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SUSTAINABLE DESIGN

STEENSEN VARMING

Consultant Advice Note

Sydney February 27th, 2017
Project No. 15814

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Project Name:	Macarthur Memorial Park	**Document No**	15814 CAN S01
Project No:	15814	**Revision**	01
Subject	Sustainability Strategies		

1.0 Sustainability Strategies

For the development of the sustainability strategy for the Macarthur Memorial Park, Steensen Varming have been appointed to provide Sustainability advice for the development of the park and buildings.

Steensen Varming understand the sensitivities surrounding the project, including the need to minimise visual impact of the buildings from surrounding areas. The sustainability strategies presented below focus on low impact, mainly passive design features, which will help improve the overall efficiency of the buildings, and provide a narrative for how the development responds to its surroundings and the climatic conditions of the site.

This sustainability report reviews the following areas:

- Site Assessment – including:
  - Climate conditions such as temperature, solar radiation, wind and humidity;
  - Landscape features such as topography, vegetation and water bodies;
- Energy Strategy measures – including:
  - Micro-climate analysis – ensuring the design is appropriate for the local climate conditions;
  - Building fabric considerations;
  - Systems efficiency recommendations;
  - Renewable energy opportunities;
- Water efficiency measures:
  - Efficient indoor water use measures;
  - Efficient irrigation and planting;
  - Water storage and re-use;
- Indoor Environment:
  - Acoustics;
  - Lighting;
  - Air quality;
- Materials considerations:
  - Sustainably sourced materials;

Mechanical Engineering
Lighting Design
Sustainable Design
Electrical Engineering

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2.0 Site Assessment

2.1 Site Location

The Macarthur Memorial Park site is located in Varoville, to the South West of Sydney, North of Campbelltown, as shown on the plan below (site highlighted in red):

Macarthur Memorial Park comprises a 113 hectare purchased by the Catholic Cemeteries Metropolitan Trust with a view to providing a community landscape cemetery within Western Sydney. The facility will comprise the following developments:

1. Gate house
2. Chapel
3. Function Room
4. Café & Flower Shop
5. Administration Office
6. Mortuary
7. Ground Staff Facilities

The above developments are indicated on the following image:

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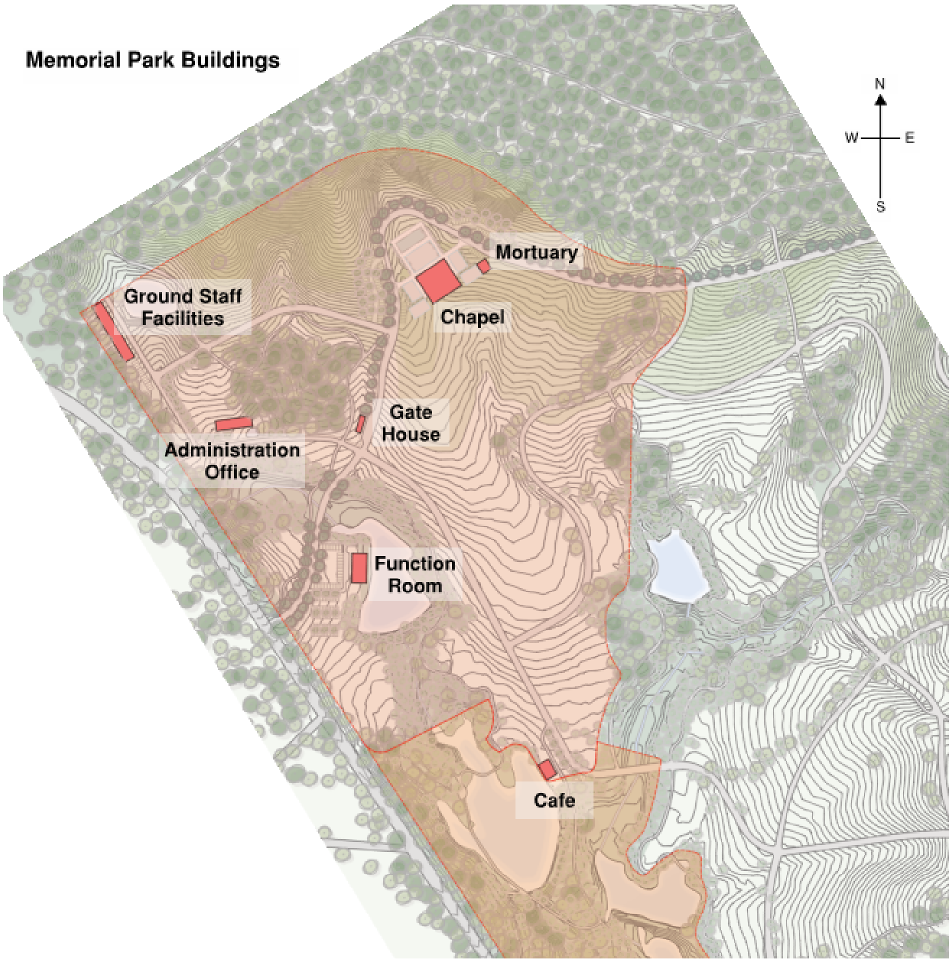

2.2 Site Climate

As mentioned, the site is located to the South West of Sydney. The site is located approximately 25km inland, which leads to summer high temperatures around 4°C higher and winter low temperatures around 4°C lower than central Sydney.

Temperature:

The following graph shows the average temperature fluctuations throughout the year for the site:

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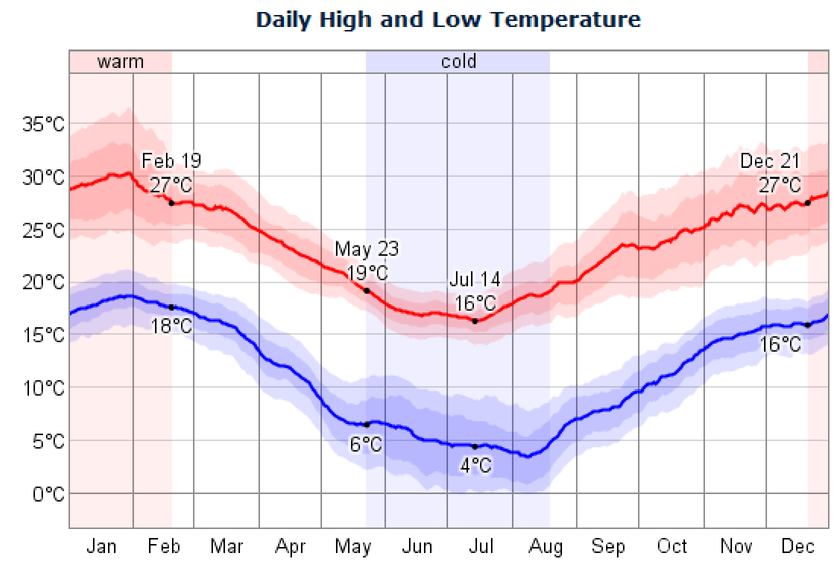
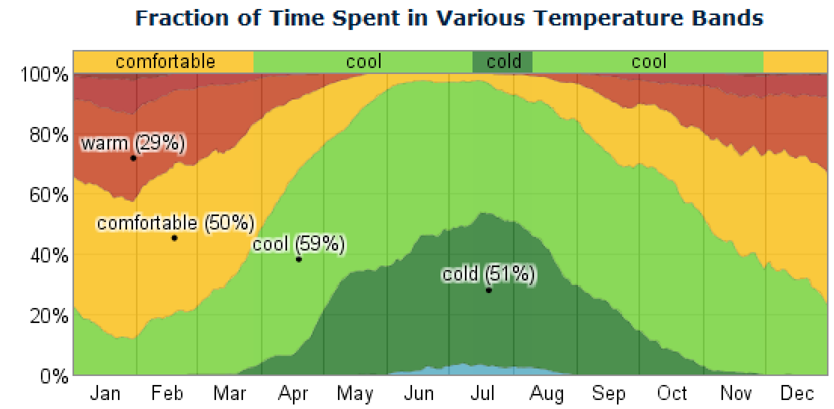


The daily average low (blue) and high (red) temperature with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

Daily high and low temperatures (Source: https://weatherspark.com/averages/34087/Richmond-New-South-Wales-Australia)

The comfort zones for the site are shown below for each month of the year:



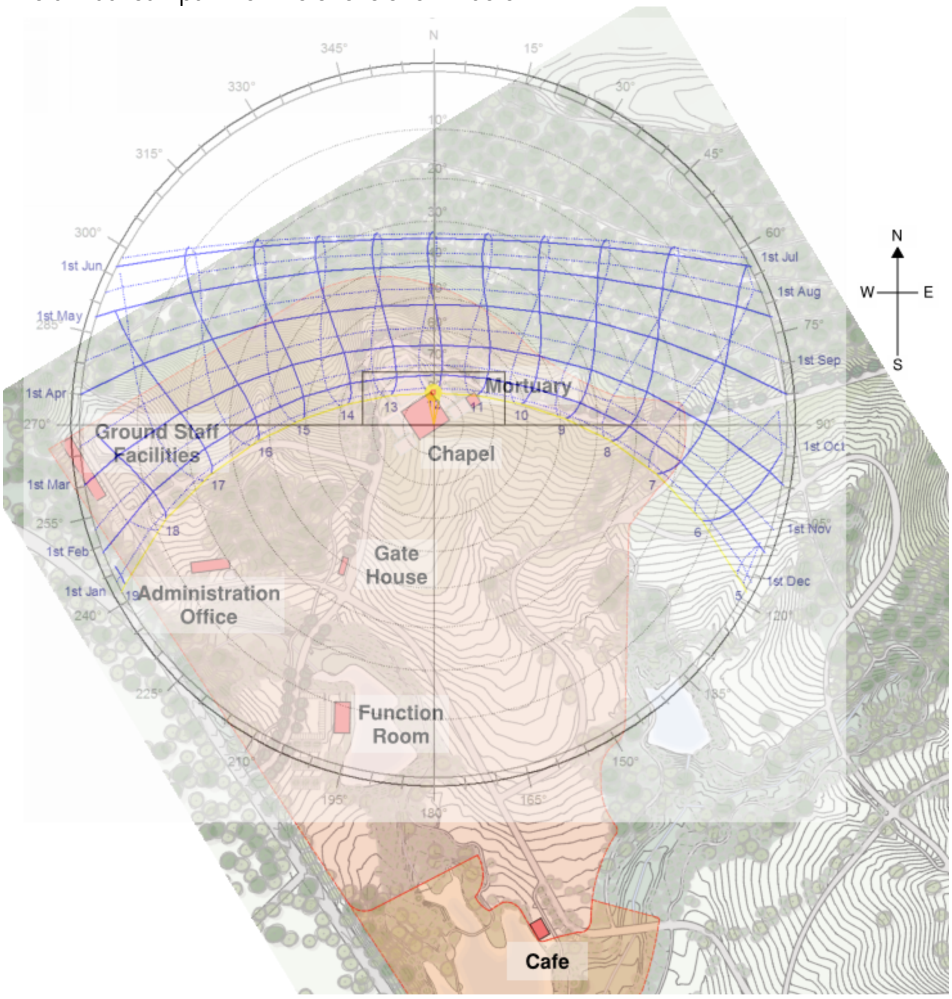
The average fraction of time spent in various temperature bands: frigid (below -9°C), freezing (-9°C to 0°C), cold (0°C to 10°C), cool (10°C to 18°C), comfortable (18°C to 24°C), warm (24°C to 29°C), hot (29°C to 38°C) and sweltering (above 38°C).

Time spent within external comfort zones throughout the year (Source: https://weatherspark.com/averages/34087/Richmond-New-South-Wales-Australia)

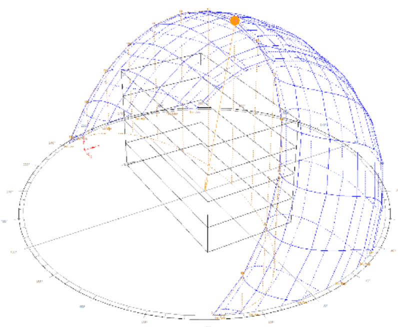
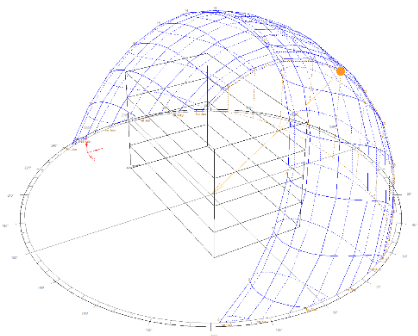
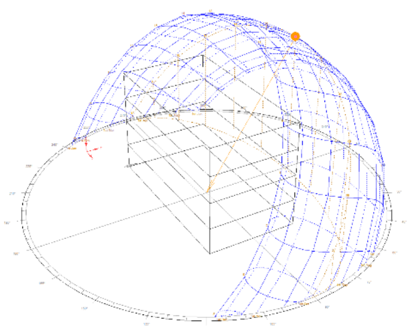
While temperatures can get hot in summer and cool in winter, the overall temperature range is fairly comfortable, and careful consideration of passive design strategies can help reduce overall energy demands.

Sun Path:

The annual sun path for the site is shown below:



Seasonal sun positions:

Summer sun angle (1st January)	Winter sun angle (1st July)	Equinox (20th March)
		

The following diagrams show the following features:

- Sunrise and Sunset positions for winter and summer;

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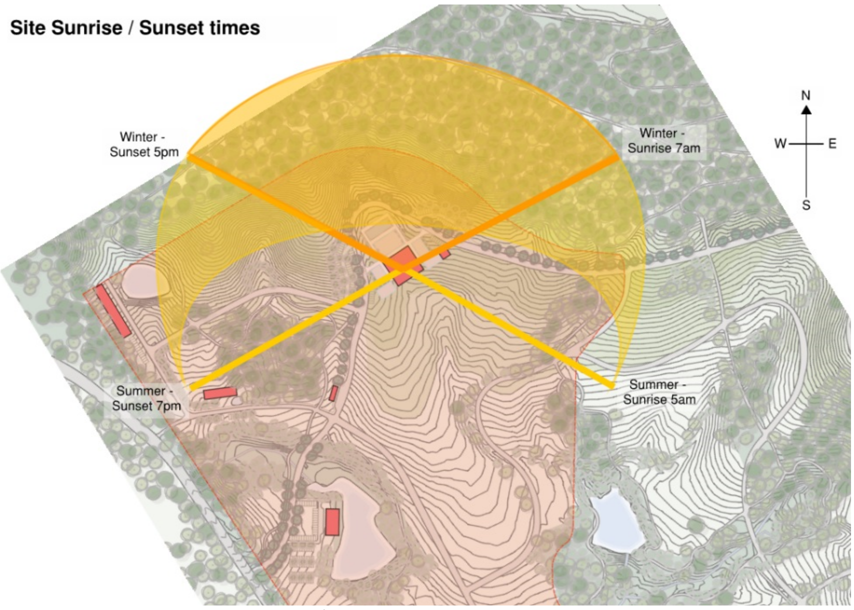
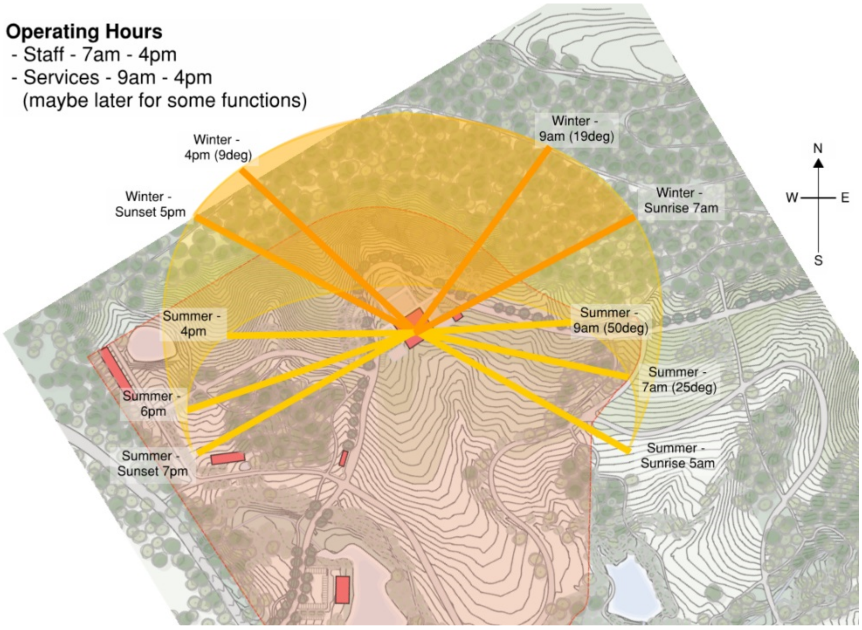
- Sun positions at key operational times for the buildings.



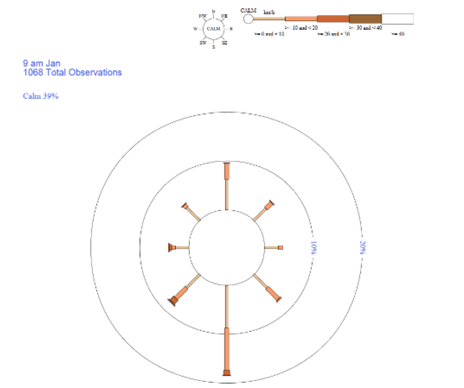
Anticipated operating hours for the site are shown below. As shown, services are expected to end around 4pm, but it is possible that some functions or services may run later.



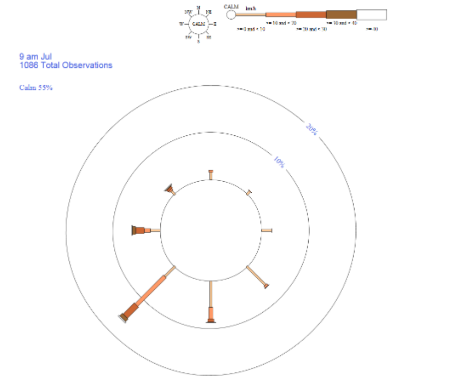
Wind Speed & Direction:

Wind speeds for the site have been taken from the Bureau of Meteorology (BOM) website, using Camden Airport AWS weather station data, as this station is in close proximity to the site. A sample of the results are shown below for summer and winter conditions, with reports from 9am and 3pm:

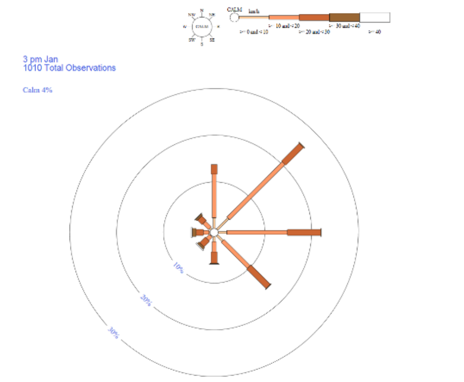
Summer 9am



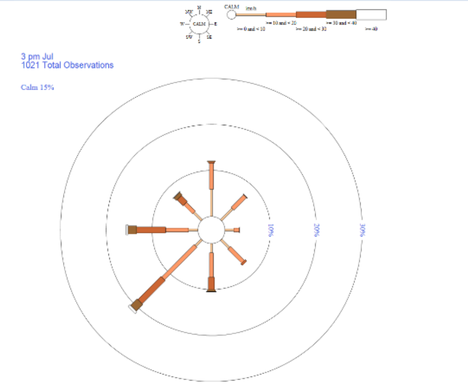
Winter 9am



Summer 3pm



Winter 3pm



The results show that while winter wind direction is fairly consistent throughout the day, from the SW, the summer profile fluctuates far more throughout the day, from a southerly prevailing morning wind to North Easterly and Easterly in the afternoon.

For passive design considerations, protection should be provided where possible from strong winter winds, while summer winds, especially in the afternoon when temperatures are hotter, should be encouraged.

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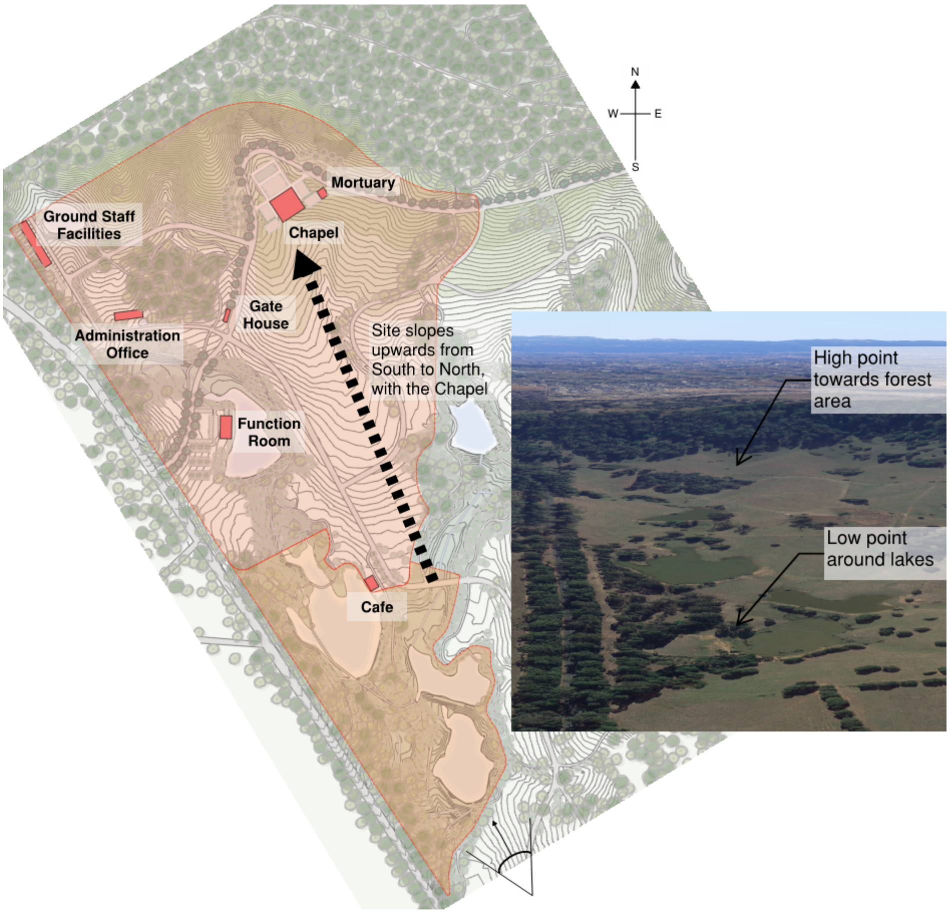
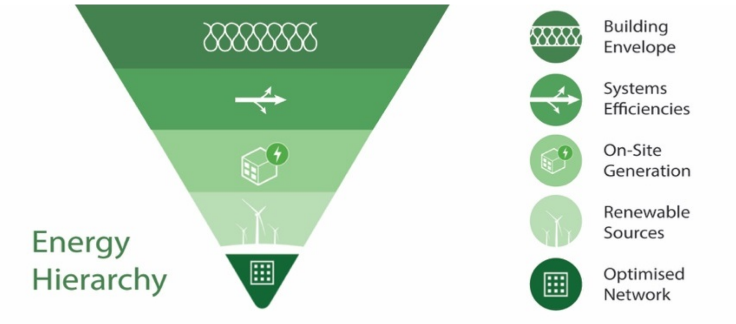
Site Topography:

The following diagram shows the site contours, along with a google earth snapshot showing how the site slopes up from the lakes.



3.0 Energy Strategy

For the design of the buildings within the development, the following energy hierarchy is recommended to optimize cost effective energy efficiency measures:



This energy hierarchy considers passive reduction of energy use as its first priority, and then seeks to meet the remaining energy demand by systems efficiency measures and then renewable energy sources.

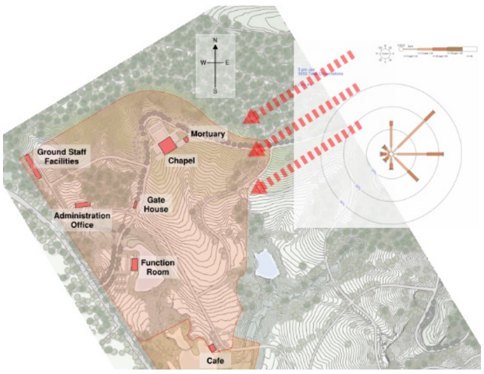
3.1 Passive Design Measures:

The façade design, including shading, openings and window ratios should be designed based on the climatic conditions discussed above in Section 2.0.

As the buildings within the site are relatively small scale and isolated from each other, there is little scope for sharing systems such as cooling, heating or hot water. It is therefore recommended that each building energy performance is optimised as follows:

Massing, Orientation and Building Envelope Design:

Promote natural ventilation:

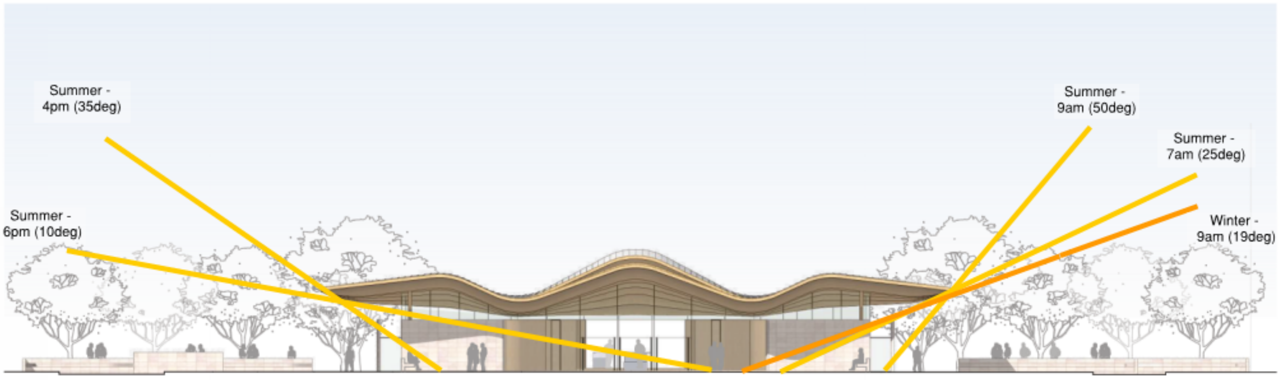


- Orientate buildings towards prevailing summer winds (NE and E);
- Openings on the eastern and western facades will help promote the stronger afternoon summer winds through the buildings.

Optimize solar exposure:

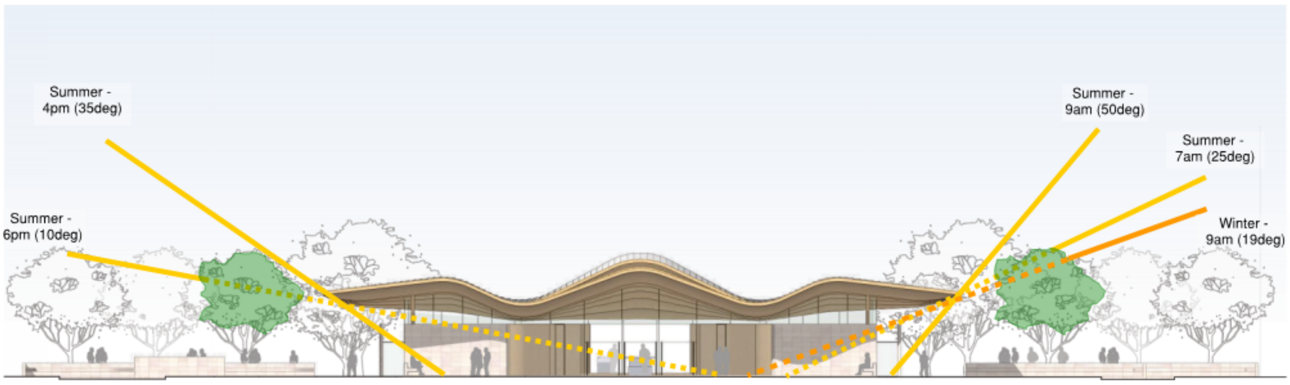
- Reduce solar gains during summer, both internally and externally;
- Promote shading of internal and external spaces;
- Allow some winter sun to enter buildings to provide passive heating.

Chapel Considerations:
The following diagram show the sun angles in relation to the main chapel building, with the view from the South:



The overhang on the east and western façade helps reduce the higher angle summer sun which is good, although the summer evening sun may cause additional unwanted heat gains. The eastern and western facades have large amounts of glazing, so the following recommendations could be considered:

- Increase overhang to further reduce sun angles able to enter the building;
- Provide internal blinds to be used for the critical periods;
- Reduce overall glazing ratio on the eastern and western facades;
- Provide external shading, either through shading structures or planting of trees – the diagram below shows how trees could be strategically located to block low angle morning and evening solar radiation.



For the North and South facing facades, and the north facing rooflight, the following diagram shows the summer and winter sun angles entering the building.

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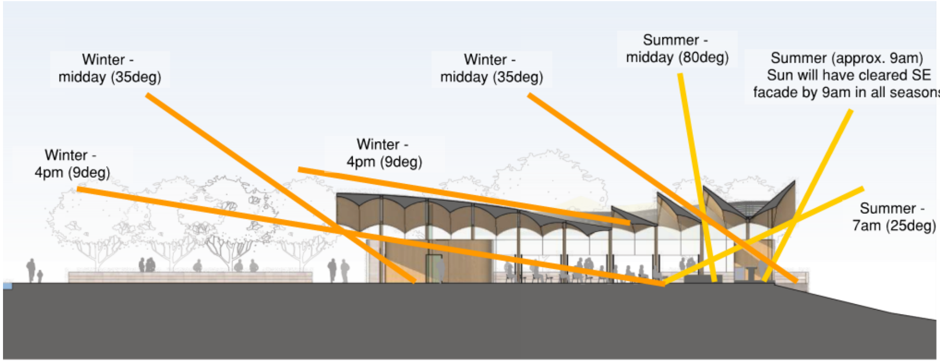


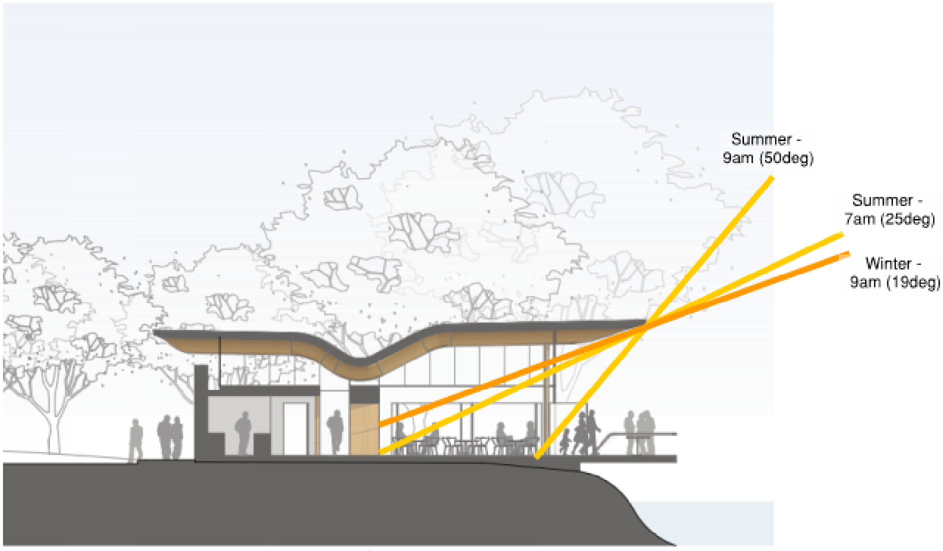
The current design of the northern and southern facades works well with the sun angles for limiting summer solar gains. There will be some light solar penetration in the summer early morning, which could be reduced by increasing the overhang at the front of the building.

For the rooflight design, it is understood that some directional light is desired to enhance the internal aesthetics during services. The following is therefore recommended for the roof light:

- Overall glazing areas should be kept to a minimum to reduce large solar gains;
- Consider use of shading or fritting to allow directionality of light while reducing overall radiation entering building.
- Consider designing roof light to block peak summer angles, and to achieve directional light, use reflective roof materials to reflect higher angle sun into the space

Function Room Considerations:

The following sketch shows the function room cross section, showing the eastern façade overhanging the water front, with the morning sun angles shown for summer and winter:



As shown, there is the potential for quite high solar gains in the mornings throughout the year, which could lead to increased cooling demands and potential glare and thermal discomfort for occupants. To mitigate this issue, it is not possible

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to locate trees due to the adjacency to the lake, but external shading, internal blinds or increased over hang length could help reduce the issue.

The café will have a similar problem but in the afternoon with the west facing façade suffering from evening low angle solar gains.

Thermal insulation –
- Insulation is important for maintaining internal temperatures and reducing unwanted heat transfer between outdoor and indoor conditions (heating and/or cooling);

Thermal mass and night time purging –
- Thermal mass can help reduce variations in internal temperatures, by absorbing heat during hotter daytime conditions, and releasing heat once the temperature cools;
- It is recommended that exposed thermal mass is considered wherever possible within the main buildings on the site to help reduce the cooling demand of the building.

Performance glazing –
- Glazing should be selected to optimise performance, admitting good daylight levels, while controlling the transmission of solar heat and thermal conduction;
- Double glazing and low Solar Heat Gain Coefficient (SHGC) glazing is recommended for the glazed walls and roof lights within the buildings;
- Glazing performance will also help reduce diffuse radiant heat gains.

Glazing ratio –
- Glazing ratios need to achieve an equilibrium between allowing daylight to enter buildings while reducing solar and conductive heat gains;
- While it is understood that the main Chapel, Function room and café have high levels of glazing, it is recommended that the overall glazed areas are reduced if possible.

Building air tightness –
- Doors should be designed to close automatically to reduce unwanted heat transfer during peak summer and winter conditions. Consider revolving doors where applicable to maintain air tightness;

Landscaping:

- Provide trees to add additional shading, especially on the eastern and western edges of the buildings (as discussed above);
- Trees can also reduce heat island effect, buffer of cool winds, and promote biodiversity;
- Water bodies or features – Strategic location of water bodies can encourage evaporative cooling externally or within building areas;
    - The Function room is well located to benefit from this evaporative cooling effect, due to it's eastern facing façade towards the lake;
- Green roofs – Help reduce overall building heating and cooling loads by providing better thermal insulation. They also help reduce external temperatures and relative humidity and encourage biodiversity;

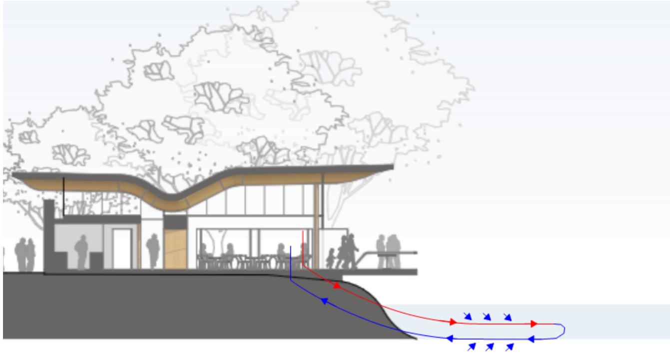
- o It is understood that the light weight design of the main chapel, function room and cafe precludes the use of green roofs, but they could be considered on the administration and support buildings.

3.2 Active Energy Strategies

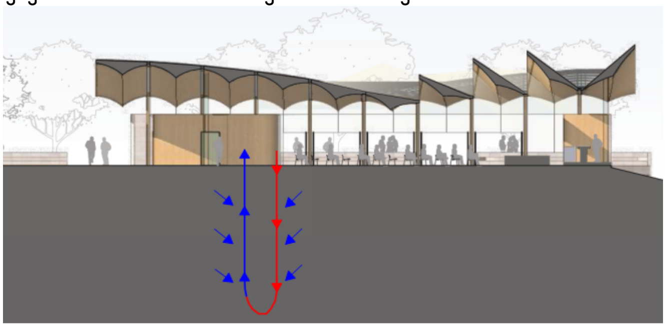
Having reduced the overall energy demand through passive measures, the next focus is on how to supply the cooling, heating and electrical loads efficiently. Measures to be considered include:

Free Cooling –
- Run mechanical cooling plant in economy cycle when conditions are appropriate;
- Use evaporative cooling options;
- Use labyrinths, earth ducts, night purge and other strategies;

Pre-temper outside air –
- Use of ceiling fans to circulate air;
- Use of geothermal or heat recovery systems to lower outside air temperatures;
- The café and function rooms could both benefit from using the lakes adjacent to the buildings for summer cooling and winter heating;
  - o The lake water, if of sufficient size and depth throughout the year, will provide a relatively constant temperature, based on the average daily and average annual temperature. It can therefore provide free cooling or heating during certain times of the year, and pre-tempering of air during the hottest and coldest periods of the year.



- The chapel and other buildings could benefit from geothermal energy, using ground source heating and cooling:



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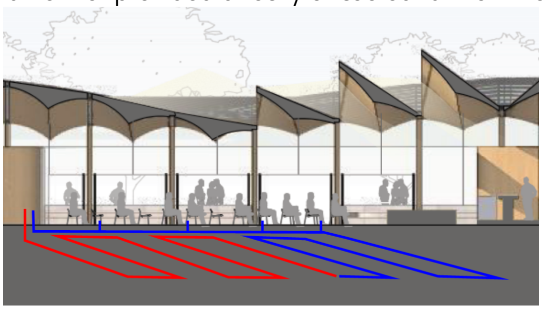
- It is worth noting that due to the cost of ground source pipe work installation, and given the relatively low energy demand and short operating hours of the chapel, a geothermal system may not provide a reasonable return on investment.
- The water based system for the café and function rooms would likely be more cost effective due to the lower capital costs of installation.

A thermal labyrinth could also be considered for the chapel building, along with displacement ventilation. Air could be pre-tempered using a labyrinth or ground source pipes, with air either provided directly or cooled further if required.



For external spaces, in peak summer days, to promote thermal comfort either before or after a service, evaporative cooling through mist sprays could be considered.

Ceiling Fans –
- Consider installation of ceiling fans to circulate air, promote evaporative cooling and reduce air conditioning requirements.

Relax internal set points –
- Allowing a greater range of thermal conditions can reduce heating and cooling plant loads.

Seasonal temperature and humidity set points –
- Set-points could be varied throughout the year based on expected comfort ranges of the building occupants.

Reduce Hot Water usage –
- Consider providing cold water only wash basins for the public.

High Efficiency plant –
- Provide high efficiency heating, cooling, hot water and ventilation systems.

Efficient lighting and lighting controls –
- Use of LEDs, occupancy and daylight sensors.

Metering and Monitoring –
- Consider installation of energy, water and air quality metering and monitoring to promote healthy environment and save energy energy and resources.

Building Management Systems (BMS) –
- Installation of a BMS to link to sensors and meters throughout the park, with the ability to control lighting, hydraulic and mechanical systems could

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help reduce energy and water usage throughout the buildings and the park itself.

System Commissioning –
- Comprehensive commissioning of the buildings is essential to ensure the buildings function as planned.

4.0 Renewable Energy Review

Given the sensitivity and open nature of the site, the options for renewable energy are limited. However, an overview of renewable energy options that could be could be considered for the site is discussed below:

4.1 Solar PV

Photovoltaic (PV) panels convert solar energy directly into electricity. PV is the most likely technology to be applicable for the site, given the expected low heat demand for the site buildings. Possible locations for PV could include:
- Building roofs;
- Site landscaped areas;
- Roads / Walkways.

Building Roof PV:

Given the design of the roofs, it is understood that standard PV panels mounted on the roof may not achieve the desired aesthetic. However, it could be possible to consider the use of thin film PV panels or PV cells integrated into the roof lights.

Thin film PV has a slightly lower energy conversion efficiency than the standard PV panels, but provides the ability to apply cells to a curved surface, such as the roofs of the chapel, function room and café.

Standard Roof Mounted PV Panels

Thin Film flexible PV panel

PV Cells integrated into Glass Pane

PV cells within glazed roof shading system

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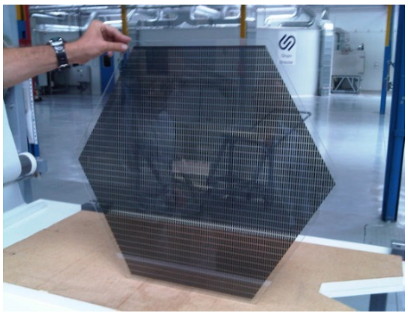
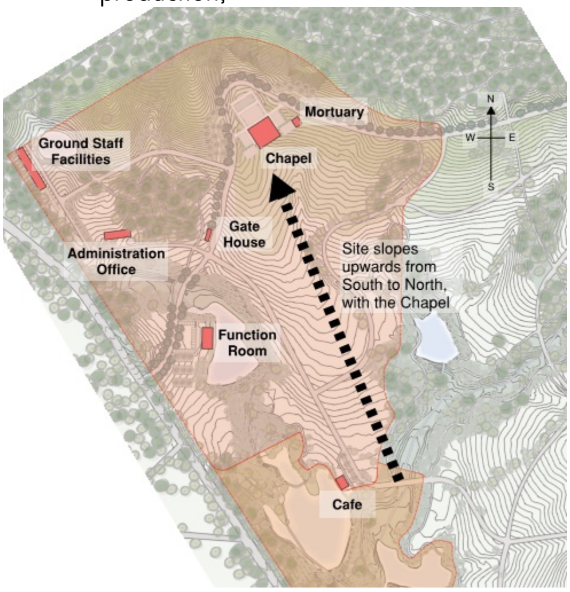


Site Landscaped Areas:

At present, it is understood that there is limited availability of space for location of large PV arrays. This is due to the following:

- It is understood that large PV panel areas are not desirable from a visual perspective;
- The topography of the site slopes up from South to North, which exposes the site to nearby areas and also reduces the effectiveness of PV energy production;



Site Roads and Walkways:

There are PV applications that can be integrated into roadways or walkways. Applications have included a cycleway in the Netherlands, and a recent commitment in France to build large scale PV roadways.

Common arguments against the technology include durability concerns plus cost and efficiency concerns when compared more standard PV applications. An image of the PV walkway installed in the Netherlands is shown below:

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Due to the visual constraints of this site, and the low expected vehicle movements, there may be scope to integrate PVs into the roadways to help power both the buildings and any street lighting that might be considered for the site.

4.2 Solar Thermal

Solare thermal panels convert solar energy into heat for use as hot water or heating. The panels are relatively cheap and have good efficiency. It is recommended that they could be considered for the staff facilities building, to serve any showers or hot water demand within those buildings.

Solar thermal panels could also be used at night for cooling, through radiant cooling, to cool thermal mass.

Solar Thermal Panel

4.3 Wind Power

Due to the size and visual impact of wind turbines, wind power is not considered a viable option for the site.

4.4 Cogeneration / Trigeneration

Due to the environmentally sensitive nature of the site, it is understood that no combustion of gas or other materials (such as biomass, waste, biodiesel, etc) can be considered. Therefore, these options are not considered viable for the site.

5.0 Water Efficiency Measures

The following initiatives are considered viable for the buildings within the site:

- Rainwater Collection from Roof for reuse as grey water for toilet flushing and irrigation;
- Efficient Fixtures and Fittings can be installed throughout the buildings: WELS rated 3/6 litre flush; Five (5) star rated mixer taps; Five (5) star rated shower heads and tapware water outlets will be provided.
- Landscape Irrigation: Aim for low or zero water demand planting throughout landscaped areas. Where irrigation is required, install efficient irrigation systems (bubblers / drip irrigation) and re-use rainwater or treated grey water;
- Solar Hot Water: As mentioned above, Solar Hot Water could also be considered for the staff facilities;
- Water meters should be provided to record and monitor water consumption, and meters to be linked to the BMS system.

6.0 Healthy Environment

6.1 Human Environment

Good indoor environmental quality (IEQ) is one of the key priorities to ensure comfort, health and well-being of the building occupants.

IEQ is of particular importance for the staff facilities and workspace areas as poor IEQ is the principal cause of sick building syndrome, which can reduce productivity of staff and have detrimental health impacts.

Key factors affecting IEQ

Key IEQ issues

The indoor environment of a building is influenced by the following factors, which should be carefully considered during design and operation:

Thermal comfort:

- This includes temperature, humidity and air speed;

Acoustic comfort

- This includes the ability of a building to minimise external noise as well as the noise levels within the occupied space;
- Acoustic performance is of particular importance for the chapel, to ensure that services can be heard by all guests. Also, if multiple services are taking place at once, it is important to acoustically separate each service.

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Indoor air quality:

Following are some of the key strategies that should be considered for the performance of the buildings:

- Ventilation rates and outdoor air opportunities should be considered to reduce the build-up of internal pollutants such as carbon dioxide (from respiration) and odours.
- Low Volatile Organic Compound (VOC) finishes should be considered for the project. Low VOC finishes include paints, adhesives and sealants, carpets and other flooring i.e. vinyl and fit out items.
- Low formaldehyde products should be specified for the project.
- CO2 / pollutant sensors should be used on mechanical services to monitor and control the indoor air quality.
- General outdoor air supply should be maximised where possible.

Any sensitive spaces within the buildings, or areas where pollutants are regularly emitted (such as cleaning cupboards, waste storage, printer rooms) are clearly separated from other spaces and separately ventilated / exhausted.

7.0 Materials

Consideration should be given to materials of low embodied energy content, high recycled content and/or highly recyclable. In addition to impact of the material, the construction technique for systems is being assessed to favour those systems that reduce requirements.

Material selection is an important aspect of environmental design because building materials consume energy and natural resources during its manufacture and for their transportation to the construction site.

All materials have an associated embodied energy. Embodied energy is the energy consumed by all the processes associated with the making of a product, from the mining and processing of natural resources to manufacturing, transport and product delivery.

To minimize embodied energy the design should, wherever possible:

- Use locally sourced materials to reduce transportation;
- Re-use materials from the demolition of onsite or nearby buildings;
- Select low embodied energy materials (which may include materials with a high recycled content);
- Select materials that can be re-used or recycled easily at the end of their lives using existing recycling systems;
- Give preference to materials manufactured using renewable energy sources.