Dark Sky Planning Guideline

Protecting the observing conditions at Siding Spring

NSW GOVERNMENT

Planning and Environment

Acknowledgement of Country

The New South Wales Government acknowledges the Traditional Custodians, the First Peoples of Australia, and pays respect to Elders past, present and emerging. We recognise that Aboriginal people have unique cultural and spiritual relationships to place and their rich contribution to Country.

Published by NSW Department of Planning and Environment

Document Title: Dark Sky Planning Guideline
ISBN: 978-1-74256-001-4

First published: June 2023

Image on front cover, and image (left): Ángel López-Sánchez
Artwork (left) by Nikita Ridgeway.

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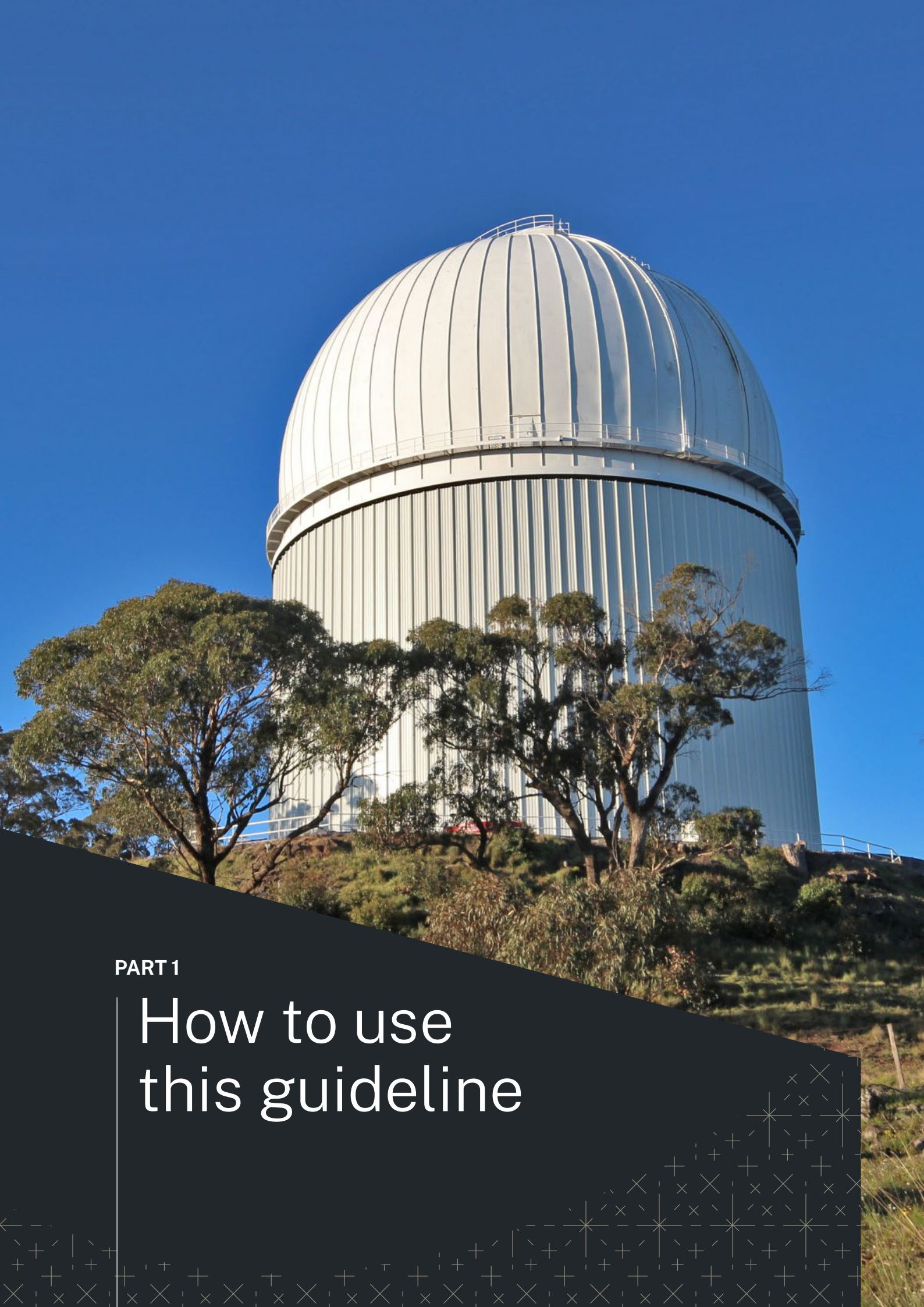


PART 1

How to use this guideline

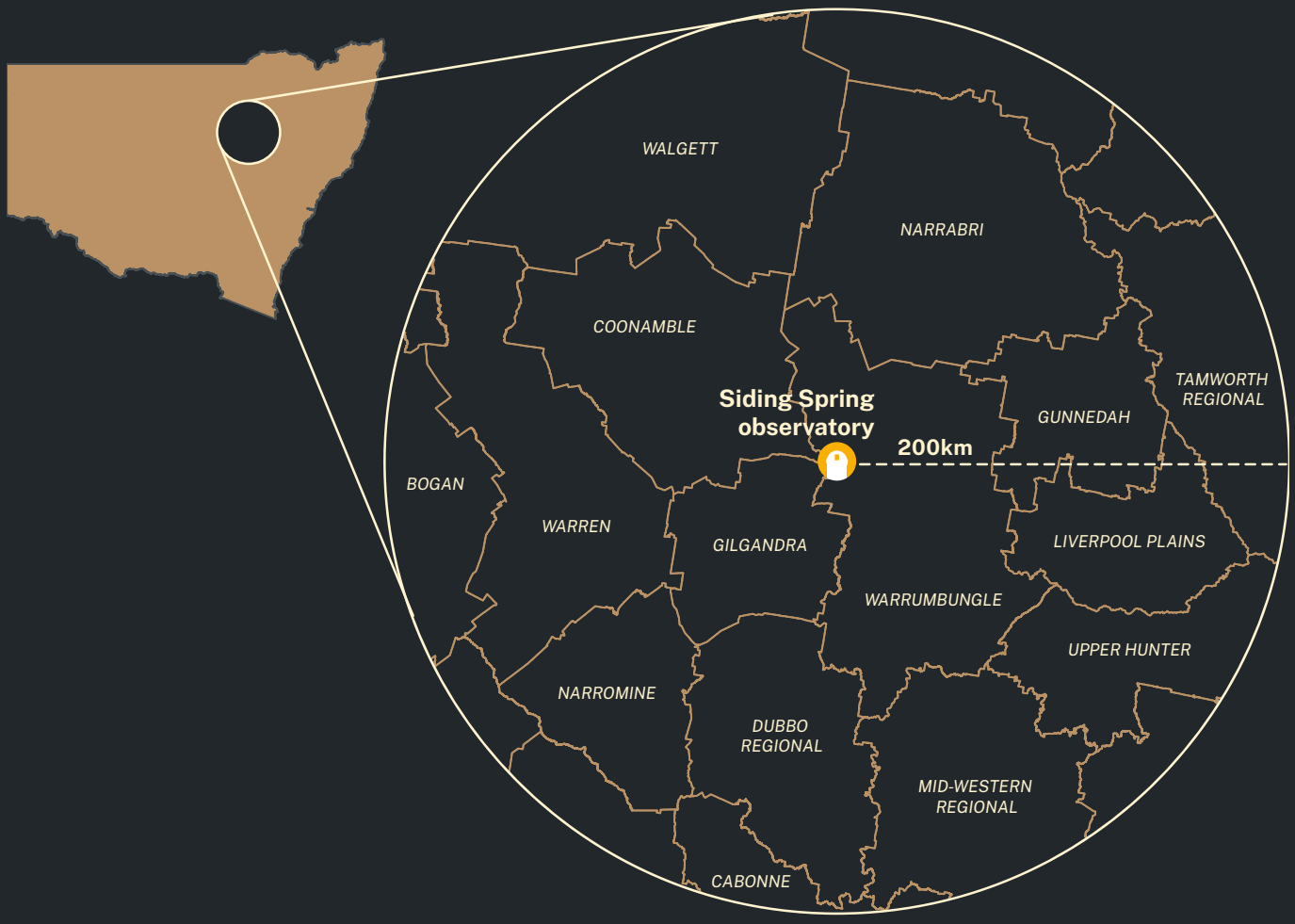


Figure 1: The Dark Sky region

1.1 Introduction

The Dark Sky Region in NSW is centred on the site of Australia's most important visible-light observatory at Siding Spring, located on the edge of the Warrumbungle National Park. The observatory has over 40 telescopes and is one of few in the world that can observe the whole southern-hemisphere sky. It is critical to our understanding of the universe and the scientific endeavours of Australian and international astronomers. Each year the observatory attracts over 24,000 visitors and injects more than $5 million directly into the local economy. Its continued operation depends on the night sky being free from light pollution. Light from developments in the Dark Sky Region has the potential to reduce how effectively the optical telescopes operate.

This guideline informs state and local government, industry and the community about managing light in the Dark Sky Region (Figure 1). It shows how we can manage light from development to reduce effects on the observatory's operation. The guideline informs development controls that apply to land within the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle, and the assessment of significant development within 200 kilometres of the observatory. It supports the design and operation of development in the region and gives key information to ensure that lighting used in development does not reduce the effectiveness of the observatory.

The observatory and the neighbouring Warrumbungle National Park are part of Australia's first internationally accredited dark sky park. The accreditation – certified by the International Dark Sky Association – gives tourists more incentives to visit the region. The certification required robust community support for protecting the dark sky and an ongoing commitment to its preservation.

This guideline gives advice and technical information on good lighting design and encourages the use of shielded, downward-facing lighting that is appropriate for its site. The management of light in the Dark Sky Region is important because the telescopes at Siding Spring Observatory need clear, dark nights to work well. Good lighting also reduces energy waste and has environmental, health and economic benefits for communities and ecosystems.

◂ The Anglo-Australian Telescope, Australia's largest on-shore optical telescope. Image courtesy of Ángel López-Sánchez.

1.2 Structure of the guideline

This guideline includes the following parts:

Part 2 – The Dark Sky Region

This part gives information about Siding Spring Observatory and how light from development in the Dark Sky Region affects its operation.

Part 3 – Factors affecting the observing environment

This part describes the key factors associated with artificial lighting that have the potential to affect the observing conditions at the observatory.

Part 4 – Good lighting design principles

This part sets out the design principles that must be considered in preparing, designing and assessing development that involves lighting.

The principles promote lighting practices that maintain a dark night sky and support the operation of the observatory as well as saving energy.

Glossary and Appendices

This part includes a glossary of key definitions, a Siding Spring Observatory location map, a table detailing the light output from common bulb types, references to resource documents and links to more information.

1.3 Who is this guideline for?

The NSW Department of Planning and Environment has prepared this guideline to:

- help planning professionals in state and local government assess development proposals
- guide planners, developers, builders and other professionals when preparing a development application in the Dark Sky Region
- inform the wider community about lighting practices that maintain a dark night sky.

Astronomy: role and importance

Astronomy is the observational and theoretical study of objects in space. It includes vast fields of knowledge in physics, chemistry and mathematics.

Professional and amateur astronomers study the whole universe, including the moon, planets, stars, galaxies, quasars and black holes. Knowledge gained from these studies helps us to understand the nature of the universe, from its origin 13.8 billion years ago to today. At the cutting edge of knowledge are profound questions on the nature of space and time, and whether there is life beyond the earth.

Astronomy is also an ancient science, associated with the earliest forms of time keeping, navigation and agricultural calendars. As a modern science, astronomy has improved our knowledge in physics and has allowed scientists to make advances in medicine, geology, solar energy, remote sensing and communications. It has stimulated the development of technologies such as digital cameras, wi-fi and laser technology. Astronomy also informs our understanding of the great care required to protect our planet's fragile environment for future generations. If astronomers can no longer study the universe from observatories like the one at Siding Spring due to light pollution, we will lose this important information and astronomical data.

1.4 When does the guideline apply?

A consent authority, such as a council, must consider the guideline when assessing development applications within the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle, under clause 61 of the Environmental Planning and Assessment Regulation 2021 (the Regulation).

A consent authority must also consider the guideline for:

- state-significant development
- designated development
- development specified in State Environmental Planning Policy (Planning Systems) 2021, Schedule 6 (regionally significant development) that is likely to affect the night sky and is within 200 kilometres of Siding Spring Observatory.

The Regulation also requires a proponent to consider the guideline when preparing an environmental impact statement for state-significant infrastructure on land less than 200 kilometres from the observatory.

Clause 5.14 of the Coonamble, Dubbo Regional, Gilgandra and Warrumbungle local environmental plans sets out the matters that consent authorities must consider when assessing development. These considerations aim to minimise light pollution and protect observing conditions at the observatory.

Lighting requirements

Lighting requirements for exempt and complying development are set out in the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 and vary depending on the distance from the observatory and the type of development proposed. Certifying authorities must ensure that the lights installed in a development comply with certain standards when issuing an occupation certificate for complying development. The consent authority must consult with the observatory director for certain types of lit development (see section 1.5 below).

The guideline will help consent authorities consider the impacts of lighting associated with a development application. To manage contribution to artificial skyglow, the consent authority may impose conditions for the:

- design of light fittings
- shielding of light
- design and operation of development
- hours of lighting operation.

Other matters to consider

Other considerations may include:

- the design of roads
- dust mitigation
- night-time operations for extractive industries, coal seam gas and other development types.

Refer to Appendix A for the possible conditions of consent the department has developed.

1.5 Consultation requirements

Consent authorities must consult with the observatory director where a development has the potential to affect the observing conditions at the observatory for large projects such as state-significant infrastructure or designated development within the Dark Sky Region.

Under the State Environmental Planning Policy (Transport and Infrastructure) 2021, proponents must consult with the observatory director for specified development that may increase the amount of artificial light in the night sky on land within 200 kilometres of the observatory. This aims to ensure that these developments apply best-practice lighting.

Clause 5.14 of the Coonamble, Dubbo Regional, Gilgandra and Warrumbungle local environmental plans (LEPs) also requires consultation with the observatory director for certain types of development. Consent authorities must also seek concurrence from the Secretary of the Department of Planning and Environment before granting development consent for a development that is likely to emit over 1 million lumens, such as supermarket car parks, sports fields, commercial stock yards and transport terminals.

We recommend that you discuss your proposal with your local council to find out if you need to consult with the observatory.

1.6 Where to find more information

Appendix D Useful publications and references has more information on the types of lighting that maintain a dark night sky and the effect of light on astronomical observations.

Where appropriate, we recommend that you consult with your local council at an early stage in the design process to ensure suitable lighting design and installation. You may need to consult with the observatory where you expect a more significant impact.

PART 2

The Dark Sky Region

2.1 Overview

This part includes information about the observatory and how light from development in the Dark Sky Region affects its operation.

The Dark Sky Region consists of the land within a 200-kilometre radius of Siding Spring Observatory (see Figures 1 and 2). Good lighting design within the Dark Sky Region supports the successful functioning of the observatory. Lighting design is important because the steady increase in light pollution from distant and nearby light sources affect observing conditions and operation of the observatory. Lights with a direct line of sight to the observatory and those which shine above the horizontal plane of a light fitting have particularly negative effects on observing conditions.

◂ Image courtesy of Ángel López-Sánchez

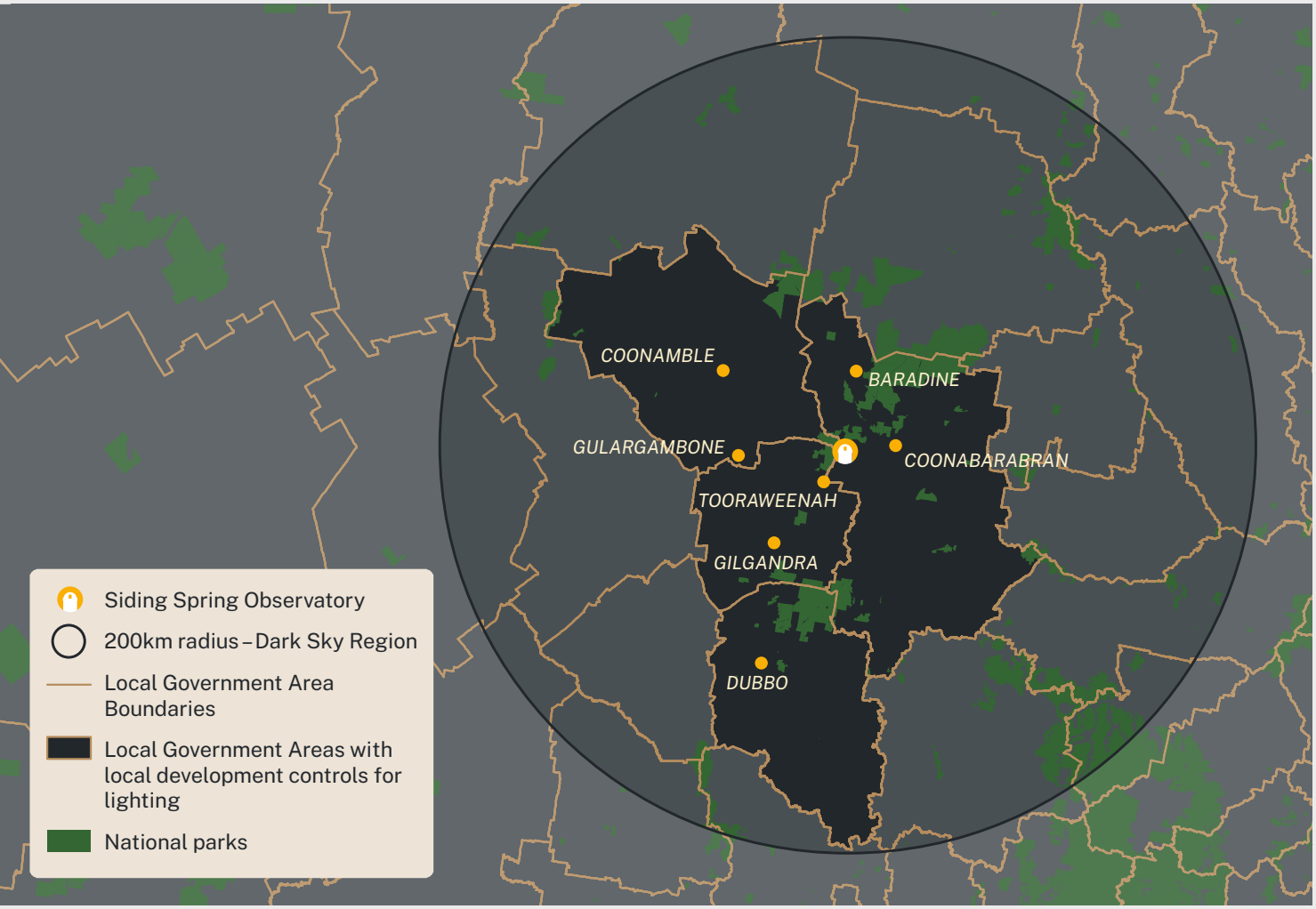


Figure 2: Map illustrating the application of local controls for lighting in the Dark Sky Region

2.2 Siding Spring Observatory

The observatory's location is an important vantage point for studying time variables and explosive phenomena such as supernovae (exploding stars), and other astronomical sources.

It is located on the eastern boundary of the Warrumbungle National Park (see Figure 2) in the Warrumbungle Range. Both the observatory and the national park are part of Australia's first internationally accredited dark sky park.

The observatory is surrounded by the flat plains of Coonamble and Gilgandra Shires and the undulating terrain of Coonabarabran. The Timor Valley is situated to the east of the observatory and comprises a mixture of rural farmland, rural residential development and undeveloped bushland.

The town of Coonabarabran is about 20 kilometres east of the observatory. Other surrounding centres include Baradine, Coonamble and Gulargambone to the north and north-west, and Tooraweenah, Gilgandra and Dubbo to the south. There are large areas of nature reserve and state forest to the north and north-east.

The telescopes at the observatory are owned and operated by a wide range of agencies including the Australian Government, Australian and overseas universities and privately funded enterprises. There are more than 40 telescopes on the site. The Anglo-Australian Telescope is the largest optical telescope in Australia and has a mirror diameter of 3.9 metres, while the 1.2-metre UK Schmidt Telescope is the third largest wide-angle telescope in the world. Both telescopes are operated by the Australian National University. Other large telescopes on the site include the university's 2.3-metre Advanced Technology Telescope and the 2-metre Faulkes Telescope South, which provides internet-accessible observing services for schools. Despite advances in the exploration of the universe from space, there will always be a need for ground-based facilities.

▲ Image courtesy of Ángel López-Sánchez

2.3 The impact of light on the observatory

In the night sky, there are 2 types of light: natural and artificial. Both contribute to skyglow that affects astronomical observations.

Natural skyglow is the brightness of the night sky that is created by natural light sources such as the sun and the moon. It is primarily caused by activity in the upper atmosphere and occurs in the night sky regardless of light from any human-made structure.

The darkness of the sky varies with natural events, but the benchmark of natural skyglow is the amount measured at the minimum of the solar cycle, when the sky is at its darkest.

Artificial skyglow is the brightness of the night sky created by light from human-made sources.

It is the result of light from urban and regional development that is scattered and has interacted with molecules, aerosols and particulate matter in the atmosphere. Outdoor lights that shine into the night sky increase artificial skyglow the most. Interior lights can also contribute where windows, skylights or openings are uncovered.

Advances in astronomy rely on the use of telescopes to detect and observe very faint objects in the depths of the universe. Discoveries and measurements of such objects by large telescopes need a pristine sky, free from light pollution. Increased artificial light in the night sky mean that at some of the world's major observatories, particularly in the northern hemisphere, faint objects can no longer be observed.

2.4 Impact of existing and future development on the observatory

NSW has one of the highest levels of light pollution in Australia. In the Dark Sky Region, lights from large urban centres, rural towns and developments, significant infrastructure and resource projects are visible from the observatory. The growth of towns and industries in the Dark Sky Region presents challenges for ensuring the dark night sky is free from light pollution and increased levels of atmospheric dust.

It is through the development assessment process that the applicant and the consent authority consider the effects of lighting associated with development. Part 4 of this guideline gives the design principles that apply to lighting, which the applicant must consider when preparing a development application, or an activity under the State Environmental Planning Policy (Transport and Infrastructure) 2021.

Rural development

Many activities associated with agriculture in the surrounding rural area, including grazing livestock and producing crops, generally emit only low levels of light into the atmosphere and have a minimal impact on levels of artificial skyglow. Rural industries and intensive livestock agriculture operations including greenhouses, dairies, feedlots, piggeries and poultry farms generally require more significant levels of lighting and, if not properly shielded, are likely to contribute to artificial skyglow.

Dust associated with rural industries and some extractive industries can disperse light at night. The design and management of sites and development must minimise dust to reduce light pollution.

Urban development

Urban development, including sports fields, industrial and commercial buildings, housing, advertising signage and street lights, has a significant effect on the level of artificial skyglow. The nearest urban centre in the Dark Sky Region is the town of Coonabarabran, which is about 20 kilometres east of the observatory. Other nearby urban areas include Baradine, Coonamble, Narrabri, Gunnedah, Tooraweenah, Gilgandra and Dubbo. Because they are near the observatory, light-generating activities associated with the growth of housing and industry in these areas have the potential to significantly increase levels of artificial skyglow.

This guideline sets out the reasons for development standards within the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle. It also helps proponents, planners and consent authorities consider if a development is likely to hinder observing conditions at the observatory.

Illuminated signage

Illuminated signage can contribute significantly to artificial skyglow and has the potential to increase with the emergence of high-efficiency, high-output lighting such as light-emitting diodes (LED) lighting. Consideration of lighting design and operation is especially important for this type of lighting.

There are several types of illuminated signs, including LED signs, fluorescent tubes and those that are illuminated from the interior. While it is hard to shield these signs because of their orientation, proponents can reduce the impact on the night sky by adopting the following:

a. Luminance level

Signs must comply with *AS/NZS 4282, Control of the obtrusive effects of outdoor lighting*. During night hours, signs should not be illuminated within 18 km of the observatory.

b. Monitoring

Owners of illuminated signage should continuously monitor signs including the reliability of hardware, software, network and other support infrastructure.

▲ Image courtesy of Ángel López-Sánchez

c. Size limits

Larger illuminated signs have a proportionally greater effect on the night-time environment. The size of a sign should be appropriate for its purpose.

d. Shielding

Where practical, a roof or shield should be constructed over the top of the sign. This does not eliminate all upward light spill but can reduce it.

e. Light curfews

Where practical, light curfews should be adopted. This can include the use of timers which switch off the illuminated sign at a certain time, for example after 9.00pm.

Skylights and solar tubes

Skylights and solar tubes can let light inside a house escape outside. To prevent light escaping into the night sky, skylights should be fitted with automated blinds and solar tubes with shutters.

A skylight or roof window is not permitted as exempt or complying development on land within the local government areas of Dubbo Regional, Coonamble, Gilgandra and Warrumbungle.

Mining and extractive industries

Other major emitters of light in the Dark Sky Region include mining and extractive industries, in particular gas flares on gas fields. The operation of these projects must maintain clear skies and consider air quality, dust emissions and night-lighting impacts, including light from flares, rail or truck movements. Night operation of this development has the potential to increase skyglow and will need effective management.

Exempt and complying development

Exempt and complying development carried out under the State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 also has certain limitations, exclusions and specific development standards for lit development within the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle.

PART 3

Factors affecting the observing environment

3.1 Overview

This part describes the ways artificial lighting can affect the observing conditions at the observatory.

There are 4 key factors:

- the distance between the light source and the telescope
- the quantity of light
- the type of light emitted
- the direction in which the light shines.

These factors are measurable and can be considered and managed in land use and development assessment.

3.2 Distance between the light source and the telescope

The distance between the light source and the telescopes at the observatory is the most critical factor in determining the level of artificial skyglow. Sky brightness reduces rapidly the farther the light source is from the observatory. For example, the impact of light emitted from a single dwelling 1 kilometre from the observatory can be comparable to 150 dwellings located 20 kilometres away.

Lighting areas

To control the impact of lighting from development within critical distances of the observatory, 3 different lighting areas are applied to land in the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle. These areas are defined by clause 5.14 of each council's LEP as:

a) 0 km to 12 km from the observatory
–where a maximum of 4 shielded outside lights of no more than 900 lumens each is appropriate

b) 12 km to 18 km from the observatory
–where a maximum of 4 shielded outside lights of no more than 1,800 lumens each is appropriate

c) Farther than 18 km from the observatory
–where a variety of light controls apply, relevant to the type of development and the potential impact on the observatory.

A Siding Spring Observatory Location Map in Appendix C illustrates the 0 km to 12 km and 12 km to 18 km radii from the observatory.

On land more than 18 kilometres from the observatory, a dwelling, secondary dwelling, or each dwelling in a dual occupancy, must have no more than 7 shielded outside light fittings with at least 2 of these light fittings automatically activated by a sensor. A household should not have more than 5 outside lights that are not activated by a sensor. These measures ensure that light emitted from both an individual development, and the cumulative effect of light emissions, do not hinder the observing conditions at Siding Spring Observatory.

Within 18 kilometres of the observatory, certain unlit developments are permitted as exempt development. This includes fencing, cubby houses, unlit greenhouses, mailboxes and other low-impact development.

A development requiring lighting within 18 kilometres of the observatory will require a development application and its design must incorporate measures to manage light pollution.

Skylights and roof windows

A skylight or roof window is not permitted as exempt or complying development on land within the 4 local government areas. A skylight or roof window may be considered as part of a development application and conditions attached to a consent. For example, skylights may be permitted if they can be fully blocked out with a blind. Skylights (including 'solar tubes') can let light in the house escape outside. To prevent light escaping into the night sky, skylights can be fitted with blinds and solar tubes can be fitted with shutters.

◂ Image courtesy of Ángel López-Sánchez

Night use → Day use

Kelvin colour temperature	2700K	3000K	3500K	4100K	5000K	6500K
Associated effects and moods	• ambient • intimate • personal	• calm • warm	• friendly • inviting	• precise • clean • efficient	• daylight • vibrant	• daylight • alert
Appropriate applications	• living / family rooms • commercial / hospitality		• kitchen / bath • Light commercial	• garage • commercial	• commercial • industrial • institutional	

Most preferred → Least preferred

Table 1: Colour temperatures and appropriate uses
Note: LEDs can produce any colour temperature, but warm colours are preferred.

3.3 Quantity of light

The observing conditions at Siding Spring are directly affected by small amounts of light within the Dark Sky Region.

The effect of individual sources of light on the level of artificial skyglow is cumulative. Detailed computer modelling can estimate the cumulative effect of artificial light on the level of skyglow at any given landmark.

At the observatory, a threshold figure of 10% of the natural skyglow at 30 degrees above the horizon has been adopted as the maximum tolerable level of artificial light.

The Astronomical Society of Australia has ratified this threshold, which is critical to assessing impacts on observing conditions at the observatory.

For development with 24-hour operations, proponents must implement night-lighting measures to manage cumulative impacts.

The table in Appendix B of this guideline gives the quantity of light associated with bulb types, expressed in lumens.

3.4 Type of light emitted

A variety of light bulbs are available for different applications. The most common bulbs used for outdoor lighting include LEDs, high-pressure sodium, low-pressure sodium, fluorescent and incandescent.

The major difference between the types of bulbs is the distribution in light wavelength. This accounts for the different colour of light. For example, a high-pressure sodium bulb gives a peach-coloured light, while a metal halide bulb produces a whiter light.

The perceived colour of light, ranging from blue to white and yellow is referred to as colour temperature.

As the atmosphere scatters blue-rich light the most, outdoor lighting should have a colour temperature below 3,500 Kelvin to reduce the effect of light on the observing environment. Table 1 gives information on light colour temperature.

3.5 Direction of light

Changing how a light fitting is mounted and aimed can reduce artificial skyglow.

When light shines below the horizontal plane of the light fitting, there is a dramatic reduction in the level of artificial skyglow produced. The design of light fittings and buildings, and the use of landscaping, can also support good lighting outcomes, directing light where it is needed. Local suppliers now stock a range of shielded light fittings for residential, commercial and industrial applications.

To control spill light, it is better in most situations to select a greater mounting height, a narrow beam and an appropriate vertical aiming angle (refer to Figure 3).

On average, 14% of light that is shielded is reflected off surfaces into the sky. The amount reflected varies greatly, depending on the type of surface. For example, a clay tennis court will reflect much more than a bitumen road. The reflective properties of ground and wall surfaces should also be considered to minimise reflected light.

Particles of dust in the atmosphere also affect the direction in which light travels. When lit, fine particles of dust scatter light, which may contribute to skyglow. Where development has the potential to generate dust, the proponent must carefully consider lighting design to ensure that dust will not be illuminated. Figure 4 depicts dust particles redirecting light towards the observatory.

Where dust emissions could affect observing conditions at Siding Spring, proponents and consent authorities should implement measures to minimise dust, including through conditions on an approval.

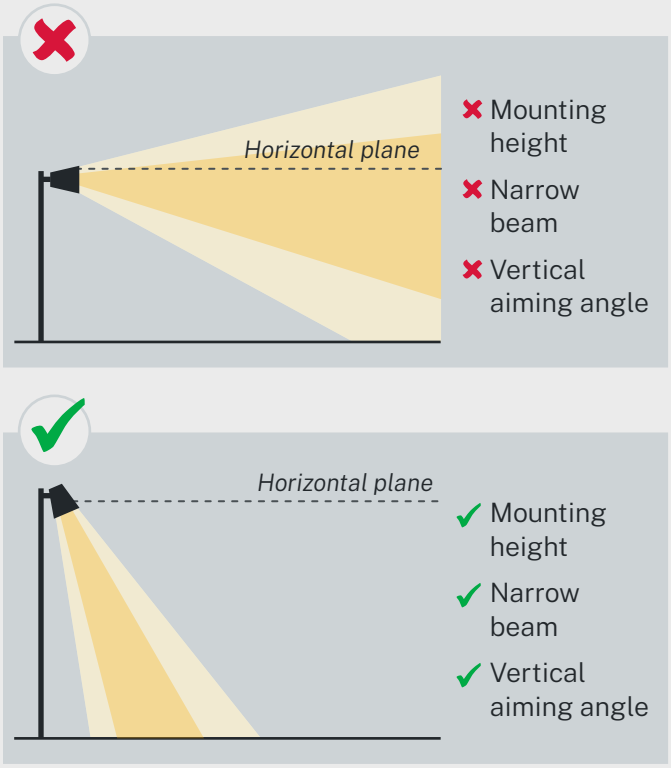


Figure 3: Application of mounting height and vertical aiming angle to control light spill

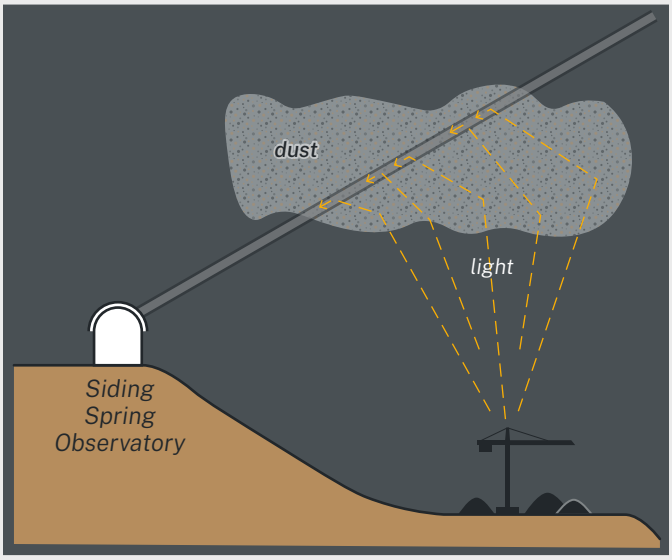


Figure 4: Scattering of artificial light by dust in the atmosphere

PART 4

Good lighting design principles

4.1 Overview

This part sets out the design principles that proponents, consent authorities and planners must consider when preparing, designing and assessing development.

Good lighting design follows the following principles:

1. Light must have a clear purpose
2. Eliminate upward spill light
3. Direct light downward, and avoid light trespass
4. Use shielded fittings
5. Avoid excess lighting
6. Switch lights off when not needed
7. Use energy efficient bulbs
8. Use asymmetric beams
9. Direct lights away from reflective surfaces
10. Use warm white colours

◂ Image courtesy of Ángel López-Sánchez

4.2 The design principles

Principle 1 Light must have a clear purpose

Before installing or replacing a light, decide if the light is needed. There must be a clear justification; lighting should serve a beneficial purpose and not be unnecessary.

Consider how the use of light will affect the surrounding area. Lighting should be appropriate for its setting and not light beyond where it is needed.

Common purposes for lighting include safety (road lighting), lighting an activity (sports field lighting) or creating an ambiance. Table 2 lists typical levels of light associated with common outdoor activities.

Before installing or replacing a light, consider the purpose of the light by deciding:

- when the light is used
- how the use of light will affect the surrounding area
- where the light should be directed.

If there are alternative sources of light (torches, indoor light spill, fluorescence, cats' eyes, etc.) or if the light is used rarely, consider if permanent lighting is necessary. If you do need to introduce light, it should be appropriate for its setting in luminance and intensity and light only where it is needed.

◂ Image courtesy of Ángel López-Sánchez

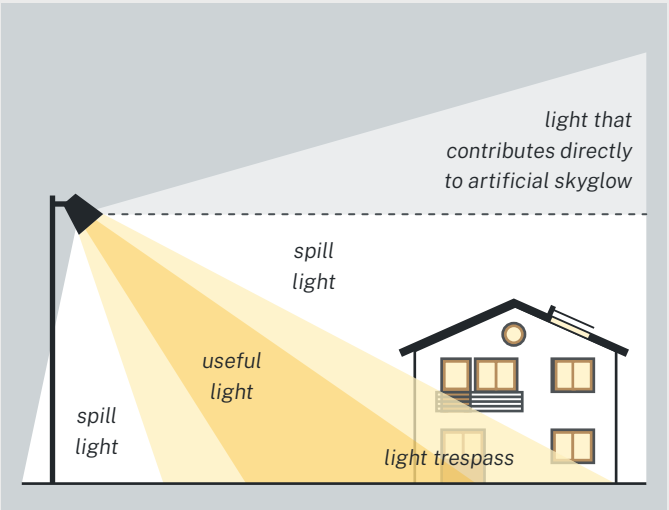


Figure 5: Common aspects of light pollution

Principle 2 Eliminate upward spill light

Spill light is light that falls outside the area that you intend to light. Spill light from the internal and external lighting of a development can cause glare, light trespass (see Figure 5), and wastes energy. Spill light above the horizontal plane contributes directly to artificial skyglow.

All light fittings should be located, aimed or shielded to avoid lighting unintended areas, especially above the horizontal plane of the light fitting (see Figure 5).

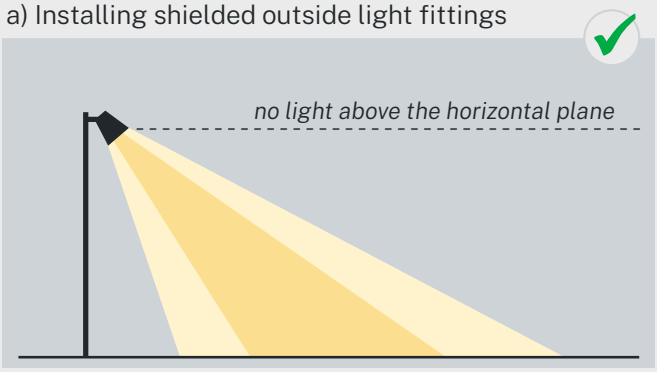
Proponents can prevent light from shining above the horizontal plane by:

- installing light fittings with an opaque cover and flat glass, mounted horizontally on both axes
- mounting the light under part of a building such as an awning, verandah or roof, so that light is blocked from shining above the horizontal plane
- designing buildings to internalise light and prevent it from escaping into the night sky
- using a blind or shutter to prevent light escaping from skylights and solar tubes

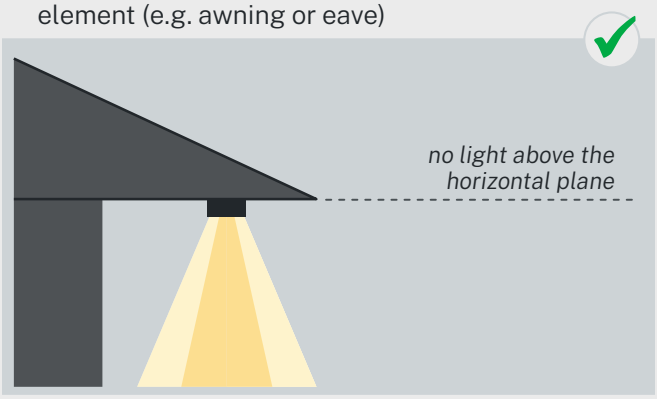
Adequate measures to avoid and minimise interior light escaping through windows, roof windows, sliding doors and skylights include full block-out curtains, blinds or shutters. Consent authorities should impose suitable conditions to manage the spill of internal light into the night sky.

Figure 6 gives design solutions to minimise light spill above the horizontal plane. Figure 7 shows examples of upward light spill ranging from the worse case to the best.

a) Installing shielded outside light fittings



b) Installing outside light fittings under a building element (e.g. awning or eave)



c) Using building design e.g. verandahs and block-out blinds to control the spill of internal lighting

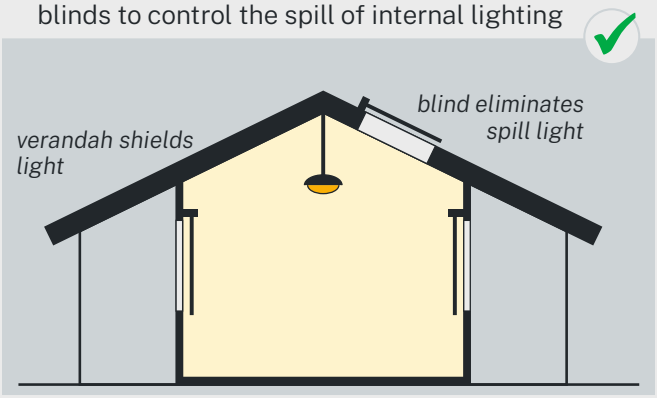


Figure 6: Design solutions to minimise interior spill light above the horizontal plane

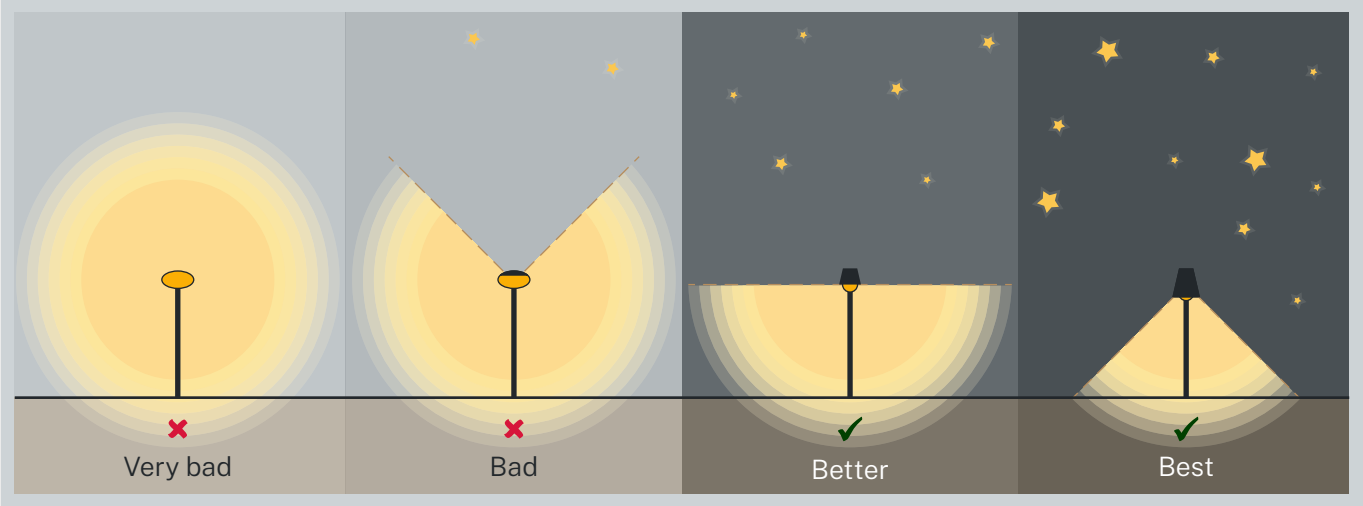


Figure 7: Examples of upward light spill ranging from the worst case (left) to the best case (right)

Principle 3 Direct light downwards and avoid light trespass

Wherever possible, light should be directed downwards, not upwards. This includes light used for roads, public amenities and the vertical lighting of structures such as advertising boards and building facades. If there are special reasons that make up-lighting necessary, proponents must show that the light will not spill into the night sky. This may be achieved by using a wide overhang to the building that stops the light shining directly into the night sky or by moving the lights to shine down the building façade to achieve the same effect.

Directional fittings (for example, floodlights, spotlights and sign lights) should be installed so that they do not shine directly into a neighbouring residence, onto a roadway, skyward or outside a property boundary. They should also be installed in such a way that they do not shine directly up into skylights, solar tubes or roof windows.

To keep glare to a minimum, use higher mounting heights that allow lower main beam angles that are closer to vertical.

The lighting of all night operations such as mines, extractive industries and intermodal hubs need to be downward-facing, peach-coloured and shielded. Where strong light is needed or there are gas flares or burning associated with the development, proponents must consult with the observatory director to find an appropriate way to light the development.

Principle 4 Use shielded fittings

Proponents should use light fittings that are designed to minimise light shining near or above the horizontal plane.

Shielded fittings are those that do not allow any light above the horizontal plane. Figure 8(a) shows a fitting with a completely exposed bulb, allowing light to shine in all directions. Figure 8(b) shows a bulb that has a partial shield, minimising light above the horizontal plane and 8(c) shows a shielded fitting that allows light to project downward only. The shielded fitting is the preferred design in the Dark Sky Region.

Figure 8: Shielding characteristics of light fittings

To verify the effective light distribution or shielding characteristics of a light fitting, refer to the manufacturer's specifications.

In some urban locations, particularly within heritage conservation areas, outdoor lights have a decorative cover. These designs may leave the bulb completely exposed and allow light to shine in all directions. To minimise light spill, the bulb should be fitted into the top of the fitting, allowing only the downward projection of light (see Figure 9).

Lighting suppliers stock a range of shielded light fittings suitable for residential, commercial and industrial applications.

If a supplier cannot provide a shielded fitting, a shielding device should be applied. Most outside light fittings are equipped with or are capable of being fitted with a baffle, visor or hood to ensure light is appropriately directed (see Figures 10 and 11).

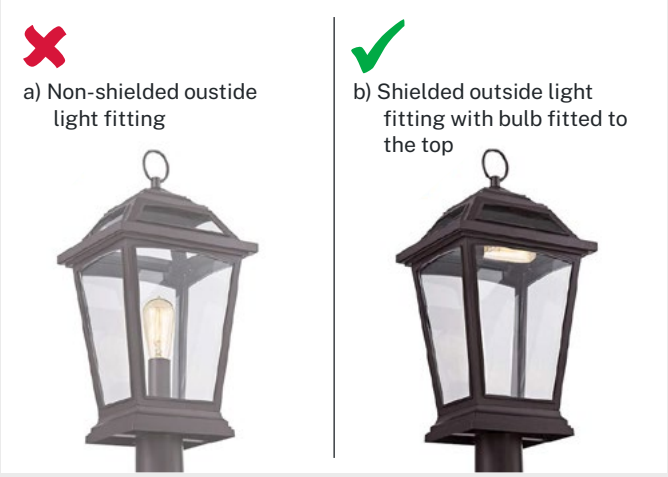


Figure 9: Exposed bulb that allows light to shine in all directions and a fitting designed to minimise light spill by only allowing downward projection of light

Figure 10: Floodlight fitted with shielding attachment

Figure 11: Floodlight that incorporates shielding in the fitting design (no attachment necessary)

What is a light fitting?

A light fitting, or luminaire, is the complete lighting unit. It includes the bulb, elements designed to give light output control such as a reflector (mirror) or refractor (lens), the ballast, housing and the attached parts.

Where multiple light fittings are mounted on a single base, as illustrated in (b) below, these are to be counted as additional light fittings. For example, a dwelling with 7 outside light fittings may have 3 type (a) light fittings and 2 type (b) light fittings, of which 2 must be automatic light fittings.

Principle 5 Avoid excess lighting

To avoid excess lighting, select a suitable bulb type and light the area used for the task, rather than lighting the broader environment.

Improvements in technology mean that many new bulb types produce significantly more light while using equivalent or smaller amounts of energy. Halogen bulbs produce more light than standard incandescent bulbs for the same energy use. LED lights produce between 2 and 5 times the amount of light as incandescent bulbs. Careful selection of bulb type will ensure the amount of light produced is appropriate for what is needed.

Self-illuminating signs also have the potential to significantly contribute to artificial skyglow. Self-illuminating signs come in several types. They can be internally lit, made of fluorescent tubes that have been bent into words or other shapes, or be LEDs. LEDs are becoming more common. While it is hard to shield these signs, proponents can reduce the effect on the night sky by:

- turning lights off at night if they are not needed
- using the night setting of LED lights when they are on at night
- adding a roof over the top of the sign. This does not eliminate all upward light spill, but it can reduce it

The amount of light produced (lumen), rather than the amount of energy used (watt) is the most important consideration in ensuring that an area is not lit excessively. Table 2 gives an appropriate light output for common activities as a guide. For common bulb types and their associated lumen output, refer to Appendix B.

Table 2: Typical levels of outdoor lighting for common activities

Activity type	Lumens emitted
Dwelling	1,800 to 7,200
Single porch light	900
Tennis court (domestic purposes)	100,000
Farm building	1,800 to 7,200
Single security light	900 to 4,000
Swimming pool	12,000
Public open space /small car park	12,000
Small sports oval (single field)	1,000,000
Road lighting	Refer to *AS/NZS 1158*
Rural industries	Less than 1,000,000
Stockyards (commercial)	Less than 1,000,000
Mining and extractive industries	More than 5,000,000
Advertising signage (externally lit)	1,800 to 7,200
Small motel or commercial building	12,000
Recreational, decorative, promotional and special events lighting	No greater than necessary

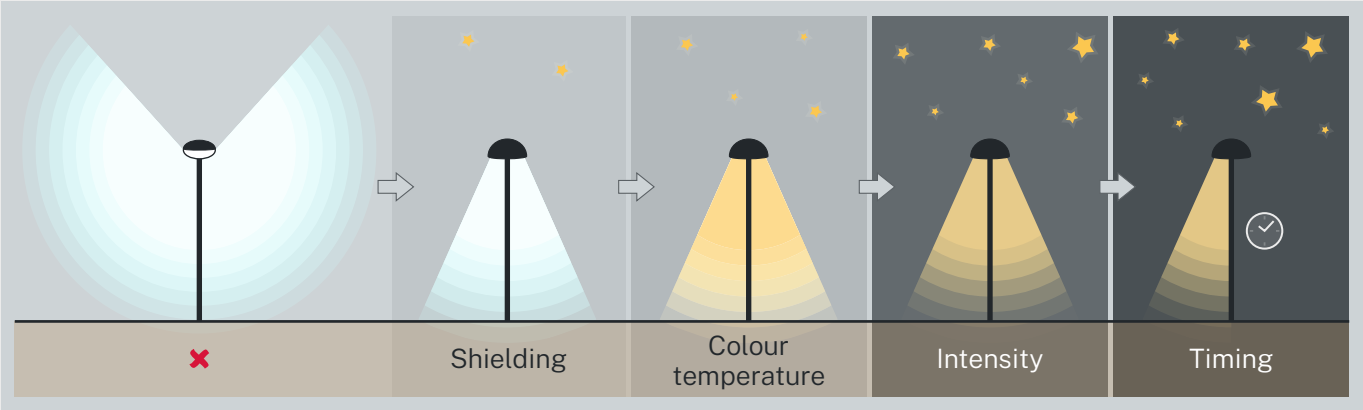


Figure 12: Key lighting terms

Principle 6 Switch lights off when not needed

Lights should be switched off when they are not needed. We encourage the use of light curfews, which restrict the hours of lighting. Examples include extinguishing or dimming advertising, decorative lighting and illuminated signage after 9.00 pm. We also encourage using light fittings with timers that switch on at dusk and switch off by 9.00 pm.

We also encourage using lights that are activated by a sensor and switch off automatically after a period as they reduce the cumulative amount of light emitted from development. This is beneficial for the observatory and reduces energy waste.

Where night lighting is necessary – for example, for development with 24-hour operations or for safety and security purposes – proponents need to take measures to manage cumulative impacts.

Principle 7 Use energy efficient bulbs

Improvements in technology mean that many bulb types use significantly less energy to produce the same amount of light.

Energy efficient globes include LEDs, metal halide, induction bulbs, high-pressure sodium, linear and compact fluorescent. High-pressure sodium lights emit a peach-coloured light and are suitable for various applications. They are energy efficient and have a lower impact than white lights.

White lights such as LEDs, modern fluorescent lights and metal halide lights should be used where recognising colour is important, including pedestrian crossings, major road intersections and sports grounds. Blue-white mercury bulbs have commonly been used for roadway lighting, but are no longer permitted in new installations.

An Australian Standard (*AS/NZS 1158*) addresses lighting for roads and public spaces, including parks and gardens, and must be applied, where relevant.

Principle 8 Use asymmetric beams

Where floodlights are needed – for example, sports lighting applications and commercial stock yards – use fittings with asymmetric beams that permit horizontal glazing wherever possible. Keep these at or near parallel to the surface being lit, usually the ground. Only light the area that needs to be lit, preventing spill light (see Figure 13).

An asymmetric beam also allows the light fitting to be mounted on the edge of an area and avoids the need to tilt fittings upwards. Install flat glass light fittings with the glass horizontal to make efficient use of the brightest part of the beam, eliminate spill light and minimise light trespass.

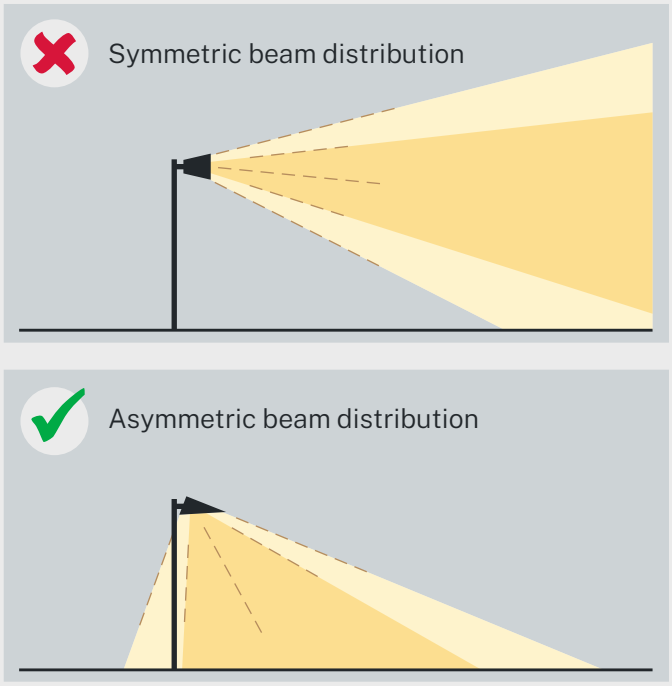


Figure 13: Appropriate floodlighting design includes use of an asymmetric beam

Principle 9 Direct lights away from reflective surfaces

At the design stage, it is preferable to select surfaces with a low level of reflectivity near outdoor lighting, compatible with the area's function.

Illuminance is a measure of the amount of light reflected by a surface and is determined by its reflective properties. Where a natural grass surface is used, the illuminance will be low, but may be significant where the surface is relatively light in colour – for example, uncoloured concrete, artificial grass with sand infill or light-coloured walls. Table 3 gives a guide to the reflective properties of common surfaces.

Table 3: Reflective properties of common surfaces

Surface	Reflective properties
Natural grass and vegetation	Low
Painted surface (dark)	Low
Pre-coloured factory metal (dark)	Low
Brick (dark)	Low
Raw or stained timber	Medium
Stone surface	Medium
Uncoloured concrete	High
Painted surface (light)	High
Artificial grass (sand base)	High
Pre-coloured factory metal (light)	High
Brick (light)	High
Coated steel (unpainted)	High

Principle 10 Use warm white colours

Use warm-coloured light bulbs. Avoid using cool, blue-rich, high-colour temperature bulbs, as these create the most light pollution.

Table 1 gives more information on colour temperature.

Compliance for existing light installations

Where an existing lighting installation is inconsistent with these guidelines, one or more of the following measures may be necessary:

a. To reduce light spill, adjust the lighting horizontally by reducing the aiming angle.
b. Replace the bulb with a lower output one to improve lighting control.
c. Install a device such as hood, screen or louver to reduce emission of high-intensity light.
d. Use physical barriers to reduce light spill – for example, trees, fences, earth mounds, shade cloth or screens.

Where existing fixtures are replaced, the project should show how it will reduce light pollution, or at a minimum, not increase it.

Glossary

Artificial skyglow is that part of the night sky's brightness that is caused by human-made sources of light.

Baffle is an opaque or translucent element to shield a light source from direct view, or to prevent light reflecting from a surface such as a wall.

Brightness is a subjective sense of how strongly a lit surface emits light to the naked eye.

Bulb is the source of electric light and is a part of a light fitting, not a light fitting on its own.

Candela is the international unit of measurement for the intensity of light. A candle emits light with a luminous intensity of approximately one candela.

Colour temperature is the perceived colour of a light source ranging from cool (blue) to warm (yellow), measured in degrees Kelvin (K). A low colour temperature such as 2,500 K will have a warm appearance, while 6,500 K will appear cold and harsh.

Horizontal plane means the horizontal plane passing through the centre of the light source (for example the bulb) of the light fitting.

Illuminance is the amount of light reflected from a surface.

Incandescent bulb is a bulb that gives light by using an electric current to heat a filament to a high temperature.

Intensity is the amount of energy or light in a given direction.

Light is the radiant energy that is visible to humans and animals. Light stimulates sight and makes things visible.

Light fitting is the complete lighting unit. It includes the bulb; elements designed to control light output, such as a reflector (mirror) or refractor (lens) and the ballast; the housing and the attached parts.

Light pollution means the brightening of the night sky caused by artificial light.

Light trespass happens when the spill light is cast where it is not wanted.

Lumens are a measure of light output from a bulb. The quantity of lumens a bulb produces is independent of the wattage. Some types of bulb are more energy efficient than others and produce more lumens per watt. Appendix B of this guideline gives lumen values for common bulb types.

Luminance is the amount of light emitted in a given direction by the light source or illuminated surface. This is measured in candelas per square metre.

Lux is the unit of measure for illuminance, equal to one lumen per square metre.

Natural skyglow is that part of the night sky's brightness that is caused by radiation from the stars and moon and luminescent processes in the Earth's upper atmosphere.

Mounting height is the height of the fitting or bulb above the ground.

Outside light fitting means a light fitting that is attached or fixed outside or on the exterior of a building or structure, whether temporary or permanent.

Reflected light is light that bounces off a surface. Light-coloured surfaces reflect more light than dark-coloured ones.

Shielded light fitting means a light fitting that does not allow light to shine above the horizontal plane and prevents light trespass. If a development will use a fitting that is not shielded, some form of permanent physical opaque shield must be used to stop light trespass. This can be a cover or part of a building. Adjacent surfaces, if they are lightly coloured, must also be shielded to stop excessive reflected light from adding to skyglow. The shielding should be constructed to minimise emissions in the 10 degrees below horizontal.

Skyglow is the brightness of the night sky caused by the cumulative impact of reflected radiation (usually visible light), scattered from the constituents of the atmosphere in the direction of observation. Skyglow has 2 separate components: natural and artificial skyglow.

Spill light is light that falls outside the boundaries of the object intended to be lit. Spill light serves no purpose and, if directed above the horizontal plane, contributes directly to artificial skyglow.

Wattage is the amount of electricity needed to light a bulb. Generally, the higher the wattage, the brighter the light will be and the more lumens it will produce.

Appendix A

Example content for conditions of consent for local councils surrounding Siding Springs Observatory

The following text is an example of what a consent authority could include in conditions of consent on a notice of determination (decision) for lit development. Advisory notes can also be used by councils to make proponents aware of requirements and guidance related to light pollution. For more information, please contact your local council.

Hours of operation:

During ongoing use, the hours of operation of any illuminated signage associated with the development must be restricted so that no light is emitted from the development after 9:00 pm, until sunrise.

Maintenance of light fittings:

During ongoing use, any future maintenance of light fittings associated with the development, must be consistent with the Department of Planning and Environment's Dark Sky Planning Guideline (as amended from time to time).

Light bulb colour:

Before the issue of an occupation certificate, documentation must be provided to the satisfaction of the certifier that all lighting associated with the development will have a colour temperature of no more than 3,000 K (that is, warm white to orange).

Lighting direction:

Before the issue of an occupation certificate, documentation must be provided to the satisfaction of the certifier that demonstrates lights are not directed towards reflective surfaces or cause nuisance to other residences or motorists in the surrounding area from light spill. The documentation must be provided to the certifier.

Appendix B

Lumen values for common bulb types (general lighting)

Light output (Lumens)	Power (Watt)			
				
	Incandescent	Tubular florescent bulb	Compact florescent bulb	LED
150	25	N/A	N/A	N/A
250	N/A	N/A	N/A	N/A
400	N/A	N/A	7	N/A
460	40	N/A	N/A	N/A
600 to 700		N/A	N/A	9
890	60	N/A	N/A	N/A
900			13	
1,000	N/A	N/A	13 to 18	6 to 7
1,190	N/A	N/A	N/A	N/A
1,210	75	N/A	N/A	N/A
1,200		N/A	18	15
1,750	100	N/A	N/A	
1,800			26	18
2,050	N/A	30	N/A	N/A
2,450	N/A	36	N/A	N/A
2,880	150	N/A	N/A	N/A
2,900	N/A	N/A	32	N/A
3,000	N/A	39	N/A	N/A
3,700	N/A	50	N/A	N/A
3,900	N/A	52	N/A	N/A
4,600	N/A	55	N/A	N/A
5,400	N/A	70	N/A	N/A
6,300	N/A	75	N/A	N/A
6,360	300	N/A	N/A	N/A
23,800	1,000	N/A	N/A	N/A

Note: Industrial and sportsground lighting requires specialist design with a variety of different bulb types

Appendix C

Siding Spring Observatory location map

This map is a composite representation of the Siding Spring Observatory Location Maps for Coonamble, Gilgandra and Warrumbungle LEPs. It shows the 0 km to 12 km and 12 km to 18 km distance bands from the observatory where particular lighting measures apply.

On land beyond the 18 km radius from the observatory, a range of lighting measures apply within the local government areas of Coonamble, Dubbo Regional, Gilgandra and Warrumbungle. These are set out in the relevant LEP.

Legend

- Siding Spring Observatory
- 0 km to 12 km radius from the observatory
- 12 km to 18 km radius from the observatory
- Local government boundary

Appendix D

Useful publications and references

Australasian Dark Sky Alliance (ADSA) https://www.australasiandarkskyalliance.org/

ADSA Approved Lighting https://www.australasiandarkskyalliance.org/adsa-approved

Australian National University, Research School of Astronomy and Astrophysics rsaa.anu.edu.au

Dark Sky Society www.darkskysociety.org

Department of Climate Change, Energy, the Environment and Water, National Light Pollution Guidelines for Wildlife https://www.dcceew.gov.au/sites/default/files/documents/national-light-pollution-guidelines-wildlife.pdf

Illuminating Engineering Society and International Dark Sky Association, Model Lighting Ordinance with User Guide (2011) www.darksky.org/outdoorlighting/mlo

International Dark Sky Association www.darksky.org

Light Pollution Science and Technology Institute, The night sky in the world, satellite monitoring of the artificial night sky brightness and the stellar visibility (2000) www.lightpollution.it/dmsp/

Meredith P (May 2015) 'The end of darkness', Australian Geographic, Issue 126

Nixon D (2008) Lighting and Light pollution simulator, Need Less Campaign

www.britastro.org/dark-skies/

Standards Australia, Australian Standard 4282-1997: Control of obtrusive effects of outdoor lighting

Standards Australia, Australian Standard/New Zealand Standard 1158: Lighting for Roads and Public Spaces

Standards Australia, Australian Standard 2560: Sports Lighting General Principles

Sydney Outdoor Lighting Improvement Society www.solis.org.au

The Astronomical Society of New South Wales Incorporated, Light Pollution Awareness www.asnsw.com/node/747

Planning and Environment

dpie.nsw.gov.au

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Department of Planning
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Street Address:
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12 Darcy Street
Parramatta NSW 2150

NSW GOVERNMENT