



SUSTAINABILITY REPORT

Log Cabin Pub

Lot 20-22, Memorial Avenue, Penrith NSW 2750

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PREPARED FOR
FDC
22-24 Junction Street, Forest Lodge
NSW 2037

Sustainability Report

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30.03.2020	1	Issue for DA	B. Park	I. Van Eerden

Northrop Consulting Engineers Pty Ltd

ACN 064 775 088 | ABN 81 094 433 100

Level 11, 345 George Street, Sydney NSW 2000

02 9241 4188 | sydney@northrop.com.au | www.northrop.com.au

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Executive Summary

The intent of this report is to outline the sustainability strategy adopted for the new Log Cabin Pub at Lot 20-22 Memorial Avenue, Penrith, and demonstrate compliance with sustainability objectives set out by Penrith City Council. This report has been prepared on the basis of the plans prepared by FDC to satisfy the DCP requirements of Penrith City Council.

The Log Cabin Pub development will be targeting the following key sustainability objectives:

- Minimised production of greenhouse gas emissions and optimised energy efficiency;
- Minimised mains potable water use;
- Minimised waste going to landfill and improved waste collection efficiency; and
- Minimised effects of urban heat island effect
- On-site renewable energy generation

These outcomes will be achieved through demonstrating compliance with the following;

- Building Code of Australia – compliance with the requirements of Section J Energy Efficiency (mandatory);
- Energy efficient heating, ventilation and air conditioning including natural ventilation to indoor space;
- Water efficient building services including rainwater collection and fire system reuse;
- Minimisation of the projects impact on Stormwater flow entering the municipal systems;
- Maintenance of the site's ecology and biodiversity.

Based on the above, the design initiatives outlined in this Sustainability Report provides a framework for the development that aims to exceed the minimum benchmarks of Penrith City Council's Development Control Planning requirements.

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1. Introduction

1.1 General

The intent of this report is to outline the sustainability strategy and demonstrate the sustainability initiatives being considered by development of the Log Cabin Pub at Lot 20-22 Memorial Avenue, Penrith.

This report has been developed in accordance with the Penrith City Council's Development Control Plan (DCP) 2014 Volume One and aims to align the development design with the objectives outlined in C1.2.2 – Built Form – Energy Efficiency and Conservation and C3.1.5 – The Water Cycle/Water Conservation for Commercial Premises. The sustainability initiatives listed in the subsequent sections of this Sustainability Report have been suggested as pragmatic and cost-effective solutions for the project and are to be reviewed for consideration by the design team.

1.2 Building Characteristics

The Log Cabin Pub development incorporates the renewal of a site located on the embankment by the Nepean River to be built as a principle of social gathering and accommodate beverage and restaurant facilities. The project will provide high quality outdoor dining area along the embankment of the river, activating the surrounding area of Penrith LGA. The proposed development is located on the Eastern embankment of the Nepean River between Victoria and Yandhai Bridge, connected by Memorial Avenue in Penrith.



Figure 1 – Site Plan of the Proposed Development at Lot 20-22 Memorial Ave Penrith Designed by Team2 Architects

1.3 Limitations of the report

Due care and skill has been exercised in the preparation of this report.

No responsibility or liability to any third party is accepted for any loss or damage arising out of the use of this report by any third party. Any third party wishing to act upon any material contained in this report should first contact Northrop for detailed advice, which will take into account that party's particular requirements.

2. Building Code Compliance – Section J

As part of the buildings sustainability assessment Northrop Consulting Engineers has conducted a Deemed-to-Satisfy (DTS) assessment of the building fabric in accordance with Section J of the National Construction Code (NCC) 2019. The following section provides an outline of the minimum compliance requirements for the building fabric as outlined in Part J1 of the code.

The table below outlines compliance requirements for J1.0 to J1.6:

Table 1: Insulation and Glazing System requirements for the building fabric

Building Fabrics	Required Minimum Thermal Performance
Roof and Ceiling	R3.2; Solar Absorptance (SA) < 0.45
External Walls	R1.5
Partition Walls to Non-Conditioned Space	R1.5
Floors (Slab-on-ground, exposed & semi-exposed)	R2.0
All External Windows	U-value: 5.9 SHGC: 0.48
All Internal Windows	U-value: 5.9 SHGC: 0.77

Should the requirements listed above be deemed unfeasible, it is recommended that the project team should proceed with a JV3 performance-based solution. This approach is more flexible as it offers a holistic assessment of the building performance, rather than individual components.

2.1 Building Description

The Log Cabin Pub Penrith is classified as Class 6 and 9b – retail and assembly building as stipulated in Blackett Maguire and Goldsmith’s preliminary BCA assessment of the proposed development. For the purposes of Section J – Part J1 Class 6 and 9b was considered for the assessment of the building fabric encapsulating conditioned spaces throughout the development. This proposed development is located in LOTS 20-22 Memorial Avenue, Penrith NSW 2750 which belongs to climate zone 6 as shown in Figure 1 below.

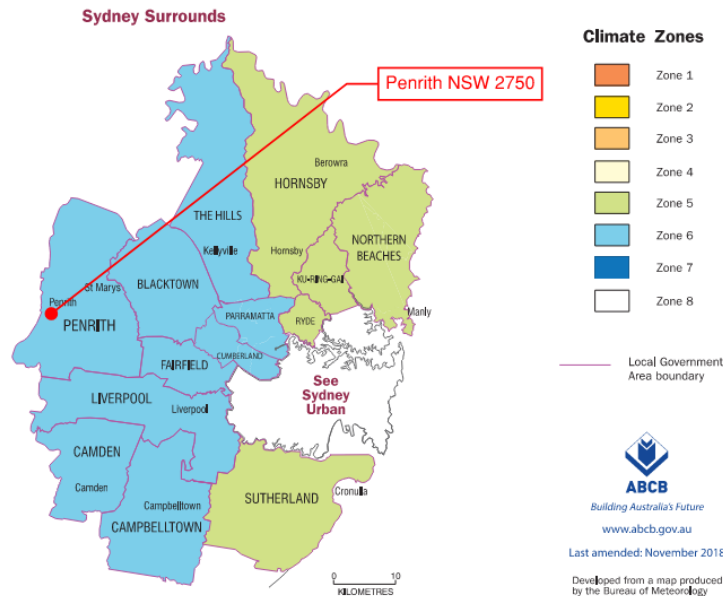


Figure 2 - Climate Zone Map of Sydney Surrounds

2.2 J1 Building Fabric

Building fabric thermal insulation requirements apply to the building fabric enclosing habitable and conditioned spaces forming part of the thermal boundary of the site (building envelope). This is demonstrated in the thermal boundary markup attached in Appendix B of this report.

Below entails the thermal performance requirements of each components of the building fabric applicable to Log Cabin Pub Penrith development, which are assessed against Parts J1.3 to J1.6.

J1.3 Roof and Ceiling Construction

Roof and ceiling construction must achieve a total system R-Value of R3.2 with solar absorptance value of no more than 0.45.

J1.5 Walls and Glazing

The total system U-Value the wall-glazing construction* of Log Cabin Pub Penrith must not be greater than U2.0 as per J1.5 clause (a)(i).

The table below outlines the thermal performance requirements of the external walls, partition walls and the glazing system required to achieve the specified maximum of U2.0.

Table 1 - Required Code Compliant Thermal Performance of the Wall-Glazing System

Wall-Glazing Component	Required Thermal Performance
External Wall	R1.5 (See Note Below)
Partition Wall	R1.5 (See Note Below)
External Glazing	U-Value: 5.9 SHGC: 0.48
Internal Glazing	U-Value: 5.9 SHGC: 0.77

Note: The total system R-Value of the external and partition walls reflect thermal performances inclusive of the thermal bridging effect caused by building support structures. As such the buildup must achieve the stipulated R-Values with the effects of thermal bridging taken into account.

J1.6 Floors

All ground floors* and floors to non-conditioned space such as floors exposed to the outside air and semi-exposed floors must achieve a total system R-Value of 2.0 (See Appendix B for Thermal Boundary Markup).

*The required total system R-Value of the slab-on-ground is met through the inclusion of the layer of soil in contact with the ground floor. See Appendix C for the R-Value calculation of the soil layer.

3. Sustainability Initiatives

Further to the minimum code compliance assessment of the development, the project team have also looked at potential additional design strategies to improve the environmental performance of the development. In line with the Penrith City Council's Cooling the City Strategy, strategies to mitigate the effects of urban heat island effect (UHI) have been developed addressing the councils concerns regarding the financial, environmental and the social impacts of this issue on the Penrith Local Government Area (LGA).

The following objective framework in the Penrith City Council's DCP requirements were applied to set guidance in the formulation of the design initiatives proposed in the report:

- To ensure that development is designed on a 'whole of building' approach by:
 - Encouraging passive solar building design;
 - Allowing reasonable daylight access to all developments and the public domain;
 - Reducing the necessity for, or improve the control of, mechanical heating and cooling;
 - Reducing the energy consumed by installed
 - Improving the indoor environmental quality of occupants;
 - Minimising greenhouse gas emissions
- To reduce consumption of potable water for all development types within the City;
- To use harvested rainwater, treated urban stormwater or treated wastewater for non-potable substitution where appropriate.
- Utilising, where possible, sustainable materials that minimise impacts on the environment, maintenance and waste

3.1 Passive Design

Passive design is a key element when designing low energy buildings. Passive design reduces the need for auxiliary heating or cooling by taking advantage of varying climate to achieve thermal comfort. The following initiatives will play a significant role in ensuring that the building's annual energy performance is lower than the set thresholds.

Key considerations include thermal performance of the building fabric, glazing selection and extent, external shading, daylight direction devices, surface properties and possible natural ventilation openings.

3.1.1 Building Insulation

Climatic conditions influence the appropriate level and type of insulation, as it acts as a barrier to heat flow and is essential for retaining thermally comfortable indoor temperature. In line with the National Construction Code 2019 Volume One, the proposed development is deemed to meet the best practice (minimum code) requirements of the wall-glazing construction to provide the appropriate insulation level across the building envelop.

3.1.2 Roof Solar Reflectance Index (SRI)

Solar Reflectance Index (SRI) is a numerical value used to denote the roof's ability to reflect incident energy from the sun away from the building. It is determined from two parameters of the roof – solar reflectance, which represents the extent to which a surface reflects sunlight, and thermal emittance, which quantifies the ability of a surface to release absorbed thermal energy. Higher SRI therefore correlates to the ability to reflect heat away from the surface with minimal absorption, which is often observed in lighter-coloured roof materials.

The development proposes a light-coloured roofing material with solar absorptance of below 0.45, which largely involves higher SRI yielding roof materials. This helps to comply with part J1 of the National Construction Code 2019, but also helps to mitigate the effects of the urban island effect by reflecting the energy from the sun away from the building, rather than absorbing and re-emitting it back to the atmosphere.

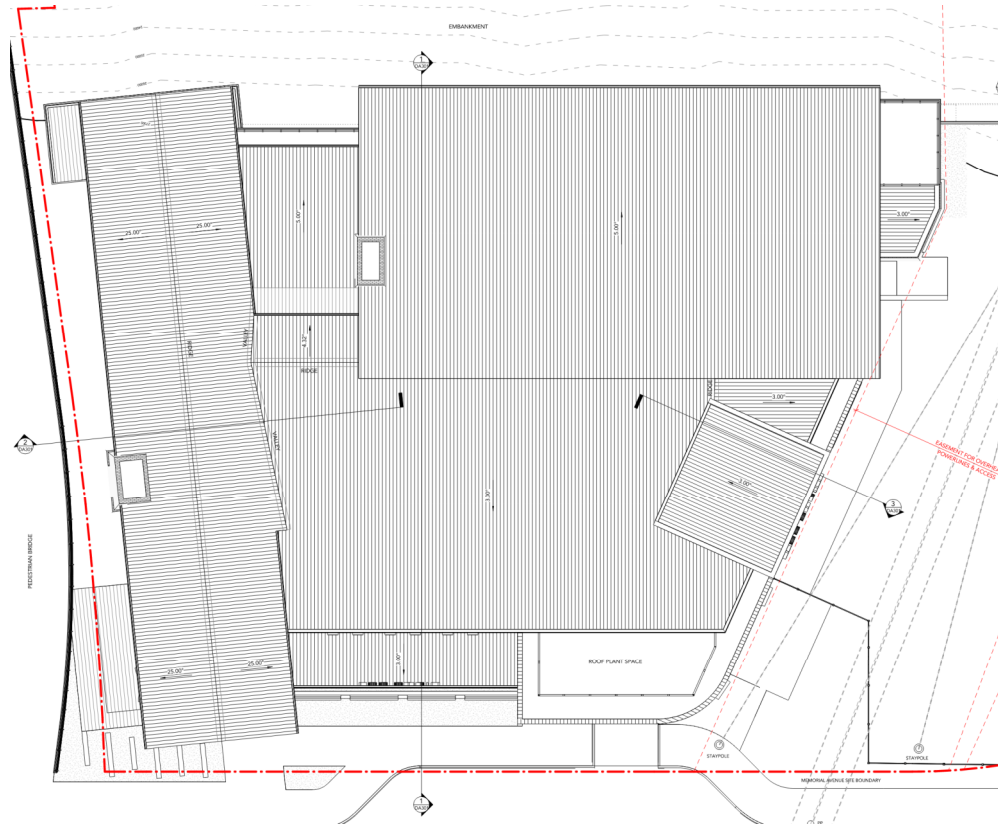


Figure 3 Roof specification for Lob Cabin Pub Development

3.1.3 Natural Ventilation

The building is designed for good use of naturally ventilated spaces. This is demonstrated by the fully openable, well-shaded windows and doors on the Western façade of the building across both floors. Increasing the natural ventilation of the space is a method used to passively cool and ventilate the space without using mechanical air conditioning systems and thus an effective way to minimise energy consumption in the building.

3.1.4 Natural lighting – Light Shelving

Effective use of daylight in buildings has been shown to reduce building energy consumption and improve the occupants' sense of well-being. The controlled transmission of natural light into a building will reduce the reliance on artificial lighting for much of the year, whilst still achieving acceptable illumination.

While the current design of the envelope aims to open the buildings to more natural light where possible, this can also be maximised utilising high reflectance finishes and light shelving.



Figure 4 Example of natural light shelving

3.1.5 High VLT Glazing

Selecting a glazing that provides a high transmittance of visual light, while still meeting the thermal performance needs of the code, will allow a greater level of daylight into dwellings and improve tenant visual comfort within the space.

The selection of glazing with a VLT of 60% within the occupied spaces should not present a significant premium as it will largely involve the provision for daylighting within the Section J assessment to find an optimal balance between daylight and thermal comfort.



Figure 5 Indication of VLT glazing tints

3.1.6 Optimised Shading

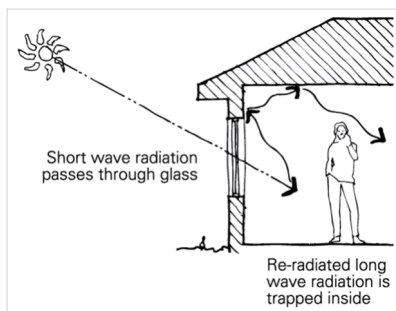


Figure 6 shading prevents the entry of solar radiation in summer but should allow warmth to enter in winter

Direct solar radiation entering a building can act as a heater in winter, however, it can drastically increase air-conditioning loads throughout summer. As such optimised shading will allow the entry of warmth in winter and block this in summer.

The placement of the shading devices should be focused on the North, West and Easterly facades to reduce unwanted heat gain resulting from the low angle suns in the Summer months. The development proposes an extensive shading in the West where most of the glazing is located, thereby mitigating the effects of heating in warmer months.

Adjustable vertical shade sails on the Western deck are also proposed to resolve the potential problems of direct solar heat gain and glare from the afternoon sun.

3.1.7 Thermal Mass

High thermal mass can be used for heating and cooling as brings a delay on reaching the maximum and minimum temperature on daily bases which provides temperature stability and enhances the thermal comfort.

Heating with thermal mass happens through storing solar heat during the day and releasing it at night, while cooling through thermal mass can happen through allowing night breeze to cool the high thermal mass and it will release that coolness during daytime when it is mostly needed.

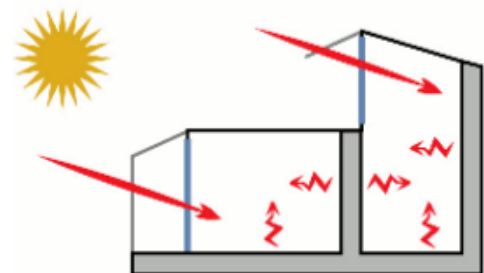


Figure 3: using thermal mass to store solar heat. (house-energy.com)

Appropriate thermal mass ratio is recommended for this development as it is located inland within Climate Zone 6, whereby high temperature swings between the day and night is expected throughout the year. Using exposed pre-cast panels on walls, and slab-on-ground can be an effective way of utilising thermal mass to dampen the unwanted temperature fluctuations.

3.1.8 Thermal Bridging Elimination

Heat will flow the easiest path from the heated space to the outside - the path with the least resistance. Several components in the building envelope usually act as a thermal bridge, a conduit for heat to leak through the walls, roofs, floors and windows internally and externally.

This results in additional energy consumed by the HVAC system to compensate for heat gains and losses and achieve comfort. Thermal Bridging could account for up to 10% of total energy consumption.

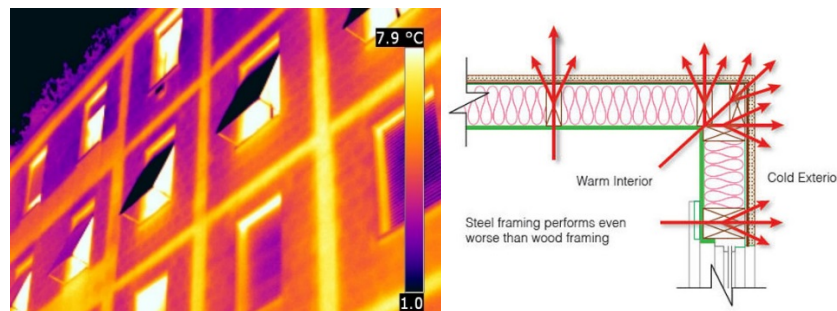


Figure 7 Typical thermal bridge heat losses

Thermal separation eliminating thermal bridging is recommended for the following components;

- Utilising, where possible, sustainable materials that minimise impacts on the environment, maintenance and waste
- Foundation wall transitions;
- Metal panel wall support connections;
- Parapet conditions;
- Roof to wall transitions;
- Window wall transitions;
- Window frames; an
- Curtain wall support connections;

3.1.9 Building Sealing

Air leaks is usually present in two scenarios, direct and indirect.

- Direct leaks are the most obvious, such as undercuts that allow outside air to come directly under the sill or around the frame.
- Indirect leaks are more difficult to identify but represent most of the air leakage in a typical building. Indirect leaks occur where air penetrates the exterior at one location and the interior at another.

Extensive building sealing should be applied to eliminate all heat losses in the space. This is recommended to be undertaken on the interior and exterior of the building during construction works, using expanding foam or the like.



Figure 8 interior and exterior building sealing

3.2 Energy Efficiency

3.2.1 Energy Efficient Air-Conditioning

Though the utilisation of HVAC system zoning and higher energy efficiency ratio (EER), a higher performing, energy efficient system can be employed to condition the occupied space effectively and accommodate significant variation in occupant loads across the day. Active control systems will work to maintain the space at the outer limits of the thermal dead band accounting for predicted demand increases with restaurant opening hours.

3.2.1 HVAC System Controls

While other HVAC systems operate on a more rigid full-on or full-off schedule, variable air-conditioning systems, such as chilled water and Variable Refrigerant Flow (VRF) systems deliver refrigerant at variable rates and exact amounts to spaces that need it, meeting the heating and cooling needs of the building with increased precision and efficiency.

The use of an effective controls system with an efficient air-conditioning system will allow the adjustment of the heating and cooling requirements of each space and allow the system to operate at reduced speeds, saving energy. The use of smaller systems coupled with controls sensors in each space means that differ space requirements can be accommodated with areas avoiding over cooling or heating.

3.2.2 Economy cycle - free cooling mode

Economy cycles rely on utilising cool outside air as a means of cooling the indoor space. This is achieved when outside air temperature and relative humidity is lower than return air/ recirculated air temperature.

Economy cycles should not be limited to operation when outside air temperature matched off-coil supply air conditions but can also be optimised by mixing larger outside air ratios with return air to reduce artificial cooling of return air.

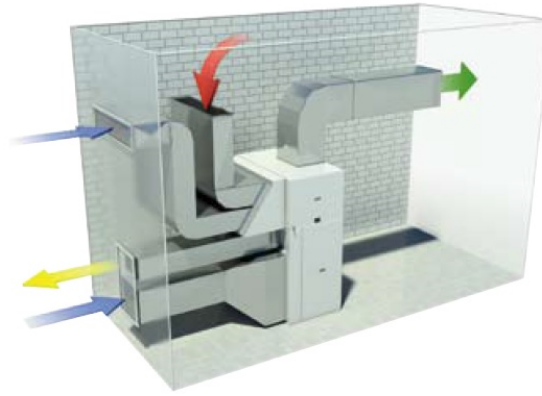


Figure 9 Typical economy cycle provisions

3.2.1 Energy Recovery Ventilation

Energy Recovery Ventilation (ERV) is the process of reclaiming the energy contained in return air being discharged and using it to pre-condition fresh outside air.

The process results in reduction of energy consumed in conditioning outside air as well as maintaining a better indoor environment quality by providing opportunities for larger fresh air supply rates.

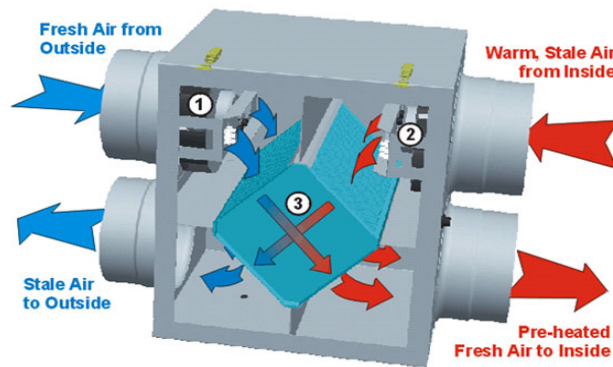


Figure 10 Heat Recovery ventilator

3.2.2 Energy efficient appliances

Minimum Energy Performance Standards (MEPS) specify the minimum level of energy performance that appliances, lighting and electrical equipment must meet or exceed before they can be offered for sale or used for commercial purposes.

MEPS are mandatory for a range of products in Australia and New Zealand. These products must be registered through an online database and meet a number of legal requirements before they can be sold in either of these countries.



Figure 11 Typical Energy rating labels

MEPS should be specified for the following;

- Domestic hot water units – minimum 5 Stars; and
- White goods – Minimum 5 stars.

3.2.3 Energy Efficient Lighting

The LED lighting technology today offers a range of suitable applications that maximises efficiency. LED Lamps offer a number of advantages over other lighting technologies being energy efficient, cost effective and robust. While LED lighting is more capital intensive, the life expectancy and energy efficiency of the fitting result in an attractive payback.



Figure 12 Sample LED light fittings

3.2.4 Fire Stairs - Occupancy Sensors & Dimming Control

Emergency luminaires within the fire stairs can be fitted with self-contained high-performance stand-by/emergency multi-function LED type luminaires, controlled with integral motion sensors.

Luminaires operate on two separate circuits. When the fire stairs are unoccupied, the light goes on stand-by mode circuit, delivering around 20% of its brightness. When movement is detected within 8m, the light's second circuit is switched ON, delivering full lumen output for an adjustable set period of time, up to 15 minutes.



Figure 13 Emergency lights in standby & occupancy modes

3.2.5 Electrical Demand Reductions

Staggering the activation of major plant equipment will reduce peak electrical demand by avoiding fans, pumps and compressors ramping up simultaneously. This will reduce peak demand on the grid and reduce energy demand costs.

3.2.6 Energy, Water and Gas Metering

Metering should be provided to allow each area of the building to monitor their energy and water usage. This will allow building users to set targets for consumption and monitor energy improvements resulting from behavioural or equipment changes.

Effective energy and water monitoring systems will also provide building users with information to better analyse their energy consumption identifying underperforming systems and enabling them to compare performance at different sites. Through providing this data the project will make energy consumption visible and assist with energy reporting.



Figure 14 Metering will assist with building management and reporting

3.3 On-site Renewable Energy Generation

3.3.1 Photovoltaic (PV)

With decreasing capital and installation costs, photovoltaic arrays can provide on-site generation with a competitive pay back rate. Photovoltaic arrays are also flexible and modular which allows them to be integrated as a secondary function of a space.



Figure 15 PV on roof structure

The performance of photovoltaic energy generation will be assessed later as its detailed design progress throughout the project.

3.3.2 Solar Hot water

Solar thermal domestic hot water generation consists of solar hot water package system complete with gas fired / electrical continuous flow boost. Solar hot water could provide 20-50% of the hot water demand.

The actual contribution from solar would need to be determined based on demand profiles, storage size and collector efficiency. The feasibility of solar hot water will be further assessed at the detailed design stage.



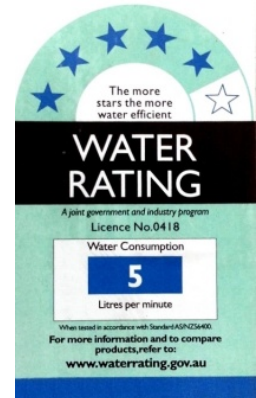
Figure 16 Solar hot water system

3.4 Water Efficiency

3.4.1 Water efficient fixtures and fittings

Water Efficient fixtures and fitting will reduce the water consumption of the site. As an indication, the following should be targeted:

- Wash hand basin taps 6 star WELS
- General taps 6 star WELS
- Toilets dual flush 4 star WELS
- Urinals 0.8 L per flush 6 star WELS
- Shower heads 7-9 L per minutes 3WELS
- Rainwater collection and ruse for Landscape irrigation and toilet flushing
- Fire testing water re-diverted to storage tank.



3.4.2 Water Harvesting and Reuse

Roof collection and tank storage – the collected water should be sufficient for the provision of irrigation to the planter boxes, as well as being used for sanitary fixtures. Water harvesting opportunities should be examined further as part of the projects detailed design.

3.5 Indoor Environment Quality

The idea of improving indoor environment quality is to ensure that building occupants are comfortable within a space and reduce exposure to internal pollutants. Through the provision of sufficient outside air, sufficient lighting levels and good visual access to outside the project should achieve good indoor environment quality. However additional initiatives for consideration include the selection of;

- Low VOC paints, flooring, sealants and adhesives; and
- Formaldehyde free engineered wood products.

3.6 Other Potential Initiatives

3.6.1 Construction and demolition waste

Building materials account for approximately half of all materials used and about half the solid waste generated worldwide incurring significant environmental impacts at each process interval. It is proposed that at least 90% of construction and demolition waste is to be recycled, to reduce the carbon footprint of the site. This commitment could be incorporated into the head contractors' Environmental Management Plan for the site. Reclamation of high value building materials should be considered first preference. Where reclamation is not viable, materials such as asphalt, bricks, timber, plastics (including PVC) and concrete should be recycled accordingly.

3.6.2 Locally sourced products and services

Locally sourcing products and services for use in the design and construction of the development would help to keep transport and distribution impacts to a minimum. It will also help to support local employment and improve economic resilience of the Penrith's manufacturing industry. Manufacturer location for materials and services should adhered to the following restrictions:

- 20% of more of the materials construction budget should come from within 500km of the construction site
- An additional 30% of the materials construction budget should come from within 1000km of the construction site or closer.

- An additional 25% of the materials construction budget should come from within 5000km of the construction site.
- 25% of materials may be sourced from any location.
- Consultants should come from within 2500km of the project location.

Utilising local manufacturing and suppliers should also help to minimise lead time for products, build positive relationships and make supply chain auditing easier. Overall, the sourcing of locally sourced products should be explored and implemented where economically feasible.

3.6.3 Dual waste segregation

Providing waste storage areas located centrally within the building to dispose of multiple waste streams will improve the waste outcomes for the development. The use of source separation of waste will drastically improve environmental outcomes as post collections segregation takes longer, costs more and increases cross contamination. Overall, the separation of general waste and comingled recycling at a minimum will reduce waste disposal costs for the development and therefore help to minimise waste levies payable. Furthermore, and for example, source separation for Paper and Cardboard with an on-site compactor to process paper-based recycling, will likely result in a notable operational cost savings because this resource stream attracts either low cost, nil charge or pay-back for its collection.

3.6.4 Waste compactors

Waste compaction is being considered for the development as a way to reduce the number of traffic movements on site, reduce vermin and rodents and improve cleanliness and sanitation on site.

The Elephants Foot compaction systems offer several options which have the potential to reduce waste services costs up to 75 percent. This would allow the reduction in size of waste rooms, help to minimise the number of collections that are required by the waste contractor and should reduce the waste disposal costs and therefore help to minimise costs to the residents and operators.

3.6.5 Urban heat island effect mitigation

3.6.5.1 Solar Reflectance

As previously discussed in Section 3.1.2, selection of roof colour has minimal impact on the architectural aesthetic or cost for the development however can have a substantial influence on the overall impact of the site in terms of heat island effect.

A provision of at least 75% of all external façade, pavement and roof surfaces follow the Solar Reflectance Index (SRI) guideline:

- For roof pitched <15° – a three-year SRI >64; or
- For roof pitched >15° – a three-year SRI >34.

The use of pale coloured roofs and facades will have marginal cost implications and would assist in the propagation of daylight through areas that are shadowed by adjacent buildings.

4. Conclusion

The inclusion of these initiatives alongside others outlined within this report will ensure that the Log Cabin Pub project delivers a development that not only meets the needs of its occupants but also those of the surrounding environment and more broadly Penrith City Council and the local government areas of Penrith.

The proposed development will present significantly improved sustainability outcomes for its occupants when compared to traditional developments of this type through the additional energy efficiency and incorporation of sustainability initiatives embedded into the building design to achieve sound environmental performance. The consideration given to the environment within the development is highlighted through the following;

- Minimised production of greenhouse gas emissions and optimised energy efficiency;
- Minimised mains potable water use;
- Minimised waste going to landfill and improved waste collection efficiency; and
- Minimised effects of urban heat island effect
- On-site renewable energy generation

As such the Log Cabin Pub's commitment to targeting significant sustainability outcomes and strict energy, water and storm-water management measures work to address the council requirements for these considerations as well as improving the overall social, economic and environmental welfare of Penrith's local government areas.

Appendix A – NCC 2019 DTS Glazing Calculator

NCC 2019 Wall-Glazing Calculator v3.0										Building Check-Values				
Wall and glazing energy efficiency in Class 2-9 buildings - Method 2 of Specification J1.5a, NCC 2019														
Building name and description				Classification		Climate Zone								
Log Cabin Pub Perth				Other		6								
Calculated Area-Weighted U-Value				2.00		Calculated Representative Air-Conditioning Energy Value				207.1				
Allowable Area-Weighted U-Value				2.00		Allowable Representative Air-Conditioning Energy Value				208.6				
Building total U-Value allowance met				100%		Building total SHGC allowance met				100%				
Check Values				Met		Display Glazing Element Requirements				-				

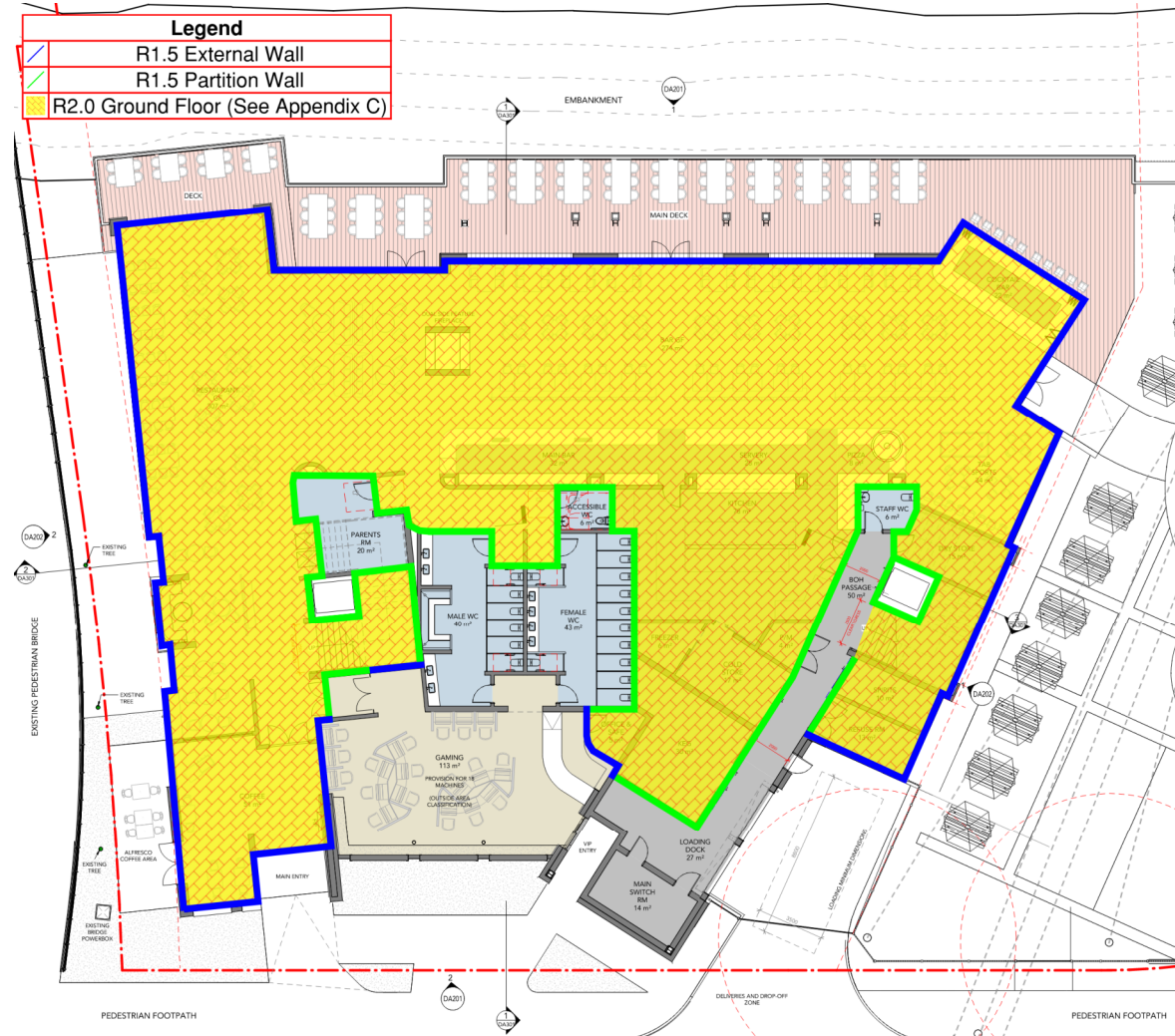
Element Description										Element Check-Values						
ID	Description (optional)	Element Type	Facing Sector	Area (m ²)	U-Value	U-Value Element share of allowance used	SHGC	Glazing Height (m)	Shading Height (m)	Shading Projection (m)	SHGC Element share of allowance used	Bounded G/H	Bounded F/H	Shading Factor	Solar Admittance	AC Energy Value
1	North	Wall	North	76.55	0.21	2% of building total					Not counted	0	0	1	0	0
2	East	Wall	East	238.27	0.71	6% of building total					Not counted	0	0	1	0	0
3	South	Wall	South	214.60	0.71	5% of building total					Not counted	0	0	1	0	0
4	West	Wall	West	169.44	0.71	4% of building total					Not counted	0	0	1	0	0
5	Partition Walls	Wall	Internal	421.81	0.71	10% of building total					Not counted	0	0	1	0	0
6						Not counted					Not counted	0	0	1	0	0
7	G_N1	Glazing	North	12.24	5.90	2% of building total	0.48	2.6	1.7	18.7	6% of building total	-0.6	1.1	1	0.48	12.45524
8	G_N2	Glazing	North	6.38	5.90	1% of building total	0.48	2.9	2.9	0.3	3% of building total	0	0.1	0.9	0.432	5.843592
9	FF_N1	Glazing	North	19.17	5.90	4% of building total	0.48				9% of building total	0	0	1	0.48	19.507392
10	FF_N2	Glazing	North	5.40	5.90	1% of building total	0.48	2.7	4	8.5	2% of building total	0.4	2.1	0.68	0.3264	3.796272
11						Not counted					Not counted	0	0	1	0	0
12	G_E1	Glazing	East	4.68	5.90	1% of building total	0.48	1.7	1.7	0.5	1% of building total	0	0.2	0.8	0.384	2.908224
13	G_E2	Glazing	East	11.52	5.90	2% of building total	0.48	3.2	3.2	2.7	2% of building total	0	0.8	0.41	0.1968	3.6727632
14	G_E3 & E4	Glazing	East	8.41	5.90	2% of building total	0.48	1.9	2.9	0.3	3% of building total	0	0.1	0.9	0.432	5.885544
15	FF_E1	Glazing	East	8.41	5.90	2% of building total	0.48	2.85	4	0.4	3% of building total	0.3	0.1	1	0.48	6.517672
16	FF_E2 & E3	Glazing	East	1.35	5.90	0% of building total	0.48	2.25	2.25	0.2	1% of building total	0	0	1	0.48	1.049376
17	FF_E4	Glazing	East	26.85	5.90	5% of building total	0.48	2.7			12% of building total	0	0	1	0.48	20.874872
18						Not counted					Not counted	0	0	1	0	0
19	G_S1 & S2	Glazing	South	14.08	5.90	3% of building total	0.48				3% of building total	0	0	1	0.48	6.7584
20	G_S3 & S4	Glazing	South	2.41	5.90	0% of building total	0.48	1.85	1.85	0.3	1% of building total	0	0.1	0.93	0.4464	1.073592
21	G_S5 & S6	Glazing	South	5.70	5.90	1% of building total	0.48	2.85	2.85	0.3	1% of building total	0	0.1	0.93	0.4464	2.54448
22	G_S7 & S8	Glazing	South	17.10	5.90	3% of building total	0.48	2.85	2.85	0.55	4% of building total	0	0.1	0.93	0.4464	7.63344
23	G_S9 & S10	Glazing	South	12.48	5.90	2% of building total	0.48				3% of building total	0	0	1	0.48	5.9904
24	FF_S1 & S2	Glazing	South	15.40	5.90	3% of building total	0.48	3.5	3.7	1.07	3% of building total	0.1	0.2	0.93	0.4464	6.87456
25	FF_S3 & S4	Glazing	South	16.72	5.90	3% of building total	0.48	3.8	4	1.07	4% of building total	0.1	0.2	0.93	0.4464	7.463808
26	FF_S5 & S6	Glazing	South	11.40	5.90	2% of building total	0.48	2.85	4	1.07	3% of building total	0.3	0.2	0.98	0.4704	5.36256
27						Not counted					Not counted	0	0	1	0	0
28	G_W1	Glazing	West	19.98	5.90	4% of building total	0.48	2.7	2.7	1.8	4% of building total	0	0.6	0.51	0.3448	8.2681368
29	G_W2 & W3	Glazing	West	25.65	5.90	5% of building total	0.48	2.7	2.7	4.2	3% of building total	0	1.5	0.35	0.168	7.126364
30	G_W4 & W5	Glazing	West	29.70	5.90	6% of building total	0.48	2.7	2.7	5.5	4% of building total	0	2	0.35	0.168	8.332632
31	G_W6	Glazing	West	0.74	5.90	0% of building total	0.48				0% of building total	0	0	1	0.48	0.593184
32	FF_W1	Glazing	West	22.93	5.90	4% of building total	0.48				8% of building total	0	0	1	0.48	16.77368
33	FF_W2	Glazing	West	21.74	5.90	4% of building total	0.48	2.7	4	8.5	6% of building total	0.4	2.1	0.68	0.3264	11.8474872
34	FF_W3	Glazing	West	14.85	5.90	3% of building total	0.48	2.7	4	1.15	6% of building total	0.4	0.2	0.99	0.4752	11.7842224
35	FF_W4 & W5	Glazing	West	29.70	5.90	6% of building total	0.48	2.7	4	1.7	8% of building total	0.4	1.4	0.68	0.3264	16.1895136
36						Not counted					Not counted	0	0	1	0	0
37	Internal Glazing	Glazing	Internal	4.62	5.90	1% of building total	0.77				Not counted	0	0	1	0	0
38						Not counted					Not counted	0	0	1	0	0
39						Not counted					Not counted	0	0	1	0	0
40						Not counted					Not counted	0	0	1	0	0
41						Not counted					Not counted	0	0	1	0	0
42						Not counted					Not counted	0	0	1	0	0
43						Not counted					Not counted	0	0	1	0	0
44						Not counted					Not counted	0	0	1	0	0
45						Not counted					Not counted	0	0	1	0	0
46						Not counted					Not counted	0	0	1	0	0
47						Not counted					Not counted	0	0	1	0	0
48						Not counted					Not counted	0	0	1	0	0
49						Not counted					Not counted	0	0	1	0	0
50						Not counted					Not counted	0	0	1	0	0

Disclaimer:
 This calculator has been developed to assist in developing a better understanding of the glazing energy efficiency parameters of NCC 2019. While the author believes that the calculator, if used correctly, is likely to produce accurate results, it is provided "as is" and without any representation or warranty of any kind, including that it is fit for any purpose or of merchantable quality, or functions as intended or at all. Your use of this calculator is entirely at your own risk and the author accepts no liability of any kind.

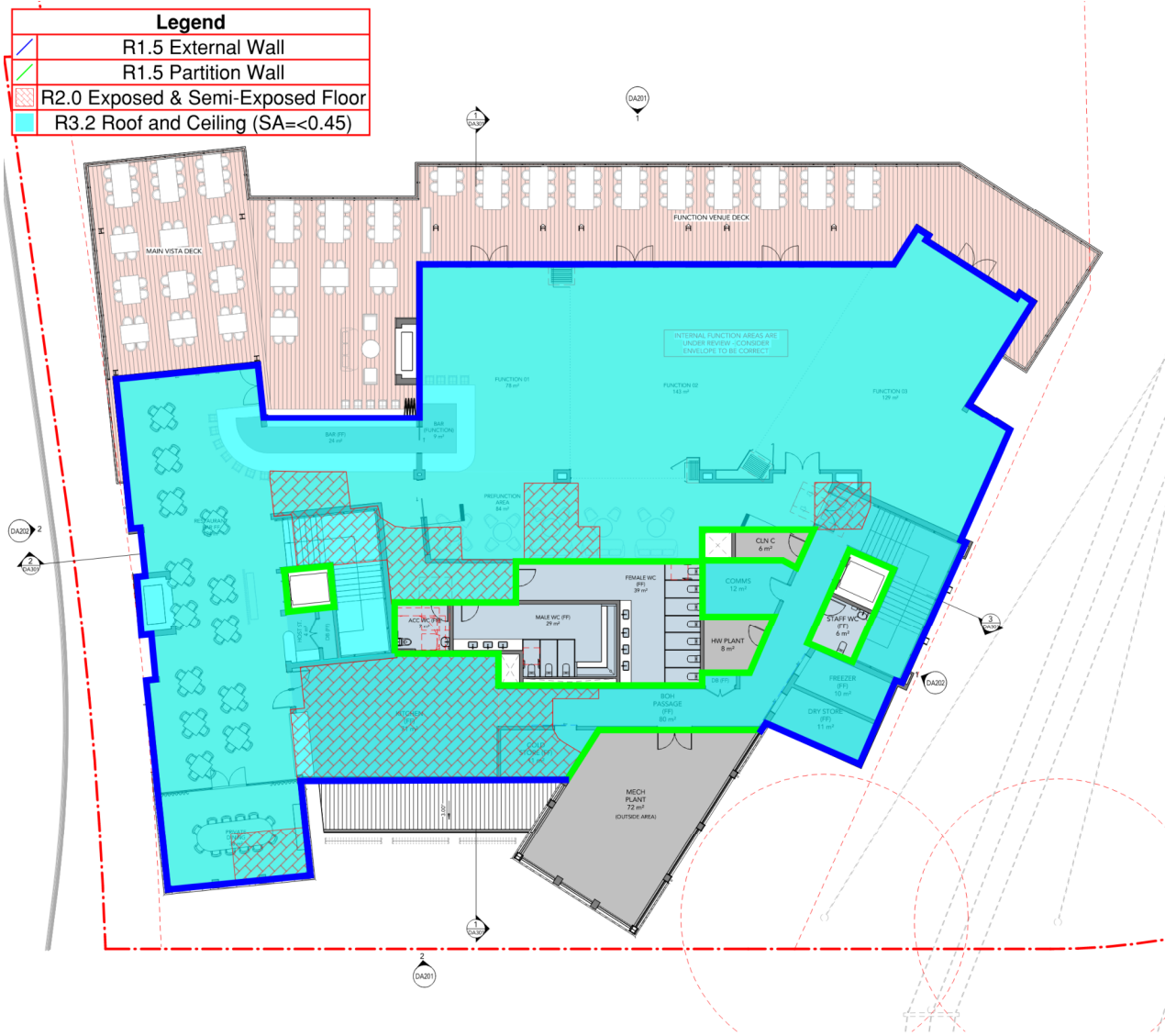
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Appendix B – Thermal Boundary Markup

Ground Floor



First Floor



Appendix C – Ground Floor Soil R-Value Calculation

Table 2 - Calculation of the R-Value of the soil layer in contact with the ground floor in accordance with Specification J1.6a Sub-floor thermal performance

Ground Floor R-Value Calculation	Floor Perimeter
Ground Floor Area	988.5 m ²
Ground Floor Perimeter	272.47 m
Floor Area to Floor Perimeter Ratio (FA/FP)	3.6
External Wall Thickness (mm)	300 mm
Equivalent R-Value of the Soil in Contact with Ground	R1.91
Ground Floor Slab (Concrete floor assumed)	R0.09
Indoor Air Film	R0.11
Total System R-Value of Ground Floor	R2.01