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104 RYANS ROAD - FAST TRACK APPLICATION

ASSESSMENT OF ENVIRONMENTAL EFFECTS (LIGHTING)

REVISION: D – 3rd Issue

DATE: 7/03/2025

QUALITY ASSURANCE STATEMENT

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DOCUMENT STATUS

Revision	Date	Type
A	17/01/2025	Draft
B	21/01/2025	1st Issue
C	25/02/2025	2nd Issue
D	07/03/2025	3rd Issue

DISTRIBUTION

Revision	Date	Issued to
B	21/01/2025	Clare Dale, Bruce Van Duyn
C	25/02/2025	Clare Dale, Bruce Van Duyn
D	07/03/2025	Clare Dale, Bruce Van Duyn, Lucy Forrester

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EXECUTIVE SUMMARY

Pedersen Read were engaged by Carter Group Limited to conduct an Assessment of Environmental Effects (AEE) for the artificial lighting associated with the proposed industrial subdivision and development at 104 Ryans Road, adjacent to Christchurch International Airport. The assessment was based on information from various external sources and included site visits during both daytime and nighttime operations.

Existing Site

The existing site at 104 Ryans Road is currently undeveloped and zoned as Rural Urban Fringe (RuUF). It is surrounded by Christchurch International Airport to the north and west, and local roads to the south and east. The area lacks existing lighting installations, except for some minor lighting at adjacent road intersections and nearby properties. Notably, the Garden City Helicopters (GCH) Aviation building at 73 Grays Road, adjacent the northern boundary of the proposed site, has clearly visible lighting, including floodlit exterior areas, lit facades, and illuminated signage, which are visible from all sides.

Proposed Development

The proposed development will be carried out in two phases: initial subdivision and services installation, followed by future development of individual lots. Street lighting will be installed during the initial phase, and individual site lighting will be developed by future property developers.

Rules and Criteria Affecting the Site Lighting

Lighting associated with the proposed development is subject to several rules and criteria, particularly due to its proximity to Christchurch International Airport. Compliance with Civil Aviation Authority (CAA) rules and Christchurch District Plan (CDP) prohibited activity rules is crucial to ensure the safety of aircraft operations and manage adverse effects on the environment. These rules govern aspects such as light spill, glare, and the intensity and colour of lighting, and must be adhered to throughout the development and operations process to avoid potentially significant effects.

Lighting Effects and Mitigations

The assessment identified several potential effects of artificial lighting, including impacts on neighbouring residents, transport systems, the Christchurch International Airport, the night sky, and wildlife. Adverse effects are able to be mitigated using good lighting design measures and careful component selection, including the use of warm (≤3000K) colour temperature lighting, flat glass fittings, no tilt, and shielding to minimise spill light. Additional mitigation measures are proposed to address some specific effects unique to the site's situation and context in close proximity to the Christchurch International Airport. A non-exhaustive selection of these are presented below, split by project phase.

Phase 1 mitigations are intended to be read as potential resource consent conditions appropriate for the initial development of the site, including street lighting.

Phase 1 (by the subdivision developer, Carter Group Limited)

- No construction requiring artificial lighting during the hours of darkness.
- Use of warm colour temperature (≤3000K) street lighting.
- Light streets within 500m of the runway to PR4 standard (>1.3lux average, <2.5lux maximum).

Phase 2 mitigations are **examples only** and intended to demonstrate that the potential effects of artificial lighting can be managed by future individual site developers. Some mitigations may not be appropriate, or required, for all sites within the subdivision. Instead, a site specific assessment of environmental effects for artificial lighting should be carried out by an appropriately experienced and qualified lighting designer, familiar with the requirements of the CAA and CDP, as an integral part of the development of each site, and mitigation measures put in place to manage the effects identified in both this report, and the site specific report.

Phase 2 (by the individual lot developer)

- Use of warm colour temperature lighting (≤3000K) including interior spaces visible from exterior spaces.
- Limiting exterior lighting within 500m of the runway threshold including façade and yard lighting.
- Requiring façade lighting and illuminated signage be limited to the eastern side of buildings only.
- Requiring roller shutter doors (and similar) be limited to the eastern side of buildings only.
- Use of low-level lighting (eg. bollards) for parking and pedestrian areas.
- Lighting of parking areas within 500m of the runway to PR4 standard (>1.3lux average, <2.5lux max).
- Loading areas within 500m of the runway be precluded from operating outside daylight hours.
- Use of tinted windows, blinds and motion detection for interior spaces visible from the exterior.
- No use of internally illuminated signage.
- No transparent or translucent façades.

Conclusion

This assessment has shown that the rules and standards applicable to artificial lighting at the development site are able to be met and the effects appropriately managed, during both the initial subdivision (Phase 1), and the future development of individual lots (Phase 2).

The proposed mitigations are assessed to reduce the severity of lighting effects to **<u>no greater than minor</u>**, on the basis that compliance with the CAA and CDP requirements is achievable.

Consultation with airport users is recommended to ensure any further potential effects are identified and mitigated.

Careful implementation of the proposed controls will ensure compliance with relevant rules and guidelines, allowing the development to proceed whilst managing the environmental effects associated with artificial lighting.

CONTENTS

APPENDICES

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LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Pedersen Read have been engaged by Carter Group Limited to undertake an Assessment of Environmental Effects (AEE) for the artificial lighting associated with the proposed subdivision and development at 104 Ryans Road, adjacent the Christchurch International Airport.

The assessment is based upon the information provided by others, including (but not limited to):

- PDP Memorandum “Lighting Management for Aerial Fauna – 104 Ryans Road”
- Novo Group “Integrated Transport Assessment for Rolleston Industrial Developments Ltd – 104 Ryans Road, Christchurch”
- Capture Land Development Consultants “Proposed Subdivision of Part Lot 3 and Lot 4 DP 22679, 104 Ryans Road, Harewood”

In addition, an assessment of rules and guidelines associated with lighting and applicable to the project was carried out.

Two site visits were undertaken on 9 December 2024 and 17 December 2024, covering both daytime and nighttime operations in the area. During the site visits, it was clear that the proximity to the airport and associated aeronautical activity were key considerations for the project, in particular the identification and control of effects to ensure safe take-off and landing operations.

Locations from which the site was observed in the context of the airport are summarised below in Figure 1.

Figure 1 - Site Visit Photo Counts

2. EXISTING SITE

2.1 LOCATION AND CONTEXT

The existing, undeveloped site, located at 104 Ryans Road, Christchurch is currently zoned Rural Urban Fringe (RuUF). It is bounded to the north and west by the Christchurch International Airport, zoned as Specific Purpose (Airport) Zone, and to the south and east by Ryans Road and Grays Road respectively, both of which are classified as Local Roads.

Pound Road to the west is currently classified as a Minor Arterial Road.

Adjacent sites beyond Pound Road to the west, Ryans Road to the south and Grays Road to the East are classified as RuUF (shown as green in Figure 2 and Figure 3 below). These sites are currently developed with a mixture of lifestyle/rural homes, paddocks, and associated outbuildings.

It is noted that there are lawfully established industrial/commercial activities on the sites at 614 Pound Road (outdoor storage and truckyard) and at 22 Ryans Road (wood incineration activity).

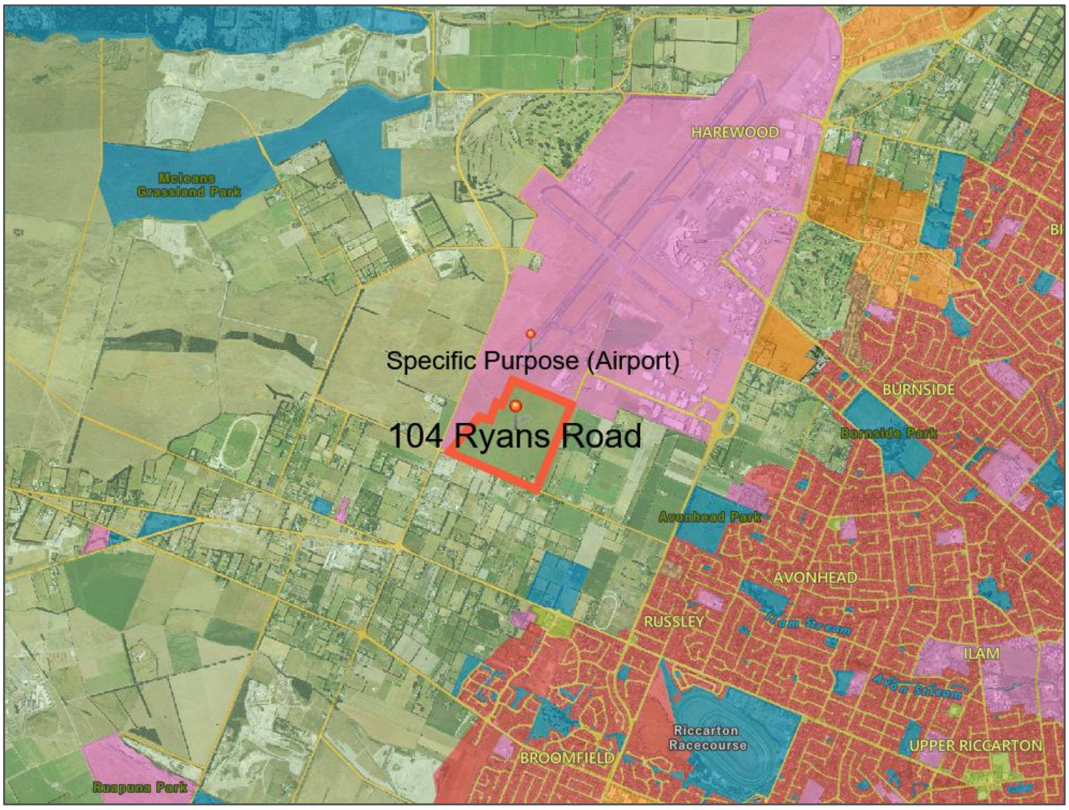

Figure 2 - Existing Site Locality Plan

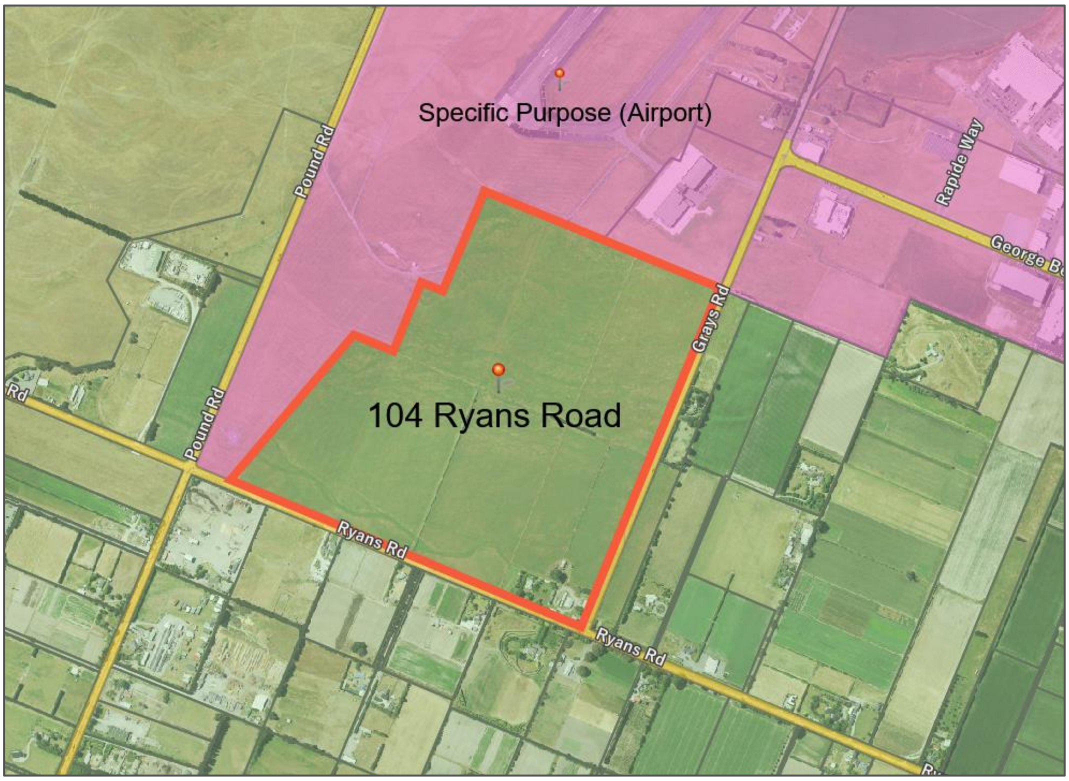

Figure 3 - Existing Site Locality Plan (Close)

2.2 LIGHTING ARRANGEMENT

Two site visits were undertaken (one during daylight hours and one after dark). Weather at the time of the inspections was generally as outlined below:

1. **12pm, 9 December 2024**

   Clear, 24°C, Visibility >10km, Wind 32km/h (N), First Quarter Moon (50%), Sunrise @ 5:41am, Sunset @ 9:01pm

2. **9pm, 17 December 2024**

   Clear, 11°C, Visibility >10km, Wind 22km/h (NE), Waning Gibbous Moon (98%), Sunrise @ 5:43am, Sunset @ 9:08pm

It was noted that there are no existing lighting installations within the proposed development area, however there are existing streetlights visible at the adjacent road intersections, and some adjacent residences and businesses.

As expected for the road and zone classifications, it was noted that none of the adjacent roads were lit with streetlighting, with the exception of the Ryans Road/Grays Road intersection as pictured below in Figure 5. The Pound Road/Ryans Road intersection has modern LED street lighting installed, however it was either turned off or non-operational at the time of inspection (refer to Figure 4). This may be an active operational decision due to the proximity to the airport runway, though that is unconfirmed.

Figure 4 - Pound Road/Ryans Road Intersection Lighting (Airport in Distance on Left)

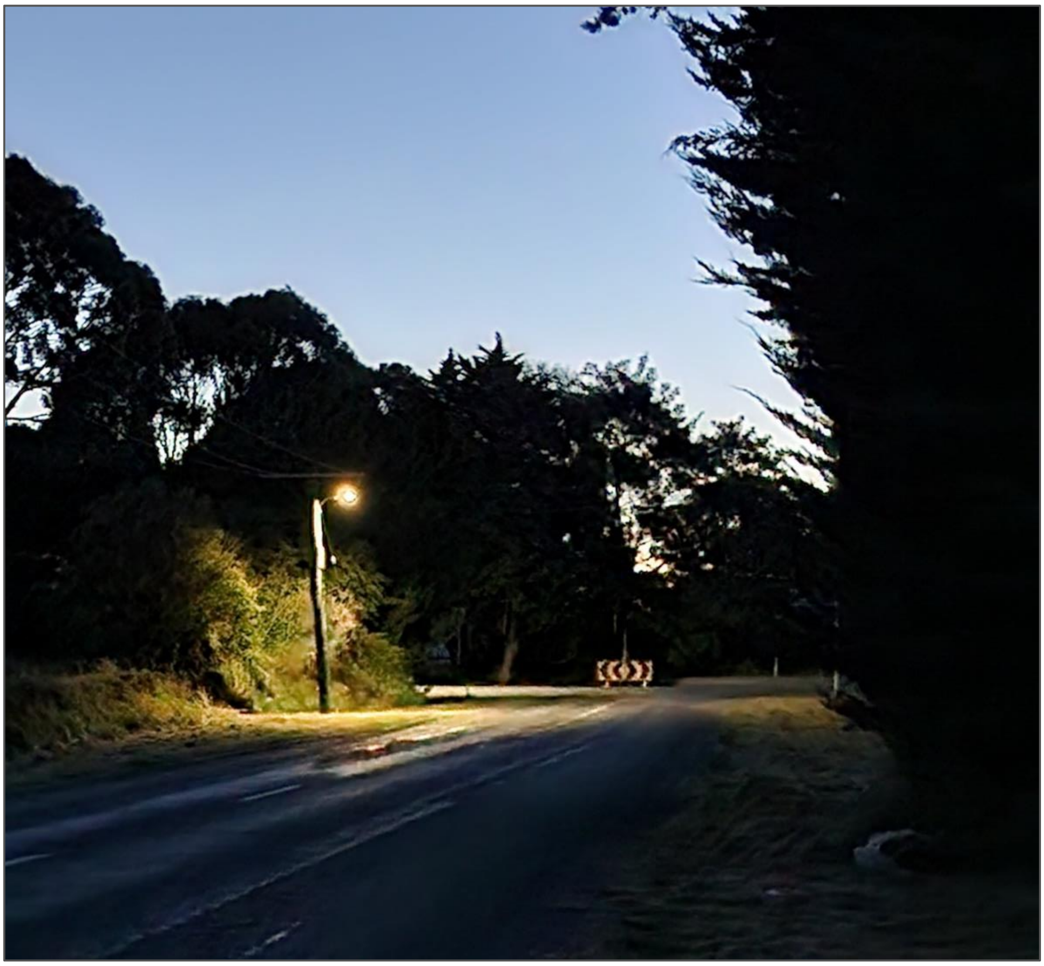

Figure 5 - Ryans Road/Grays Road Intersection Lighting

The most clearly visible adjacent installations are:

- GCH Aviation (Garden City Helicopters) at 73 Grays Road
- Christchurch International Airport at 30 Durey Road

The GCH Aviation building is particularly visible, with floodlit exterior areas, lit facades, internally illuminated and coloured signage and translucent cladding resulting in clearly visible glare and upward light. These existing effects are most visible from the east and west sides (from Pound Road and Grays Road), however illuminated signage on the southern side of the GCH building is also visible from the south and likely visible to residents along the southern side of Ryans Road. Refer to Figure 6 and Figure 7.

It should be noted that the GCH Aviation site is located within the Specific Purpose (Airport) Zone.

Refer also to Figure 8, Figure 9 and Figure 10 for further images, depicting the proposed development site in the context of the local environs, particularly the existing lighting associated with the airport terminal building.

Lighting also exists on the western façade of the Online Distribution Building at 98 Grays Road (refer to Figure 11). This appeared minor in the context of the other lighting in the area, and utilised well controlled, wall mounted, flat glass fittings of a warm colour temperature.

Limited visible lighting exists at adjacent properties along the southern side of Ryans Road.

Figure 6 - View of GCH Building from Pound Road Looking East

Figure 7 - View of GCH Building from Pound Road/Ryans Road Intersection Looking North East

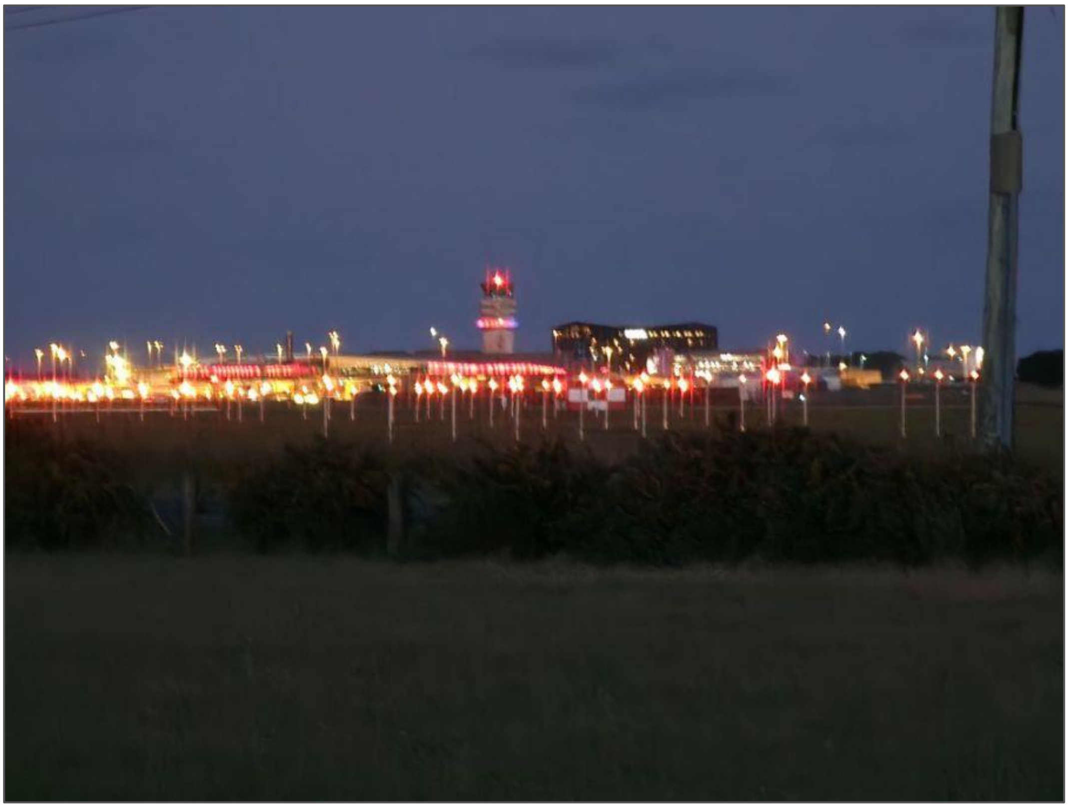

Figure 8 - View of CIAL Building from Pound Road/Ryan Road Intersection Looking North East

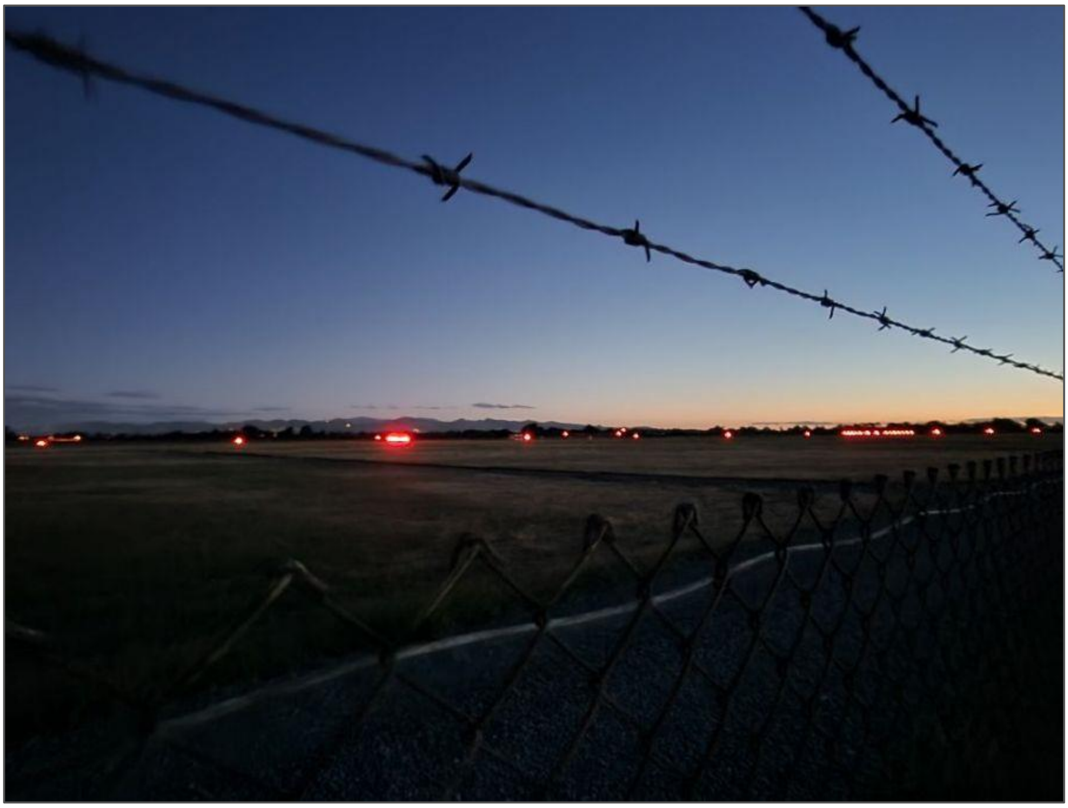

Figure 9 - View Across Proposed Site from Pound Road Looking South East

Figure 10 - View from Pound Road/Ryans Road Intersection Looking East/North East

Figure 11 - Western Facade of the Online Logistics Building as Viewed from Grays Road

3. PROPOSED SITE

3.1 SUBDIVISION AND LAYOUT

It is proposed to subdivide the existing site to permit industrial activities, generally consistent with the Industrial General Zone under the CDP. Development of the site will essentially be carried out in two phases as outlined below, with identified effects and proposed mitigations owned by the relevant party.

Phase	Activity	Who?
1	Initial subdivision of the land into smaller parcels. Roading and services installation including streetlighting.	Initial subdivision developer (Carter Group Limited)
2	Future development of individual lots and building construction.	Individual lot developer

It will be key to the success of this project that any identified effects and proposed mitigation measures are passed through to the developers of both the initial subdivision and individual lots.

A conceptual site plan can be found below in Figure 12.

Figure 12 - Proposed Subdivision (plan by Capture Land Development Consultants)

3.2 CONSTRUCTION LIGHTING

No construction, that would require the use of artificial lighting, is proposed to be carried out during the hours of darkness during the initial subdivision/land development activity (Phase 1).

The construction methodology for future individual lot development (Phase 2) is unknown, however it will be critical to the success of this project, that potential effects and mitigations are communicated to these Phase 2 developers through site specific assessments.

Amber flashers/warning lights are likely to be used during daytime construction for safety purposes.

3.3 PERMANENT LIGHTING

3.3.1 Street Lighting (Phase 1)

A transport report prepared by Nick Fuller of Novo Group has been reviewed (and should be read in conjunction with this report) and it is understood that new interior roads are proposed to be classified as local roads. For compliance with Christchurch City Council Infrastructure Design Standard Part 11 (Lighting), these roads should be lit to a minimum of Lighting Category PR4.

Table 3.3 of AS/NZS 1158.3.1:2020 (Lighting for roads and public spaces) specifies the following technical parameters for category PR4 roads in local areas:

- Average horizontal illuminance ≥1.3lux
- Point horizontal illuminance ≥0.22lux
- Illuminance (horizontal) uniformity ≤8

In addition, new street lighting would be added to each new intersection with Ryans Road and Grays Road at the entry points to the subdivision.

Street lighting within the subdivision is proposed to be designed to provide ≥1.3lux average (for compliance with PR4 categorisation), and ≤2.5lux maximum for roads within 500m of the runway (refer to Section 4.1.2 Christchurch District Plan Rules).

3.3.2 Individual Site Lighting (Phase 2)

Individual site lighting would be developed by each individual property developer separate to this application, however it would be expected that developers of individual sites may propose some or all of the following types of lighting for their individual developments:

- Exterior and yard lighting (including façades)
- Interior Lighting
- Illuminated Signage

The environmental effects of these expected lighting types are assessed in the following sections, and it will be critical to the success of this project, that effects and mitigations are communicated to these Phase 2 developers through site specific assessments.

4. LIGHTING EFFECTS

4.1 BASIS FOR ASSESSMENT (RULES & CONSTRAINTS)

4.1.1 Civil Aviation Authority Rules

The Civil Aviation Authority of New Zealand (CAA) is the government agency responsible for ensuring aviation safety and security in New Zealand. It oversees and regulates all aspects of civil aviation, aiming to protect people, property, and the environment.

Civil Aviation Rules (CAR) part 77 and 139 include rules regarding the use of lights within navigable airspace, including ground lights outside an aerodrome. CAA Advisory Circular AC139-6 issued 24 November 2021 provides an acceptable means of compliance with CAR139, and is an appropriate document against which to measure lighting in the vicinity of an airport.

Specifically, section 5.3 of AC139-6 states that:

- **5.3.1 Lights which may endanger the safety of aircraft**

  "A non-aeronautical ground light near an aerodrome which may endanger the safety of aircraft should be extinguished, screened or otherwise modified so as to eliminate the source of danger."

- **5.3.2 Lights which may cause confusion**

  "A non-aeronautical ground light which, by reason of its intensity, configuration or colour, might cause confusion or prevent the clear interpretation of aeronautical ground lights should be extinguished, screened or otherwise modified so as to eliminate such a possibility."

For the Christchurch International Airport, these rules apply particularly to the area as pictured in Figure 13 and Figure 15 (in yellow).

4.1.2 Christchurch District Plan Rules

The Christchurch District Plan (CDP) Chapter 6.3 Outdoor Lighting contains rules to achieve the following objective and policy:

- Chapter 6 General Rules and Procedures / 6.3 Outdoor Lighting / 6.3.2 Objectives and Policies

  6.3.2.1 Objective – Artificial outdoor lighting and glare

  "Artificial outdoor lighting enables night-time work, rural productive activities, recreation activities, sport, entertainment activities, transportation and public health and safety while:

  i. *managing adverse effects on residential, commercial, open space and rural amenity values; areas of natural, historic or cultural significance and the night sky; and*

  ii. *avoiding interference with the safe operation of transport and infrastructure."*

  6.3.2.1.1 Policy – Enabling night-time activity while managing the adverse effects of artificial outdoor lighting

  "*Recognise and provide for artificial outdoor lighting for night-time activities and safety while managing its scale, timing, duration, design and direction in a way that:*

  i. *avoids, remedies or mitigates adverse effects on the rest or relaxation of residents; or any areas of natural, historic or cultural significance;*

  ii. *does not interfere with the safe operation of the transport network or aircraft;*

iii. minimises unnecessary light spill into the night sky."

Given the location of the proposed site adjacent the Christchurch International Airport, the safe operation of transport and infrastructure is key.

The following specific sections from the CDP are particularly applicable.

- Chapter 6 General Rules and Procedures / 6.3 Outdoor Lighting / 6.3.4 Rules - Activity status tables - Control of glare

  6.3.4.5 Non-complying activities

  NC1 – "*Any activity that results in a greater than 2.5 lux spill (horizontal or vertical) into any land outside the Specific Purpose (Airport) Zone that is within 500 metres of the threshold of a runway at Christchurch International Airport."*

  NC2 – *"Any non-aeronautical ground lights in the areas shown in Appendix 6.11.7.4 that shine above the horizontal."*

The areas in which NC2 apply are illustrated below in Figure 13. Refer to Figure 15 for a combined sketch illustrating the areas affected by both NC1 and NC2.

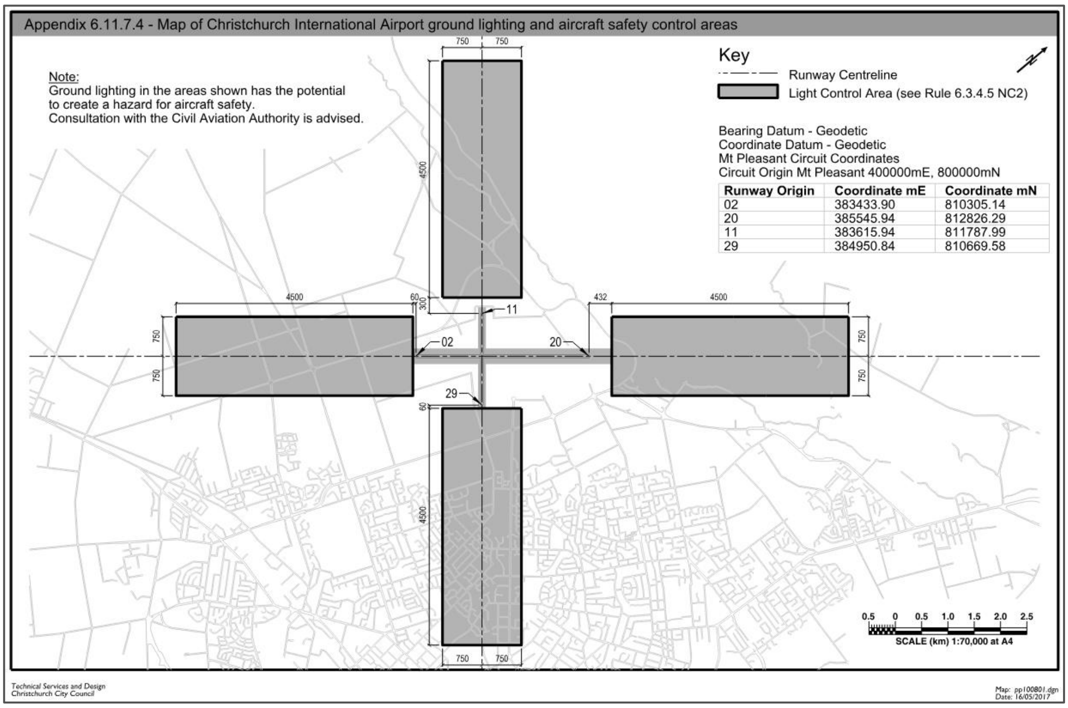

Figure 13 - Christchurch International Airport Light Control Areas per 6.3.4.5 NC2

In addition to Chapter 6.3, Chapter 6.7 Aircraft Protection also applies. The objective of this section of the Chapter is as follows:

- Chapter 6 General Rules and Procedures / 6.7 Aircraft Protection

  6.7.2.1 Objective - Safe and efficient aircraft operation

  a. *"Aircraft are able to safely and efficiently approach, land, take-off and depart from airports, airfields or helipads."*

Specifically:

- Chapter 6 General Rules and Procedures / 6.7 Aircraft Protection

  6.7.4.2.6 Prohibited activities

  PR4 – *"Production of direct light beams or reflective glare that could interfere with the vision of a pilot excluding:*

a. *normal operational reflection from glass and mirrors used in motor vehicles; and*

b. *normal operational light from motor vehicles."*

This applies to areas within the Runway End Protection Areas (REPA) as pictured below in Figure 14, and overlaid onto the proposed site in Figure 15.

Examples of lighting arrangements designed to limit direct glare are shown in Figure 17 and Figure 18.

Note that assessment of reflective glare is outside the scope of this artificial lighting AEE.

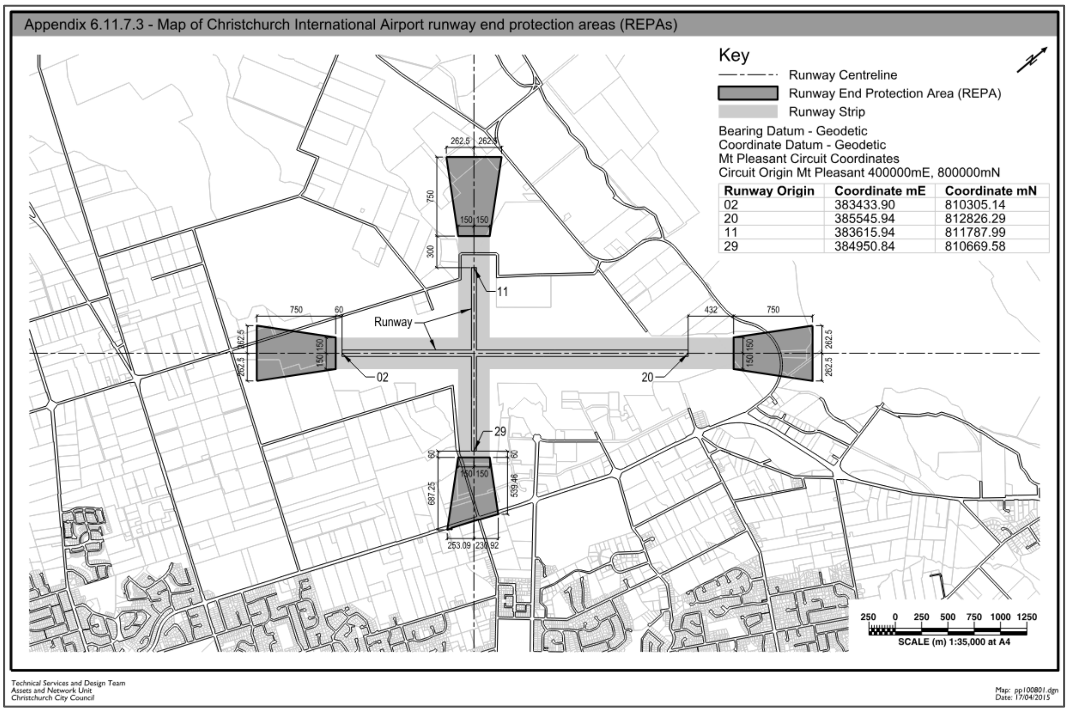

Figure 14 - Christchurch International Airport Runway End Protection Areas (REPA)

The zones referred to under 6.3.4.5 NC1 (blue) and NC2 (yellow), and 6.7.4.2.6 PR4 (red) above have been approximately marked on the proposed site within Figure 15 (below) for reference.

Figure 15 - Sketch of Areas Affected by 6.3.4.5 NC1 and NC2 and 6.7.4.2.6 PR1

Chapter 6.3 of the CDP also places other limits on the control of glare and spill light into neighbouring properties. Specifically:

- Chapter 6 General Rules and Procedures / 6.3 Outdoor Lighting / 6.3.4 Rules - Activity status tables - Control of glare

  6.3.4.1 Permitted activities

  P1 – *"Any activity involving artificial outdoor lighting, other than activities specified in Rule 6.3.4.5 NC1 or NC2."*

  Activity specific standards – *"All fixed exterior lighting shall, as far as practicable, be aimed, adjusted and/or screened to direct lighting away from the windows of habitable spaces of sensitive activities, other than residential units located in industrial zones, so that the obtrusive effects of glare on occupants are minimised."*

  "Artificial outdoor lighting shall not result in a greater than 2.5 lux spill (horizontal or vertical) into any part of a major arterial road or minor arterial road or arterial route identified in Appendix 7.5.12 where this would cause driver distraction."

- Chapter 6 General Rules and Procedures / 6.3 Outdoor Lighting / 6.3.5 Rules - Activity status tables - Control of Light Spill

  6.3.5.1 Permitted activities

  P1 – *"Any activity involving outdoor artificial lighting except as specified in Rule 18.4.1.1 P26."*

  Activity specific standards – *"Any outdoor artificial lighting shall comply… with the light spill standards in Rule 6.3.6 as relevant to the zone in which it is located, and; where the light from an activity spills onto another site in a zone with a more restrictive standard, the more restrictive standard shall apply to any light spill received at that site."*

Spill light limits for the **zones adjacent to the area proposed for development** are as summarised below based on CDP Table 6.3.6.1: Light Spill Standards by Zone:

- Specific Purpose (Airport) Zone – 20lux
- Rural zones, all other – 10lux

Compliance with these general clauses within CDP Chapter 6.3 will generally be achieved via careful design and selection of appropriate, modern LED exterior luminaires.

Rule 18.4.1.1 P26 is not relevant to this proposal.

In addition to Chapter 6.3, the CDP also contains the following rule regarding the design of parking and loading areas:

- Chapter 7 Transport / 7.4 Rules - Transport / 7.4.3 Standards - Transport

  7.4.3.6 Design of parking areas and loading areas

  "All non-residential activities with parking areas and/or loading areas used during hours of darkness (except hosted visitor accommodation or unhosted visitor accommodation)" shall maintain a minimum illumination *"level of two lux, with high uniformity, during the hours of operation."*

In areas affected by Rule 6.3.4.5 NC1 in addition to Rule 7.4.3.6 (ie. parking areas and loading areas within 500m of the runway), this equates to an illumination level of >2lux but <2.5lux, which is an unachieveably tight range, and too low for safe and effective loading activities. To manage these competing activities the following is proposed:

- Parking areas within 500m of the runway shall be illuminated to the same standard as the streetlighting within this zone (ie. PR4, >1.3lux average, <2.5lux maximum) to balance pedestrian and vehicular safety with the requirements of the CDP.
- Loading areas within 500m of the runway be precluded from operation outside daylight hours.

4.1.3 Standards, Guidelines and Best Practice

As noted in the previous section, compliance with the activity specific standards within CDP Rule 6.3.4.1 P1 can generally be achieved via careful design and selection of appropriate, modern LED exterior luminaires. However, current professional practice in evaluating the effects of artificial lighting goes beyond the CDP, requiring consideration of the additional impacts and mitigation strategies outlined in the latest version of AS/NZS 4282:2023. This is particularly applicable for this project given its proximity to the adjacent CIA.

Within section 6.3.7.1 (Matters of discretion – Amenity, applicable where compliance with Rule 6.2.4.1 P1 is not achieved) of the CDP, reference is made to AS 4282:1997 (Control of the Obtrusive Effects of Outdoor Lighting). This standard has now been superseded by AS/NZS 4282:2023. The updated standard refers to the United Nations Environment Program Convention on Migratory Species Resolution 13.5 (Light Pollution Guidelines for Wildlife), which urges parties to use the guidelines in order to minimise the impact of lighting on migratory animals. The guidelines endorse the use of the Australian National Light Pollution Guidelines for Wildlife.

The aim of the Australian National Light Pollution Guidelines is to assist in the management of artificial light such that wildlife is:

- Not disrupted within, or displaced from, important habitat
- Able to undertake critical behaviours such as foraging, reproduction and dispersal.

The guidelines state that they "… *do not infringe on human safety obligations. Where there are competing objectives for lighting, there may be a need for creative solutions that meet both human safety requirements for artificial light and threatened and migratory species conservation*".

The guidelines recognise that animals perceive light differently from humans, with most animals being sensitive to ultraviolet/violet/blue light. Figure 16 is taken directly from the guidelines (guidelines Figure 2) and illustrates comparative light perception among a selection of different species groups.

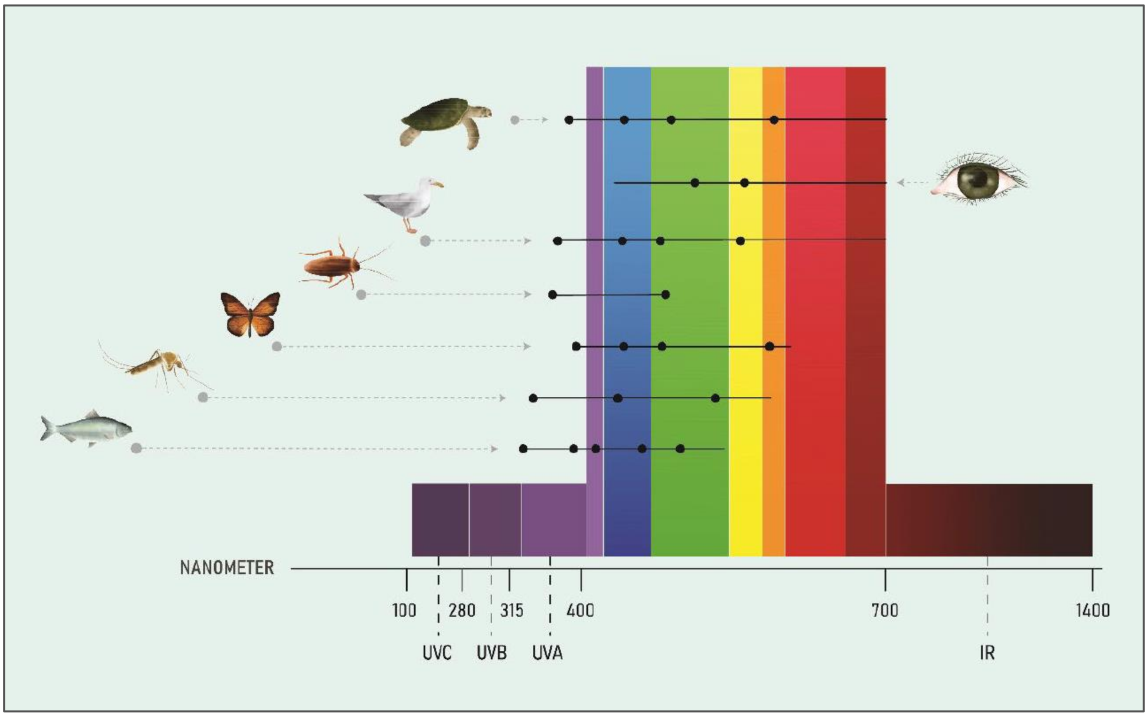

Figure 16: Comparative light perception among different species groups (peak sensitivity shown as black dots)

The guidelines recommend:

- Always using best practice lighting design to reduce light pollution and minimise the effect on wildlife.
- Undertaking an environmental impact assessment of effects of artificial light on listed species for which artificial light has been demonstrated to affect behaviour, survivorship or reproduction.

According to the guidelines, best practice lighting design incorporates the following design principles:

1. Start with natural darkness and only add light for specific purposes.
2. Use adaptive light controls to manage light timing, intensity and colour.
3. Light only the object or area intended – keep lights close to the ground, directed, and shielded to avoid light spill.
4. Use the lowest intensity lighting appropriate for the task.
5. Use non-reflective, dark-coloured surfaces.
6. Use lights with reduced or filtered blue, violet and ultraviolet wavelengths.

An environmental impact assessment (EIA) process is recommended if there are species that are known to be affected by artificial light within 20km of a project.

AS/NZS 4282:2023 Section 2 *"Potential Obtrusive Effects"*, provides a guide for the extent of potentially obtrusive effects of a lighting installation. This includes the following specific effects which will be used as a basis for this assessment.:

- Effects on residents

- Effects on transport systems (including users and signalling systems)
- Effects on the night sky and astronomy
- Cultural impacts
- Effects on flora and fauna

These effects are generally the result of the following:

- Spill light as defined by AS/NZS 4282:2023 as *“light emitted by a lighting installation that falls outside the boundaries of the property for which the lighting installation is designed”.*
- Glare as defined by AS/NZS 4282:2023 as a *“condition of vision in which there is discomfort or a reduction in ability to see, or both, caused by an unsuitable distribution or range of luminance, or to extreme contrasts in the field of vision.”*
- Sky Glow as defined by AS/NZS 4284:2023 as the, “b*rightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter), in the direction of observation.”*

Various Light Technical Parameters are documented in the standard to provide a basis for design and measurement of these effects. The recommended limits vary based on the Environmental Zone affected. For the purposes of this report, we have determined through site inspection and engineering judgement, that the following Environmental Zone would be appropriate for this project:

- **Environmental Zone A2**

  “Low district brightness. Sparsely inhabited rural and semi-rural areas. Generally roadways without streetlighting through suburban, rural or semi-rural areas other than intersections.”

In general, well designed exterior lighting utilising modern LED luminaires will meet the recommendations and limits within AS/NZS 4282:2023, such as that pictured below:

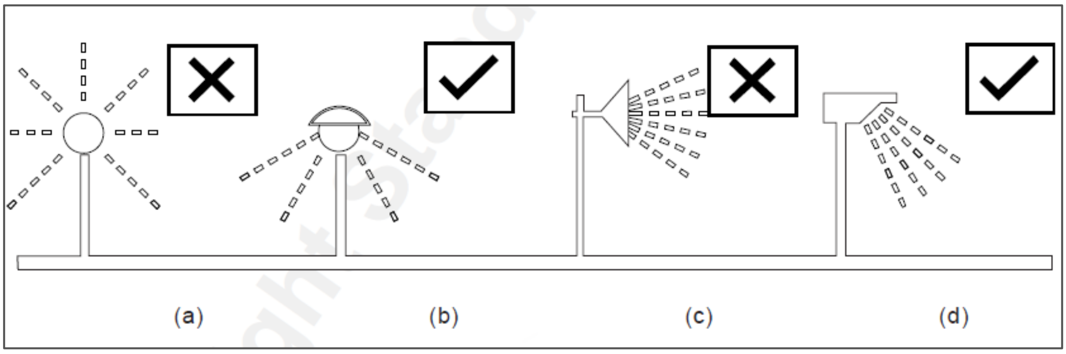

Figure 17 - Simplified Lighting Types and their Ability to Control Obtrusive Light (AS/NZS 4282:2023 Appendix A, Figure A1)

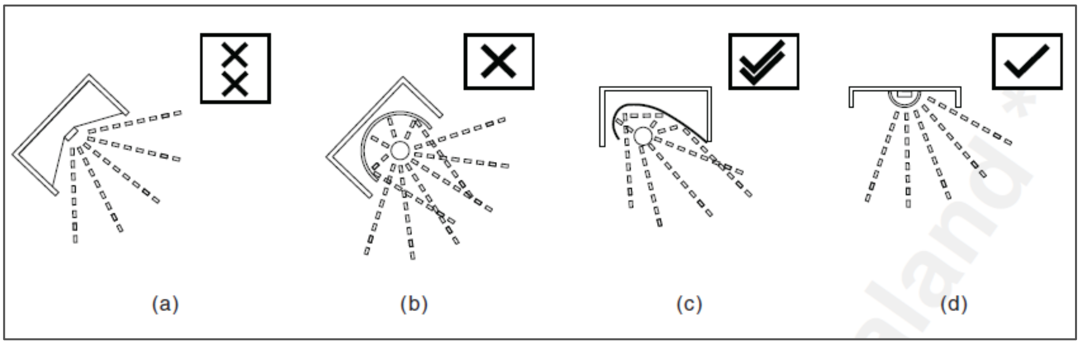

Figure 18 - Effect of the Light Distribution of the Luminaire on the Ability to Control Obtrusive Light (AS/NZS 4282:2023 Appendix A, Figure A2)

In addition to permanently installed exterior lighting, vehicle headlights, task lights, and safety lights (eg. Amber flashers) have the potential to cause effects, the extent of which depends on their intensity, aiming configuration, and location.

4.1.4 Environmental Impact Assessments

A memorandum has been provided by Pattle Delamore Partners (PDP) outlining the potential effects of artificial lighting on the avifauna, insect and other blue light sensitive species potentially impacted by outdoor lighting associated with the development of the proposed site, and recommending ways to minimise this impact. The full memorandum and accompanying recommendations can be found within Appendix C, with those directly relevant to this assessment summarised below.

- Use warm (≤3000K colour temperature) lighting, specifically avoiding the use of lighting within the white/blue spectrum.
- Use shielded, flat (0-5 degree tilt) fittings in order to minimise skyglow, glare and spill light.
- Utilise low mounting heights for parking areas and walkways.
- Use of motion sensors to activiate lights only when necessary.
- Use of non-reflective, dark colour surfaces to avoid reflected skyglow.

The memorandum notes that there are species within 20km of the site known to be sensitive to artificial lighting (as recommended with the Australian National Light Pollution Guidelines for Wildlife). The recommendations proposed within their memorandum would effectively control the impact of any identified effects of lighting to these species.

4.2 ASSESSMENT OF EFFECTS

4.2.1 Effect Severity Definitions

This assessment of environmental effects uses the following effect severity definitions, as informed by Quality Planning New Zealand in their AEE guidance.

Effect Severity	Description
Nil	No effects at all.
Less than minor	Effects that are discernible day-to-day effects, but too small to affect other persons.
Minor	Effects that are noticeable but will not cause any significant impacts.
More than minor	Effects that are noticeable that may cause an adverse impact but could be potentially mitigated or remedied.
Significant	An effect that is noticeable and will have a serious impact on the environment but could be potentially mitigated or remedied.
Unacceptable	Extensive adverse effects that cannot be avoided, remedied or mitigated.

Table 1 - Effect Severity Definitions

4.2.2 Assessment Summary

A summary of proposed effect mitigations can be found below. Refer to Appendix A for a matrix containing the full assessment of the environmental effects (lighting), and proposed mitigations.

Phase 1 mitigations are intended to be read as potential resource consent conditions appropriate for the initial development of the site.

Phase 2 mitigations set out in Table 2 (below) are examples only and intended to demonstrate that the potential effects of artificial lighting can be managed by future individual site developers. Some mitigations may not be appropriate, or required, for all sites within the subdivision. Instead, a site specific assessment of environmental effects for artificial lighting should be carried out by an appropriately experienced and qualified lighting designer, familiar with the airport environment, as an integral part of the development of each site. Mitigation measures should be put in place, as required to comply with the relevant lighting standards, to manage the effects identified in both this report, and the site specific report.

Remnant effects associated with the proposed development following implementation of the mitigations summarised in Table 2 (below) are assessed to be **no greater than minor**, on the basis that compliance with the CAA and CDP requirements is achievable.

Type	#	Proposed Mitigation	Phase 1	Phase 2 (subject to site specific assessment)
General	1	No construction during the hours of darkness.	✓	✓
	2	Consultation with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	✓	✓
	3	Consultation with effected neighbours regarding construction activities, if there is a specific need to undertake works at night.	✓	✓
	4	Compliance with glare and spill light limits at the adjacent RuUF and Specific Purpose (Airport) zones.	✓	✓
Streetlighting	5	Categorise roads within the development as local roads with a lighting category of no greater than PR4 (1.3lux minimum), and light to no greater than 2.5lux within 500m of the runway.	✓	
	6	Streetlights to be flat glass with zero upward component and installed without tilt.	✓	
	7	Utilise streetlighting of ≤3000K (warm) colour temperature.	✓	
	8	Utilise shielding to ensure spill light is controlled.	✓	
	9	Dim lights to achieve minimum required lighting levels, appropriate to the activity.	✓	
Exterior Lighting	10	No exterior lighting within 500m of the runway threshold, including façade and yard lighting.		✓
	11	All exterior lighting to be flat glass with zero upward component and installed without tilt.		✓
	12	No uplighting of façades or features to be undertaken.		✓
	13	No or very slow transition motion detection for all exterior lighting.		✓
	14	No coloured lighting.		✓
	15	No lighting of facades on the southern, western or northern sides of buildings (Grays Road side only).		✓
	16	Pedestrian and parking areas to be lit from bollards or low level lighting to minimise light source visibility.		✓

Type	#	Proposed Mitigation	Phase 1	Phase 2 (subject to site specific assessment)
	17	Utilise exterior and façade lighting of ≤3000K (warm) colour temperature.		✓
	18	Dim lights to achieve minimum required lighting levels, appropriate to the activity.		✓
	19	Utilise shielding to ensure spill light is controlled.		✓
	20	Use dark coloured non-reflective surfaces to minimise reflected upward light.		✓
	21	Light parking areas within 500m of the runway to PR4 standard (>1.3lux average, <2.5lux max).		✓
	22	Loading areas within 500m of the runway be precluded from operating outside daylight hours.		✓
Interior Lighting	23	Requiring tinted windows and blinds to be utilised in all spaces with the potential for visibility from exterior spaces.		✓
	24	Requiring tinted windows and blinds to be installed on all windows on all buildings within 500m of the runway threshold.		✓
	25	Requiring tinted windows and blinds to be installed on all windows on all buildings within the runway end light control area.		✓
	26	Requiring tinted windows and blinds to be installed on all windows on the southern, western and northern sides of buildings.		✓
	27	No roller shutter doors to be installed on the southern, western and northern sides of buildings.		✓
	28	Motion detection with very slow transition to be utilised in all interior spaces with the potential for visibility from the exterior.		✓
	29	No coloured lighting in spaces with the potential for visibility from the exterior.		✓
	30	Utilise interior lighting of ≤3000K (warm) colour temperature in interior spaces with the potential for visibility from the exterior.		✓
	31	No transparent or translucent façades.		✓
Illuminated Signage	32	No internally lit signage.		✓
	33	No illuminated signage within 500m of the runway.		✓
	34	Illuminated signage to be installed on the eastern side (Grays Road side) of buildings only.		✓
	35	All illuminated signage to be lit from above utilising flat glass fittings with zero upward component and no tilt.		✓
	36	Illuminated signage to be lit with lighting of ≤3000K (warm) colour temperature.		✓
	37	No transitioning signage or coloured lighting.		✓
	38	Dim lights to achieve minimum required lighting levels, appropriate to the activity.		✓

Table 2 - Effect Mitigation Summary

5. CONCLUSION

This assessment has considered the potential effects of artificial lighting associated with the proposed development at 104 Ryans Road and proposed a series of potential controls to mitigate the severity of those effects.

The mitigated effects have been found to be **no greater than minor** on the basis that compliance with the CAA and CDP requirements is achievable.

Construction of the initial subdivision (Phase 1) is proposed to be undertaken outside the hours of darkness. This removes the need for temporarily installed general area lighting. Flashing amber lights associated with daytime construction would be limited, and consultation with airport users is recommended to ensure any potential effects are mitigated.

Permanently installed lighting will include streetlighting installed during the initial land development and subdivision (Phase 1). Categorisation of the roads as Local Roads will enable lighting to category PR4 to be provided, allowing street lighting throughout the development, including within 500m of the runway threshold.

Future development of individual sites (Phase 2) will require careful controls on a per project basis. The identified Phase 2 mitigations demonstrate that the potential effects of artificial lighting can be managed by future individual site developers. A site specific assessment of environmental effects for artificial lighting should be carried out by an appropriately experienced and qualified lighting designer, familiar with the requirements of the CAA and CDP, as an integral part of the development of each site, and mitigation measures put in place to manage the effects identified in both this report, and the site specific report.

Careful and considered mitigation strategies, consent conditions, design, specification and construction will ensure that the identified effects are able to be managed.

APPENDICES

Appendix A Assessment of Effects Matrix

Effect Definitions

This assessment of environmental effects uses the following effects definitions, as informed by Quality Planning New Zealand in their AEE guidance.

Effect Severity	Description
Nil	No effects at all.
Less than minor	Effects that are discernible day-to-day effects, but too small to affect other persons.
Minor	Effects that are noticeable but will not cause any significant impacts.
More than minor	Effects that are noticeable that may cause an adverse impact but could be potentially mitigated or remedied.
Significant	An effect that is noticeable and will have a serious impact on the environment but could be potentially mitigated or remedied.
Unacceptable	Extensive adverse effects that cannot be avoided, remedied or mitigated.

Phase Definitions

Phases identified in the assessment matrix are defined as follows, effects and potential mitigations are owned by the identified party.

Phase	Activity	Who?
1	Initial subdivision of the land into smaller parcels. Services installation including streetlighting.	Initial subdivision developer
2	Future development of individual lots and building construction by others.	Individual lot developer

Assessment Matrix

Lighting Type	Phase	Lighting Subtype	Effect Type[3]	Identified Effect	Proposed Mitigation	Mitigated Severity
Existing[1]	-	-	Transport Systems and Users	-	-	-
			Flora & Fauna	-	-	-
			Night Sky and Astronomy	-	-	-
			Cultural[2]	-	-	-
			Residents	-	-	-
Construction	1	-	Transport Systems and Users	Construction lighting associated with vehicle headlights and area lighting results in glare to airport users including pilots and air traffic control.	No construction during hours of darkness.	Nil
				Construction lighting within 500m of the runway produces >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	No construction during hours of darkness.	Nil
				Construction lighting within the runway end light control area produces light above the horizontal plane in contravention of CDP Rule 6.3.4.3 NC2.	No construction during hours of darkness.	Nil
				Flashing construction lighting (eg. amber beacons) confused for ground control lights during nighttime construction.	No construction during hours of darkness. Consult with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	Less than minor
				Construction lighting associated with vehicle headlights and area lighting results in an increase in insect activity and associated insectivorous bird activity, increasing bird strike risk.	No construction during hours of darkness.	Nil
			Flora & Fauna	Construction lighting associated with vehicle headlights and area lighting results in an increase in insect activity and associated insectivorous bird activity.	No construction during hours of darkness.	Nil
			Night Sky and Astronomy	Construction lighting produces light above the horizontal plane, increasing sky glow and blue light component.	No construction during hours of darkness.	Nil
			Cultural[2]	-	-	-
			Residents	Lighting from construction activities is noticed by nearby residents.	No construction during the hours of darkness.	Nil

Permanent	1	Street	Transport Systems and Users	Street lighting within 500m of the runway produces >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	Categorise roads within the development as local roads with a lighting category of no greater than PR4 (1.3lux minimum), and light to no greater than 2.5lux within 500m of the runway.	Nil
				Street lighting within the runway end light control area produces light above the horizontal plane in contravention of CDP Rule 6.3.4.3 NC2.	Streetlights to be flat glass with zero upward component, and installed without tilt.	Nil
				Street lighting within the runway end light control area increases insect activity and associated insectivorous bird activity, thereby increasing bird strike risk.	Utilise streetlighting of ≤3000K (warm) colour temperature, flat glass with zero upward component, and installed without tilt. Dim lights to achieve minimum required lighting levels.	Minor
				Street lighting in a previously unlit area close to the airport runway results in complaints from pilots, air traffic controllers and other airport users.	Consult with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	Less than minor
			Flora & Fauna	High blue light component in LED streetlighting increases insect activity, associated insectivorous bird activity and other avifauna sensitive to blue spectrum lighting.	Utilise streetlighting of ≤3000K (warm) colour temperature.	Less than minor
				Light spill and upward light causes disruption to nocturnal birds.	Streetlights to be flat glass with zero upward component, and installed without tilt. Utilise shielding to ensure spill light is controlled. Dim lights to achieve minimum required lighting levels.	Nil
			Night Sky and Astronomy	Upward component of lighting results in increased sky glow and increased blue spectrum component, affecting astronomical observance.	Utilise streetlighting of ≤3000K (warm) colour temperature, flat glass with zero upward component, and installed without tilt.	Nil
			Cultural[2]	-	-	-
			Residents	Residents adjacent to the site notice the addition of lit roads within the development.	Compliance with CDP rules related to outdoor lighting limiting glare and spill light.	Nil
	2	Exterior and Facade	Transport Systems and Users	Exterior and facade lighting within 500m of the runway produces >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	No exterior lighting within 500m of the runway, including façade and yard lighting.	Nil
				Exterior and facade lighting within the runway end light control area produces light above the horizontal plane in contravention of CDP Rule 6.3.4.3 NC2.	All exterior lighting to be flat glass with zero upward component, and installed without tilt. No uplighting of facades or features to be undertaken.	Nil
				Flashing, coloured or quickly changing exterior or façade lighting confused for ground control lights.	No or very slow transition motion detection for all exterior lighting. No coloured lighting.	Less than minor
				Exterior or façade lighting results in glare to airport users including pilots and air traffic control.	All exterior lighting to be flat glass with zero upward component, and installed without tilt. No uplighting of facades or features to be undertaken. No lighting of facades on the southern, western or northern sides of buildings. Pedestrian and parking areas to be lit from bollards or low level lighting to minimise light source visibility.	Less than minor
				Exterior lighting in a previously unlit area close to the airport runway results in complaints from pilots, air traffic controllers and other airport users.	Consult with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	Less than minor
				Exterior and façade lighting within the runway end light control area increases insect activity and associated insectivorous bird activity, thereby increasing bird strike risk.	Utilise exterior and façade lighting of ≤3000K (warm) colour temperature, flat glass with zero upward component, and installed without tilt. Dim lights to achieve minimum required lighting levels.	Minor
				Parking areas within 500m of the runway produce >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	Light parking areas within 500m of the runway to PR4 standard (>1.3lux average, <2.5lux max).	Less than minor
				Loading areas within 500m of the runway produce >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	Loading areas within 500m of the runway be precluded from operation outside daylight hours.	Nil
			Flora & Fauna	High blue light component in LED lighting increases insect activity, associated insectivorous bird activity and other avifauna sensitive to blue spectrum lighting.	Utilise exterior and façade lighting of ≤3000K (warm) colour temperature.	Less than minor
				Light spill and upward light causes disruption to nocturnal birds.	All exterior lighting to be flat glass with zero upward component, and installed without tilt. Utilise shielding to ensure spill light is controlled. Pedestrian and parking areas to be lit from bollards or low level lighting to minimise light spill.	Less than minor
			Night Sky and Astronomy	Upward component of lighting (direct or reflected) results in increased sky glow and increased blue spectrum component, affecting astronomical observance.	All exterior lighting to be flat glass with zero upward component, and installed without tilt. Dark coloured, non-reflective surfaces to be utilised.	Nil
			Cultural[2]	-	-	-

			Residents	Residents adjacent to the site notice the addition of exterior lighting within the development.	Compliance with CDP rules related to outdoor lighting limiting glare and spill light.	Nil
	2	Interior	Transport Systems and Users	Interior lighting penetrating through glazing within 500m of the runway produces >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	Tinted windows and blinds to be installed on all buildings within 500m of the runway. Motion detection to be utilised in all interior spaces with the potential for visibility from the exterior. No transparent or translucent façades.	Less than minor
				Interior lighting penetrating through glazing within the runway end light control area produces light above the horizontal plane in contravention of CDP Rule 6.3.4.3 NC2.	Tinted windows and blinds to be installed on all buildings within the runway end light control area. Motion detection to be utilised in all interior spaces with the potential for visibility from the exterior. No transparent or translucent façades.	Less than minor
				Flashing, coloured or quickly changing interior lighting penetrating through glazing confused for ground control lights.	Very slow transition motion detection for all interior lighting with the potential for visibility from exterior spaces. No coloured lighting in spaces with the potential for visibility from the exterior.	Less than minor
				Interior lighting penetrating through glazing or open roller shutter doors results in glare to airport users including pilots and air traffic control.	Tinted windows and blinds to be installed on all windows on the southern, western and northern sides of buildings. No roller shutter doors to be installed on the southern, western and northern sides of buildings. Motion detection to be utilised in all interior spaces with the potential for visibility from the exterior. No transparent or translucent façades.	Minor
				Visible interior lighting in a previously unlit area close to the airport runway results in complaints from pilots, air traffic controllers and other airport users.	Consult with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	Less than minor
				Interior lighting penetrating through glazing results in increased visible exterior lighting, increased insect activity and associated increased insectivorous bird activity, increasing bird strike risk.	Tinted windows and blinds to be utilised in spaces with the potential for visibility from exterior spaces. Motion detection to be utilised in all interior spaces with the potential for visibility from the exterior.	Less than minor
			Flora & Fauna	High blue light component in interior LED lighting visible through exterior glazing increases insect activity, associated insectivorous bird activity and other avifauna sensitive to blue spectrum lighting.	Utilise interior lighting of ≤3000K (warm) colour temperature in interior spaces visible through glazing. Tinted windows and blinds to be utilised in spaces with the potential for visibility from exterior spaces.	Less than minor
				Interior lighting penetrating through glazing results in light spill and upward light causing disruption to nocturnal birds.	Tinted windows and blinds to be utilised in spaces with the potential for visibility from exterior spaces. Use of dark coloured, non-reflective surfaces.	Less than minor
			Night Sky and Astronomy	Interior lighting penetrating through glazing results in upward lighting increasing sky glow and blue spectrum lighting, affecting astronomical observance.	Tinted windows and blinds to be utilised in spaces with the potential for visibility from exterior spaces. Use of dark coloured, non-reflective surfaces.	Less than minor
			Cultural[2]	-	-	-
			Residents	Residents adjacent to the site notice the addition of lit interiors within the development.	Motion detection to be utilised in all interior spaces with the potential for visibility from the exterior. Compliance with CDP rules related to glare and spill light.	Less than minor
	2	Illuminated Signage	Transport Systems and Users	Illuminated signage within 500m of the runway produces >2.5 lux spill in contravention of CDP Rule 6.3.4.5 NC1.	No illuminated signage within 500m of the runway.	Nil
				Illuminated signage within the runway end light control area produces light above the horizontal plane in contravention of CDP Rule 6.3.4.3 NC2.	All illuminated signage to be lit from above. No internally lit signage.	Nil
				Flashing, coloured or quickly changing illuminated signage confused for ground control lights.	No transitioning signage or coloured lighting.	Less than minor
				Illuminated signage results in glare to airport users including pilots and air traffic control.	All illuminated signage to be lit from above utilising flat glass fittings with zero upward component and no tilt. Illuminated signage to be installed on the eastern side (Grays Road side) of buildings only.	Nil
				Illuminated signage in a previously unlit area close to the airport runway results in complaints from pilots, air traffic controllers and other airport users.	Consult with CAA and CIAL prior to construction, informing them of the proposed activity and demonstrate planned lighting control measures for their endorsement. Consider additional controls proposed by those parties.	Less than minor
				Illuminated signage within the runway end light control area increases insect activity and associated insectivorous bird activity, thereby increasing bird strike risk.	Illuminated signage to be lit with lighting of ≤3000K (warm) colour temperature, flat glass with zero upward component, and installed without tilt. Dim lights to achieve minimum required lighting levels.	Less than minor

			Flora & Fauna	High blue light component in LED lighting associated with illuminated signage increases insect activity, associated insectivorous bird activity and other avifauna sensitive to blue spectrum lighting.	Illuminated signage to be lit with lighting of ≤3000K (warm) colour temperature.	Less than minor
				Light spill and upward light causes disruption to nocturnal birds.	All illuminated signage to be lit from above utilising flat glass fittings with zero upward component and no tilt.	Nil
			Night Sky and Astronomy	Upward component of lighting (direct and reflected) results in increased sky glow and increased blue spectrum component, affecting astronomical observance.	All illuminated signage to be lit from above utilising flat glass fittings with zero upward component and no tilt.	Nil
			Cultural[2]	-	-	-
			Residents	Residents adjacent to the site notice the addition of illuminated signage within the development.	Compliance with CDP rules related to illuminated signage.	Less than minor

1. There is no existing lighting within the proposed development area, beyond the minor street lighting at the existing intersections. It is assessed that the existing lighting has Nil effects across all categories.
2. Consultation with Ngai Tūāhuriri Rūnanga and Te Taumutu Rūnanga has been conducted via Mahaanui Kurataiao prior to lodgement. Neither Rūnanga raised concerns about lighting effects on cultural values and no further effects on cultural values have been identified.
3. Effect types as defined by AS/NZS 4282:2023, and then further grouped and refined.

Appendix B Glossary of Lighting Terms

The following simple definitions are based upon those within AS/NZS 4282:2023 "*Control of the obtrusive effects of outdoor lighting"* and apply to terms used in this report:

- **Asymmetric and Symmetrical Light Distribution**

  The term asymmetric light output is the term to describe a system where light is directed sideways (or in an asymmetric pattern). Symmetrical lighting in comparison spreads the light equally in all directions.

- **Backlight Shields**

  Backlight shields are barriers mounted on or in the luminaire to minimise light spilling behind the primary aiming direction of the light.

- **Environment Impact Assessment (EIA)**

  An environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, considering the inter-related socio-economic, cultural and human safety impacts, both beneficial and adverse.

- **Glare**

  Condition of vision in which there is discomfort or a reduction in the ability to see, or both, caused by an unsuitable distribution or range of luminance, or extreme contrasts in the field of vision.

  The two terms that are normally used to describe the effects of glare on the ability to see are *disability* and *discomfort*.

  - **Disability Glare**

    Glare that impairs the visibility of objects without necessarily causing discomfort.

    A typical example of *disability* glare is the glare from approaching headlights on the open highway at night, which prevent anything else being seen on the road. The eye is unable to adapt to the bright headlight and to the significantly lower brightness on the road at the same time. Hence the glare is having a disabling effect. This disabling effect is related to the intensity of the source in the direction of the eye with respect to the brightness of the surroundings. As a comparison, the same car approaching with its headlights on during the day would cause almost no disability because of the brightness of the surroundings.

  - **Discomfort Glare**

    Glare that causes discomfort without necessarily impairing the visibility of objects.

    An example of discomfort glare is a bright sky on a sunny day can cause discomfort, particularly to those used to wearing sunglasses who are without them, however the ability to see is not impaired.

  The key difference between the two is that disability glare has a physiological effect and can be objectively measured, whereas discomfort glare has a psychological effect and is much more subjective. What may not cause discomfort to one person may cause significant discomfort to another person.

  Both *disability* and *discomfort* glare may be present concurrently.

- **Illuminance**

The measure of illumination level, which is the amount of light or luminous flux (i.e. Lumens) incident on a surface, per unit area, measured in Lux (1 Lux = 1 Lumen /m²).

- **Luminaire**

  The international term for a lighting fitting, which is the assembly that contains a light source and distributes the light output.

- **Luminance**

  The measure of brightness, which is a function of concentration or density of luminous intensity (i.e. Candelas) in a given direction per unit area, measured in Candela/m² (Cd/m²).

- **Lux**

  The International System (SI) unit of illuminance and luminous emittance, measuring luminous flux per unit area. It is equal to one lumen per square metre.

- **Skyglow**

  The brightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter), in the direction of observation.

  It comprises two separate components as follows:

  - **Natural Sky Glow**

    That part of the sky glow that is attributable to radiation from celestial sources and luminescent processes in Earth's upper atmosphere.

  - **Man-Made Sky Glow**

    That part of the sky glow that is attributable to man-made sources of radiation (e.g. outdoor lighting).

- **Spill Light**

  Light emitted by a lighting installation that falls outside the boundaries of the property for which the lighting installation is designed.

Appendix C PDP Memorandum “Lighting Management for Aerial Fauna – 104 Ryans Road”

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memorandum

TO	Tim Carter	FROM	Wayne Westcott and Lizzie Civil
	Carter Group Limited	DATE	4 March 2025
RE	Lighting Management for Aerial Fauna – 104 Ryans Road		

1.0 Introduction

Carter Group Limited (CGL) is applying for resource consent to develop land for industrial land-use at 104 Ryans Road (the site), Yaldhurst, Christchurch. The 55.5 ha site is located south of Christchurch International Airport Limited (CIAL), 170 m from the threshold of runway 02. The site is currently covered by rank grass, shrubs and larger trees, with multiple old, abandoned buildings present. The proposed development will include the establishment of industrial activities including logistics, warehousing, light manufacturing, and other airport-related businesses.

The site is subject to bird strike management provisions in accordance with the Christchurch City District Plan (CCDP) due to it being within 3 km of CIAL. This requires land use activities on the site, that have the potential to attract or influence avifauna species, to be mitigated and managed to reduce operational bird strike risks on CIAL. Additionally, most of the site is within the CIAL Ground and Lighting Safety Control Areas as per Appendix 6.11.7.4 of the CCDP. This indicates that the site is subject to several lighting rules to ensure operational activities at CIAL are not affected.

Pattle Delamore Partners (PDP)[1] has undertaken desktop and onsite avifauna assessments to inform the Fast-track application through the formation of two technical memorandums:

1. Avifauna Hazard Management – 104 Ryans Road (PDP, 2025); and
2. Lighting Management for Aerial Fauna – 104 Ryans Road (this memorandum).

These included broadscale habitat mapping, bird counts, and an avifauna risk assessment to determine potential effects on avifauna populations. The Avifauna Hazard Management memorandum (PDP, 2025) concluded that the development has the likelihood of decreasing overall bird activity with a reduction in grass, tree and derelict habitats. There is potential that urban bird species activity will increase with the development of industrial roof tops, but this risk will be managed through the implementation of a Wildlife Hazard Management Plan (WHMP). As part of this report regarding Lighting Management for Aerial Fauna, PDP also assessed potential bird species within 20 km of the project area, following the National Light Pollution Guidelines for Wildlife (Department of Environment and Energy (Australia), 2020) who recommend an environmental impact assessment if there are species that are known to be affected by artificial light within 20 km of a project.

[1] Appendix A contains information on the experience of PDP staff involved in providing avifauna advice contained in this memorandum for 104 Ryans Road Fast-track application.

This technical memorandum is supplementary to the Avifauna Hazard Management memorandum (PDP, 2025) and provides recommendations for lighting at the proposed development site in respect to aerial fauna. Its primary purpose is to inform ways to manage avifauna that may frequent the site and its surroundings through informing potential lighting designs for the site and subsequently reduce the risk of bird strike at CIAL. Impacts on insect and bat populations were also considered to ensure a holistic assessment of all flying fauna that may increase the risk to operations at CIAL.

2.0 Existing Environment

2.1 Avifauna

The avifauna assessments and a desktop review identified potential bird habitat on and surrounding the site. These included open pasture, rank grass, shrubs and exotic tree clumps, golf courses, waterbodies including wetlands and Waimakariri River located 6 km north of the site (see Appendix B in PDP, 2025) and the coast approximately 20 km to the east of the site. The proposed development will alter the current habitat onsite and, in doing so, likely alter wildlife behaviour.

PDP bird counts identified 14 bird species on and around the site (italicised common name in Table 1). These included four New Zealand endemics: long-tailed cuckoo (*Eudynamys taitensis*), pūkeko (*Porphyrio melanotus)*, South Island pied oystercatcher (*Haematopus finschi*), and swamp harrier (*Circus approximans*). A desktop review of annual bird checklists for CIAL showed a total of 33 species have been observed near the site (Cornell Lab of Ornithology, 2024) (Table 1).

Bird species that may be influenced by light emanating from the proposed development include migratory seabirds, wetland birds, fledglings, and those that forage at night. Although lighting could cause strike risk with all bird species, endemic and protected species should be analysed due to their protection levels, further discussed in Section 4.0.

Note: in Table 1 below, species that forage at night are identified as [2] and native species are identified as [3]

Table 1: Avifauna observations at the site and desktop records from the CIAL

Common Name	Scientific Name	NZ Threat Classification Status (Robertson et al., 2021)
African collard-dove	*Streptopelia roseogrisea*	Introduced and Naturalised
Australian magpie, Makipai	*Gymnorhina tibicen*	Introduced and Naturalised
Australasian swamphen, pūkeko[3]	*Porphyrio melanotus*	Not Threatened
Black-billed gull, tarāpuka[2 3]	*Chroicocephalus bulleri*	At-risk – Declining
Black shag, māpunga[2 3]	*Phalacrocorax carbo*	At-risk – Relict
California quail, Tikaokao	*Callipepla californica*	Introduced and Naturalised
Canadian goose[2]	*Branta canadensis*	Introduced and Naturalised
Cattle egret[3]	*Bubulcus ibis*	Migrant
Chaffinch, pahirini	*Fringilla coelebs*	Introduced and Naturalised
Common pheasant	*Phasianus colchicus*	Introduced and Naturalised
Common redpoll	*Acanthis flammea*	Introduced and Naturalised
Common starling, Tāringi	*Sturnus vulgaris*	Introduced and Naturalised
Dunnock	*Prunella modularis*	Introduced and Naturalised
Eurasian blackbird, Manu pango	*Turdus merula merula*	Introduced and Naturalised
Eurasian skylark, kairaka	*Alauda arvensis*	Introduced and Naturalised
European goldfinch, Kōurarini[2]	*Carduelis carduelis*	Introduced and Naturalised
European greenfinch[2]	*Chloris chloris*	Introduced and Naturalised
House sparrow, Tiu	*Passer domesticus*	Introduced and Naturalised
Long-tailed cuckoo, koekoeā[3]	*Eudynamys taitensis*	Nationally Vulnerable
Mallard Duck	*Anas platyrhynchos*	Introduced and Naturalised
New Zealand pigeon, Kererū[3]	*Hemiphaga novaeseelandiae*	Not Threatened
New Zealand fantail, Pīwakawaka[3]	*Rhipidura fuliginosa*	Not Threatened
Paradise shelduck, Pūtangitangi[2]	*Tadorna variegata*	Not Threatened
Pied stilt, poaka[3]	*Himantopus himantopus*	Not Threatened
Rock pigeon, kererū	*Columba livia*	Introduced and Naturalised
Silvereye, Tauhou	*Zosterops lateralis*	Not Threatened
Song thrush, Manu-kai-hua-rakau	*Turdus philomelos*	Introduced and Naturalised
Southern black-backed gull, karoro[2 3]	*Larus dominicanus*	Not Threatened
South Island pied oystercatcher, tōrea [2 3]	*Haematopus finschi*	At-risk – Declining
Spur-winged plover[2]	*Vanellus miles*	Not Threatened

Table 1: Avifauna observations at the site and desktop records from the CIAL

Common Name	Scientific Name	NZ Threat Classification Status (Robertson et al., 2021)
Sulphur-crested cockatoo	*Cacatua galerita*	Introduced and Naturalised
Swamp harrier, kāhu[3]	*Circus approximans*	Not Threatened
Welcome swallow, Warou	*Hirundo neoxena*	Not Threatened
Yellowhammer	*Emberiza citrinella*	Introduced and Naturalised

2.2 Insects

A desktop review of research grade iNaturalist observations within 5 km of the site indicated a total of 570 species recorded since 2015. Approximately 16% of the species identified are nocturnal and are attracted to light. These species included, amongst others, the nocturnal wēta (*Halmus chalybeus*) and huhu beetles (*Prionoplus reticularis*), and various moths such as the slender owlet moth (*Rhapsa scotosialis*). Insects are a potential food source and attractant of birds.

2.3 Bats

Bat species in New Zealand are limited to three species: long-tailed bat (*Chalinolobus tuberculatus*), lesser short-tailed bat (*Mystacina tuberculata*), and greater short-tailed bat (*M. robusta*) (ECan, 2000). It is understood that greater short-tailed bat is likely extinct based on it last being identified in 1967 (O'Donnell et al., 2023). A study undertaken by the Department of Conservation (DoC) for ECan in 2000 indicated that of the two extant bat species, only the long-tailed bat is known from Canterbury. A steady decline in long-tailed bat numbers has occurred since the 1990s and it appears to be locally extinct in Christchurch and Banks Peninsula areas based on most recent monitoring data (ECan, 2000).

DoC bat records for Christchurch (updated November 2024) and iNaturalist research grade data within 10 km of the site were reviewed to identify potential bat species presence. No bat species were recorded in either database. According to Canterbury Maps the closest long-tailed bat roosting site is located 109 km southwest of the site (ECan, 2024).

In summary, based on the available information, it is unlikely that bats frequent the site or will be influenced by light emanating from it.

3.0 Christchurch City District Plan

3.1 Outdoor lighting requirements

CCDP Chapter 6.3 '*outdoor lighting*' was reviewed to determine the specific outdoor lighting requirements for the site. The objective and policy of the rules seek to manage adverse effects on the surrounding natural and anthropogenic environments and avoid "interference with the safe operation of transport and infrastructure". Table 2 presents light-related Rules applicable to the site. Figure 1 illustrates the proposed development in the CIAL Ground Lighting and Aircraft Safety Control Areas.

Table 2: CCDP activities relevant to the lighting of the site

Activity		Rationale
Rule 6.3.4.5 Non-complying Activities		
NC1	“*Any activity that results in a greater than 2.5 lux spill (horizontal or vertical) into any land outside the Specific Purpose (Airport) Zone that is within 500 metres of the threshold of a runway at Christchurch International Airport*.”	The northwestern corner of the site falls within a 500 m radius of runway 2/20 threshold. Lights that exceed the 2.5 lux spill threshold will trigger this rule.
NC2	“*Any non-aeronautical ground lights in the areas shown in Appendix 6.11.7. that shine above the horizontal*.”	The majority of the proposed development falls within the CIAL Ground Lighting and Aircraft Safety Control Areas (Figure 1). Lights that shine above the horizontal will trigger this rule.

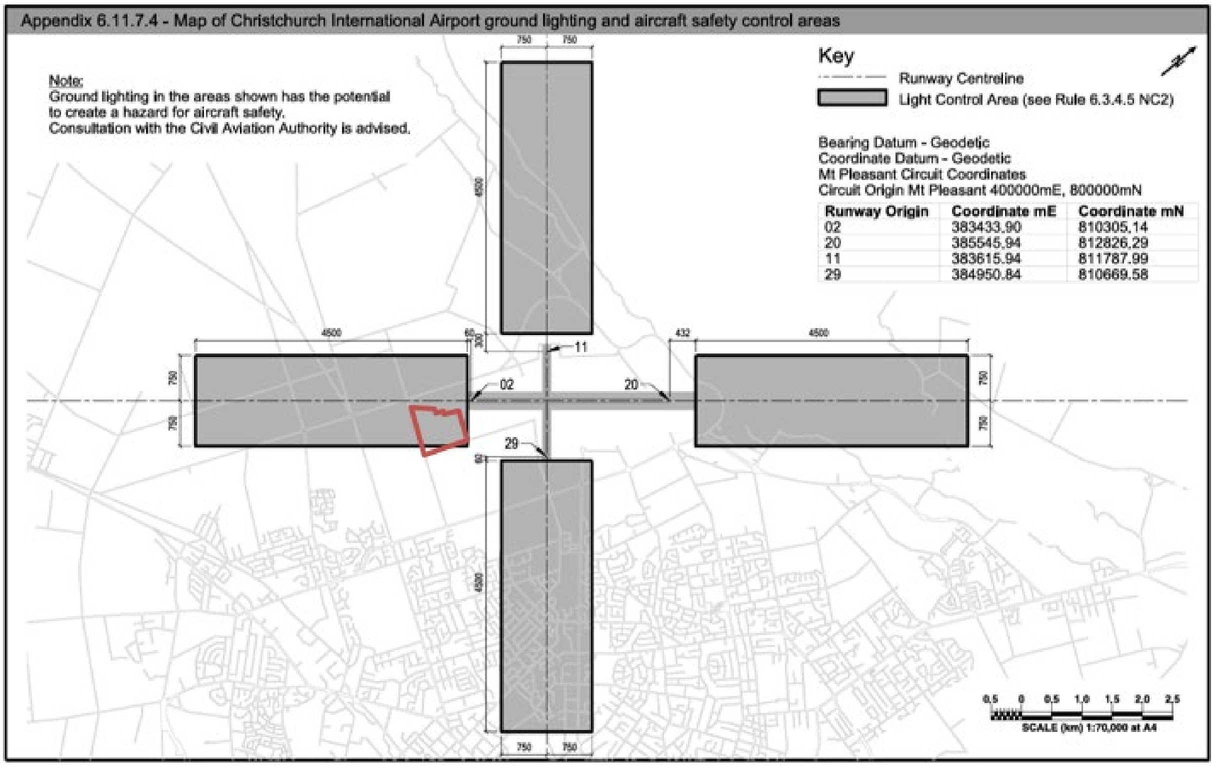

Figure 1: Map of Christchurch International Airport Ground Lighting and Aircraft Safety Control Areas (CCC, 2017). Red polygon shows approximate location of project site at 104 Ryans Road.

3.2 Aircraft protection

Chapter 6.7 ‘*aircraft protection*’ was reviewed to identify any lighting requirements for aircraft to be able to “*safely and efficiently approach, land, take-off and depart from airports*” (CCC, 2017). Table 3 presents light-related prohibited activities within the CIAL Runway End Protection Areas (REPAs). It is understood that the site has prohibited the development of particular buildings/structures within the REPAs which are within the proposed development site (Figure 2). The applicable rule has been included below to ensure an accurate presentation of available information.

Table 3: Lighting rules and prohibited activities associated with Christchurch International Airport

Activity		**Rationale**
Rule 6.7.4.2.6 Prohibited Activities		
PR4	*"Production of direct light beams or reflective glare that could interfere with the vision of a pilot excluding:* *a) normal operational reflection from glass and mirrors used in emergency motor vehicles; and* *b) normal operational light from motor vehicles.* *Advice notes: Refer also to Rule 6.3.4.5 with regard to rules applying to outdoor lighting within 500 metres of the threshold of a runway at Christchurch International Airport."*	The northern section of site falls within the REPA of runway 2/20 (Figure 2).

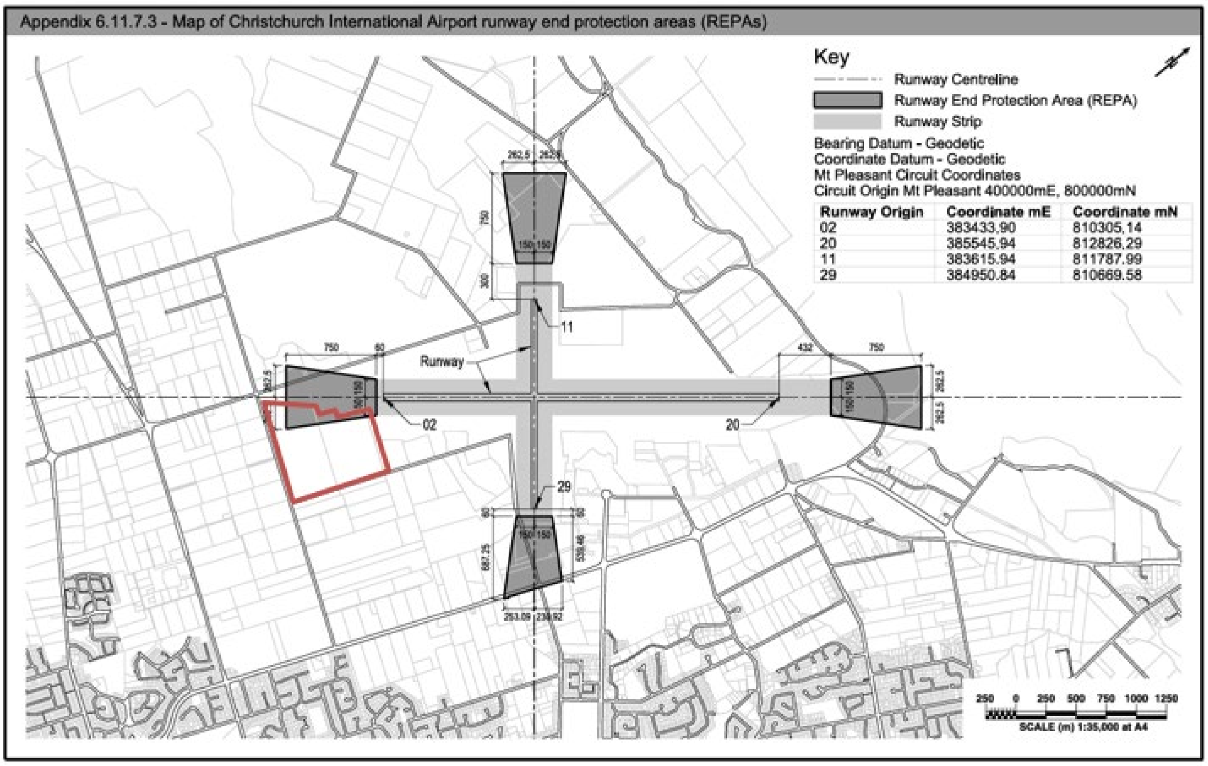

Figure 2: Map of Christchurch International Airport runway end protection areas (REPAs) (CCC, 2017). Red polygon shows approximate project site location at 104 Ryans Road.

4.0 Potential Effects of Lighting on Avifauna

4.1 Overview

Humans and animals perceive light differently. Animals typically have a visible light range from 300 nm to greater than 700 nm, whereas humans view light between 380 nm and 780 nm (Department of the Environment and Energy (DEE), 2020) (Figure 3). Birds and insects are reportedly sensitive to high energy, short wavelength ultraviolet, violet and blue light, extending into green and yellow light (Campos, 2017; DEE, 2020). Birds are less sensitive to warm orange to red light.

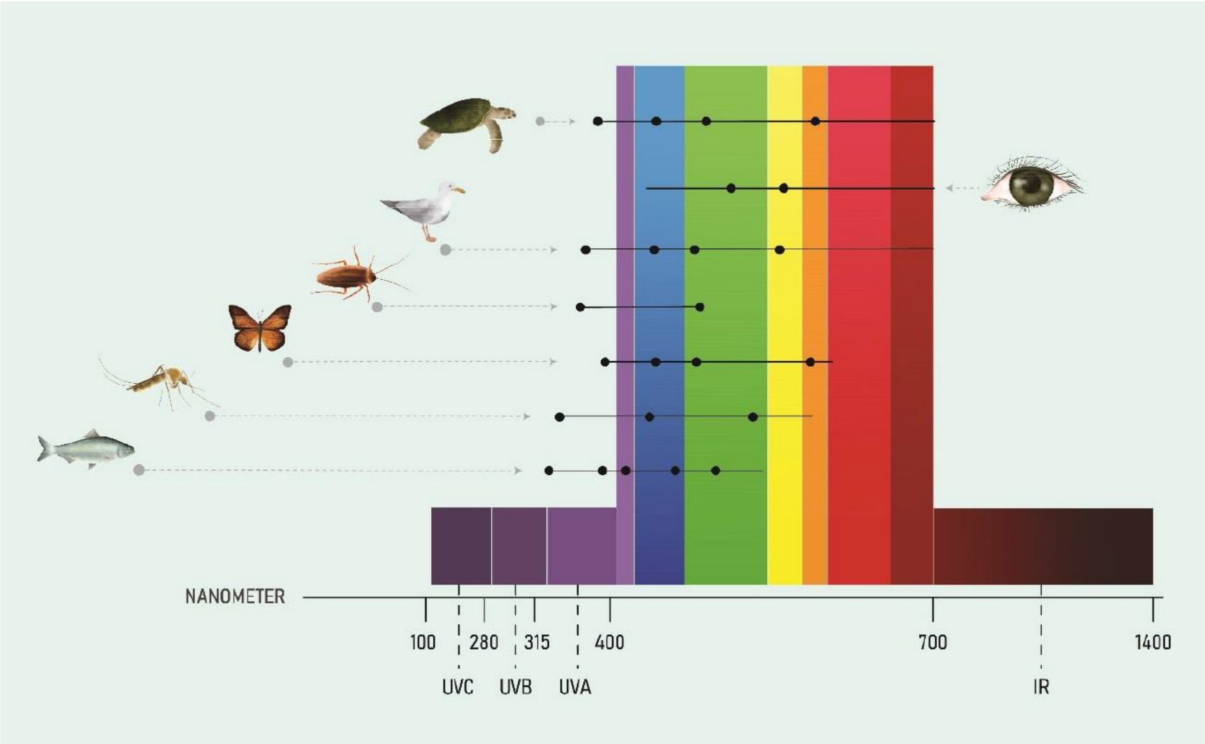

Figure 3: Ability of humans (right) and animals (left) to view different light wavelengths shown by horizontal lines. Black dots are peak sensitivities (Campos, 2017; DEE, 2020).

The amount, intensity and colour of light produced has the potential to adversely affect insects and birds at varying levels depending on the species. Artificial light at night (ALAN) is an escalating concern for wildlife and has been recognised as one of the most significant emerging threats to urban ecosystems (Stanley et al., 2015). This is largely attributed to new energy efficient technology such as light emitting diodes (LEDs). LEDs produce a peak blue-green light that is absent in other types of lighting, such as metal halide and high-pressure sodium (HPS) lights (Pugh & Pawson, 2016; Davies et al., 2013). The blue hue of LED lights is particularly sensitive to a range of animals (Davies et al., 2013).

According to global data, 19.6% of birds, 64.4% of invertebrates, and all bat species are nocturnal (Holker et al., 2010). These nocturnal species are particularly likely to be affected by changes in lighting conditions (Holker et al., 2010), however diurnal species can also experience negative impacts through direct ALAN exposure or indirect effects.

Studies have been completed overseas on LED light implications to birds, bats and insects with an increased number of mortalities caused by LED road lights. Auckland Transport (AT) recently replaced over 90,000 HPS lamps with new, blue LED lights to improve energy efficiency and illumination of roads and highways around Auckland. Evidence suggests that an increasing number of birds, bats and insects are being negatively affected (e.g., increased fledgling seabird grounding) since the LED installation and AT are currently investigating ways to mitigate these negative effects.

The adverse effect of ALAN and specifically LED lamps on animals, specifically birds, insects and bats, is supported by national (NIWA, 2023; Schofield, 2021; Pugh & Pawson, 2016; Whitehead et al., 2019; Cieraad & Farnworth, 2023) and numerous international (Pugh & Pawson, 2016; Campos, 2017; Davies et al., 2013) literature. For example, the following adverse effects from ALAN and conversion from metal halide and HPS lights to LED on avifauna have been reported:

- Behavioural changes, including altered breeding and feeding habits (Pugh & Pawson, 2016), and delayed onset of dawn song in species such as common myna (*Acridotheres tristis*) and tūī (*Prosthemadera novaeseelandiae*) in Auckland (McNaughton et al., 2021).
- Altered bird species composition. McNaughton et al. (2021) reported a 15% increase in introduced avian species richness and abundance of native grey warbler (*Gerygone igata*) and introduced rock pigeon increased by 2.3% and 5.5%, respectively, in Auckland.
- Disorientation of migratory and nocturnal birds (Whitehead et al., 2019). The effect of this is exasperated on cloudy and foggy nights when birds typically fly low between their feeding grounds, nesting sites and during migration. This can result in birds crashlanding or being grounded putting them at-risk of predation by introduced species and vehicles (Rodríguez et al., 2017). Fledgling seabirds are more susceptible to this presumably due to inexperience and their innate behaviour to align with bioluminescent prey or navigate using celestial bodies (Whitehead et al., 2019; Rodríguez et al., 2017).
- Disrupted circadian rhythm, migration and breeding timing due to altered perception of day length and natural light cues. Birds rely on natural light-dark cycles and photoperiod signals to regulate their biological clocks, migration and breeding. ALAN has the potential to interfere with these cycles and influence overall health.

Christchurch underwent a largescale conversion of streetlights from yellow/orange HPS to mainly blue-white LEDs to improve energy efficiency and reduce costs (NIWA, 2023) (Figure 4). Considering the sensitivity of birds to blue light, any addition of blue LED lights at the proposed development has potential to cumulatively contribute an effect on migratory and nocturnal birds.

To mitigate potential effects of lighting, lighting designs at the project site should be compliant with CCDP regulations (see Section 3.0). For example, the colour and intensity of lights to be fitted should be carefully considered, particularly given the potential cumulative effect of additional blue-white LEDs on top of the recent conversion of Christchurch City lights to LED. It is recommended that lighting designs are consistent with the existing ambient lighting surrounding the site, such as at the airport.

The following sections (4.2 – 4.4) examine the potential species-specific effects of lighting on nearby bird, insect and bat communities. Detailed recommendations for mitigating lighting effects on avifauna are provided in Section 5.0.

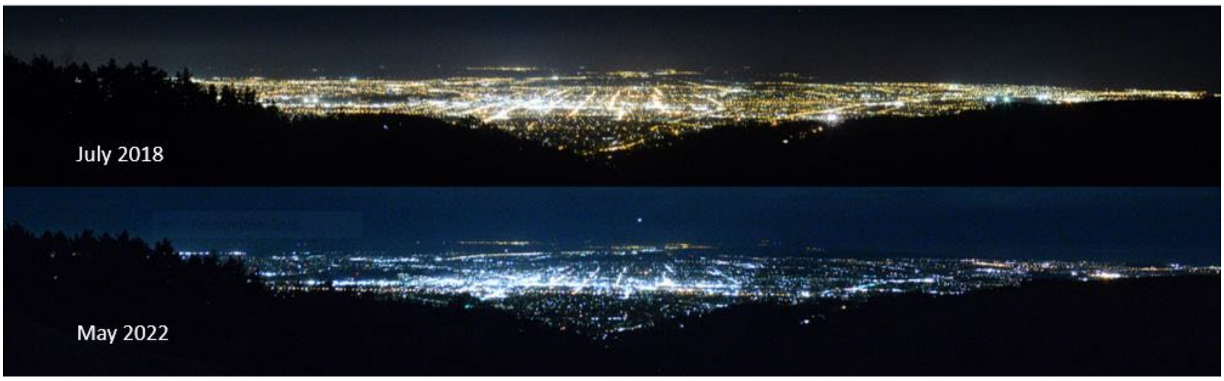

Figure 4: A nighttime view of Christchurch City captured from Summit Road on the Port Hills. Top image: July 2018 at the beginning of the streetlight conversion to LEDs. Bottom image: later in May 2022 when the conversion was nearly complete (NIWA, 2023).

4.2 Birds

The Australian National Light Pollution Guidelines recommend an environmental impact assessment process if there are species that are known to be affected by artificial light within 20 km of the project site. The following species are endemic birds that are within 20 km of the project area, are either nationally vulnerable, at risk or in decline, and may be affected by artificial light.

1. Long-tailed cuckoo - nationally vulnerable
2. Black-billed gull and black shag - at risk
3. South Island pied oystercatcher - at risk/declining

Long tailed cuckoo are inconspicuous birds that are rarely seen. They lay their eggs in white head, brown creeper and yellow head nests. None of these species were seen or are known to be within the project area, therefore they are unlikely to occupy the area for long (if at all) and are unlikely to be affected by site lighting.

Black-billed gulls and South Island pied oystercatcher forage and breed on riverbeds and shorelines around New Zealand, but mostly in the South Island. They rarely come inland, preferring to travel along river corridors and shorelines. It is unlikely that they would be affected by lighting from the project area.

4.3 Insects

The connection between insects exhibiting positive phototaxis (light attractance) and the presence of birds lies in food-web dynamics. Insects attracted to artificial lights create a concentrated food source for insectivorous or opportunistic birds, particularly those that are nocturnal or crepuscular. Opportunistic migratory birds flying over the site may also be attracted to concentrations of insects. Some birds may form mixed flocks to improve foraging efficiency and increase protection from predators (e.g., swamp harrier or New Zealand falcon (*Falco novaeseelandiae*) found in the region) (Dean, 1990). This may increase the risk of bird strike if the insect population is not managed onsite.

The following birds frequently observed at CIAL and seen onsite during PDP avian counts (Table 1) are insectivorous or opportunistic omnivores. They include migratory, nocturnal and crepuscular species:

- Welcome swallow
- Spur-winged plover
- Starling
- Eurasian blackbird
- Southern black-backed gull

Any decrease to the number of insects at airports is encouraged due to reduced risk of bird attractance and therefore bird strike (Bernhardt et al., 2010; Buckley & McCarthy, 1994; Steele & Renner, 2010; Washburn et al., 2011). International research has been done on the effect of positive phototaxis insects on airport bird strike risk. Hauptfleisch & Dalton (2015) found that 97% of aircraft wildlife collisions at two rurally situated airports were reported to be with insectivorous birds. This is not unlike the CIAL Wildlife Management Plan (CIAL, 2020) which indicates the highest bird strike rates were also associated with insectivorous birds like the spur-winged plover.

Hauptfleisch & Dalton (2015) indicated that insects were more attracted to white light, while yellow and orange light attracted significantly less insects. It found that insect habitat availability, such as natural areas like grasslands, within the setting of airports influence the attractiveness of lights to insects. Rural airports, in particular, are more attractive to insects due to the lower levels of surrounding ambient light. Developing the current rural site at 104 Ryans Road into an industrial land use will reduce insect habitat availability. The study concluded that habitat management and the use of yellow or orange-coloured lights are important factors in reducing insect abundance, thereby lowering the risk of bird strikes at airports.

4.4 Bats

It is unlikely that the activities at the project site will influence bats due to bats likely absence from the area (see Section 2.3). In implementing the precautionary approach, the recommendations provided in Section 5.0 have been tailored to also reduce the risk to bats.

5.0 Recommendations

The following light management measures are recommended to reduce the influence of lighting on avifauna (bird, insect and bat) species, and consequently reduce the risk of possible bird strike incidents, at the proposed development site. It is important that the recommendations are considered in site lighting designs as well as the proposed WHMP to be utilised post-development as recommended in the Avifauna Hazard Management Memorandum (PDP, 2025).

- LED impacts (e.g., potential increases to insect and bird numbers) can be mitigated by reducing light intensity and duration, and controlling light spill and spectrum to avoid peak sensitivities of most birds and insects to shorter wavelengths.
  - Use warm (≤3000 degrees Kelvin (K) colour temperature) yellow and orange lights only (Figure 5). The use of lights in this spectrum will also minimise disruption to the circadian rhythms of birds and reduce light scattering, which affects nocturnal activity.
  - Avoid using white and blue colours due to bird and insect sensitivity, and red due to it being used for airport signalling lights (ICAO, 2004).

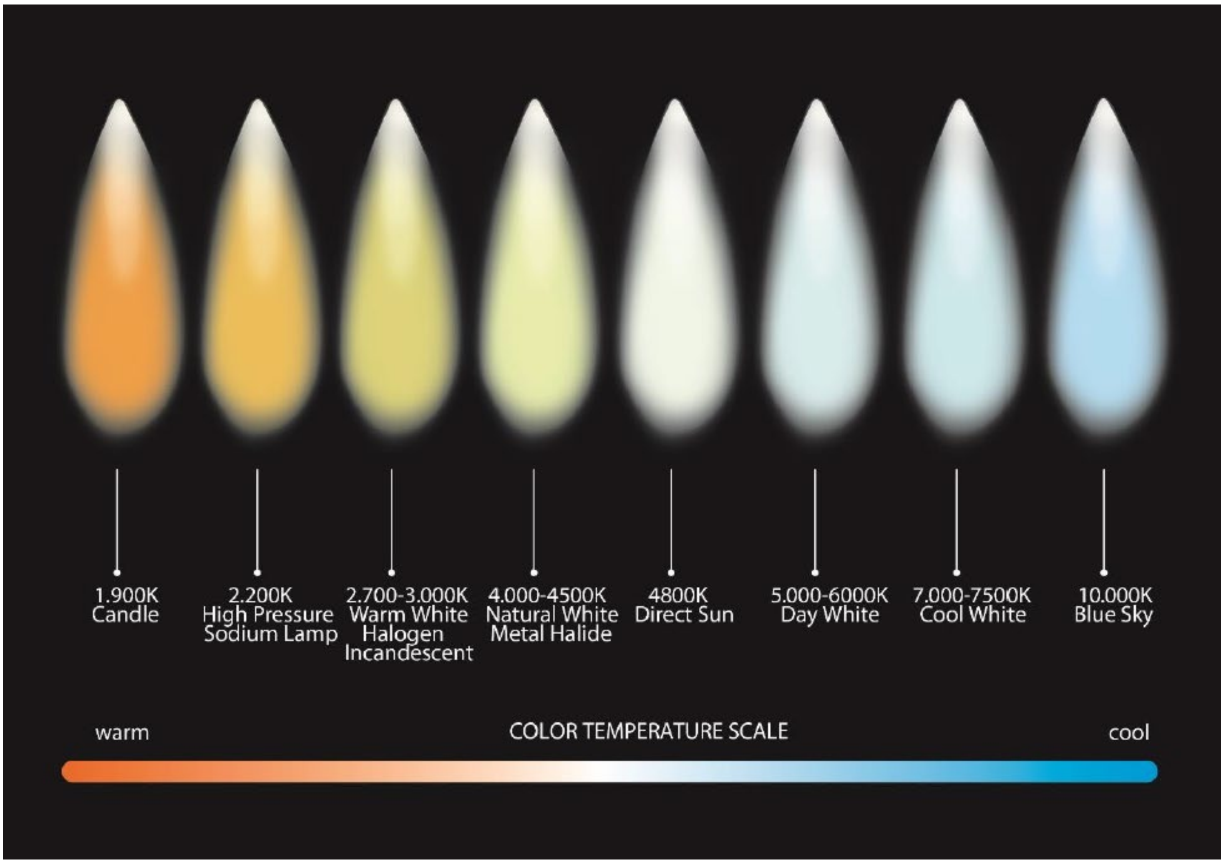

Figure 5: Correlated colour temperature (CCT) range from warm 1,000 K to cool 10,000 K (DEE, 2020).

- Shield outdoor lights to direct illumination downward and minimise unnecessary light spill into natural habitats (Figure 6). This strategy reduces disruptions to nocturnal birds by limiting skyglow and glare that interfere with natural behaviours such as navigation and hunting.
  - To help mitigate these adverse effects, luminaires should be installed on all external lights preferably with no tilt, or at a maximum tilt of 5 degrees.

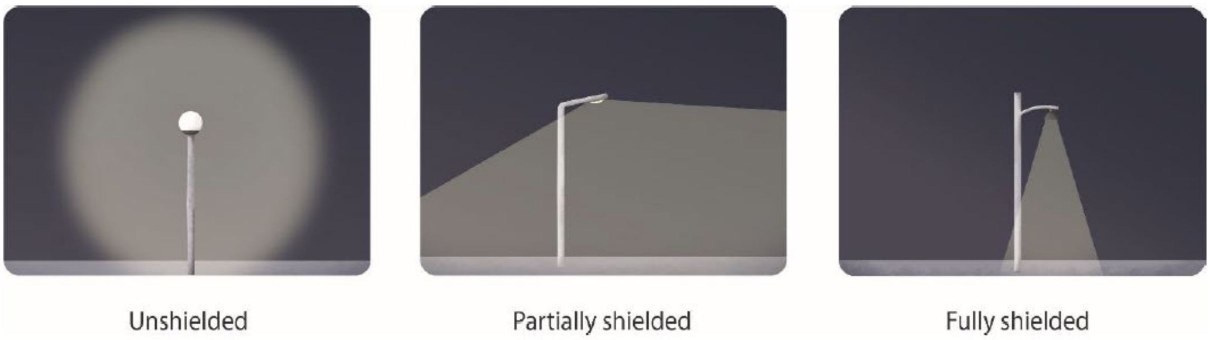

Figure 6: Illustration of varying degrees of light shielding, with fully shielded preferred (DEE, 2020; Witherington & Martin, 2003).

- Lower-height lighting that is directional and shielded is preferred for parking areas and walkways. Light fixtures should be positioned as close to the ground as possible and shielded to avoid sky glow (Figure 7).

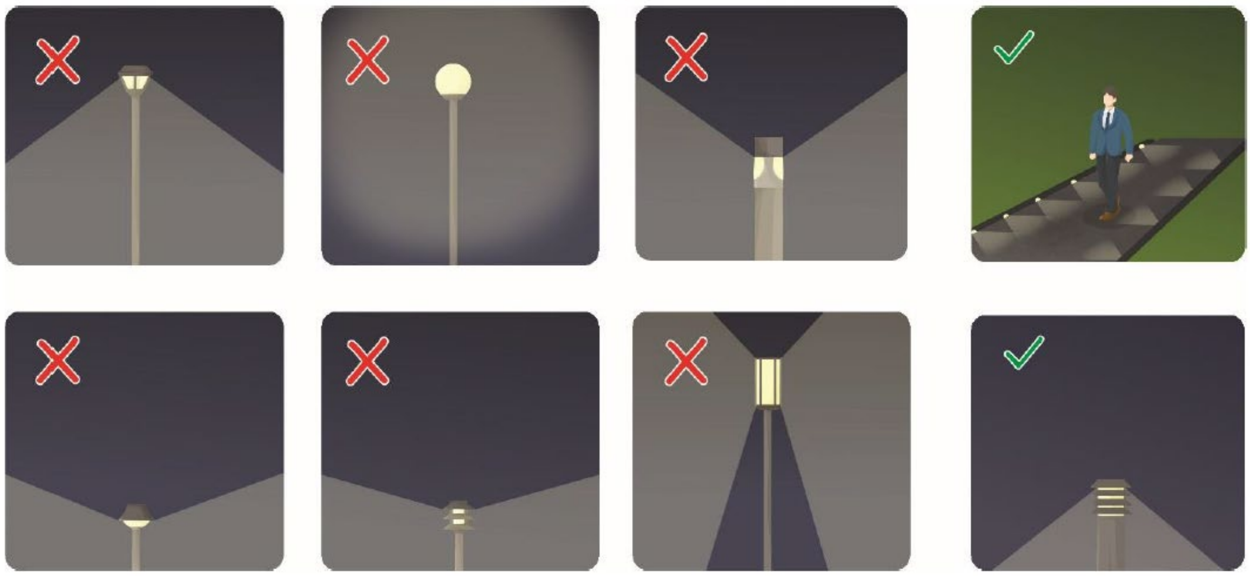

Figure 7: Low walkway and parking bay lighting should be used (DEE, 2020; Witherington & Martin, 2003).

- Limited external lighting, and the use of motion-sensors on external lights, may help reduce potential disorientation and grounding of seabirds flying close to the proposed development site. Care must be taken with motion-sensor timer frequencies to ensure they do not turn on and off too frequently, potentially confusing pilots. However, shielded and downward facing lights will further eliminate this risk.
- Reducing the intensity of lighting, or using motion sensors to activate lights only when necessary, can significantly decrease light pollution. This measure is especially effective for avifauna species sensitive to prolonged exposure to artificial light.
- Use non-reflective, dark coloured surfaces on roof structures to avoid high reflectivity. Reflected light from highly polished, shiny, or light-coloured surfaces, such as white-painted structures, polished marble, or white sand, can increase sky glow and influence migratory species.

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7.0 Limitations

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by CGL. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This memorandum has been prepared by PDP on the specific instructions of CGL for the limited purposes described in the memorandum. PDP accepts no liability if the memorandum is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Prepared by

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Senior Environmental Scientist - Ecology

Reviewed by

Lizzie Civil

Service Leader – Ecology

Reviewed and approved by

Jarred Arthur

Technical Director – Ecology

Appendix A – Project Team

The assessments outlined in this memorandum were undertaken by the following qualified ecologists:

Lizzie Civil (Avian Ecologist)

Lizzie is an Avian Ecologist with over 13 years of experience in the Aviation/Transport Industry, as well as conservation projects. She graduated from Unitech with a Bachelor of Science (Biodiversity) in 2011. She has been the chair of the New Zealand Aviation Wildlife Hazard Group (NZAWHG) since 2016. The NZAWHG works together to manage wildlife and human interactions and their associated risks around New Zealand Airports.

Lizzie has worked as an Airfield Manager and Grounds and Wildlife Manager for the New Zealand Defence Force and Auckland Internation Airport Limited, respectively. In these roles, she worked with airports across New Zealand to develop Wildlife and Pest Management Plans, Grounds Audits, Safe Operating Procedures, Recommended Practices and Risk Analysis in accordance with Civil Aviation Rules and Regulations. Prior to Pattle Delamore Partners, she worked as an independent ecological consultant conducting a range of tasks including monitoring assessments of avian biology behaviour.

Recently, Lizzie has created Wildlife Hazard Management Plans for Hamilton, New Plymouth, and Rotorua Regional airports. She has been working on two studies for Auckland International Airport investigating water and sediment quality effects on sea grass growth and its effects on the black swan population. She has also collated and analysed geospatial data for avian species movements to select an effective artificial shell roost location.

Wayne Westcott (Senior Ecologist)

Wayne is a multidisciplinary ecologist with 10 years' experience working in the field of environmental consulting. In 2015, he graduated from Rhodes University in South Africa with a Bachelor of Science (Hons) in Environmental Science. He is a member of the New Zealand Freshwater Sciences Society (NZFSS).

Wayne has worked extensively across both South Africa and New Zealand. He has undertaken wetland delineations, freshwater and terrestrial ecological assessments, and macroinvertebrate and fish surveys applicable to the renewables, mining, agriculture, and industrial and urban development sectors. This allowed him to gain valuable knowledge in implementing applicable legislation and associated assessment methodologies.

Wayne's research and consulting work across multiple ecological disciplines has afforded him a strong skillset to interpret and assess ecological impacts holistically. For example, he has broad training qualifications in hydropedology (hydrodynamics of soils), macroinvertebrate and fishing techniques, soil classification and land capability, and wetland management and restoration. He is familiar with New Zealand ecosystems and avian communities having joined PDP in early 2024.