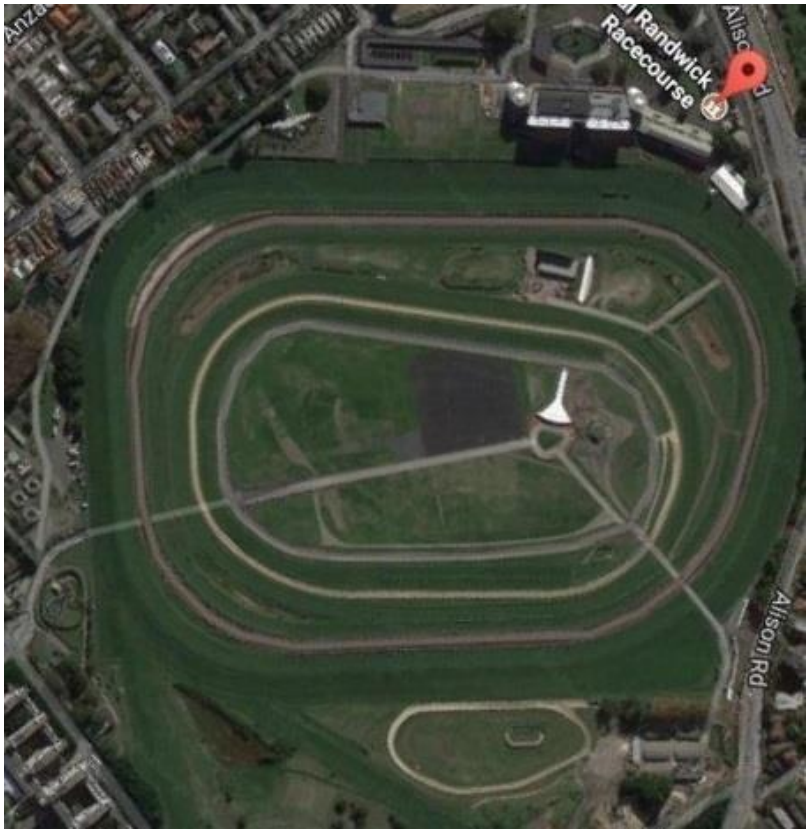

AUSTRALIAN TURF CLUB
Royal Randwick Racecourse

Night Racing Lighting Assessment

Job Number: EN - N17_19
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1. CONTENTS

1. GLOSSARY

Please find following a table of acronyms and technical terms that are not commonly used in everyday language which may be used within the body of this report.

Acronym or Technical Term	Meaning/ Definition
ATC	Australian Turf Club
RRRC	Royal Randwick Racecourse
SSDA	State significant development application
I	Luminous Intensity measured in cd
cd	Intensity Candelas
d	Distance
Lux	Illuminance measurement
LED	Light Emitting Diode
ULR	Upward light ratio
MF	Maintenance Factor

The following table identifies the SEARs being addressed with cross-references to the specific sections in the report which address each assessment criteria identified.

SSDA 8706 SEARS Being Addressed	Section of this Report which Addresses Assessment Criteria
General Requirements	Sections 4, 5, 8 & 9
Key issues – Item Matter 2	Sections 3, 7 & Appendix A & D
Key issues – Item Matter 5	Sections 7 & 9
Key issues – Item Matter 6	Sections 7 & 9

2. EXECUTIVE SUMMARY

This *Night Racing Lighting Assessment* has been prepared to support a State Significant Development application for night racing at the Royal Randwick Racecourse.

The Australian Turf Club is looking for opportunities to improve the racing experience at Royal Randwick for spectators, increase revenue and re-invest into its people, racing infrastructure and entertainment facilities.

Royal Randwick has been part of Australia's racing culture for over 150 years and is the country's oldest horse racing venue, with a history of racing dating back to 1833.

Today, Royal Randwick enjoys a reputation as being one of Australia's premier racing venues and is considered the *Jewel in the Crown of Sydney racing* - hosting some of the world's richest turf races, including The TAB Everest and the Longines Queen Elizabeth Stakes.

As part of a vision to secure Royal Randwick's long-term future and enhance its status as a world-class destination for thoroughbred racing, the ATC has prepared a proposal to introduce night racing at Royal Randwick. The night racing events will create a new spectator experience, attract new audiences, and enhance the status of Royal Randwick on the state, national and international racing stage. The night racing events will also provide an alternative night-time cultural and sporting event with the opportunity for providing increased tourism and boosting Sydney's night-time economy.

The scope of the proposal includes:

- Consent for up to 16-night racing events per annum (predominately between October and April);
- New trackside lighting to facilitate televised broadcasting;
- Upgrade to spectator precinct lighting for patron's safety;
- Permanent electricity generators to supply the new track lighting system.

This report provides an assessment of the proposed illumination of the Royal Randwick Racecourse to international broadcast standards and investigates if there are any associated effects of spill lighting on neighbouring residential areas.

3. INTRODUCTION

Royal Randwick Racecourse is located in the eastern suburbs of Sydney, NSW, approximately 6 km from Sydney's CBD. It consists of the course proper (2224m circumference) and the inner Kensington track (2100m circumference). The site is on Crown Land leased to The Australian Turf Club and is bounded by Alison Road, Wansey Road, High Street and Doncaster Avenue. Along these boundaries is a diverse range of neighbouring properties of varying heights: UNSW Sydney campus as well as several commercial and residential properties.

The Australian Turf Club proposes to facilitate a maximum of sixteen (16) night race meetings per year running typically between 6pm to 10pm from October to April. The anticipated mix of events with associated estimated crowd numbers and proposed track use is as follows:

Criteria	2020 Proposal
Class 3 Events (0 – 10,000 patrons)	12 Events per annum
Class 2 Events (10,001 – 15,000 patrons)	4 Events per annum
Class 1 Events (35,000 + patrons)	0 Events

Horse racing is a large spectator sport, usually viewed from the grandstand and the lawn along the home straight and finish line. For television coverage camera/s are located at the finish line.

Floodlighting is required to uniformly light the width of the tracks while providing high vertical illuminance to identify the vertical facing sides of the jockeys and horses over the entire course. Higher levels are required for the photo-finish.

The lighting is principally designed to be confined within the width of the tracks but due to the laws of physics, light cannot physically stop at the boundary. Illuminance from the floodlights, however, does reduce proportionally to the distance i.e. inverse square law ($E = I/d^2$).

Tolerable levels will be influenced by the surrounding existing ambient lighting and although Sydney, on a global scale, is not a major offender of sky glow, Randwick is close to the CBD and the densely populated eastern suburbs means the associated ambient lighting levels are generally higher.

Australian Standard AS/NZS 4282:2019 states:

With any outdoor lighting, it will rarely be possible to contain all light within the boundary property on which it is installed. Some light will inevitably be spilled outside properties boundaries, either directly or by reflection. The determination of when spill light becomes obtrusive to others is difficult since both physiological and psychological effects are involved.

For the purposes of the SSDA submission, only the effects of the lighting required to facilitate night racing will be assessed. The upgrade of the spectator precinct lighting (stewards lighting, outdoor carparks, amenities etc.) is in existing areas, set back within the site and uses relatively short pole heights. Therefore, it will not be assessed as part of this report. Refer to Appendix D.

Figure 1 - Site Plan

Figure 2 - Proximity to Sydney CBD

4. METHODOLOGY

4.1 General

IGS invited a multi-national sports lighting supplier/manufacturer to undertake computer modelling to meet the lighting design criteria for television broadcast lighting. This report is based on this supplier's design.

The lighting supplier was provided with the following documentation to enable modelling using their proprietary light modelling software:

- Design criteria (see clause 5)
- RRC240311ma CAD file
- DA-24 Elevation NW-SE camera 1
- Proposed grandstand floodlight mounting locations
- RRRC Site boundary
- CIBSE Lighting Guide 4: Sports Lighting, Section 7a Lighting for television Appendix A1 calculation method

[1] Lighting suppliers/manufacturers names are confidential at this stage of design development

4.2 Applicable Australian Standards

The Australian Standards do not have a specifically dedicated standard for horse racing or lighting for television. However, the sources which were identified and provided some minimum requirements and guidance for good practice are summarised below:

- AS 2560.1:2002 Sports Lighting - General Principles
- AS/NZS 4282:2019 Control of Obtrusive effects of outdoor lighting
- AS/NZS 1158.2:2020 Lighting for roads & public spaces
- AS/NZS 3827.1:1998 Lighting system performance – accuracy and tolerances
- CIBSE Lighting Guide 4: Sports Lighting, Section 7a Lighting for television
- OP-31 Free TV Australia Operational Practice, Lighting Requirements for Television

4.3 Influence of surrounds

There are many physical features around the site boundary which assist to restrict the spill light but the lighting model does not take into consideration these obstructions, topography of the site and surrounding areas.

5. DESIGN CRITERIA

The relevant lighting design criteria used to assess the effects of night racing light are summarised below:

5.1 Broadcaster's Requirements

International Standard for Colour TV Venues

Vertical Illuminance (Ev) towards camera 1	Ev Illuminance toward main camera 1 from other directions	Colour temperature (K)	Colour Rendering (Ra)
1400 lux	1000 lux	5600	≥86

5.2 Other Minimum Requirements

Glare Rating (GR)	Uniformity (U)	Calculation grid	Flicker Factor (FF)
50 for participants 40 for camera	Vertical 0.7 on the home straight 0.6 elsewhere Horizontal 0.8	1.5m above ground level	≤10% with camera speeds ≤600 fps

5.3 Obtrusive Lighting Recommendations

AS/NZS 4282:2019 specifies limiting values for assessment and provides limits for both before and after curfew period i.e. between 11pm and 6am. Environmental zones consider land zoning and night-time activity.

5.4 AS/NZS 4282:2019 1.4 Relevant Definitions

1.4.1 Control Direction – the direction that lies in the vertical plane and contains the luminaire's maximum intensity, and its declination is at a vertical angle below the horizon.

1.4.12 Reference Direction – the direction to which the luminous intensity of a luminaire is referred. The reference & the control direction may lie in the same plane.

1.4.13 Relevant Boundary – any boundary of a residential property or environmentally sensitive area over which it is physically possible for spill light from the subject lighting installation to pass and directly impact on a dwelling.

1.4.17 Sky glow -the brightening of the night sky that results from man-made sources eg outdoor lighting

1.4.18 Spill light – light emitted by a lighting installation that falls outside of the design area. Spill light may or may not be intrusive depending on what it affects

1.4.20 Upward light ratio (ULR)
The proportion of flux of a luminaire and/or installation that is emitted, at and above the horizontal, excluding reflected light, when the luminaire(s) is/are mounted in its installed position(s). ULR = upward flux / total flux of luminaire.

3.3.2 Sports venues illuminated for TV coverage

3.3.2.1 *General*

Conformance to the limiting values specified in Tables 3.2, 3.3 and 3.4 shall be assessed on the basis of calculations of the applicable light technical parameters in accordance with Section 4.

NOTE: See Section 5 for guidelines on conducting check measurements that are not intended for validation.

3.3.2.2 *Calculation of illuminance in a vertical plane (E_v)*

The illuminance calculations for E_v shall be made for a grid of points on a horizontal plane at a height of 1.5 m above ground level. The points shall be spaced at not more than 10 m horizontally. E_v is calculated at each point facing towards the centre of the total playing area (TPA). See Figure 3.3.

Conformance to the limits for E_v in Tables 3.2 and 3.4 (appropriate) shall be determined by calculation only.

3.3.2.3 *Calculation of intensity (I)*

The intensity limit in Table 3.3 shall apply to each luminaire at all azimuth planes for all elevation angles at and above the control direction when the luminaire is mounted in its installed position. The control direction shall be as follows:

(a) For new installations, 10° below the horizontal.

(b) For existing installations, 7° below the horizontal.

See Figure 3.4.

5.5 AS/NZS 4282:2019 limiting values

Refer to following applicable AS/NZS 4282:2019 tables & figures for relevant limits listed below:

5.5.1 **Table 3.1** Environmental Zones
TV zone is applicable to the RRRC as this is a considered a major sports stadium being used for TV broadcast.

5.5.2 **Table 3.2** Sky Glow **(ULR)**
TV zone 0.08%

5.5.3 **Table 3. 3** Max. intensity per luminaire
TV zone L1 (level 1)

- 100 000 cd precurfew (before 11pm)
- 0 cd after curfew (11pm to 6am)
- Control direction min. 10º below horizon

5.5.4 **Table 3.4** Max. initial Vertical camera illuminance precurfew for initial camera illuminance (Ec) range >1000 & ≤1400 lux

Zone	D(m) from TPA	Max. (Ec) lux
TV1	>50 ≤100	110
TV2	>100 ≤200	20
TV3	>200 ≤300	8
TV4	>300	4

5.6 Lighting design results according AS/NZS 4282:2019

The following results show compliance with applicable limiting values for zones as noted above.

5.6.1 Table 3.2

The lighting supplier used three (3) types of luminaires. The highest ULR is shown below.

Applicable Zone	ULR permitted	ULR achieved	Compliance achieved
TV	0.08%	0.001%	✓

5.6.2 Table 3.3

The lighting supplier used three (3) types of luminaires. The highest intensities for each are shown below.

Luminaire code	Max. Intensity (cd) per luminaire permitted	Max intensity (cd) achieved	Control direction angle required	Control direction angle achieved	Compliance achieved
A	100 000	85 326	>10º	18.09°	✓
B	100 000	90 248	>10º	15º	✓
C	100 000	81 758	>10º	19.12º	✓

TV Zone Level 1	Max Intensity (cd) permitted	Max intensity (cd) achieved	Compliance achieved
Pre-curfew	100 000	90 248	✓
Curfew	0	0	✓

5.6.3 Table 3.4

Initial vertical illuminances are all less than the maximum limits.

Applicable Zone	D(m) from TPA	Max. Ec lux	Results at 1.5m agl	Initial MF 1.0 **	Compliance achieved
TV1	>50 ≤100	110	99.9	104.2	✓
TV2	>100 ≤200	20	2.99	3.14	✓
TV3	>200 ≤300	8	0.12	0.126	✓
TV4	>300	4	0.03	0.031	✓

** MF used was 0.95. Results are 5% higher at initial MF=1.0

5.7 AS/NZS 4282:2019 Applicable Tables & Figures

TABLE 3.1

ENVIRONMENTAL ZONES

Zones	Description	Examples
A0	Intrinsically dark	UNESCO Starlight Reserve, IDA Dark Sky Parks, Major optical observatories No road lighting -unless specifically required by the road controlling authority
A1	Dark	Relatively uninhabited rural areas No road lighting - unless specifically required by the road controlling authority
A2	Low district brightness	Sparsely inhabited rural and semi-rural areas
A3	Medium district brightness	Suburban areas in towns and cities
A4	High district brightness	Town and city centres and other commercial areas Residential areas abutting commercial areas
TV	High district brightness	Vicinity of major sports stadium during TV broadcasts

,

TABLE 3.2

MAXIMUM VALUES OF LIGHT TECHNICAL PARAMETERS

Zones	Vertical illuminance levels (E_v) lx		Threshold increment (TI)		Sky glow
	Non-curfew	Curfew	%	Default adaptation level (L_{ad})	Upward light ratio
A0	See Note 1	0	N/A	N/A	0
A1	2	0.1	N/A	N/A	0
A2	5	1	20%	0.2	0.01
A3	10	2	20%	1	0.02
A4	25	5	20%	5	0.03
TV	See Table 3.4	N/A	20%	10	0.08

TABLE 3.3

MAXIMUM LUMINOUS INTENSITIES PER LUMINAIRE

Zone	Luminous intensity (I), cd		
	Non-curfew L1	Non-curfew L2	Curfew
A0	See Note	See Note	0
A1	2 500	5 000	500
A2	7 500	12 500	1 000
A3	12 500	25 000	2 500
A4	25 000	50 000	2 500
TV	100 000	150 000	0

L1 (level 1) non-curfew limits apply for new installations.

TABLE 3.4

MAXIMUM VERTICAL ILLUMINANCE NON-CURFEW LIMITS FOR SPORTS VENUES ILLUMINATED FOR TV COVERAGE

Zone	D m	Initial camera illuminance (E_c), lx							
		≤500	>500 ≤700	>700 ≤1000	>1000 ≤1400	>1400 ≤1900	>1900 ≤2500	>2500 ≤3200	>3200
TV1	>50 ≤100	40	55	80	110	150	200	260	330
TV2	>100 ≤200	8	10	15	20	25	35	45	55
TV3	>200 ≤300	3	4	6	8	10	14	18	22
TV4	>300	1.5	2	3	4	5	7	9	11

LEGEND:
E_c = initial (MF = 1) average illuminance to the camera
D = distance from the nearest part of the TPA (refer to AS 2560.1)

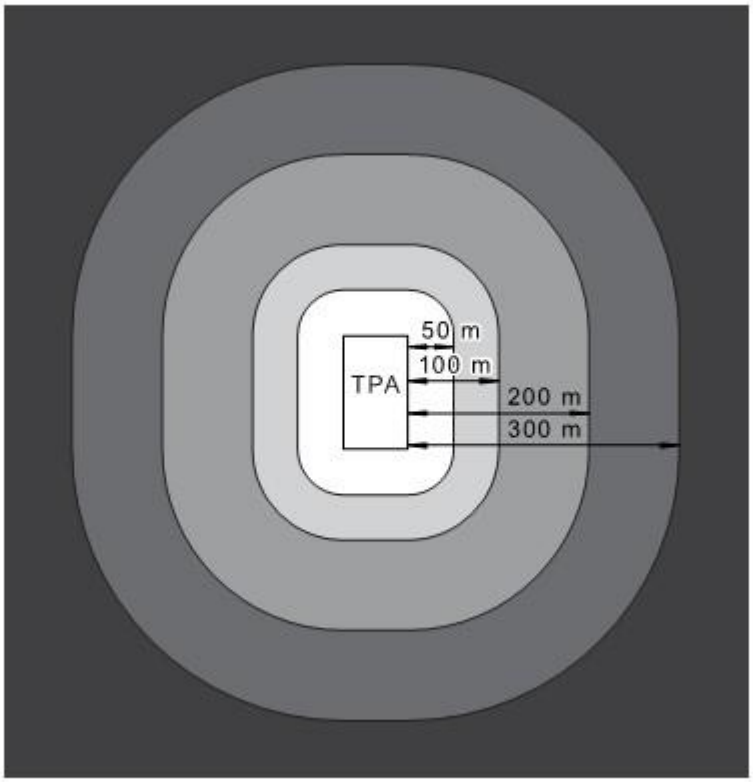
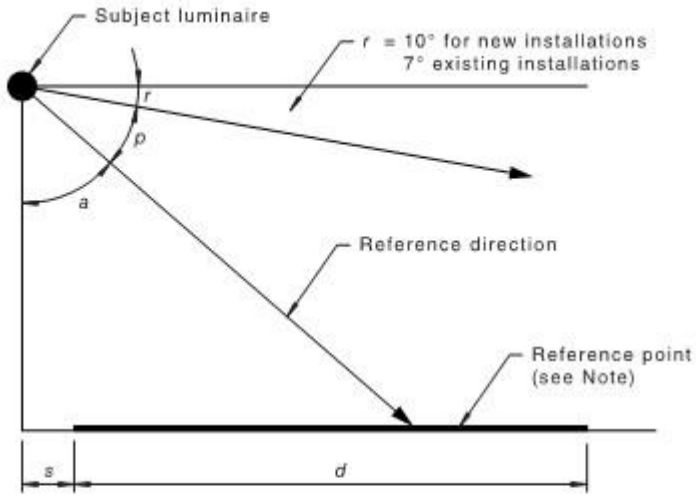


FIGURE 3.3 EXAMPLE SHOWING APPLICATION OF LIMITS FOR E_V FOR TV

AS 2560.1 definition
TPA – total playing area i.e. the edge of racecourse, not the boundary of the site.



LEGEND:
H = mounting height of the subject luminaire above the plane of the subject area
s = setback of the luminaire from the edge of the subject area, perpendicular to the edge of the subject area
d = dimension of the subject area, perpendicular to the edge of the subject area
a = reference angle of the subject luminaire in elevation (see Note)
p = angular displacement, in elevation, of the control direction from the reference direction
r = angular difference between control direction and the horizontal

NOTE: See definition of 'reference direction' in Clause 1.4.12.

FIGURE 3.4 ILLUSTRATION OF THE APPLICATION OF LIMITS FOR INTENSITY FOR TV

5.8 AS/NZS 4282:2019 2.4 Specific Effects

The Australian standard states effects on residents involve perceived reduction in amenity arising from:

a) Spill light, particularly when entering habitable rooms
b) Direct view of bright luminaires in normal view

The tolerable levels of these parameters will be influenced by existing environment ambient lighting and the distance from the new lighting installation.

Generally, residential areas are assessed by their ambient light conditions e.g. rural areas or city centres. Maximum spill light limits are applied for permanent lighting installations.

As high light levels are required to broadcast for TV, the Australian Standard defines limits of light spill from a TV broadcasting installation at specific distances from the sports field. This is a measure of maximum acceptable light spill (lux) at the height of 1.5m vertically. Values are shown in AS/NZS 4282:2019 Table 3.4 and see Appendix B for examples of what these values look like in everyday situations.

6. LIGHTING DESIGN IMPACTS

Data compiled from the lighting supplier was assessed on the following basis:

- Compliance with the broadcast lighting criteria;
- Identify “sensitive” locations adjacent to the racecourse;
- Resulting illuminance (lux);
- Resulting luminance (candela);
- Pole positions & mounting heights;
- Luminaire specification, quantities, tilt, aiming angles;
- Mitigation measures available (if required);
- Comparison of a similar racecourse and existing sports lighting installations around the world.

7. SENSITIVE AREAS

The highest lighting levels are required on the home straight and finish line. The floodlights illuminating this section will be mounted from the grandstand at approx. 30.5m and aimed to achieve 1400 lux on the vertical plane at 1.5m above the track. Therefore, it is from here where the highest intrusion would emanate.

7.1 Boundary Descriptions

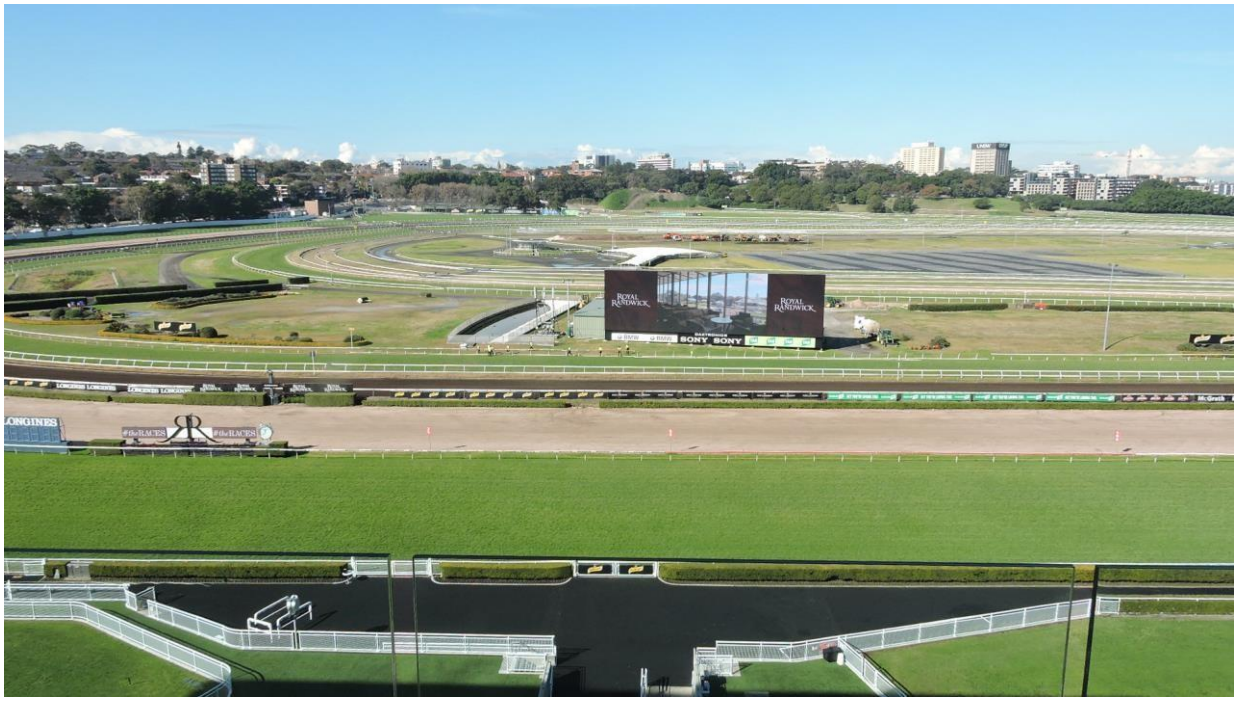


Figure 3 - View from grandstand looking north-east.

Boundary 1 Alison Rd to the North

- Between the racecourse site boundary and the dwellings across the road are dense evergreen trees;
- Possible side view of grandstand floodlights, being approx 300m to 500m away;
- Close to 1600m starting chute where pole heights are 27.4m;
- Close to straight 1

Boundary 2 Wansey Rd to the East

- Between the racecourse site boundary and the dwellings across the road are dense evergreen trees;
- Direct view of grandstand floodlights, being approx 800m to 900m away;
- Close to 1400m starting chute where pole heights are between 18.3m & 27.4m.

Boundary 3 High St to the South West

- Between the racecourse site boundary and the dwellings across the road are some dense evergreen trees;

- Direct view of grandstand floodlights, being approx 900m away;
- Close to 1400m chute where pole heights are 27.4m.

Boundary 4 Doncaster Ave to the West

- Dwellings close on turn 4;
- Not in direct line of view of grandstand floodlights, being 450m to 500m away.

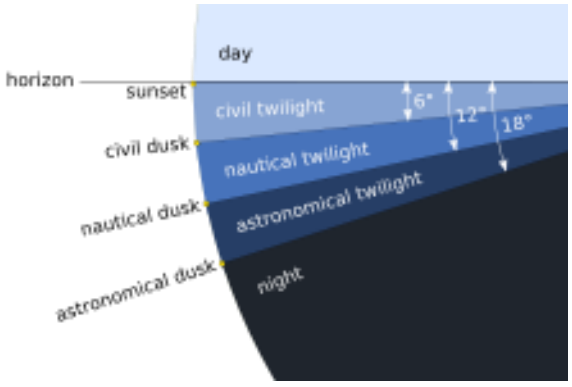
- **Table 3.5**

Boundary	Zone	Max. Lux allowed	Max intensity (cd) allowed	Compliance achieved. See tables in section 5.6.
1	TV3 to TV4	4 to 8	100 000	✓
2	TV4	4	100 000	✓
3	TV4	4	100 000	✓
4	TV4	4	100 000	✓

7.2 Event timing

In Sydney between October and April, the sun sets between 6.50 pm to 8 pm. Sunset is when the sun is below the horizon. It is not until the sun reaches 18 degrees below the horizontal that it becomes “night” (some 30 minutes later) when the sky is only illuminated by the moon, stars and artificial light sources.

http://spiff.rit.edu/classes/phys235/solar_path/solar_path.html TW Carlson



Daylight produces 100 000 lux, an overcast day provides from 1 000 to 20 000 lux, while there is 400 lux at sunset on a clear day.

Therefore, the effects of the racecourse lighting will not be as noticeable until between the hours of 7.20 pm to 8.30 pm (depending on beginning, end or mid-summer) up to 10 pm, approximately 34 hours per racing season. When dimming between races is taken into account and the fact that each

race lasts between 5-7 minutes, the amount of time the lights will be on at full intensity during “night” reduces significantly to approximately 8.5* hours per racing season.

Lighting levels calculated at the vertical face of surrounding properties do not take into account any window coverings. Any habitable rooms, by definition of living, bedroom or study, after provision of any mitigation measures, could have the option of being able to draw their curtains or blinds if the additional light is intolerable.

*This is based on a 40 minute race to race turnaround of which 10 minutes would be at full brightness.

7.3 Spectator Precinct

The upgrade of these existing areas - steward’s areas, Theatre of the Horse, stewards, outdoor carparks and amenities are all set back within the site. Luminaires and lamps are being upgraded to LED sources and poles are a maximum of 10m high. Refer to Appendix D for specification.

7.4 Effects on Natural Environment

Considering the high ambient lighting of the surrounds of Royal Randwick Racecourse and the limited hours of operation of this lighting installation, there would be minimal impact on local flora or fauna.

7.5 What does lux look like?

Lux is the level of illumination falling on a surface. Refer to Appendix B for graphical examples.

Some typical outdoor examples are:

- Sunny day 100 000 lux
- Overcast day 2 000 lux
- Cricket class I (non-televised) 750 lux square, 500 lux outfield
- Competition tennis 250 lux
- Football practice 100 lux
- Loading Dock 50 lux
- Outdoor Carpark 7 lux
- Local Road lighting 3.5 lux
- Moonlight 0.5 lux

7.6 Light Spill impact on surrounding zones

If Randwick Racecourse were a non-broadcast lighting installation, assessment would be made at the face of residential properties or on the relevant site boundary, based on the criteria for Zone A4 high brightness district.

Table 3.6 below compares the obtrusive lighting requirements for broadcast lighting zones TV1 to TV4 to high brightness district zone A4. This illustrates that for zones TV2 to TV4 (greater than 100m away from the TPA) for broadcasting areas, the broadcast criteria are more stringent than non-broadcast areas. For example, no spill light is permissible after curfew for TV1 to TV4, whereas 5 lux is permissible after curfew for zone A4.

7.6.1 Table 3.6

Zone	Lux Pre-curfew	Lux Curfew	Intensity cd Pre-curfew	Intensity cd Curfew
TV1	110	0	100 000	0
TV2	20	0	100 000	0
TV3	8	0	100 000	0
TV4	4	0	100 000	0
A4	25	5	25 000	2 500

8. POLE AND LUMINAIRES

8.1 General

The luminaires in the design use light-emitting diode (LED) as the light source. LED technology provides instant control, stepped illumination levels, energy efficiency, excellent colour rendering and long lamp life so the best quality lighting is produced for HDTV broadcasting.

8.2 Luminaires

Type C or Type C cut-off luminaires are recommended for sports lighting. The specified luminaires are Type C & Type C cut-off classification luminaires.

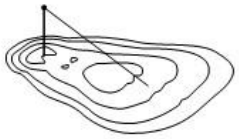
C		Asymmetrical in the vertical plane giving a fan shaped beam. The peak intensity is typically 30°–40° above the normal to the light emitting surface. The light emitting surface may be tilted from 0°–40° in normal application. There is some 'run-back' of intensity above the peak intensity	
C cut-off		Asymmetrical in the vertical plane giving a fan shaped beam. The peak intensity is typically 60° to the normal to the light emitting surface. The light emitting surface may be tilted from 0°–10° in normal application. There is rapid 'run-back' of intensity above the peak intensity	

Figure 4

Refer to Appendix C typical Isocandela curves showing luminaire light distribution curves

Luminaire code	No. off	Wattage (W)	Lumens	Max pole height
A	1805	1170 - 1430	131 200	40.0
B	3	480 - 540	54 950	24.4
C*	104	1430	135 130	?

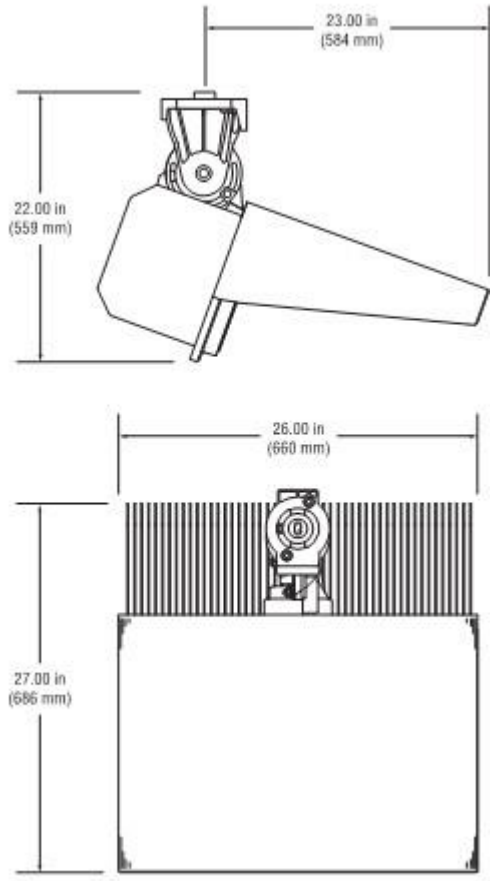


Figure 5 – Luminaires A, B & C LED floodlights

8.3 Luminaire Mitigation Accessories

Visors, louvres, baffles or shields assist in controlling spill light but may affect the performance of the luminaires. In the design visors have been included to the fittings. Baffles can be added to reduce the spill lighting, but care is taken to maintain the appropriate lux levels and uniformity over the track as horses are sensitive to variations in light levels.

Figure 6 Luminaires A, B & C with visors

8.4 Poles - Heights and Locations

Refer to Appendix A for Trackside Lighting showing pole locations.

Illumination levels are required at 1.5m above ground level in order to see the jockeys, the horses and the racing colours.

Pole locations have been designed to allow for an unimpeded view of the home straight during racing and minimise the view of poles on the back straight and bends.

The closer to the track the more inward or lower the floodlight aiming can be. However, to achieve the required vertical illumination at 1.5m at close proximity such as the finish line from the grandstand, the tilt angle needs to be high. The home straight requires the same high vertical illumination but has been lit from higher poles further back on the spectator lawn.

It is necessary to switch the pole positions from the inside on the back straight and bends to outside for the home straight to provide adequate vertical illumination to horses and jockeys. The three (3) starting chutes require similar consideration.

Higher poles provide better uniformity with less luminaires but are more conspicuous during the daytime.

Whilst poles have been located to suit tree protection zones & the required structural footings, the exact location may vary by up to 10% due to arborists advice & when geotechnical reports have been carried out. Final locations will be confirmed during detailed design stage.

There is a total of 79 lighting poles, each approx. 750dia, proposed around the track which house 1912 fixtures. 40 of these poles are 27.4m, another 24 poles are in the range of 18.3m – 27.4m and

along the main straight there are 14 poles of 27.4m to 40.0m. On top of the grandstand, there are 16 locations housing 44 fixtures.

Pole Code	Pole Height min. (m)	Pole Height max. (m)	No. off poles	Max no. off luminaires on pole
A	27.4	40	14	48
B	27.4		40	46
C	18.3	27.4	24	20
F*	24.4		1	10
M	30.5*		16**	8

*Photo-finish

**Grandstand mounted

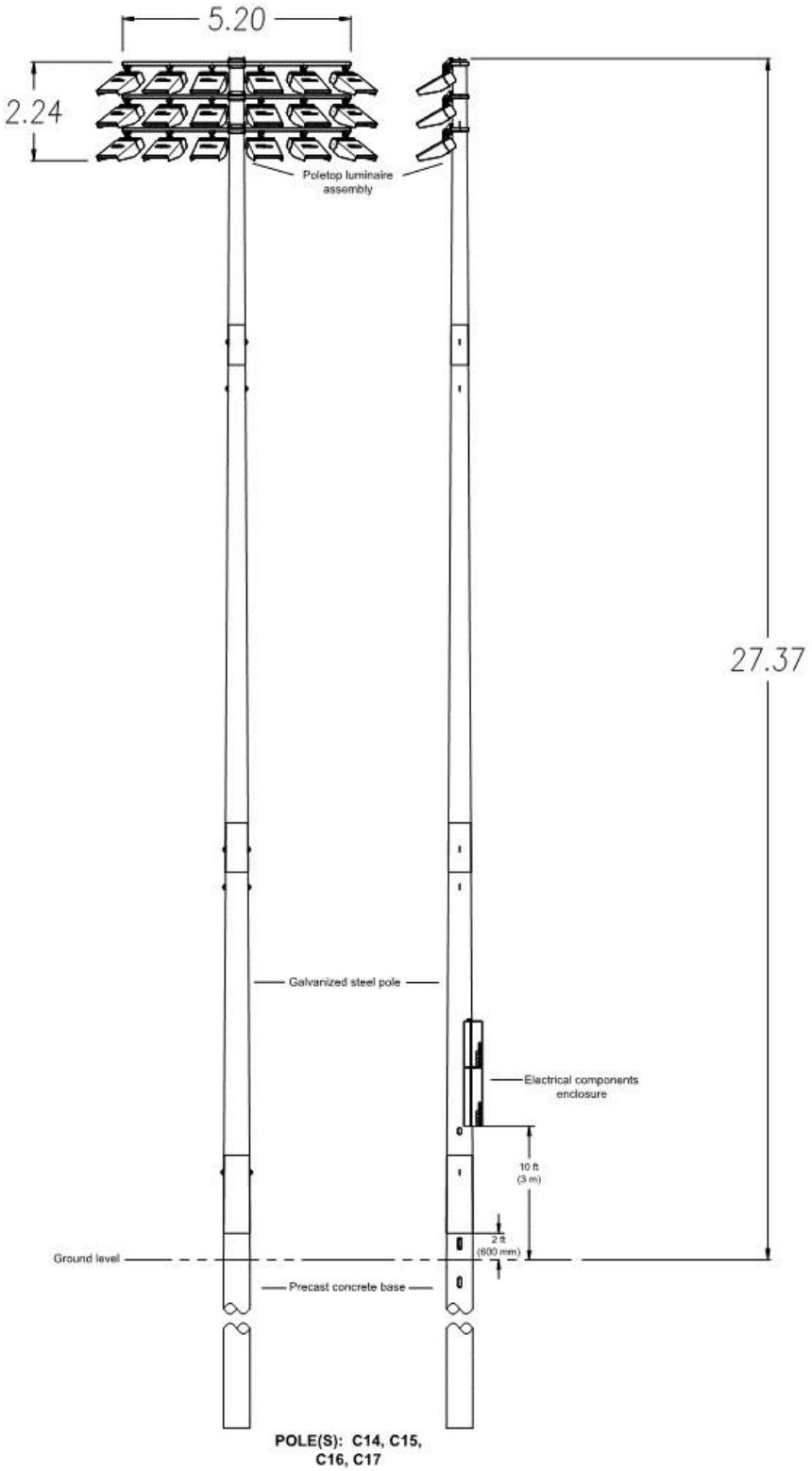


Figure 7 Typical 27.37m pole

9. EXISTING LIGHTING INSTALLATIONS

The following images are examples of existing horse racing courses and sporting stadiums where lighting is installed to TV broadcast lighting requirements.

9.1 Horse & greyhound racing venues with night racing

There are a number of horse and greyhound racing sporting complexes which offer night time racing and with it illuminated arenas. The table below shows the number of events held per year at some of these venues with the number of races proposed for RRRC generally within the average range to those already held at these other venues.

All/some of these venues are also nearby residential (sensitive) areas and therefore are similar to RRRC. We are, however, unaware which, if any, of these arenas are lit to international broadcast requirements.

NAME	STATE	NUMBER OF NIGHT RACE MEETINGS PER YEAR	SURROUNDING INTERFACE
Sunshine Coast Racecourse	Queensland	15	Non-Sensitive
Toowoomba Racecourse	Queensland	37	Sensitive
Moonee Valley Racecourse	Victoria	17	Sensitive
Cranebourne Racecourse	Victoria	16	Sensitive & Non-Sensitive
Canterbury Park Racecourse	NSW	10	Sensitive
Launceston Racecourse	Tasmania	17	Sensitive
Wentworth Park (Greyhounds)	NSW	104	Sensitive

9.2 Canterbury Park Racecourse, NSW

Figure 8 - view of grandstand from turn 1

Figure 9 – View South West, pole heights up 40m

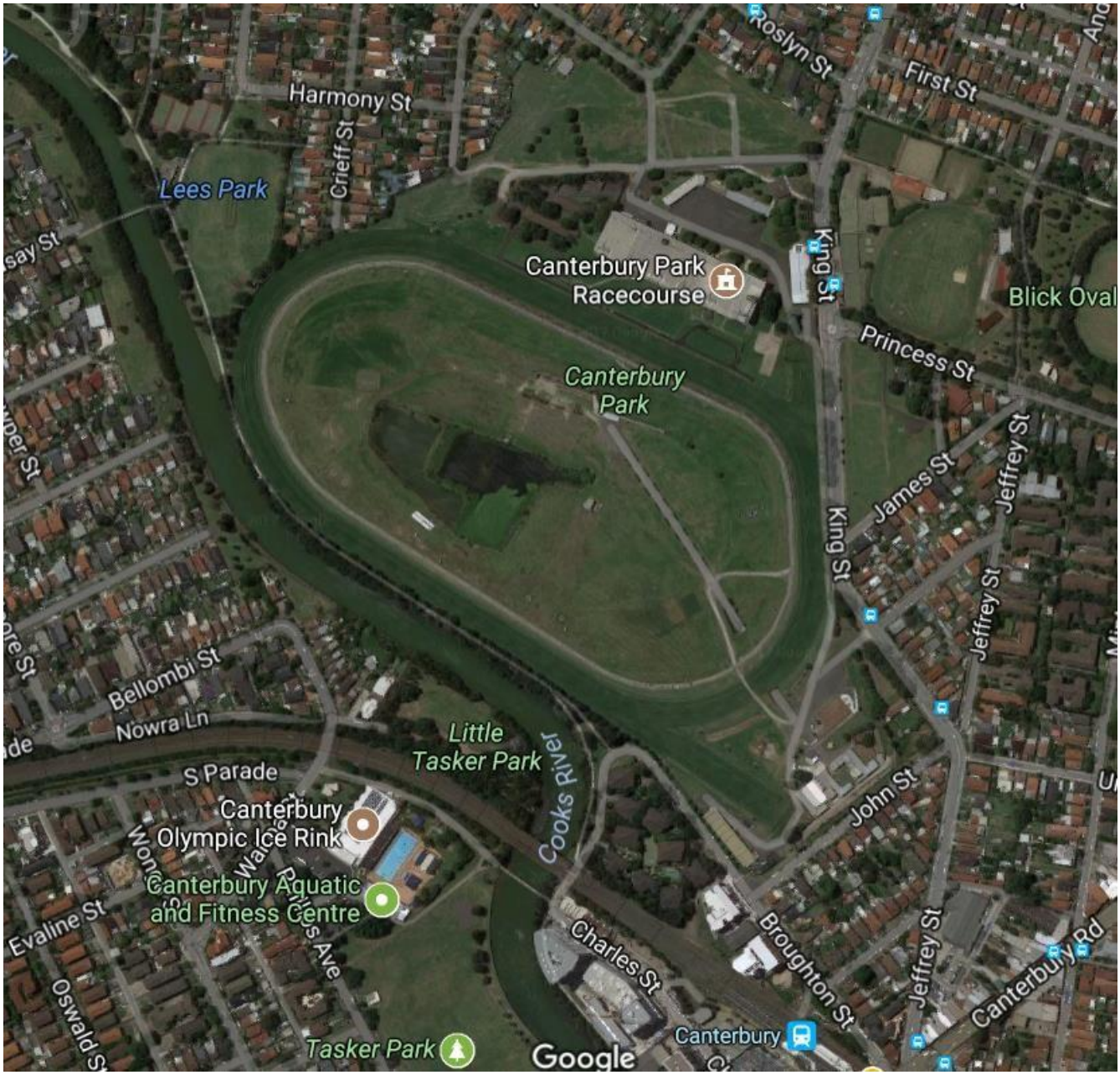


Figure 10 - Canterbury Park Racecourse at Canterbury, NSW is 11km SW of Sydney's CBD. Population 7200.

The ATC also manages the Canterbury Racecourse. This site began night race meetings in 1998. The Canterbury City Council DA 8910/97 conditions specifically related to lighting were:

- 12 race meetings per year from 5pm to 11pm;
- Bear reasonable costs associated with Council engaging monitoring experts for one meeting in the first years of operations if required;
- Lighting equipment and accessories to be non-reflective;
- Redirect or fit louvres if necessary, to prevent adverse effects to residential properties or rail users.

9.3 Survey of Canterbury Park Racecourse

Illuminance level measurements were taken with a calibrated light meter at 5m intervals at 1.5m above ground level on the relevant boundaries of the Canterbury Park Racecourse. This was carried out on Monday 11 September 2017 at 6.30pm after the metal halide lamps had been running for one (1) hour.

Boundary Number (refer Appendix E)	Boundary Location (refer Appendix E)	Lux Min at 1.5m (Ev)	Lux Max at 1.5m (Ev)	Average Lux
1	King St edge of vacant land opposite Turn 1	4	22	8
2	Back Straight (part)	112	472	292
3	Turn 3	80	324	258
4	Turn 4 & ends of Crieffe & Malleny Streets	3	80	28

9.4 Sports Grounds with broadcast lighting

Although rugby league/union and football lighting requirements are different to horse racing, there are many large sports arenas requiring broadcast lighting, successfully operating in Australia. Examples of which are shown in the following images. The images discuss pole eights and provide a comparison point for the proposed heights of poles at RRRC.

9.5 Sydney Cricket Ground

Figure 11 – Sydney Cricket Ground (close proximity to Randwick Racecourse)
Pole heights up to 60m

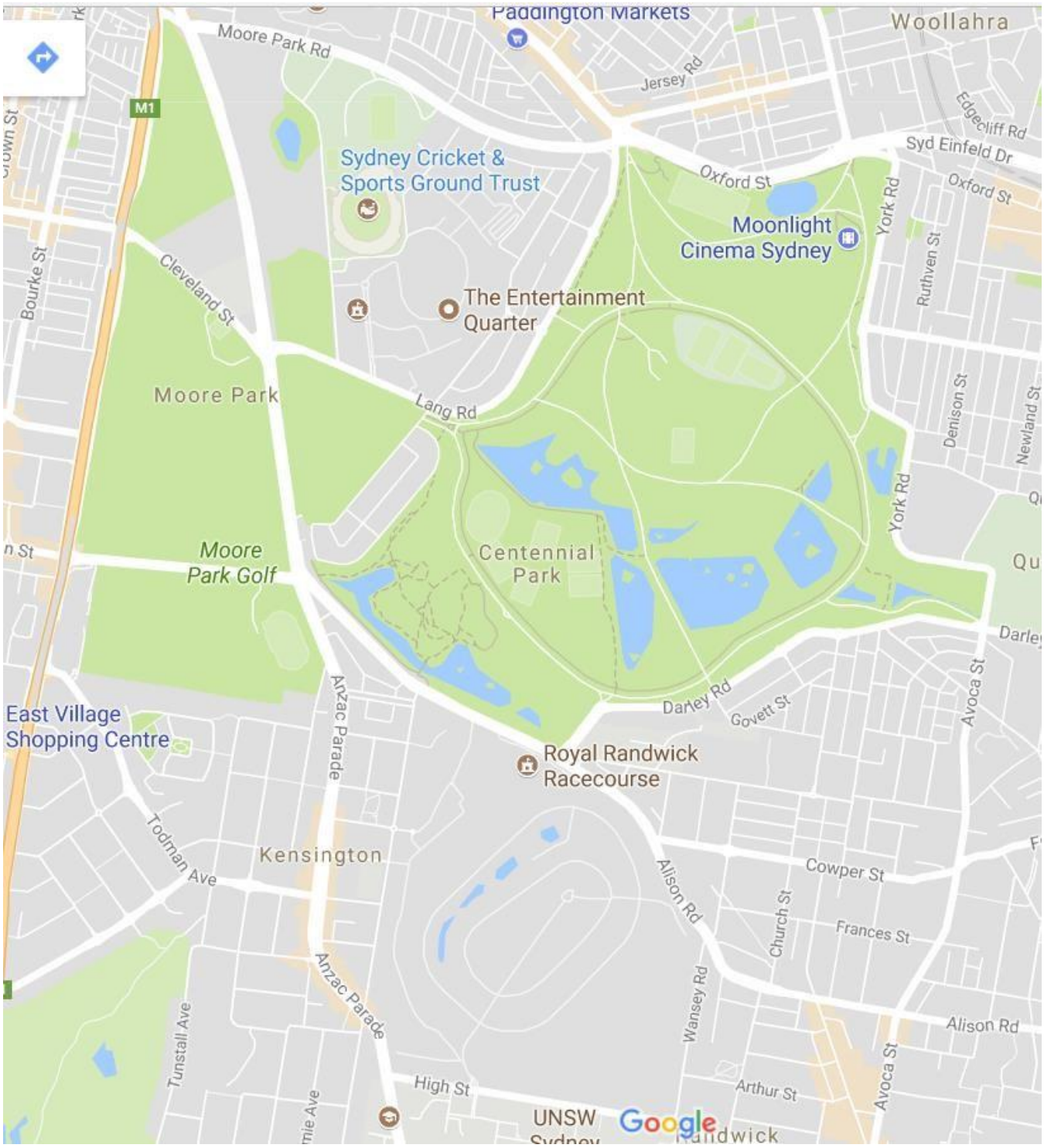


Figure 12 - Sydney Cricket Ground, Moore Park NSW, is located 3km from Sydney's CBD and is 1.5km from Randwick Racecourse. Built in 1848.

9.6 Melbourne Cricket Ground

Figure 13 - Melbourne Cricket Ground, Victoria Pole height 75m plus 10m head frame.

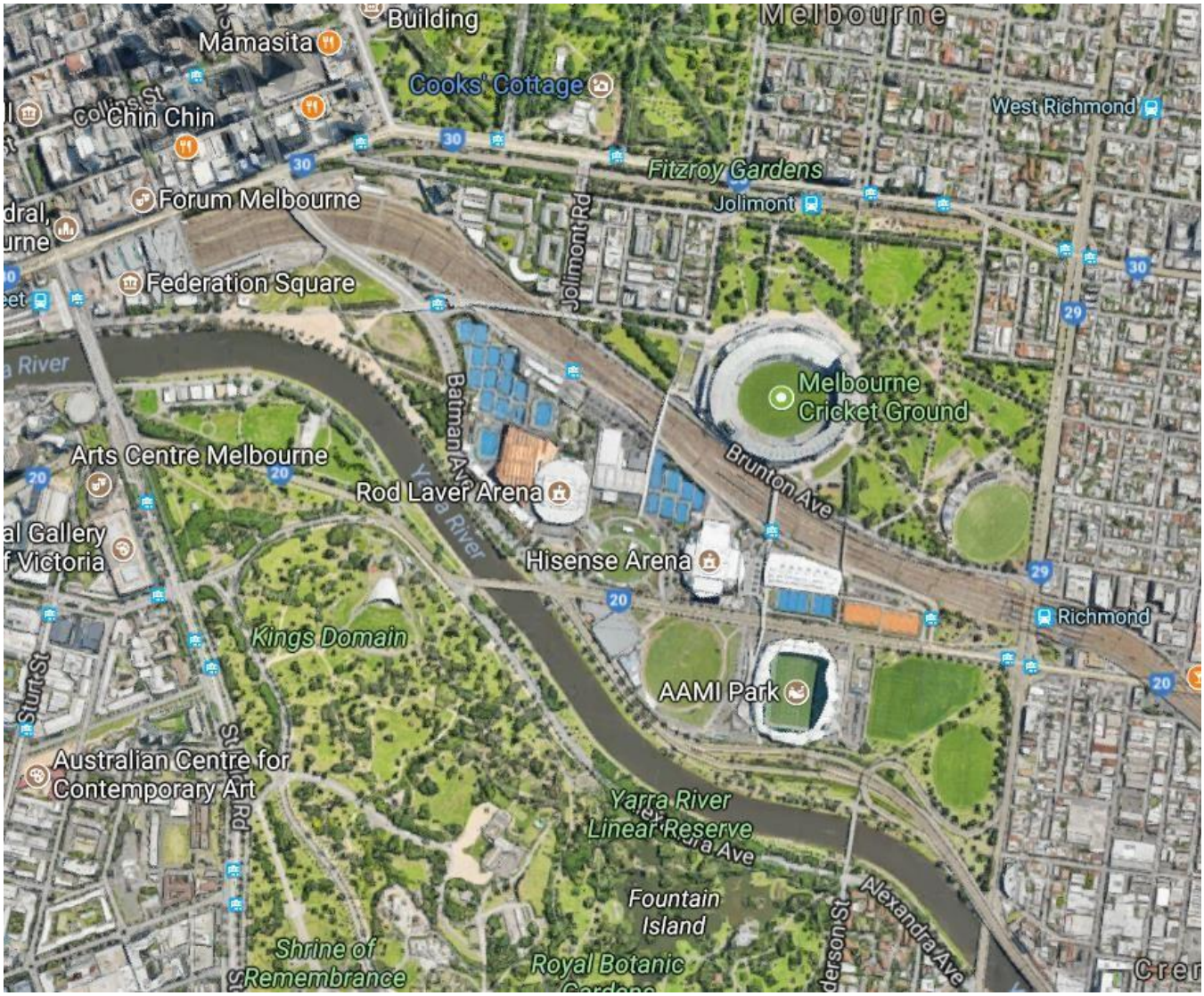


Figure 14 - Melbourne Cricket Ground, Richmond Victoria is located within the Melbourne CBD. Built in 1853 and is listed on the Victorian Heritage Register.

9.7 Proposed RRRC Installation Images

Figure 15 – View from grandstand (simulated)

Figure 16 – View from Alison Road (simulated)

Figure 17 – Night view at Meydan Racecourse, Dubai shows a similar vantage to Randwick Racecourse

10. MITIGATION MEASURES

10.1 General

Given ATC has successfully operated night racing at Canterbury Racecourse for 18 years where limited complaints have been received, and they are committed to considering the surrounding environmental impact we recommend implementing the following mitigation measures to minimise the environmental impacts of the proposed lighting design.

10.2 Control

Racecourse lighting:

- Control shall be via PC based software similar to Canterbury Racecourse with dimmable relay modules located within each MSB;
- Lights shall be enabled via 'Race Day' function (activated manually) via software controlled by PE cell at dusk to turn on at 20% (LED drivers to be dimmable); Lights shall dim up to 100% 5 mins before race start;
- The night racing lighting will be in operation for up to four (4) hours each evening and will be dimmed between races
- It is proposed races will be run typically 30 minutes apart for 5 to 6 mins. As LED technology can be easily dimmed, we recommend gradual dimming between races. Lights shall dim down to, say, 20% between races if required. Over a period of 2 minutes lights can be dimmed down to 20% to 30% of the maximum levels;
- Lights shall be extinguished or dimmed down at 10pm or as per DA / SEARS requirements;
- Potential separate switching/control of Kensington track & course proper;

Spectator Precinct:

- Lights shall turn 'on' via Photo-electric (PE) cell at dusk;
- Lights shall turn 'off' by time clock at a time to be confirmed e.g. 11pm, when spectators have left the site.

Infield Carpark:

- The area in the centre of racecourse can be used typically for overflow. Lighting will operate from dusk on race meeting nights to provide additional car parking and safe entry and egress for patrons after the night's events.

10.3 Reduction of Luminaires

AS 2560.1 Sports Lighting General Principles Definitions *Clause 1.4.1.13 Maintained illuminance (Em).*
The defined level below which the average illuminance on a reference plane of a lighting system is not allowed to fall.

This essentially means the design provides for the number of luminaires to ensure light levels do not fall below those required for the provision of television broadcasting of horse racing.

AS/NZS 1158.1.1-2005
Clause 2.10.4 Maintenance factor (MF)
The maintenance factor shall not exceed the following: b)
For IP 6X luminaires: 0.8
This factor allows for deterioration due to dirt accumulation and light loss associated with the depreciation of the luminaires and its components. This assumes regular daily use of the lighting installation.

The lighting supplier's design calculations include a MF of 0.95.

The proposed floodlights all use LED as the light source where the manufacturer's recommendations are up to 70% of the lumen output is guaranteed for 120,000 hours running time.

As the race meetings will only be held on 16 occasions per year which is less than 64 hours per annum and maintenance can be carried out during daylight or twilight hours, a realistic maintenance regime can be adopted to reduce the total number of luminaires required. This means a MF 0.95 is realistic.

10.4 Baffles / Shields

To improve the directional aiming of the individual luminaries, baffles or shields have been fitted (refer section 8.3 for examples).

These aid in reducing the spill light in certain areas and improved glare control.

10.5 Notification

Prior to each race meeting or race season, neighbouring properties should be notified with adequate time.

10.6 Commissioning and Notification

It is recommended the surrounding residents are notified when the final commissioning and aiming of floodlights is carried out as this will be required to take place at night time.

11. ENVIRONMENTALLY SUSTAINABLE DESIGN (ESD) INITIATIVES

The track and precinct lighting design will take into consideration a number of ESD initiatives. These are as follows:

11.1 LED Lighting

Both the track and augmented precinct lighting will utilise luminaires with LED lamps. These are not only more energy-efficient than the previous generation metal halide lamps but also have a longer lamp life (more than double).

11.2 Dimming of Lighting

One of the mitigation measures being proposed is that between races the track lighting be dimmed to reduce the duration of the maximum lighting effect. This will be possible since we are employing luminaires with LED lamps. The previous generation metal halide lamps could not be dimmed. The luminaires will consume less energy when dimmed.

11.3 Use of Generators

The track lighting will be supplied by diesel generators located around the course.. This will allow the lighting to be fed “off-grid’ as well as help minimise the amount of additional cabling which will be required from the existing Main Switchboards to be reticulated around the course throughout the site.

11.4 Use of Copper Cabling

All electrical cabling will be copper which is regarded as recyclable.

11.5 Use of Steel Lighting Poles

The lighting poles will be constructed from steel which is regarded as recyclable.

12. CONCLUSION

In order to illuminate the Royal Randwick Racecourse to international broadcast standard lighting levels, a lighting design was carried out using pole mounted floodlights which is typical for sports ground lighting applications.

The proposed lighting design complies with the relevant Australian Standards including AS/NZS 4282:2019.

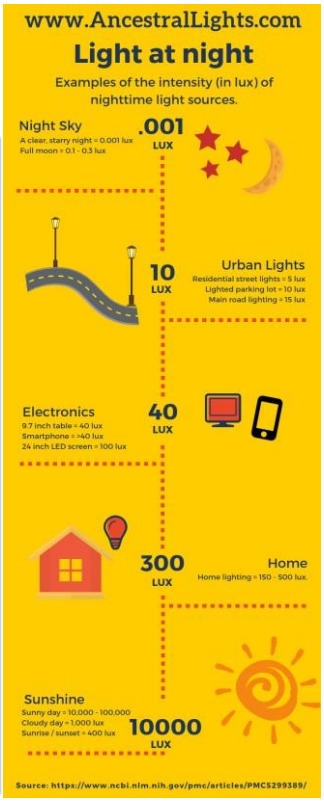
Due to the proposed lighting installation's limited number of events, the mitigation measures offered and compliance with relevant obtrusive lighting standards, the minimal light spill is considered to have acceptable impact on adjoining properties and residents.

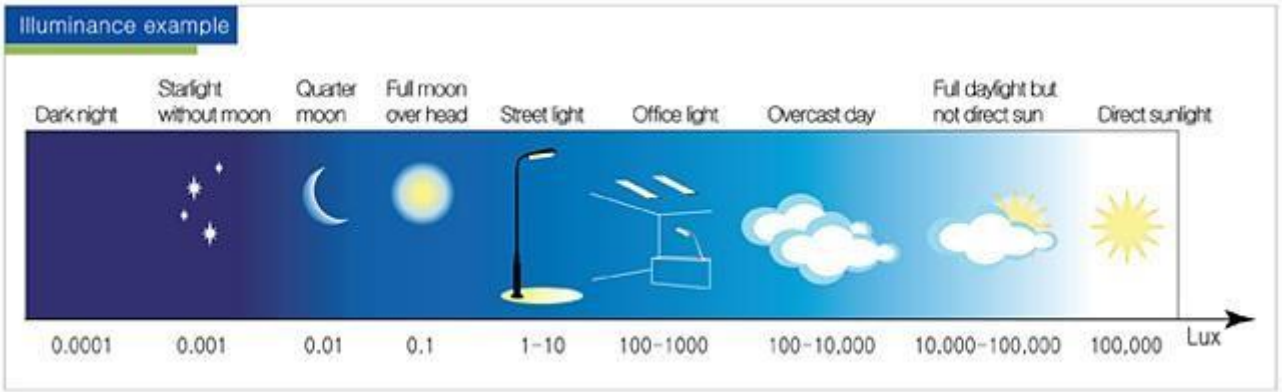
13. APPENDICES

13.1 Appendix A - Trackside Lighting Layout

13.2 Appendix B – Illuminance examples

abode Level	Illumination Level Range (LUX)	Description
0	0 - 19	Minimum security risk lighting or public area lighting with dark surrounding or street lights
1	20 - 31	Sunrise/sunset or good main road lighting
2	32 - 50	
3	51 - 81	Passageway or outside working area
4	82 - 130	
5	131 - 207	Well-lit public area or family living room
6	208 - 329	
7	330 - 523	Minimum for easy reading
8	524 - 830	Well-lit office
9	831 - 1316	
10	1317 - 2087	Overcast day or cloudy (with sun)
11	2088 - 3309	
12	3310 - 5246	Cloudy blue sky
13	5247 - 8316	
14	8317 - 13181	Clear sky
15	13182 - 20891	
16	20892 -	Direct sun





13.3 Appendix C – Isocandela curves

13.4 Appendix D – Spectator Precinct Lighting Layout