The shade handbook.

A practical guide for shade development in Western Australia

Cancer Council WA

SunSmart®

Acknowledgements

This resource is an updated version of Shade for the public - Guidelines for local government in Western Australia, written by Ann Blunden and Jude Comfort and first published in 1999 by Cancer Council Western Australia (formerly the Cancer Foundation of Western Australia).

This edition was revised by Amy McDonald & Mark Strickland.

Materials in this book have been adapted from the following publications:

- Shade for everyone: A practical guide for shade development, 2004 (The Cancer Council Victoria).
- Under cover: Guidelines for shade planning and design, 2005 (NSW Health Department, Cancer Council NSW, Cancer Institute NSW).

Cancer Council Western Australia greatly appreciates the support of these organisations in allowing us to use their text, photographs and illustrations.

Illustrations (designed by Ography) on the following pages are featured courtesy of
Cancer Council Victoria: 3, 7, 8.

Photographs on the following pages are featured courtesy of :
Queensland Health: cover, 10, 13, 14, 19, 25.
Blue Gum Montessori School: 17

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Suggested citation: Cancer Council Western Australia. 2020. The shade handbook: A practical guide for shade development in Western Australia, Cancer Council Western Australia, Perth.

ISBN: 1 876628 92 8
November 2020

Contents

About these guidelines

These guidelines can be used by individuals, organisations and local governments wanting to increase availability of quality shade in a range of outdoor settings, both large and small. This includes places such as pools, sport venues, beaches, parks, schools, early childhood services, pedestrian thoroughfares, transport facilities, shopping centres and homes.

These guidelines can help you to:

- Improve your understanding of ultraviolet (UV) radiation.
- Improve your understanding of shade design principles.
- Assist you to identify shade needs.
- Improve your understanding of how to undertake a shade audit.
- Assist you to plan, implement and evaluate a shade project.

The information provided can be easily adapted to address the needs of the different regions of Western Australia.

Why is shade important?

Australia has one of the highest rate of skin cancer in the world, with Western Australia second only to Queensland[1]. At least 2 in every 3 Australians will be diagnosed with skin cancer before the age of 70[2]. Over 2,000 Australians die each year from skin cancer[3] and the Australian health system spends more money on the diagnosis and treatment of skin cancer than on any other cancer, estimated at over $900 million each year [4-5].

Skin cancer is a serious public health issue. The majority of skin cancer is caused by overexposure to ultraviolet (UV) radiation from the sun. UV radiation is classified as a group 1 carcinogen[6]. Shade provides good protection from UV radiation and it can be easy for people to use. Most forms of shade can reduce UV exposure by up to 75%[7]. It is important to note that shade is the one form of sun protection that people cannot easily supply themselves. Shade used in conjunction with other protective measures, such as sun-protective clothing, hats, sunglasses and sunscreen provides maximum protection from UV radiation exposure.

The provision of shade has been identified as an important component in the design and creation of safe and healthy communities and as a priority in the State Public Health Plan for WA 2019-2024[8-9].

How to use these guidelines

These guidelines have two parts. Part 1 contains background information relating to UV radiation and shade design principles. Part 2 provides more detailed information to help you plan, implement and evaluate a specific shade project. Contact details for where to find more information and resources are provided at the end of these guidelines.

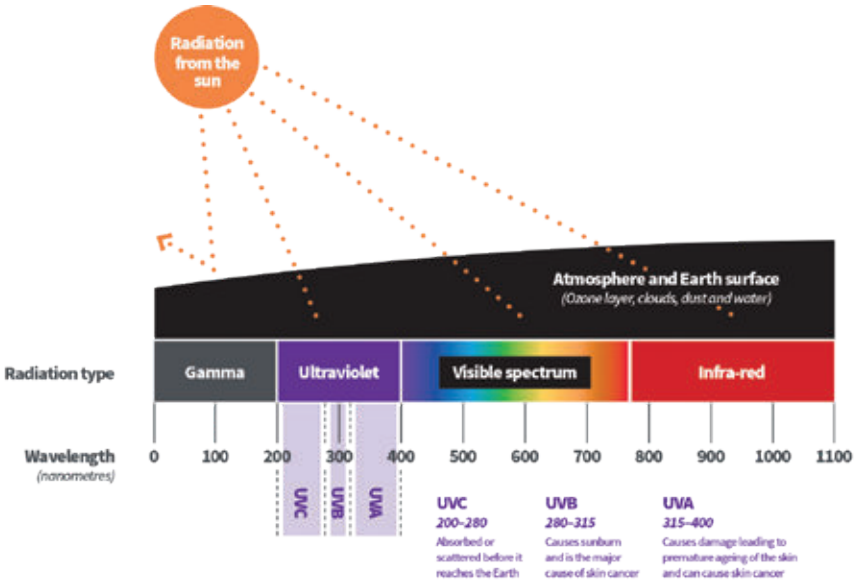
The Cancer Council WA website contains further information. Please visit www.cancerwa.asn.au

Part 1: Understanding sun and shade

Ultraviolet radiation

What is ultraviolet (UV) radiation?

The sun emits different types of radiation. As well as visible light (sunlight), there is invisible radiation. One type of invisible radiation is infrared radiation, which provides heat. The other type of invisible radiation is ultraviolet (UV) radiation. We cannot see or feel UV radiation but overexposure can lead to sunburn, skin cancer and eye damage. UV radiation is present in the sun's rays throughout the year in varying amounts.



The outdoor temperature does not affect UV radiation levels, which can be high enough to cause damage to skin even on cool or cloudy days.

UV radiation is made up of three components: UVA, UVB and UVC. UVA and UVB are the harmful rays of the sun that cause skin damage. UVC from the sun does not reach the earth's surface as it is absorbed by the ozone layer.

(Source: Australian Radiation Protection and Nuclear Safety Agency 2020)

Direct and indirect UV radiation

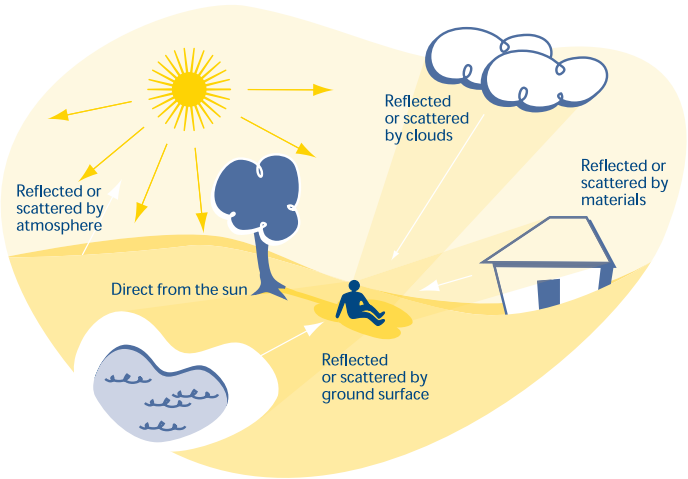
UV radiation can reach you on the ground from three sources:

- Directly, from the sun.
- Indirectly, from the open sky. UV radiation is scattered by clouds or other particles in the atmosphere.
- Indirectly, reflected from surfaces such as water, concrete and sand.

Indirect UV radiation can reduce the effectiveness of sun-protective measures such as hats and shade. For example, a person on a boat under a canopy may appear to be shaded but may still be receiving considerable UV radiation reflected from the water and deck, and scattered by the open sky.

People using open areas, such as the beach or park, can receive as much UV radiation from indirect sources, as direct sources. Effective shade design can protect people from both direct and indirect sources of UV radiation.

Direct and indirect sources of UV radiation



What affects UV radiation levels?

A number of factors affect UV radiation levels during the day and throughout the year. It is important to understand and consider these when planning a shade project. It is also important to remember that temperature and UV radiation levels are not related.

1. Height of the sun above the earth

The main factor that affects UV radiation levels is the position of the sun in the sky. UV radiation is most intense when the sun is directly overhead and the path of the radiation through the atmosphere is shortest. When the sun is lower in the sky, the path of the radiation through the atmosphere is much longer and so more of the radiation is absorbed.

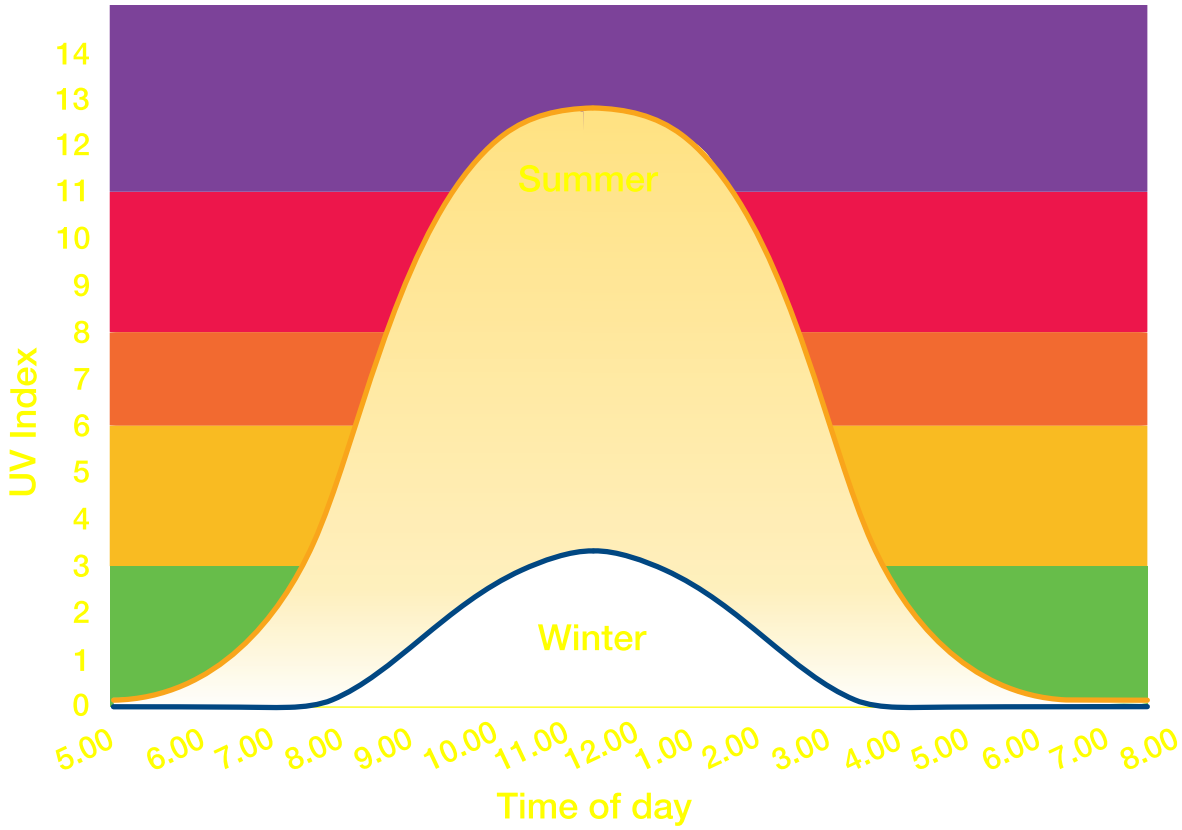
The time of day

The amount of UV radiation varies throughout the day. On a cloud-free day, the maximum UV radiation level occurs at solar noon, between 12 noon and 1pm, when the sun is directly overhead. The maximum temperature usually occurs later in the day.

The time of year

Levels of UV radiation will be higher during the summer months when the sun is higher in the sky as compared to the winter when the sun is lower.

Seasonal variation in UV radiation intensity - Perth, Western Australia



(Source: Australian Radiation Protection and Nuclear Safety Agency 2006)

2. Scattered UV radiation
When UV radiation passes through the earth's atmosphere, some of it will collide with other molecules and particles in the air. This causes UV radiation to scatter and change direction. People can be exposed to scattered UV radiation whenever open sky can be seen, even when in the shade.

3. Reflected UV radiation
Some surfaces can reflect large amounts of UV radiation, such as water, concrete and sand. This means that UV radiation may still reach you even if you are in the shade or wearing a hat.

Table 1: Reflected UV radiation from different ground surfaces[10]

Material	Level of reflected UV radiation
Lawn grass, summer/winter	2.0% - 5.0%
Grasslands	0.8% - 1.6%
Soil, clay/humus	4.0% - 6.0%
Asphalt roadway, new (black), old (grey)	4.1% - 8.9%
House paint, white	22.0%
Boat deck, wood/fibreglass	6.6% - 9.1%
Open water	3.3%
Open ocean	8.0%
Sea surf, white foam	25.0% - 30.0%
Beach sand, wet	7.1%
Beach sand, dry, light	15.0% - 18.0%
Snow	50.0% - 88.0%
Concrete footpath	8.2% - 12.0%

4. Position on earth
Due to its geographical location closer to the equator, Australia has higher levels of UV radiation compared to Europe and North America. Additionally, during summer in Australia, the earth's elliptical orbit brings it closer to the sun than the northern hemisphere during the northern summer. This means that Australia receives 7% more UV radiation during summer than countries in the northern hemisphere [11].

5. Cloud cover
Cloud cover can affect UV radiation levels, depending on the density and type of cloud pattern present. On lightly overcast days the UV radiation level can be similar to that of a cloud-free day and high enough to cause sunburn. Heavier cloud cover can reduce the strength of UV radiation. When cloud is scattered, levels of UV radiation rise and fall as clouds pass in front of the sun.

6. Ozone layer
Ozone is a gas that occurs naturally in the earth's upper atmosphere. Ozone absorbs some of the UV radiation that would otherwise reach the earth's surface. Ozone levels vary over the year and even across the day.

While ozone depletion is a major environmental issue, other factors such as sun height and changes in cloud cover, may have more influence locally on the levels of UV radiation reaching the ground

7. Altitude
Locations at higher altitudes are exposed to more UV radiation than locations at sea level. This is because at higher altitudes there is less atmosphere for the UV radiation to pass through before it reaches the ground, so less UV radiation is absorbed or scattered.

Temperature is not an indicator of UV radiation levels. The temperature does not affect the amount of UV radiation reaching the ground. Therefore it is possible to get burnt on a cool and cloudy day.

There is no such thing as 'windburn'.
It is actually sunburn. The wind may dry the skin but does not burn it.

What is the UV Index?

The UV Index indicates the level of UV radiation that reaches the earth's surface on any given day. The UV Index is forecast by the Bureau of Meteorology (BOM) and can be found on their website (www.bom.gov.au/weather/uv). It is also reported in newspaper, radio and television weather reports and can be found at www.myuv.com.au and on the free SunSmart app, available at www.SunSmart.com.au

The higher the level of UV radiation the quicker your skin can be damaged by sun exposure. **Sun protection is recommended when the UV Index is three or above.** The higher the UV Index, the faster your unprotected skin will be damaged. Sun protection is recommended at all times for people who work outdoors, even when the UV Index is less than 3.

UV index 1	UV index 2	UV index 3	UV index 4	UV index 5	UV index 6	UV index 7	UV index 8	UV index 9	UV index 10	UV index 11+
Low		Moderate			High		Very high			Extreme

(Source: World Health Organization 2002)

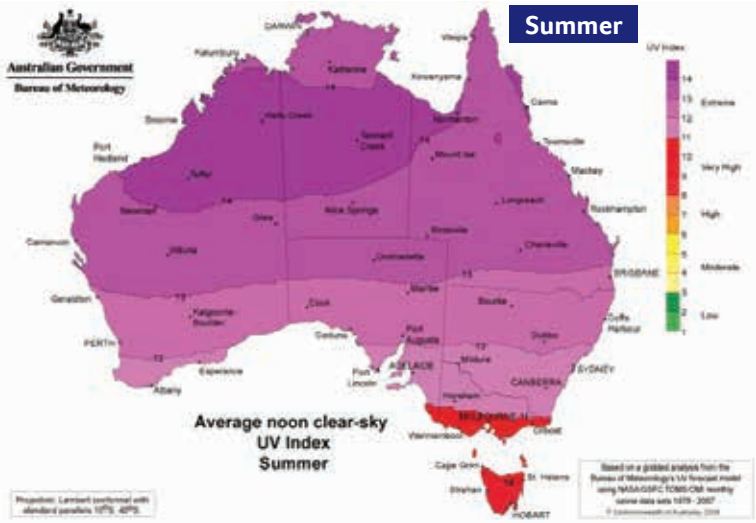
UV radiation levels in Australia

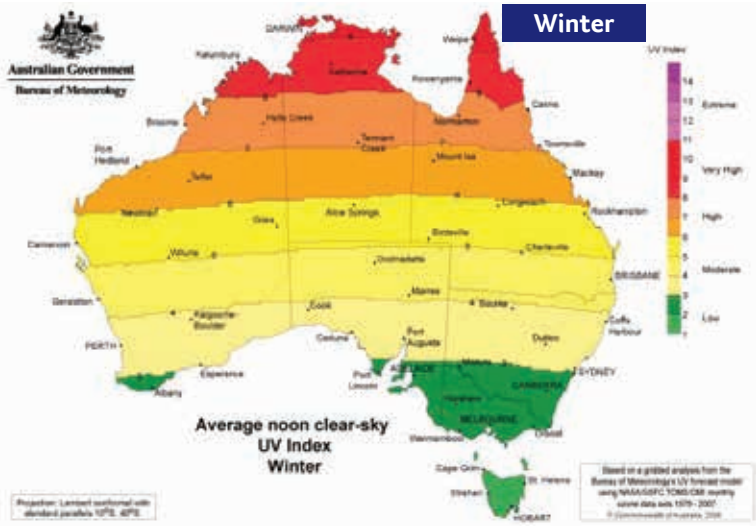
These maps from the Bureau of Meteorology show the average, predicted maximum UV Index readings for Australia in the middle of summer and the middle of winter.

You will note that in summer all parts of Western Australia have UV radiation readings which are in the extreme range (11+).

In winter most areas of Western Australia have UV Index readings of three or above. Therefore in most parts of Western Australia protection from UV radiation is required all year round, even when temperatures are cooler.

UV radiation levels in Australia





(Source: Bureau of Meteorology)

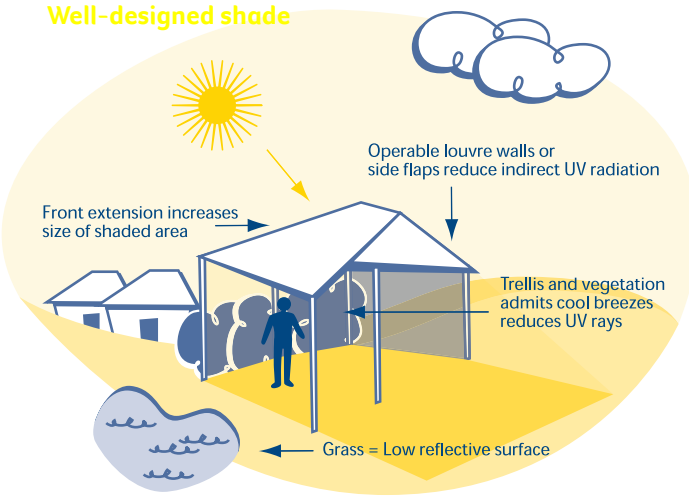
Understanding your shade options

Quality shade provides protection from UV radiation where it is needed, at the right time of day, and at the right time of year. It is well-planned and well-designed. Quality shade considers how many people will use the space and how they will use it. It is attractive, practical and environmentally friendly.

Quality shade ensures that:

- People are protected from both direct and indirect UV radiation.
- The space is comfortable to use in all seasons.

Well-designed shade



Reducing direct and indirect UV radiation

The most common method of controlling direct UV radiation is to place a barrier so that it intercepts the sun's rays, creating shade. There are a number of design strategies that can be used to reduce an area's exposure to both direct and indirect UV radiation.

Ensure the shade structure is of an adequate size
The larger the structure the greater the opportunity to avoid both direct and indirect UV radiation. This is because UV radiation levels are greater towards the edge of the shaded area than at the centre.

Consider the arrangement of existing structures
For example, if there are a large number of small umbrellas, group them together to form a single larger canopy for greater protection.

Consider using barriers for side as well as overhead protection
Vertical screening with plants and trellises or a system of opaque louvres can provide a barrier to indirect UV radiation while still allowing breezes to flow through.

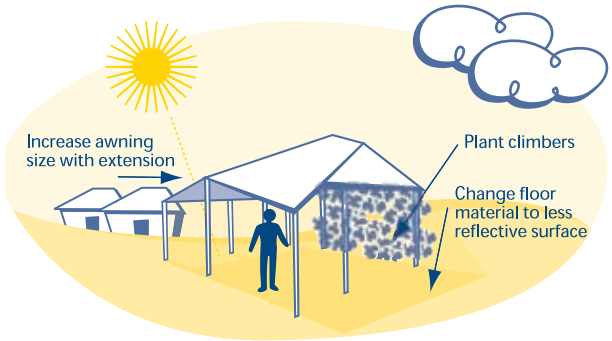
Extend overhead barriers past actual use areas
A simple rule of thumb is to make sure there is at least one metre of overhang past the actual area of use.

Avoid highly reflective surfaces
Where possible select surfaces that reflect minimal UV radiation. Generally, soft or rough surfaces such as brick pavers and grass reflect less UV radiation than hard or smooth surfaces.

Adapt existing surfaces
Depending on the site it may be possible to adapt an existing surface that reflects high levels of UV radiation.

Consider any external sources of reflected UV radiation from existing buildings and adjacent properties
For example, if the property next door has a large reflective wall facing your site you will need to design a shade system that blocks the reflected UV radiation.

Reducing direct and indirect UV radiation



Climate and comfort

It is important to consider the climate of a location in order to design effective shade structures. Different regions of Western Australia experience different climates.

Shade structures need to be comfortable and attractive in all seasons, so that people want to use them all year round. Remember, however, that the sun can still cause damage even on cooler days.

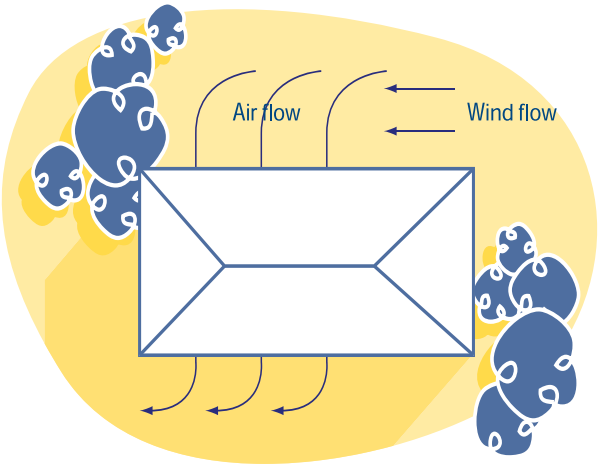
There are four key elements to consider when ensuring a shade structure is comfortable:

- Air temperature.
- Humidity.
- Air movement.
- Heat radiated from the sun and surroundings.

Once climatic factors are understood, the basic principles for designing an outdoor environment can be adapted to best suit the characteristics of a given climate. For example, if it is hot and sticky, provide shade to exclude the sun and allow cross ventilation to capture the breeze for cooling. If it is cold and windy, provide wind breaks to exclude the breeze and use north facing openings to collect the warmth and light from the sun.

The following methods can be used to provide a cool place when it is hot:

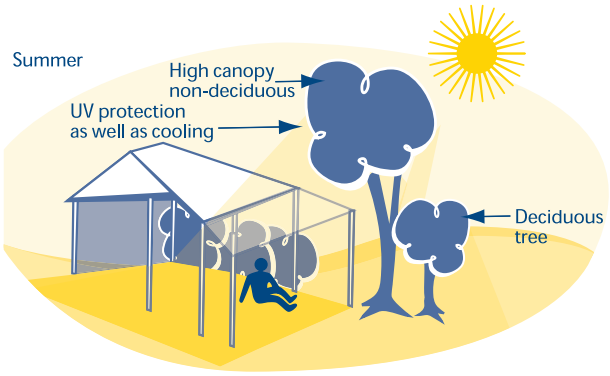
- Design the shaded space to capture and channel breezes. For example, orientate openings towards incoming breezes.
- Provide shade to the openings of shade structures. For example, when putting up a marquee, place it so a nearby tree will shade the entrance.



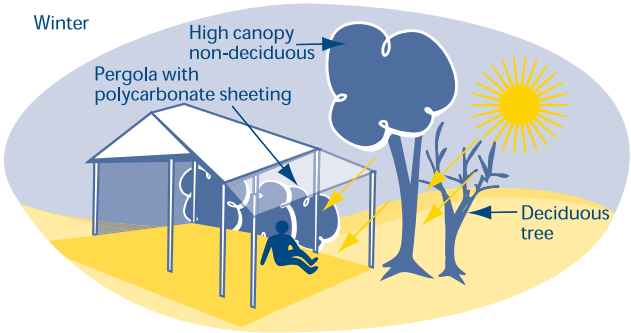
- Add eaves to the design of built shade. This will cool the space immediately outside the shade structure, which will help the shaded area to be cooler.
- Prevent certain surfaces (such as sand or concrete) from heating up, as this can cause the air surrounding these surfaces to become hotter, which may make a nearby shade structure hotter too. Shade the surface, change it or select a surface that does not get too hot.

The following methods can be used to provide warmth and light when it is cooler:

- Plant deciduous trees and shrubs that lose their leaves in winter to let in the sun's warmth and light in cooler months but provide shade during warmer months.
- Plant windbreaks to stop cold winds.
- Provide shade that blocks out UV radiation but lets in warmth and light from the sun. For example, use see-through shade material such as polycarbonate.



Deciduous trees shade in summer and allow light in winter



Built shade

An overview of built shade

Built shade can be stand-alone or built onto existing buildings or structures. All built shade consists of two parts. Firstly, the supporting structure which keeps the shade structure in place and holds it up. Secondly, the primary shading element, which is the material that makes up the canopy or roof of the shade device.

Built shade structures have the following advantages over natural shade:

- The shade they cast is more predictable.
- They can provide protection from the rain.
- Some types can be erected quickly.
- They have a range of alternative uses, for example, to collect rainwater for irrigation or to support a solar power device.

For all built structures, no matter what the size, it is vital to seek professional advice. Certification from a qualified structural engineer may be required to ensure structural integrity and safety. Additionally, to build any permanent shade structure, you will need to gain approval from your local government.

Different types of built shade

Permanent systems

Permanent shade systems are designed to last at least 10 years. Examples include pergolas, verandahs and covered decks. It is important that permanent systems are durable, as they need to withstand all weather conditions. Regular maintenance is essential to ensure their long lifespan. The components of a permanent shade system should be easy to replace.

Demountable systems

A demountable shade structure can be easily put up and pulled down. Examples include tents, marquees and lightweight shade sails. A demountable system is ideal when:

- A site only needs shade occasionally.
- Temporary shade is required at different places at the same time.
- A permanent structure is not suitable because of the type of activities that take place at the site.

Demountable systems need to be strong enough to withstand frequent transportation, assembly and dismantling. Advantages of demountable systems are:

- Some demountable systems can be used on a variety of ground surfaces, such as grass, sand or concrete.
- Some can be adapted for use in a variety of situations, such as above-tiered seating, as well as over large surface areas.
- Some are designed in modular form that can be extended or contracted depending on the number of people who will need to use it or the space available.
- Walls can be removed depending on the setting and desired airflow.
- Most systems are easy to put up, take down and/or move around and store.
- The temporary nature of demountable systems means that they are less likely to be vandalised.

Adjustable systems

These systems can be modified to provide effective shade as the sun moves during the day and at different times of the year. Adjustable systems are often attached to building, and include retractable devices, such as canvas awnings or louvres. Care needs to be taken to ensure structures are correctly and safely installed and that the integrity of the building wall is not compromised.

Adjustable systems should be easy and convenient to operate. In the event of a storm or in windy weather, they need to be able to be taken down or closed quickly. When buying or making an adjustable system, ensure that parts such as pulleys and cables will not rust or wear out quickly. Stainless steel parts are best for such a system.

Tension membrane structures (TMS) or shade sails

Tension membrane structures (TMS) or shade sails are increasingly used in shade projects and can be permanent or demountable.

A TMS has several advantages: they can be attractive, usually require minimal support structures and can be cost-effective where shade is required for large areas that need to be column-free, such as playgrounds and swimming pools.

For small areas, pre-made, off-the-shelf TMSs may produce good results, provided that the item is of good quality and that care is taken with orientation.

Some important points to consider include:

- The quality of the TMS, in terms of how protective and durable it is, related directly to the cost.
- The curve of the fabric affects where the shade will fall. If more than one curved structure or sail is used in combination, they need to be carefully orientated to ensure protection from both direct and indirect UV radiation.
- Fabric structures may not necessarily be a cheaper solution. Lightweight steel roofing or other shade choices, such as a pergola framework supporting climbing plants, may be cheaper.
- The design and construction of shade sails is a specialized field. Consult a professional if you are considering this type of shade structure.

Portable shade

Portable shade is ideal for places where other shade options are not available, such as on the beach. Portable structures provide a quick and often inexpensive solution to a shade problem. There is a wide range of portable shade structures available in different sizes, shapes and designs, such as small tents, beach shelters and umbrellas. Keep in mind that umbrellas provide limited protection from indirect UV radiation.

The Ultraviolet Effectiveness (UVE) rating

Since 2018 Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has recommended the use of the Ultraviolet Effectiveness (UVE) rating for woven and knitted shade fabrics in line with the Australian Standard AS 4174:2018. The Ultraviolet Effectiveness (UVE) rating indicates how effective a shade fabric is at providing shade for sun protection. The rating is based on the percentage of UV radiation that is blocked by the shade fabric. For instance, a UVE rating of 95% means that 95% of UV radiation is blocked by the shade fabric and 5% of UV radiation is transmitted. When designing a shade structure consider using shade fabrics that have the highest UVE ratings available, ideally those with a rating of most effective.

Table 1: UVE protection categories

Protection category	UVE %
Effective	**80.0 – 90.9**
Very effective	**91.0 – 94.9**
Most effective	**95.0+**
(Source AS4174:2018)	

What affects the UVE rating of a fabric?

Different fabrics have different UV radiation absorbing properties:

- Less UV radiation passes through tightly woven fabrics.
- Darker colours usually block more UV radiation than light colours.
- Heavier-weight fabrics usually block more UV radiation than lightweight fabrics of the same type.
- Fabrics that are overstretched, wet or worn out may have reduced UV radiation protection.

Good-quality shade fabric is an important part of your shade structure. However, effective shade depends on more than the shade fabric you use. The location of the structure in relation to the area you want shaded, its size and height, and any surrounding reflective surfaces, will all contribute to the quality of shade provided. **The UVE rating does not take into consideration the overall design of the shade structure.**

Selecting the right shade material

Some basic guidelines to help you select appropriate materials for your shade project are found overleaf.

Table 2: Guidelines for selecting shade materials

	Glass	Polycarbonate and fibreglass sheeting	Canvas or other tightly-woven cloths	Knitted polyethylene or woven PVC shade fabric	Timber	Steel roof sheeting
Suitability	Good windbreak where visibility and light are required.	Roofing, walling louvre, awnings, skylights, canopies.	Good for small, low-budget jobs.	Canopies	Pergolas, trellis screens.	Roofing, walling. Steep or low pitches.
Ultraviolet protection	Depends on thickness. House window glass absorbs 90% of UV radiation.	Very high.	Very high when new, lower if material deteriorates over time.	Refer to UVE rating.	Very high. Direct barrier to UV radiation.	Very high. Direct barrier to UV radiation.
Waterproof	Yes.	Yes.	Yes, watertight up to saturation point.	Depends on fabric.	Depends on detailing and use.	Yes.
Light transmission	High, depending on tint.	High, but varies according to thickness, profile and colour.	Light colours allow more light.	Light colours allow more light but reflect and scatter more UV radiation.	Depends on detailing.	No light transmission.
Solar heat gain*	Less heat gain if tinted.	High.	Dark colours are hotter.	Darker colours are hotter but reflect less UV radiation.	Does conduct heat.	High if not insulated.
Structural implications	Need to select glass appropriate to the site.	Need to incorporate wind uplift considerations into design.	Guy ropes (if present) can cause obstruction.	Wind drags through porous material.	Need to incorporate wind uplift onsiderations into design.	Need to incorporate wind uplift considerations into design.
Life span	Long life, if does not sustain impact.	About 10 years. Discolouration may occur sooner.	Limited. Susceptible to breakdown due to UV radiation exposure.	10 years.	Long life if well maintained.	Long life if well maintained.
Maintenance requirements	Needs regular cleaning.	Low maintenance. Impact resistant.	Without specific treatment is not mould resistant.	Susceptible to mould growth and dirt accumulation.	Guard against termites.	Subject to moisture and condensation conditions.

(Source: The Cancer Council Victoria 2004)
** Solar heat gain is an important consideration when selecting shade materials but it must be remembered that heat or temperature is not related to UV radiation levels.*

Natural shade

An overview of natural shade

Vegetation is an essential part of shade planning as it is one of the most effective and aesthetically appealing ways of providing shade, whilst providing a myriad of co-benefits. The effectiveness of natural shade depends on the density of the foliage and the size of the canopy. As a general rule, trees with a canopy that is dense and closer to the ground provide the best protection from direct UV radiation. The larger the canopy, the greater the protection from both direct and indirect UV radiation.

Natural shade has many advantages:

- Vegetation makes an area pleasant for users.
- Using vegetation for shade can have a number of environmental benefits such as providing habitat for local wildlife, enriching the soil and absorbing carbon dioxide in the atmosphere.
- Vegetation can be used to screen unwanted views and provide privacy.
- Vegetation can provide protection from the wind.
- Carefully chosen trees can cool an area by reducing the air temperature in summer up to 30%.
- Vegetation can contribute to the urban tree canopy cover.

Considerations when providing natural shade:

- Planting should be consistent with the character of the surrounding environment, both natural and built.
- Seek advice about local conditions, such as soil type, climate and salinity, before selecting plants for a site.
- Check that the size and shape of a plant when it is fully grown is appropriate to the space available.
- Avoid plants that are toxic, attract bees, drop limbs, have thorns or spikes or are known to cause adverse health effects such as asthma and skin irritation.
- Avoid plants that are considered to be harmful to children, such as those with the common name of angel's trumpet, rhododendron, black locust, cotoneaster, duranta, oleander, rhus and white cedar.
- Avoid trees with invasive roots that may become a problem for nearby buildings, paths and drains.
- Consider whether deciduous or evergreen plants are more suitable. Deciduous plants are ideal for sites where you want winter sun, while evergreen plants are ideal for sites where screening is required. It must be remembered however that some areas in WA experience high levels of UV radiation all year round.
- Check with the Department of Primary Industries and Regional Development that the plant is not an environmental weed or has the potential to spread rapidly and become a weed problem on the site.
- Take care not to use trees or plants that will obstruct thoroughfares or create tripping or slipping hazards, such as when berries or seeds fall on surrounding ground surfaces.
- To help prevent crime and vandalism, ensure that the vegetation does not obscure sightlines, limit surveillance or provide cover or access for criminal activity.
- Keep large trees away from powerlines and underground services such as water and gas.
- Consider the costs associated with the ongoing maintenance needs of vegetation, such as watering, fertilising and pruning.
- Consider the lifespan of the vegetation and develop a plan for replacing old and dying vegetation so that the natural shade on the site is ongoing.
- Plan for natural shade requirements by planning well in advance of any physical construction.

Shade trees suitable for Western Australia

Table 4 and Table 5 contain a list of native shade trees suitable for planting in Western Australia. It is important to consider which trees are local to the specific area of your shade project.

Table 4: Native shade trees suitable for planting in Western Australia

Species Name	Minimum rain	Soil type	Average height	Wind break	Salt tolerant	Useful shade after	Comment
Agonis flexuosa Peppermint	700 mm	Sand Loam	10 m	✔		5 - 10 years	Coastal planting, aromatic foliage
Allocasuarina fraseriana Sheoak	800 mm	Most soil types	15 m	✔		10 years	Fine needle-like foliage
Banksia menziesii Firewood Banksia	500 mm	Sand	10 m		✔	5 - 10 years	Attractive new growth
Banksia prionotes Saw-tooth Banksia	350 mm	Sand	10 m			5 - 10 years	One of Perth's fastest growing banksias
Casuarina obesa Swamp Sheoak	350 mm	Salt Loam Clay	10 m	✔	✔	4 - 6 years	Coloniser of salty swampy areas, erosion control
Callistemon "Kings Park Special"	800 mm	Most soil types	5 m	✔	✔	5 - 10 years	Scarlet bottle-brush flowers. Keep to one stem to form a tree
Corymbia calophylla Marri, Redgum	500 mm	Most soil types	30 m	✔		8 - 10 years	Good form, abundant cream flowers
Corymbia ficifolia Red Flowering Gum	750 mm	Most soil types	10 m	✔	✔	8 - 10 years	Good display of red flowers at Christmas
Eucalyptus accedens Powderbark Wandoo	400 mm	Clay Gravel	15 m			5 - 10 years	Lovely tree with pale salmon bark
Eucalyptus decipiens Redheart	800 mm	Most soil types	15 m			8 years	Will grow near the ocean
Eucalyptus gomphocephala Tuart	800 mm	Most soil types but not clay	30 m			5 - 10 years	Perth's largest tree
Eucalyptus laeliae Darling Range Ghost Gum	550 mm	Laterite Loam	20 m			10 years	Attractive white trunk
Eucalyptus lanepoolei Salmon White Gum	600 mm	Gravel Loam	12 m				Attractive pale trunk
Eucalyptus marginata Jarrah	700 mm	Sand	40 m				
Eucalyptus megacarpa Bullich	400 mm	Sand Loam	30 m			10 years	Provides winter food source for native birds
Eucalyptus rudis Flooded Gum	300 mm	Clay	25 m	✔		5 years	Fast grower good for river banks and flood plains
Eucalyptus utilis	400 mm	Most soil types	15 m	✔	✔	5 - 10 years	Coastal planting
Eucalyptus wandoo Wandoo	800 mm	Clay Gravel	20 m			5 - 10 years	Beautiful pale trunk
Melaleuca cuticularis Saltwater Paperbark	800 mm	Most soil types	8 m		✔		Wet sites
Melaleuca preissiana Moonah	800 mm	Most soil types	10 m		✔	5 - 10 years	Wet sites
Melaleuca rhaphiophylla Swamp Paperbark	600 mm	Most soil types	10 m		✔	5 - 10 years	Swamp, freshwater sites

Table 5: Native shade trees suitable for planting north of Geraldton

Species Name	Soil type	Average height	Wind break	Salt tolerant	Useful shade after	Comment
Eucalyptus camaldulensis	Most types	15 m	✔		5 - 10 years	Swamp, freshwater sites
Sesbania formosa Dragon Tree	Most soil types	10 m -15 m			3 - 5 years	Riverbanks. Deciduous
Acacia para-aneura	Clay	10 m			3 - 5 years	Weeping form
Acacia cyperophylla	Sand	5 m -10 m			3 - 5 years	Poplar gum
Eucalyptus victrix	Clay	10 m -15 m			5 - 10 years	Coolibah
Eucalyptus bigalerita	Clay	10 m -15 m			5 - 10 years	
Eucalyptus torquata	Sand, clay or limestone	8 m -15 m			3 - 5 years	Coral gum
Eucalyptus leucophloia	Clay	10 m -15 m				Snappy gum
Melaleuca leucadendra	Sand and clay	10 m -18 m			5 - 10 years	Medium tree
Melaleuca argentea	Sand and clay	10 m -15 m			5 - 10 years	Graceful attractive tree
Grevillea striata	Clay	10 m -15 m			10 - 20 years	Beefwood, very tough
Information kindly provided by Greening Australia with the assistance of the Botanic Gardens and Parks Authority.						

Canopy density guidelines

The following guide will help you to assess the level of UV radiation protection provided by different trees. View the tree canopy against the sky and compare it with the images below.

HEAVY - over 90% UV radiation protection
Good protection from direct UV radiation. Protection of indirect UV radiation will depend on canopy size and where a person is positioned under the canopy. Suitable for long stay use if personal protection measures are also used.

MEDIUM - around 60% UV radiation protection
Filtered shade provides low levels of protection from direct and indirect UV radiation. Suitable for short stay use only. Personal sun protection measures should also be used.

LIGHT - less than 30% UV radiation protection
Poor protection from direct and indirect UV radiation. Suitable for transit shade only.

Combining natural and built shade

Combining natural and built shade, such as growing plants onto a pergola or lattice, has many benefits and is often the best solution for a site:

- Built shade structures can protect people from direct UV radiation while the vegetation reduces exposure to indirect UV radiation and helps cool the space by letting in breezes.
- Temporary built structures can be used to provide shade until trees planted for shade purposes mature.

Part 2: Designing and implementing your shade project

Identifying your shade needs

Where should shade be?

Shade is needed in all outdoor areas where people gather and spend time during the day. However, some areas have a greater need for shade than others. This section, suggests how to identify and prioritise sites for shade development.

The following section, outlines how to plan, implement and evaluate your shade project. This overall process is outlined in this flow chart.

Conduct a shade inventory to identify all sites where shade is important

↓

Prioritise the sites based on greatest need for shade

↓

Select a site for shade development

↓

Conduct a shade audit to identify the shade needs of the selected site

↓

Plan the shade project

↓

Implement the shade project

↓

Evaluate the shade project

The path of the sun and its effect on shade

The main objective of shade planning is to provide shade at the right place, at the right time of day and at the right time of year. Therefore it is important to understand the sun's path to predict where a tree or shade structure will cast its shadow.

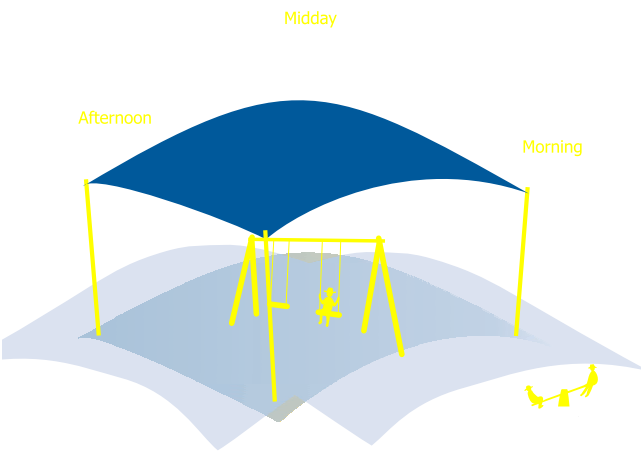
The sun moves continuously across the sky during the day, from rising in the east to setting in the west. There are three basic shade patterns every day:

1. **Morning** – where the shadow will fall in a westerly direction away from the object casting the shadow.
2. **Midday** – when the shadow will be close beneath the object casting the shadow.
3. **Afternoon** – when the shadow will fall in an easterly direction away from the object casting the shadow.

The constant movement of the sun makes it difficult to predict where the shade cast by an object will fall. For this reason, a lot of shade is incorrectly located and poorly designed, resulting in structures or vegetation that do not provide shade to an area where it is needed most.

To ensure that your shade falls in the right place at the right time you may decide to seek professional advice.

Three daily shade patterns



Conducting a shade inventory

The first step in developing a shade strategy is to do an inventory of sites where shade is important. This will include all sites where any outdoor activity takes place. This list should be comprehensive and include such sites as swimming pools, parks, reserves, bicycle and pedestrian paths, public mall areas, early childhood centres, playgrounds, beaches, ovals, school grounds and tennis courts.

Prioritising shade sites

Having identified all potential sites, each site should then be individually assessed based on usage patterns. It is suggested that the following five criteria be used in this process.

1. Age of user

Research indicates that the skin is most vulnerable to UV radiation damage during the first 15 years of life. Shade is therefore a priority in areas often used by children and young people.

2. Time of use

UV radiation levels are at their peak around the middle of the day, however sun protection is required whenever the UV Index reaches 3 or higher. Sites with a high usage during these times have an increased need for protective shade.

Summer is generally the period of greatest seasonal UV radiation intensity. Therefore, sites used extensively in summer have greater priority shade needs than those used predominantly in winter. However it must be remembered that some parts of Western Australia, particularly in the north, have high levels of UV radiation all year round.

3. Duration of use

The length of time over which the outdoor activity takes place is an important factor when determining priority. Damage from UV radiation is cumulative, which means the longer the period of exposure to UV radiation the greater the risk of harm. In summer, sunburn can occur in as little as ten minutes. Therefore the longer the period of exposure to UV radiation the greater the priority of the shade site.

4. Level of use

Sites that have high levels of use should generally take priority over less used sites. Well used facilities with good shade will protect more people more often.

5. Nature of the activity

The nature of the activity may affect the risk of sun damage among users. Sites such as swimming pools, lakes, rivers and beaches generally involve considerable risk of sun damage to users because of the high levels of reflected UV radiation from water and sand. It is also likely that users at these sites will be wearing minimal clothing. At these sites the priority for shade should be high.

Shade priority checklist

Use the shade priority checklist below to prioritise each site.

Score each site against the five factors mentioned previously, then add up the grand total for each site and compare the final scores.

Sites with the highest point scores should be viewed as a high priority for shade. For sites with a lower score, shade is still an important issue, however shade provision may be delayed in favour of those sites of higher priority. This prioritising system can be a useful tool when budgeting and timetabling decisions need to be made.

Shade priority checklist

Key factor relating to shade priority	No never	Sometimes	Yes always	Overall score
Age of users:				
• 30% or more of regular users are aged 0 -18 years	1	2	3	
Time of use:				
• Activity at the site is likely to occur around the middle of the day	1	2	3	
• The site is used over summer	1	2	3	
• The site is used over spring and autumn	1	2	3	
Duration of use:				
• Activity at the site occurs for 15 minutes or more at a time	1	2	3	
Level of use:				
• The site is well used on weekends	1	2	3	
• The site is well used on weekdays	1	2	3	
Nature of the site and the activity:				
• Users of the site are exposed to high levels of indirect UV radiation	1	2	3	
• Activity at the site is likely to occur in minimal clothing	1	2	3	

Conducting a shade audit

Once you have decided that a site is a high priority for shade development, it is important to study the site in detail to ensure any shade created is placed where it will have the most benefit. A shade audit will help you to identify the shade needs of a site and will provide you with the basis of a detailed project brief which may be used to seek funds, to gain organisational endorsement or to engage a contractor.

Critical Protection Time

The Critical Protection Time is the time of day and year when sun protection is most important at the site. It is likely to be during summer, however for some parts of Western Australia, particularly in the north, it could be at any time of the year. Keep in mind that UV radiation levels are at their highest around the middle of the day when the sun is closest to being directly overhead.

It is important to assess shade at a site during the Critical Protection Time. It is also advisable to assess the shade at the same time of day on a 'typical' winter day so that summer shade initiatives do not negatively impact on winter conditions at the site.

A shade audit has five steps:

Step 1. Determine the usage patterns of the site.

Step 2. Determine the amount and useability of existing shade at the site.

Step 3. Consider the effects of reflected UV radiation.

Step 4. Assess the need for improved or increased shade at the site.

Step 5. Identify possible options to improve shade at the site.

To complete the shade audit you will need a copy of a site plan. The site plan should include the perimeter of the site, an outline of any buildings and the location of any features that will affect the shade and useability of the site, such as garden beds, trees, fences and car parks. Remember to include any underground services, as well as emergency or access routes that must be maintained. As you progress through the five stages of the shade audit remember to plot any new information onto the site plan.

Step 1: Determine the usage patterns of the site

Usage patterns can be obtained by observing users during the Critical Protection Time and also by interviews with users, managers and staff.

Examples of questions you might like to ask are summarised below.

Users of the site:

- What time would you usually arrive to use the site?
- How long would you usually stay for?
- How often do you visit the site?
- What area do you use for the activity?
- Are there any shaded areas that you prefer not to use? If yes, why?
- Do you think there is enough shade?
- What suggestions do you have for increasing or improving shade?

Managers and staff of the site:

- Do you think existing shade is adequate? If not, what recommendations would you make to increase the available shade?
- Do you think there is a need to relocate activities to make better use of existing shade?
- Do you think there is a need to reschedule activities to avoid peak UV radiation times of the day?
- Do you know of any future plans for the site or the general area?

Some points to consider at this stage:

- Identify the main outdoor activities undertaken at the site and when and where they occur.
- Identify the time of year the site is most in use.
- Identify the time of day the site is most in use.
- Identify where people tend to congregate. Consider if people gather in a location because it is the only place for a particular activity, or if the activity could be moved to a shaded area.
- Make a note of whether people are using the available shade.
- Identify the number of people using the site and their age.
- Consider any personal protective strategies of the user, i.e., are they wearing sun protective clothing or using portable shade structures?

Step 2: Determine the amount and usability of existing shade at the site

This step involves determining the extent of existing shade structures and how often they are used. Observe, measure and record the way existing shade changes during the day and the seasons. It may be necessary to engage a professional or use a computer program to project shade patterns throughout the year.

Ensure that existing natural shade is also recorded on the site plan, such as the location of trees or groups of trees. Note details of each tree or planted area such as maturity, density of canopy and whether it is deciduous or evergreen.

Some points to consider at this stage:

- Consider where shade is available at the site, for example from buildings, verandahs, shade structures, fences, adjoining walls or neighbouring properties.
- Determine if people can easily access the existing shade. It may be that a garden bed or car park occupies the best shaded position and is therefore unavailable for people to use for other activities.
- Gauge the opinions of users, managers and staff on the adequacy of existing shade at the site and the need for more shade. They will also be able to verify your observations on what is accessible shade as well as any barriers to the use of existing shade.

Step 3: Consider the effects of reflected UV radiation

When identifying the existing shade available you will also need to be aware of the potential for reflected UV radiation at the site. For example, an adjacent surface such as a wall or roof may reflect UV radiation into a shaded area and thereby reduce the shade's effectiveness.

Some points to consider at this stage:

- Make a note of the ground surface within each outdoor zone.
- Make a note of the surfaces or finishes of adjacent buildings as well as the direction they face.
- Consider if any of these surfaces can be modified to reduce reflection.

Step 4: Assess the need for improved or increased shade at the site

The next stage of the shade audit involves comparing the amount and usability of existing shade (Step 2) to the usage patterns (Step 1) while also considering the effect of reflected UV radiation (Step 3). This will indicate if there is a need for additional shade.

Some points to consider at this stage:

- Consider the amount of existing shade at the Critical Protection Time and compare this with the need for shade.
- Consider whether the location of existing shade is appropriate, given the usage patterns at the site.
- Consider the likely impact of future tree growth on the amount of shade at the site. You may need to provide interim shade until trees have matured.
- Examine opportunities to better utilise or access existing shade.
- If additional shade is required, consider where it should be located, keeping in mind the site usage patterns and winter shade patterns.
- Consider the impact of reflected UV radiation on the site and possible means of reducing its impact.

Step 5: Identify possible options to improve shade at the site

An increase in protective shade at sites can be achieved in several ways, including:

- Building permanent shade.
- Using temporary shade.
- Planting trees (natural shade).
- Improving access to existing shade.
- Relocating or rescheduling activities.

Some points to consider at this stage:

- If you choose to create new shaded areas, provide information on the performance characteristics of the proposed shade, for example, the amount of additional shade that is needed, where it should be located and the times of day and year that the shade is required. Also think about the range of shade options (both natural and built) that may be appropriate and their likely costs.
- Optimise the use of existing shade. For example: relocating activities or outdoor equipment to shaded areas; relocating seating to shaded areas; pruning low branches from trees to allow access;

or relocating garden beds that are in shaded areas.

- Investigate ways to revise site management practices to access any shaded 'out-of-bounds' areas or to reschedule outdoor activities.
- Minimise the effects of reflected UV radiation on the site by modifying surfaces or designing shade structures that protect from indirect UV radiation.
- Ensure that shade structures do not create safety hazards. For example, support systems such as upright posts should be clearly visible and ideally have rounded edges or padding. Also, shade structures should not obstruct the views of patrons, particularly around playgrounds, early childhood services and swimming pools where adults are supervising children.

Different settings will have different issues that need to be considered when making shade design decisions. Information on the following settings is available from the publications section of the Cancer Council WA website. Visit www.cancerwa.asn.au

- Early childhood services.
- Schools.
- Public swimming pools.
- Beaches and other waterside recreation areas.
- Parks and reserves.
- Playgrounds.
- Sports grounds and facilities.
- Outdoor restaurants and cafes.
- Streetscapes.
- Homes.

Planning, implementing and evaluating your shade project

Once a shade site audit has been completed you will have a comprehensive picture of the needs of the site. The next step is to plan, implement and evaluate your shade project.

Planning your shade project

While the degree of planning depends on the size and setting of your shade project, the following points outline general issues you should consider including some of the steps outlined in preceding sections:

- Form a project team to develop the project. If possible, include people with skills in areas such as architecture, engineering, horticulture or landscape architecture. Also include interested individuals or groups who will benefit from, or will be affected by, the project.
- Read and work through earlier sections of this resource to increase your understanding of sun and shade issues as well as the characteristics of your site.
- Draw up a detailed site plan to identify the features of the site.
- Estimate the costs of the design and implementation of your shade project and explore if applicable, sources of funding.
- Identify the permits, approvals and documentation that may be required. Building and construction permits are often needed for the erection of built shade structures. It is important to consult the building and planning departments of your local council to ensure you comply with building and planning regulations and requirements. The regulations may vary depending on the local council, the setting and the type of construction planned. Pruning trees and other vegetation may also require permits and approvals.
- Determine any external constraints such as heritage issues, environmental impact considerations and local community reaction.
- Develop a timetable for the completion of the shade project. Identify any time constraints on construction, such as difficulty in accessing a school site during a school term.

Preparing a design brief

You will need to draw up a detailed design brief to assist in applying for funding, tendering or constructing your shade project. The design brief should include:

- The overall site plan.
- Shade needs:
  - The Critical Protection Time.
  - Where and when you would like the shade to fall.
  - Types of shade preferred, for example built or natural, permanent or demountable.
  - The need for shelter from the wind or rain.
  - Nature of activities in the vicinity of the project, for example children at play or vehicle movements.
  - Climatic conditions.
  - Likely security or vandalism issues.
  - Maintenance needs.
  - Anticipated shade lifespan.
- Money and labour requirements:
  - Project budget.
  - Timetable for the work.
  - How the project will be overseen and monitored.
  - Additional costs, such as insurance, liability and approval permits.
- Timeframe for the completion of the project.

Selecting a company to implement a shade project

You may decide to use a specialist company to do all or part of your shade project.
If so, it is useful to consider the following questions:

- Does the company specialise in constructing shade structures?
- Can the company provide you with a list of previous projects and clients who can act as referees?
- Does the company's submission include certification by a structural engineer, the acquisition of permits and approvals or outline relevant standards with which the design must comply?
- What insurance (for example, public liability) is provided?
- Do you receive product warranties upon completion?
- What ongoing services (for example, safety checks, maintenance and cleaning) are offered and what fees are involved?
- What are the specifications of the materials proposed? For example, what is the durability and Ultraviolet Effectiveness (UVE) rating of the shade material?

Managing your shade project

When shade is one part of an overall venue construction or upgrade, budgets can be spent before the cost of shade construction or landscaping is included. Keep a written record of the progress of the project. This will help if the management of the project needs to be handed over to someone else, and is also useful for evaluating the project.

Evaluating your shade project

After your shade project has been completed it is important to evaluate how well it meets the shade requirements of the site and its users. It is helpful to consider how you will evaluate your project during the planning stage. Evaluation will assist in planning future shade projects. Useful questions to consider include:

- Was the shade installed according to the plan?
- Does the shade meet the design requirements?
- Do people use the shade?
- Were there any unexpected costs?

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For more information

Information and statistics on skin cancer and sun protection

SunSmart
Cancer Council Western Australia
Level 1, 420 Bagot Rd
SUBIACO WA 6008
Phone: (08) 9212 4333
Fax: (08) 9212 4334
Sunsmart @cancerwa.asn.au
www.cancerwa.asn.au
Cancer Council 13 11 20

Information about ultraviolet (UV) radiation and the UV Index

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
www.arpansa.gov.au

Bureau of Meteorology
www.bom.gov.au/uv

INTERSUN, the global UV project
World Health Organization (WHO)
www.who.int/uv/en

Contact details for local government

Western Australian Local Government Association (WALGA)
Level 1, 170 Railway Parade
WEST LEEDERVILLE WA 6007
Phone: (08) 9213 2000
Fax: (08) 9213 2077
www.walga.asn.au

Department of Local Government, Sport and Cultural Industries
Gordon Stephenson House
140 William Street
PERTH WA 6000
Phone: (08) 6552 7330
Fax: (08) 8490 2351
Freecall: 1800 634 541 (Regional callers only)
www.dlgsc.wa.gov.au

Advice on planning, designing and implementing your shade project

Planning Institute Australia (WA Division)
PO Box 8305
SUBIACO EAST WA 6008
Phone: (08) 9382 2100
Fax: (08) 9382 4400
Email: wa@planning.org.au
www.planning.org.au/wa

Australian Institute of Architects (WA chapter)
33 Broadway
NEDLANDS WA 6009
Phone: (08) 6324 3106
Email: wa@architecture.com.au
www.architecture.com.au/wa

Australian Institute of Landscape Architects (WA Chapter)
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www.aila.org.au/wa

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Email: j.greenwood@webshade.com.au
www.webshade.com.au

Natural shade issues and horticultural/vegetation advice

Greening Australia
UWA Field Station
1 Underwood Avenue
SHENTON PARK WA 6008
Phone: (08) 6488 6699
Fax: (08) 6488 6700
Email: per.general@greeningaustralia.org.au
www.greeningaustralia.org.au

Trillion Trees
Lot 2, Stirling Crescent
HAZELMERE WA 6055
Phone: (08) 9250 1888
Email: contact@trilliontrees.org.au
www.trilliontrees.org.au

Department of Biodiversity, Conservation and Attractions
17 Dick Perry Ave, Technology Park Western Precinct
KENSINGTON WA 6151
Phone: (08) 9219 9000
www.dpaw.wa.gov.au

Department of Primary Industries and regional Development, Agriculture and Food Division
3 Baron-Hay Court
SOUTH PERTH WA 6151
Phone: (08) 9368 3333
Fax: (08) 9474 2405
Email: enquiries@dpird.wa.gov.au

Grant directories and assistance

GrantConnect - Australian Government
www.grants.gov.au

Community grants program - Department of Communities
www.dlgc.communities.wa.gov.au

Australian standards relating to UV protection and play equipment

Relevant standards include:

AS 4174:2018 *Knitted and woven shade fabrics*

AS/NZS 4399:2020 *Sun protective clothing - evaluation and classification*

AS/NZS 2604:2012 *Sunscreen products - evaluation and classification*

AS/NZS 1067:2016 *Eye and face protection: sunglasses and fashion spectacles*

AS/NZS 1337.1:2010 *Personal eye protection, part 1: eye and face protectors for occupational applications*

AS/NZS 4685.0:2017 *Playground equipment and surfacing*

Cancer Council WA | SunSmart®

For support and information on cancer and cancer-related issues, speak to a Cancer Council Nurse on **13 11 20.** Calls are confidential and available statewide Monday to Friday during business hours.

11/2020