NAVIGATUS CONSULTING

Ryans Road Industrial Development

Aviation Safeguarding Assessment

Prepared for Carter Group Limited

by

Navigatus Consulting

28 November 2025

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Prepared for Carter Group Limited

by Navigatus Consulting Ltd

Auckland
+64 9 377 4132

Queenstown
+64 21 884 425

www.navigatusconsulting.com

Quality Control

Prepared by: Geraint Bermingham, David Spencer

Review by: Geraint Bermingham,

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Abbreviations

AC	**Aviation Circular**: Guidance on means of compliance with CARs
AGL	Above Ground Level
AMSL	**Above Mean Sea Level**
ANE	**Air Navigation Equipment**
ANSP	**Air navigation service provider** (Airways NZ)
AIP	**Aeronautical Information Publication:** The definitive source of information on aerodromes and air navigation features.
ATC	**Air Traffic Control service**
ATS	**Air Traffic Services (covers more than ATC alone)**
AWO	**All Weather Operations**
BRA	**Building Restricted Area** is defined as a volume where buildings have the potential to cause unacceptable interference to the signal-in-space in the service volume of CNS facilities for AWO. All CNS facilities have BRA defined which are not limited to actual site boundaries of the facility but extend to significant distances from the facility (ICAO European Guidance Material On Managing Building Restricted Areas 5th Ed 2015)
CAR	**Civil Aviation Rule** (secondary regulation)
CAT I	**CAT I** (Category I) refers to a standard type of precision instrument approach and landing using the Instrument Landing System (ILS), with specific minimums for visibility and decision height of at least 200 feet and a runway visual range of 550 meters or more.
CAT III	**CAT III**: These offer lower minimums for visibility and decision height than CAT I or II, with CAT III allowing for almost zero visibility landings in some cases.
CNS	**Communications, Navigation and Surveillance.**
DCA	**Director Civil Aviation Authority**
DME	**Distance Measuring Equipment**, is an aviation navigation system that tells a pilot the slant range distance to a ground-based beacon. The aircraft transmits a signal to the ground station, which replies with a signal. The aircraft's onboard equipment measures the time it takes for the signal to travel to the ground station and back to calculate the distance, which is then displayed in nautical miles.
DVOR	**Doppler Very High Frequency Omni Directional Range**, a short to medium-range radio navigation system used by aircraft to determine their position and heading relative to a ground-based beacon.
ICAO	**The International Civil Aviation Organization –** an agency of the UN that coordinates the principles and techniques of international air navigation established under the Chicago Convention, ICAO rules and guidance is the basis of that of national regulatory authorities such as the CAA.
ILS	**Instrument Landing System** is a ground-based radio navigation system that provides pilots with precise horizontal and vertical guidance for landing an aircraft, especially in low-visibility conditions like fog or heavy rain. It consists of two main components: the localizer for horizontal alignment with the runway centre-line, and the glide slope for correct descent angle guidance.
LoS	Line of Sight
NM	**Nautical Miles.** Units of geographical distance as used within the aviation sector
NZCH	ICAO identifier code for Christchurch aerodrome (as referenced in aviation documents)
PSR	**Primary Surveillance Radar** is a non-cooperative radar system that detects an aircraft by receiving reflected radio signals to provide bearing, distance and in some cases altitude information to air traffic controllers,
RCS	**Radar Cross Section** is a measure of how reflective an object is to radar signals, indicating its impact on a radio signal. It is not the same as an object's physical size but depends on its shape, material, and orientation relative to the radar source.

AC	**Aviation Circular**: Guidance on means of compliance with CARs
RF	Radio Frequency
SDES	**Short Distance Echo Suppression**. A function in aviation navigation aids like DME and is a function to prevent false readings from reflected radio signals.
SSR	**Secondary Surveillance Radar**, a system that works with an aircraft's transponder to provide air traffic control with information like an aircraft's identity and altitude.
VHF	**Very High Frequency –** The principal radio communication system used by aviation for both voice and data.

1 Executive Summary

1.1 Introduction

This Aviation Safeguarding Assessment has been prepared by Navigatus Consulting to support the Fast Track consent application for the proposed Ryans Road industrial development, adjacent to Christchurch International Airport. The assessment addresses the relevant aviation safety matters within the scope set out in Section 3.

1.2 What is Safeguarding?

Safeguarding is the proactive management of risks to aviation safety arising from land use development and other activities near aerodromes. It involves protecting airspace, navigation and communication systems, and mitigating hazards such as obstacles, wind effects, and bird strike. Safeguarding requirements are mandated by District Plans, the Civil Aviation Act, Civil Aviation Authority (CAA) rules and guidance, and international standards set by the International Civil Aviation Organisation (ICAO).

For the Ryans Road development, safeguarding is triggered because some proposed buildings, while restricted in height to avoid penetrating Obstacle Limitation Surfaces (OLS), may intersect notification surfaces—lower imaginary surfaces that require notification to the CAA if penetrated as well as other safeguarding surfaces associated with air navigation and communication equipment. Construction activities and equipment may also require notification and management to ensure air navigation safety during construction.

1.3 Scope of Assessment

As detailed in Section 3, this assessment covers:

- **Aviation regulatory and planning context**
- **Helicopter and heliport aspects:** Including emergency/autorotative landing areas, wind shadowing, rotor downwash/outwash, and protection surfaces.
- **Building-induced wake turbulence:** Assessment of wind effects from new structures in the vicinity of the main runway.
- **Other aviation matters:** Including technical safeguarding of radar (PSR, SSR) and navigation aids (DVOR, ILS), review of Cyrrus technical assessment, and implications of Runway End Protection Areas (REPA)
- **Overall conclusions and recommended conditions**

This assessment should be read in conjunction with the report prepared by L+R Airport Consulting and the technical safeguarding assessment prepared by UK specialists Cyrrus.

1.4 Key Findings

- **Helicopter/Heliport:** The development will reduce the area currently available for emergency helicopter landings. While suitable land remains in the vicinity of the heliport, analysis indicates that the preferred straight-ahead emergency landing option for helicopters approaching over the development will not be available once construction occurs. While there is no regulatory requirement for the entire approach or departure slope to remain clear, CAA guidance recommends avoiding approach paths over built-up areas. Pilots – particularly those operating single-engined helicopters - may need to adjust flight procedures to comply with civil aviation regulations and maintain safety margins. This may be by; approaching at a higher altitude and flying steeper descent profiles, using alternative published approach routes, flying around the development and completing a final manoeuvre within the GCH area, or if wind conditions dictate, land elsewhere. Whilst these operational adjustments by pilots operating from GCH could address this issue, an alternative option is presented, should the panel be minded to impose controls on the development to address this issue. This entails a controlled area (that corresponds with the approach-descent / take off-flight path) within which, development would be precluded, except where it is authorised in accordance with an aeronautical study prepared in accordance with AC139-15 and any relevant approvals are obtained from CAA.
- **Downwash:** Helicopters approaching from the south will pass over the development and will be low on approach or departure when passing over Lot 121. As a result, some downwash hazard may be created. This hazard will need to be mitigated by any developer of Lot 121 by design and health and safety controls.
- **Wake/Turbulence:** Building-induced wind effects have been assessed using established methods and applying conservative criteria. Proposed building heights, locations and scale have been assessed and found acceptable in terms of air disturbance effects.
- **Radar and Navigation Aids:** Technical assessments of the modelled development confirm that impacts on radar and navigation aids are minor and manageable while further mitigation options are available if required. It is noted that radar systems preform as required despite many existing buildings already penetrating the radar safeguarding surfaces.
- **REPA:** The development complies with District Plan restrictions for REPAs, ensuring no prohibited activities occur within these areas.

1.5 Conclusions

With the adoption of recommended conditions and provided compliance with aviation regulations, the effects of the proposed development on aviation safety matters within the scope of this report will be acceptable.

All identified risks to safe air navigation can be managed through design controls, operational procedures, and regulatory oversight. Subject to these controls, the assessment provides confidence that aviation safety will be protected, supporting the consent application.

2 Introduction

Carter Group proposes an industrial development of approximately 55 hectares at 104 Ryans Road and 20 Grays Road, Christchurch (the Site). The development will deliver 126 freehold industrial lots, supported by infrastructure and a framework of rules (in the form of consent conditions) to enable industrial activities and site development with associated buildings and improvements. The Site adjoins the boundary of Christchurch International Airport.

Carter Group submitted the Ryans Road Industrial Fast Track Application (the Application) in March 2025. Comments on aviation-specific issues from relevant parties, including Airways NZ and Christchurch International Airport Limited (CIAL), identified concerns requiring additional information to address aviation safety issues.

Airways NZ determined that the Ryan Road industrial development could encroach on the safe boundaries of its navigational services, potentially impacting the provision of communication, navigation and surveillance (CNS) services and, consequently, the safety of air navigation. Further analysis was therefore required.

In August 2025, Carter Group submitted a memorandum of counsel with amendments and additional information, including an airport safeguarding assessment prepared by L+R Airport Consulting.

Navigatus was subsequently engaged by Carter Group to provide additional technical aviation advice and expert analysis to respond to and address concerns raised by Airways NZ and CIAL.

3 Scope of Work

Navigatus have been engaged to:

- Provide context and outline:
  - Relevant aviation regulations
  - Responsibilities of various parties under the aviation framework
  - Additional relevant guidance
- Assess helicopter and heliport related factors, including:
  - Autorotative / emergency landing areas
  - Building induced wind shadowing of the heliport and runway
  - Downwash and outwash hazard
  - Heliport protection surfaces
  - Heliport notification surfaces
- Addresses other aviation matters, including:
  - Building-induced wake turbulence affecting the heliport and main runway
- Consider additional aviation issues:
  - Summarise technical assessments by CYRRUS
  - Identify radar pre-build and post-build mitigation options
  - Explains implications of the REPA
- Draw overall conclusions relevant to the application and the basis for proposed conditions

4 Aviation Context

4.1 Legal and Regulatory Framework

The Civil Aviation Authority (CAA) is the regulatory agency that safeguards civil aviation in New Zealand. The CAA monitors compliance with safety standards and enforces obligations under the 1944 Chicago Convention, which established the International Civil Aviation Organisation (ICAO), and the Civil Aviation Act 2023.

The CAA enforces secondary legislation through Civil Aviation Rules (CARs) made under the Act. All aviation system 'participants' – and any parties whose activities may influence aviation safety - are required to comply with these rules.

To support compliance, the CAA issues Advisory Circulars (ACs), which outline standards, practices, and procedures considered acceptable by the Director of Civil Aviation (DCA). Where full compliance with ACs is not possible, "alternative means of compliance" (AMOC) may be proposed. In complex cases, a risk-based "safety case'' may be required to demonstrate how safety will be assured.

NZ Aviation References relevant to the Ryans Road Development

- CAR Part 77 – **Objects and Activities Affecting Navigable Airspace**
- CAR Part 139 – **Aerodromes Certification, Operation and Use**
- AC139-6 – **Aerodrome Design Requirements**
- AC139-8 – **Aerodrome design: Heliports**
- AC139-10 – **Control of Obstacles**
- AC139-15 – **Aeronautical Studies for Aerodrome Operators**

4.2 Local Planning References

Chapter 6 (General Rules and Procedures) of the Christchurch District Plan (CDP) includes three sub-chapters that contain provisions relevant to aerodrome safeguarding:

4.2.1 Aircraft Protection Surfaces for Christchurch International Airport

Defined airspace surfaces above and adjacent to the aerodrome restrict or prohibit activities that could compromise aircraft safety during low-altitude manoeuvres. These surfaces – known as Obstacle Limitation Surfaces (OLS)- are described in Section 6.7.4.4 and are illustrated in Appendices 6.11.7.1 and 6.11.7.2 of the CDP. (See Section 4.4 below for further discussion).

4.2.2 Runway End Protection Areas (REPAs)

Four REPAs are located at the end of the runways for Christchurch International Airport, as illustrated in Appendix 6.11.7.3 of the CDP. These areas aim to reduce risks associated with aircraft accidents and pilot visibility. Provisions restrict mass assembly of people, most buildings, the use and storage of hazardous substances, and activities that could interfere with the vision of a pilot or exacerbate the effects of an aircraft accident. For example, the provisions seek to avoid unwanted light sources, an aspect normally managed under CAR Part 77. REPAs are discussed further in Section 12 of this report.

4.2.3 Bird-strike Management Areas

Within 3km of runway thresholds, activities that attract birds must be mitigated to reduce bird-strike risk. This includes managing water bodies and vegetation species. Details of these controls are provided in the CDP Section 6.7.4.3 and Appendix 6.11.7.5. Bird-strike risk for Ryans Road has been addressed separately by specialists (Lizzie Civil, Pattle Delamore Partners), and is not covered by this report.

4.3 ICAO guidance

ICAO Annex 10 sets out requirements for Aeronautical Telecommunications systems:

- **Volume I -** Radio Navigation Aids (in this respect the *ILS, DME, DVOR)*
- **Volume IV** - Surveillance and Collision Avoidance Systems (in this case: the *PSR and SSR*).

ICAO[1] also provides publishes guidance on Building Restricted Areas (BRA), where development and buildings could compromise navigational and surveillance equipment performance (see Figure 1).

[1] ICAO_ EUROPEAN GUIDANCE MATERIAL ON MANAGING BUILDING RESTRICTED AREAS 3rd Ed Nov 2015

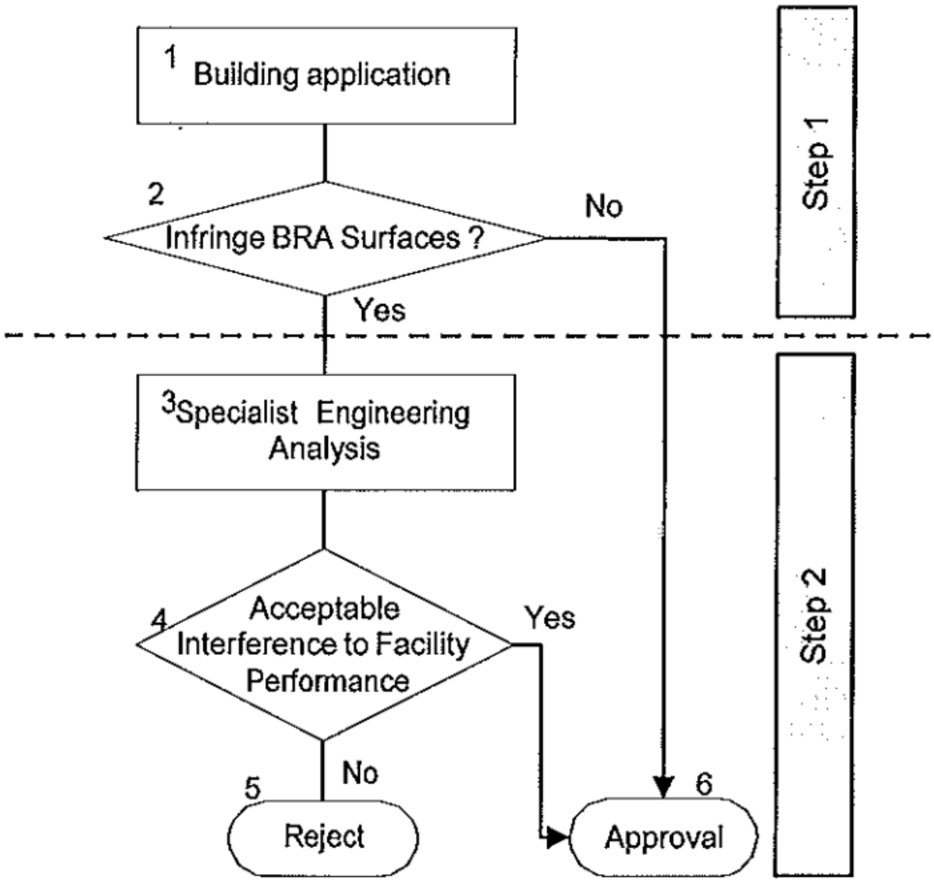

Figure 1: Guidance review process

Figure 1: BRA process (after ICAO EUR DOC 2015)

4.4 Obstacle Limitation Surfaces

Aircraft operating near aerodromes are protected by imaginary three-dimensional surfaces established around the aerodrome. These Obstacle Limitation Surfaces (OLS) define the limits to which objects can project into the airspace without affecting the safety and regularity of air operations.

OLS are critical for maintaining safe flight paths for both visual and instrument approaches, and ensuring the aerodrome remains usable. They are designed according to international standards (principally ICAO Annex 14) and vary in shape and slope depending on the runway type, approach category, and operational requirements.

For NZ aerodromes operating medium and large transport aircraft – such as Christchurch- are set out in AC139-6. While these surfaces are precisely defined by the aviation rules, they are also illustrated in district plans to aid planning control. The Christchurch District Plan includes OLS and associated restrictions to prevent construction of structures that could inhibit safe and efficient airport operations.

4.5 Christchurch Aerodrome / International Airport

Christchurch aerodrome is New Zealand's second busiest airport, after Auckland, both in passenger numbers and aircraft movements.

The prevailing wind conditions in Christchurch results in the airport having two approximately perpendicular runways (refer Figure 2):

- **Primary runway (02/20)** – aligned with prevailing north-easterly and south-westerly winds
- **Secondary runway (11/29)** – used mainly during north-westerly conditions.

The southern end of runway 02/20 (closest to the proposed development) is most frequently the 'landing' end.

Christchurch Airport is a key domestic hub and international gateway. It also serves as an 'alternate' for Auckland Airport, requiring advanced navigation aids, including DVOR and ILS. While the ILS currently provides CAT I capability, it is maintained to support CAT III services in the future, pending stakeholder decisions on the business case.

4.6 Airways NZ

Airways New Zealand is New Zealand's sole Air Navigation Service Provider (ANSP), responsible for providing Communication, Navigation and Surveillance (CNS) and Air Traffic Control (ATC) service. Airways manages all domestic and international air traffic operating within New Zealand's 30 million square kilometres of airspace, including much of the South Pacific.

Airways' services are funded primarily through direct charges to airspace users (airlines, cargo operators, charter operators and general aviation).

Airspace management relies on two key elements:

- Direct communications (voice VHF)
- Surveillance technologies

4.6.1 Surveillance Systems

Airways employs a combination of ground-based radar and satellite-based Automatic Dependent Surveillance-Broadcast (ADS-B) technology to track aircraft. While the traditional radar network —known as Primary Surveillance Radar (PSR)—has been in place for decades, New Zealand has transitioned to ADS-B for more accurate and efficient surveillance

The PSR system remains in service as a backup in case of GNSS / GPS failure and to detect 'non-cooperative' targets (aircraft without transponders) or intruders.

Secondary Surveillance Radar (SSR) now acts as a contingency for ADS-B, ensuring resilient coverage between Auckland, Wellington, and Christchurch. Additionally, Multilateration (MLAT) is used to provide coverage in remote areas, although it is not used in the Christchurch area.

4.7 Responsibilities under CAA regulations

All ‘participants’ in the aviation system (airlines, airports, pilots, etc.) must comply with Civil Aviation Rules (CARs) enacted under the Civil Aviation Act[2]. These obligations also apply to ‘non-participants’ – those outside the aviation system –whose activities may affect aviation safety.

The key responsibilities of parties relevant to this development are summarised below.

4.7.1 *Lot owners / Builders*

Part 77

CAR Part 77 is the most relevant rule for parties undertaking construction near aerodromes. Its objective is to ensure aircraft safety is not compromised by obstacles or hazards in navigable airspace. This includes permanent structures and temporary hazards such as lights, lasers, colours, and construction dust.

Under Part 77, any activity that may penetrate an OLS or a related ‘notification surface” - either temporarily or permanently - must be notified to the CAA. The Director of Civil Aviation then determines whether the object or efflux constitutes a hazard and, if so, sets requirements (known as a ‘determination’) to mitigate risk.

Typical determinations include:

- Fitting lights to cranes and restricting their use to periods when runways are closed
- Controlling dust emissions
- Directing floodlights downward

(See Section 6.2 for the application of CAR Part 77 to the southern GCH helicopter approach path).

4.7.2 *Christchurch Airport*

Being a certificated[3] aerodrome, CIAL are required to retain compliance with CAR Part 139, which covers:

- Aerodrome certification and operation;
- Security measures;
- Use of aerodromes by aircraft operators;
- Provision of reporting services.

[2] NZ Civil Aviation Act 2023

[3] Relatively busy aerodromes and those handling air transport operations have to meet the most stringent requirements of CAR 139.

Sub-part 139.121 (*Protection of navigation aids and Air Traffic Services (ATS) facilities*) requires aerodrome operators to:

(1) prevent any construction or activity on the aerodrome or surrounding area that the certificate holder has authority over, that could have an adverse effect on the operation of any electronic or visual navigation aid or air traffic service facility for the aerodrome; and

(2) prevent, as far as it is within the certificate holder's authority, any interruption of electronic or visual navigation aid or air traffic service facility for the aerodrome.

"*Authority over"* is typically exercised through the District Plan process and associated designations. Compliance guidance for the visual aids to navigational as well as OLS, and obstacles is provided in Aviation Circulars (ACs) – principally AC 139-6, and AC139-8. Compliance and protection advice with regard to the protection of the performance of electronic navigation aids and ATS is highly specialised and would typically be sought from Airways NZ.

4.7.3 Airways NZ

Airways NZ, as the national Air Navigation Service Provider (ANSP) is responsible for:

- Managing New Zealand's airspace through air traffic control,
- Maintaining navigation infrastructure, and
- Operating radar centres and aerodrome navigation equipment (ANE).

All ANE at Christchurch aerodrome is owned and operated by Airways.

To ensure safe operation, Airways must maintain certification under relevant CAR Parts, including CAR Part 171, *Aeronautical Telecommunication Services - Operation and Certification,* and comply with AC171-1, *Aeronautical telecommunication services - operation and certification.* These rules govern the construction, maintenance and safe operation of radars and other ANE at Christchurch aerodrome.

5 Development Site

The proposed development site is located adjacent to Christchurch Aerodrome (NZCH) and is close to the Garden City Helicopters (GCH) heliport. It is located south-west of the main runway, approximately 200m from the threshold of Runway 02, and approximately 150m south of the centre of the heliport's Final Approach and Take-off (FATO) area (refer Figure 2 and Figure 3).

The site lies beneath the transition side OLS of the main runway and the approach / departure path of the nearby heliport (refer Figure 4).

The development is intended to include various building heights, yard layouts, and ground areas over time. In response to concerns raised by CIAL and Airways - and based on further information provided by Airways - Carter Group has amended aspects of the proposal to address the identified impacts. The principal changes include:

- Restricting the height of buildings closest to the DVOR
- Excluding development on two proposed lots.

Because the lots will be sold to individual owners who will design and construct their buildings, the exact position, height and floor plan of each building cannot be confirmed at this stage. However, the development 'model' (refer Figure 5) has been designed to reflect a commercially realistic scenario and has been used to assess constraints and potential impacts.

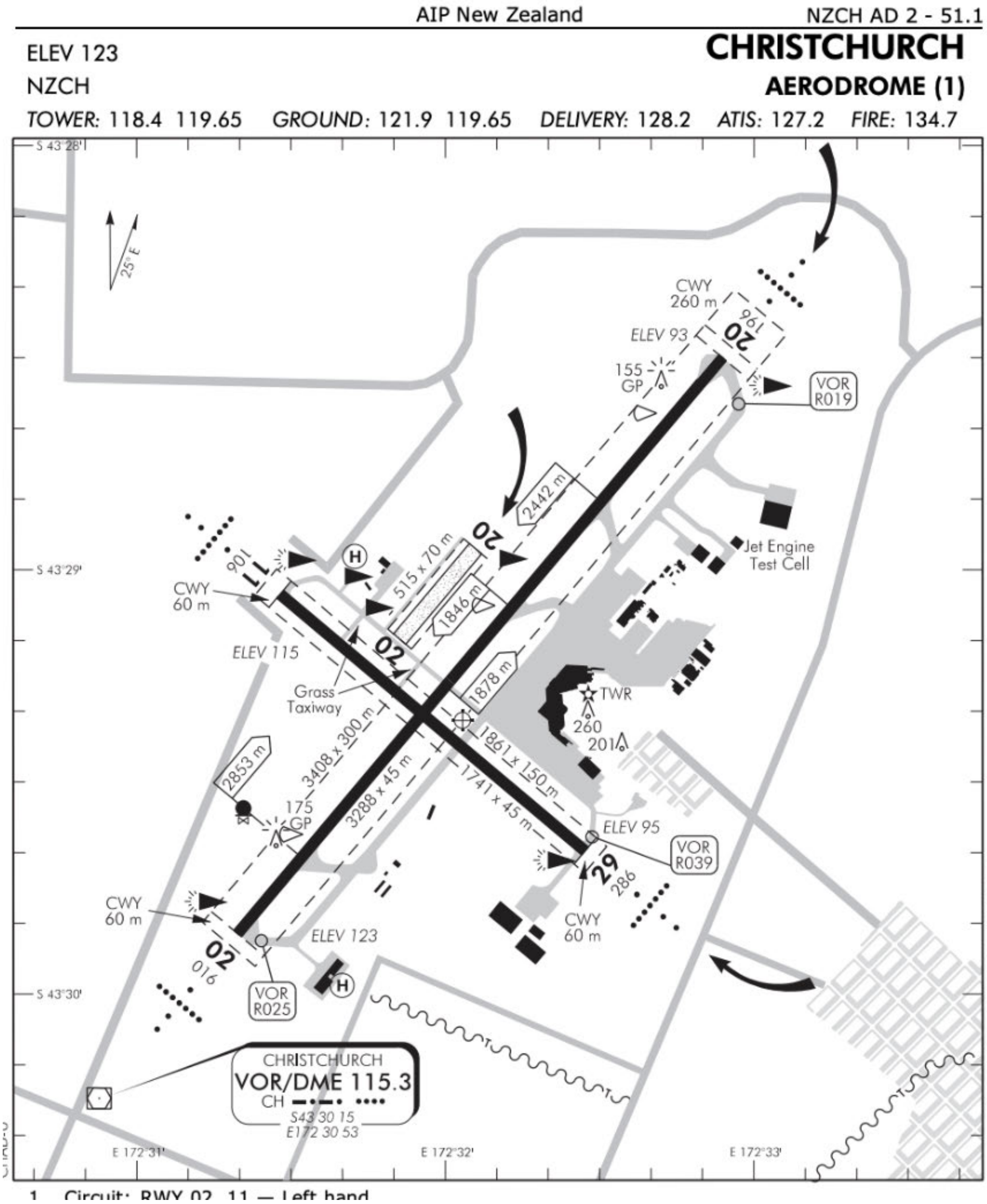

Figure 2 Layout of the principle features of the Airport as shown in the AIP

Figure 3 Location of proposed development

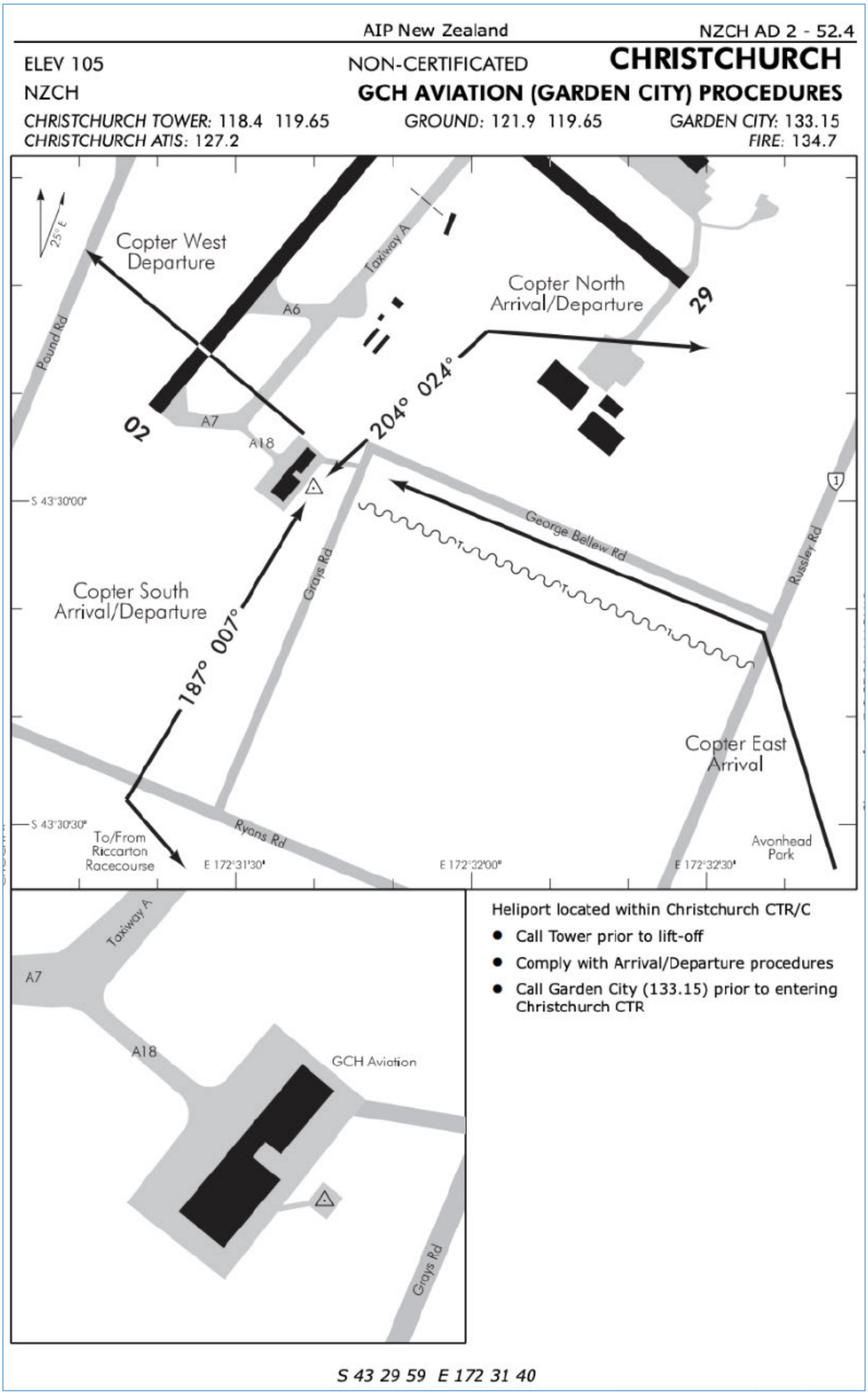

Figure 4 Garden City published approach and departure routes.

Figure 5: 'Model' development showing potential building sizes and heights (location of PSR/SSR, DVOR and heliport also shown)

6 Heliport OLS

6.1 OLS Relevant to the Development

In addition to the main runway OLS (specifically the 1:7 transitional surface), parts of the proposed development are located under the approach path of the GCH heliport. These constraints have been considered, and as a result, the maximum permitted building heights for Lots 123,124,125, and 126 have been restricted accordingly (see Figure 6).

Note: The main runway OLS, potential future changes from ICAO, and the implications for the development are addressed in a separate report prepared by L+R Airport Consulting.

6.2 CAR Part 77 requirements

In addition to the OLS, there is a lower imaginary surface known as a 'notification surface'. Under CAR Part 77, any person proposing to construct or alter a structure must notify the Director of Civil Aviation if the structure "… *is located below the approach or take-off surfaces of an aerodrome … and extends to a height greater than a surface, … extending outward and upward at a slope of 1:25 from the nearest point of the safety area of a heliport...".*

Although the rule does not explicitly define the datum for a heliport, in this case – given the heliport consists of a single FATO and Touchdown and Lift-off (TLOF) area - it is reasonable to consider the FATO as the reference point, as this is where helicopters arrive and depart at ground level.

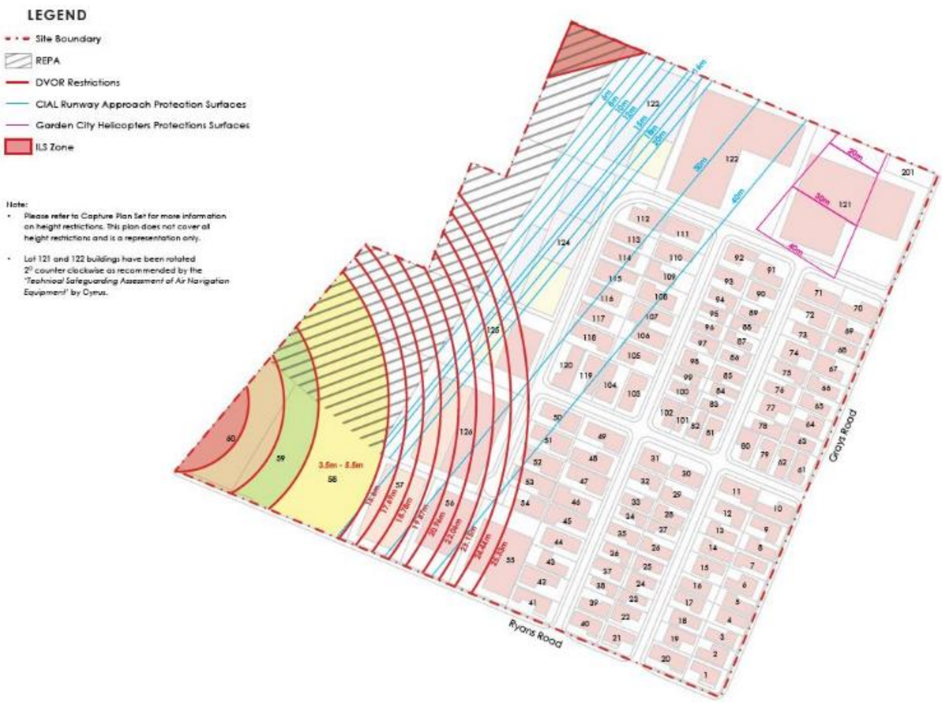

Figure 6: Proposed development with OLS heights for the main aerodrome and the heliport shown.

The closest point of the development is approximately 140m from the edge of the FATO area. Applying a 1:25 slope, this equates to 5.6m above ground level at the site boundary and approximately 8m at the southern edge of the potential Lot 121 building (see Figure 7).

Note: A FATO is in effect the 'aiming' point just above the ground that pilots descend to before transitioning into a hover for landing or hover-taxi. It is also the point where a helicopter initiates full forward flight during climb-out.

Practical requirements

The implications of the 1:25 notification surface, as shown in Figure 7, are:

- Construction on Lots 121, and likely Lot 122 and some smaller lots across the internal road to the south, may require CAA notification. Developers must await the DCA's determination regarding potential hazards and any required mitigations before proceeding with site works.
- Any building:
  - Closer than 500m to the FATO and >20m in height, or
  - Closer than 400m to the FATO and >16m in height

  will also similarly require notification to the CAA.

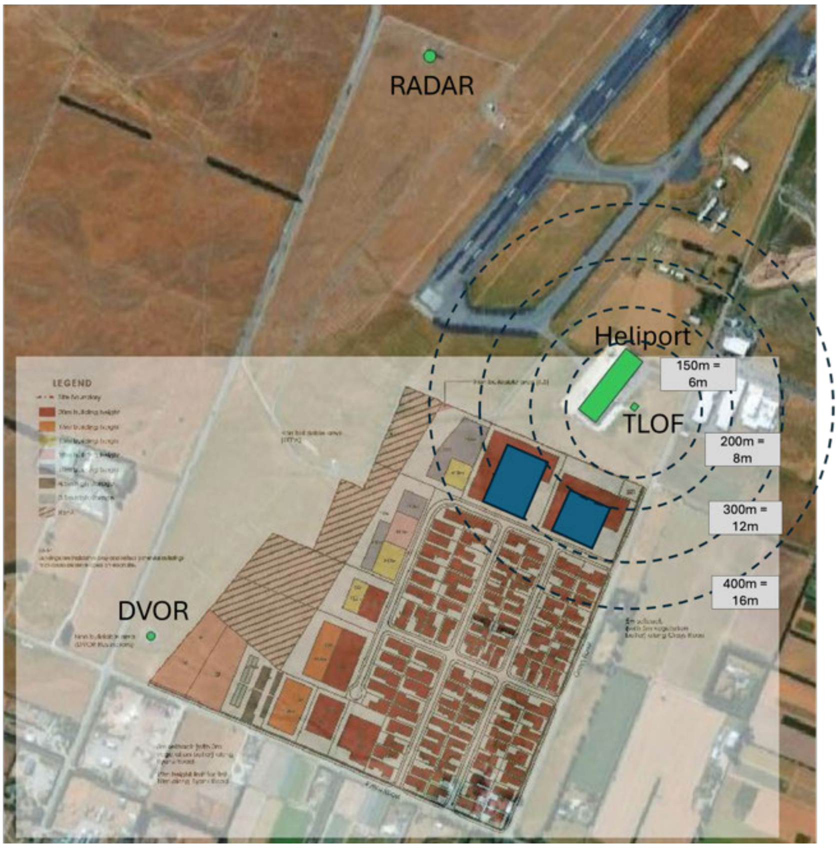

Figure 7 Part 77 notification height map for GCH FATO

Given the proximity of the development to the FATO and the proposed maximum building heights, any restrictions during construction are likely to focus on:

- Crane booms,
- Dust emissions,
- Lighting and lasers

These controls should be incorporated into a Construction Management Plan to ensure compliance with aviation safety requirements and mitigate potential hazards to air navigation.

6.3 Conclusions:

Although the proposal includes building height limits to prevent penetration of the runway and heliport OLS, CAR Part 77 still applies. Compliance actions under this rule will be required because:

- Some buildings will penetrate the ‘notification surfaces’ for both the runway and the FATO.
- Construction activities will also trigger Part 77 requirements.

6.4 Suggested conditions

Compliance with CAR Part 77 requirements must be ensured by:

- The lead developer (Carter Group) during overall site development; and
- Individual lot owners and builders during construction
- Individual lot owners and occupiers on an ongoing basis following the completion of construction as directed by the CAA under the Part 77 determination or if new works are intended.

7 Helicopter autorotative landing areas/emergency landing areas

7.1 Context

As shown in Figure 4, the published "Copter South Arrival / Departure" flight path passes over the proposed development site.

CAA Advisory Circular AC139-8 provides guidance that:

- *Heliports should have approach and take-off paths such that, if the helicopter is not a performance Class 1 helicopter, an autorotative landing can be conducted without any undue risk to any person on the ground; and*
- *Ideally the approach and take-off surfaces should be over water, or land, free of third parties and with a minimum of obstructions. Approach and take-off flight paths over residential or industrial areas, playgrounds, occupied car parks, or any other populated area should be avoided.*

The land proposed for development currently provides an unobstructed area that supports emergency landing options. Ensuring that this capability is retained—or that suitable mitigations are put in place—will ensure operational resilience for GCH.

It is noted that the GCH fleet includes both single-engine and twin-engine helicopters. Twin engine helicopters, typically classified as 'Performance Class 2', significantly reduce the likelihood of an emergency landing scenario. However, for single-engine helicopters, while engine failures are rare, they require immediate access to a clear, flat area for safe auto-rotation and operational adjustments by pilots would be necessary to preserve this option during critical phases of flight.

7.2 Analysis

A basic analysis was undertaken to model an autorotation response to a sudden engine failure occurring over the development site, assuming:

- Initial speed of 60 knots over the ground and planned 1:6 descent ratio
- A 1:4 auto rotation descent ratio
- Prompt pilot reaction

The results indicate that, clear land remains accessible to the east for an emergency landing prior to the initial stage of approach. However, once buildings are constructed, options for a straight-ahead emergency landing during the later stage of approach will not be available (see Figure 8). The green zone illustrates the ground that would potentially be theoretically within reach during the early part of the over-flight (given the assumptions above) while the red is the direction that would not offer a safe landing option.

This will therefore require pilots of at least single engine helicopters to fly an alternative approach procedure.

Pilots have the ultimate responsibility to ensure the safety of a flight and when operating under Visual Flight Rules (VFR)[4] they would retain flexibility to adjust approach profiles (e.g., steeper descent or offset tracking along or close to Grays Road) or subject to ATC any direction, select to use an alternative published routes such as Copter North or Copter East (see Figure 4). Such operational adjustments will be available under most but not all weather conditions. When not, landing at an alternative location may be necessary until an alternative approach procedure has been developed.

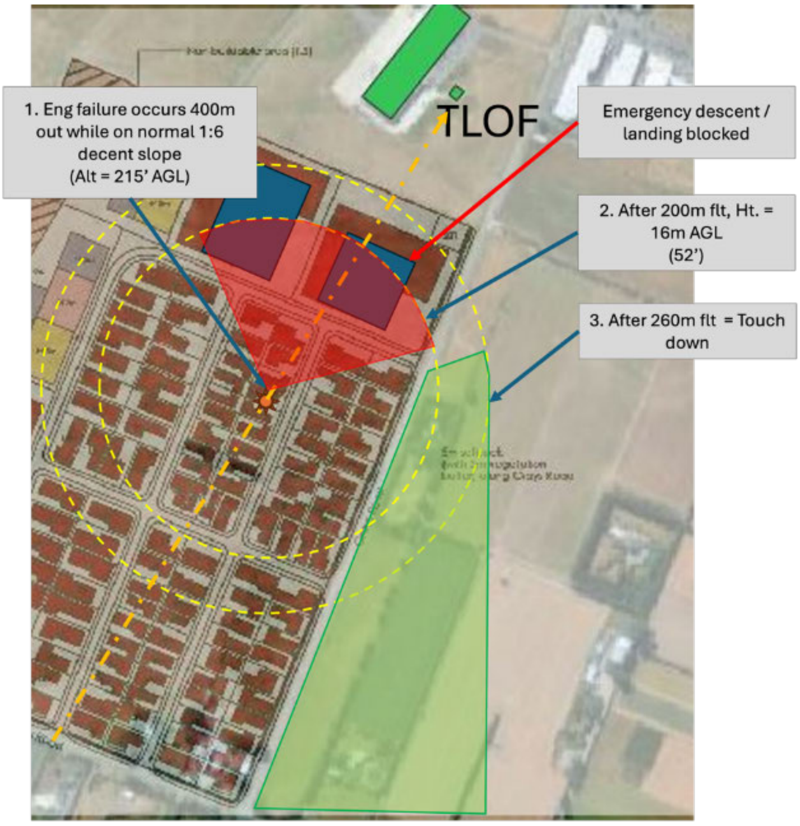

Figure 8: Areas available or blocked for emergency landing given engine failure during a normal 1:6 descent profile (assuming failure occurs on approach at the point shown).

7.3 Options for Mitigation

Given the above, this issue can be mitigated through operational adjustments by pilots operating from GCH, as described above.

However, should the panel be minded to impose controls on the development, such that operational changes by pilots at GCH are not relied on, consideration has been given to alternative mitigation, in the form of a 'controlled area' on part of the development site as shown in Figure 9 below.

[4] As is the case at GCH heliport

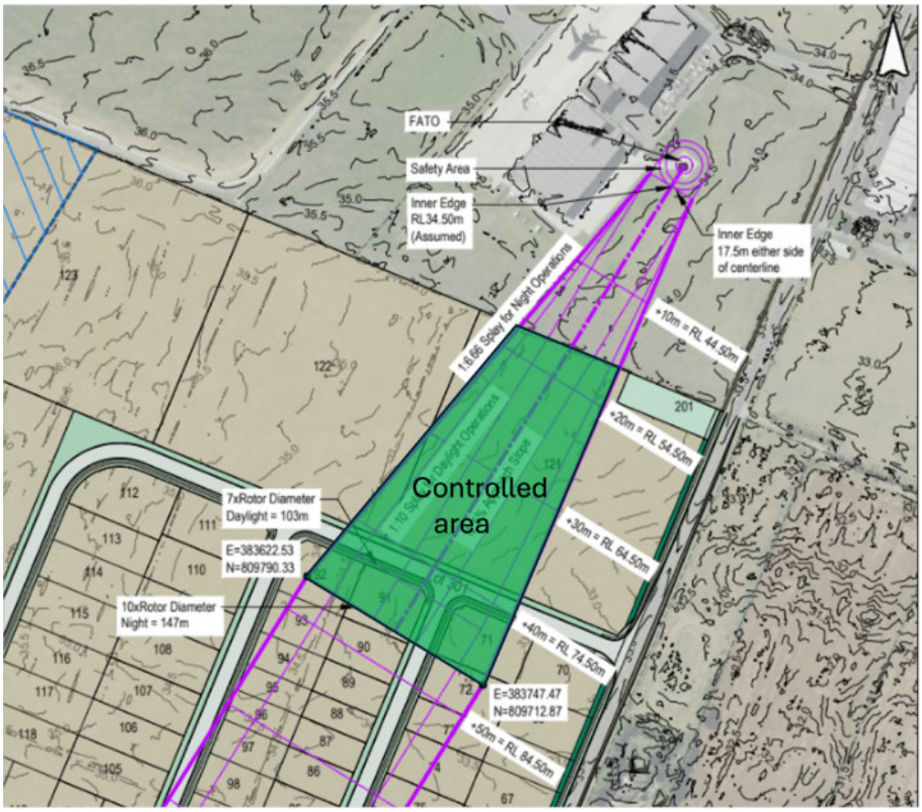

Figure 9: Proposed 'controlled area' in which restrictions on construction and the built environment may need to be applied to enable safe straight-ahead emergency landings

The controlled area is to the south of the GCH heliport and matches the area under the take-off-climb surface as provided by CIAL for the extent of the approach descent / take off climb (being the critical phase of flight). The purpose of the controlled area would be to control development within this area so that straight-ahead emergency landings are not impeded.

The nature of this control would be a requirement to undertake an aeronautical study prior to any proposed development of the controlled area occurring. The scope content and purpose of aeronautical studies is set out in AC139-15. Such studies require formal consideration of the risk environment including analysis of any data (e.g. flight and incident records) and engagement with the operational stakeholders (i.e. local helicopter operators / GCH). In practice, it is expected that such a study would ascertain the acceptable building footprints, heights and positions within this area, to ensure any risk to helicopter operations is considered and accounted for.

7.4 Conclusion

There is no regulatory requirement for the approach /departure slope to remain clear of development. However, CAA guidance recommends avoiding approach paths over built-up areas where practicable. Separately, pilots are required to operate so as to always have an emergency landing option available.

Analysis confirms that, once the proposed buildings are constructed, there will be a short segment of the southern approach where straight-ahead autorotation options will not be available This is principally an issue for single engined helicopters.

However, pilots can and will mitigate this through alternative routes or adjusted profiles. Such operational adjustments will be available under most but not all weather conditions. When not, landing at an alternative location may be necessary until an alternative approach procedure has been developed.

Whilst operational adjustments by pilots operating from GCH would address this issue, an alternative option is presented, should the panel be minded to impose controls on the development to address this issue. This entails a controlled area that corresponds with the approach descent / take off climb extent of the Copter South Arrival / Departure flight path. Within the controlled area, development would be precluded, except where it is authorised in accordance with an aeronautical study prepared in accordance with AC139-15 and any relevant approvals are obtained from CAA.

7.5 Suggested conditions

For the reasons above, conditions on the development are not considered necessary, on the basis that pilots operating from GCH would adjust approach profiles or select alternative published routes, or develop new routes and procedures as required, as the development is constructed. However, should the panel be minded to impose the 'controlled area' mitigation described above, the following condition could be adopted:

1. Prior to any development, construction, or placement of buildings or structures within the area identified as the 'Controlled Area' (Figure 9 – Controlled Area Plan) the consent holder shall commission and complete an aeronautical study in accordance with Advisory Circular AC139-15. The study shall, as a minimum:
    a. Assess the risk environment for helicopter operations associated with Garden City Helicopters, including analysis of flight data and incident records;
    b. Engage with relevant operational stakeholders, including local helicopter operators and Garden City Helicopters; and
    c. Determine acceptable building footprints, heights, and positions within the Controlled Area to ensure safe straight-ahead emergency landing capability.
2. No construction or development within the Controlled Area shall occur until the aeronautical study has been completed and its recommendations implemented to the satisfaction of the Council, and any Civil Aviation Authority approvals or determinations have been satisfied.

8 Building-induced wake effects

8.1 Background

Buildings disrupt natural airflow, creating wind shadows, wind shear, and wake turbulence as wind speed increases. Given the proximity of the development to the airport runway and heliport, there is potential for building-induced wind effects to impact operational safety.

Currently, there is no formal New Zealand guidance on assessing wake turbulence from buildings. However, the *Australian Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts* provides guidance (Guideline B[5]) on the analysis of building induced wind shear and turbulence near runways.

Guideline B adopts a layered risk approach to the building siting and design, using a series of triggers to determine whether analysis is required:

a. Is the building within the assessment trigger area?

b. If so, does it penetrate a 1:35 slope from the runway centreline?

c. If so, does desktop analysis indicate windshear criteria are met?

d. If not, does the building meet experimental wind tunnel criteria?

e. If not, can mitigation be achieved through design or operational procedures?

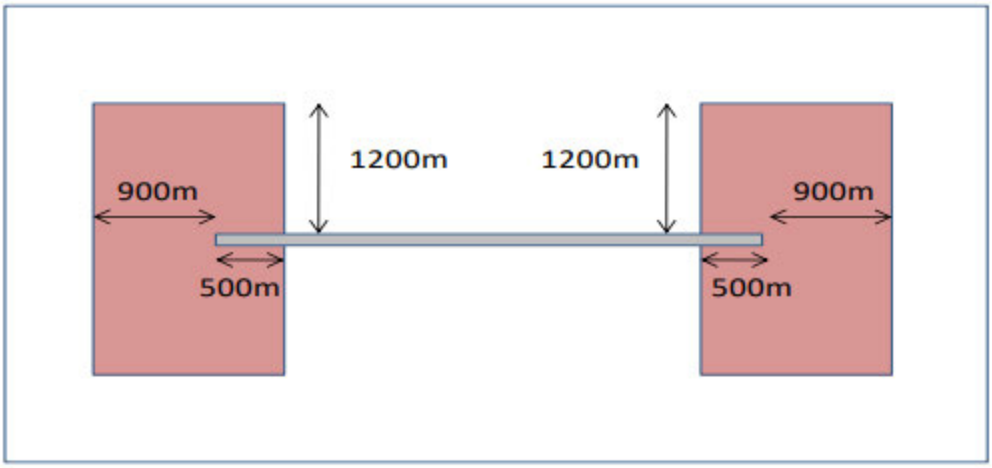

Figure 10: Wind Assessment trigger areas

The proposed development is within the assessment trigger area for the southern end of the main runway 02/20 (see Figure 3 and Figure 10), between approximately 300m and 700m from the extended runway centreline. Some building heights could penetrate the 1:35 slope (equivalent to heights of 8.5m to 20m). Therefore, under Guideline B, a desktop assessment will likely be required for at least some buildings.

National Airports Safeguarding Framework Managing The Risk Of Building Generated Windshear And Turbulence At Airports

The guidance uses specific windshear criteria based on 'mean wind speed deficit' which is defined as *"the difference between the mean undisturbed wind field (with no structures present) and the mean disturbed wind field (downwind of the structure)*[6]*.* The criteria are:

- 7 knots (3.6 m/s) parallel to the runway centreline (or extended runway centreline) at heights below 61m AGL, over a distance of at least 100m.
- 6 knots (3.1 m/s) perpendicular to the runway centreline (or extended runway centreline) at heights below 61m AGL, over a distance of at least 100m.
- Horizontal wind speed standard deviation must remain below 4 knots (2.1 m/s) at heights below 61m AGL.

In simple terms, this means that:

- The wind experienced by an aircraft as it moved (sic) down the runway should not be reduced by 7kn from the building unless this change occurs over a period of 100m or more.
- The wind experienced by an aircraft as it moved (sic) perpendicular to the runway should not be reduced by 6kn from the building unless this change occurs over a period of 100m or more.
- The turbulence that the buildings generate must be less than 4 knots in standard deviation. *With regard to this 4kn criterion; wind measurements taken by Navigatus elsewhere with similar wind speeds and building dimensions indicate that turbulence from the building is unlikely to exceed 1.5kn in standard deviation – notably less than the 4kn criterion. This prior trial provides confidence that the building generated turbulence will dissipate to less than 1.5kn at approximately 150m, which is less than the distance from any building to the runway. This criterion has therefore not been applied in the analysis as described below.*

The guidance itself provides a tool for a preliminary assessment of the magnitude of building-induced windshear. This analysis uses a table that calculates the size of the acceptable wind shadow based off the building's width-to-height ratio, and the mean wind speed.

8.1.1 Wind Profile

Figure 11 shows that Christchurch aerodrome's predominant wind direction is a north-easterly, with speeds of 10-20km/h most common. The directions most relevant to this analysis are:

- South-easterly - could cause building induced wind shear from Lot 122 or 123 toward the runway.
- South-westerly - could cause wind shear from Lots 121 and 122 toward the GCH FATO.
- Southerly - less frequent than south-westerly.

2.2.5-Guideline-B-Windshear.pdf

The wind speed profile indicates that analysing wind shear at 20kn (37km/h) would be sufficient and conservative for all three relevant wind directions.

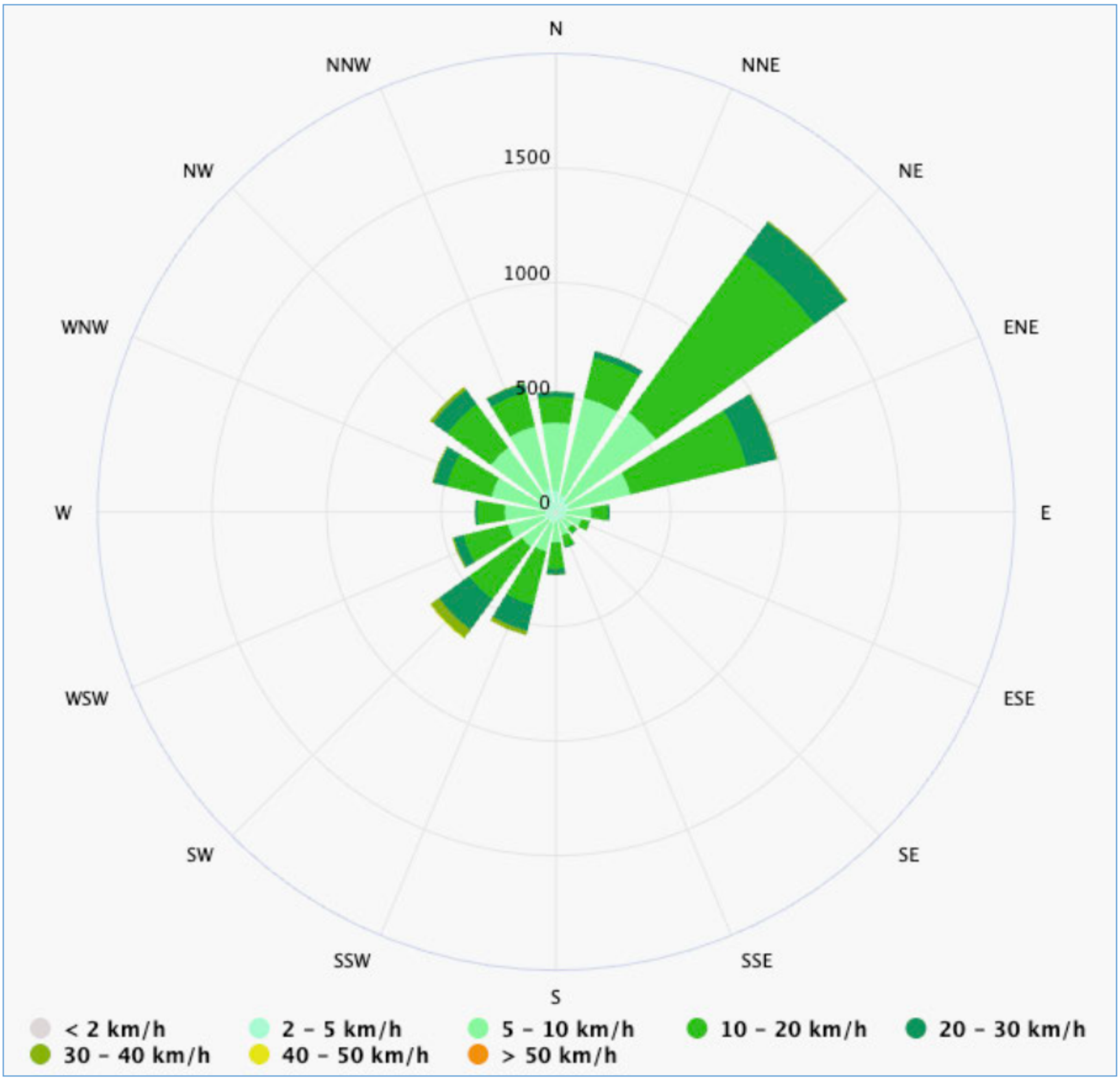

Figure 11: Wind rose for Christchurch aerodrome[7]

8.2 Models applied

Desktop modelling relies on understanding the assumptions and constraints that are embedded in that particular model. In the case of modelling for estimated wind shadow dimensions, Navigatus has relied on three generalised models to gain an initial understanding of the range of effects of the wind shadow from the proposed development on the helicopter operations at the aerodrome. These models can be summarised as the following:

[7] Source: Metroblue

- First model – analysis from understanding the shadowing of a single building. This inputs a general width and height of the buildings proposed, acting as a single 'building' in the model, to understand the scalar of distance for different wake regions
- Second model – this model aims to understand how the layout of the building will impact wind shadowing, including the gaps that those buildings might contain, and factors in the different material make-up of buildings. This gives an understanding of the ground-level wind shadowing and profile, including how the gaps in structures may impact wind flow.
- Third model – this model includes the depth of the buildings, as well as the height and width, to model wind shadowing effects. Its limitation is that it wasn't modelled on the depths that are noted for the proposed development.

These models were applied to the buildings as originally proposed. That is with building sizes that have subsequently been modified for a variety of reasons. The height and width were reduced – dimensions that mainly drive wind disturbance effects. It follows that the initial analysis can be considered conservative and the results overstating, to some extent, the effects.

Subsequent to this initial three-model analysis, a fourth model was applied – this being the one suggested in the Guidelines. This model applies the three criteria described in Section 8.1.

8.3 Runway Wind Analysis

8.3.1 Context

Aircraft usually land and take off into the wind. At Christchurch, RWY02 is normally used for landings during northerly winds. Under these conditions, the proposed development would not create wind shear affecting the runway, as any wind shadow would fall to the south.

However, during southerly or south-easterly winds, aircraft use RWY20, lifting off near the RWY02 threshold, which is the area of interest.

The closest point of the proposed development to the threshold is Lot 123, but as the building on Lot 122 is expected to be taller, the analysis models a building on Lot 122. This building is approximately 350m from the extended runway centreline- comparable to the distance of the GCH building, which is about 370m from the runway edge.

8.3.2 Model 1 analysis

The first model applied was based on the *1996 paper Wind Shadow Model for Air Infiltration Sheltering by Upwind Obstacles* and created a variable that was used to determine the wind shadow called the 'characteristic dimension' of the structure. This is primarily determined by the height of the building. The characteristic dimension of the 'L shaped' buildings (plots 122) was 35.3 (assuming 20m height and a width relative to a south-easterly of 110m). The model has four regions of different wind profiles. Various wind regions are defined. They are:

- Curved Streamline Region,
- Recirculating Wake Region,

- Near Wake Region, and
- Far Wake Region.

Findings from Model 1

Based on the '*characteristic dimension*' of the modelled structure, the following was determined;

- the Curved Streamline and Recirculating Wake regions ends 35m distant from the modelled structure,
- the Near Wake region ending at distance of 106m from the modelled structure, and;
- the Far Wake region continued for a distance of 176m from the modelled structure.

As the buildings are approximately 350m from the extended runway centreline, the runway would be outside the Far Wake Region (see Figure 12). The Far Wake Region's effect is negligible and only the momentum deficit of the wind is important so can be considered an incidental effect.

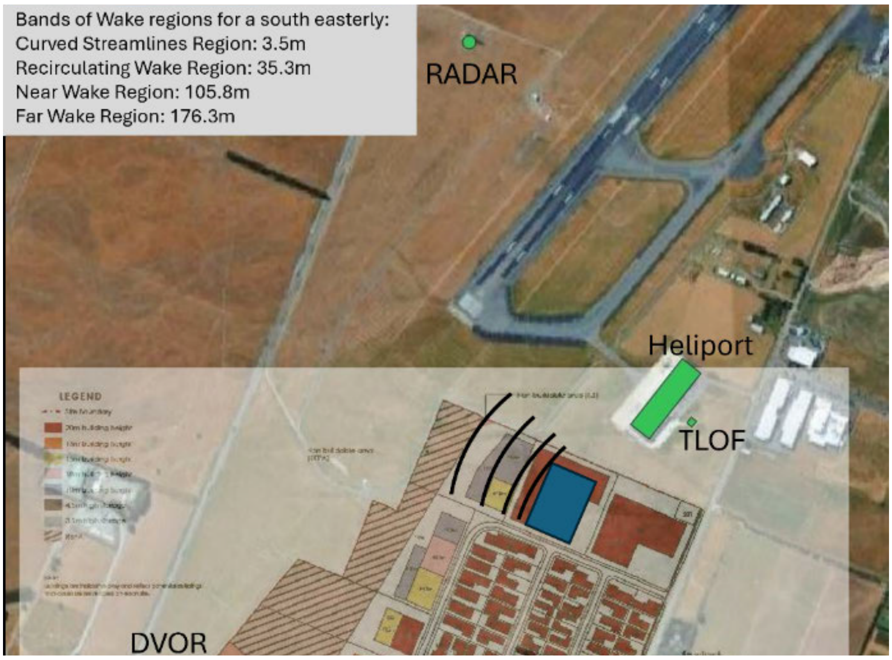

Figure 12 Wind shadow regions of Lot 122 in a south-easterly

8.3.3 Model 2 analysis

The second model[8] was based off a guide on assessing the impact of the recirculating wake near a structure with an emphasis on its impact on pedestrians. While the consideration of pedestrian comfort is outside the scope of this analysis, it is noted that this paper considers ways that wind can be channelled and funnelled between buildings. The intensity of this channelling/funnelling is unknown, and while creating issues for those standing next to the buildings, can reasonably be assumed to reduce far field wind shadowing effects. It is of

[8] file:///C:/Users/David.Spencer/OneDriveCloudTemp/JH2FHD3G/BBSC_433_Jessica-Bennett_Wind-Design-Guide.pdf

note that the distance between the building has since been increased and so any effects less critical.

8.3.4 Model 3 analysis

The third model[9] was based on a paper that reviewed how building shapes impact wind and heat transfer. This paper considered the length of wind shadows as a function of a structure's height, width, length, and roof design. While this study only has specific combinations of these four variables, an understanding of what is the driving force of wind shadow can be deduced.

As the distance of Lot 122 to the extended runway centreline is approximately 350m, and the height of the buildings was 20m, the distance was approximately 17.5 times the height. The model has an upper limit of the expected wind shadow to be 3.25 times the height of the building. This ratio equates to 65 metres which is notably less than the 350m distance to the extended runway centreline.

8.3.5 Take-away from initial analysis

Each of these methods delivered insights:

- Model 1 had the runway being outside of all wake regions, including the 'Far Wake Region' – this held regardless of the structure's floor plan shape.
- Model 2 highlighted the potential impact of wind funnelling and channelling. From this analysis, the spacing between buildings could be seen as acting to reduce in impact of any wind shadowing, and
- Model 3 showed that the length of the wind shadow will be less than the distance to the runway.

8.3.6 Initial conclusions re runway

Despite the analysis being informative, it was felt necessary, for completeness, to undertake an analysis as per the Guidelines.

For this reason, both the Lot 122 building and the GCH building were analysed to determine compliance with Guideline B wind shear criteria and to compare the proposed development's impact with an existing structure assumed to be acceptable (see Figure 13 and Figure 14).

8.3.7 Model 4 analysis

The analysis assessed whether building induced wind shear would impact fixed wing aircraft landing on RWY02 or taking off from RWY20. Key factors considered:

- **Building heights:** GCH building at 11m, and Lot 122 at 20m.
- **Distance from extended runway centreline:** GCH building at 370m, and Lot 122 at 350m.

[9] Scrutinizing_Solar_Gain_and_Ventilation_in_Traditi.pdf.

- **Wind speed**: Conditions modelled at 20kn southerlies and south-easterlies. Note: winds above 20kn would be expected to lead to RWY11 being used for narrow body aircraft, as this would provide a headwind rather than a strong crosswind.

The figures below show the wind deficit for both the Lot 122 and GCH buildings under a 20kn south-easterly, as well as Lot 122 under a 20kn southerly. Using 20kn as the test wind is conservative, as Figure 11 shows that 10kn (20km/h) is the strongest south-easterly typically experienced.

Existing GCH building - effects

Figure 13 show the wind speed deficit caused by GCH in a 20kn south-easterly:

- **Red band:** 9.6kn deficit - acceptable if this occurs before the runway.
- **Orange band:** 7kn criteria – also prior to the runway centreline , so acceptable.
- **Yellow band:** 6kn criteria – also prior to the runway centreline, so acceptable
- **Green / blue bands:** show deficit dissipates to acceptable levels before the runway.

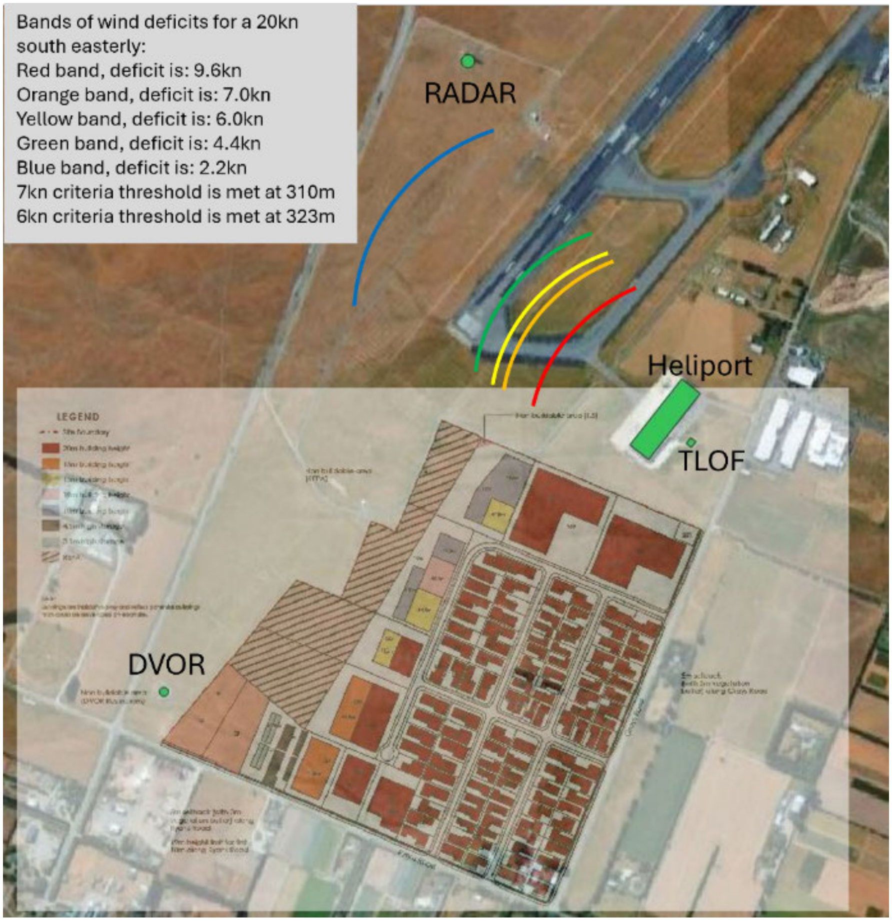

Figure 13 GCH building wind shear for runway

Lot 122 building - effects

Figure 14 shows the wind deficit for Lot 122 under a 20kn south-easterly:

- **Red band:** 9.6kn deficit - occurs before the extended runway centreline, so acceptable.
- **Orange band:** 7kn criteria – also prior to the extended runway centreline , so acceptable.
- **Yellow band:** 6kn criteria – also prior to the extended runway centreline, so acceptable
- **Green / blue bands:** Deficit dissipates to acceptable levels before reaching the runway.

Figure 14 Lot 122 wind shear given an south-easterly wind and building design of 20m X 100m X 140m (HxWxD)

Figure **15** shows the wind deficit for Lot 122 under a 20kn southerly. This wind direction results in the building being over 500m south of the runway centreline. This was analysed to assess the wind when parallel to the runway:

- **Red band:** 9.6kn deficit - occurs before the runway, so acceptable.
- **Orange band:** 7kn criteria – also prior to the runway, so acceptable.
- **Yellow band:** 6kn criteria –prior to the runway, so acceptable.

- **Green / blue bands:** Deficit dissipates to acceptable levels before reaching the runway.

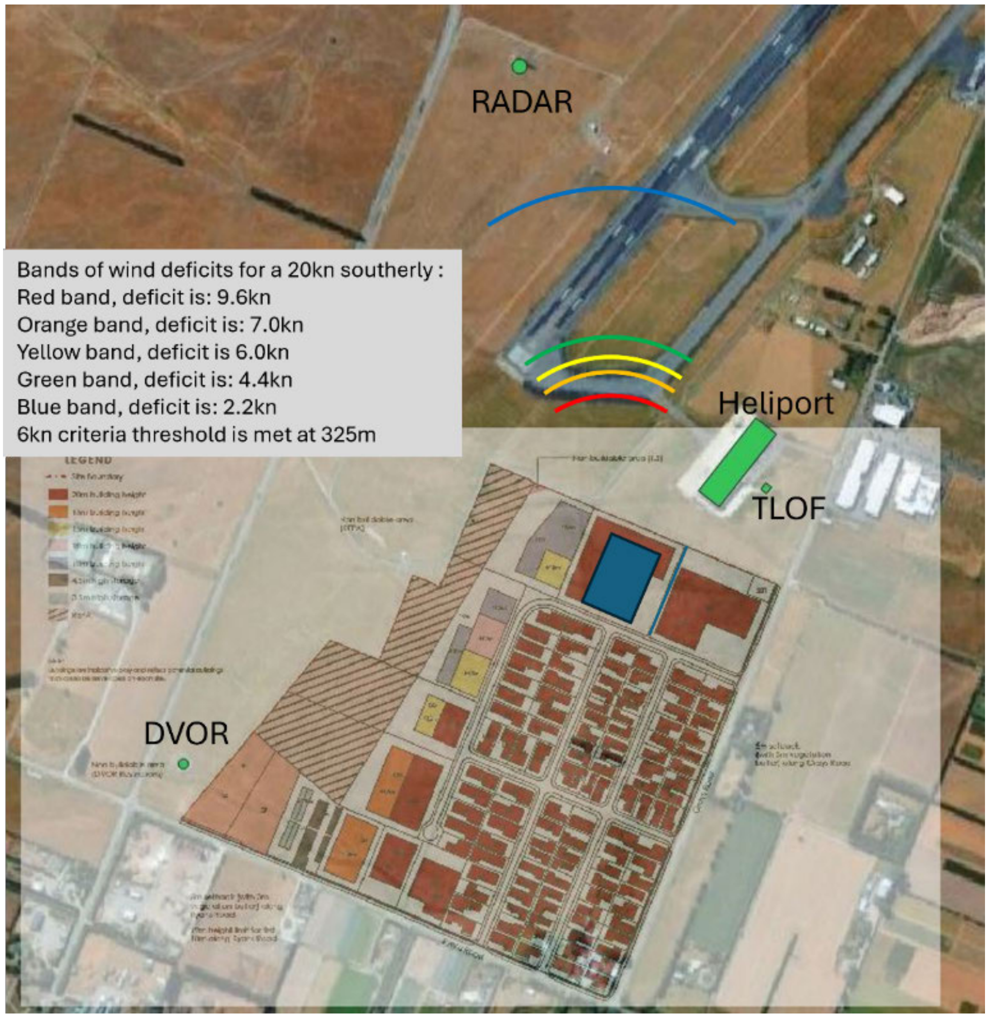

Figure 15**: Lot 122 wind shear given a southerly wind and building design of 20m X 100m X 140m (HxWxD)**

Model 4 Conclusion

Both the GCH building and that modelled on Lot 122 meet both the 6kn and 7kn Guideline B criteria, with the GCH's wake effect extending a similar distance compared to Lot 122's.

8.3.8 Runway – Overall conclusions

It is noted that all other buildings within the development are either lower in height (e.g. Lot 123) or further from the runway therefore any building less than 20 m tall and further than 350 m from the extended runway centre line can be expected to meet Guideline B wind shear criteria.

It is understood that the developer previously proposed conditions requiring certification for lots penetrating the 1:35 wind shear trigger plane (Capture drawing PG126). Based on this assessment, the proposed development will not adversely affect runway operations due to building induced wind shear. These conditions can therefore be removed or updated.

It is noted that the literature indicates that smaller buildings placed upwind of larger buildings tend to reduce wind shadowing effects, as loses energy over rough surfaces. As the development 'fills in', the overall wind shadowing effect is expected to remain stable or reduce slightly.

8.3.9 Suggested conditions

As the building on Lot 122 will not exceed 20m in height and provided it does not exceed the planned 100m X 140m in floor plan, no additional conditions are proposed.

8.4 Helicopter FATO Wind Analysis

8.4.1 Applicability to Heliports

There is no specific guidance for building induced wake turbulence for heliports. In the absence of such guidance, the analysis applies the guidance for runways serving fixed wing aircraft. This approach is conservative because:

- Helicopters routinely land very close to hangar buildings
- Helicopters are generally more tolerant of turbulence than fixed wing aircraft.

This conservatism is confirmed by observations of helicopter flightpaths at the GCH FATO during strong westerly winds –the condition most likely to create wind shear from the existing GCH building. Figure 16 shows an example where a helicopter landed east of the building in a westerly/nor westerly wind of approximately 30mph (26kn), directly within the area of greatest wind shadow.

Figure 16 Westerly wind and landing of helicopter at GCH

8.5 Building-induced wind effects on FATO

8.5.1 Initial analysis

While the proposed development contains many buildings, and as they are close together, the two most northerly buildings (121 and 122) were modelled as one continuous building. These buildings were initially modelled as large 'L' shaped buildings (in Models 1, 2, 3) as originally proposed. The Guideline analysis was updated to reflect a smaller building as subsequently proposed.

As with the runway analysis, the first model applied was based on the *1996 paper Wind Shadow Model for Air Infiltration Sheltering by Upwind Obstacles* and created a variable that was used to determine the wind shadow called the 'characteristic dimension' of the structure. This is primarily determined by the height of the building. The characteristic dimension of the 2 'L shaped' buildings (plots 121 and 122) was 44.5 (assuming 20m height and a mostly continuous building structure of 220m). The length of 220m was selected so that the helicopter FATO/TLOF was effectively aligned with the centreline of the wind effect and so where the shadow was longest. The model has four regions of different wind profiles. Various wind regions are defined. They are:

- Curved Streamline Region,
- Recirculating Wake Region,
- Near Wake Region, and
- Far Wake Region.

8.5.2 *Findings of initial modelling*

Based on the '*characteristic dimension*' of the modelled structure, the following was determined;

- the Curved Streamline and Recirculating Wake regions ends 45m distant from the modelled structure,
- the Near Wake region ending at distance of 135m from the modelled structure, and;
- the Far Wake region continued for a distance of 223m from the modelled structure.

Model 1

The first model: As the buildings are approximately 150m from the FATO/TLOF, the FATO/TLOF would be inside the Far Wake Region but outside the Near Wake region and the Curved Streamline and the Recirculating region.

The Far Wake Region's effect is negligible and only the momentum deficit of the wind is important so can be considered an incidental effect.

Model 2

The second model[10] was based off a guide on assessing the impact of the recirculating wake near a structure with an emphasis on its impact on pedestrians. While the consideration of pedestrian comfort is outside the scope of this analysis, it is noted that this paper considers ways that wind can be channelled and funnelled between buildings. The intensity of this channelling/funnelling is unknown, and while creating issues for those standing next to the buildings, can reasonably be assumed to reduce far field wind shadowing effects. It is of note that the distance between the building has since been increased and so any effects less critical.

[10] file:///C:/Users/David.Spencer/OneDriveCloudTemp/JH2FHD3G/BBSC_433_Jessica-Bennett_Wind-Design-Guide.pdf

Model 3

The third model[11] was based on a paper that reviewed how building shapes impact wind and heat transfer. This paper considered the length of wind shadows as a function of a structure's height, width, length, and roof design. While this study only has specific combinations of these four variables, an understanding of what is the driving force of wind shadow can be deduced. This model treated the entire 20m tall complex as one structure.

As the distance of the two closest buildings to the TLOF is approximately 200m, and the height of the buildings was 20m, the distance was approximately 10 times the height. The model has an upper limit of the expected wind shadow to be 5.75 times the height of the building. This ratio equates to 115 metres which is notably less than the 200m distance to the FATO/TLOF.

8.5.3 Take-away

Each of these methods delivered insights:

- Model 1 had the TLOF being in a region known as the 'Far Wake Region' – this effect is negligible and only the momentum deficit of the wind is important so can be considered an incidental effect.
- Model 2 highlighted the potential impact of wind funnelling and channelling. From this analysis, the spacing between buildings could be seen as acting to reduce in impact of any wind shadowing, and
- Model 3 showed that the length of the wind shadow will be less than the distance to the FATO/TLOF.

8.5.4 Initial conclusions re FATO

Despite the analysis being informative, it was felt necessary, for completeness, to undertake an analysis as per the Guidelines. Additionally, due to other factors, the footprint and exact location proposed for the northern Lots was reduced. The following analysis details this later analysis.

8.5.5 Model 4 Analysis

The analysis considered Lot 121 and Lot 122, the two closest proposed buildings to the FATO. It assessed conditions under which building induced wind shear could occur and whether it would impact helicopter operations during landing or taking off. Key factors included:

- **Building height:** Lot 121 at 16m; Lot 122 at 20m.
- **Building width:** Assessed at 80m, 100m, 125m, and 140m
- **Distance from FATO:** Minimum distances evaluated for given heights and widths.
- **Wind speed:** Modelled at 15kn and 20kn southerlies.

Figure 17, Figure 18, and Figure 19 show the wind speed deficit for Lot 121 under a 20kn southerly across three layout scenarios. In each case, the yellow band (7kn criteria) occurs

[11] Scrutinizing_Solar_Gain_and_Ventilation_in_Traditi.pdf.

prior to the FATO, meaning the proposed Lot 121 meets the criteria in all three building layout scenarios.

Similarly, analysis for Lot 122 under a 20kn south-easterly (Figure 20) shows the yellow band prior to the FATO, confirming compliance with the 7kn criterion.

Figure 17 Wind shear from Lot 121 given design of 16m X 80m X 125m (HxWxD)

Figure 18 Wind shear from Lot 121 given design of 16m X 125m X 80m (HxWxD)

Figure 19 Wind shear from Lot 121 given design of 16m X 100m X 100m (HxWxD)

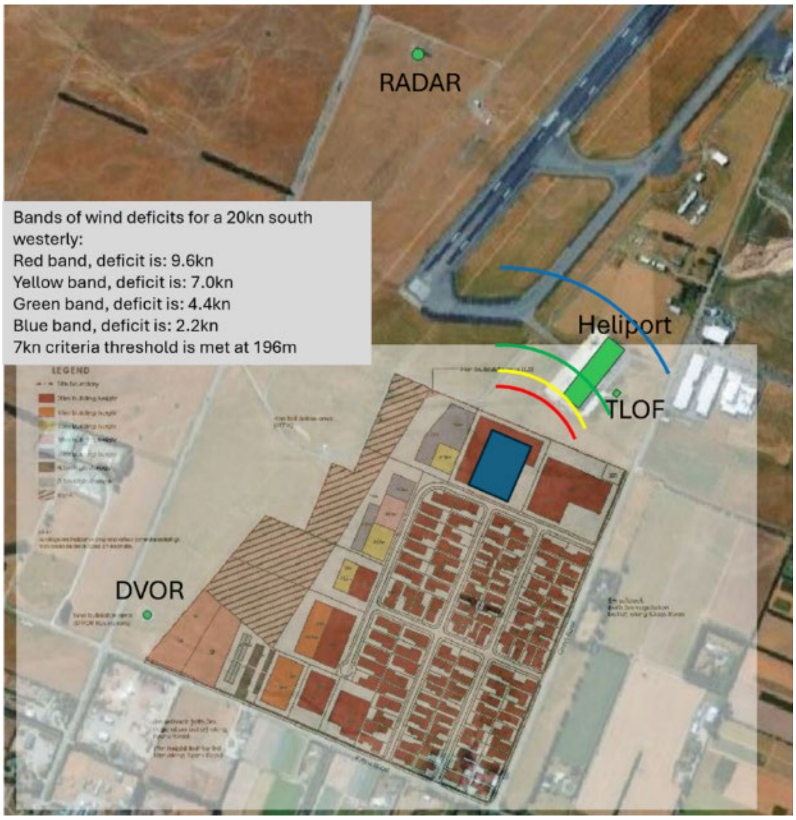

Figure 20 Wind shear from Lot 122 given design of 20m X 100m X 140m (HxWxD)

8.5.6 *FATO – Overall Conclusion*

All assessed scenarios—three designs for Lot 121 (16 m height) and one for Lot 122 (20 m height)—meet the 7 kn wind shear criterion before the FATO. These buildings represent the largest and closest structures in the development to the FATO; therefore, all other buildings can be expected to generate smaller wind shadows and require no further assessment.

Additionally, a 'stepped' building design could further reduce wind turbulence. For example, a covered yard of approximately 10m height located to the north of the building on Lots 121 or 122, would likely reduce turbulence during strong southerlies.

8.5.7 *Suggested conditions*

To prevent undue wind shadowing on the GCH FATO, the following conditions are suggested:

- **Lot 121:**
  - Maximum building height: 16m
  - Building location: towards the southern boundary of the lot
  - Maximum floor plan dimensions (width, depth): 125m x 80m, or 100m x 100m, or 80m x 125m
- **Lot 122:**
  - Maximum building height: 20m
  - Building location: towards the southern boundary of the lot
  - Maximum floor plan dimensions (width, depth): 100m x 140m

8.6 Suggested conditions – building wake

To prevent undue wind shadowing on the GCH FATO, the following conditions are suggested:

- **Lot 121:**
  - Maximum building height: 16m
  - Building location: towards the southern boundary of the lot
  - Maximum floor plan dimensions (width, depth): 125m x 80m, or 100m x 100m, or 80m x 125m

9 Downwash and Outwash

9.1 Background

Downwash refers to the downward airflow produced by a helicopter's rotor system as it generates the thrust required for lift and sustained flight. This phenomenon occurs when the rotor blades force air downward at high velocities to counteract the aircraft's weight. For heavier helicopters, the lift required is substantial, resulting in downwash that is significantly stronger than typical wind conditions.

Understanding the extent of downwash and whether it poses a hazard is essential for safety, particularly for:

- Workers handling large items that can catch the wind
- Construction crews during building works
- Maintenance personnel working on roofs post-construction.

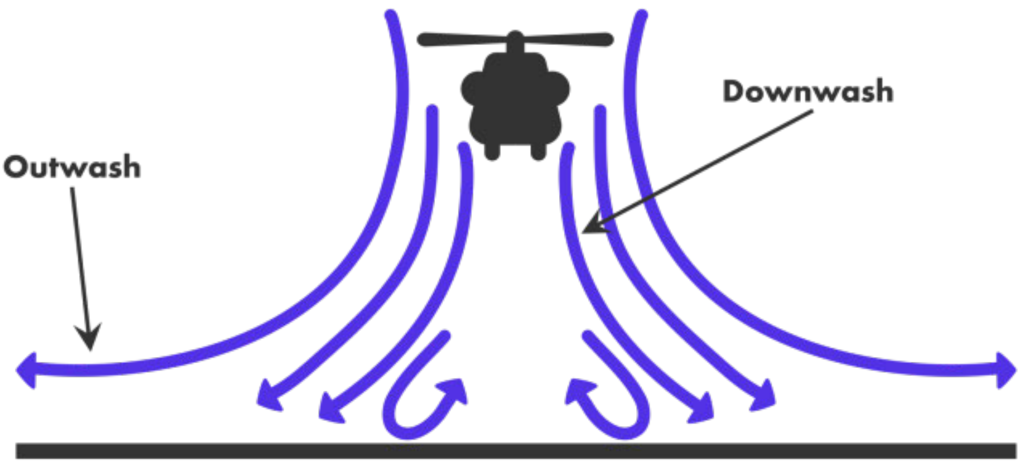

Figure 21 Downwash and Outwash[12]

9.2 Method – assessing helicopter downwash

Downwash depends on both aircraft mass and rotor disc area. Navigatus modelled likely downwash for helicopters operating from the GCH helipad using publicly available information from the GCH website.

Eight helicopter types were identified as routinely using the GCH helipad. The largest two – H145 and BK117 - have similar mass and rotor disc area, representing the highest potential for downwash. All eight helicopter types were modelled using two methods:

[12] https://pilotswhoaskwhy.com/2024/01/29/understanding-rotor-downwash-the-ultimate-pilot-guide/

- **Method 1:** Calculates downwash directly below the rotor disc, then scales using Bernoulli's principle at three rotor widths below the blades.
- **Method 2:** Based on French Civil Aviation Authority guidance, calculating windspeed three rotor widths below the aircraft and factoring horizontal displacement. This method applies a 30% 'safety margin' for conservatism.

9.3 Results – helicopter downwash

Analysis of downwash from helicopters operating at GCH found that:

- **Method 1**: BK117 produced the strongest downwash—51.1 kn at three rotor widths (33 m) directly below the aircraft. This equates to "storm" conditions on the Beaufort scale but lasts only 2–3 seconds as the helicopter passes overhead.
- **Method 2:** BK117 again produced the strongest downwash—46.2 kn at the same height. Horizontal displacement analysis showed that the 20 kn safety threshold (considered safe without prior notice) would not be exceeded with a horizontal distance of 35m (or more) from the track of the helicopter, including the 30% safety margin.

Based on this analysis, the helicopter downwash generated from helicopters operating at the GCH helipad could be of significance to persons on the proposed development and also while construction or maintenance work is being carried out.

9.4 Protection

To mitigate, a Downwash Protection Zone (DPZ) - that ensures people, vehicles, and objects are kept clear of the hazardous downwash- should be defined along the published approach path, extending approximately 260 m in length and 70 m in width. This distance corresponds to the point where a helicopter would be three rotor widths above ground level if flying at the OLS height. In practice, helicopters are likely to be higher, reducing downwash intensity below the 20kn safety threshold.

Controls for the DPZ (the extent of which is shown in Figure 22) should include:

- **Construction phase:** Incorporate downwash hazard management into the Construction Management Plan (likely combined with Part 77 requirements).
- **Post-construction:** Implement measures to prevent lightweight materials (e.g., tarpaulins, polystyrene sheets) from becoming airborne hazards. A covered yard could provide effective protection and also reduce building-induced turbulence (see Section 8).

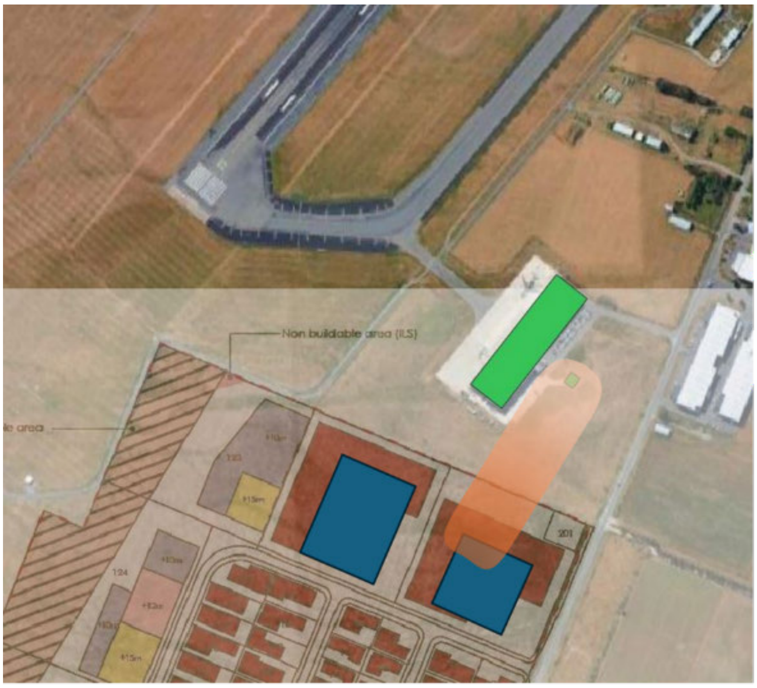

Figure 22 Proposed DPZ (Orange area) of GCH FATO with the proposed Lots 122 (left) and 121 (right) shown in blue.

9.4.1 Conclusions

1. A potential downwash hazard exists over limited portions of the development, specifically Lot 121.
2. Hazard mitigation will be required during building construction of buildings and ongoing site use.
3. Practical controls are available to manage the hazard to a safe level:

    i. **Subdivision works:** Identify hazard and communicate to workers (risk assessed as low, noting minimal or no work within the proposed DPZ).

    ii. **Building construction**: Manage hazard under a Construction Management Plan.

    iii. **Post-construction**: Include hazard in owner/ occupier health and safety plans, especially for roof and yard operations.

    iv. **Engineered control:** A covered rear yard may provide effective protection.

9.5 Suggested conditions

To ensure awareness of the helicopter downwash hazard, a consent notice on the record of title for Lot 121 is recommended, which notifies owners of the helicopter downwash hazard that exists on the site.

10 Radar (PSR / SSR)

10.1 Background

Airways NZ manages New Zealand's airspace using a combination of surveillance technologies:

- **Secondary Surveillance Radar (SSR)**
- **Automatic Dependent Surveillance-Broadcast (ADS-B)** – the primary surveillance system
- **Multilateration (MLAT)**

While SSR now acts as a contingency for ADS-B, a 'traditional' **Primary Surveillance Radar** (PSR) remains in use as a fallback and for detecting non-cooperative aircraft in controlled airspace (those without a working transponder).

A recent radar replacement programme upgraded Christchurch's older PSR station to a combined PSR and SSR (Figure 23). This modern phased array radar provides significantly extended coverage and range compared to previous technology. Technical specifications of the PSR and SSR are below in Figure 24.

Figure 23: The combined PSR/SSR (right) located on an 18-metre tower slightly west of the old PSR (left).

- Details on the radar facilities,

	PSR (primary)	SSR (secondary)
Manufacturer	Indra	Indra
Model	PSR3D	MSSR
Frequency	L-Band (1290.50MHz, 1274.96MHz, 1277.96MHz)	1030/1090 MHz
Power	16 kW/ 72 dBm	2.5 kW/ 64 dBm
Antenna gain	33.3 dBi	27 dBi
Antenna elev.	23.4 m AGL	25.5 m AGL
Polarization	Unknown	Vertical
Latitude	43°29'33.2494" S	
Longitude	172° 31' 19.8046" E	

Figure 24: Technical information of PSR and SSR

10.2 Location relative to nearby buildings

Figure 25 and Figure 26 below illustrate the position of existing airport and industrial buildings that penetrate the PSR/SSR safeguarding surfaces. Notably, the GCH buildings, the airport terminal, and several existing buildings within Dakota Park penetrate these safeguarding surfaces.

Assuming the radars operate to ICAO Annex 10 Volume IV performance standards, one or more of the following is likely:

i. **Safeguarding surface is conservative** and buildings do not interfere with radar signals regardless of design.

ii. **Prior safeguarding analysis has influenced building design**, ensuring compliance (see Note 1).

iii. **Radar systems have been tuned** to account for stationary objects (see Note 2).

Note 1: It is our understanding that no safeguarding analysis was undertaken for existing buildings during their design and construction.

Note 2: Airways confirms that radar tuning can mitigate some effects but prefers not to exacerbate potential issues.

Refer to Section 11 for further consideration of potential impacts from the proposed development on radar operations.

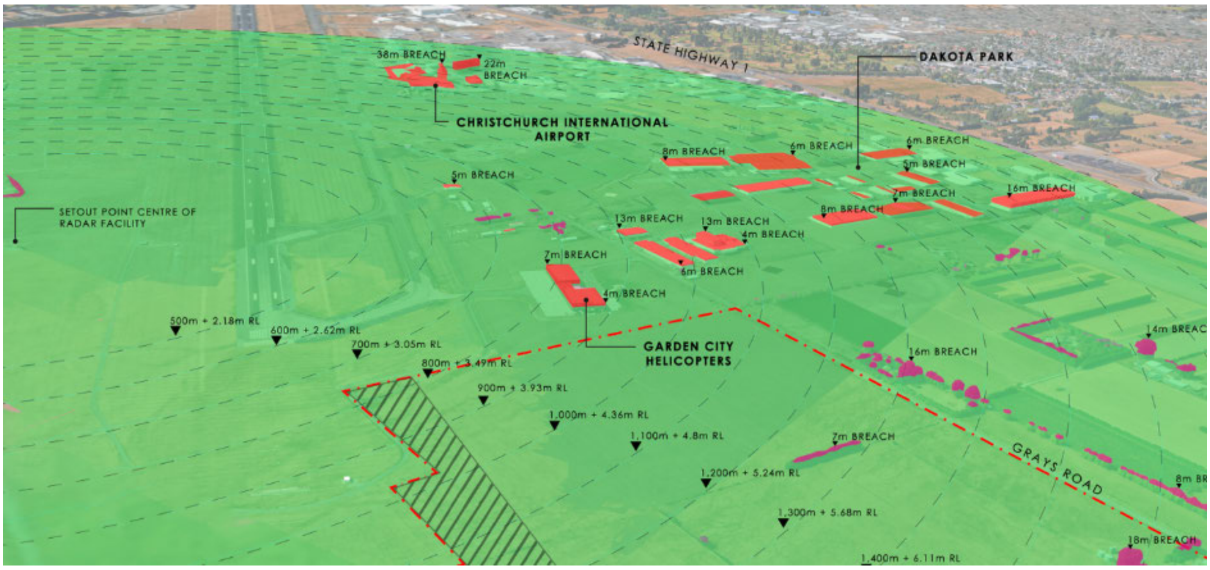

Figure 25: Model showing buildings currently penetrating the radar protection area / surface (viewed looking NE)

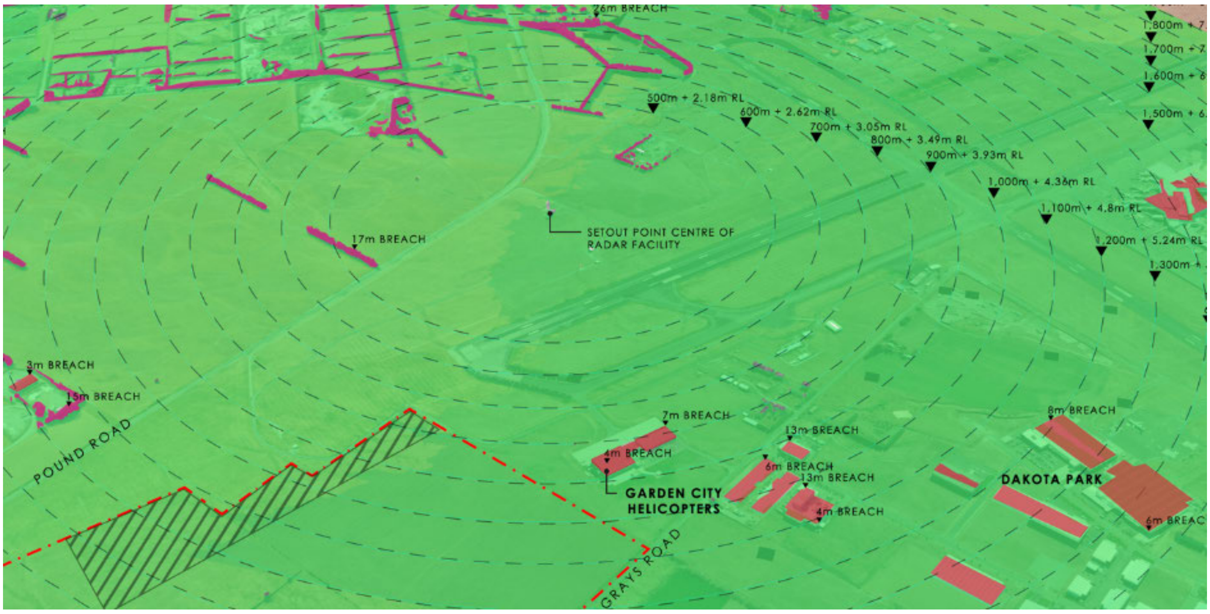

Figure 26: Model showing buildings currently penetrating the radar protection area / surface (looking NW)

11 Safeguarding analysis

11.1 Introduction

Given the complexity and specialist expertise required to assess the potential impact of buildings on air navigation equipment (ANE), Carter Group commissioned Cyrrus Limited, a UK-based specialist company recommended by Airways NZ.

The objective of the Cyrrus assessment was to evaluate and identify how to ensure that the proposed Ryans Road Industrial Development will not adversely affect the safe operation of ANE supporting Christchurch aerodrome and Airways' nationwide services.

The proposed development infringes, or is in close proximity to the protection surfaces for the following air navigation facilities:

- Instrument Landing System (ILS) Localiser Runway 02;
- ILS Localiser Runway 20;
- ILS Glidepath Runway 02;
- ILS Distance Measuring Equipment (DME) Runway 02;
- Doppler VHF Omni-directional Range (DVOR)/DME; and
- Primary Surveillance Radar (PSR)/Secondary Surveillance Radar (SSR).

11.2 Methodology

The safeguarding assessment applied internationally accepted processes as follows:

- **ILS analysis:** Followed a staged process: first, a worst-case computer simulation is conducted, modelling the development as highly reflective surfaces to assess maximum potential impact on ILS signal parameters.
- **DME analysis:** Involved assessing the potential effects of large structures on DME signals, focusing on reflections that could cause multipath interference and incorrect distance measurements, and line-of-sight (LoS) shadowing.
- **DVOR analysis:** Involved using computer simulation tools to model the effects of large metallic structures on DVOR radio signals. 3D radio propagation modelling to assess the extent of signal shadowing, was then undertaken ensuring to identify and evaluate any impacts against international standards.
- **Radar analysis:** The assessment evaluated the potential effects of large structures on both PSR and SSR by considering three main risks; beam forming, shadowing and reflections. The analysis accounted for the proximity and height of proposed buildings relative to radar antennas and modelled the likely paths of reflected signals.

11.3 Findings

The analysis[13] findings are summarised here:

ILS Localiser Runway 02:

- ▷ The proposed development will be expected to have, at most, a very minor and acceptable impact on Localiser 02 performance.

ILS Localiser Runway 20:

- ▷ The proposed development will have a negligible and acceptable impact on Localiser 20 performance.

ILS Glidepath Runway 02:

- ▷ The development will have only a minor and acceptable impact on Glidepath 02 slope guidance performance.

ILS DME Runway 02:

- ▷ As the DME 02 ground transponder is configured with SDES enabled, no effects are anticipated from building reflections. Potential LoS shadowing of DME signals will be outside of required area of operational coverage.

DVOR/DME:

- ▷ The proposed development will have some disturbance to the DVOR signal, but this will have no impact on aircraft flying VOR approach procedures.
- ▷ DME reflections from the proposed development they will have no impact on aircraft flying runway approaches.
- ▷ If configured, SDES would provide immunity from building reflections.
- ▷ Potential LoS shadowing of DVOR/DME signals will have no impact on aircraft flying VOR/DME approach procedures to runways 02 and 20 and therefore will have no effect on airport operations.

Radar:

- ▷ The proposed development should not adversely affect the PSR/SSR's ability to meet Eurocontrol minimum ATM surveillance system performance requirements (ESASSP v1.3).
- ▷ Shadowing and obscuration of radar signals will not affect airborne targets.
- ▷ Reflected radar energy from vertical building surfaces will have no effect on surveillance system performance.
- ▷ Reflections of radar energy from horizontal building roofs can potentially result in PSR target fading or SSR data corruption. As a result, any reflections will be detectable by aircraft at a range of 20NM or below altitudes of circa 1,000 feet.

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[13] Technical Safeguarding Assessment of Air Navigation Equipment, Ryans Road Industrial Development, Christchurch (CL-6216-RPT-002 DC, 18 Nov 25) prepared by CYRRUS.

- ▷ Discontinuities on building roof areas will scatter the radar reflections, reducing the likelihood of adverse effects.
- ▷ If configured to avoid radar illumination of the proposed development, any impacts on the PSR will be mitigated and be acceptable.
- ▷ The SSR builds up its own internal reflector file so that it will ignore reflections from known receptors. Any impacts are therefore acceptable.

11.4 Conclusions from technical analysis

11.4.1 CYRRUS Conclusions

The analysis report by Cyrrus:

1. Confirmed that the effects on air navigation equipment from development of the Ryans Road land are manageable to an acceptable standard.
2. Modelled a worse-case scenario. The actual effects are expected to be less than those predicted by the worst-case model.
3. Confirmed that effects on ANE from development of the Ryans Road land will be of an acceptable standard, provided that:
    a. Development occurs in accordance with the modelled parameters of the development.
    b. Development is of no greater height or width than the modelled parameters of the development.
    c. Alternative development is re-modelled and assessed to confirm it has acceptable effects on air navigation equipment.

11.4.2 Navigatus comments

In addition to the stated findings and conclusions of the technical safeguarding analysis, some further insights can be deduced. These include:

- The potential modelled adverse effects on the long-range radar low-level coverage to the south-east are noted. However, given the terrain (Banks Peninsula) the radars do not have long range LoS to the south-east and so this effect is somewhat theoretical.
- Enabling the SDES on the DVOR (by Airways) could further reduce building reflection risk.

11.5 Pre-Build Mitigation Options

Fundamentally, the avoidance or mitigation of effects on ANE should be achieved by ensuring that building designs remain within the height, width and orientation parameters modelled during the safeguarding assessment by Cyrrus, or alternative parameters are subsequently remodelled to confirm acceptability.

Whilst not relied on by Cyrrus or this assessment, incorporating design features to reduce reflections (e.g., discontinuities, radar-absorbing materials) may also benefit ANE performance.

11.6 Post-Build Mitigation Options

While the analysis indicates that the impacts of the proposed development will be very limited and acceptable, thought has been given to various post-build mitigation options that could be considered:

- **Radar Systems:** Use of software code to remove static building returns, which is supported by modern PSR systems and may already have been done for some of the many large industrial style buildings on or near the aerodrome. As noted previously, Airways have advised that this solution is possible, but they also do not wish to exacerbate any problems.
- **ILS Systems**: Redirect reflections using suitable cladding or tuned frequency absorbers.
- **Building Detailing:**
  - Use radar-absorbent materials (e.g., wood cladding).
  - Install tuned frequency absorbers or wire mesh to disrupt reflections.

11.7 Conclusions

The analysis by Cyrrus has confirmed that the effects of a worse-case scenario development proposal on ANE are manageable to an acceptable standard, provided that development is of no greater height or width than the modelled parameters of the development and that some key relative angles of building surfaces are maintained as modelled.

Navigatus otherwise concludes that credible and practical options for post-build mitigation also exist. In particular, for a radar system impact Airways would have scope to ‘code remove’ any offending building(s).

11.8 Suggested conditions

As recommended by Cyrrus, development should be conditioned to occur in accordance with the modelled parameters of the development, or be of no greater height or width than the modelled parameters of the development and the orientation of some key surfaces adhered to. Alternative development should otherwise be re-modelled and assessed to confirm it has acceptable effects on air navigation equipment.

12 Runway End Protection Areas

12.1 Background

Runway End Protection Areas (REPA) are areas at the end of runways that are intended to reduce the societal risk of injury or death to people on the ground in the event of an aircraft undershoot or overrun.

Most REPAs shown in New Zealand district plans are based on older FAA guidance. More modern, risk-based approaches – such as those used in the Auckland District Plan – typically result in REPAs that are longer but significantly narrower, reflecting refined risk modelling .

12.2 Christchurch Aerodrome REPA

Christchurch Aerodrome has four REPAs defined in the District Plan (see Figure 27). These are based on the traditional FAA model and are located at the end of the airport's runways.

The Christchurch District Plan provisions go beyond basic risk reduction measures (such as avoiding the mass assembly of people, most buildings, and the use and storage of hazardous substances). They also seek to avoid activities that could interfere with pilot vision or exacerbate accident consequences - for example, avoiding unwanted light sources,[14]. While unusual, these provisions are considered reasonable in the context of aviation safety.

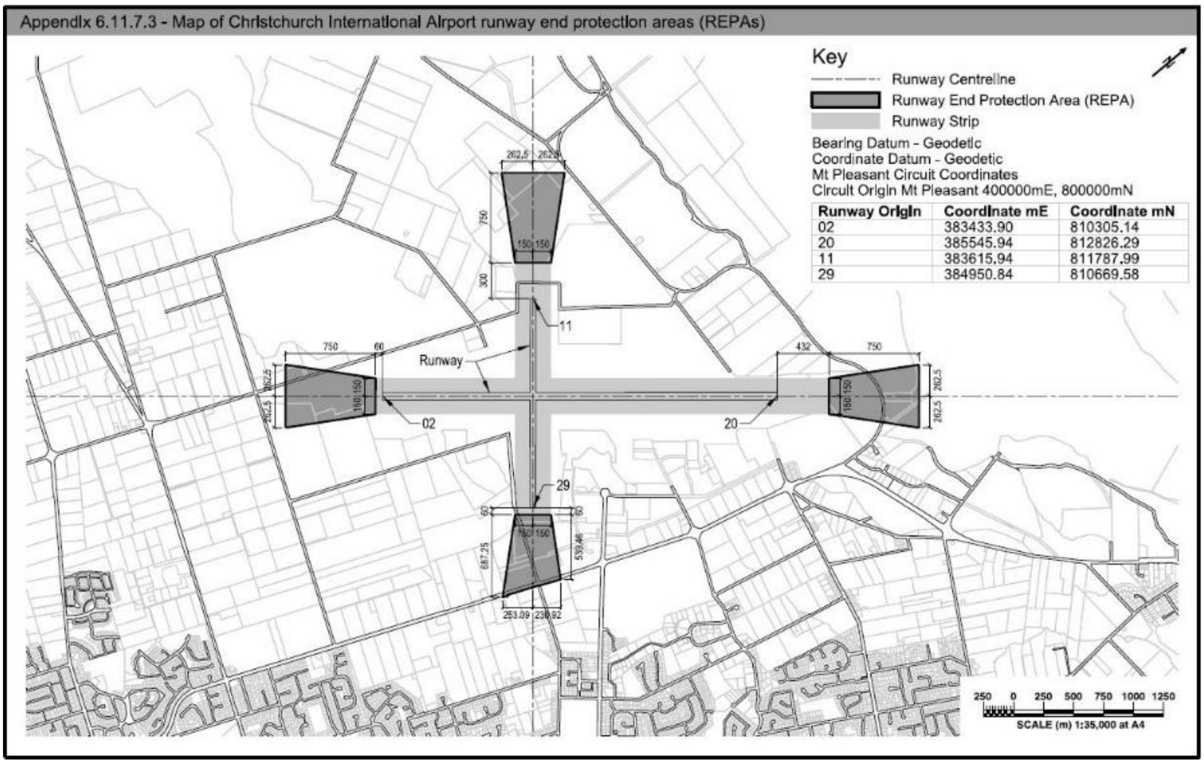

Figure 27 REPA positions from Christchurch district plan

[14] See Christchurch district plan 6.7.1

12.3 Implications

If the proposed development was located within a REPA, it would be a prohibited activity, under the District Plan rule which prohibits:

Any building or utility, excluding:

- *navigational aids for aircraft;*
- *structures associated with upgrades for State Highway 1;*
- *maintenance or repair works on any existing building or utility;*
- *enclosed walkways associated with vehicle parking areas which are no greater than 2.4 metres in height and 1.8 metres in width; and*
- *the establishment or replacement of any underground utility.*

Carter Group has appropriately excluded development within the designated REPA (see Figure 5, hashed area). However, this area must still be managed to avoid aviation safety risks, such as:

- Loose materials that could be blown onto the aerodrome
- Vegetation that could attract wildlife.

12.4 Conclusions

The development will comply with the restrictions set out in the District Plan for the area of the REPA, meaning that only limited development (e.g. underground utilities) may occur.

12.5 Suggested Conditions

Compliance with the specific rules and requirements in the District Plan for the REPAs should be expressly noted in conditions or as an advice note as should guidance on the management of the area so as to avoid loose material accumulating and potentially being blown over onto the aerodrome areas. Otherwise, the REPA should be subject managed in accordance with the Construction Management Plans for the development and for the nearby Lots and maintained as required by the Wildlife Hazard Management Plan.

13 Overall Conclusions

This assessment has considered all relevant aviation safety matters associated with the proposed Ryans Road industrial development adjacent to Christchurch International Airport. The analysis has been undertaken of a commercially credible worst-case development model, with reference to applicable regulations, technical guidance, and expert assessments.

13.1 Key conclusions for each topic are as follows:

13.1.1 Helicopter and Heliport Effects

Helicopter/Heliport: The development will reduce the area currently available for emergency helicopter landings. While suitable land remains in the vicinity of the heliport, analysis indicates that the preferred straight-ahead emergency landing option for helicopters approaching over the development will not be available once construction occurs. While there is no regulatory requirement for the entire approach or departure slope to remain clear, CAA guidance recommends avoiding approach paths over built-up areas. Pilots – particularly those operating single-engined helicopters - may need to adjust flight procedures to comply with civil aviation regulations and maintain safety margins. This may be by; approaching at a higher altitude and flying steeper descent profiles, using alternative published approach routes, flying around the development and completing a final manoeuvre within the GCH area, or if wind conditions dictate, land elsewhere. Whilst these operational adjustments by pilots operating from GCH could address this issue, an alternative option is presented, should the panel be minded to impose controls on the development to address this issue. This entails a controlled area (that corresponds with the approach-descent / take off-flight path) within which, development would be precluded, except where it is authorised in accordance with an aeronautical study prepared in accordance with AC139-15 and any relevant approvals are obtained from CAA.

Downwash: Helicopters approaching from the south will pass over the development and will be low on approach or departure when passing over Lot 121. As a result, some downwash hazard may be created. This hazard will need to be mitigated by any developer of Lot 121 by design and health and safety controls.

13.1.2 Building-Induced Wake Turbulence

The potential for building-induced wind effects on runway and heliport operations has been assessed using a range of models and conservative criteria. Proposed building heights and locations ensure compliance with accepted standards, and recommended conditions will avoid unacceptable impacts on operations.

The analysis demonstrates that, with the specified controls, the development will not adversely affect runway or heliport operations due to wind shear or turbulence.

13.1.3 Other Aviation Issues

Technical safeguarding assessments (including those by Cyrrus) indicate that impacts on radar and navigation aids (DVOR, ILS, PSR/SSR) are minor and manageable. The required radar system performance is achieved despite various large buildings already penetrating safeguarding surfaces . A range of further mitigation options are available if required.

The development complies with District Plan restrictions for Runway End Protection Areas (REPA), ensuring no prohibited activities occur within these areas. Ongoing management of loose materials and vegetation will prevent aviation safety risks being created.

13.2 Overall Acceptability

All identified aviation safety risks can be managed to an acceptable level through design controls, operational procedures, and regulatory compliance. The requirement for CAR Part 77 notification and determination provides an additional safeguard, ensuring that any activity with potential to affect navigable airspace is subject to review and direction by the Civil Aviation Authority.

The recommended consent conditions and advice notes that address aviation aspects provide robust and practical safeguards, ensuring ongoing compliance and protection of the safety of the aviation-system.

In summary, provided the development proceeds in accordance with the modelled parameters and recommended conditions, the effects on aviation safety are acceptable. The assessment provides confidence that aviation safety risks are identified, managed, and mitigated.