (VSS)[9]	Only penetrations that can be mitigated
Obstacle Clearance Surface (OCS)	No penetrations
Departure gradient	3.3%
Engine Out gradient	2.0 – 2.5%
Aircraft payload	Needs to be at or near MTOW

v. Engine Out Procedure Design

For every flight departure of any aircraft type at any airport in the world, airlines must calculate the permissible payload of passengers, baggage, freight and fuel that can be carried, allowing for the remote possibility that an engine might fail just after the point where the aircraft must continue with the take-off, thereby reducing power available for the climb

[8] NAVSPEC (navigation specifications) are a set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept.

[9] VSS (Visual Segment Surface) and Obstacle Clearance Surface (OCS) are design segments of an airport approach procedure, which need to be kept clear of any penetrations by obstacles.

out to an altitude from which it is safe to continue to either return to the airport or fly to another airport. This "engine out" scenario could occur:

- On the runway before take-off, when there is insufficient remaining runway length to safely stop on the ground,
- Soon after take-off while aircraft speed is still relatively low and altitude is low, or
- In the course of the climb out prior to the aircraft achieving sufficient altitude to safely fly with the consequential reduction in thrust.

For airports with relatively long runways and little or no terrain, the payload that can be carried is usually the maximum take-off weight (MTOW) that the aircraft has been structurally designed to carry.

However, for airports surrounded by high terrain there needs to be a flight path that can safely accommodate the climb out of all aircraft types that might have suffered the remote prospect of an engine failure. Such flight paths are specifically designed and referred to as Engine Out Standard Instrument Departures (EOSID).

The design of EOSIDs was undertaken by Astral in parallel with the Aeropath design work which included All Engines procedures (AESID), for both Phase 1 Baseline and Phase 2 Optimisation stages.

For Phase 1, the EOSID and payload work was conducted just for larger CAT C and D jet aircraft. For Phase 2, the work included both jet aircraft and for the ATR-72 turboprop aircraft.

A key philosophy underpinning the design of both AESID (by Aeropath) and EOSID (by Astral) is that the two procedures should have flight paths that align/coincide in plan view until a point along the flight path (referred to as the Branch Point) that an aircraft flying an engine out procedure has reached sufficient altitude to be able to safely divert above terrain to an airport of refuge. Implementing this policy involved iterative design collaboration between Aeropath and Astral.

vi. Departure Payloads

The engine out procedures and EOSID flight paths are critical components in the assessment of the payload that can be carried for every aircraft departure.

Astral undertook analyses to estimate indicative take-off weights for various aircraft types in that might be expected to operate at COA, taking account of the candidate pathway, critical obstacles along and adjacent to that pathway and climb characteristics for each aircraft type in an engine-out (single engine operating) scenario.

From this, Astral estimated the number of passengers that would likely be able to be carried on each departure for each take-off for each runway alignment option.

vii. Environmental Guidance: Potentially Socially Sensitive Areas

An initial assessment was made of the potential environmental effects (other than the measure of aircraft noise) of aircraft operations associated with scheduled passenger airline operations utilising the Phase 1 Baseline flight tracks.

This was undertaken by examining the locations of pathways of the Phase 1 Baseline flight tracks to identify areas which might have levels of potential social sensitivity to having aircraft flight paths overflying. Such sensitivities included:

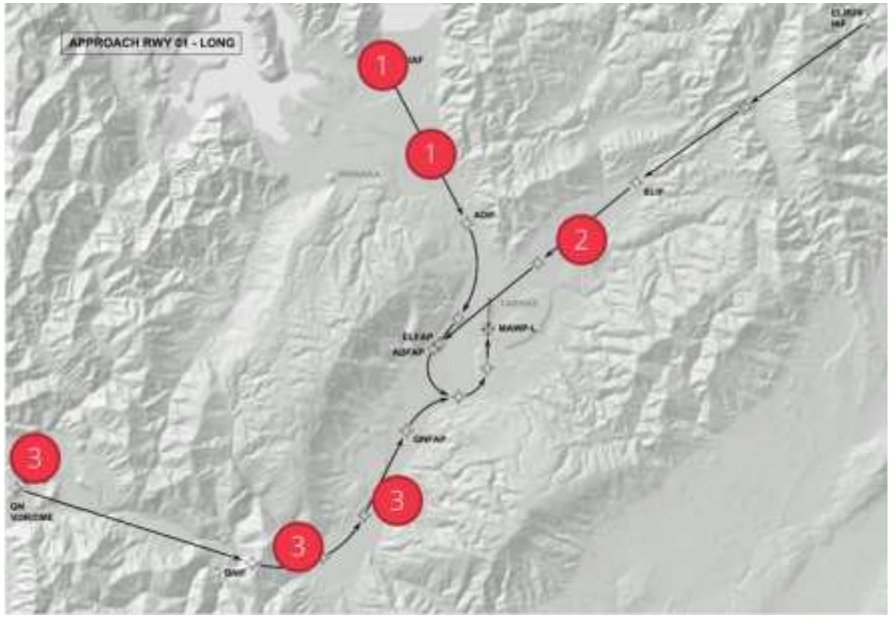
- Potential noise effects (over towns and residential areas)

- Impacts on visual amenity (over towns and possibly over wilderness areas).

Potential mitigations have been identified and have been incorporated into the briefing guidance to Aeropath for their Phase 2 flight tracks design optimisation. These have primarily comprised suggestions to mitigate environmental effects on areas considered to be potentially socially sensitive, without degradation of safety and efficiency, such as lateral shift of a flight track if practical to avoid proximity to a potentially socially sensitive area or increased climb gradient for a SID to provide a higher altitude over a such an area.

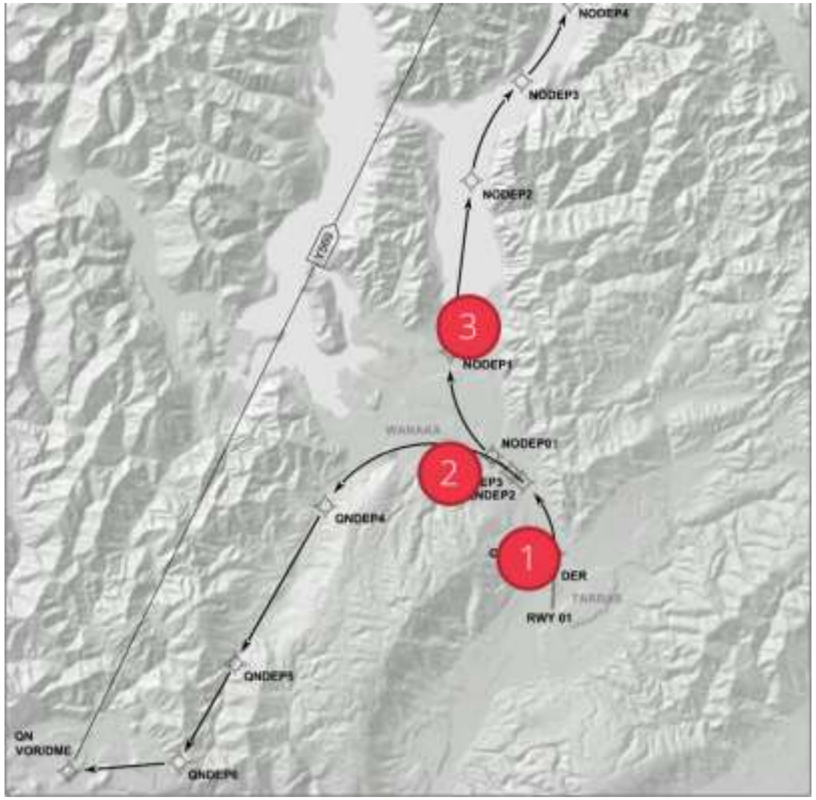
The Phase 1 Baseline areas identified as being potentially socially sensitive are depicted in Figure 5-1 through Figure 5-8. Each of these figures also describes the nature of the mitigation that has been applied as environmental guidance to Aeropath for their subsequent Phase 2 Optimisation design work.

Figure 5-1: Runway 01 Phase 1 Baseline Arrivals, Potentially Socially Sensitive Areas



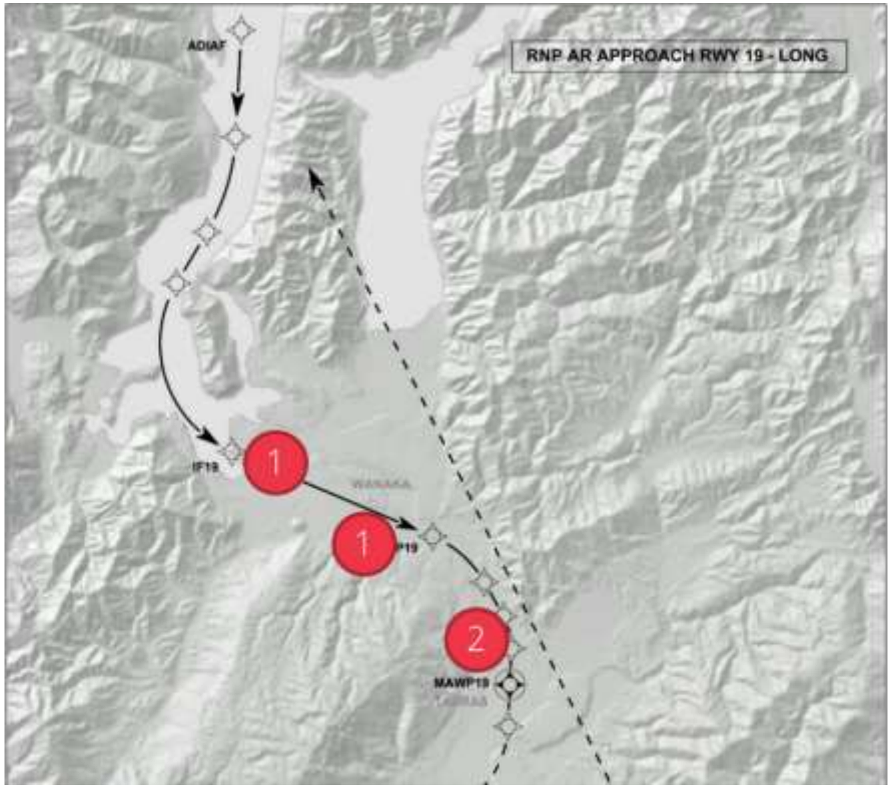
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity in Hāwea Valley and Luggate	Relocate approach to avoid overflying Lake Hāwea township, push approach to eastern side of Hāwea Valley as far as possible?	3
2	Noise / Visual Amenity in Lindis Valley	Relocate approach to avoid use of the Lindis Valley as far as possible?	4
3	Visual Amenity at Queenstown and Cromwell	Relocate approach to avoid overflying Queenstown and Cromwell, approach follows centre or east of Lake Dunstan?	3

Figure 5-2: Runway 01 Phase 1 Baseline Departures, Potentially Socially Sensitive Areas



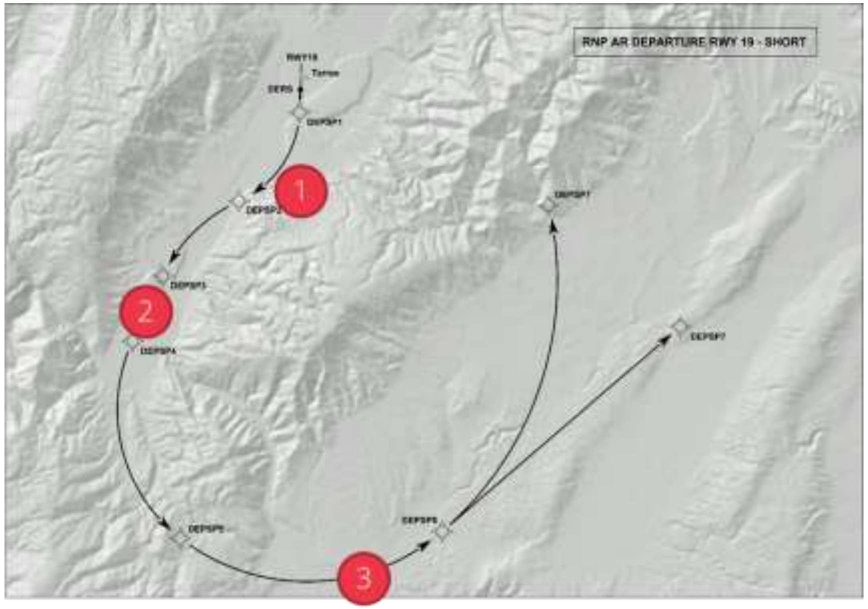
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity at Queensberry	Shift east away from Queensberry to minimise any potential noise and visual amenity effects?	3
2	Visual Amenity	Shift south of Luggate township reducing overflight?	3
3	Visual Amenity	Shift east or west of Lake Hāwea township, reducing overflight?	3

Figure 5-3: Runway 19 Phase 1 Baseline Arrivals, Potentially Socially Sensitive Areas



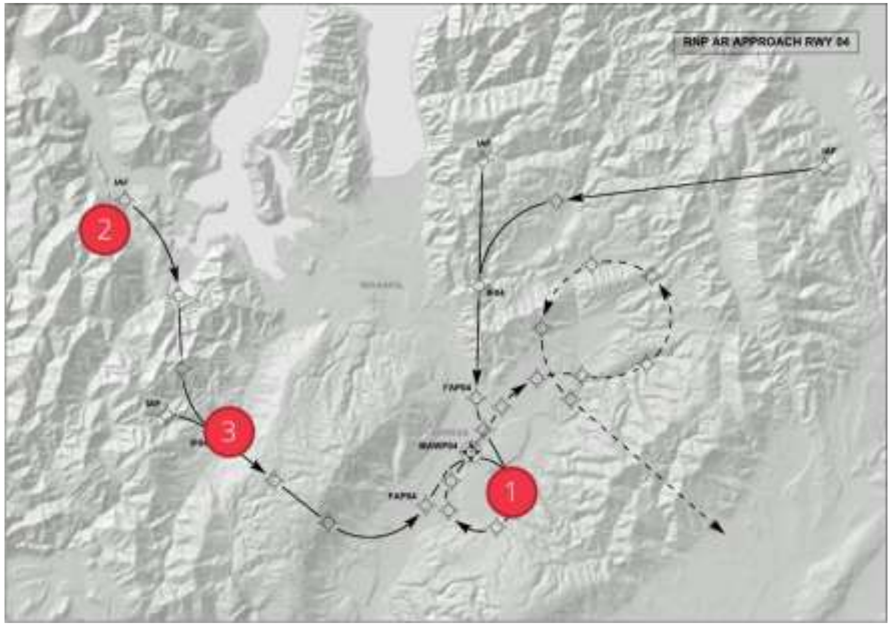
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity in Wanaka and Luggate	Shift approach to avoid overflying Wanaka and Luggate?	3
2	Noise / Visual Amenity in Queensberry	Shift approach east as far as possible to avoid Queensberry?	3

Figure 5-4: Runway 01 Phase 1 Baseline Departures, Potentially Socially Sensitive Areas



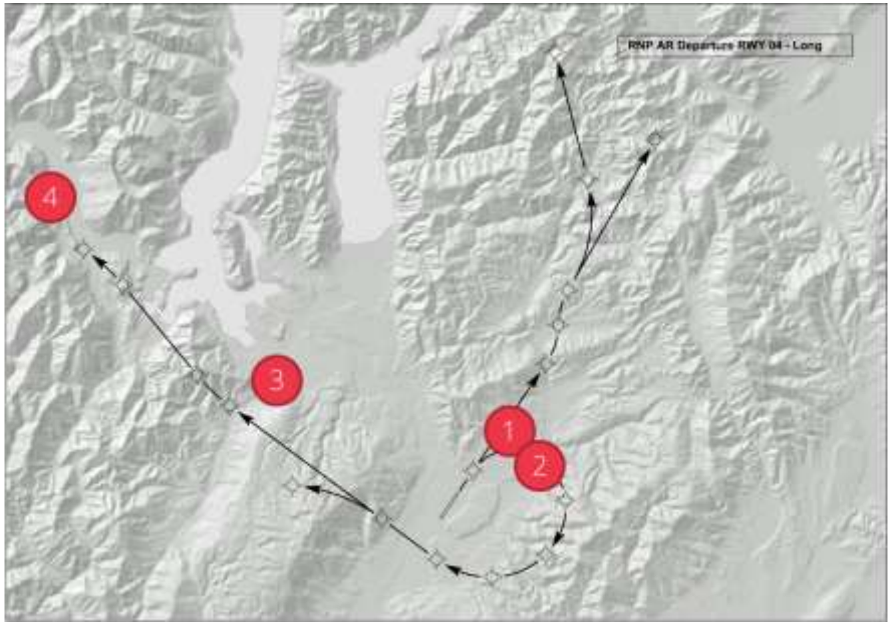
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity at Bendigo	Shift track west to avoid Bendigo area, centering tack on Lake Dunstan?	3
2	Noise / Visual Amenity along western shoreline	Shift track to centre (or eastern side) side of lake to avoid overflying Pisa Moorings and Cromwell?	4
3	Visual Amenity Maniototo / avoid Gliding conflicts in area	Shift track south or north to avoid bisecting Clyde and Alexandra and overflying the Maniototo. Track out towards east coast then north?	4

Figure 5-5: Phase 1 Baseline Runway 04 Arrivals, Potentially Socially Sensitive Areas



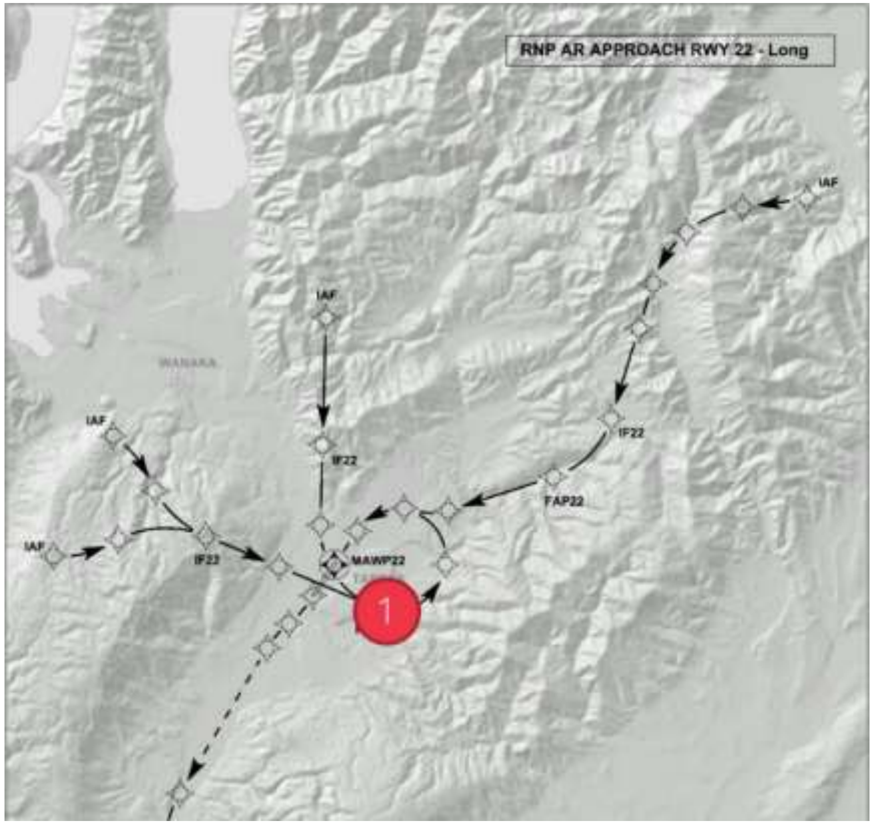
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity over Ardgour Valley	Alter circling approach to avoid overflying Ardgour Valley?	4
2	Visual Amenity over Mt Aspiring	Avoid approach over Mt Aspiring?	4
3	Noise / Visual Amenity over Cardrona	Avoid approach over Cardrona?	4

Figure 5-6: Phase 1 Baseline Runway 04 Departures, Potentially Socially Sensitive Areas



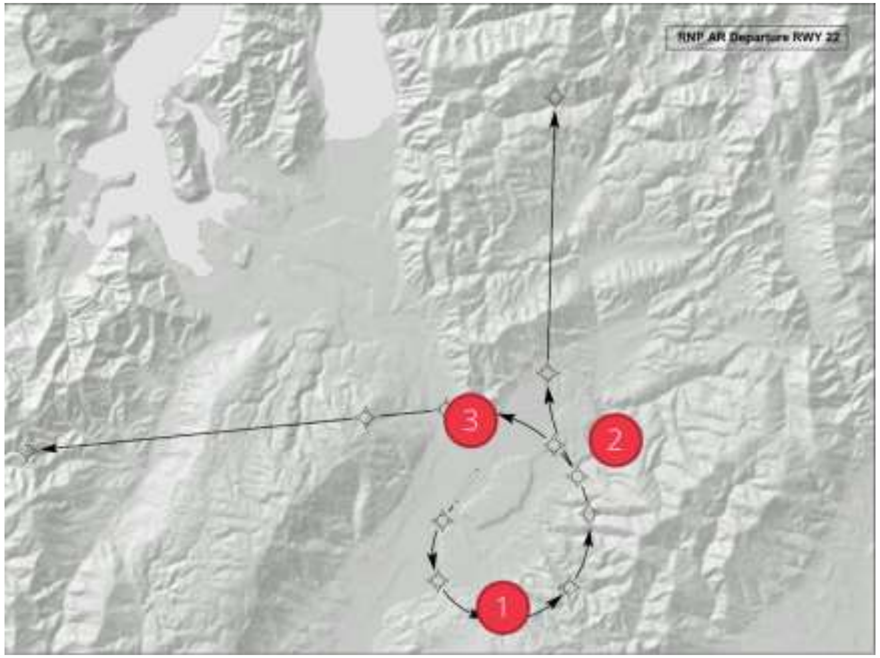
ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity over Lindis Valley	Turn departure track north-west as soon as possible to avoid Lindis Valley rural areas?	4
2	Noise / Visual Amenity over Lindis Valley	Turn departure track north-west as soon as possible, following AKL/CHC route then west to Tasman destinations, to avoid Lindis Valley rural areas?	4
3	Visual Amenity over Wanaka	Avoid overflying western fringe of Wanaka?	3
4	Visual Amenity over Mt Aspiring	Avoid overflying Mt Aspiring?	4

Figure 5-7: Phase 1 Baseline Runway 22 Arrivals, Potentially Socially Sensitive Areas



ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity over Ardgour Valley	Alter joining point FAP22 to avoid Ardgour Valley (move south)?	4

Figure 5-8: Phase 1 Baseline Runway 22 Departures, Potentially Socially Sensitive Areas



ID	Consideration	Possible Mitigation	Phase 1 Assessment
1	Noise / Visual Amenity over Bendigo	Extend southern portion of track to start eastern turn after Bendigo?	3
2	Noise / Visual Amenity over Lindis Valley	Extend track north to avoid upper areas of Lindis Valley, tracks split over mountainous areas (no over the Lindis Valley)?	4
3	Noise / Visual Amenity over Queensberry	Shift track north to avoid Queensberry?	3

viii. Phase 2 Flight Tracks Outputs

The flight tracks resulting from Aeropath's Phase 2 Optimised flight track design work are depicted on Figure 5-9 through Figure 5-12 following showing the main tracks for arrivals and departures for the main routes.

The Phase 2 flight tracks have responded to the guidance provided by Airbiz and described in the preceding section to avoid areas identified in the Phase 1 Baseline tracks as being potentially socially sensitive.

For both phases of their work, Aeropath has provided aeronautical performance metrics for each track, such as gradients for arrival, departure and missed approach tracks, which have formed the basis of the aeronautical evaluation described following.

Figure 5-9: Phase 2 Optimised Flight Tracks: Runway 01

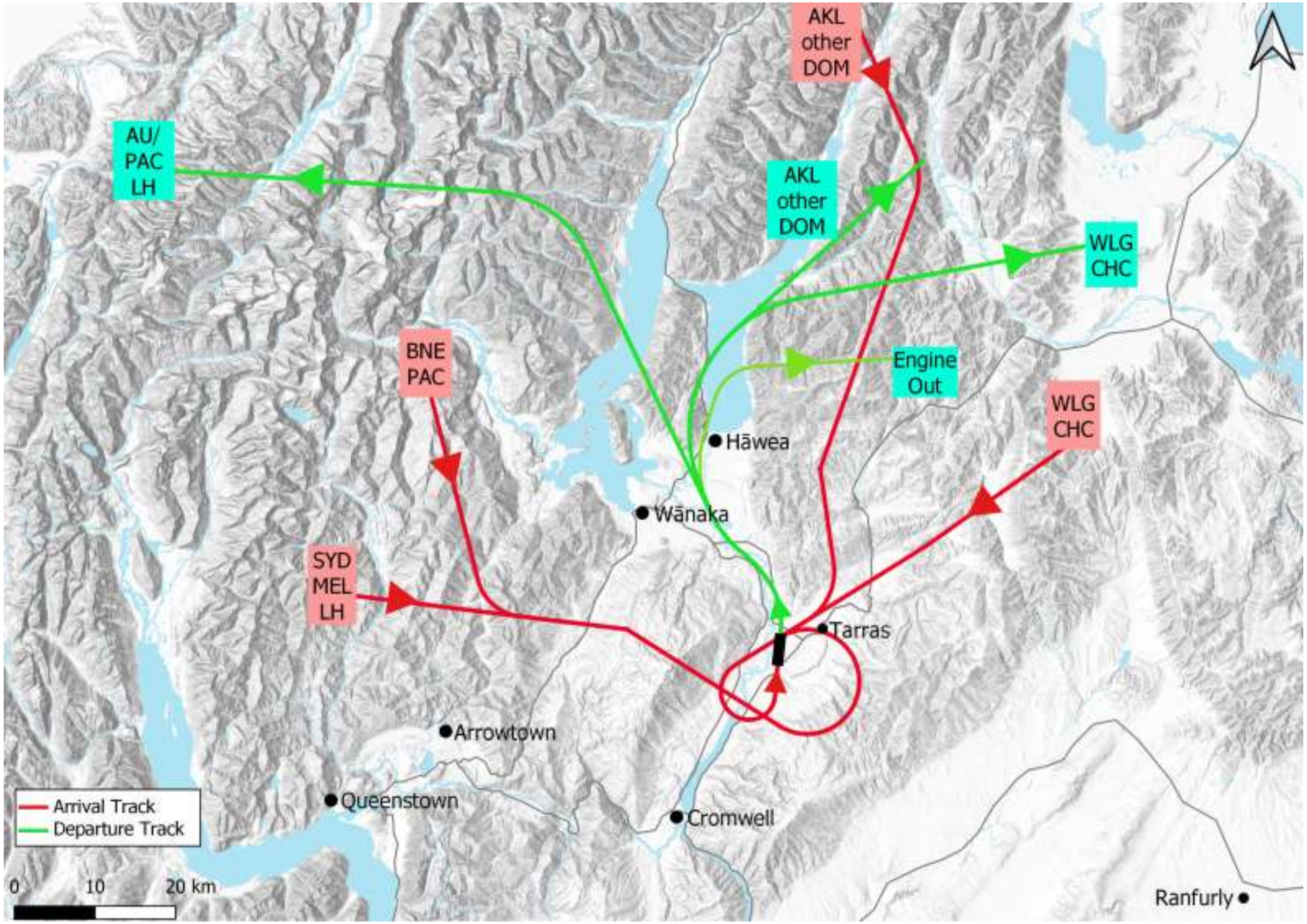


Figure 5-10: Phase 2 Optimised Flight Tracks: Runway 19

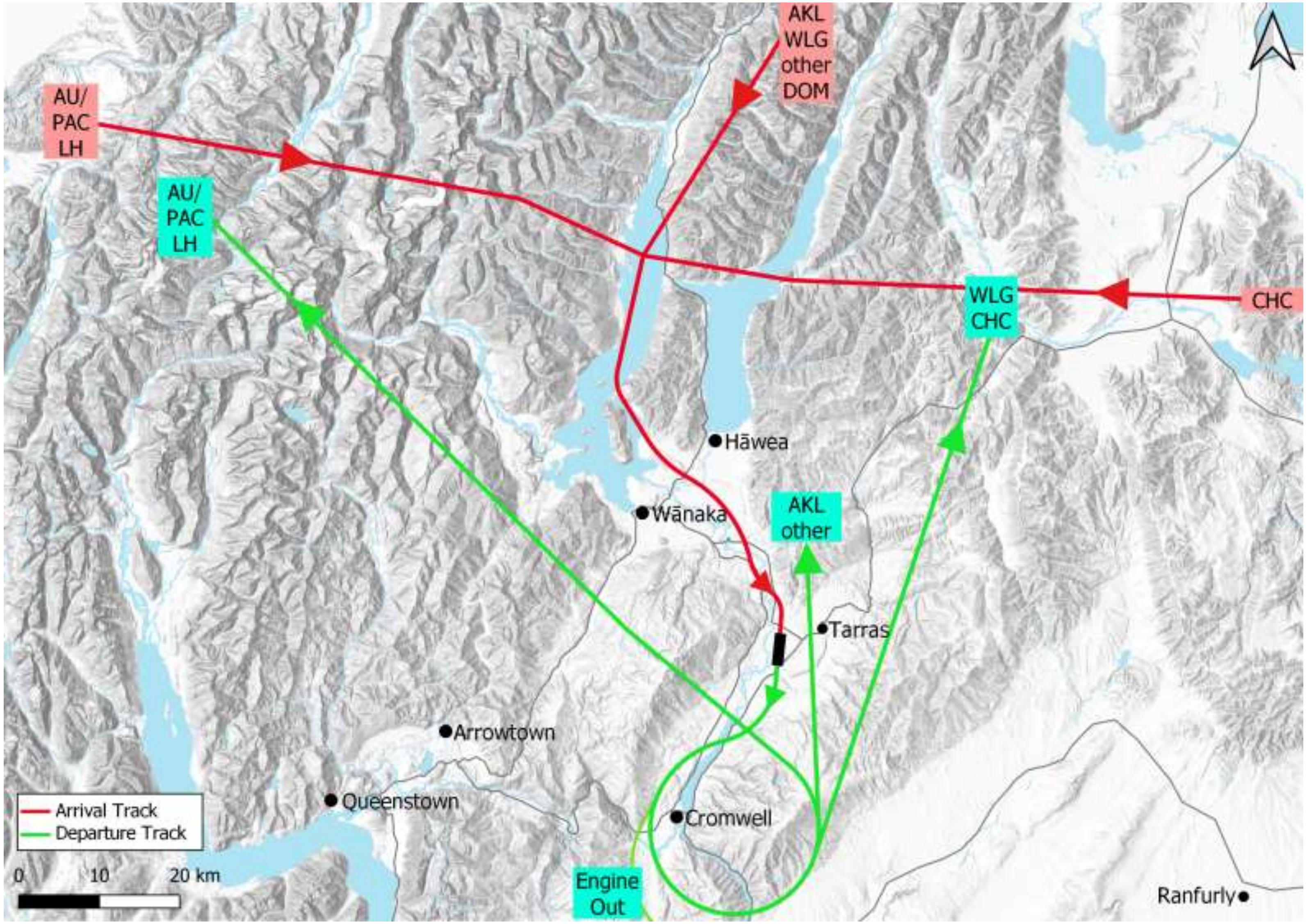


Figure 5-11: Phase 2 Optimised Flight Tracks: Runway 04

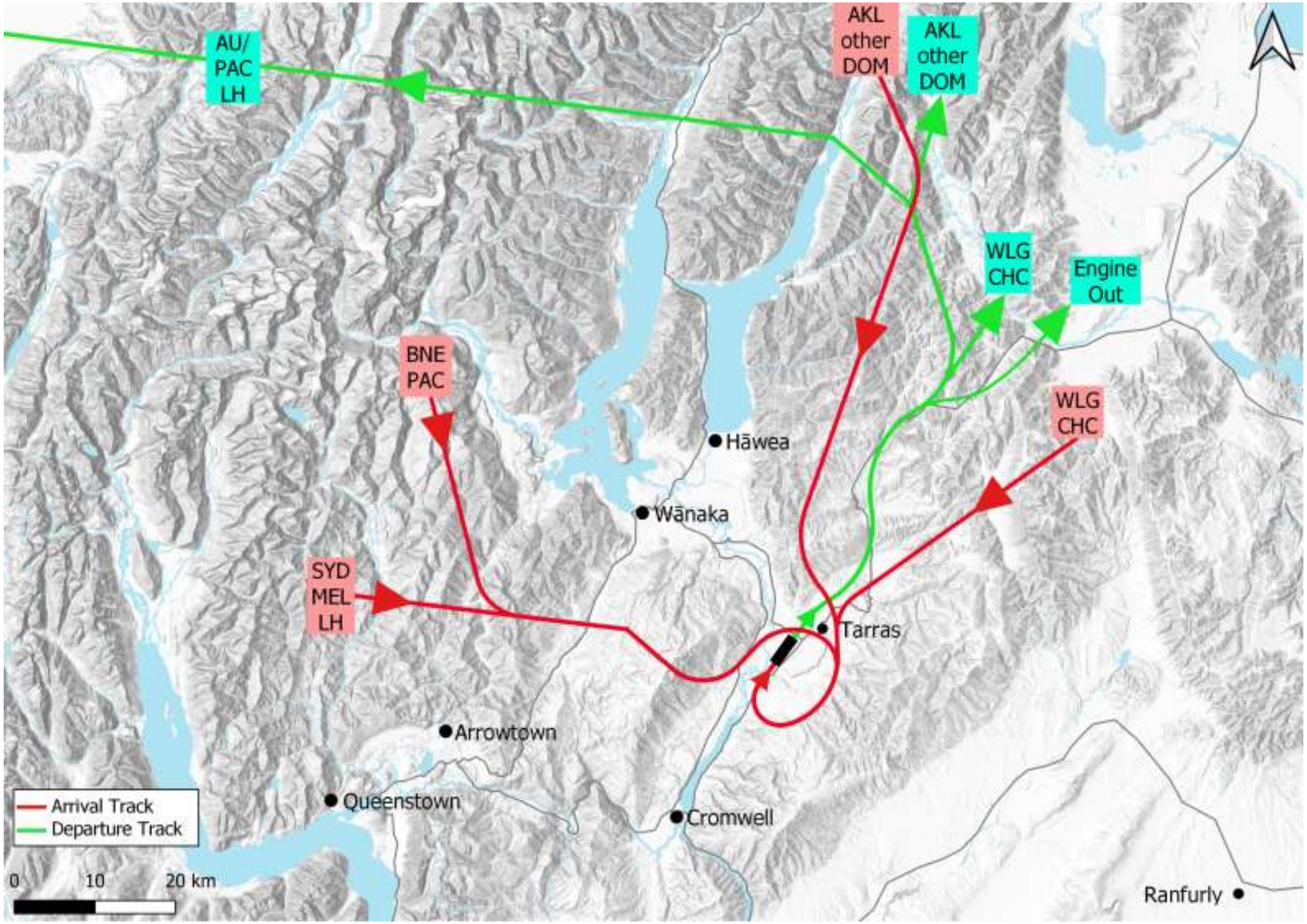
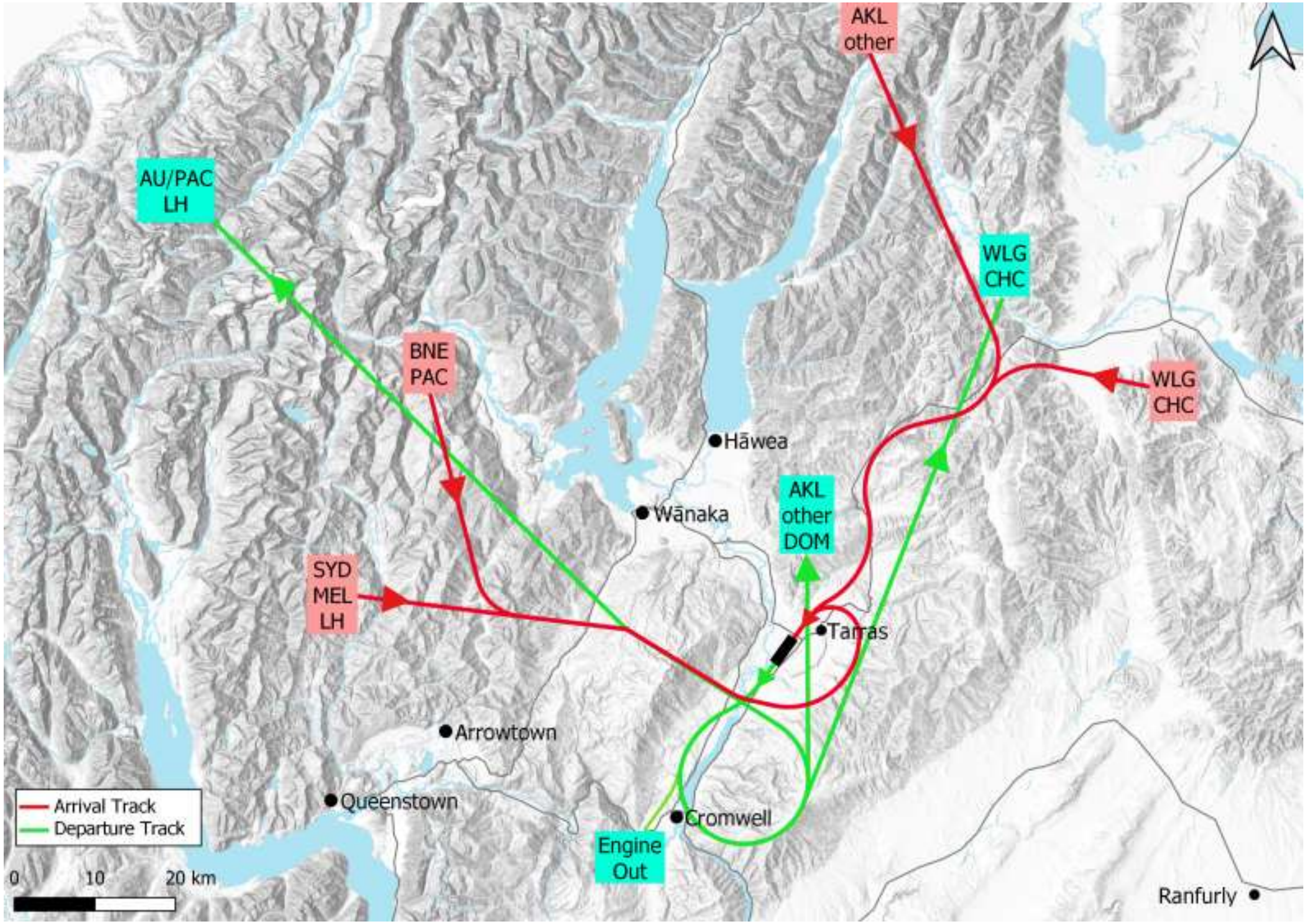


Figure 5-12: Phase 2 Optimised Flight Tracks: Runway 22



6. Assessment and Evaluation

i. Efficiency Assessment: Aeronautical Performance

The Efficiency assessment of aeronautical performance of the Optimised flight tracks resulting from Aeropath's Phase 2 design work are tabulated at Figure 8-6 through Figure 8-9 and summarised in Figure 8-5 below.

Figure 6-1: Phase 2 Optimised Aeronautical Assessment Summary

	RWY 01	RWY 19	RWY 04	RWY 22
	5	2	5	5
nt	5	5	5	5
	5	4	5	5
Missed Approach gradient	4	5	5	5
	3	4	4	3
	4	4	5	5
	5	5	5	5
ent	5	5	5	5
	5	3	3	5
Aircraft Payload	5	1	3	5

The key outcomes from the Phase 2 Flight Tracks design, assessment and evaluation are that the optimisation process has improved most aspects of aeronautical performance except:

<u>For RWY 19 Approach</u>: The target RNP 0.3 specification is not possible to achieve using ICAO criteria due to proximity of terrain in the late stage of the APCH. Not being able to achieve the RNP 0.3 specification would reduce the versatility of the runway and airport for a broad range of airlines, aircraft and pilots.

<u>For RWY 19 Departure:</u> The departure payload is likely to need to be significantly limited for EOSID protection, due to proximity of terrain soon after take-off.

<u>For RWY 04 Departure:</u> Departure payload may be affected for most aircraft types but likely to be acceptable. This issue could be partly mitigated with 22 departures within tailwind limits.

<u>For RWY 01 and 22 Arrivals:</u> Possible infringement of the VSS would need to be investigated further These are understood to be located on the land owned by CIAL and are expected to be able to be removed during construction – other mitigations such as increased visibility distance requirements could be applied if required to achieve an acceptable accommodation of the penetration of the VSS.

The assessment shows that the 04/22 runway alignment is more favourable.

Figure 6-2: Phase 2 Optimised Aeronautical Assessment: Runway 01

Criterion	Target or Specification	Applied or Achieved	Workable?	Comment	Phase 1 Assessment	Phase 2 Assessment
APPROACH						
NAVSPEC	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	Yes		3	5
Approach gradient	3.0°	3.0°	Yes		5	5
Decision Height	250 ft	RNP-AR 0.1 = 510ft RNP-AR 0.2 = 540ft RNP-AR 0.3 = 570ft	Yes	Long runway increases the minima but still acceptable	4	5
Missed Approach gradient	2.5%	2.5%	Yes	Very long and complex MA	4	4
VSS	Only mitigated penetrations	Obstacles penetrate	2200m - yes 3000m - possibly no	3000m RWY unlikely to work as it takes in high terrain to the south	2	3
OCS	No penetrations	Minor penetrations	Likely	Small obstacles that could likely be cleared during construction	4	4
DEPARTURE						
NAVSPEC	RNP-AR 0.3	RNP-AR 0.3	Yes		4	5
Departure gradient	3.3%	5.5% to ???	Yes		4	5
EOSID	2.0% - 2.5%	3000m Cardrona 2.3% 3000m Hāwea 2.5%	Yes		4	5
Aircraft Payload	At or near to MTOW	2200m BNE c. 100% 3000m SIN c. 100%	Yes		4	5

Figure 6-3: Phase 2 Optimised Aeronautical Assessment: Runway 19

Criterion	Target or Specification	Applied or Achieved	Workable?	Comment	Phase 1 Assessment	Phase 2 Assessment
APPROACH						
NAVSPEC	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	RNP-AR 0.1 RNP-AR 0.2	Yes with limitations	RNP 0.3 is not possible using ICAO RNP-AR Criteria	2	2
Approach gradient	3.0°	3.0°	Yes		5	5
Decision Height	250 ft	RNP-AR 0.1 = 270ft RNP-AR 0.2 = 290ft RNP-AR 0.3 = Not possible	Yes with limitations		5	4
Missed Approach gradient	2.5%	2.5%	Yes		5	5
VSS	Only mitigated penetrations	Minor penetrations	Likely	Trees that could likely be removed	4	4
OCS	No penetrations	Minor penetrations	Likely	Trees that could likely be removed	4	4
DEPARTURE						
NAVSPEC	RNP-AR 0.3	RNP-AR 0.3	Yes		4	5
Departure gradient	3.3%	5.5% to ???	Yes		4	5
EOSID	2.0% - 2.5%	3000m 3.6%	Operationally workable		3	3
Aircraft Payload	At or near to MTOW	2200m BNE c. 65% for A320/A321 3000m SIN c. 35% for B789/A359	No	Runway 19 length (at 2200m) and obstacles limit payloads for narrow body jets to c. 65% pax loads	2	1

Figure 6-4: Phase 2 Optimised Aeronautical Assessment: Runway 04

Criterion	Target or Specification	Applied or Achieved	Workable?	Comment	Phase 1 Assessment	Phase 2 Assessment
APPROACH						
NAVSPEC	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	Yes	Full range of range of RNP values	3	5
Approach gradient	3.00°	**3.10°**	Yes	Slope increased to 3.1° to accommodate RNP 0.3 (NZQN uses 3.2° for context)	5	5
Decision Height	250 ft	RNP-AR 0.1 = 360ft RNP-AR 0.2 = 520ft RNP-AR 0.3 = 560ft	Yes		4	5
Missed Approach gradient	2.50%	2.50%	Yes	Improved missed approach design achieved using data from EOSID analysis	4	5
VSS	Only mitigated penetrations	Minor penetrations	Likely	Trees that could likely be removed	4	4
OCS	No penetrations	OK	Likely		5	5
DEPARTURE						
NAVSPEC	RNP-AR 0.3	RNP-AR 0.3	Yes		4	5
Departure gradient	3.3%	5.5% to ???	Yes		4	5
EOSID	2.0% - 2.5%	RWY 04 3000m 3.5% RWY 05 3000m 3.2%	Operationally workable		3	3
Aircraft Payload	At or near to MTOW	2200m BNE c. 90% for A320/321 3000m SIN c. 80% for B789 & A359		RWY 04 and 05 (at 3000m) have obstacles (relating to EOSID) that restrict pax payloads to c. 80% for B787-9 and A350-900.	2	3

Figure 6-5: Phase 2 Optimised Aeronautical Assessment: Runway 22

Criterion	Target or Specification	Applied or Achieved	Workable?	Comment	Phase 1 Assessment	Phase 2 Assessment
APPROACH						
NAVSPEC	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	RNP-AR 0.1 RNP-AR 0.2 RNP-AR 0.3	Yes	Full range of range of RNP values	3	5
Approach gradient	3.0°	3.0° (with displaced threshold)	Yes		5	5
Decision Height	250 ft	RNP-AR 0.1 = 380ft RNP-AR 0.2 = 450ft RNP-AR 0.3 = 470ft	Yes		5	5
Missed Approach gradient	2.5%	2.5%	Yes		5	5
VSS	Only mitigated penetrations	Obstacles penetrate	2200m - yes 3000m - possibly no	3000m runway with a displaced threshold is unlikely to be clear due to the high terrain to the north.	2	3
OCS	No penetrations	OK	Yes	With a displaced landing threshold of 265m for Long RWY	5	5
DEPARTURE						
NAVSPEC	RNP-AR 0.3	RNP-AR 0.3	Yes		4	5
Departure gradient	3.3%	5.5% to ???	Yes		4	5
EOSID	2.0% - 2.5%	RWY 04 2.5% RWY 05 2.5%	Yes		4	5
Aircraft Payload	At or near to MTOW	2200m BNE 100% for A320/A321 3000m SIN 100% for B789/A359	Yes	For both RWY 04 and 05	4	5

ii. Environmental Assessment: Noise Effects

An assessment of the effects of aircraft noise associated with scheduled passenger airline operations was undertaken for both Phase 1 Baseline and Phase 2 Optimised flight tracks.

Context for Aircraft Noise Effects

How aircraft noise is perceived depends very much on where and how it is experienced.

On a typical day, the combination of multiple man-made and natural sound occurrences creates an ambient noise setting. Importantly, the ambient noise level does change throughout the day and night-time hours. Depending on the sound level of a given aircraft noise event, the extent and nature of the ambient sounds will impact how aircraft noise is perceived. This means that a loud aircraft noise event may go unnoticed for the person walking down a busy street with higher ambient noise while a similar or even quieter aircraft noise event may be more distinctively perceived by a person walking in an environment with lower ambient noise.

Therefore, a first step in assessing the potential aircraft noise impacts is scoping the existing local ambient noise environment.

Figure 6-6 following shows indicative sound levels for a selection of man-made sounds, many of which already exist and contribute to ambient noise in the local area, also showing indicatively how the noise from various aircraft at differing heights would compare. This diagram indicates that the range of aircraft noise loudness at varying heights in the vicinity of an airport are broadly comparable to noise levels ranging from a busy office environment through to a heavy truck in close proximity on a highway.

Single Event Contours

Single operations in the vicinity of the proposed airport site (an arrival and a departure) were modelled for typical Code C and E aircraft types on three representative routes – Auckland (AKL), Christchurch (CHC) and International (INT). for each direction on each runway alignment option. The single event noise contours for each of these operations were then aggregated and compared.

The aircraft types selected are in current common use in the region and are currently the most practical indicators of future types. Refer to Figure 6-7 following. However, the choice of current types for assessment of noise effects is likely to be conservative given expectations that next generation aircraft will be marginally quieter than current types.

The aggregated contours for each runway alignment identify the areas on the ground where 80, 70 and 60dBA will be the loudest levels experienced for a short period of time as an aircraft overflies an area. The composite noise contours are depicted illustratively at Figure 6-8 and Figure 6-9.

The effects are measured in social terms by estimating the number of existing dwellings and relating that to the numbers of persons (residents) that may be impacted in their place of residence, by various levels of aircraft noise.

This methodology provides a simple and effective measure of relativity between the effects associated with each runway alignment although it does not take account or provide measures of the future volumes of aircraft movements and therefore of cumulative noise effects.

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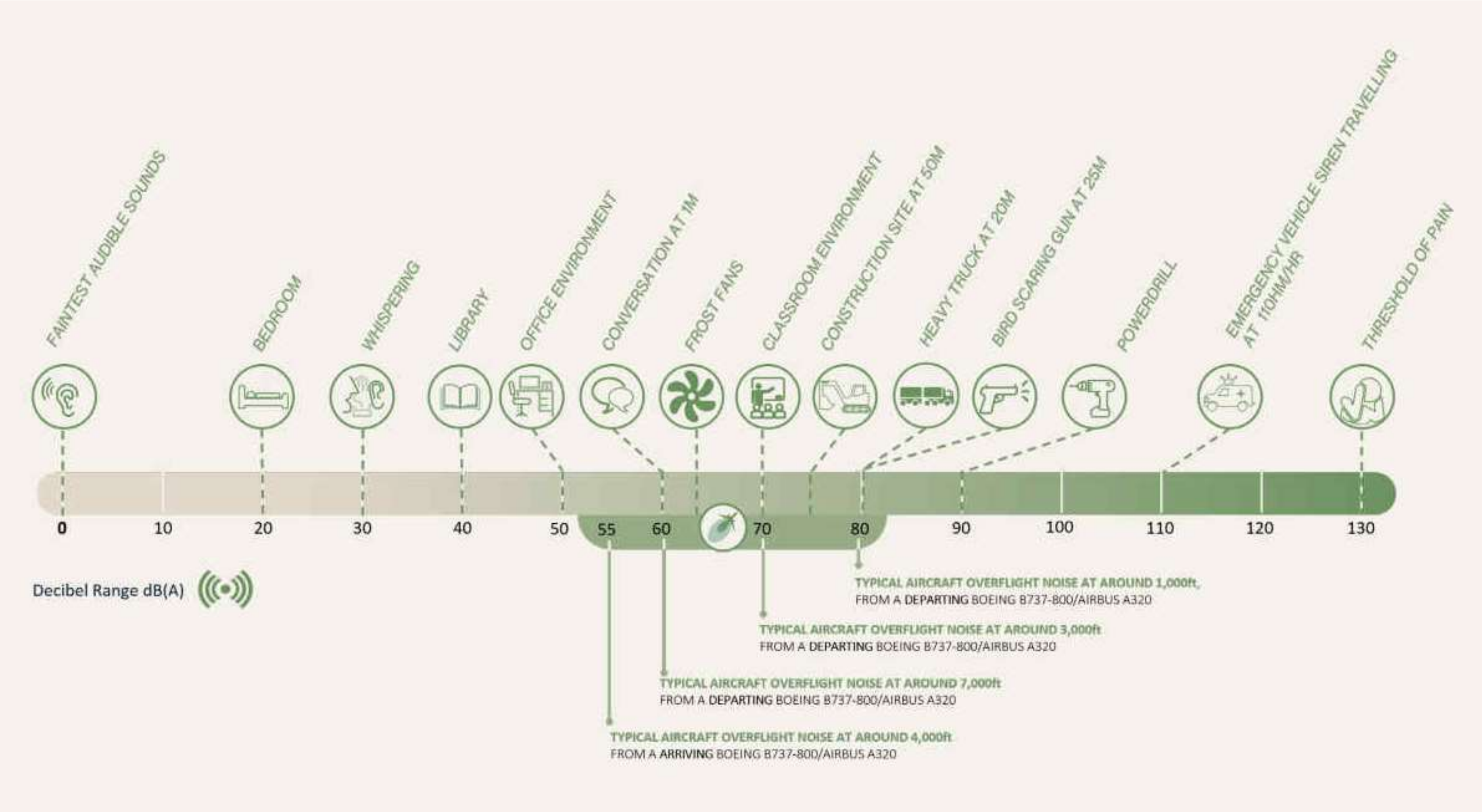
Figure 6-6: Comparison with Local Noise Environment



Note:

Some selected sound levels are sourced from Waka Kotahi NZ Transport Agency

Local noise levels are indicative and require specific site validation

Figure 6-7: Aircraft types and routes applied in noise modelling

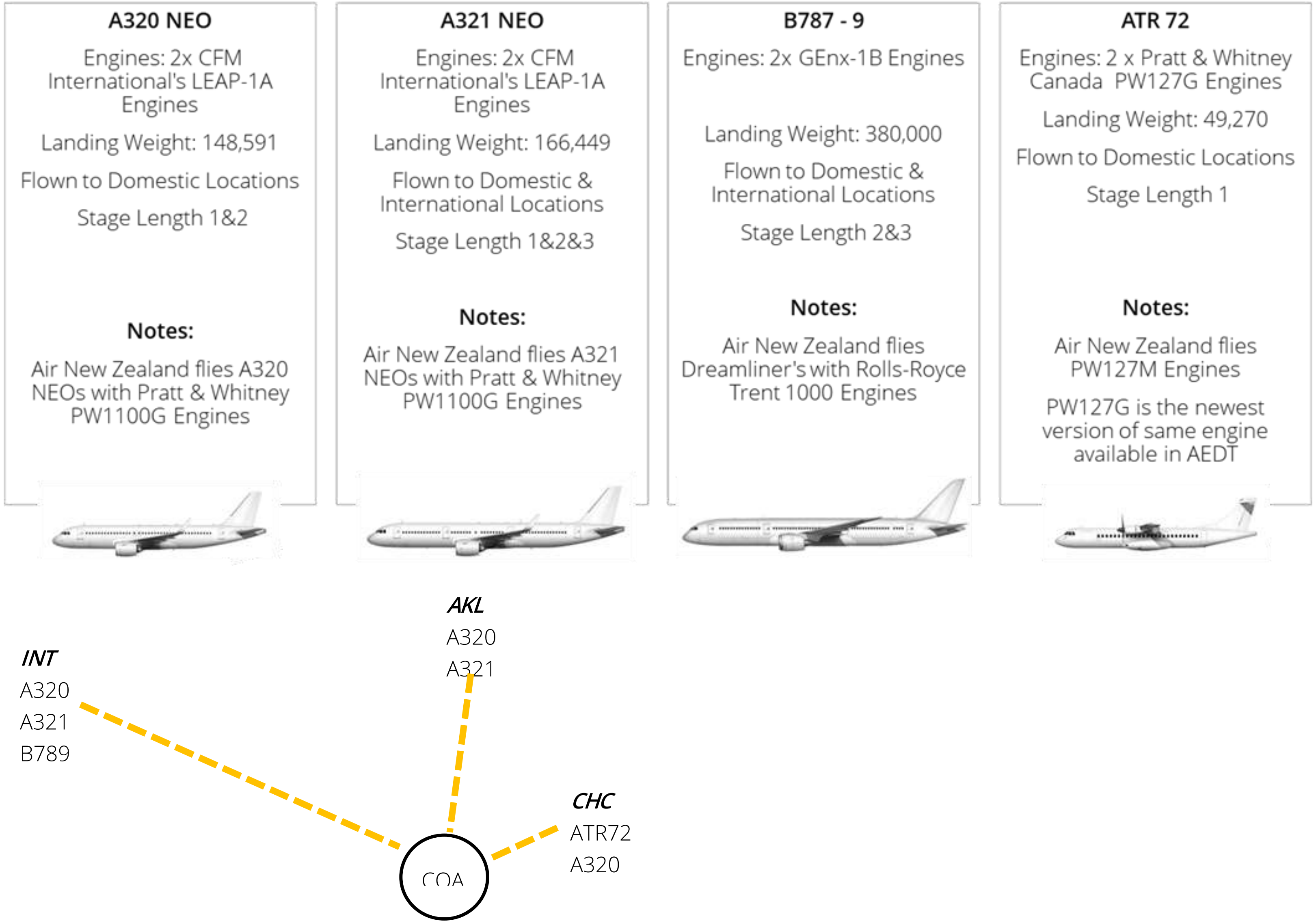


Figure 6-8: Runway 01-19, Phase 2 Optimised Tracks: Noise Effects, Single Event Contours, composite of aircraft types, routes, directions, arrivals + departures

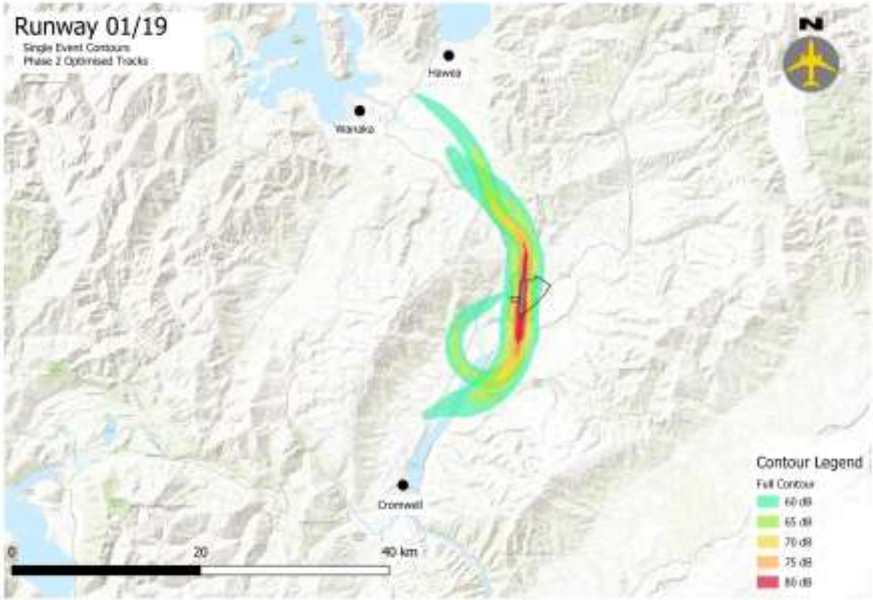
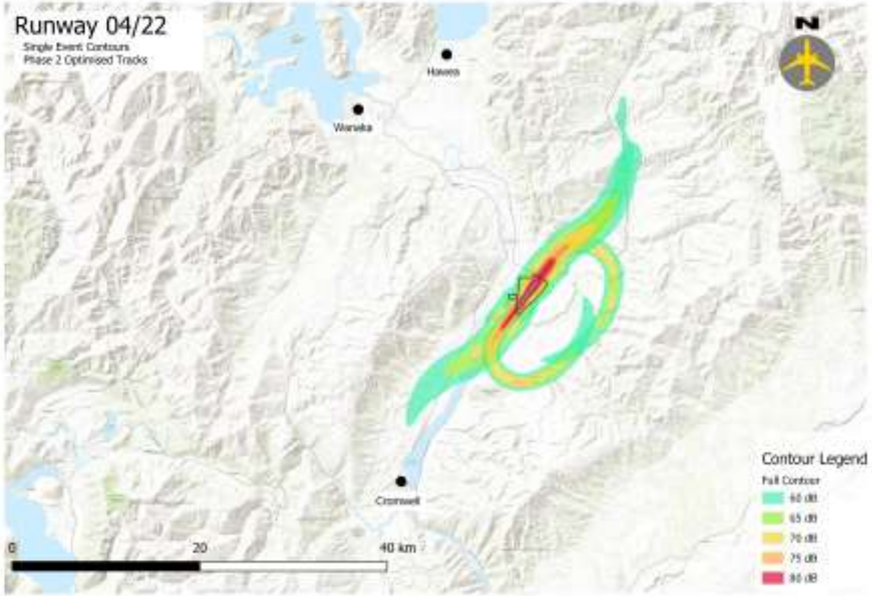


Figure 6-9: Runway 04-22, Phase 2 Optimised Tracks: Noise Effects, Single Event Contours, composite of aircraft types, routes, directions, arrivals + departures



Phase 2 Noise Effects Assessment Summary

A summary of the Phase 2 Optimised Tracks comparative noise effects assessment is given at Figure 6-10 below.

The scale of exposure of existing dwellings[10] and persons (residents in the dwellings)[11] to aircraft noise at all noise levels is relatively low for both runway alignment options, and similar/equivalent for higher noise levels (65-80 dB(A)).

Exposure for the lower noise level of 60 dB(A) is significantly greater for the 01/19 option with flight tracks in the Hāwea Valley.

These comparisons show:

- Exposure of houses and persons to aircraft noise at all noise levels is relatively low for both options,
- 60dB(A) exposure for the Phase 2 optimised RWY 01/19 flight tracks has been significantly reduced from Phase 1, and
- RWY 04/22 has similar exposure effects between Phases 1 and 2.

The comparison indicates that the 04/22 runway alignment is more favourable.

[10] Excluding properties yet to be built

[11] Estimates of residents were generated by applying the average residents per dwelling for each affected census block, sourced from Statistics New Zealand

Figure 6-10: Phase 2 Optimised Tracks: Noise Effects Summary Comparison, Single Event Contours

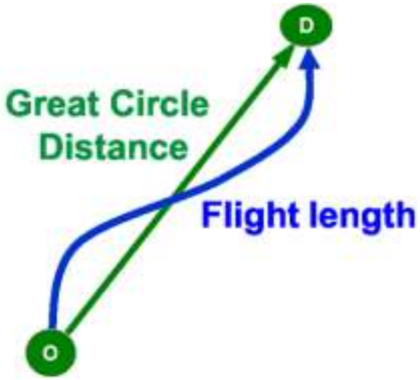
Single Event Noise Levels dB(A)	Estimated Number Affected	Runway 01		Runway 19		RWY 01/19	Runway 04		Runway 22		RWY 04/22
		Arrival	Departure	Arrival	Departure	Any Movement	Arrival	Departure	Arrival	Departure	Any Movement
60	Dwellings	12	62	29	51	**104**	13	31	10	38	**52**
	Population	27	145	69	118	**252**	26	63	21	79	**109**
65	Dwellings	9	33	18	13	**49**	4	25	8	24	**43**
	Population	20	73	44	26	**109**	8	51	17	50	**89**
70	Dwellings	2	14	11	8	**25**	2	11	6	14	**22**
	Population	4	28	27	16	**54**	4	23	12	28	**44**
75	Dwellings	2	9	3	5	**12**	1	8	3	7	**12**
	Population	4	18	6	10	**24**	2	17	6	14	**24**
80	Dwellings	1	4	3	4	**6**	1	3	1	3	**4**
	Population	0	8	6	8	**12**	2	6	2	6	**8**

iii. Efficiency and Environmental Assessment: Horizontal Flight Efficiency

This assessment was conducted to ascertain whether either of the runway alignment options produced a material difference in the horizontal lengths of flight path on main routes flown. The rationales for investigating this factor are:

- The desirability of being able to achieve the shortest possible flight path distance (and time in flight) for a route, and
- As a proxy for the quantum of carbon emissions.

Horizontal Flight Efficiency is a measure of the relativity between the actual flight path length and a hypothetical direct distance (if flown along the Great Circle path), as shown below.



Horizontal flight efficiency was analysed for both Phase 1 Baseline and Phase 2 Optimised flight paths for the two runway alignment options for:

- Four international routes – Brisbane (BNE), Sydney (SYD), Melbourne (MEL and Singapore (SIN), and
- Three domestic routes – Auckland (AKL), Wellington (WLG) and Christchurch (CHC).

The optimisation process at Phase 2 has resulted in improvements in terms of shorter route distances for all routes, with a result that compared with Phase 1 in which 04/22 was more favourable for all routes:

- Runway 01/19 is slightly more efficient than 04/22 for BNE, SYD and AKL
- Runway 04/22 is more efficient for SIN, WLG and CHC
- The disparities between 01/19 and 04/22 for the WLG and CHC routes at Phase 1 are significantly reduced at Phase 2.

The percentage differences that 04/22 is shorter by are:

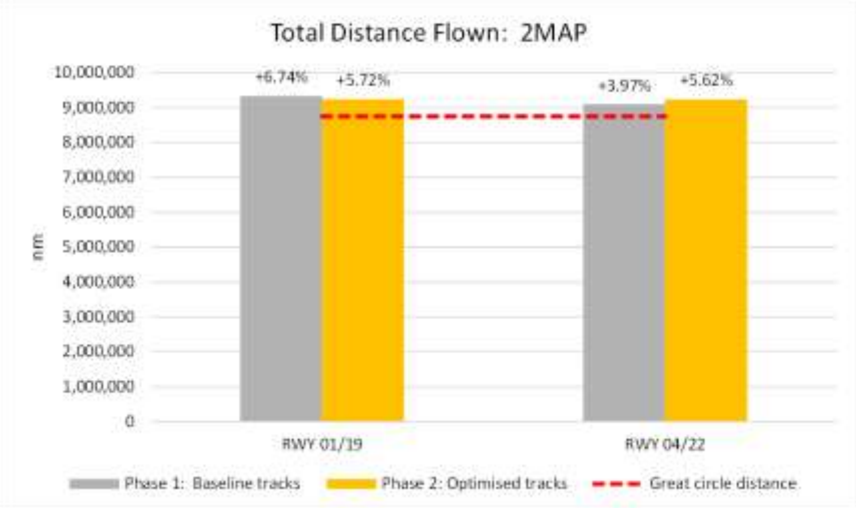
International	RWY	shorter by:	Domestic	RWY	shorter by:
BNE	01/19	0.7%	AKL	01/19	0.8%
SYD	01/19	0.4%	WLG	04/22	3.6%
MEL	04/22	0.6%	CHC	04/22	6.5%
SIN	04/22	0.2%			

A further comparison of horizontal flight efficiency was estimated by calculating, for the Phase 2 Optimised tracks for each alignment option, the hypothetical aggregate of flight distance flown for a future scenario when the COA would be processing around 2 million annual passengers (2 MAP). This was undertaken by assessing a mix of routes, flight frequencies, aircraft capacities (in passenger terms) that combined to equate to 2 MAP. Phases 1 and 2 outcomes were then compared as shown in Figure 6-11 below.

Runway 01/19 has become more efficient by a small amount between Phases 1 and 2, while Runway 04/22 has become slightly less efficient at Phase 2. Both alignment options have very similar aggregated annual flight distance for 2MAP scenario, with a distance of approximately 9 million nautical miles.

For Phase 2 tracks, the 04/22 option would be 5.62% longer than the hypothetical minimum possible (Great Circle distance), compared with 01/19 at 5.72% longer than minimum possible.

Figure 6-11: Total Aggregated Route Distances, Comparison of Phases 1 and Phase 2 Tracks, 2 MAP scenario



iv. Environmental Assessment: Carbon Emissions

For the purposes of contributing to the identification of a preferred runway alignment, an assessment of the aggregated carbon emissions was analysed for Phase 2 Optimised aircraft flights on the mix of routes, flight frequencies, aircraft types and capacities (in passenger terms) that combined to equate to 2 MAP scenario. The aircraft types selected are in current common use in the region and are currently the most practical indicators of future types. However, the choice of current types for assessment of carbon emissions is likely to be conservative given significant efforts in the aircraft industry to develop propulsion and fuel technologies for next generation aircraft that will have significantly lower carbon emissions.

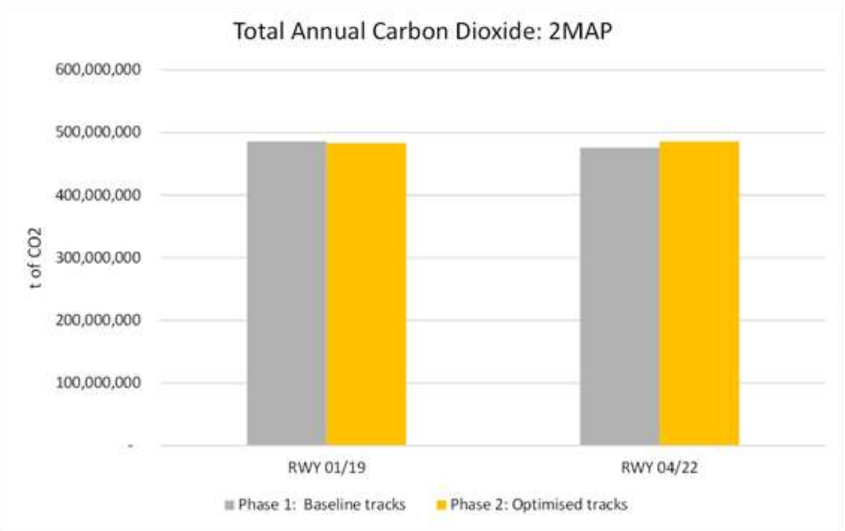
The methodology was the same as previously described for Phase 1. As shown in Figure 6-12, the Runway 04/22 option has 0.54% higher total annual emissions than 01/19 for 2MAP scenario.

Compared with Phase 1, the optimised Phase 2 tracks result in:

- Runway 01/19 emissions being slightly decreased, and
- Runway 04/22 emissions being slightly increased.

The scale of differences in both Phase 1 and Phase 2 outcomes are so small to be within the margins of imprecision relating to the modelling, and therefore it is reasonable to conclude that there is effectively no difference in carbon emissions between two alignment options.

Figure 6-12: Comparison of Phase 1 and 2 Tracks: Total Annual Carbon Emissions, at 2 MAP scenario



v. Efficiency Assessment: Airport Land Use

An assessment has been made of the respective efficiencies of potential aeronautical land use requirements within the site boundary for each runway alignment option.

This work involved preparing indicative layouts of key aeronautical infrastructure elements on the site of the proposed airports, to identify any potential constraints (i.e. reduced efficiency) to aeronautical land use requirements based on the runways alignment and length for a given set of planning parameters.

The infrastructure elements included in the preparation of the layout plans were:

Airfield Zone

- Runway at 2,200m or 3,000m (3,000m has been illustrated for this assessment)
- Runway strip
- Runway End Safety Area (RESA)
- Runway End Protection Area (REPA)
- High Intensity Approach Lights (HIAL)
- Parallel taxiway
- 2nd Parallel taxiway

Apron Zone

- Apron Edge Taxilane
- Rear of Stand Road
- Code E Multi Aircraft Ramp System (MARS) Stand Depth
- Head of Stand Road

Terminal Zone

- Terminal reserve

Landside Zone

- Landside Pick-up and Drop off and Short-term Parking reserve

Each zone described has been applied to each runway alignment option based on the following:

- The Airfield zone is laid out based on the runway centreline and runway threshold positions for each option as used in the Aeropath Phase 1 Baseline design.
- The longitudinal location of the Apron, Terminal and Landside Zone along the runway length is not yet defined, therefore these are illustrated as zones generally running the full length of the runway

with the purpose of understanding any site constraints imposed that may influence a particular area within each zone.

The preliminary layouts for aeronautical land use for each alignment option are depicted in Figure 6-13 through Figure 6-15, and summarised in Figure 6-16.

Two alternatives are shown for the 04/22 option because there would likely be flexibility to have the terminal and apron reserves on either east or west sides of the runway. However, due the shape of the land on the airport site, the only possible location for Runway 01/19 would be at the western side of the site, with the terminal and apron reserves to the east of the runway.

Each of these figures also describes various issues relating to airport land use and the nature of a potential resolution.

In summary, neither runway alignment options currently have sufficient length of land to fully accommodate the infrastructure elements for RESA and HIAL associated with a 3000m runway option, within the site.

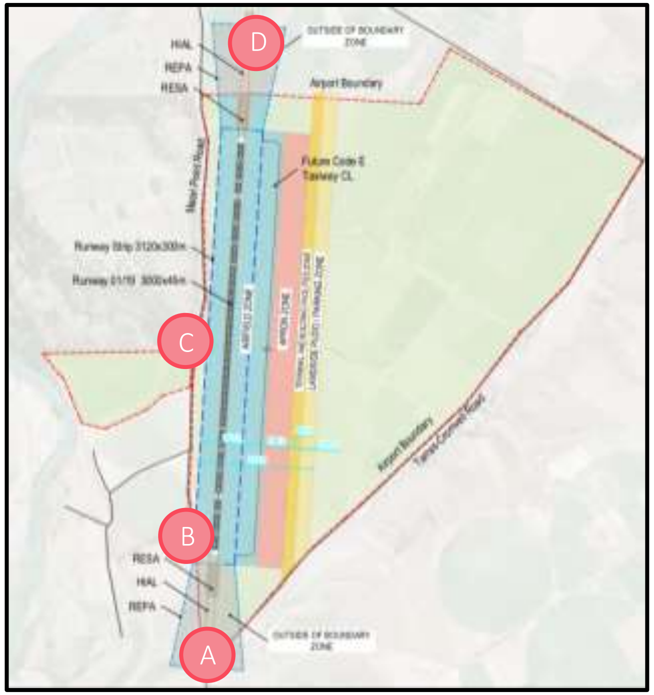
Options to resolve this issue could include acquisition of additional land and/or restricting the longer runway length to be less than 3000m, to fit the available length of land.

Alignment option 01/19 depicts the runway located very close to the western boundary of the site resulting in:

- Potential conflicts with road activity on Māori Point Road, and
- Inability to provide any supporting infrastructure on the western side of the runway.

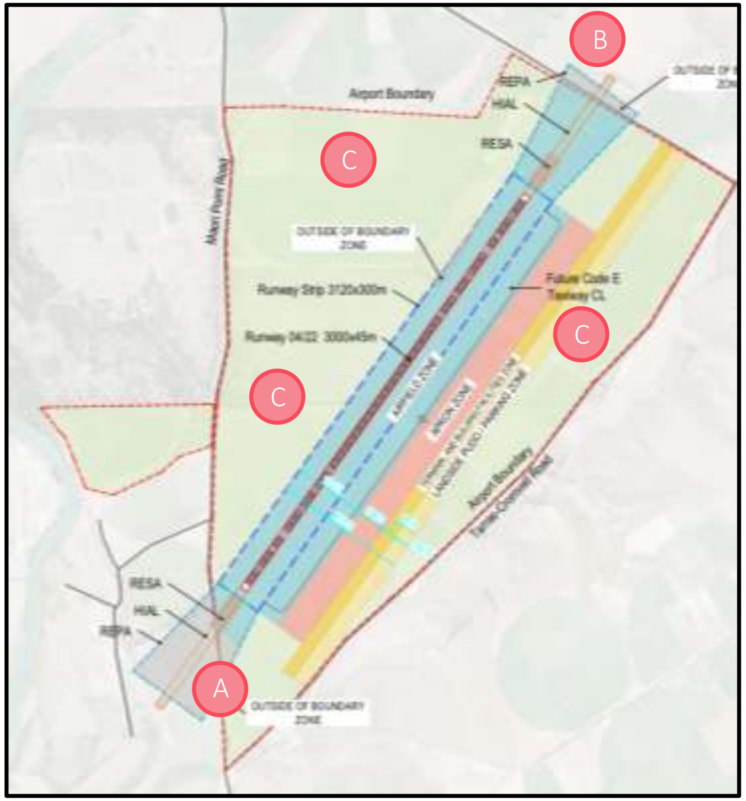
Indications are that the 04/22 runway alignment might be more favourable.

Figure 6-13: Airport Land Use Assessment - Runway 01/19



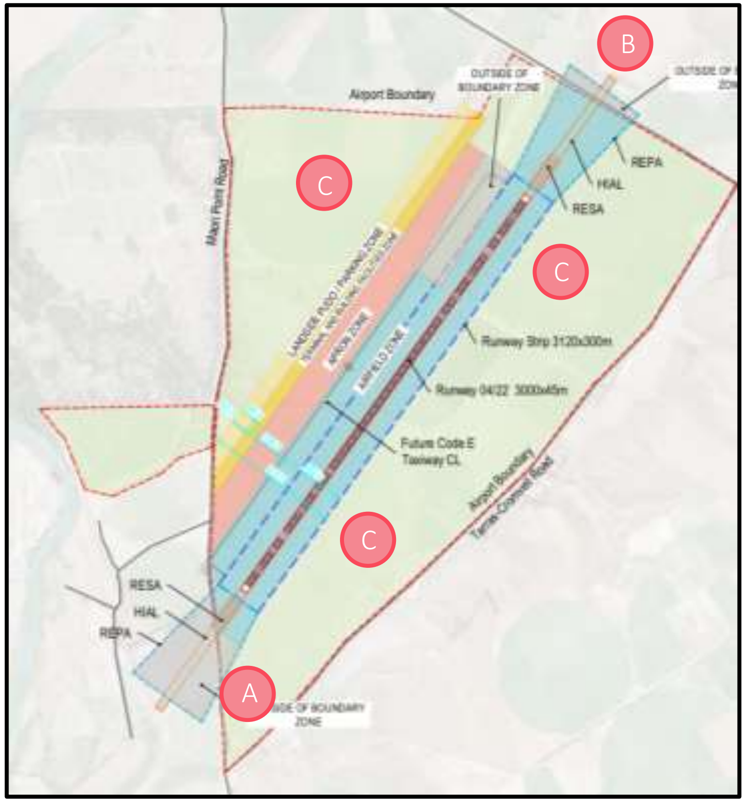
ID	Issue	Resolution	Phase 1 Assessment
A	Strip, RESA, HIAL needs to extend over Maori Point Road	Consider purchase of south block, realign road and possibly reduce RWY length to fit	4
B	Strip needs to extend over Maori Point Road and Sub-station	Consider purchase of south block, realign road and possibly reduce RWY length to fit	4
C	No option for development on west side of runway	Shift east, but with negative impacts on IFPs and RWY length	2
C	Close proximity of runway to Moari Point Road may create conflicts with road traffic	Shift east, but with negative impacts on IFPs and RWY length	2
D	HIAL outside of boundary	Consider purchase of additional land for HIAL	4

Figure 6-14: Airport Land Use Assessment - Runway 04/22 - Terminal to East



ID	Issue	Resolution	Phase 1 Assessment
A	RESA, HIAL needs to extend over boundary, and over Maori Point Road and Sub-station	Consider purchase of south block, realign road and possibly reduce RWY length to fit	4
B	RESA, HIAL needs to extend over boundary	Possibly reduce RWY length to fit	4
C	Options available for balanced development on both sides of runway	N/A	5

Figure 6-15: Airport Land Use Assessment - Runway 04/22 - Terminal to West



ID	Issue	Resolution	Phase 1 Assessment
A	RESA, HIAL needs to extend over boundary, and over Maori Point Road and Sub-station	Consider purchase of south block, realign road and possibly reduce RWY length to fit	4
B	RESA, HIAL needs to extend over boundary	Possibly reduce RWY length to fit	4
C	Options available for balanced development on both sides of runway	N/A	5

Figure 6-16: Airport Land Use - Comparison of Assessments

	RWY 01/19	RWY 04/22 Terminal East	RWY 04/22 Terminal West
Sufficiency length of land on site to fully accommodate 3000m runway, RESA and HIAL	4	4	4
Sufficiency length of land on site to fully accommodate 2200m runway, RESA and HIAL	4	5	5
Potential conflicts due to proximity of roads	2	5	5
Opportunities for utilisation of balance of land	5	5	5

vi. Efficiency and Capacity Assessment: Departure Passenger Payload

Indicative departure passenger payloads for various routes, jet aircraft types and the ATR-72 turboprop type were estimated by Astral as an output from an assessment of ability of the Phase 2 Optimised flight tracks to provide for payloads that airlines would generally consider to be commercially feasible, taking account of the constraints required for engine out procedures.

The assessment was made considering:

- Tasman operations – using Brisbane (BNE) as a proxy because it is the furthest of the three largest east coast Australian cities, Sydney, Melbourne, and Brisbane,
- Long haul operations – using Singapore as a proxy,
- Domestic operations – examining Auckland (AKL) as a proxy for jet departures because it is the furthest distance of New Zealand cities; and assessing both Wellington (WLG) and Christchurch (CHC) for ATR72 departures because these have had or still have turboprop operations.
- 2,200m and 3,000 runway length options for international,
- Only 2,200m option for domestic, and
- Both runway alignment options - 01/19 and 04/22.

A variation of Runway 04/22 was also considered examining a sub-option 05/23 with the runway shifted eastward on the site and the alignment rotated approximately 10^{o} clockwise to assess whether there might be payload advantages due to lower terrain to the north of the site on that alignment.

Aircraft types considered were:

- ATR72-600 for COA-CHC and COA-WLG,
- A320NEO and A321NEO for COA-AKL,
- A320NEO, A321NEO, B777-300 and B787-9 for COA-BNE, and
- B777-300 and B787-9 for COA-SIN.

The payload assessments derived from the Astral analysis are depicted graphically in Figure 6-17 and Figure 6-18 following.

The payload outcomes for the 05/23 sub-option are virtually the same as for the main 04/23 option. Accordingly, the following summaries are provided only for 01/19 and 04/22 options.

The payload analysis for the runway options indicates:

Runway 01/19 Alignment Option

Runway 01

For the 2200m length scenario:

- BNE is unrestricted for A320/B787/B777, but restricted to 88% for A321,
- SIN is significantly restricted for B787/B777 and likely unworkable,
- AKL is unrestricted for A320/A321,
- WLG and CHC are restricted to 82% and 91% respectively for ATR72.

For the 3000m length scenario:

- BNE is unrestricted for A320/A321/B787/B777,
- SIN is unrestricted for B787/B777.

Runway 19

For the 2200m length scenario:

- BNE is unrestricted for B787/B777 but significantly restricted for A320/A321 and likely unworkable,
- SIN is significantly restricted for B787/B777 and likely unworkable,
- AKL is restricted to 97% for A320 and 85% for A321, the latter which is likely to be undesirable for airlines,
- WLG and CHC are restricted to 50% and 42% respectively for ATR72, which is likely unworkable.

For the 3000m length scenario:

- BNE is unrestricted for A320/A321/B787/B777,
- SIN is significantly restricted for B787/B777 and likely unworkable.

Runway 04/22 Alignment Option

Runway 04

For the 2200m length scenario:

- BNE is unrestricted for B787/B777, but restricted to 92% for A320 and 80% for A321,
- SIN is significantly restricted for B777/B789,
- AKL is unrestricted for A320/A321,
- CHC is unrestricted and WLG is minimally restricted to 98% for ATR72.

For the 3000m length scenario:

- BNE is unrestricted for A320/B787/B777 and restricted to 90% for A321,
- SIN is unrestricted for B777 and restricted to 79% for B787.

Runway 22

For the 2200m length scenario:

- BNE is unrestricted for A320/A321/B787/B777,
- SIN is significantly restricted for B777/B789,
- AKL is unrestricted for A320/A321,
- WLG and CHC are unrestricted for A320/A321 for ATR72.

For the 3000m length scenario:

- BNE is unrestricted for A320/A321/B787/B777,

SIN is unrestricted for B787/B777.

Figure 6-25 and Figure 6-26 summarise the percentages of passenger (and baggage) payload capacities that have been assessed for the various scenarios of runway alignment, runway length, routes and aircraft types.

The colour coding is indicative only for purposes of contrast and comparison and are not intended to be representative of payload viability or otherwise.

Figure 6-17: Passenger Payload, Runway 01/19 Option: Percentage of Full Capacity

INTERNATIONAL		A320NEO	A321NEO	B787-9	B777-300
Runway 01					
2200m	**BNE**	100%	88%	100%	100%
	SIN			72%	73%
3000m	**BNE**	100%	100%	100%	100%
	SIN			100%	100%
Runway 19					
2200m	**BNE**	65%	59%	100%	100%
	SIN			19%	35%
3000m	**BNE**	100%	100%	100%	100%
	SIN			32%	60%

DOMESTIC		A320NEO	A321NEO	ATR72-600
Runway 01				
2200m	**AKL**	100%	100%	
	WLG			82%
	CHC			91%
Runway 19				
2200m	**AKL**	97%	85%	
	WLG			50%
	CHC			42%

Figure 6-18: Passenger Payload, Runway 04/22 Option: Percentage of Full Capacity

INTERNATIONAL		A320NEO	A321NEO	B787-9	B777-300
Runway 04					
2200m	**BNE**	92%	80%	100%	100%
	SIN			56%	62%
3000m	**BNE**	100%	90%	100%	100%
	SIN			79%	100%
Runway 22					
2200m	**BNE**	100%	100%	100%	100%
	SIN			80%	64%
3000m	**BNE**	100%	100%	100%	100%
	SIN			100%	100%

DOMESTIC		A320NEO	A321NEO	ATR72-600
Runway 04				
2200m	**AKL**	100%	100%	
	WLG			98%
	CHC			100%
Runway 22				
2200m	**AKL**	100%	100%	
	WLG			100%
	CHC			100%

The key findings from the payload assessment when considering from the viewpoint of route operations are:

For Tasman operations:

- For the 2200m length scenario for alignment option 01/19, payloads on the BNE route are limited to approximately 80% for A321 on Runway 01 and 60-65% for Runway 19. Runway 19 would need to be significantly longer than 2200m to be workable.
- For the 2200m length scenario for alignment option 04/22, payloads for A321 are limited to approximately 80% on Runway 04. An increased length for Runway 04 will be of marginal benefit.

For Singapore operations:

- 2,200m runway scenarios for both 01/19 and 04/22 alignment options are insufficient in length for operations to SIN (long haul) with acceptable payloads. A runway longer than 2200m is needed for long haul operations.
- For the 3,000m length scenario for Runway 19, runway payloads are limited to 32% for B787 and approximately 60% for B777-300 which are almost certainly not workable for long haul operations.
- For the 3,000m length scenario for Runway 04, payloads are limited to 79% for B787 while unrestricted for B777-300.

For Domestic operations:

- The 2200m runway scenario for alignment option 01/19 has restrictions of 97% for A320 and 85% for A321 for operations to AKL on Runway 19.
- It also has significant payload restrictions for ATR72 operations to WLG and CHC for Runway 19, rendering this scenario unworkable.
- The 2200m runway scenario for alignment option 04/22 is unrestricted for A320 and A321 operations to AKL, and unrestricted to ATR72 operations to WLG and CHC.

Summary

The alignment option 01/19 is clearly inferior and probably unworkable for being able to support passenger payloads close to aircraft capacities.

Alignment option 04/22 is the better alternative being unrestricted for domestic operations and for A320 on Tasman operations (at 2200m scenario). BNE payloads for A321 and SIN payloads for B787 have restrictions that warrant further investigation.

vii. Comparison of Runway 04/22 vs 05/23

A comparison of the respective merits of the two similar options Runway 04/22 and Runway 05/23 was made with consideration of three assessment lenses. The outcomes are shown below in Figure 6-19 below.

From this assessment it is clear that the Runway 05/23 sub-option is inferior in all lens considerations and should be discarded.

Figure 6-19: Phase 1 Comparison of 04/22 and 05/23 Options

Lens	Criteria	Runway 04/22	Runway 05/23	Notes
Environment	Socially Sensitive Areas	✓		Runway 05/23 flight tracks would be closer to Tarras village than 04/22 Expect greater noise effects and social sensitivity effects with 05/23 than 04/22
	Aircraft Noise Effects	✓		
Efficiency	Airport Land Use	✓		Available land on the eastern side of Runway 05/23 would be constrained by adjacency to State Highway 8. Terminal and associated facilities would have to be on the western side unlike for 04/22 where both sides of the runway would have sufficient land for development.
	Aircraft Departure Payload	✓	✓	Payloads for departures on 04/22 and 05/23 are virtually the same.
	Obstacle Limitation Surfaces	✓		OLS for 05/23 would be closer to State Highway 8, potentially conflicting with the highway corridor.

viii. Capacity Assessment: Airspace

For the Capacity lens assessment, a set of considerations has been provided that will be used to inform subsequent flight procedures and airspace management formulation, to ensure that factors affecting capacity positively and negatively are taken into account.

The assessment is qualitative. A quantitative assessment will need to be considered once runway alignment has been fixed and flight path development moves into the next phase.

The determination of the available runway capacity is not part of the flight path development stage of this project. However, a movement rate of 44 – 48 aircraft per hour could be expected where no airspace constraints exist.

Avoiding Airspace Constraints that Limit Capacity

Overall system efficiency is more important than individual aircraft flight efficiency.

- Flight path design should:
- Minimise the need for ATC intervention to tactically separate aircraft on conflicting arrival/arrival and arrival/departure tracks (“safety by design”),
- Where possible have arriving turboprop and jet aircraft only use a common flight path for the last 20 miles of flight,
- Seek to have a minimum number of merge points close to the airport requiring conservative final approach spacing to be applied by ATC to ensure a maintenance of separation as all traffic flows through a common merge point,
- Have commonality between the enroute stage of flight and an inner airspace boundary (normally 30 – 50 miles from an airport) irrespective of which runway is in use at the airport,
- Desirably to have turboprop and jet departure paths as separate tracks as soon as possible after take-off, to avoid having to have very conservative aircraft longitudinal separations as a response to differing speeds for jets and turboprops. Even if not immediately available this objective should be pursued at the earliest available point after take-off.

More detailed qualitative considerations for airspace capacity are provided in Figure 6-20 through Figure 6-22 for Departures, Arrivals and Departure/Arrival interactions.

Figure 6-20: Airspace Capacity, Departures Considerations

RWY 01	RWY 19	RWY 04	RWY 22
No close in separation of turbo prop and jet	No separation of turbo prop and jet initially but may be possible further south in the Cromwell Valley. However high close in climb gradient requirements may not facilitate separate jet and turbo prop initial departure segregation	No separation of turbo prop and jet. Phase 1 design showed two jet SIDS. Phase 2 design shows only one for all jets to all destinations. This leaves part of the Lindis Valley available for the possible development of a right turning turbo prop SID. May require some adjustment to tracking and vertical requirements on STARs.	No separation of turbo prop and jet. Although the width and depth of the Cromwell valley may allow for segregation to be designed in the next phase.

Figure 6-21: Airspace Capacity, Arrivals Considerations

RWY 01	RWY 19	RWY 04	RWY 22
Two merge points close to the Airport requiring ATC separation management as a priority over sequencing management. Outer merge point of northern and southern Tasman arrivals should be manageable by imposition of ATC speed control on upper part of the descent.	No close in merge points. Aircraft on common track from approximately 30 nm should facilitate an efficient sequence based on speed similarity of jets and turbo props achievable in last 20 nm of flight.	Auckland and Christchurch / Wellington STARs merge point has been brought much closer to the Airport than Phase 1 option. Coupled with the Pacific STAR merging in approximately the same location it now presents ATC with a more complex separation management issue as a priority over a capacity maintenance requirement than Phase 1 design. Phase 1 design option for where these two STARs merge may be preferable, particularly if a right turning turbo prop SID is viable in the Lindis valley.	Phase 2 design has reduced the close in merge points to one by having the Auckland and Christchurch / Wellington STARs merge with about 20nm to touchdown. The one close in merge point left is to merge the Pacific arrivals with the Auckland / Christchurch / Wellington track in the Lindis valley. This will still require ATC separation priority over sequence maintenance but is not as difficult as managing the previous two close in merge points.

Figure 6-22: Airspace Capacity, Arrivals and Departures Interaction Considerations

RWY 01	RWY 19	RWY 04	RWY 22
Significant improvement over Phase 1 design by removal of head to head operation in the Wanaka Valley, removing the possibility of a need for ATC to manage vertical separation requirements that may interrupt the SID/STAR descent or climb profile retirements of aircraft and thus affect capacity maintenance.	No close to airport interaction of SIDs and STAR tracks that require ATC tactical management of separation.	No significant interactions as designed. Turning the circular arrival spiral into an oval to accommodate community overflight concerns, may allow for an extension south of the oval to better accommodate possible future arrival departure interactions if a right turning turbo prop SID is viable in the Lindis valley.	All interactions will be able to be comfortably managed by SID/STAR vertical design separation requirements.

7. Preferred Runway Alignment Option Alignment

04/22 has emerged as the preferred alignment option.

Considering the four assessment lenses:

Safety

- Safety is a given – all options have Safety as a paramount requirement.

Environment

- Noise effects: 04/22 performs better than 01/19.
- Track efficiency and carbon emissions: 04/22 is similar to 01/19 in outcomes.

Efficiency

- Aeronautical: 04/22 performs better than 01/19.
- Airport Land Use: 04/22 performs better than 01/19.

Capacity

- The design process has not proceeded sufficiently for capacity to be a differentiator – indications are that there is scope for good outcomes, particularly further optimising arrival tracks and procedures.

Further work required for the Runway 04/22 alignment

Further work to be undertaken to validate and confirm the recommendation for the 04/22 alignment includes:

- Validation of the alignment option against the database of on-site meteorological recordings,
- Validating any potential wind shear effects near the site and at higher levels relating to terrain,
- Investigating any potential bird strike risks,
- Investigation of potential improvements to BNE departure payloads for A321 and SIN payloads for B787,
- Consideration of airspace management and procedures for the COA, and in conjunction with other aerodromes and general aviation activities, and
- Assessment that quantifies runway and airspace capacities.

ii. Phase 2 Optimisation Outcomes

The optimisation process at Phase 2 has, almost without exception, resulted in optimised flight tracks that improved over Phase 1 Baseline tracks. The Phase 2 optimisation work has demonstrated that:

- The desirable NAVSPEC RNP 0.3 is achievable for RWY 04/22 and RWY 01, but is not workable for RWY 19 (due to terrain proximities on approach from the north),

- Engine-out procedures are feasible but with payload impacts. The payload constraints for departure on RWY 19 almost certainly renders that alignment unworkable,
- Single event and cumulative noise effects are very low, and with lower effects for 04/22,
- Single event and cumulative noise effects greater for 01/19
- Identified socially sensitive areas can and have been substantially avoided in the Phase 2 work,
- Efficient flight tracks can be achieved in terms of Horizontal Flight Efficiency, and
- Emissions effects are similar between alignment options.

8. Appendix A: Obstacle Limitation Surfaces (OLS)

Preliminary analysis for Obstacle Limitation Surfaces has been initiated by Airbiz, to assess potential implications for land use and development outside the airport boundary arising from the need to assess and control obstacles.

The geometry of the OLS that results from the CAA specifications[12] clearly pre-supposes a runway for which approach and departure paths are "straight" and aligned to the runway for a distance of approximately 15 km. This is clearly not the case for COA, due to the influence of terrain requiring approach paths to be curved.

Airbiz is aware that ICAO is presently working on proposals to amend the specification and configuration of OLS. We understand that this may result in:

- Similar types of obstacle controls closer to the runway and for approach paths, as at present,
- Optimised obstacle controls at further lateral distances from the runway and flight tracks, and
- Accommodation of curving approach paths.

At this time, there is insufficient firm information to be able to make an advance assessment of what the implications for future OLS amendment might be, despite our enquiring to ICAO itself.

ICAO has advised us that the amendment proposals for Annex 14, Volume I will be reviewed by the ICAO Air Navigation Commission (ANC) in Q1 2023, after which it is expected that a State letter will be issued to ICAO contracting States and relevant international organization for consultation.

The effective and applicability dates for the OLS amendment proposals are likely to be July 2025 and Nov 2028 respectively.

In the meantime, in the absence of firm views for the future, we have prepared and applied current OLS specifications but have interpreted the potential implication for obstacle controls in a broad manner, assuming that our understandings listed above do eventuate. This results in our:

- Expecting that Approach surfaces will be of similar geometry, but aligned to the curving approaches in the respective valleys,
- Expecting that obstacle issues at reasonably larger lateral distances to the prescribed flight tracks, particularly where these are shielded by or in the shadow of terrain, will be of less concern than at present, with our assessment being that development proposals in such areas might need to be notified and assessed, but possibly not requiring controls.

[12] The relevant standards used for the preparation of the OLS in New Zealand are CAA NZ - Advisory Circular AC 139-6, Aerodrome Design Requirements, Revision 5, August 2016; and ICAO Annex 14 Aerodromes, Volume 1 Aerodrome Design and Operation, 7th Edition, July 2016. These are based on the approach category of the runway and the associated navigational aids in place and provided in Table 4-1 of AC 139-6. For preparing the OLS, it is assumed that the Approach Category for the runway will be accommodated by the specifications for Category II/III, Code number 3, 4.