WARM TEMPERATE CLIMATE STUDY & DESIGN GUIDELINES

Phase 3 Report: Architectural Responses to the Warm Temperate Climate

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EXECUTIVE SUMMARY

Th purpose of this report is to outline the rationale behind the Toowoomba Region Design: Warm Temperate Climate Building Design Guidelines and to expand on the design and building recommendations on designing for a Warm Temperate Climate.

The report provides a brief overview of the phase one and two reports and points to the relevant sections of those reports that have directly informed the guidelines. It includes an overview of the climate data findings and the data presented alongside the transects. The transects provide a clear depiction of how the topography creates Toowoomba's unique climate and are diagrammed as a visual aid to describe the climate in the guidelines.

Phase Two report findings are also summarised, with specific emphasis on the four tier framework and how this framework is translated to the four principles for the guidelines:

Principle One: Design with the Neighbourhood in Mind

Principle Two: Design the Building for the Seasons

Principle Three: Use Natural Energy from the Sun and Wind to your Advantage

Principle Four: Increase Comfort, Decrease Costs

As well as an additional section to address designing buildings for a changing climate.

The report then outlines key strategies for designing buildings for a warm temperate climate under each of the principles. The report also outlines the results from a community consultation event in terms of the visual and material qualities of the guidelines. The consultation highlighted that the guidelines be written for a general audience and used to promote and support local construction professionals. As a result, a photographer was commissioned to capture local exemplary projects to include in the guidelines.

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1. INTRODUCTION

The purpose of the Warm Temperate Climate Study and Guideline Project (the WTC project) is to establish a climate-based rationale for sustainable design to promote liveable and ecologically sustainable built environment outcomes in the Toowoomba Region as it develops into the future. The scope of this project is aimed at clearly signalling the key strategies for applying WTC design principles in most housing types and some commercial and multi-residential buildings.

Phase 1

Phase One of the WTC project examined the different ways climate definitions are represented in legislation, policy and strategy documents in Australian, state and local government jurisdictions. Phase One also described the general characteristics of Toowoomba region's climate and projected climate characteristics according to accepted climate change modelling.

The Australian Building Codes Board (ABCB) identifies the Toowoomba Region as a Zone 5 Climate: Warm Temperate. However, this designation for Toowoomba's climate is derived from the pursuit of energy efficient heating and cooling alone, via the National Construction Code. It is apparent that the Toowoomba Region is differentiated from other Zone 5 localities in Australia, being at a lower latitude and on the east of the continent. An analysis of long-term station-based weather data in the region according to scientific parameters determined that the climate is classified as temperate, with reasonable annual rainfall, and hot summers, whereas other Zone 5 areas are drier and some parts are quite a bit cooler. Future projections are for the Toowoomba Region to become both hotter and drier.

Phase 2

Next, Phase Two established a generic framework for climatic design analysis and applied it to an investigation of the approaches variously taken in vernacular and contemporary buildings in warm temperate regions globally, nationally and locally. A specific WTC design framework was developed by mapping the principles and strategies for heating, cooling and lighting that were found to be applicable to the warm temperate conditions onto the analytical framework. Best practice examples of climate-responsive architecture were compiled into an illustrated compendium.

Phase 3

Phase Three of the WTC project comprises this report with a separate illustrated design guideline. The report synthesises the findings of the first two phases, providing recommendations for incorporating WTC principles into the Toowoomba Region Urban Futures Framework (TRUFF) and the new Toowoomba Region Planning Scheme.

This report considers questions of what might need to change in standard housing subdivision layouts and building design in order to avert negative consequences, but does not determine to what extent, and how. While the geometry of subdivision planning and the layout of lots is outside the scope of this research, these factors coupled with topographical characteristics of the terrain, are very influential on individual building performance. They affect the density or sparsity of built form, overshadowing, orientation for access to solar energy, daylight, space for vegetation, urban ventilation. In turn, built outcomes at the individual lot scale can either enhance or worsen amenity for neighbours and the public in terms of urban climate comfort.

The climatic design **guideline** recommends appropriate climate-responsive design approaches to Toowoomba's architecture for detached housing, small lot, duplex, med-density, multi-storey, mixed-use and commercial building typologies.

Phase 3 Scope and Limitations

- The report and guideline do not cover physical and technological aspects of sustainable building design and construction beyond design principles and strategies.
- The report and guideline do not provide technical advice on specific topics.
- The report and guideline do not include draft planning scheme provisions.

DEFINING TOOWOOMBA'S WARM TEMPERATE CLIMATE

Phase One provided a comprehensive overview of the Toowoomba region's present and future macro-climate as evidenced by records and by modelling the future climate conditions. It reviewed the human comfort criteria to relate desired indoor comfort design criteria (physiological) to outdoor climate factors that prevail across the region. This is linked to regulatory requirements to design energy efficient buildings.

The ABCB differentiates between eight main climate zones nationally in order to regulate buildings' thermal performance and services for energy efficiency (EE). The Toowoomba Regional Council LGA is designated Zone 5 - warm temperate. The eleven South East Queensland LGA's east of the Great Dividing Range including Brisbane are designated Zone 2 - subtropical, warm humid summer, mild winter.

In order to establish a definition of the Toowoomba Region's warm temperate climate, scientific parameters related to the Koppen-Geiger

international climate classification system were used as a foundation. According to the Koppen-Geiger system, the Toowoomba Region is a Cfa climate, where ‘C’ is a temperate climate, ‘f’ denotes it is without dry season and ‘a’ indicates a hot summer. Brisbane is also classified as a Cfa climate. However, there are enough variations in climate between the Darling Downs plateau and the coastal plain to warrant different building design responses.

Data collected from weather stations in the Toowoomba Region and close surrounds also show that some subtle design differences may be warranted within the region depending on the particular place.

Climate projections show that Toowoomba’s climate will become warmer and drier, with lower relative humidity and precipitation in the next few decades.

Toowoomba region climate characteristics

Climate research based on available long term weather data established the climatic characteristics that predominate in the Toowoomba Region. These are described in Table 19 from the Phase One Report

What differentiates Toowoomba Region's warm temperate climate Zone 5 from the coastal plain's subtropical climate Zone 2?

The Toowoomba Region and the adjacent coastal plain share similar macro-climatic temperature and precipitation conditions. Summers are warm to hot, humidity is high, and winters are mild. However, Toowoomba has less rainfall and is cooler than Brisbane in both winter and summer. Toowoomba's mean annual minimum winter temperatures are lower than Brisbane's and it has more days that are 2°C or below. Brisbane may often feel hotter because higher average humidity is coupled with lower windspeed at 3.00pm. Toowoomba has fewer clear sunny days than Brisbane.

Climate differences within the Toowoomba Region

The data gathered from weather stations in the Toowoomba Region (Toowoomba and Oakey) and within Zone 5 but in adjacent LGAs (Kingaroy, Dalby and Warwick stations) indicate that a more nuanced approach to thermal design is warranted in response to local micro-climates. Noticeable differences in temperature and relative humidity were found amongst weather stations. Though it is not necessarily representative of the entire Toowoomba region, data from the Oakey weather station earns the Toowoomba LGA an ABCB Zone 5 classification, and NatHERS Zone 50 classification in building legislation requirements for energy efficient thermal design for buildings.

Data from the Toowoomba Airport weather station demonstrates a benign climate that only requires passive heating and cooling solutions for buildings.

There is a strong relationship between design for climate and local character and amenity that should be utilised in drafting future specific Local Plans for areas such as distinct towns and villages. A survey of certain local topographical features that accentuate a change in local climate (for example altitude, terrain, soil and vegetation, water bodies etc) is recommended.

DEFINING WTC ARCHITECTURE: PROVEN SOLUTIONS FOR WTC CLIMATE BUILDING DESIGN

Phase Two comprised a study of the architecture of buildings from similar warm temperate regions nationally and internationally, and locally, in order to identify best practice architectural responses and develop relevant climate-responsive principles.

The report looked at how traditional architecture responds to the warm temperate climate - Traditional passive strategies - orientation, building form and materials to regulate heat and air flow - what we learned from them. These findings have potential to inform the TRUFF - TRPS with terms and methods for respecting local climatic responses and character.

The report also analysed a series of case studies and how contemporary architecture responds to the warm temperate climate. This was important because contemporary passive strategies take into account modern spatial aesthetics and function.

WTC design framework for the Toowoomba Region

Importantly, the Phase Two report established the Four Tier Framework for analysing building design in a Warm Temperate Climate. This Four Tier Framework (table 2 Analytical Analytical design framework WTC specific) is carried through to this report and to the guidelines. For the purposes of the Phase Three report and the Design Guidelines, the four tiers are distilled to key design approaches, listed as four design principles.

The Four Principles are:

Principle One: Design with the Neighbourhood in Mind

Principle Two: Design the Building for the Seasons

Principle Three: Use Natural Energy from the Sun and Wind to your Advantage

Principle Four: Increase Comfort, Decrease Costs

As well as an additional section to address designing buildings for a changing climate.

Each of these Principles is expanded upon in The Design Guidelines section to follow in the report.

Consultation findings

In Phase Two a community consultation event revealed local perceptions and experiences of Toowoomba's warm-temperate climate, as well as ideas about warm-temperate climate architecture for the region. Local members of the community, as well as built environment experts contributed perspectives on climate-responsive design including social and political factors; the impact of a building's context on sustainability outcomes; and optimal building form. The Warm-Temperate Design Guideline developed through Phase Three aims to respond to some of the social and political factors that currently obstruct climate-responsive design outcomes in the Toowoomba region, while incorporating local knowledge on sustainable built environments and building form.

As part of Phase Three, a second expert consultation event was conducted to understand how local built environment professionals would use a Warm Temperate Design Guideline and for what purpose.

The consultation event was conducted online using a Miro board to collect insights from local government representatives, architects, developers, construction consultants and builders. Through this event, the research team mapped how participants intend to use the guidelines, preferences for format and graphic communication style.

A Highly Motivated Local Built Environment Sector

There is a notably high level of motivation for sustainable and climate-responsive design among local built environment professionals in Toowoomba. This motivation is reinforced by a portion of the local community who attended the Phase Two workshop. There is also a strong desire for place-based approaches to climate-responsive design, evidenced by:

- A resistance to standardised building designs originating from other locations or suited to climate conditions elsewhere.
- The view that Toowoomba's climate is distinct from Brisbane and surrounds, requiring locally specific design strategies (e.g. diurnal range and prevailing winds)

This strong desire for locally climate-responsive design is coupled with the sense that policy and planning schemes frequently obstruct quality design outcomes. Projects such as this Warm Temperate Climate Study and Design Guideline address calls for Council to lead the way in sustainable design, connecting with local values and potentially alleviating frustration. Further to this, built environment professionals indicated that, even with alignment between their own priorities and those of Council, building design outcomes are also determined by client

values. Importantly, workshop participants highlighted the need for a guideline that can be used as an advocacy or educational tool *by* built environment professionals and *for* the public.

Guideline impacts

Phase Three workshop participants expressed a range of priorities in how they want the WTC Design Guide to positively impact the region. The desired purpose of the guideline is outlined below according to four impact areas: (1) impact on carbon emissions and climate change; (2) impact on built environment and architectural character; (3) impact on professional practice; and (4) impact on the community.

Impact Areas	Desirable Impacts
Carbon emissions and climate change	• Promoting energy efficient and sustainable materials (e.g. “no black roofs”) • Designing climate change adaptive built environments • Low-energy / energy efficient outcomes • Reducing embodied energy through local materials • Building resilience for future climatic conditions. • Mitigating climate change impacts • Guidance on embodied and emitted carbo
Built Environment and Architectural Character	• Improving liveability of buildings • Positioning climate as main driver of character not “temporary values” • Positive influence on “off-the-shelf" building design • Promoting of place-based design that is unique for Toowoomba • Learning from and reinforcing/celebrating architectural heritage • WTC design principles for urban and rural communities.
Professional Practice	• Easily accessible reference list of local architectural exemplars • More experimentation with smaller building footprints • Promoting flexible design and ageing in place. • Empower professional designers and architects. • Inform better regulation of development projects.
Community	• Educating the public about temperate climate and corresponding design principles • Increasing client awareness and knowledge for improved decision-making. • Promotion of cost-effectiveness of sustainable design • Tool for initiating fundamental conversations between industry professionals and clients. • Reducing living costs. • Improved building comfort.

Graphic style

Workshop participant preferences for graphic communication style aligned with the consensus that the guideline should be an educational tool for use with clients and the general public. For this reason, clear, easily understandable visualisations combined with photographs are preferred.

Most Popular:

- Illustrations combined with written explanations.
- Diagrams illustrating single ideas.
- Sketches to aid interpretation of technical information (as opposed to technical drawings).
- Analytical diagrams to communicate complex or strategic ideas.

Least Popular:

- Icons / infographics can limit the amount of information conveyed.
- Technical drawings are only effective for a professional audience.

A digital format is strongly preferred for ease of access, cost effectiveness and environmental impact. This was reinforced by the concern that a "live" document could result in circulation of uncontrolled copies, making updating difficult. as well as ensuring some print copies are available for certain portions of the community. Despite these challenges, participants noted that some portions of the community do require hard copy versions.

While beyond the scope of this project, of note were suggestions that Council could communicate the design principles using social media platforms such as Instagram, Tik Tok as well as online utilisation of online platforms and video walkthroughs.

Summary

There is the sense that the purpose of the guideline should be more as an advocacy tool for educating the general public, than as a guide for built environment professionals

… to *"work through design options and benefits with clients"* as a *"go to reference".*

"Awareness and information that is readily available and easy to understand, not just for those in industry but the public"

"the how and why of temperate design"

"getting clients interested in sustainable design principles" … "practices that relate specifically to Toowoomba" … "good for the back pocket"

As a result the guidelines have been designed for the general public. The process involved working with a publicist (Lindy Johnston Creative) to

simplify and expand of the language. The diagrams were also developed in a more illustrative style and avoided any technical graphic conventions to convey simple ideas for the general public to work with. The guidelines also highlight the work of skilled local practitioners and suggests engaging their services for more advanced climate responsive buildings.

The guidelines are also image driven, with a series of images of local examples of houses and buildings that demonstrate best practice design for a warm temperate climate.

THE DESIGN GUIDELINES: DEFINING WTC ARCHITECTURE FOR TOOWOOMBA

This section of the report outlines Warm Temperate Design Principles (WTDPs) for Class 1, 2, 5 and 6 buildings (NCC). The goal of these principles is to support and encourage climatic-responsive architecture to reflect the Toowoomba's regional environment (natural and built) and warm temperate features.

These principles are intended to be general and adaptable to work with building performance objectives, which can vary depending on whether the criteria is low-carbon, zero energy (passive), energy efficiency, or high performing (optimisation).

The application of the WTDPs is intended to support indoor comfort whilst utilising and interacting with climatic features (through building form, materials and systems) for heating, cooling and lighting.

Phase 2 report summarised the WTDPs as a matrix across categories of heating, cooling and lighting (see Table 2). This section of this report is an extension of the matrix in descriptive and technical terms. In practice and in general, the application of design principles would be a highly reiterative and concurrent process. Building practitioners will have unique design methodologies to account for climate-related factors, to ensure that their design philosophies retain resonance. Thus, the application of the WTCDPs can be a linear and non-linear process.

Buildings benefiting from the micro-climate to reduce artificial energy and indoor comfort is possible in the Toowoomba region because of its proximity to the escarpment in the Great Dividing Range. The summary of principles for WTC:

- Mixed-mode: integration of passive and active systems (contingency, complementary or zoned)
- Longest axis of the building oriented towards solar north for daylighting and passive heating in winter;
- WWR of % north (rule of thumb);
- Prioritise as much shading to from hot conditions and anticipate hotter conditions in the future
- Earth coupling or slab on grab will minimise artificial indoor cooling and heating
- Prioritise as much shading and landscaping features
- Aim for mixed mode and natural cross ventilation (multiple window openings)

Principle One: Design with the Neighbourhood in Mind. [Micro-climate siting (Tier 1)]

Micro-climates are characterised by localised atmospheric conditions that can depart slightly or significantly from a region's global conditions. The differential in weather is greatly influenced by its interactions with the built and natural environment. As an example, water features such as lakes or other large water bodies impact the surrounding temperature and relative humidity, providing a cooling effect with its evaporative qualities. In contrast, urban areas with a high ratio of hard and impermeable features (e.g., concrete buildings and roads) are prone to higher temperatures because of solar radiation absorption, trapping heat and releasing it directly back into the urban environment.

Lighting and heating

Generally, warm temperate climates in equatorial regions benefit from higher and longer exposure to the sun (see report one). Irrespective of the building class, the solar orientation can utilise daylight exposure for indoor lighting (natural lighting) during the day and passive heating using solar radiation for winter.

In principle, the longest face (length) of the building should orient towards north (see Figure 1). This is to allow as much sunlight in habitable rooms all year long, whilst limit the total area of radiant heat exposure on the building face when the sun is at its lowest in the morning and afternoon. This principle is applicable to all building classes.

Notes:

Lighting and heating principles are all applicable to building classes 1, 2, 5 and 6.

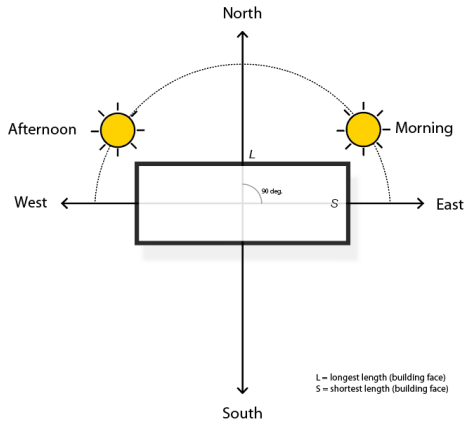


Figure 1. Utilising solar north via the building's orientation for daylighting and passive heating in winter. Ideally, the longest face (axis) of the building should face north and south, with the shortest axis facing east and west.

Natural ventilation, shading and cooling

The orientation of the building is equally beneficial for natural cooling and ventilation. Natural ventilation removes stagnate air and other indoor pollutants by providing fresh air for respiratory and thermal comfort. Prevailing wind masses travel from east and north-east of the Toowoomba region in required periods of cooling (i.e., summer) [see report one]. Building faces that are ideally or closely oriented perpendicular (ideally or close to 90°) to prevailing winds maximises natural cooling and ventilation. Additional native trees or plants located in front of the building can provide evaporative cooling to further reduce temperature or the humidity content. (see Figure 2).

The effectiveness of passive ventilation is influenced by the surrounding environment and urban planning. Neighbouring buildings can change the direction of prevailing wind loads, which requires additional strategies such as dense trees or walls to redirect wind pressure into the building.

Key notes

Orient building faces east and north-east to maximises natural ventilation during warmer periods of the year. Add trees and plants for evaporative cooling. Additional strategies are required to redirect prevailing wind loads when there are neighbouring buildings blocking prevailing winds. Strategic planting of dense trees or walls can redirect wind loads into the building.

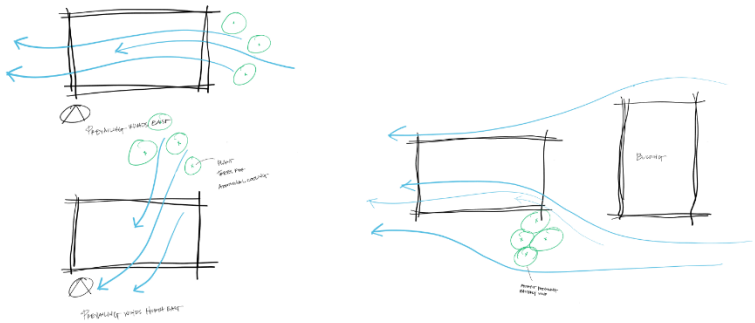


Figure 2. Ideally orient building faces perpendicular to prevailing wind loads to maximise natural ventilation. Adding trees or tall plants and shrubs can reduce air temperature through evaporation.

Building form and spatial zoning

The location of rooms should be prioritised such that each room is oriented according to usage and access to daylight, heating and cooling. Habitable rooms that have longer periods of occupancy during the day, benefit from a north and east orientation for the purposes of natural lighting and ventilation (see Figure 3). Non-habitable rooms such as bathrooms and laundries are best located to the west and south west,

which is exposed to the heat of the afternoon sun in summer and cold south-westerly winds in winter.

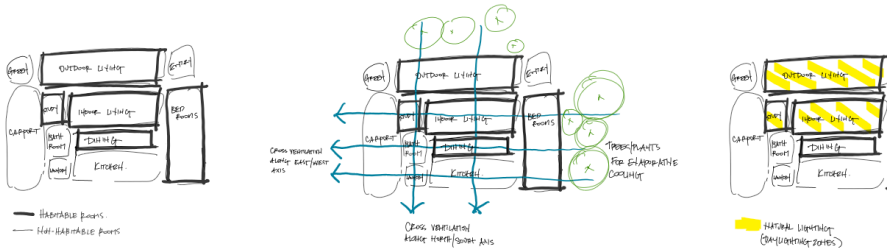


Figure 3. An example of spatial planning using bubble diagrams to plan the location and orientation of habitable and non-habitable rooms for Toowoomba's climate (residential buildings).

Additionally, the building form (i.e., shape and volume) contributes to natural lighting and ventilation performance. For Toowoomba's climate, elongated building forms such as courtyards are well-suited to warm-temperate climates. Compacted building forms can quickly overheat rooms that would lead to discomfort.

For multi-residential buildings, building forms that are double-sided work well for natural ventilation in warm temperate climates. However,

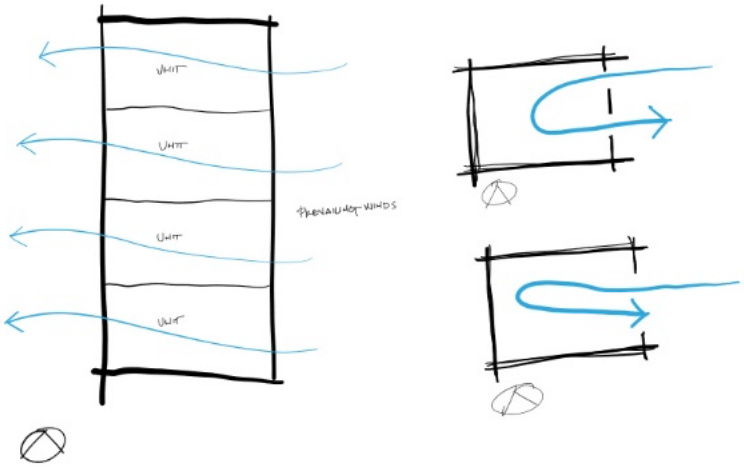


Figure 4. Building forms that are double sided provide cross-ventilation and work well in warm temperate climates like Toowoomba. When this is not possible, single-sided ventilation [finish].

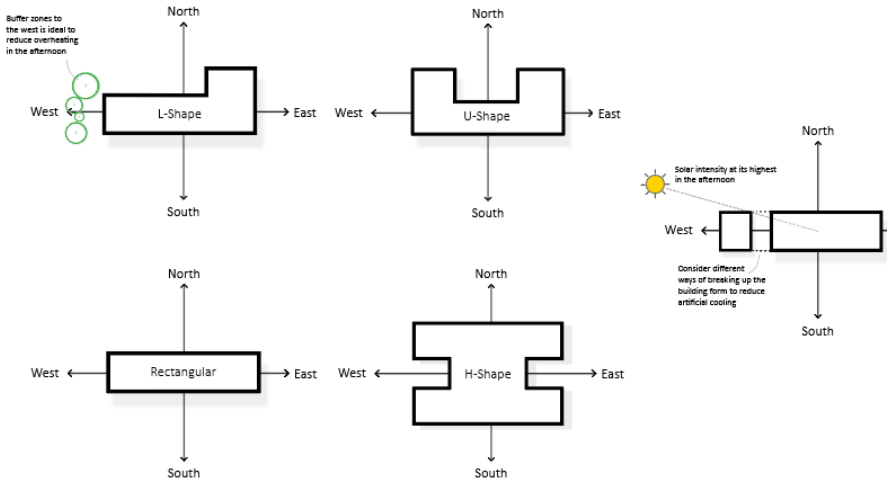


Figure 5. Articulated forms are most suitable for Toowoomba's climate.

Notes:

Aim for elongated building forms and away from compacted forms to maximise natural ventilation and air flow in the building.

Principle Two: Design the Building for the Seasons [Building articulation (Tier 2)]

Features of the building form can encourage and promote passive heating, cooling and lighting. Lightweight construction is most suited in warm temperate climates, particularly in Toowoomba (see Figure X). It responds well and quickly to prevailing winds for cooling

Building materials [finish]. This is largely determined by the building structure. Lightweight structures such as timber are

These include the building material(s) (e.g. concrete, timber, brick), insulation type (e.g. reflective, bulk), fenestration (the arrangement of openings) and colour finishes.

- Construction type: lightweight versus high thermal mass construction
- Building materials: low versus high thermal mass
- Building insulation and waterproofing
- Fenestrations: WWR and location of openings

For passive ventilation and cooling, a building face should ideally orient perpendicular to prevailing winds. Natural air can flow through the building to and allow warmer air to rise and exit. The addition of vegetation (e.g., trees or tall shrubs can provide evaporative cooling).

For apartment buildings where single sided (single loaded) ventilation is provided..

Movement of wind is highly dependent upon the surrounding context. Urban planning has an indirect impact on how much wind is available

> Note:
>
> High thermal mass materials should be well shaded to be useful for cooling. The close thermal mass is to the ground the better – if above ground requires ample shading otherwise not the best.

Principle Three: Use Natural Energy from the Sun and Wind to your Advantage [Passive systems (Tier 3)]

Passive building systems are [non-mechanical] and do not rely on artificial energy sources.

Shading systems and window openings are multi-purposeful. When designed correctly, they should provide 1) control of daylighting, 2) protection from visual discomfort or glare, 3) control of heat gains or loads.

- Design of openings are critical to increase air-change rates to provide sufficient cooling capacity with natural ventilation (internal heat gains)
- Daylighting: operable shading and finishes
- Deciduous trees
- Thermal mass and earth coupling

Shading systems have immense utility for passive ventilation, daylighting and heating. Passive systems are non-mechanical systems such as solar shades, thermal mass, fenestration systems (window or opening arrangements) and [etc.,]. Shading systems effectively block unneeded sun in summer but provide passive heating in winter. S**olar** shading can effectively block unneeded sun in overheated periods of the year (summer) and provide natural heating in colder seasons (winter)

Principle Four: Increase Comfort, Decrease Costs [Active systems (Tier 4)]

There are times of the year, in Summer and Winter, where active systems such as mechanical heating and cooling are required to achieve thermal comfort in Toowoomba. Recommendations for active systems are:

- Passive systems should not work separately to active systems that use artificial energy. For example, good thermal insulation in building envelopes will minimise the energy requirements for mechanical heating. Ceiling fans and natural ventilation can

provide adequate cooling for sleeping at night for most of summer, as long as bedrooms are oriented to the south.

- Consumers should research active heating and cooling systems and purchase energy efficient systems and learn to use them in combination with passive systems
- Minimise the application of active systems to one or two smaller enclosable rooms to minimise and control the energy requirements.

Translation of the design principles to building types

The Warm Temperate Climate Building Design Guidelines in Appendix One translate the four principles to practical design applications for residential, multi-residential and commercial buildings.

Recommendations for the TRUFF and the new planning scheme

This report recommends that TRC develops a range of character- and amenity-based planning provisions that reiterate the importance of climatic design to urban design and architecture in Toowoomba.

There is a strong relationship between design for climate and local character and amenity that should be utilised in drafting future specific Local Plans for areas such as distinct towns and villages. A survey of certain local topographical features that accentuate a change in local climate (for example altitude, terrain, soil and vegetation, etc) is recommended.

It also recommends that TRC develops benchmarks for assessment of character- and amenity-based provisions that account for desirable climate-and-place based outcomes.

Conclusion and suggested future work

The Guidelines have set out an important foundation in designing buildings for Toowoomba's Warm Temperate Climate. The next phase for this work needs to be in the development of specific building type guidelines, especially housing. Throughout this project, we were unable to locate and exemplary multi-residential project in the region. When a climatically responsive multi-residential project is complete in the region, this is one aspect of the guidelines that will require rework. Climatic design guidelines for building refurbishment, heritage conversions and housing renovations is also very much needed. One tangible outcome of this project has been the installation of additional weather stations in the Toowoomba Region. After a period of some years, a more accurate picture of microclimate data for suburbs within Toowoomba could be achieved. A series of climatic guidelines in reponse to this new data is also a potential future project

TOOWOOMBA REGION DESIGN

Warm Temperate Climate Building Design Guidelines

TOOWOOMBA REGION
Rich traditions. Bold ambitions.

QUT Design Lab

Sub Tropical Cities

UNIVERSITY OF SOUTHERN QUEENSLAND

LIVEWORM

Message from Mayor Paul Antonio

The Toowoomba Region's climate is changing, and climate responsive building design is essential to the liveability of our Region for our growing community.

Our Garden City is the hub of one of Australia's most attractive Regions, blending city and country lifestyle in an amazing warm temperate climate. Our diverse landscape covers 12,973 square kilometres – from the Great Dividing Range through to the Darling Downs flood plains. With our near neighbours we are the only inland non-coastal warm temperate area in the eastern half of Australia. Little research into good building design currently exists, relative to our beautiful and unique climate. Toowoomba Regional Council is committed to addressing this.

The first step is to understand the local climate characteristics. To ensure best practice we established an evidence-based process – a research project aimed at defining the warm temperate climate relative to our Region. Council has worked collaboratively with the Queensland University of Technology (QUT) and the University of Southern Queensland (USQ) to define our Region's climate in addition to gathering up-to-date, and predictive data. Council is leading the way – by defining our climate and gathering our own data we're able to develop a model establishing forward-looking built environment strategies that are specific to our local climate.

Toowoomba Region Design – Warm Temperate Design Guideline is Council's first step towards promoting investment in climate responsive building design for our Region. It builds on the legacy of the Toowoomba Region Urban Design Initiative and adds to the value of our Green Infrastructure Strategy.

The Guideline includes a series of strategies for creating buildings that will maintain a comfortable lifestyle in changing climatic conditions. It recognises the importance of getting the basics right in designing your buildings – as these impact on your everyday life, the cost of living, the environment, and the community around you. The Guideline breaks down these strategies into four key areas and provides advice for harnessing the basic principles so that we can all start to live more sustainable lives.

Moving forward we encourage our community to start using the Guideline to design more responsive buildings. The value and benefits of this investment by our community will be a lasting legacy for our Region. An extension to this project has enabled USQ to install additional Automatic Weather Stations across the Region which will provide valuable ongoing data to benefit our community.

Acknowledgement of Traditional Owners

We acknowledge the Traditional Custodians of the Toowoomba Region whose song lines traverse these lands and pay our respect to Elders past, present and emerging, for they hold the knowledge, rich traditions and bold ambitions of Australia's first peoples

Disclaimer

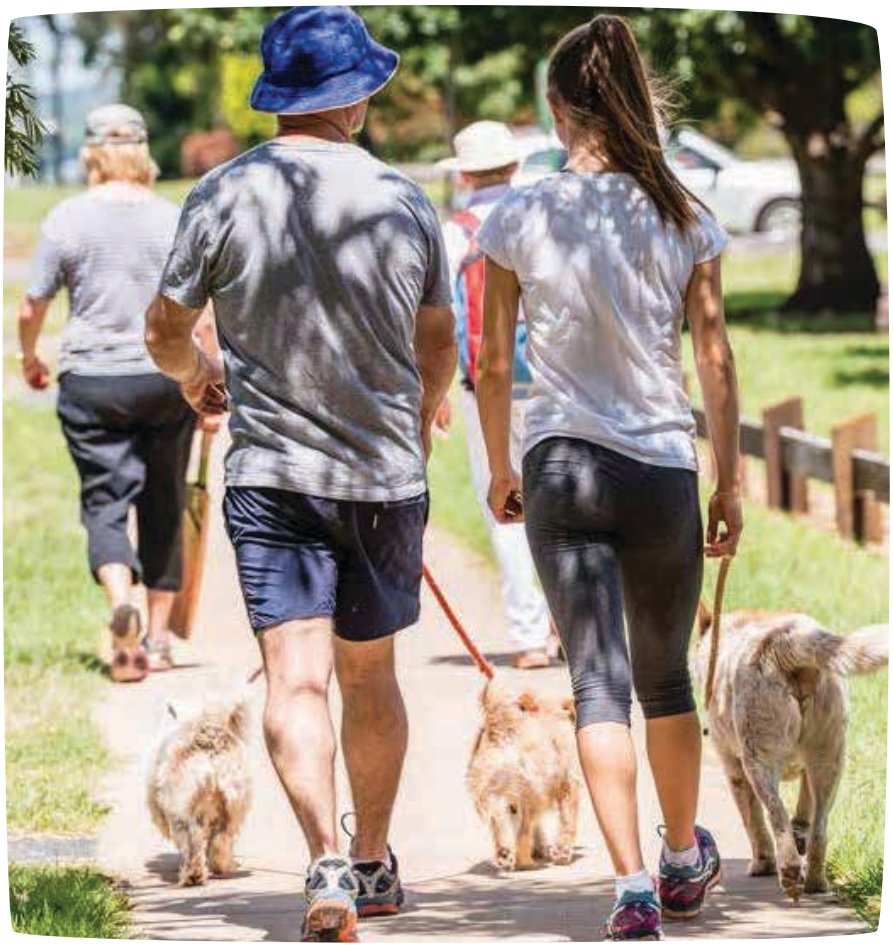
1. This guideline is not a statutory document. It has been prepared to help improve the quality, design and climate resilience of buildings in Toowoomba's Warm Temperate Climate.
2. The images, graphics and other illustrations are for consideration only and are not intended to represent a specific design. Any resemblance to an existing building is unintentional.
3. The specific circumstances of your building and lot should be considered including, but not limited to, orientation, slope, existing trees, the position of existing street trees and services and planning provisions regarding building height, site cover and setbacks.
4. If you submit a development application, copying or recreating any design from the examples or illustrations in this guide does not guarantee approval of the application. Every building design should be developed considering the specific elements and features of your site along with its street and neighbourhood context. Each application is assessed on an individual basis considering statutory planning provisions.

Contents

PART ONE:
TOOWOOMBA'S WARM TEMPERATE CLIMATE

Introduction

These guidelines help homeowners, commercial property owners and renters, in rural and central Toowoomba, to design new buildings that complement our climate. Ours is warm and temperate — a climate unlike any other in Southeast Queensland. Good design celebrates these conditions as well as our rich history and distinctive character. Here, you'll also find design tips to improve energy efficiency and prepare your new building for changing climate conditions. Toowoomba Regional Council is committed to a sustainable built environment that is designed for our unique climate and celebrates our legacy as the 'Garden City'. Council has invested in these guidelines to promote great design outcomes for the Toowoomba Region. The Warm Temperate Climate Building Design Guidelines is the first output from the Toowoomba Region Design series.



About These Guidelines

The Warm Temperate Climate Building Design Guidelines are informed by comprehensive research on Toowoomba's climate, and scientific projections for the climate into the future. The research informing these guidelines investigated local and international examples of best practice building design for warm temperate climates. From this research, four guiding principles were defined and now form the basis for the warm temperate design guidelines.

How to Use These Guidelines

These guidelines are for owners and renters of residential or commercial buildings. They can be used from the earliest stages of a building, such as selecting the best plot of land. Homeowners and tenants can use the guidelines to decide whether a home (new or existing) will be comfortable to occupy and energy efficient. The guidelines are most effective when building or homeowners work with design professionals such as architects and building designers. Building professionals, such as engineers, certifiers and builders can also use these guidelines to assist in communicating their ideas to clients.

Part One: Toowoomba's Warm Temperate Climate	» Provides an introduction to the Guidelines and how to use them. » Toowoomba's climate and how it impacts the way our region looks and feels. » How the region's climate influenced Toowoomba's character and heritage buildings.
Part Two: The Warm Temperate Design Guidelines	» Introduces the Four Design Principles for a Warm Temperate Climate. » Designing and building to suit our climate and character — here's how. » Designing for our changing climate

References and Resources

For further reading, please view these free resources:

Your Home: https://www.yourhome.gov.au/.

Sustainability Victoria: Energy smart housing manual.

Australian Institute of Architects: *Residential passive design for temperate climates.*

Defining Toowoomba's Warm Temperate Climate

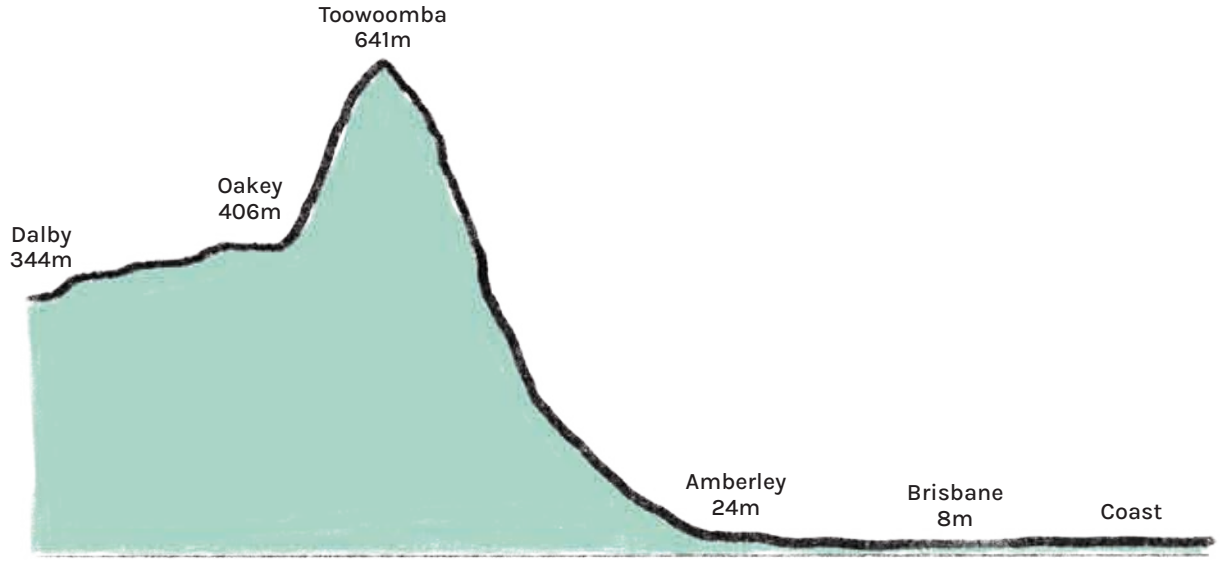
What is Toowoomba's Warm Temperate Climate?

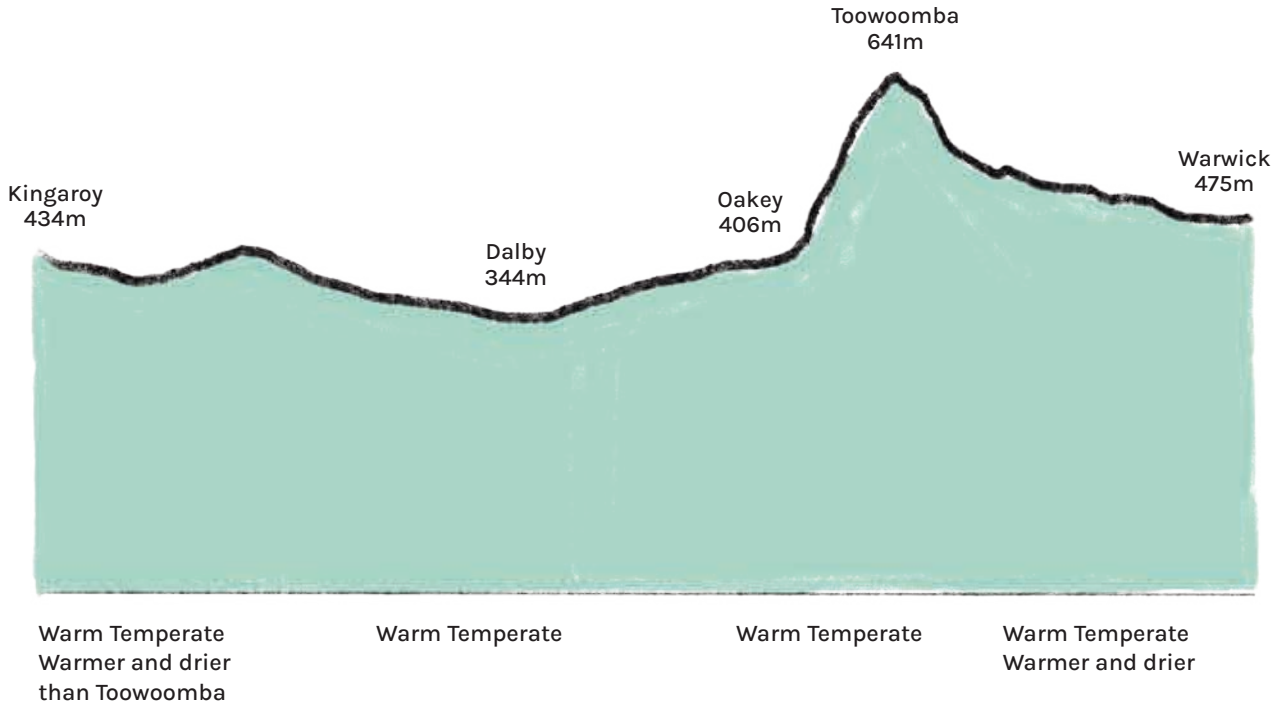
A warm temperate climate has four distinct seasons. Autumn and spring are pleasant, while winter is cold and summer is hot — sometimes very hot. In Toowoomba, the predominant winds originate from the East and South West. Toowoomba's inland, elevated position makes it cooler and less humid than coastal Brisbane. It is also exposed to cold South-Westerly winds in winter. Being one of Australia's furthermost north warm temperate regions makes Toowoomba summers hotter than other cities with a similar climate.

Cities with warm temperate climates are some of the most liveable places in the world. In Australia, warm temperate cities include Sydney, Adelaide, and Perth. Internationally, warm temperate cities include places like Bologna in Italy. Bologna and Toowoomba share a similar agricultural history, beautiful heritage buildings and both are transforming into international foodie destinations.

Toowoomba's Unique Topography

Toowoomba's unique climate is a result of its elevated position, making it cooler and drier than coastal urban centres such as Brisbane. These transects shows the difference in height above sea level between Toowoomba and Brisbane. It also shows that Kingaroy and Warwick share a similar position with Toowoomba, elevated above sea level, and all three have warm temperate climates. Kingaroy is slightly warmer than Toowoomba in summer and Warwick is cooler in winter.





Toowoomba's Future Climate

The climate in Australia is changing. Extreme weather events such as floods, droughts and heatwaves are signs of a changing climate. However, our day-to-day experience of the climate is also set to change. The projections for Toowoomba indicate a climate that will be warmer with less rainfall. The Queensland Government projects that Toowoomba's climate will be similar to Kingaroy's climate by 2030. These guidelines include a series of strategies for creating buildings that will maintain a comfortable lifestyle in changing climatic conditions.

Toowoomba's Climate and Character Buildings

When it's hot and humid, Southeast Queenslanders escape to Toowoomba to beat the heat!

Our local architects have always known how to design for our climate. Evidence dates back over a century and can be found in well-known Toowoomba buildings, Vacy Hall and St James Parish Hall. Thanks to local lads — architects like James and Harry Marks — these iconic buildings are well ventilated to ensure a comfortable temperature inside, year-round. If we take some cues from these early designs, the longevity of our new buildings will appeal to locals and tourists for generations to come.

Image Caption: Heritage listed Toowoomba City Hall, designed by Willoughby Powell architecture, built in 1900

PART TWO:
WARM TEMPERATE CLIMATE BUILDING DESIGN GUIDELINES

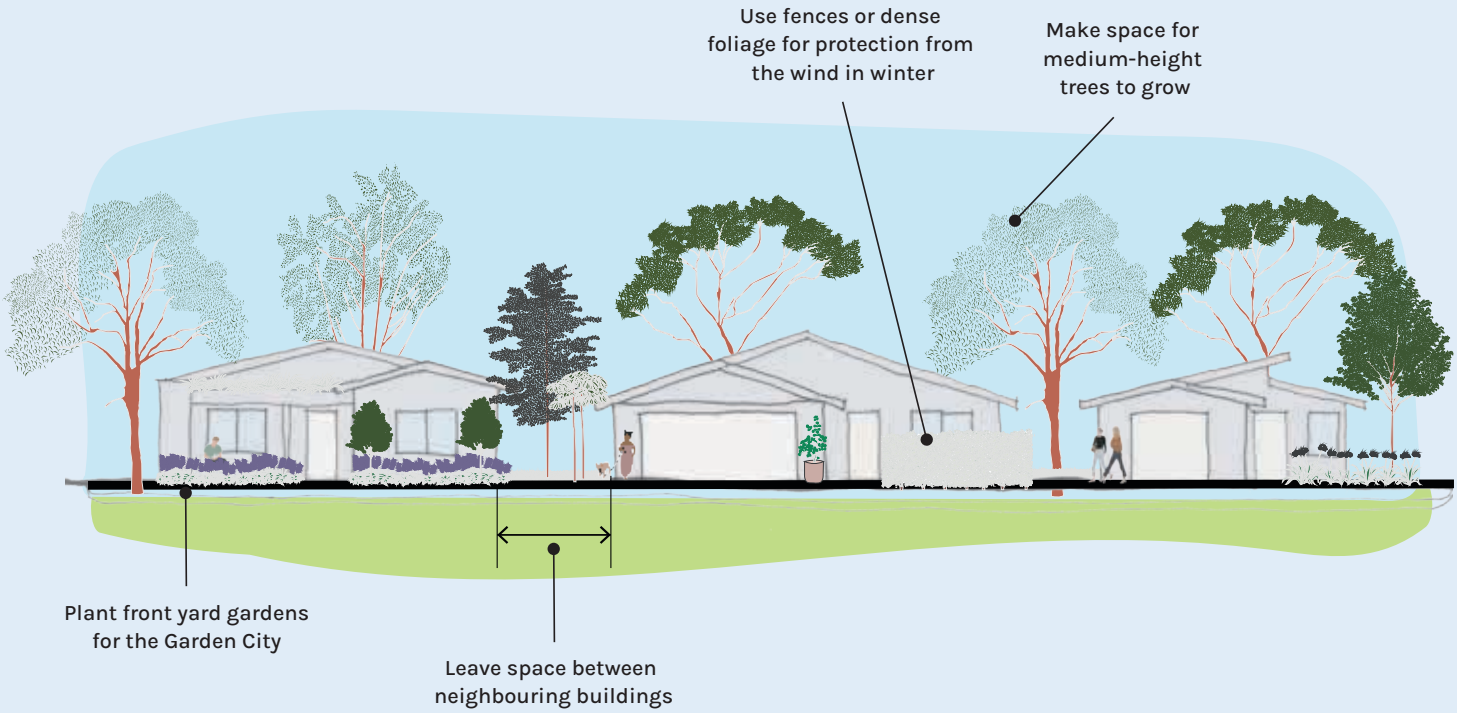
The Guidelines are based around four key design principles:

Principle One:
Design with the Neighbourhood in Mind

Principle Two:
Design the Building for the Seasons

Principle Three:
Use Natural Energy from the Sun and Wind to your Advantage

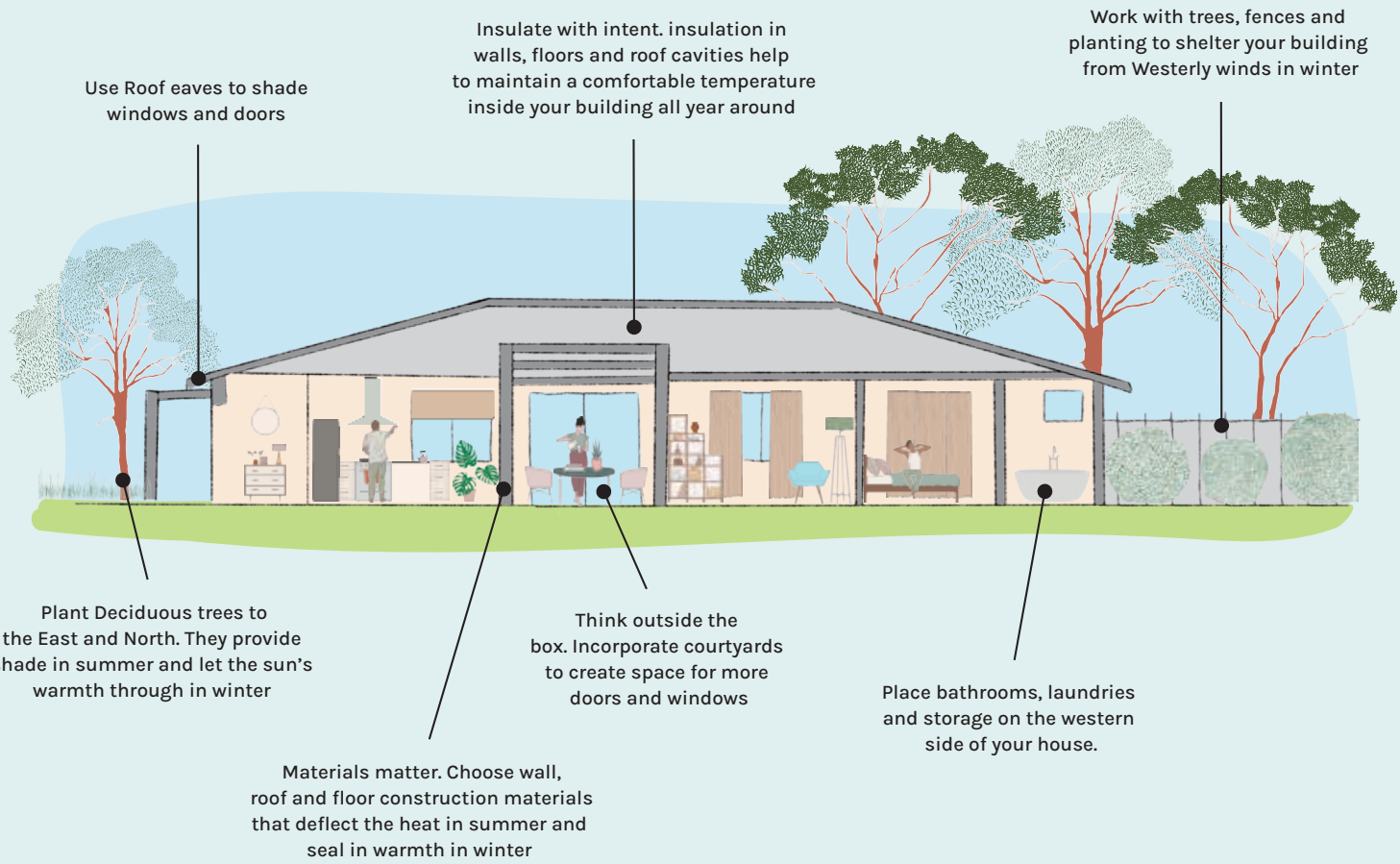
Principle Four:
Increase Comfort, Decrease Costs



Principle One:
Design with the Neighbourhood in Mind

How and where you locate your home or commercial building on a site has a direct impact on your neighbours' comfort. Think about how your building can make the most of the sun's warmth and light in winter for you and everyone in your neighbourhood.

Promote access to the sun in winter by not overshadowing your neighbours. Capture breezes in summer by leaving enough space between your home or commercial building and the one next door. Use your home or commercial building and garden design to shelter you and your neighbours from winter winds. Celebrate Toowoomba's history as the Garden City by working with existing trees and leaving space for medium and large trees to grow between buildings.

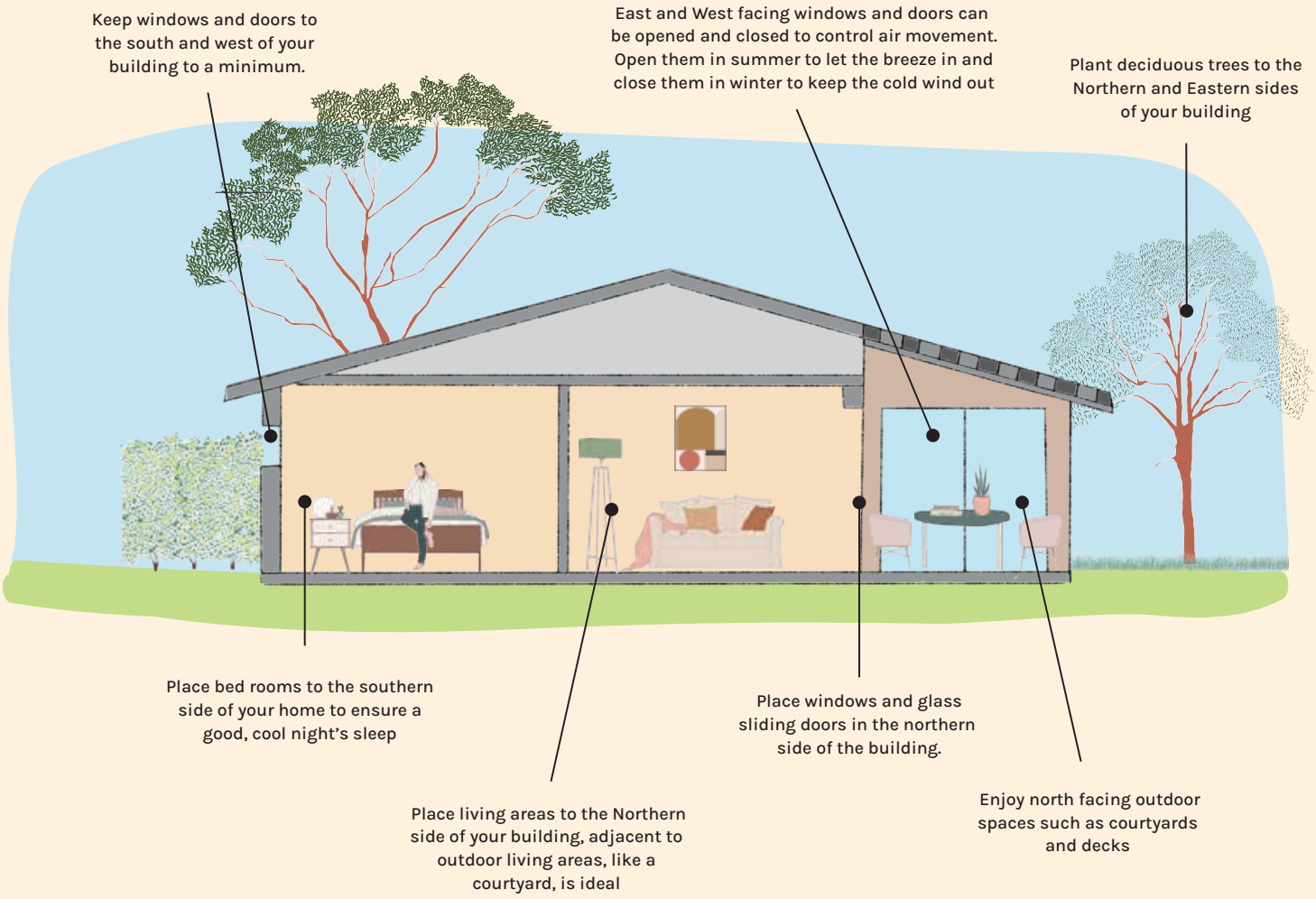


Design your building to flow from East to West so that the longest edge of the Building is facing North

Principle Two: Design the Building for the Seasons

The way you design your home or commercial building makes a huge difference to your comfort, and how much (or little) your energy bills are.

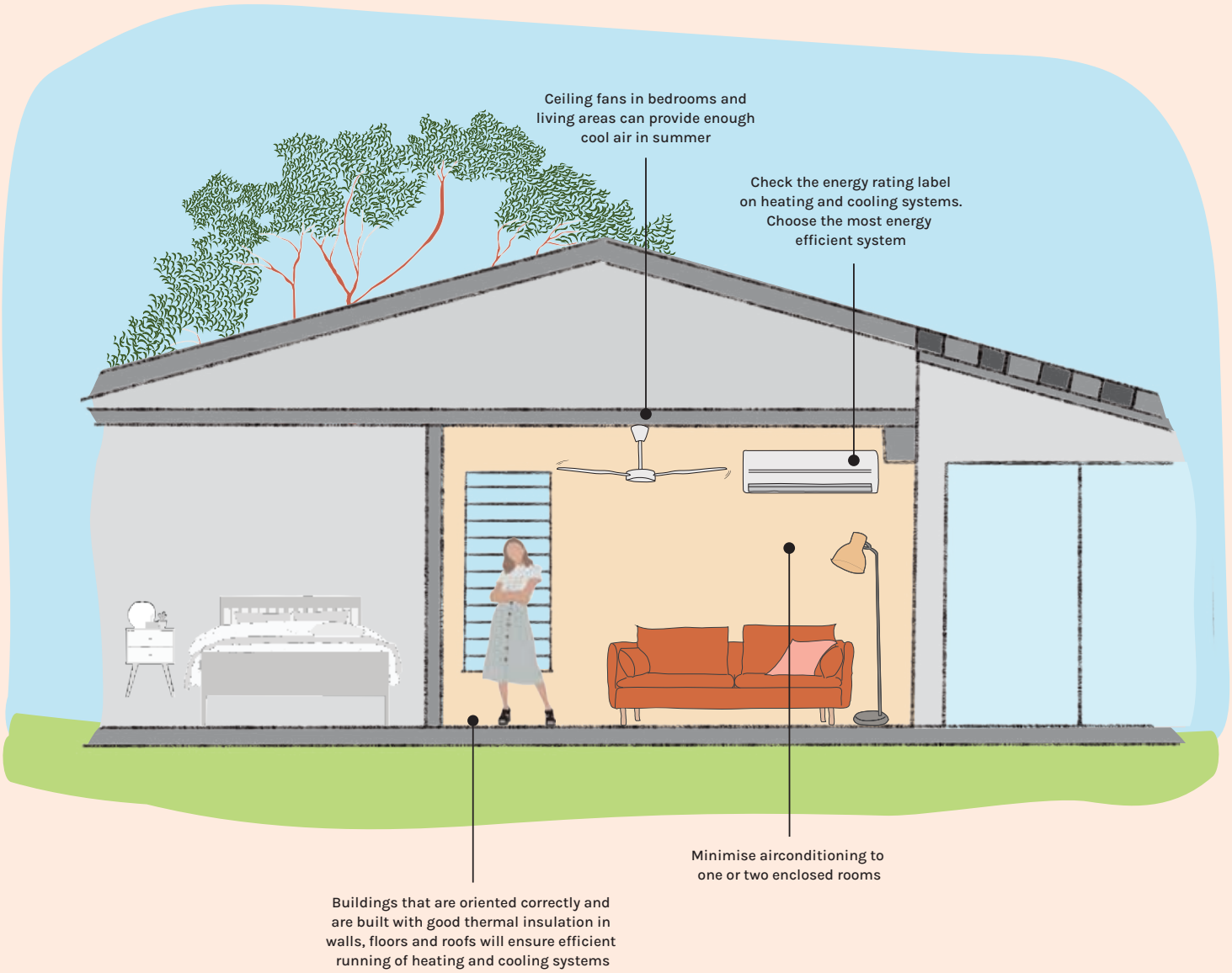
Face your building toward the sun. Where possible, make your building flow from east to west so that the longest edge of your building is facing north, that way you capture daylight and the warmth from the sun in winter. Design a roof with eaves that will shade windows and doors from the sun and reduce heat from the summer sun. Work with the existing landforms and vegetation for shelter from cold winter westerly winds and the heat of the afternoon sun. Think outside the box with your building shape. Incorporate courtyards and small nooks that create space for more doors and windows. Brighten the neighbourhood — go light with your colour selection to reflect the heat and make your building energy efficient. Materials matter — choose materials and construction systems for your walls, roof and floors that deflect the heat in summer and seal in warmth in winter. Insulate with intent — insulation in walls, floors and roof cavities help to maintain a comfortable temperature inside your building all year around.



Principle Three:
Use Natural Energy from the Sun and Wind to your Advantage

Make the most of Toowoomba's warm temperate climate by designing your building in a way that harnesses natural energy (the sun and the wind) for heating and cooling.

Place windows and glass sliding doors on the northern side of the building to capture the sun's warmth in winter. Enjoy indoor and outdoor living spaces such as courtyards and decks that face north so that you can soak up the sun. If you are adding a north-facing veranda, make sure you can enclose it (especially to the east and west) in winter, a bit like a conservatory. Control air movement for heating or cooling by placing windows and doors that can be opened or closed as required to eastern and western facing parts of the building. Protect your building from south-westerly winds by minimising windows and doors to the outside in areas that face this direction. The south-western corner of your building is a good place to locate bathrooms, laundries and other less frequently used rooms.



Principle Four:
Increase Comfort, Decrease Costs

On very hot or very cold days, you can keep a cap on costs if your design includes some strategies that will help lower your energy bills.

Well-designed buildings with correct orientation and good insulation promote the efficient running of mechanical heating and cooling systems. Ceiling fans in bedrooms ensure a cool and comfortable night's sleep. Minimise air conditioning and heating to one or two essential rooms. Choose energy-efficient heating and cooling systems.

Applying these Principles to your Building

The following information provides an overview of the best ways to design for Toowoomba's climate. You should always consider the specifics of your place, including:

- Orientation
- Slope
- Trees (on your property & beyond)
- Services (electricity, water, sewerage and natural gas)
- Planning provisions.

Following are three sets of guidelines, one each for residential design, multi-residential design, and commercial design. Each of these building guidelines share many common guidelines. There is some repetition in the guidelines for each building type. It's best to go straight to the guidelines for your specific building type.

RESIDENTIAL DESIGN GUIDELINES

The residential guidelines are written for detached dwellings on standard blocks of land and houses on small lots.

Before you begin applying the principles to your house, it's important to choose a good site to work with. When selecting a plot of land, look at the orientation of the subdivision. Look for streets that run from North-to-South and plots of land that flow from east to west. The longest edge of the plot of land should be north facing so that your home can capture natural daylight and benefit from the sun's warmth in winter. You also want the smallest edge of your building facing west to minimise the cold from winds in winter and the heat of the afternoon sun in summer. Look for street trees and parks with lots of established trees, which make suburbs cooler and more enjoyable for outdoor activities such as walking, bicycling and socialising with friends and neighbours outdoors.

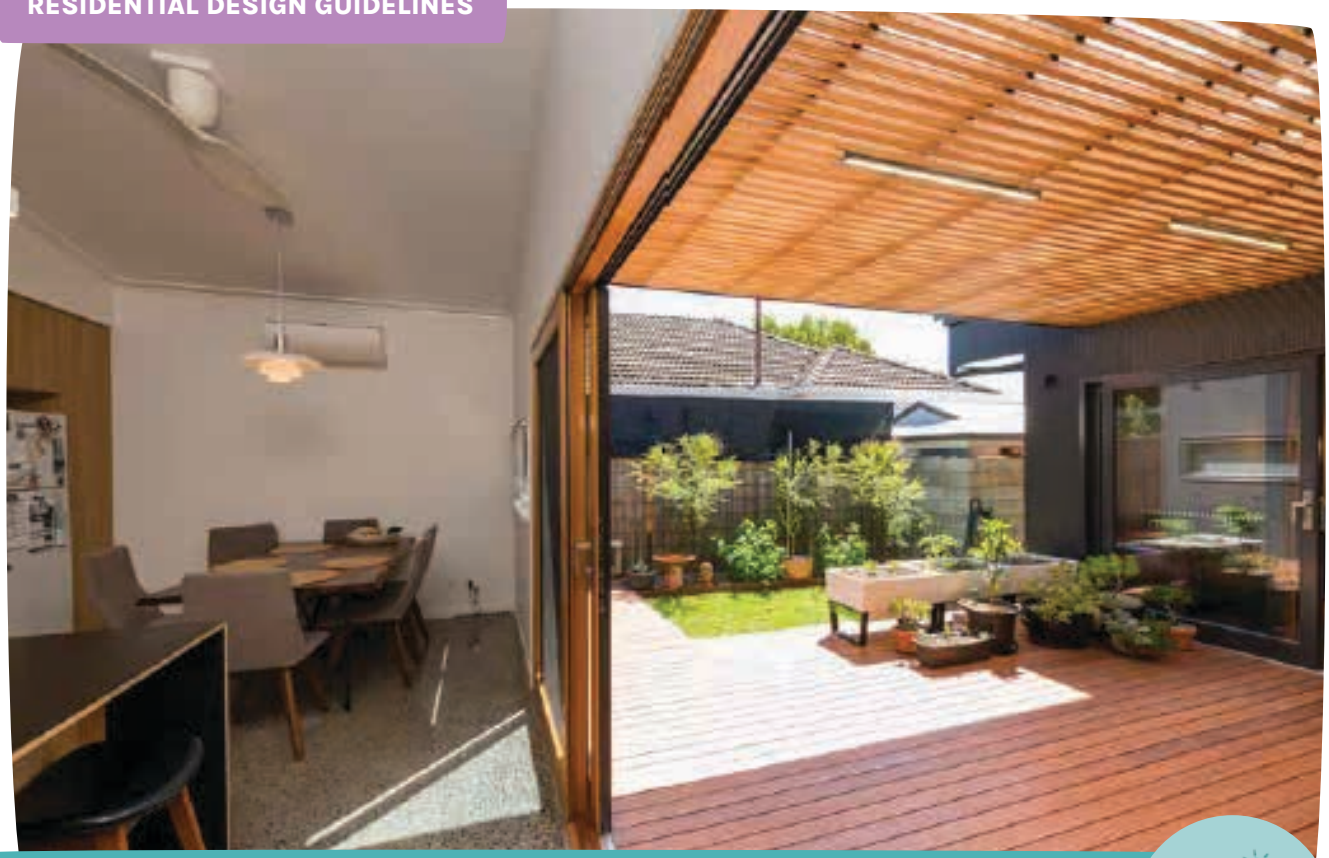
You won't always find an ideal site upon which to build, especially if you are building a small lot house on an infill site. If the site orientation is less than perfect, it is best to engage a building designer or architect skilled at designing for challenging sites.

Principle One:
Design with the Neighbourhood in Mind

Leave space required for medium-height trees to grow. They need space for their roots and canopy to flourish. Shade from trees keeps the environment around your house at a comfortable temperature and makes living and socialising outdoors much more enjoyable. Embrace Toowoomba's legacy as the Garden City and incorporate landscape design into your planning, especially in the front yard.

Set buildings back from each other to prevent overshadowing and encourage air movement between buildings. Avoid building to the boundary wherever possible. If building car accommodation along a shared boundary, consider an open-sided carport, which will promote air movement between dwellings and minimise overshadowing. Locate fencing and planting with dense foliage to the southwestern aspect of your site to block cold winter winds and provide shade from the heat in summer.

Image Caption: A local Toowoomba street scape with street trees. Fencing and planting with dense foliage is used to provide privacy and shelter buildings from cold winds in winter. There is space between each home to ensure fresh air and cooling breezes can move between dwellings in summer.



Principle Two:
Design the Building for the Seasons

Locate living areas, such as kitchen, dining, and lounge rooms to the north side of your building for natural daylight and to soak up the sun in winter. Design a roof with eaves that will shade windows and doors from the sun and reduce heat from the summer sun. Bedrooms should be located to the southern side because that's the cooler side of the house and will ensure a good night's rest. Laundries, bathrooms, and other less frequently used rooms should be located to western areas of the home. The western side of the house is exposed to the heat of the afternoon sun, and cold winds in winter, so it's best to place rooms you spend the least amount of time in on the west.

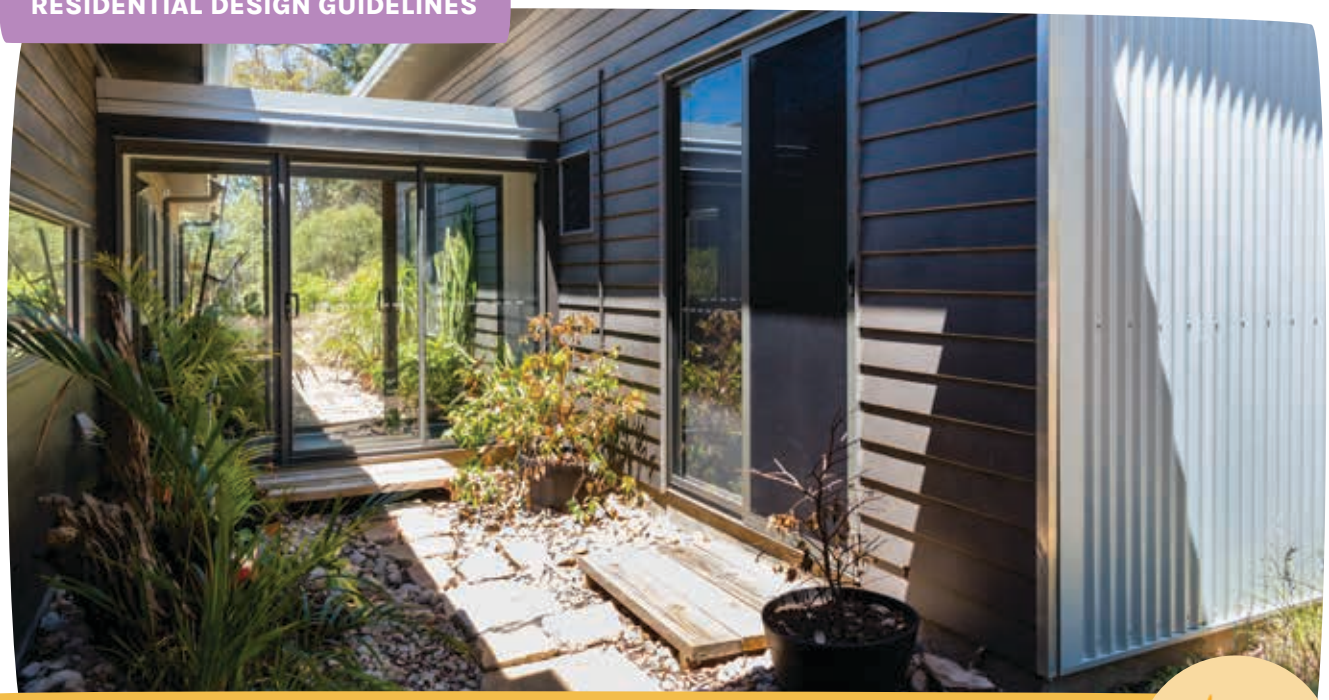
Place outdoor living areas such as courtyards and verandas to the north to soak up the warmth from the sun in winter. Make the most of outdoor spaces by placing them near living areas. This encourages people to open and close doors between indoor and outdoor spaces and promotes good practices in adjusting the building to suit the climate.

Think outside of the box! Go with a house that has nooks and recesses, especially if it includes a courtyard. This increases the surface area of the building and creates more space for windows and doors that can be opened or closed to adjust indoor temperatures. By working with an architect or building designer you can incorporate advanced design features such as south facing clerestory, which releases hot air from your house through a high level window.

Go with external roof and wall cladding colours that are light and bright. This will help to keep both you and your neighbourhood cool in summer. Dark colours absorb heat, while bright colours keep everything cool.

Choose external wall construction systems wisely. Talk to your architect, building designer, builder or certifier about the best wall, floor, and roof that will make your home comfortable all year round. Wall, floor and roof insulation will ensure a cosy home and keep your heating and cooling bills low.

Image Caption: A north facing courtyard in a home with adjacent living and dining areas. This courtyard is a warm space to use in winter and a pleasant place to spend time in summer. It brings natural daylight into the living areas of the house, filtered warmth from the sun into living areas in winter and shade from the heat in summer.



Principle Three:
Use Natural Energy from the Sun and Wind to your Advantage

Locate windows and glass sliding doors to the northern side of your building to capture the warmth from the sun in winter. Place windows that face east and west so that they can be opened to capture breezes in summer and closed to protect from cold winds in winter.

Invest in good quality window and door seals to prevent winter's cold air from sneaking in.

Courtyards are ideal outdoor spaces in Toowoomba. If you are incorporating a veranda, make sure the sides can be enclosed (a bit like a conservatory) to make the space enjoyable all year round and help to capture warmth in winter. All outdoor living areas should be north facing so that you can enjoy the sun in winter. Minimise openings such as doors and windows to the southwestern section of your home.

Image Caption: A recess creates a breezeway with glass sliding doors to the east and west that can be opened to draw in cool breezes in summer or closed to protect from cold winds in winter.

Principle Four:
Increase Comfort, Decrease Costs

Well insulated buildings with the correct orientation will minimise your heating and cooling needs and lower your energy bills. Ceiling fans in bedrooms help to maintain a cool space for sleeping. Choose one or two rooms for mechanical heating and cooling to use on days when the weather is too hot or cold. Where possible, design living areas that can be closed off into smaller rooms so that heating or cooling is only required for a small, contained area.

Avoid air-conditioning in large open areas of your home. Mechanical cooling for large areas is difficult to correctly balance, expensive to run and can lead to issues with condensation and mould. These spaces can be cooled naturally if the room is designed with adequate openings positioned to capture breezes.

MULTI-RESIDENTIAL DESIGN GUIDELINES

The multi-residential design guidelines are written for duplexes, town houses, and small blocks of units up to three storeys.

Principle One:
Design with the Neighbourhood in Mind

Leave space required for medium-height trees to grow. They need space for their roots and canopy to flourish. Shade from trees keeps the environment around your home at a comfortable temperature and makes living and socialising outdoors much more enjoyable. Embrace Toowoomba's legacy as the Garden City and incorporate landscape design into your planning, especially in the front yard.

Set buildings back from each other to prevent overshadowing and encourage air movement between buildings. Avoid building to the boundary wherever possible. If building car accommodation along a shared boundary, consider an open-sided carport, which will promote air movement between dwellings and minimise overshadowing. Place all car accommodation in one location, not attached to individual dwellings; this removes the need for excessive driveways traversing between dwellings. Locate fencing and planting with dense foliage, to the southwestern aspect of your site to block winter winds and provide shade from the heat in summer.

Principle Two:
Design the Building for the Seasons

Locate living areas, such as kitchen, dining, and lounge rooms to the north side of your building for natural daylight and to soak up the sun in winter. Design a roof with eaves that will shade windows and doors from the sun and reduce heat from the summer sun. Bedrooms should be located to the southern side of the building because that's the cooler side of the home and will ensure a cool, good night's rest. Laundries, bathrooms, and other less frequently used rooms should be located to western areas of the home. The western side of the building is exposed to the heat of the afternoon sun, and cold winds in winter, so it's best to place rooms people spend the least amount of time in on the west.

Place outdoor living areas such as courtyards and verandas to the north to soak up the warmth from the sun in winter. Make the most of outdoor spaces by placing them near living areas. This encourages people to open and close doors between indoor and outdoor spaces and promotes good practices in adjusting the building to suit the climate.

Prioritise cross ventilation. All living and sleeping areas should have windows or doors located across from each other in external walls to promote air movement. Air can get trapped in rooms that have only one window or door facing the outside.

Think outside of the box! Go with a building that has nooks and recesses, especially if it includes a courtyard. This increases the surface area of the building and creates more space for windows and doors that can be opened or closed to adjust indoor temperatures.

Go with external roof and wall cladding colours that are light and bright. This will help to keep both you and your neighbourhood cool in summer. Dark colours absorb heat, while bright colours keep everything cool.

Choose external wall construction systems wisely. Talk to your architect, building designer, builder or certifier about the best wall, floor, and roof that will make your home comfortable all year round. Wall, floor and roof insulation will ensure a cosy home and keep heating and cooling bills low.

Principle Three:
Use Natural Energy from the Sun and Wind to your Advantage

Locate windows and glass sliding doors to the northern side of your building to capture the warmth from the sun in winter. Place windows that face east and west so that they can be opened to capture breezes in summer and closed to protect from cold winter winds.

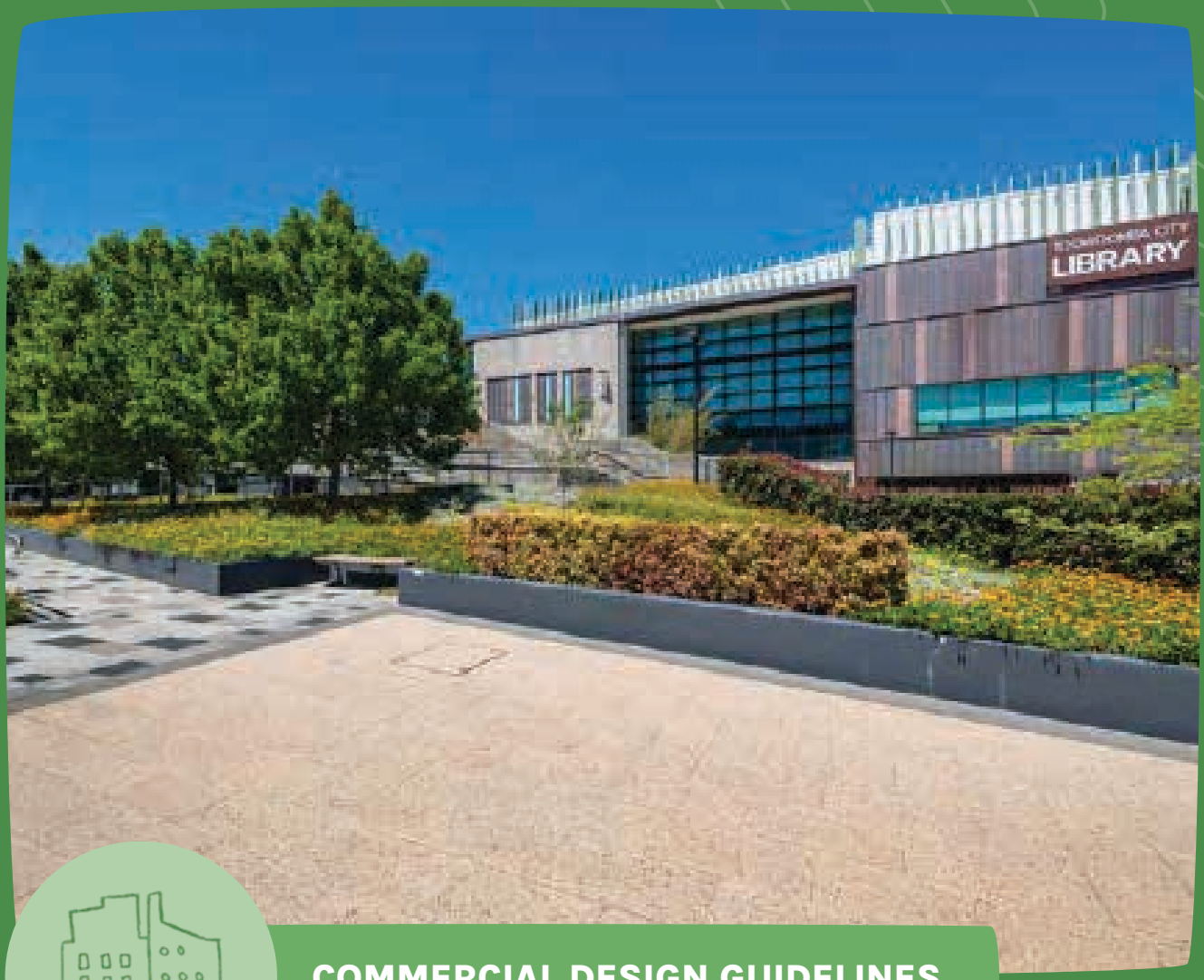
Invest in good quality window and door seals to prevent cold winter air from sneaking in.

Courtyards are ideal outdoor spaces in Toowoomba. If you are incorporating a veranda, make sure the sides can be enclosed (a bit like a conservatory) to make the space enjoyable all year round and help to capture warmth in winter. All outdoor living areas should be north-facing so that you can enjoy the sun in winter. Minimise openings such as doors and windows to the southwestern section of your building.

Principle Four:
Increase Comfort, Decrease Costs

Well insulated buildings with the correct orientation will minimise heating and cooling needs and lower energy bills. Ceiling fans in bedrooms help to maintain a cool space for sleeping. Choose one or two rooms for mechanical heating and cooling to use on days when the weather is too hot or cold. Where possible, design living areas that can be closed off into smaller rooms so that heating or cooling is only required for a small, contained area.

Avoid air-conditioning in large open areas of your building. Mechanical cooling for large areas is difficult to correctly balance, expensive to run and can lead to issues with condensation and mould. These spaces can be cooled naturally if the room is designed with adequate openings positioned to capture breezes.



COMMERCIAL DESIGN GUIDELINES

The commercial design guidelines are written for office, retail and hospitality buildings.

Principle One:
Design with the Neighbourhood in Mind

Leave space required for medium-height trees to grow. They need space for their roots and canopy to flourish. Shade from trees keeps the environment around your building at a comfortable temperature and makes living and socialising outdoors much more enjoyable. Embrace Toowoomba's legacy as the Garden City and incorporate landscape design into your planning, especially in the front of your building.

Set buildings back from neighbours to prevent overshadowing and encourage air movement between buildings. Avoid building to the boundary wherever possible. Locate car parking to the northern side of the building. This will orient the building to the north by default and leaves open space between buildings to capture the warmth from the sun in winter. Open up onto the street with a suitable awning and planting that provides shade to pedestrians and shelters openings from the rain. This will also help to increase foot traffic into businesses. Locate fencing and planting with dense foliage to the southwestern aspect of your site to block cold winter winds and provide shade from the heat in summer.

Principle Two:
Design the Building for the Seasons

Covered circulation, such as stairs and corridors located on the perimeter of the building provides an outer layer to insulate the building. It also encourages building users to open and close windows and passively adjust the temperature of internal spaces. Additionally, it welcomes visitors to the building with visible human activity!

Laundries, bathrooms, and other less frequently rooms should be located to western areas of the building. Think outside of the box! Incorporate courtyards and other spaces that will modify the building's shape and increase the surface of your building for more doors and windows.

Go with external roof and wall cladding colours that are light and bright. This will help to keep both you and your neighbourhood cool in summer. Dark colours absorb heat, while bright colours keep everything cool.

Choose external wall construction systems wisely. Talk to your architect, building designer, builder or certifier about the best wall, floor, and roof that will make your building comfortable all year round. Wall, floor and roof insulation will ensure a cosy building and keep your heating and cooling bills low.

Principle Three:
Use Natural Energy from the Sun and Wind to your Advantage

Locate windows and glass sliding doors to the northern side of your building to capture the warmth from the sun in winter. Place windows that face east and west so that they can be opened to capture breezes in summer and closed to protect from cold winter winds. Invest in good quality window and door seals to prevent cold winter air from sneaking in.

Courtyards are ideal outdoor spaces in Toowoomba. If you are incorporating a veranda, make sure the sides can be enclosed (a bit like a conservatory) to make the space enjoyable all year round and help to capture warmth in winter. Minimise openings such as doors and windows to the southwestern section of your building.

Principle Four:
Increase Comfort, Decrease Costs

Well insulated buildings with the correct orientation will minimise your heating and cooling needs and lower your energy bills. Commercial ceiling fans can move a lot of air, and are often all that is needed for cooling spaces in summer! This is a great solution for commercial spaces that include al fresco customer experiences.

Where possible, include options to break up open plan commercial spaces so that areas can be closed off into smaller rooms for heating and cooling as required. It is much more effective and efficient to heat or cool a room or a small enclosed space than an entire building.

Climate Resilience and Adaptability

Research shows our future climate will likely be warmer and drier. So how can we design our homes and commercial buildings to withstand these conditions and help protect our environment?

Design compact, efficiently-planned buildings with small footprints. Occupy the smallest feasible area of the site. Leave space for medium-height trees (5 – 15 metres). Shade from trees lowers the temperature by up to five degrees Celsius. Both evergreen trees (such as Lilly Pilly, Little Gem Magnolia, Silky Oak) and deciduous trees (including Red Maple, Crepe Myrtle, Ornamental Pear, Pin Oak) provide the same level of cooling from their shade. If you are planting trees to the northern side of your building, choose deciduous trees so that you can still make the most of the warmth from the sun in winter.

Keep as much of the site area as possible free from solid paving, driveways, car parking, and any hard surfaces (such as concrete), so that rainfall can soak into the soil. Where possible, choose ground surfaces that promote water absorption into the soil, such as Grass Cell or Grass Block Pavers. Use driveway planting such as Dwarf Mondo Grass, Native Violet, Dichondra, Society Garlic or Gazania instead of concrete.

Incorporate water storage, such as rainwater tanks, into site planning. Consider a greywater system to recycle water from sinks, laundries, and showers. See further information below on planning and building permission requirements.

Break up spaces in your home or commercial building so that there are one or two rooms that can be enclosed for air-conditioning or heating on extreme weather days. It is more effective and efficient to cool a room than an entire building. This strategy minimises stress on the energy grid and ensures that adequate heating or cooling is affordable and accessible to everyone.

Further Information

Your Home | Adapting to climate change:
www.yourhome.gov.au/live-adapt/adapting-climate-change

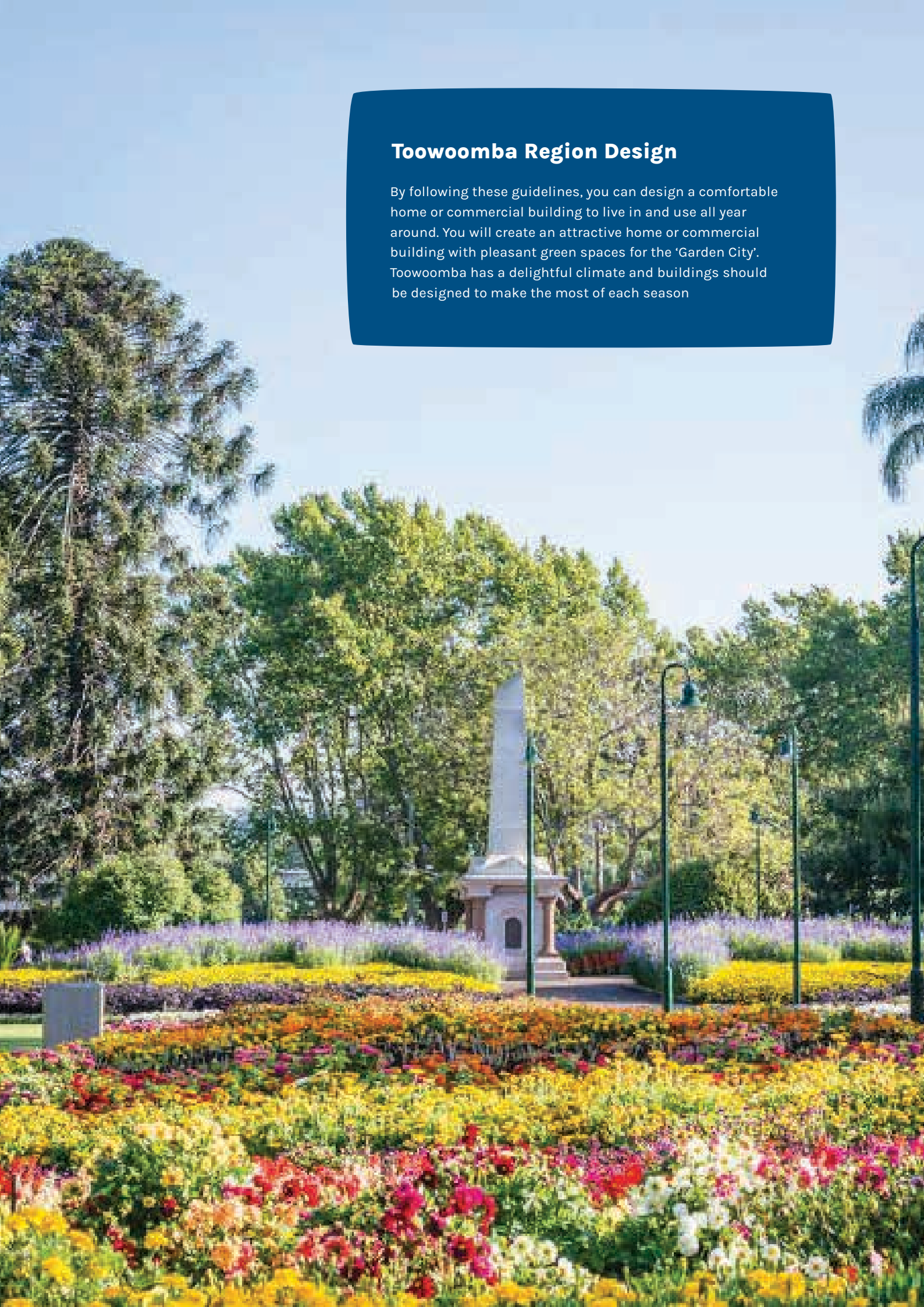
Toowoomba Regional Council | Rainwater tanks:
www.tr.qld.gov.au/environment-water-waste/water-supply-dams/water-restrictions-conservation/13320-rainwater-tanks

Toowoomba Regional Council | Greywater Use:
www.tr.qld.gov.au/environment-water-waste/water-supply-dams/water-restrictions-conservation/13392-greywater-use

Design for your Climate and Keep Cool:
www.energy.gov.au/households/household-guides/energy-saving-guide-northern-australia/design-your-climate-and-keeping-cool

Toowoomba Region Design

By following these guidelines, you can design a comfortable home or commercial building to live in and use all year around. You will create an attractive home or commercial building with pleasant green spaces for the ‘Garden City’. Toowoomba has a delightful climate and buildings should be designed to make the most of each season

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