
City of Perth
URBAN
forest
PLAN
2016-2036

Contents

Lord Mayor's Message

Across the world, more people are choosing to live in cities. This creates the need to pay closer attention to our urban environment.

With a focus on environmental sustainability and health, climate response, energy resilience, water sensitivity and consciousness our Urban Forest Plan aligns with the City's overarching Environment Strategy. The Strategy sets out our aspirations for Perth's environmentally sustainable future.

The City's green spaces, trees, plants and vegetation cool and soften our streets and public spaces. Our green networks, including cycle ways and pedestrian paths, create opportunities for active and passive recreation, helping to improve community health and well-being.

The Urban Forest Plan provides direction for how our organisation will build upon these features and ensure Perth's natural environment is able to flourish and provide a high quality of life for all flora, fauna and people.

As a community, we have the opportunity to make major environmental changes that will benefit other generations in the years to come. Increasing levels of urbanisation and climate change require dedicated resources and management, and it is imperative that we make strategic decisions today to play a proactive role in planning for a more sustainable future.

Looking towards 2036, the City will embark on a series of ambitious tree planting plans that will help keep the City cool by increasing canopy cover. We will also foster innovation in sustainable water management and develop a wider network of green infrastructure.

This Plan will maximise our urban forest's long term health and resilience and ensure our organisation's policies and procedures meet best practice standards.

By sharing knowledge and providing information on the changing condition and level of benefits provided by our urban forest, the City will look to you, our community, to help make a difference to its future.

By working together we have the potential to create a valuable and enduring legacy by handing over a greener, more beautiful, healthy and resilient City for all who live, work and play within it.

Lisa M Scaffidi

Lord Mayor

Victoria Gardens - East Perth

Vision

The urban forest will be recognised and valued as an important asset and a key element of infrastructure, one that continues to deliver a range of benefits for our community's physical and mental well-being and the overall liveability, landscape character, biodiversity and climate resilience of our City.

The urban forest will be planned and managed in an integrated manner that above all optimises canopy cover and protects and promotes its sustainable growth, health and resilience in the face of continued urbanisation and climate change challenges.

Florence Hummerston Reserve – Perth

Executive summary

The urban forest is a valuable asset and key element of city infrastructure which delivers a wide range of community benefits. Its collection of green spaces, trees and other vegetation help to improve city liveability and promote community health and well-being. The urban forest also contributes to the creation of a climate resilient city and helps improve overall environmental quality.

The City of Perth Urban Forest Plan is a strategic action plan that aims to promote the urban forest's long term health and resilience, despite the challenges it faces, and maximise the level of benefits delivered.

Using an evidence based approach the Plan sets out a clear vision for the urban forest. The vision will be achieved through the delivery of nine goals which focus on protecting the existing urban forest, promoting its sustainable expansion, adopting a strategic management approach and raising community awareness of the benefits it provides.

Improving canopy cover is a key focus of the Plan. Through a targeted program of new tree planting the City is aiming to increase the level of canopy cover within the public realm from 19 percent to 30 percent over a 30-year period. Canopy cover will also be improved by protecting existing trees, replacing those that are aging and maintaining high levels of tree health.

Rising city temperatures resulting from climate change pose a significant risk to city liveability and community health. Harnessing the potential of the urban forest to help cool city 'hot-spots' is another important focus.

Ensuring a sustainable water supply for irrigation has emerged as a critical issue if the health and cooling benefits of the urban forest are to be maximised. The Plan recognises the importance of transitioning to a water sensitive city and promotes the use of water sensitive urban design in urban forest management.

The Urban Forest Plan will be supported by an implementation plan and monitoring framework which set priorities and measure progress in achieving the vision and goals.

The City of Perth Urban Forest Plan is being developed in three stages. This report represents Stage One and addresses street and parkland trees. Subsequent stages will address trees on private property and other elements of green infrastructure. These are scheduled for completion in 2017.

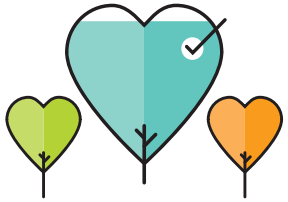
The City of Perth Urban Forest Plan currently includes all land located within the City of Perth boundaries, with the following exclusions:

- Kings Park given its primary function as a botanic garden rather than an element of the urban forest. Including it would result in an inaccurate representation of the urban forest.
- Metropolitan Redevelopment Authority projects currently under development.
- Parts of the City of Subiaco recently amalgamated with the City of Perth, under the provisions of the City of Perth Act 2016.

A separate supporting document will be issued later in 2016 to include the latter two areas within Stage One.

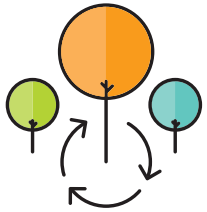
Goal 1:

Protect existing trees



Goal 2:

Replace aging trees

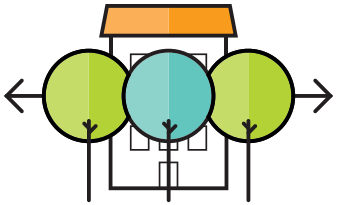


Goal 3:

Promote sustainable water management

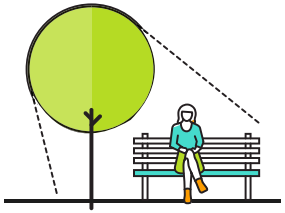
Goal 4:

Increase canopy cover



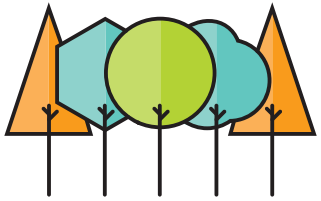
Goal 5:

Prioritise tree planting to help cool public spaces and City 'hot-spots'



Goal 6:

Promote balance and resilience in species composition



Goal 7:

Maintain tree health

Goal 8:

Implement a 'whole-of-forest' management approach

Goal 9:

Promote community engagement

1.0 Introduction

Traditionally urban trees have been valued for their beauty and aesthetic quality. They soften and add human scale to city streets. Avenues of trees and distinctive parklands help create an attractive city with a unique sense of place.

More recently, urban forests are also being valued for the social, economic and environmental benefits they provide. They help to cool our cities, improve air and water quality, reduce greenhouse gases, provide food and shelter for wildlife and improve levels of community health and well-being.

With more people choosing to live in cities, many are struggling to maintain a healthy environment and a high quality of life for their citizens.

Australia is an increasingly urbanised country with approximately 70 percent of its population living in cities (Australian Bureau of Statistics, 2013). The residential population of the City of Perth increased by nearly 50 percent between 2006 – 2011. This trend is expected to continue, with a population of 28,500 predicted by 2030 (City of Perth, 2013).

As cities become more built up and lifestyles are more sedentary, access to green space is all the more important in promoting community health and well-being.

Climate change brings another set of challenges. Our cities are heating up. Since 1950 the average number of heat wave days per year has been increasing across Australia (see Figure 1). The number of heatwave events and their duration and intensity is also increasing. Within this time frame Perth has experienced an increase from 6 to 9 heatwave days per annum (Steffan, et al., 2014).

Over the past 100 years heatwaves have been the cause of more deaths than any other natural hazard in Australia (Steffan, et al., 2014). Increases in temperatures and heat waves pose a potential risk to city liveability and the health of urban populations in future decades (Brown, et al., 2013).

Climate change projections predict that Perth will continue to experience an increase in the number of hot days over 35 °C from 28 to 67 days by 2070, along with declining levels of rainfall. More frequent and intense storm events also threaten to damage city infrastructure and buildings (see Figure 2).

The range of benefits provided by healthy and resilient urban forests means that they are uniquely placed to help cities meet these contemporary urban challenges.

Consequently, urban forests are increasingly recognised as an important part of a city's infrastructure, emerging as indispensable assets in the creation of liveable and climate responsive cities. Many of the world's major cities are currently developing, funding and implementing plans to protect and grow their urban forests.

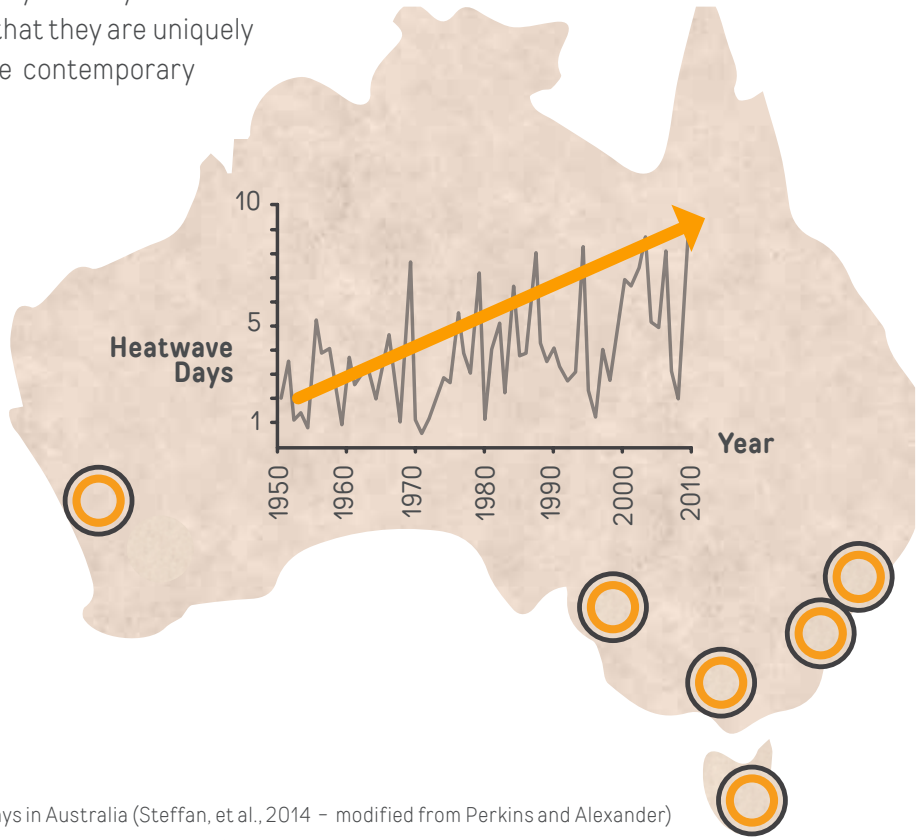
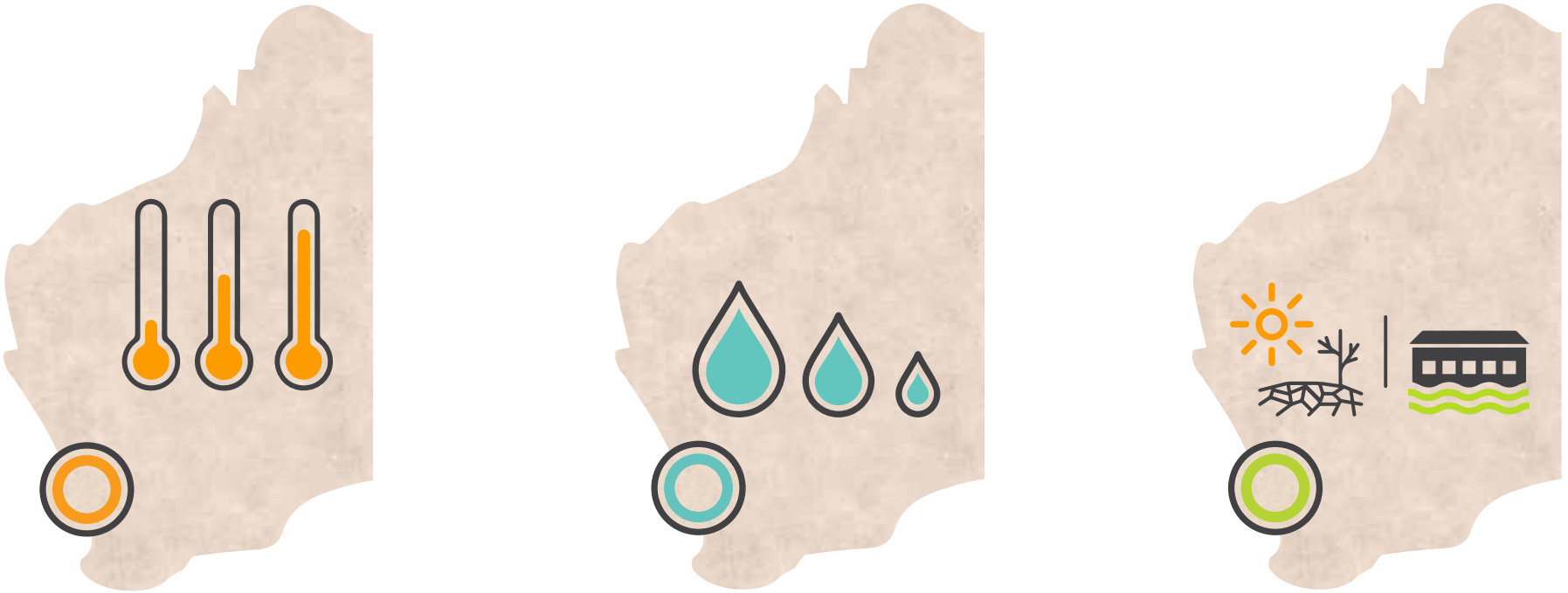


Figure 1. Rising number of heat wave days in Australia (Steffan, et al., 2014 – modified from Perkins and Alexander)

Climate change challenges facing Perth



Rising temperatures

- Average temperatures will continue to increase in all seasons.
- The number of days with temperatures over 35oC are predicted to increase from 28 days to 67 days by 2070.

Declining rainfall

- Decrease in mean annual rainfall and water runoff.
- The trend of decreasing winter rainfall is predicted to continue.
- Spring rainfall is also predicted to decrease.

Extreme events

- The intensity of extreme rainfall events is predicted to increase .
- Increased disruption from climate related events such as heatwaves and flooding.

Figure 2. Climate change challenges facing Perth

Mardalup Park – East Perth

2.0 Background

2.1 Historical development

Pre European settlement

Before European settlement, the land now covered by the City consisted of an ancient wetland, based on a series of lakes located between an area north of the existing railway line and the Swan River. Historically, these wetlands provided seasonal camping sites for the Aboriginal people and the lakes were essential for gathering food, including freshwater crayfish, turtles and frogs. The wetlands and the ancient campsites have significant cultural and spiritual value for the Wadjuk Noongar people, the traditional owners of this area (Godfrey, 1988).

Pre European settlement, Perth's landscape was characterised by a mixture of open forest, fringing woodlands and closed scrub, mainly comprised of eucalypts, banksia and melaleuca. The canopy cover provided would have been relatively open and sporadic in character, as indicated in Figure 3.

Figure 3. Pre European settlement from Re-imagining Perth's Lost Wetlands 2014. Collaboration project with ECU, Landgate, City of Perth and City of Vincent

Figure 4. Present day Perth from Re-imagining Perth's Lost Wetlands 2014. Collaboration project with ECU, Landgate, City of Perth and City of Vincent

Early European settlement

While the wetlands are the reason for Perth's long, narrow shape, this landscape has been significantly modified since the early nineteenth century due to the arrival of European settlers and their aspirations to develop the area.

The original settlement of Perth was established on a ridge near Mt Eliza overlooking the Swan River. The wetlands provided early settlers with water and fertile soils. However, they also saw the wetland system as an impediment to development, which resulted in the majority of it being drained to provide alternative uses, including market gardening, municipal gardens and a town rubbish dump (Singleton, 1988).

In the late nineteenth century, as urban development grew, the need for designated parklands became a public debate. The "city beautiful" idea became popular with planners during this time and street trees along with small parks were promoted (Bold, 1911). During the early twentieth century, the "garden city" movement pioneered by Ebenezer Howard influenced the Perth town clerk, William Bold. Bold envisioned the development of a linked system of parklands, with the wetlands forming an integral part (Blackwell & Associates Pty Ltd, 1995).

The Post-War period

During mid to late twentieth century, Western Australia experienced a mining boom resulting from the discovery of iron ore and natural gas throughout the State. The resulting surge in economic and property development in Western Australia had a significant effect on the state of the City's urban forest as canopy coverage was reduced due to the influx of new buildings.

During this period, prominent Australian landscape architect, John Oldham had a vision based on the idea of a unified landscape structured around Perth's wetland system. This vision was only partially realised and can be seen today in the Narrows Interchange parkland area (Blackwell & Associates Pty Ltd, 1995).

Recent times

In the last few decades, the City of Perth has continued to plant trees, with significant achievements made in increasing the level of street tree planting, particularly along east-west streets.

A major new tree planting program was carried out in the mid to late 2000's, with over 700 new trees planted in various locations throughout the City.

In the last decade, new tree planting has been mainly carried out as part of various streetscape upgrades and other capital works projects.

The most recent Public Spaces Public Life Study by Gehl Architects (2009) acknowledges the valuable contribution this has made in improving the quality of public space and public life. The increased number of street trees has created a greener and more beautiful city, provided shade and made a city that is better to be in.

Hay Street Mall – Perth

2.2 Strategic context

The City of Perth has set a clear direction for development in its Integrated Planning and Reporting Framework (IPRF). This Framework, the interaction between key City plans and the influence of informing strategies, is outlined in Figure 5. The intent of the IPRF is to ensure the priorities and services provided by the City of Perth are aligned with community needs and aspirations.

The City of Perth Urban Forest Plan is an informing strategy within the IPRF and works in conjunction with its suite of strategic and operational documents (see Figure 5). It integrates the relevant challenges, aspirations and strategic directions outlined in key documents including:

- Strategic Community Plan
- Corporate Business Plan
- Environment Strategy
- Transport Strategy
- Urban Design Framework
- Public Spaces Public Life Study – Perth 2009

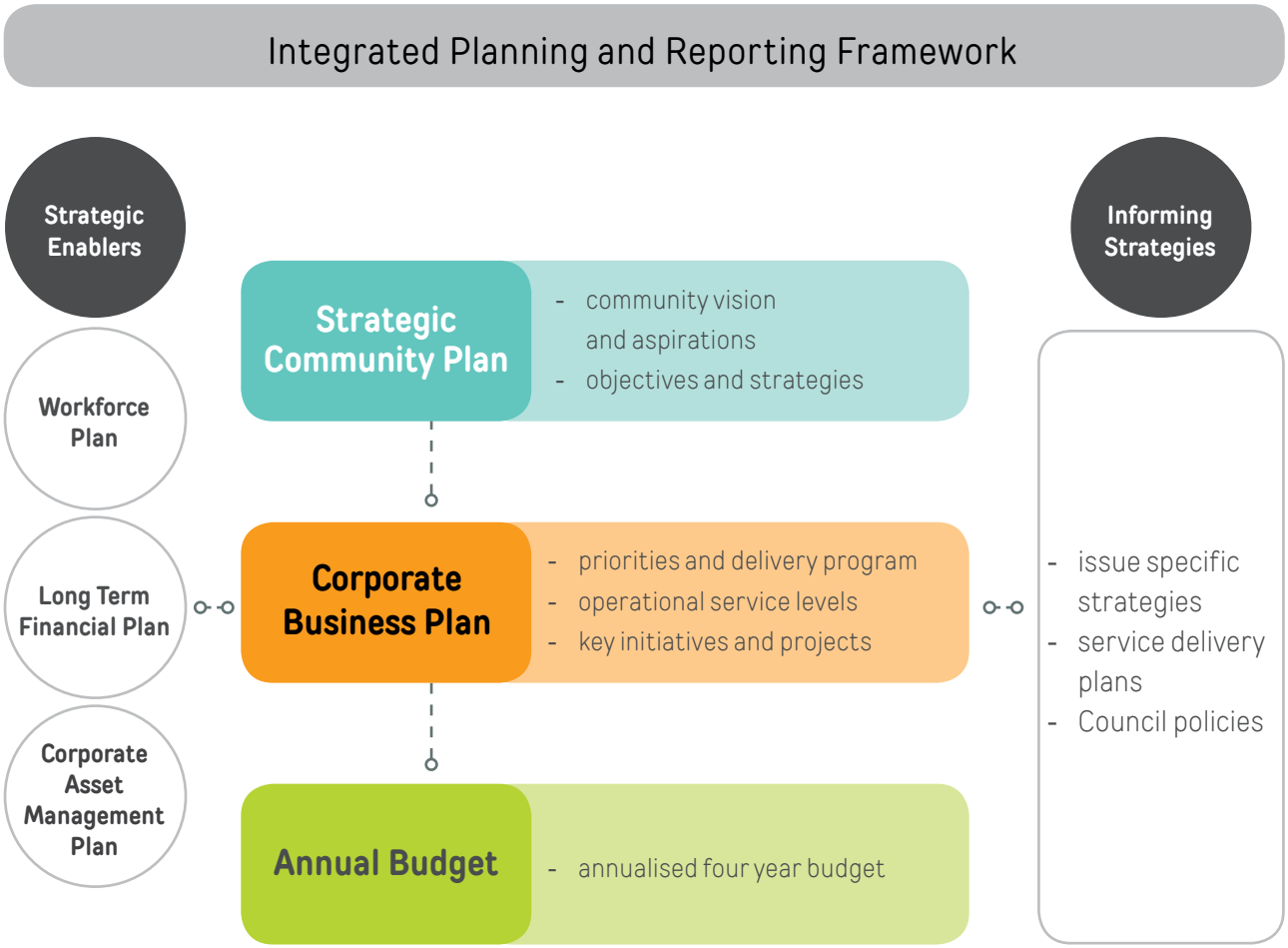
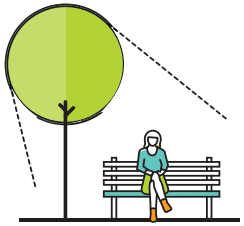


Figure 5. City of Perth Integrated Planning and Reporting Framework

2.3 Plan drivers

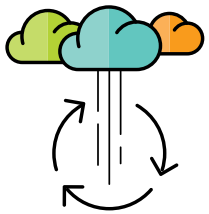
The benefits provided by the urban forest will assist in the delivery of the strategic direction for the City. Three organisational strategic drivers have been identified and these underpin the development of the City of Perth Urban Forest Plan (see Figure 6).

Designing for liveability :
Expanding the urban forest will help create a greener, more beautiful, cooler and inviting city.



Promoting community health and activity:
The urban forest will create an accessible green network that facilitates a healthy and active urban lifestyle.

Managing climate change:
A healthy, resilient and sustainable urban forest will help achieve a climate responsive city.



Strategic Community Plan
Perth is renowned as an accessible city. It is alive with urban green networks that are safe and vibrant. As a global city, there is a diverse culture that attracts visitors. It provides city living at its best. Local and global businesses thrive here. Perth honours its past, while creating a sustainable future.

Corporate Business Plan
Four year plan driven by the Strategic Community Plan and the delivery of services, key projects and capital investments. Activates the City's Informing Strategies and Action Plans.

Urban Forest Plan
City of Perth Action Plan to protect, manage and expand the urban forest.

Figure 6. Organisational strategic context

Key Informing Strategies and Action Plans

- Environment Strategy
  - environmental sustainability and health
  - cimate response
  - waterwise city
- Transport Strategy
- Lighting Strategy
- Urban Design Framework
- Public Spaces Public Life Study – Perth 2009
- Street Tree Framework
- Public Health and Wellbeing Plan 2014 – 2016

Supporting policy and guidance documents

- City of Perth Policy Manual
  - Protection and Enhancement of Open Place (15.2)
  - Street Trees – Planting Pruning and Removal (20.8)
  - Recognising the Amenity Value of the City's Trees (20.9)
- Design and Construction Notes
- Parks Management Unit – Tree Specifications
- City Design Guidelines

3.0 The Urban Forest

3.1 What is an urban forest?

An urban forest is broadly defined as the collection of green spaces, trees and other vegetation that grows within an urban area, on both public and private land (see Figure 7). Together, these green elements provide a range of benefits that enrich the quality of life and promote human well-being in the urban environment.

A primary distinguishing element of an urban forest, as compared to a 'natural' forest, is that it exists within a man-made environment, characterised by hard surfaces, a range of building types and concentrated human activity. This poses many challenges for its planning and management compared to more naturally vegetated areas.

The emerging discipline of Urban Forestry is concerned with the art and science of managing trees in urban environments to maximise the range of community benefits. Its focus is on the health and resilience of the urban forest as a whole.

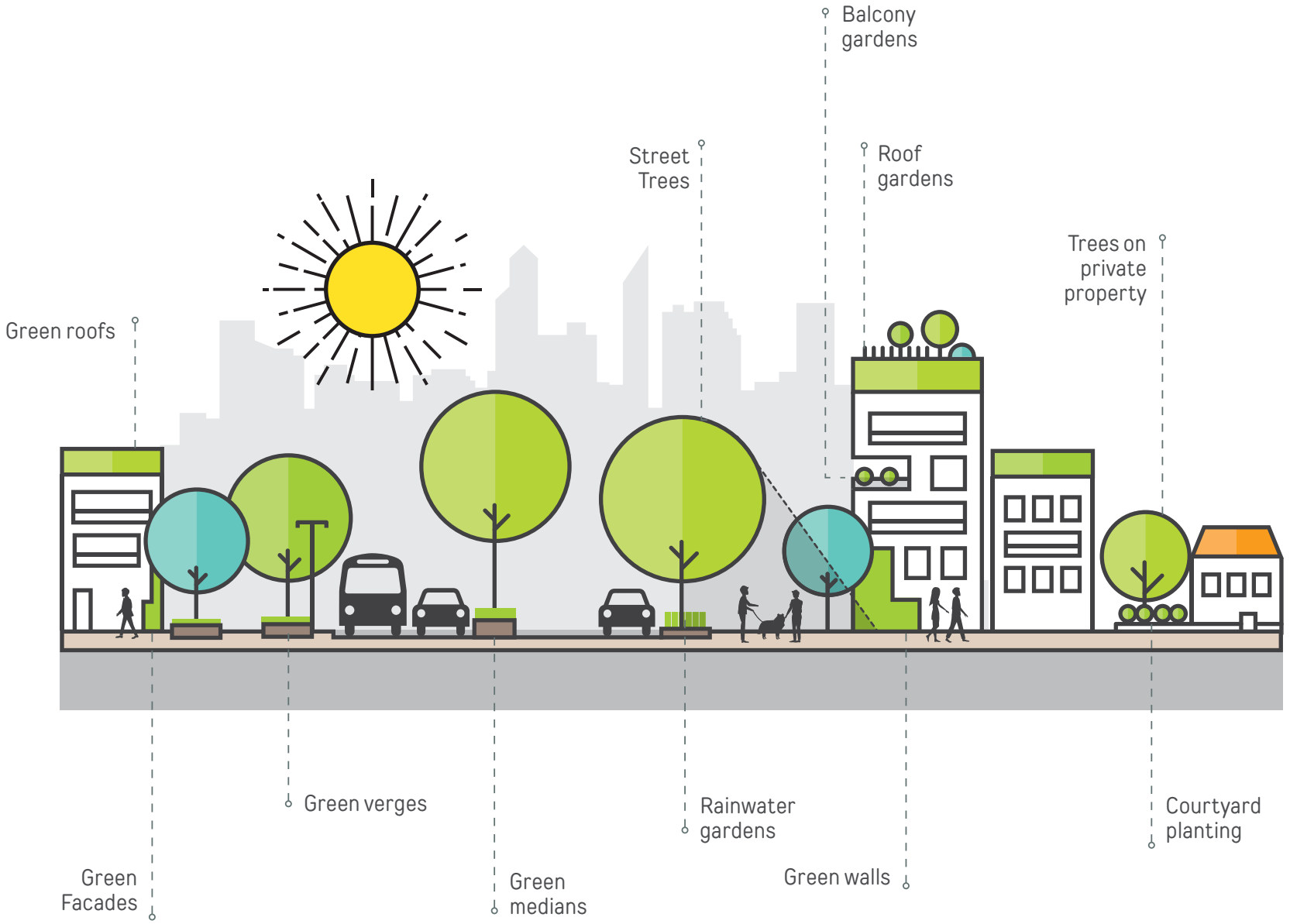


Figure 7. The urban forest

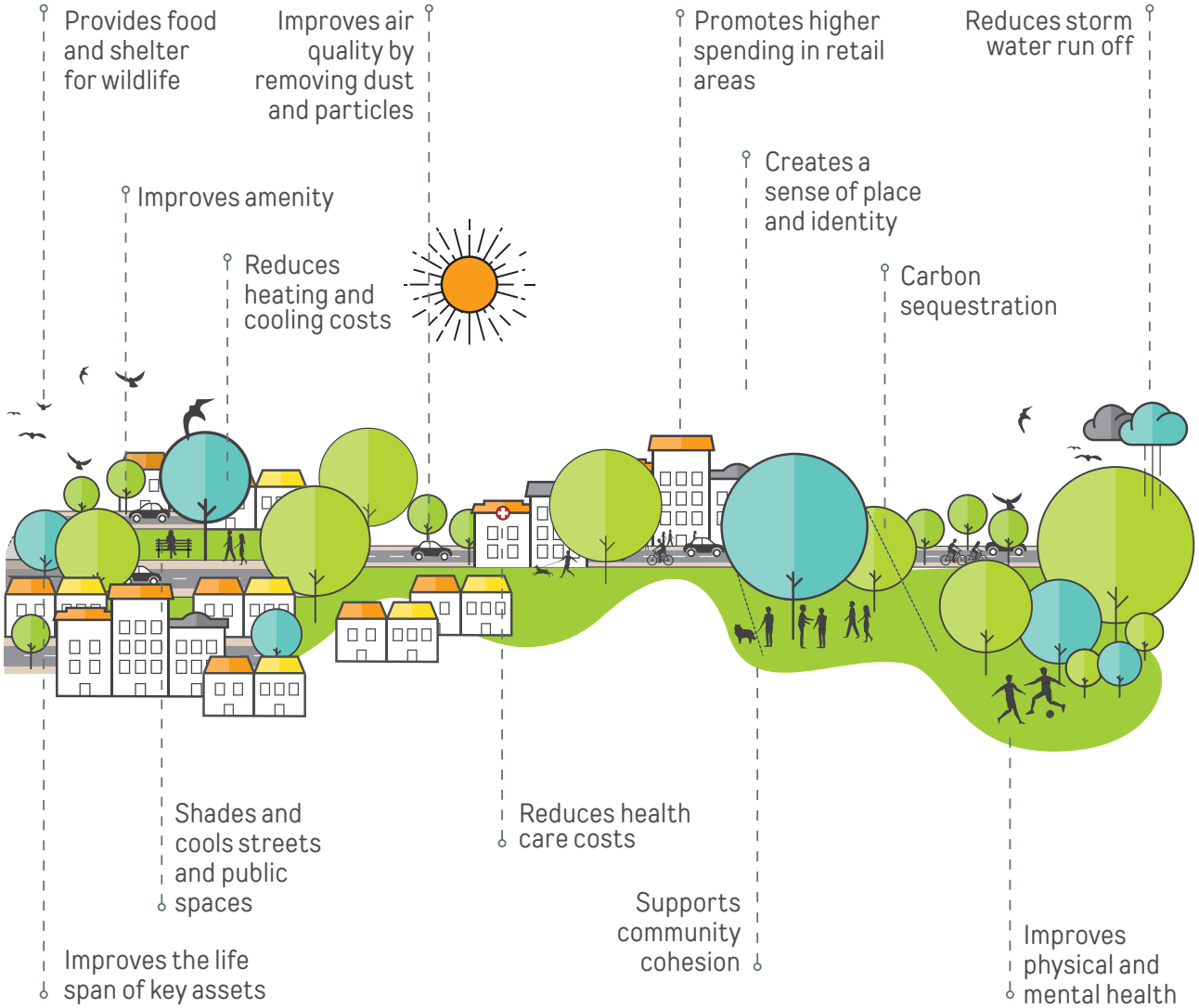


Figure 8. Benefits provided by the urban forest

3.2 What benefits can urban forests provide?

Urban forests can deliver a wide range of social, economic and environmental benefits to urban communities (see Figure 8).

Social benefits

Creates a sense of place and identity

Attractive street trees and well-designed green spaces enhance the quality of the urban environment, create a strong city image and foster a sense of connection to place.

Improves physical and mental health

Giving people the ability to access and interact with green space within cities has a range of positive health effects that improve individual and social well-being.

Supports community cohesion

Urban trees and greenery contribute to the creation of inviting public spaces that facilitate gathering and interaction, helping to promote community cohesion.

Reduces sun and heat related illnesses

Trees provide shade and protection from the potentially harmful effects of prolonged exposure to the sun and high temperatures. Research indicates that increasing the levels of vegetation in cities can reduce excess mortality rates.

Social behaviour

Access to nature can have a positive effect on the social behaviour of communities, including a reduction in the level of some crimes.

Economic benefits

Improves amenity

Trees in streets enhance aesthetics and help increase property values.

Promotes higher spending in retail areas

City streets with large, well-tended trees help create attractive shopping environments where people are prepared to spend up to 9-12 percent more for goods and services.

Reduces heating and cooling costs

Trees planted to provide shade from the sun can cool buildings by up to 8 °C , helping to reduce air conditioning costs.

Improves the life span of key assets

The shade provided by trees can increase the life span of road surfaces, reducing maintenance and replacement costs.

Reduces health care costs

People living in greener neighbourhoods are likely to exercise more. Increased levels of physical activity and improved mental health can all help to reduce community health care costs.

Environmental benefits and ecosystem services

Carbon sequestration

Trees capture and store carbon, removing it from the atmosphere and helping to mitigate the impact of global warming.

Shades and cools streets and public spaces

Trees provide shade and cool the surrounding air through the process of evapotranspiration, helping to reduce urban temperatures and improve levels of pedestrian thermal comfort.

Improves air quality by removing dust and particles

Trees trap and absorb pollutants from the air, helping to improve air quality and levels of community health.

Reduces storm water run off

Evergreen trees capture and filter storm water through their canopies and root systems, helping to slow flow rates, reduce levels of storm water run off and improve water quality.

Provides food and shelter for wildlife

Tree canopies and other vegetation provide shelter for birds, bees and other wildlife and their fruit and flowers can be an important food source.

The importance of canopy cover

Canopy cover describes the percentage of urban land covered by tree canopy when viewed from above. Improving the level and quality of canopy cover over cities is a key objective of many urban forest plans. It is a commonly used indicator of the success of the urban forest.

Research shows that there is a direct co-relation between the amount of canopy cover and healthy leaf area provided by an urban forest and the level of community benefits delivered (Nowak, et al., 2010 & Rogers et al.,2015).

However, improving the level and quality of canopy cover within a city is a more complex process than simply planting more trees. A range of additional factors need to be taken into account including tree size, species, health and spacing.

Size matters

Large trees provide significantly greater benefits compared to smaller trees, largely because they tend to have greater leaf areas and provide higher levels of canopy cover. Larger trees remove more air pollution, provide greater reduction in storm water flows, have greater cooling effect and provide greater economic benefits compared to smaller trees (Beecham & Lucke, 2015).

When planting new trees emphasis will be placed on selecting those that are vigorous and actively growing. These will be as large as possible, taking cost and space constraints into account.

Tree size

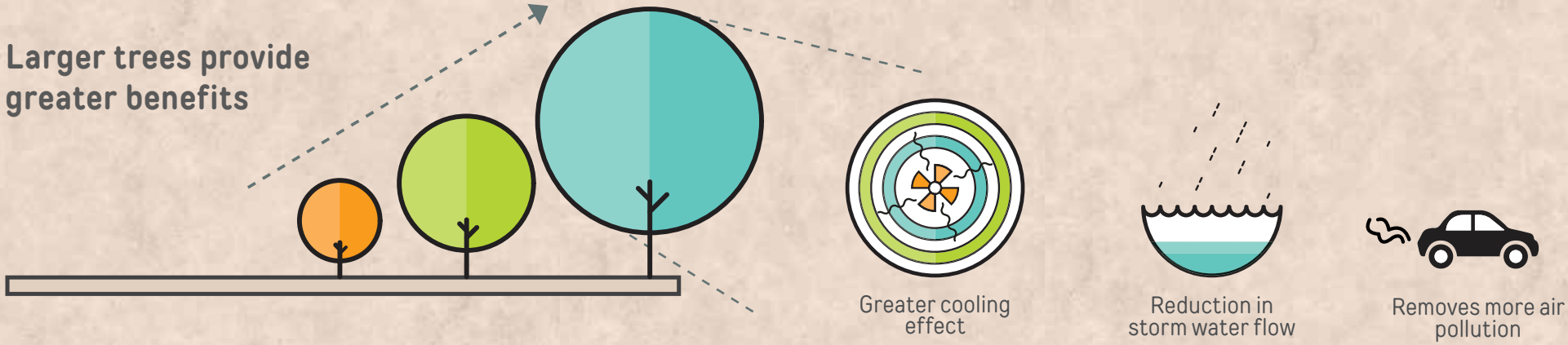


Figure 9. Benefits of larger trees

Species matters

Different tree species have different canopy architecture, partly due to the various spatial patterns they adopt for intercepting light. These canopies provide varying levels of density and depth in canopy layers, creating different types and quality of canopy cover.

Consideration will therefore be given to selecting a tree species with a canopy architecture that is appropriate to the context of its particular planting site.

Health matters

Healthy trees have healthy canopies. Species selection will therefore consider a tree's ability to become established, thrive and develop appropriate levels of healthy canopy growth within the given environmental conditions and context of its particular planting site.

Tree spacing

Where appropriate, trees will be spaced to encourage the development of an appropriate level of continuous and connected canopy cover over city streets and public spaces at maturity (see Figure 10). Consideration will also be given to ensuring that each tree has adequate space to develop a vigorous and healthy canopy, along with issues such as maintaining solar access and adequate levels of space and access for all city users.

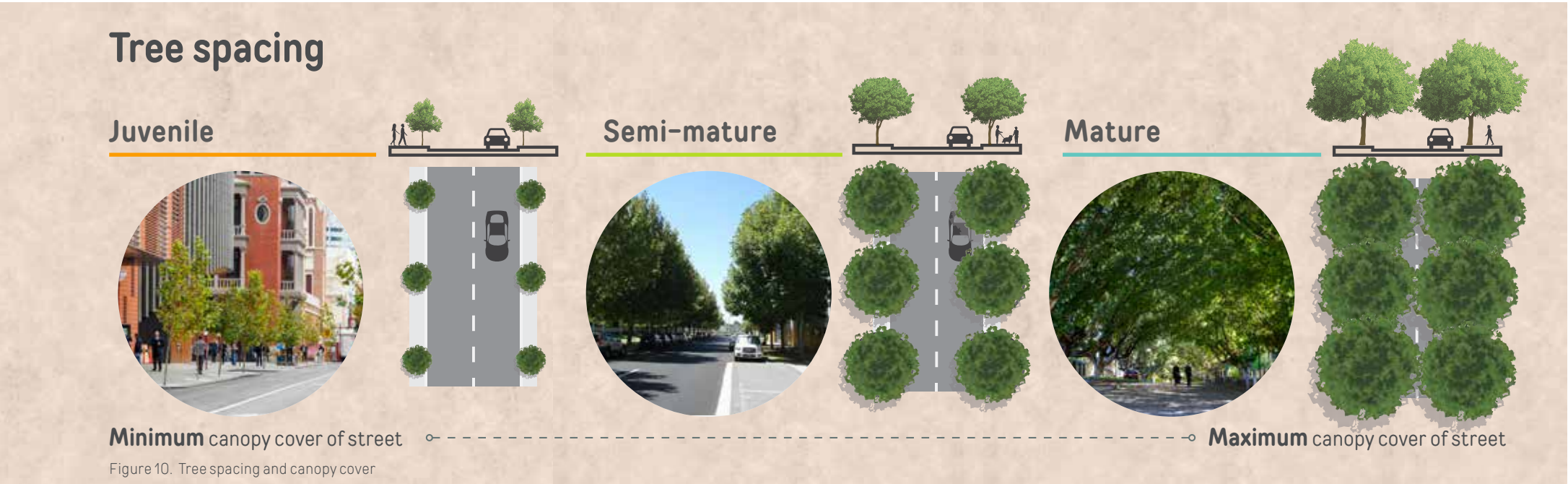


Figure 10. Tree spacing and canopy cover

3.3 Urban forests and the urban heat island effect

One of the most significant benefits that urban forests offer is their ability to cool their immediate environment. This is particularly important in cities as they are generally hotter than surrounding, less built up areas, sometimes by as much as 1-3 °C or more (U.S Environmental Protection Agency (EPA), 2008). Urban surfaces can be highly effective at absorbing and storing heat during the day, creating higher day-time temperatures in cities. This heat is released at night leading to higher temperatures after dark. This phenomenon is known as the Urban Heat Island (UHI) effect.

As a result of the UHI effect city dwellers are exposed to higher temperatures for longer periods each day. Elevated night-time temperatures mean that people are not given the chance to recover from heat stress experienced during the day. During heat waves prolonged exposure to high temperatures can lead to increased levels of heat related illnesses and morbidity. Vulnerable groups such as children, the elderly and those whose health is already compromised can be particularly affected (Block, et al., 2012).

With temperatures predicted to rise with climate change, the UHI effect is likely to intensify. Unless this is addressed, it poses significant risks to the overall liveability of cities and levels of community health and well-being.

While many factors contribute to the UHI effect, the reduced level of vegetation in cities is a key issue. This is partly because vegetated land surfaces, with good moisture levels, remain cooler during the day compared to the hard impervious surfaces that characterise urban areas. Research indicates that a 10 percent increase in urban green cover could reduce the day-time surface temperatures in cities by around 1°C (Harris & Coutts, 2013).

The City of Perth is already pursuing a range of strategies to help cool the City, including facilitating climate responsive built form and increasing green infrastructure as a whole. It is evident that the urban forest has a key role to play and this is a key driver for the development of the Urban Forest Plan.

"Globally, extreme heat events (EHE) have led to particularly high rates of mortality and morbidity in cities as urban populations are pushed beyond their adaptive capacities...many cities expect catastrophic EHEs more often, as the frequency, intensity and duration of EHE's are projected to increase with climate change" (Norton, et al., 2015).

Macey Street – East Perth

The cooling effect of urban trees

Urban trees have a key role to play in helping to mitigate the UHI effect.

Trees provide shade, which prevents urban surfaces from heating up during the day. This also helps lower night-time temperatures as less heat is trapped for release after dark.

Up to 95 percent of incoming solar radiation can be blocked by a tree's canopy (Brown, et al., 2013). The quality of shading provided depends on a range of factors such as leaf size, angle and structure. Canopy architecture, canopy clumping and continuity along with the depth and density of canopy layers, is also important (Sanusi & Livesley, 2014).

While shade can be created through the introduction of man-made elements, such as shade cloth and awnings, these fail to provide the added cooling benefit created by urban trees through evaporative cooling (Cooperative Research Centre Water Sensitive Cities, 2014). In this process, trees use the heat from the surrounding air to convert water to gas, producing a cooling effect similar to two air conditioners running for 20 hours (Brown, et al., 2013).

Shade and evaporative cooling provided by trees combine to help reduce city temperatures and the levels of heat stress experienced by urban populations.

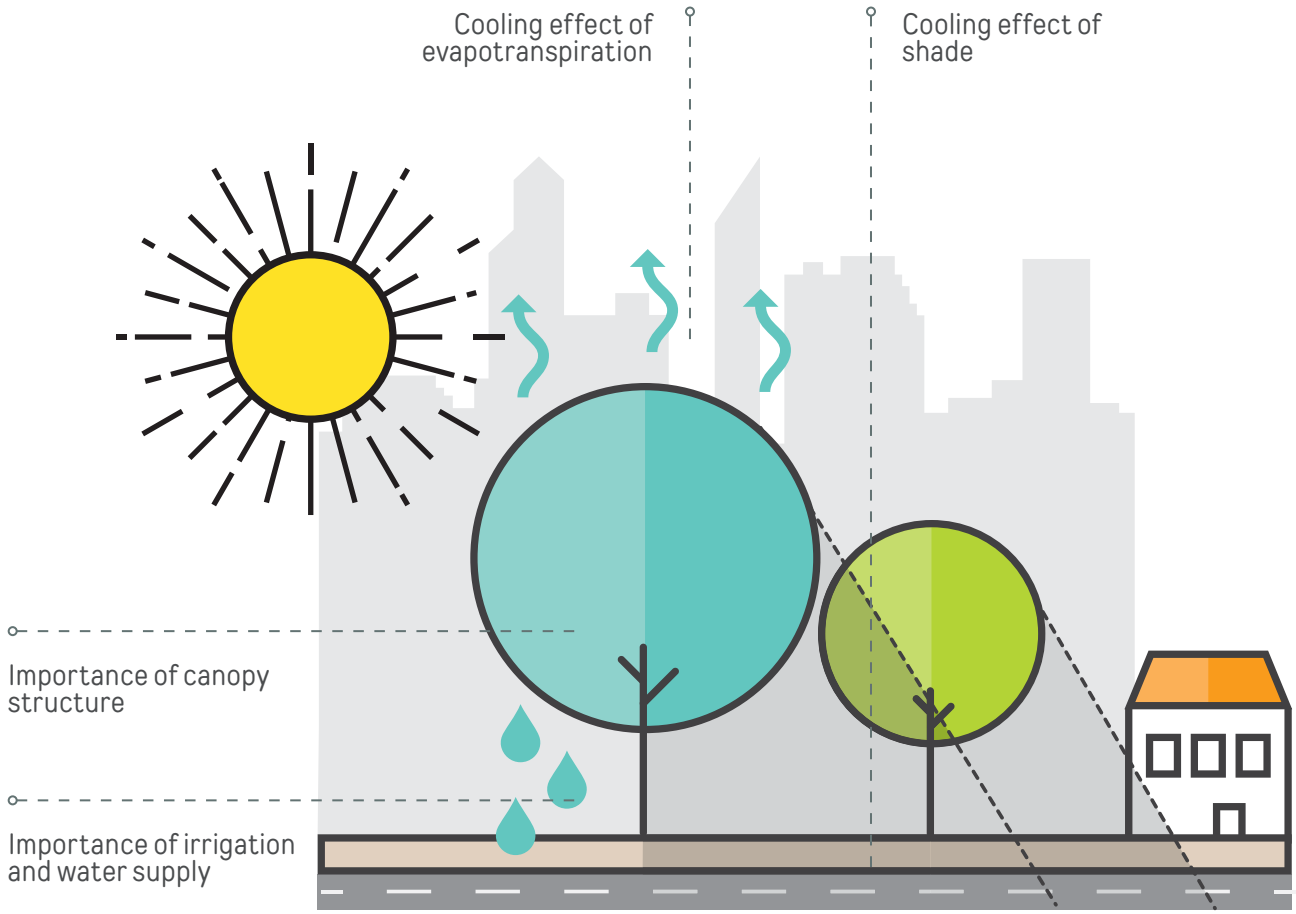
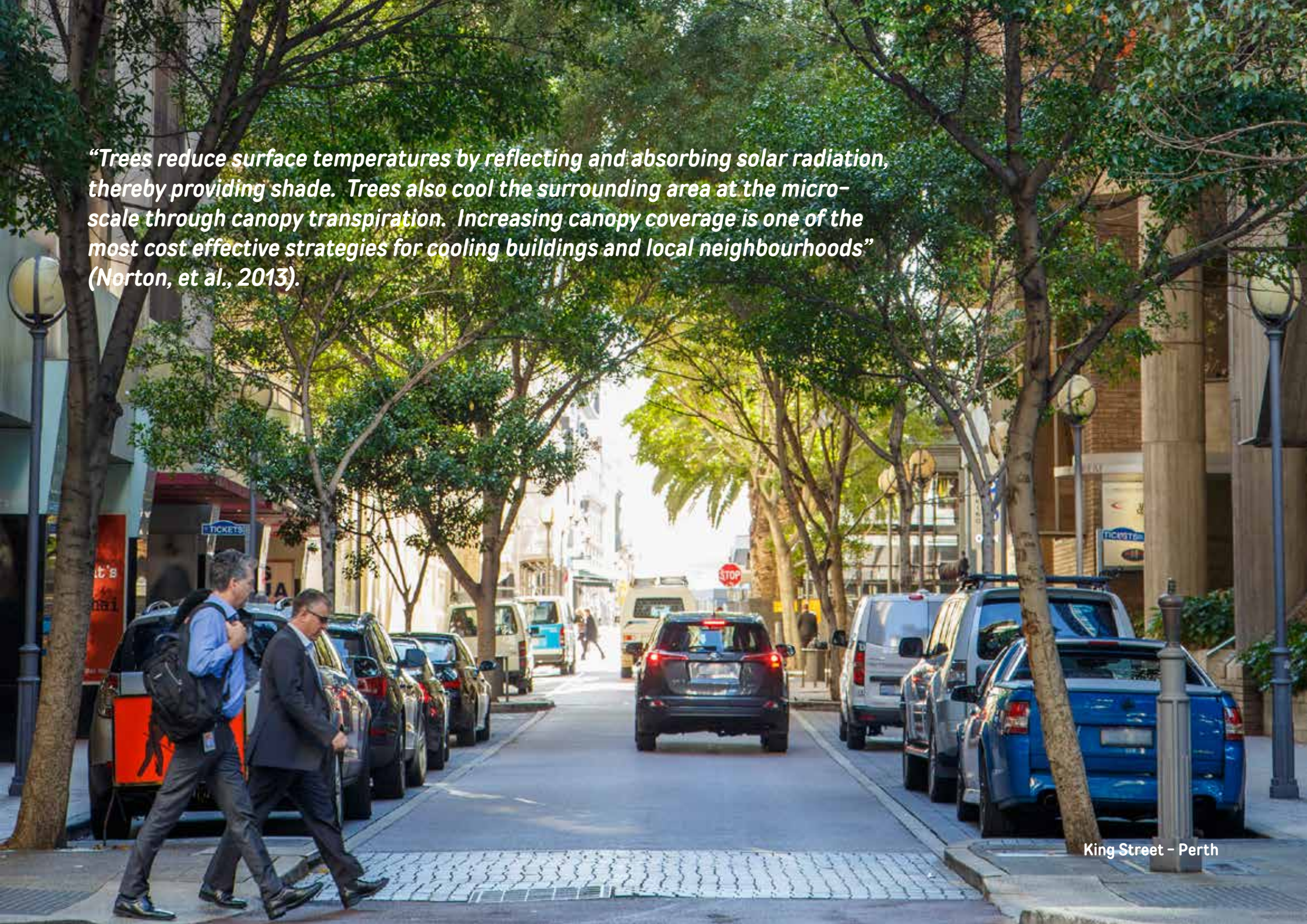


Figure 11. Cooling effect of urban trees



"Trees reduce surface temperatures by reflecting and absorbing solar radiation, thereby providing shade. Trees also cool the surrounding area at the micro-scale through canopy transpiration. Increasing canopy coverage is one of the most cost effective strategies for cooling buildings and local neighbourhoods" (Norton, et al., 2013).

King Street - Perth

3.4 Urban forests and climate change

While the benefits provided by urban forests can help achieve a climate responsive city, it is also important to consider the potential impacts climate change may have on the urban forest itself.

The exacerbation of the UHI effect in cities, for example, is likely to create more challenging growing environments for urban trees, placing them under increasing levels of heat stress. Along with reduced levels of rainfall, this may have a negative effect on the health and survival of urban trees.

The importance of irrigation

The ability of trees to contribute to urban cooling is also affected by rising temperatures and a lack of water. In periods of extreme heat, the evaporative cooling effect can be lost, just when it is needed most. Trees effectively shut down to prevent water loss and avoid water stress. High temperatures can also cause leaf scorch, and in some cases cause trees to drop their leaves altogether.

If trees are to continue to contribute to urban cooling by providing healthy canopies for shade and evaporative cooling, they will require supplementary watering through irrigation, particularly during hotter periods.

Species composition

Some tree species will respond and adapt successfully to changing environmental conditions, while others will struggle to survive and thrive. This may affect the overall composition and level of tree diversity within the urban forest, with implications for its future resilience.

Pests and diseases

Pests and diseases pose a significant threat to urban forests. Climate change can exacerbate this by creating conditions in which the lifespan and distribution of existing pests and diseases can be extended and new ones introduced.

Climate change is therefore likely to have a potentially negative effect on the overall health and resilience of the urban forest. Measures are needed to ensure that it is able to adapt and remain robust in the face of these challenges.

"Supplementary irrigation of UGI (Urban Green Infrastructure) in cities that experience hot, dry summers is a wise investment to ensure long term temperature mitigation, as well as other ecosystem services" (Norton, et al., 2015).

3.5 Why do we need an urban forest plan?

Growing and managing a thriving urban forest in the face of increasing challenges requires that a highly systematic and co-ordinated approach be taken (see Figure 12). It is essential that:

- There is a clear and shared understanding across all disciplines of the importance of the urban forest and the measures required to ensure its health and vigour.
- These measures are based on the latest scientific research and are relevant to the Perth context.
- The effectiveness of these measures is monitored and assessed systematically.

The City of Perth Urban Forest Plan sets out such an approach. It is intended for all those who have a stake, either directly or indirectly in the urban forest – its protection, management, expansion and promotion.

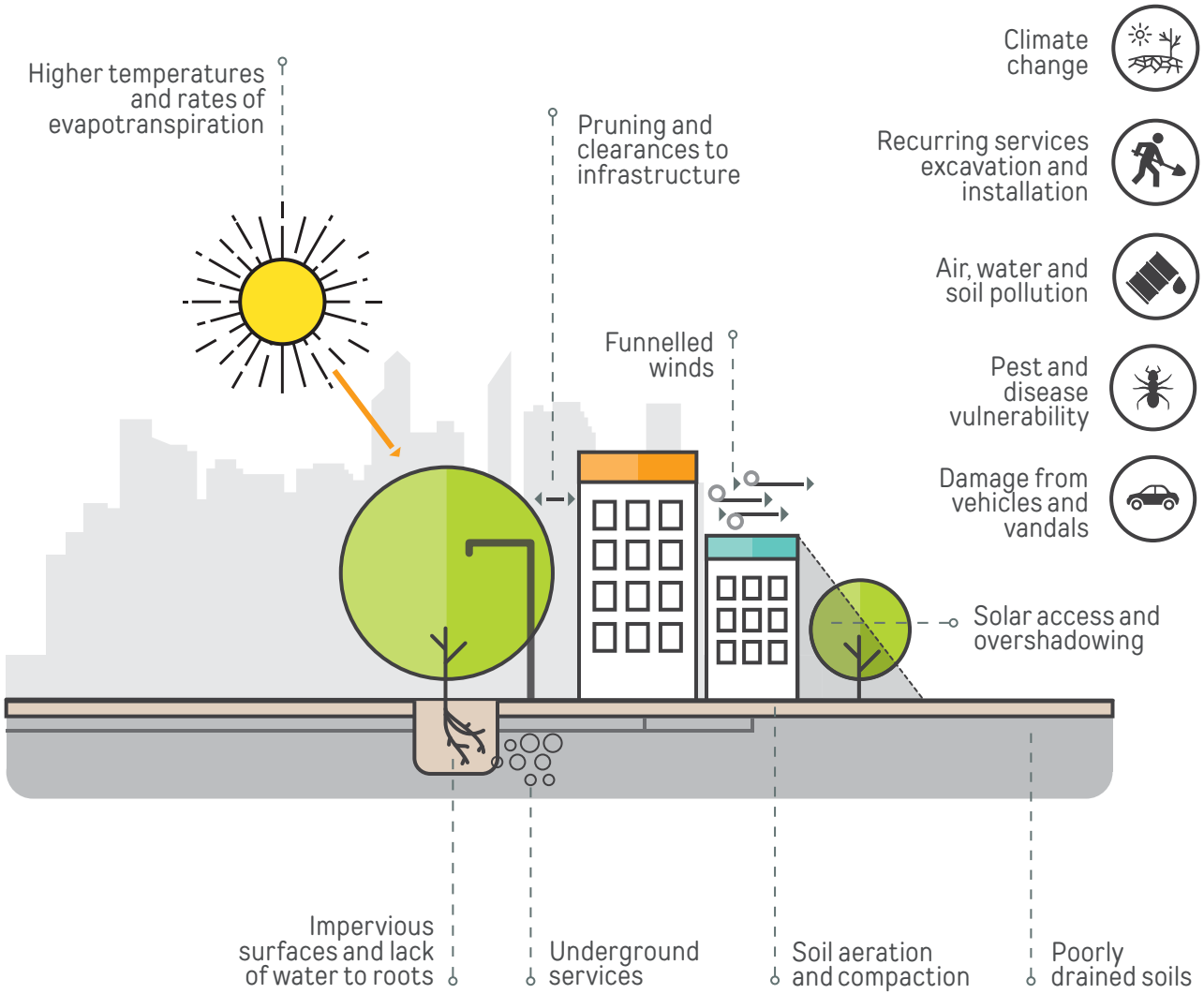


Figure 12. Street tree challenges

3.6 A staged approach

An urban forest is comprised of many elements including publically owned and managed street and parkland trees, trees on private property and other vegetation including wider elements of green infrastructure such as understorey planting, green roofs, green walls, living walls, green verges, green medians and rainwater gardens.

The City of Perth Urban Forest Plan is being developed in three stages, reflecting the complexity of the urban forest itself (see Figure 13).

Stage One focuses on the City's street and parkland trees. The decision was made to address this element of the urban forest first as the City has control of these trees and the spaces in which they are planted. It can therefore undertake early and effective action in the planning, management and expansion of the urban forest, promoting improvement and change within a short timeframe.

Stage Two will address trees planted on private property.

Stage Three will address other vegetation that makes up the urban forest, including wider elements of green infrastructure.

Both of these additional stages are scheduled for completion in 2017.

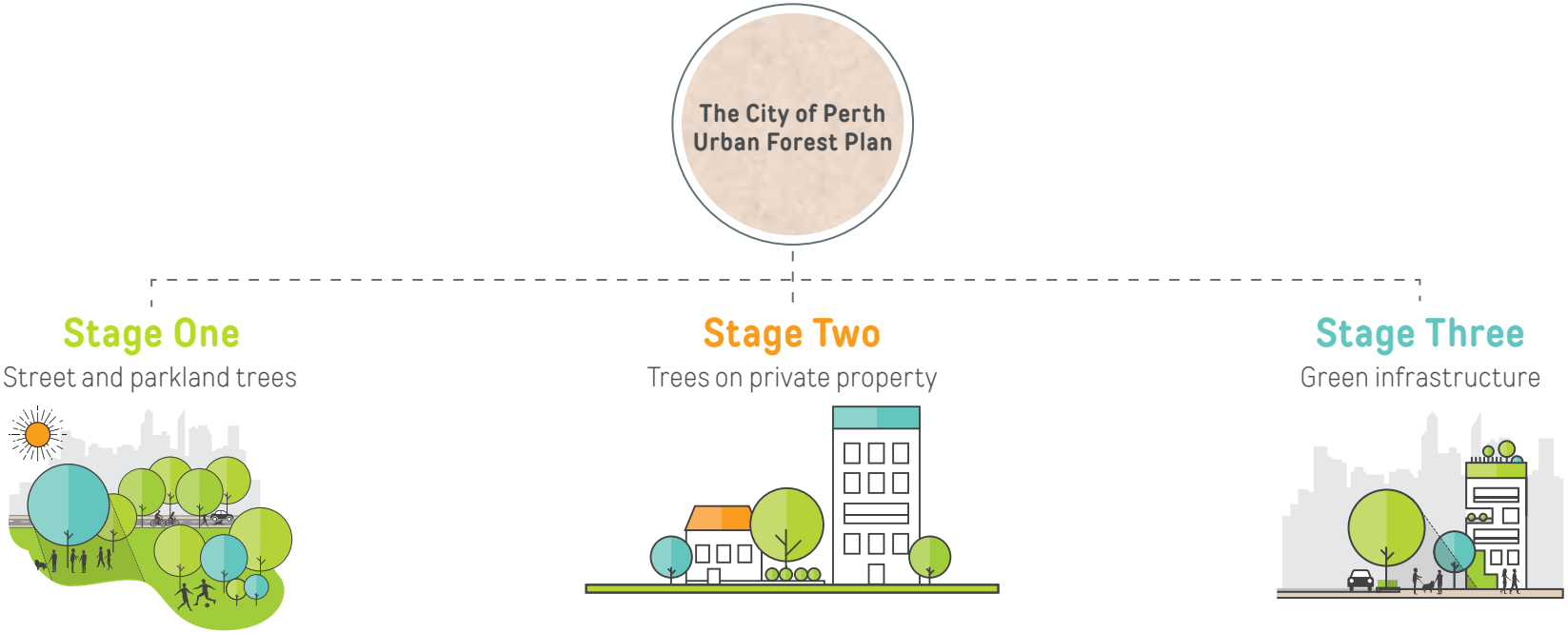


Figure 13. Staged approach

Mount Street – West Perth

4.0 Stage One– street and parkland trees

There are currently over 14,000 trees planted in the City's streets and parklands. In this context parklands include formal parks such as Wellington Square, Supreme Court Gardens and Russell Square in addition to more informal elements of the City's wider open space network, including the Narrows Interchange.

4.1 Planning for street and parkland trees

The process used to plan for the City's street and parkland trees is based on a best practice* approach structured around four key steps (see Figure 14).

Step 1: What we have

Research undertaken to collect the technical data required to develop a detailed and comprehensive understanding of the existing character and condition of street and parkland trees and identify key issues and challenges.

Step 2: Where we want to go

Research findings combined with input from a process of community consultation and engagement to establish goals and objectives for the planning, management and expansion of street and parkland trees.

Step 3: How we will get there

Implementation plan developed to identify the actions to be undertaken to deliver the goals and objectives of Stage One of the Urban Forest Plan. Indicative budgets, priority projects, timeframes and key roles and responsibilities clearly identified.

Step 4: Have we arrived

Monitoring framework developed to measure progress in implementing Stage One of the Urban Forest Plan.

*While there is no one, universally recognised 'best practice' approach to the preparation of an urban forest plan, there are a number of key guidance documents that have informed the development of the City of Perth Urban Forest Plan. These include How to Grow an Urban Forest, 202020 Vision; the Urban Forest Management Plan Toolkit, California Urban Forest Council; Trees in the Townscape: A guide for decision makers, Trees Design Action Group; and Planning the Urban Forest, Schwab.

Figure 14. Plan process

Evidence based planning

Stage One of the City of Perth Urban Forest Plan is underpinned by the findings of two specifically commissioned baseline research studies:

- Canopy Cover and Thermal Imaging Baseline Study (2015).
- Street and Parkland Tree Audit (2015).

These studies provide the technical data needed to effectively plan for the City's street and parkland trees, by assessing them against a range of commonly accepted performance indicators for urban forest management including:

- existing levels of canopy cover (including information on canopy height and width)
- age diversity
- useful life expectancy
- tree diversity
- tree health (Kenney, et al., 2016)

The Thermal Imaging Baseline Study acquired satellite, airborne and terrestrial thermal data to provide a visual representation of temperatures in the City during the day and after dark and inform an assessment of Perth's existing Urban Heat Island effect.

The research findings from these studies have been used to :

- Provide baseline data to help formulate goals and objectives.
- Establish benchmarks to measure and monitor change and progress in implementation.

4.2 What we have: issues and challenges

Data collected by the Street and Parkland Tree Audit (2015) shows that the City has a total of 14,811 street and parkland trees. Further information on how this overall population is broken down by location, tree family and species is summarised in Figure 15.

The City's parklands, including Harold Boas, Supreme Court, Stirling and Queens Gardens contain particularly diverse and varied collections of trees. Some of the oldest trees (100–150 years old) are also found in the parkland areas including:

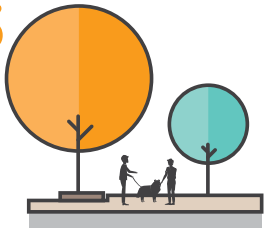
- Camphor Laurel in Harold Boas Gardens
- Moreton Bay Figs in Russell Square
- Port Jackson Figs and Flooded Gums in Wellington Square
- Norfolk Island Pine in Stirling Gardens
- London Planes in Queen's Garden and Victoria Avenue

Collectively the City's street and parkland trees have an estimated amenity value of $98 million. This figure excludes the ecosystem services they provide.

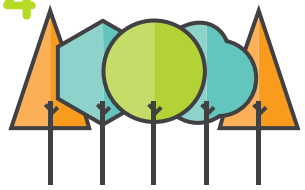
Street and parkland trees at a glance

Parkland trees
7,725

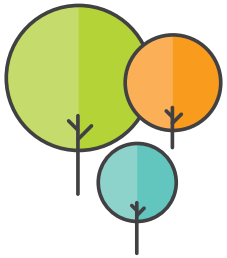
Street trees
6,833



Different tree species
264



Different tree families
41



Native tree species
64%

Trees in surface car parks
253

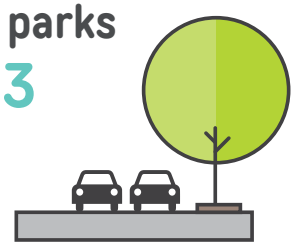


Figure 15. Street and parkland trees

The City of Perth Street Tree Framework

The selection of tree species for planting within the urban forest is currently guided by the City of Perth Street Tree Framework. This document sets out a list of existing and proposed tree species, including native and non-native trees. At present over 50 percent of the recommended tree species for planting are from the Myrtaceae family (native trees).

The Framework's approach to tree selection is based upon choosing a species that is most appropriate to its context and environmental factors. It is broadly reflective of the 'right tree for the right place' philosophy (Schwab, 2009).

Contemporary urban forestry increasingly promotes this philosophy as the primary guiding factor in tree selection processes. Once the necessary measures have been taken to maximise planting conditions at each site (e.g. soil depth, quality and volumes, availability of water) trees are primarily chosen for their ability to grow and thrive given the specific environmental qualities and challenges. This maximises the tree's potential to grow into a large, mature tree with a healthy canopy.

A range of other factors are also considered in the application of the 'right tree for the right place' philosophy including, but not limited to, issues such as local culture and heritage.

The 'right tree for the right place' helps to promote a more balanced, sustainable and evidence based approach to the tree selection process. It is a valuable tool in urban forest management.

The Street Tree Framework will be reviewed to reinforce and up date this philosophy and ensure that it aligns with and supports the goals and objectives of the Urban Forest Plan. The Framework document will also be augmented to provide guidance on key tree management issues within the City.

"We need much more specific knowledge to adequately select trees for urban areas to deliver a wide range of economic, social and environmental benefits. This will contribute to improving the welfare of urban residents in what is essentially a human habitat not a natural one" (Johnston, et al., 2012).

Issues and challenges

Research findings indicate that the City's street and parkland trees are generally performing well against key performance indicators. However, they do face some important issues and associated challenges.

Existing levels of canopy cover

Perth currently has a relatively low level of canopy cover.

The Canopy Cover Baseline Study (2015) acquired high resolution airborne multispectral imaging to measure the baseline canopy cover for all land, both publicly and privately owned within the City of Perth boundaries (see Figure 18). This data was collected on 23 February 2015. The findings were stratified into canopy cover provided by vegetation within the following height categories:

- 0–3m
- 3–10m
- 10–15m
- 15m+

Findings show that approximately 10 percent of all the land within the City's boundaries is covered by tree canopy, or vegetation greater than 3.0 metres in height (see Figure 16).

Information on canopy spread, collected as part of the Street and Parkland Tree Audit (2015), indicates that the City's streets and parklands areas (the public realm) have a canopy cover of approximately 19 percent (see Figure 17).

Setting a canopy cover target is considered important as it provides a benchmark for measuring progress in increasing canopy cover.

A number of cities have adopted the standard of between 30–40 percent canopy cover set by American Forests for cities in the United States. Other approaches suggest that canopy targets should be based on an assessment of the quality and quantity of available planting spaces and local environmental and climatic conditions, rather than the application of generic standards (Kenny, et al., 2011).

Challenge: Setting an achievable target and increasing the level of canopy cover provided by street and parkland trees .

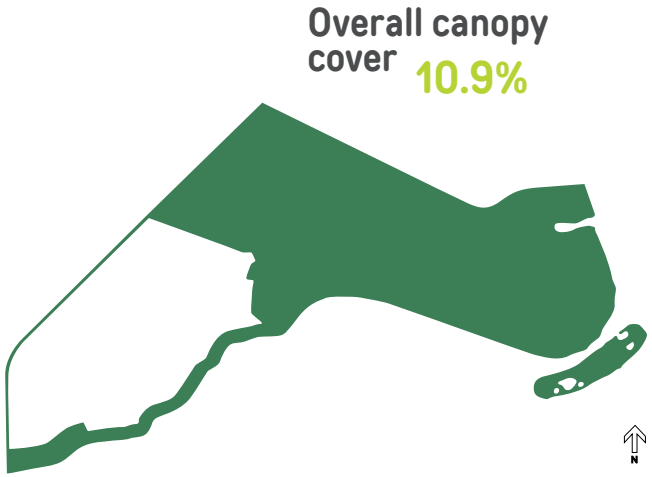


Figure 16. Overall canopy cover

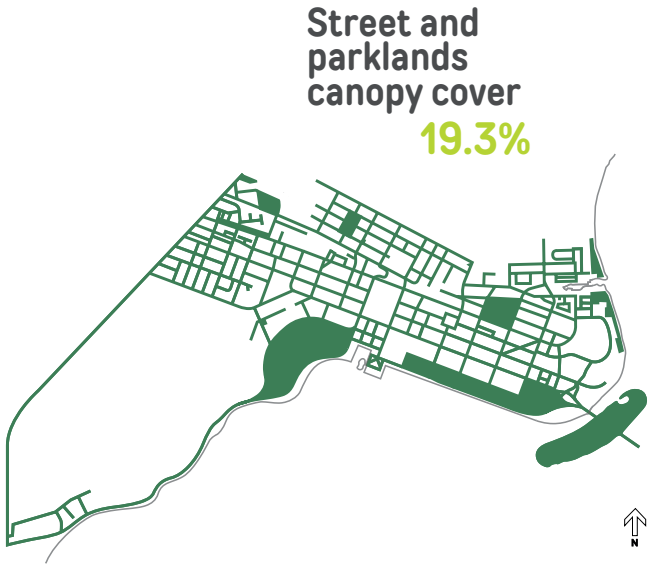


Figure 17. Public realm canopy cover

Figure 18. Baseline canopy cover stratified by height

Overall canopy cover in City precincts

At the precinct level, Crawley is performing the best with a level of overall canopy cover of 21.2 percent across both its public and private realms. Perth and Northbridge have the lowest levels – 8.1 percent and 7.2 percent respectively.

This is perhaps unsurprising given the built up and dense urban character of these areas. The outer precincts of East and West Perth have levels of 10.3 percent and 13.0 percent respectively, these higher levels perhaps reflecting their less dense and mixed commercial/ residential character.

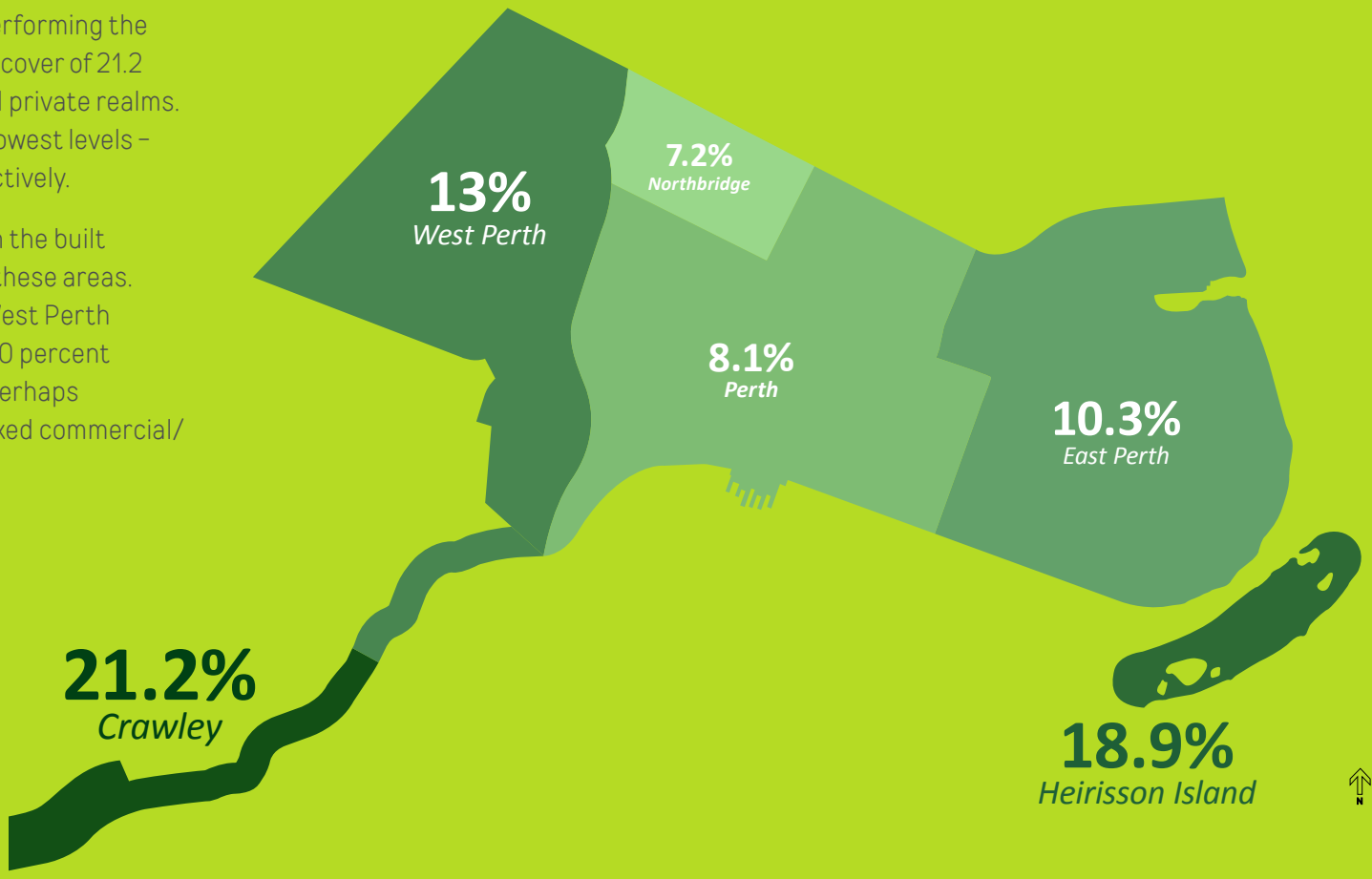


Figure 19. Levels of overall canopy cover by precincts

Ameliorating Perth's UHI effect

The Thermal Imaging Baseline Study (2015) collected data on the City's UHI effect.

Satellite data was collected mid-morning on 10 January 2014, when the day-time temperature was 34.2 °C followed by 43.3°C the next day. This data provided information on day-time land surface temperatures within the City and identified a number of 'hot-spots', or areas with high day-time land surface temperatures (see Figure 21).

'Hot-spot' areas tend to be located where there is a high concentration of hard surfaces such as the freeway, railway lands, and large areas of unirrigated natural surfaces like the East Perth Cemetery. Some are located in residential areas and around major gathering places. They also appear to correlate to those parts of the City with lower levels of canopy cover.

Airborne thermal imaging was captured after 10.30pm on 3 March 2015, following a day-time maximum temperature of 30.6 °C .

The previous 16 days were all in excess of 26 °C. This data indicates the degree to which residual heat is trapped in streets and roads after dark (see Figure 20). These areas are hotter than the more natural surfaces of parklands and public open spaces.

Perth's UHI effect is contributing to higher City temperatures, with potentially negative impacts on City liveability and community health and well-being. With City temperatures predicted to rise there is potential for this situation to worsen over time. Planting more trees and increasing the level and quality of canopy cover in City 'hot-spots' and along streets and roads will help cool the City.

Challenge: Harnessing the potential of street and parkland trees to promote urban cooling, especially in 'hot-spot' areas.

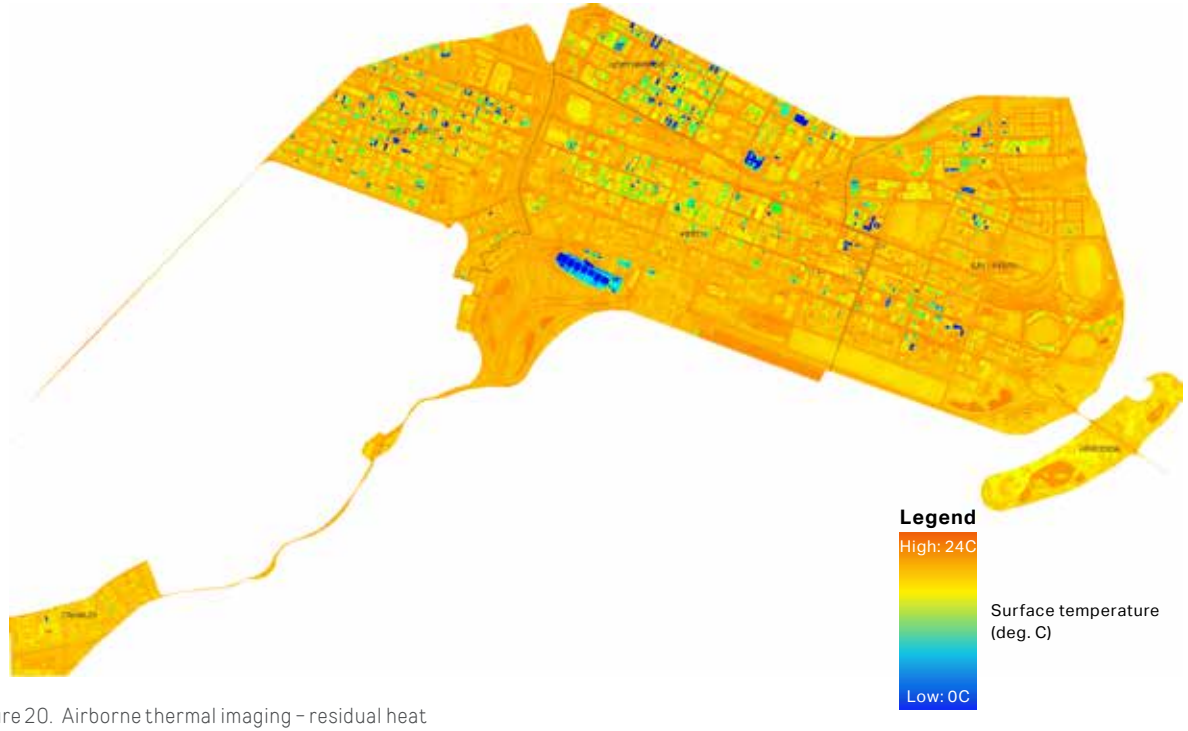


Figure 20. Airborne thermal imaging - residual heat

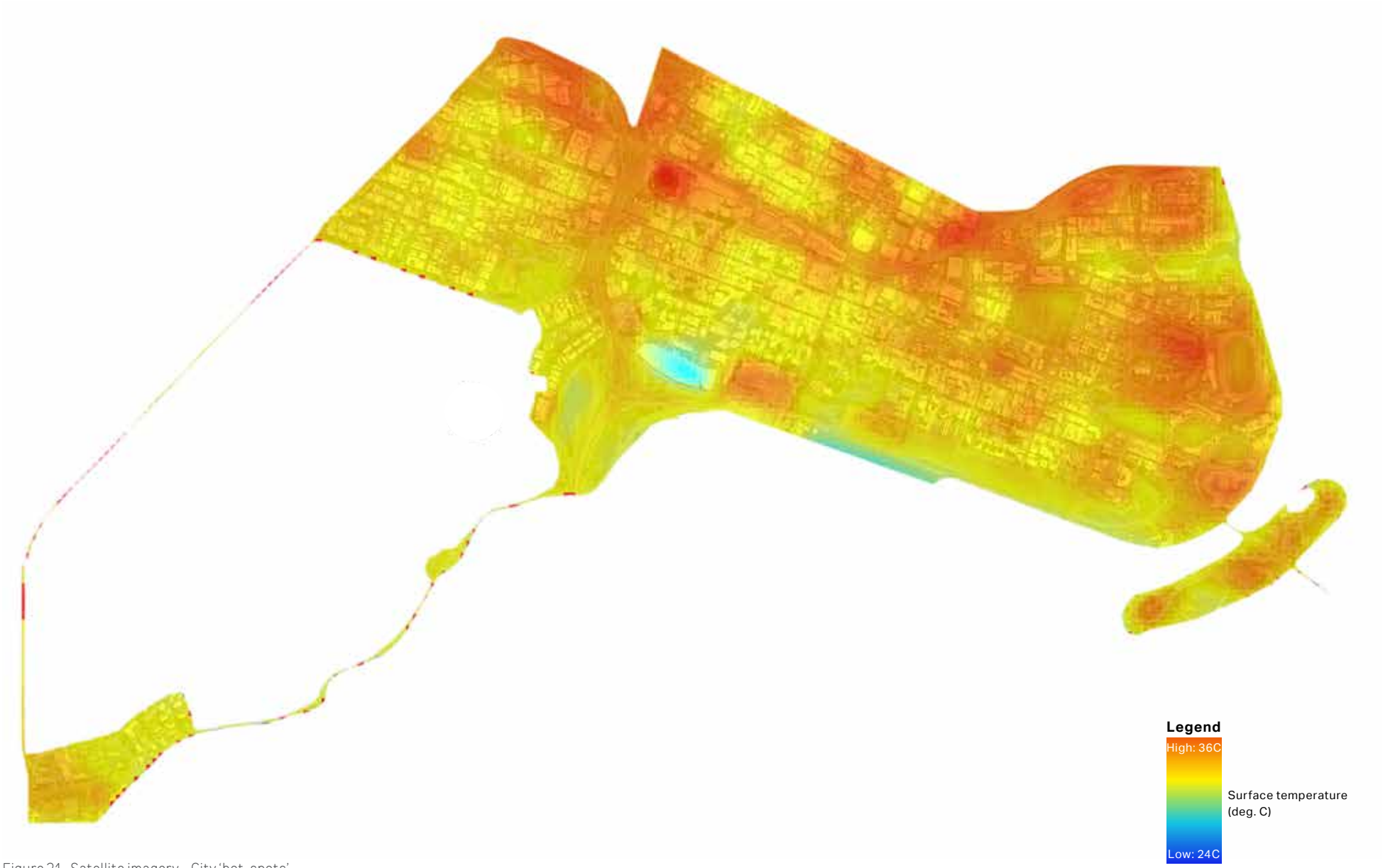


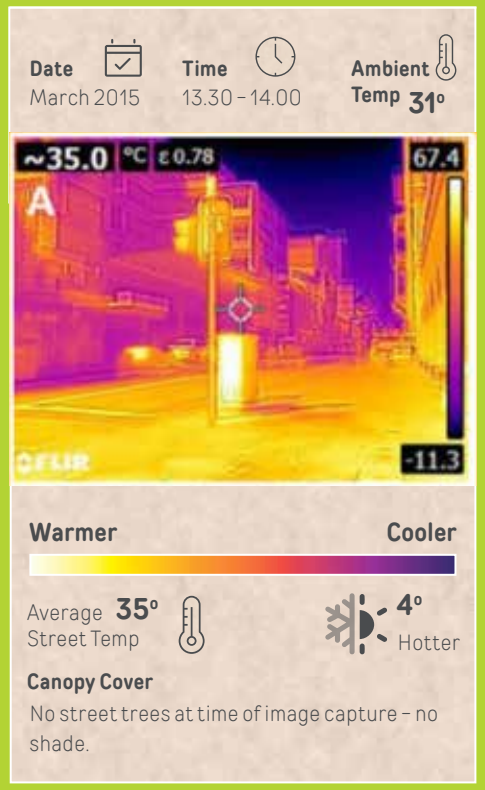
Figure 21. Satellite imagery – City 'hot-spots'

Cooling the City – the potential of street trees

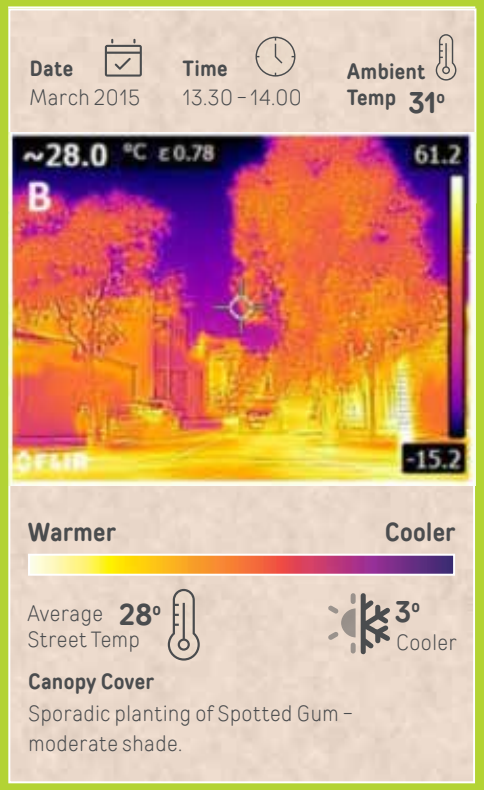
Terrestrial thermal imaging was captured as part of the Thermal Imaging Baseline Study to provide an indication of the average day-time temperatures in three City streets with different types and levels of canopy cover. This data was collected between the hours of 13.30 and 14.00 during two afternoons in March 2015, when the ambient day-time temperature was 31°C . It provides an indication of how trees contribute to urban cooling.

Victoria Avenue, with its high and wide tree canopy was over 10 °C cooler than Hay Street which had no street trees. Francis Street was 3 °C cooler than the ambient day-time temperature but nearly 4°C hotter than Victoria Avenue.

Hay Street
(between Barrack and Pier St)



Francis Street
(between Lake and William Street)



Victoria Avenue
(between St Georges Terrace and Terrace Road)

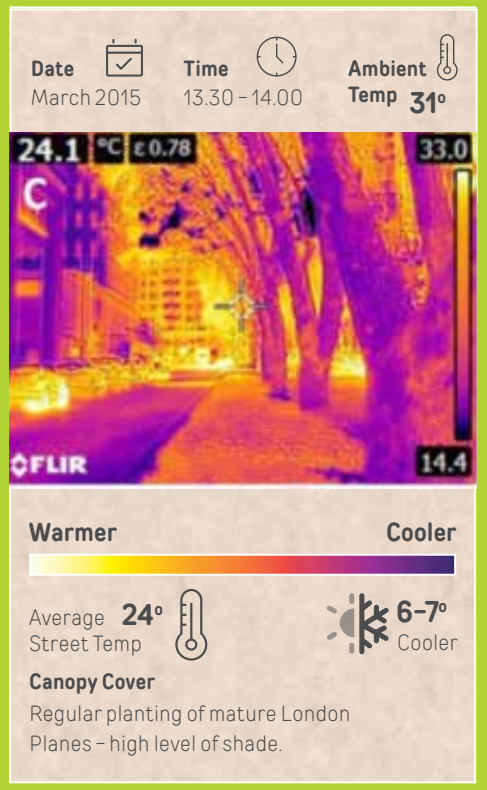


Figure 22. Terrestrial thermal imaging of three city streets

Water supply and management

Perth faces a particular set of challenges when it comes to ensuring water supply for the irrigation of the City's street and parkland trees.

The south-western part of Western Australia, including Perth, has experienced an on-going drying trend. Annual average rainfall has declined since the late 1960's (see Figure 23). The May to July drying trend has intensified over the last ten years and is predicted to continue to intensify through to the end of the century (IOCI, 2012).

Since the late 1960's the south western area has experienced a **20% decline** in autumn and winter rainfall.

Figure 23. Declining autumn and winter rainfall

Additionally, summer rainfall is low and sporadic. The monthly average summer rainfall for Perth for the last four years has been 13.2mm for December, 9.6mm for January and 12.5mm for February (Water Corporation, 2016). The City is also committed to reducing its level of water use and water restrictions imposed by the Water Corporation currently apply in summer.

Consequently, water is often least available when it is needed most to support tree health and maximise the cooling effect (see Figure 24).

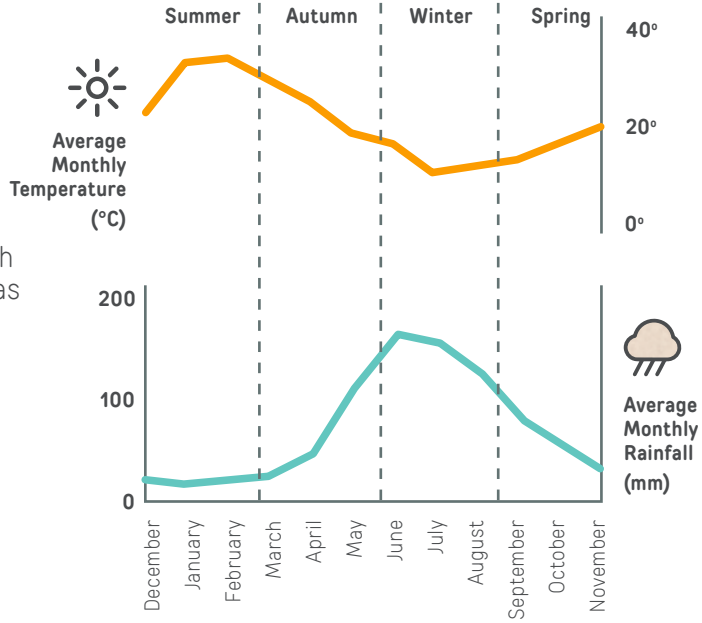


Figure 24. Seasonal rainfall and temperature patterns

At present the City's street and parkland trees are irrigated for the first two years after planting. Trees up to four years old are also irrigated during periods of extreme heat. Water for irrigation is currently sourced from a mix of scheme water, ground water and water captured in surface water bodies including the Claisebrook Inlet and Lake Vasto in Ozone Reserve.

In order to ensure the development of a robust, healthy urban forest capable of contributing effectively to urban cooling, it is imperative that steps are taken to ensure an adequate supply of water for supplementary irrigation. This is especially important during periods of extreme heat and during the establishment period for juvenile trees.

The issue of water supply and management will increase in significance as more trees are planted as part of the implementation of the Urban Forest Plan. More trees require more water.

Challenge: Securing a sustainable water supply for the irrigation needed to support tree health and maximise urban cooling.

"Water restrictions reduce the ecosystem service function of green space and vegetation, diminishing the cooling benefits locally and city wide, reducing human thermal comfort levels and increasing urban energy demands for building space cooling. The need to maintain water supply to urban trees and green spaces is evident...it is not a "waste" – it has quantifiable benefit that must be included in any policy about water use in urban areas" (Block, et al., 2012).

Point Fraser - East Perth

Imbalance in age diversity

While the street and parkland tree population is generally performing well in terms of age class distribution the majority of trees are in the mature category, reflecting a lack of significant levels of new tree planting programmes in recent times (see Figure 25).

Measures are also needed to protect 'veteran' trees (over 100 years old) and improve the aftercare and maintenance of juvenile trees to increase their levels of representation within the overall tree population.

In urban forestry it is good management practice to have an even spread of trees across a range of different age classes. This promotes resilience and long-term sustainability, helping to ensure consistency in the level of canopy cover provided and the delivery of community benefits.

Challenge: Developing and implementing measures to improve the balance of age classes over time within the street and parkland tree population.

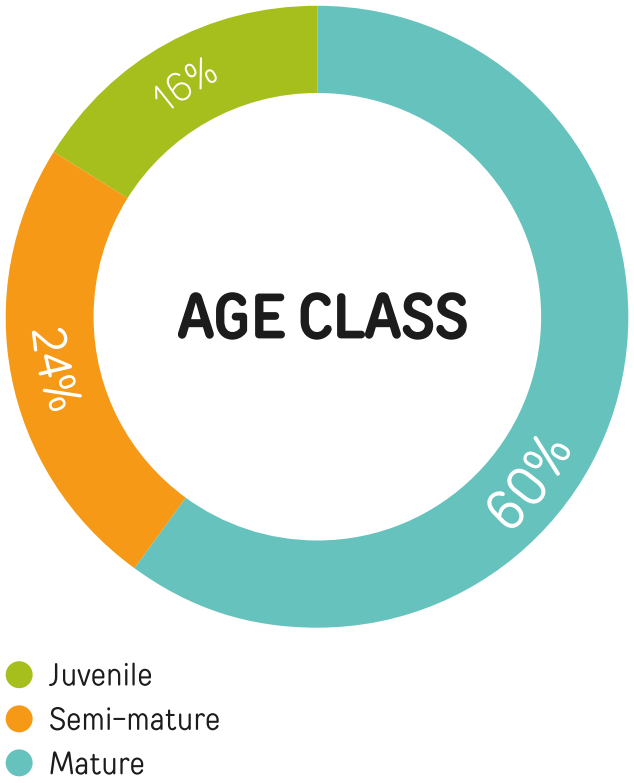


Figure 25. Age class

Aging trees

Useful Life Expectancy (ULE) is a measure of the potential time span remaining for a given tree in its existing location. A range of factors are taken into account including a particular tree's typical life span, environment, climate change impacts, land uses, pests and diseases and soil quality and volumes.

ULE is an important management tool for urban forestry (City of Melbourne, 2012). It facilitates long term planning for the staged replacement of trees that are reaching the end of their ULE at the same time. This prevents significant 'gaps' emerging in canopy cover, with a corresponding reduction in the level of benefits delivered.

Assessment of ULE at the species level is also useful as it can help to identify those that are performing poorly within an urban forest. Plans can be made to either improve the level of maintenance to increase the health of these trees, or replace affected species with one that is more suited to the urban environment.

The population of street and parkland trees is performing well in terms of their ULE. Nearly 70 percent of trees have a long term ULE and are expected to remain in place in the landscape for more than 40 years (see Figures 26 and 27).

Of the top ten tree species, only the Queensland Box has a significant issue in terms of ULE, with nearly half these trees requiring replacement within the next 15 years. This species currently makes up 1.7 percent (approx. 600 trees) of the City's street and parkland trees. The continued use of tree species with a high percentage of limited to short term ULE requires careful consideration.

Challenge: Replacing trees with a limited to short term ULE to avoid significant gaps in the canopy cover provided by street and parkland trees.

Around **2%** of street and parkland trees (approx. 350 trees) will require replacement in the next **5 years.**

A further **10%** (approx. 1,400 trees) will require replacement in the next **5 -15 years.**

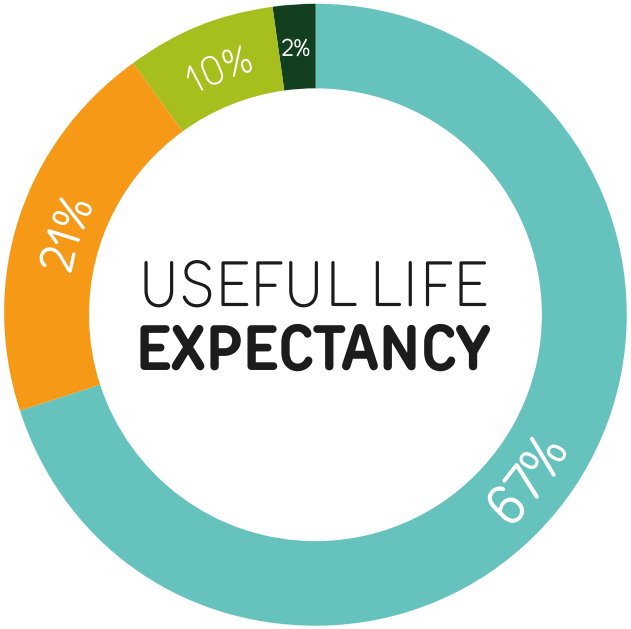


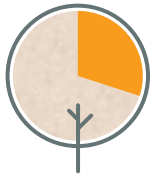
Figure 26. Useful Life Expectancy

Figure 27. ULE of street and parkland trees

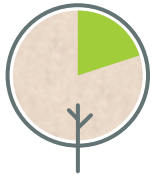
Imbalance in tree diversity

One of the most important considerations in urban forestry is the level of tree diversity present within the overall tree population. A highly diverse population is considered desirable as it reduces the risk of a catastrophic loss of trees should one particular family or species be affected by an outbreak of a specific pest or disease, or become particularly susceptible to climate change or other environmental impacts.

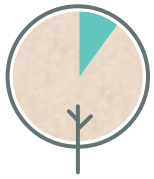
Addressing this risk is an important factor in promoting the long term resilience of the urban forest. The Street and Parkland Tree Audit (2015) analysed a range of tree diversity standards. The findings suggested that the following is the most appropriate to the Perth context (based on the work of Santamour, 1990).



No more than **30 percent** of an urban forest should be comprised of trees from the same tree family.



No more than **20 percent** of an urban forest should be comprised of trees from the same tree genus.



No more than **10 percent** of an urban forest should be comprised of trees from the same tree species.

The City's population of street and parkland trees is currently over reliant on one tree family. Trees from the Myrtaceae family make up more than 40 percent of the total population, making it the largest family present. It exceeds recommended standards by more than 10 percent (see Figure 28).

The prevalence of Myrtaceae is partly due to it being native to Australia. It also includes more than 70 different species present in the street and parkland tree population, including:

- WA Peppermint
- Queensland Box
- Tuart
- Swamp Paperbark
- Spotted Gum
- Marri
- Jarrah
- Flooded Gum
- bottlebrushes

Despite the large variety of tree species within the Myrtaceae family, potentially all of them could be susceptible to attack from the disease myrtle rust (a serious fungal disease which attacks actively growing leaves, shoot tips and young stems). Although myrtle rust is present in the Eastern States, it has not yet arrived in Western Australia. However, should it take hold here it has the potential to have a catastrophic impact on the City's street and parkland tree population.

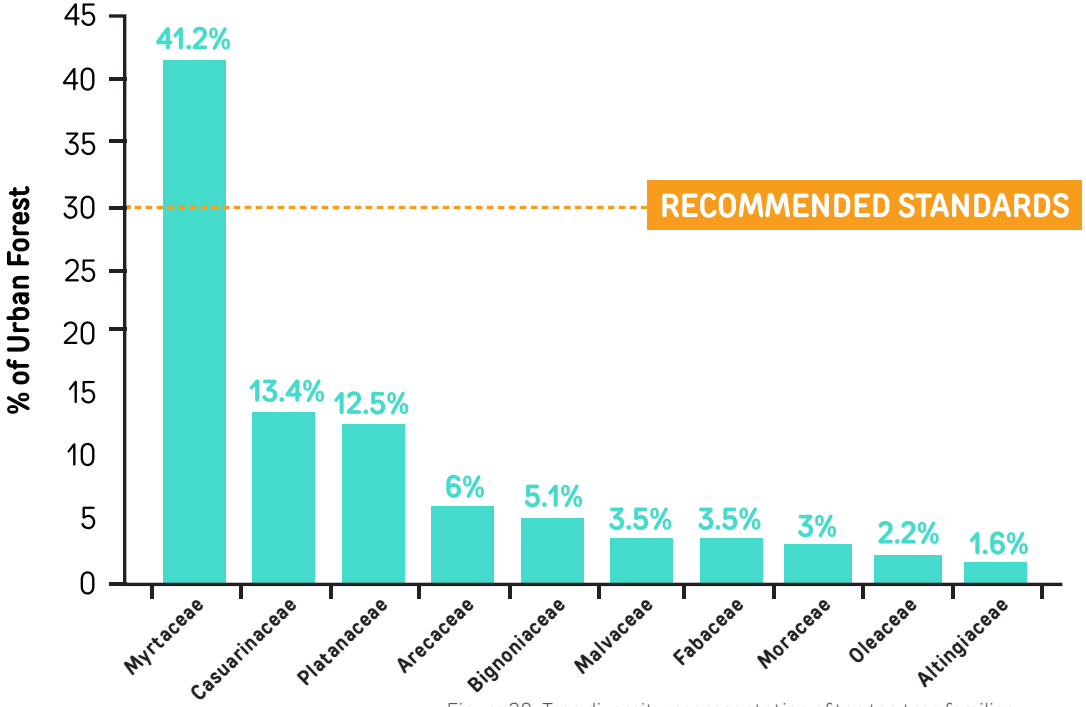


Figure 28. Tree diversity: representation of top ten tree families

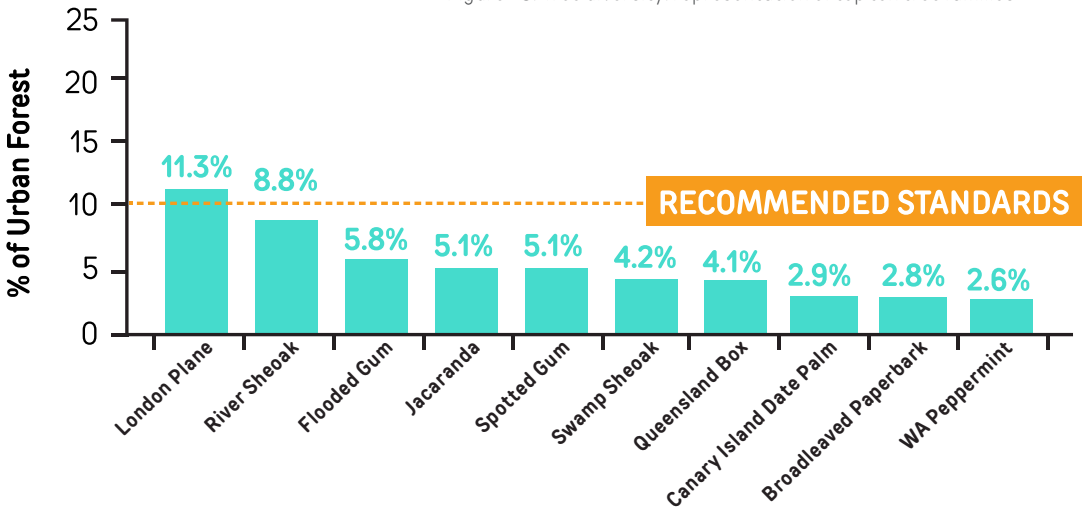


Figure 29. Tree diversity: representation of top ten tree species

At the tree species level, street and parkland trees are performing well, with potential to increase the representation of tree species other than the London Plane (see Figure 29).

Tree family

Single or group of genera that closely or uniformly resemble each other in general appearance and technical character.

Tree genus

A group of tree species that have fundamental traits in common but that differ in other, lesser characteristics.

Tree species

A natural group of trees in the same genus made up of similar individuals.

Challenge: Meeting or exceeding the recommended standards for tree diversity within the street and parkland tree population.

Native and non-native trees in the urban forest

Tree species vary in their ability to deliver benefits. Both native and non-native trees are capable of providing a range of economic, social and environmental benefits and the issue of whether to plant native or non-native species is a significant debate in urban forestry.

Native trees

A preference for planting native trees in the City has been broadly evident in recent times, with over 60 percent of street and parkland trees being native species. These trees are often planted for reasons of nature conservation and the provision of habitat for native fauna. Native trees are often also selected for patriotic and wider landscape management reasons (Johnston, et al., 2012).

An automatic preference for planting native trees can influence the overall resilience of the urban forest and result in unmitigated risks. Increasing heterogeneity and complexity of species composition can allow for adaptive management in the face of climate change. Similarly, a wide diversity of native and non-native trees can mitigate disease spread and lessen the distribution of environmental pests.

Although they are currently over-represented, native trees within the Myrtaceae family will remain a significant component in the urban forest, with a valuable role to play. They will continue to be considered for planting as part of new tree planting programmes, guided by the 'right tree for the right place' philosophy and other provisions of the Street Tree Framework.

Native trees will continue to be planted where they are considered to be most effective, for instance, along streets that are identified as wildlife corridors/eco zones and in parkland settings. Gateway plantings will also use native species where possible as a way of promoting local flora. Native tree planting will also be guided by the findings of the Biodiversity Study proposed in the City's Environment Strategy.

Non-native trees

A number of non-native species occurring within the greater Perth metropolitan region can provide ecological functions to native fauna. One example is the relationship of Carnaby's Black Cockatoo and non-native tree species including Liquidambar, Cape Lilac, Pinaster and Stone Pines.

In some instances, non-native trees can provide greater benefits than native species in the urban environment.

Non-native trees are often better adapted to thrive in the increasingly challenging and harsh growing environments within city streets, whereas native tree are often better suited to more natural areas.

Including non-native trees within the urban forest also contributes to greater species diversity and improves its long-term resilience.

For these, and other reasons, non-native trees will often be chosen for planting over native trees in particular parts of the City, especially in more built up areas, public spaces with high levels of pedestrian activity and residential areas.

The London Plane for example, is a popular and widely used urban tree species. It is frequently selected for planting within streets and public spaces in both Australian and other cities throughout the world. This is due to its ability to thrive in harsh urban conditions and provide a high level of ecosystem services.

Differing shade qualities of native and non-native trees

Research suggests that large-canopied, broadleaf trees, with thick or denser foliage can be more effective in urban cooling.

A recent study comparing the different cooling effects of three common street tree species in Australia (London Plane, European Elm and River Gum) indicates that the higher the canopy quality, the cooler the midday microclimatic conditions under that canopy in summer. Conditions were significantly hotter under the River Gum, due to its thin, open canopy architecture and more pendulous leaf structure, in comparison to the denser, rounder canopy architecture of the European Elm and London Plane trees (Sanusi & Livesley, 2014).

"Important ecological considerations for species selection are often narrowed down to a debate on whether or not native trees should be systematically preferred. Such framing diverts attention away from a balanced approach considering both ecological value and resilience" (Trees & Design Action Group , 2012).

The leaves of the native eucalypt trees tend to have a pendulous structure, allowing them to limit their exposure to the sun. As a result more sunlight passes through their canopies, creating a lower level of shade over the ground surfaces below.

The leaves of non-native, broadleaved trees tend to have a horizontal orientation, allowing them to absorb more sunlight for photosynthesis. As a result these trees tend to provide a higher level of shade over the ground surfaces below their canopies.

Photo showing different shade qualities of eucalypt trees and non-native elm

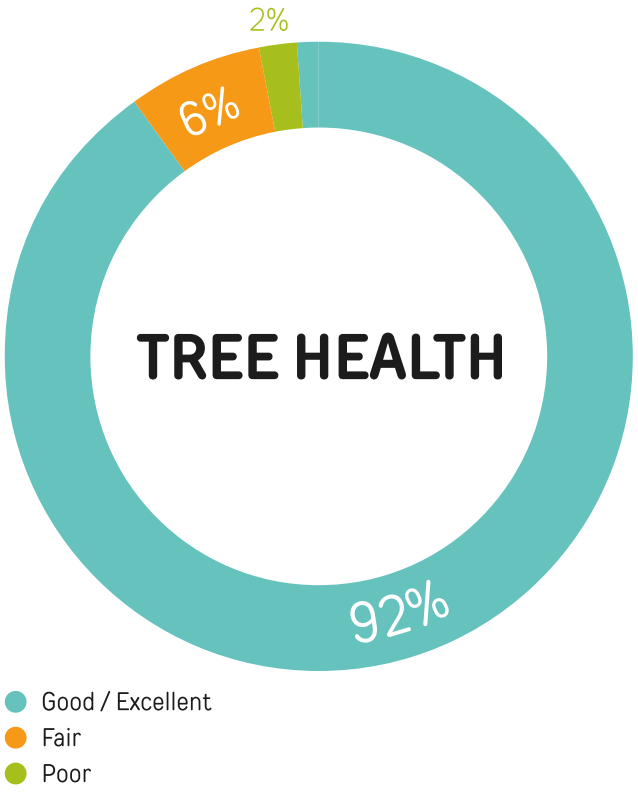


Figure 30. Tree health

Maximising tree health

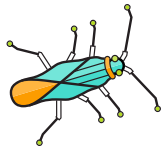
A high level of tree health within an urban forest is important for a range of reasons. Healthier trees promote higher levels of amenity. They are also more likely to reach their expected life span and attain maximum levels of growth. Larger trees, with dense healthy canopies provide significantly more benefits than smaller trees. Good levels of tree health also promote an appropriate age class mix and help reduce maintenance costs.

The City's population of street and parkland trees is performing very well in terms of overall health with over 90 percent of them in good or excellent health (see Figure 30). This is partly attributed to the fact that the most commonly used street trees, the London Plane, Jacaranda and the Spotted Gum are well adapted to the urban environment, and have proven to be very good urban tree species in the Perth context.

However, the findings of the Street and Parkland Tree Audit (2015) uncovered some specific health issues that must be addressed if these health levels are to be maintained and maximised in future.

Pests and diseases

A number of pests and diseases are present including:



Olive Lace Bug in Olive trees

Fusarium Wilt in the Canary Island Date Palm

Borer in the WA Peppermint

Canker in some Marri and Red Flowering Gums

Leaf-blister Sawfly in some eucalypts

Powdery Mildew in the London Plane

Sunscald is affecting some trees, particularly the Keaki, Illawara Flame, Flame tree and Hills Fig. The continued use of these trees as street trees may not be appropriate in Perth's climate and urban environment, consequently they often struggle to thrive and have poor levels of health.

While these pests and diseases do not appear to be having a significantly detrimental effect on tree health at present, they have the potential to significantly affect the urban forest if they escalate.

Environmental issues

Reduced rainfall is suspected of having an impact on the health of a few species including a large number of mature Queensland Box and some fig trees including the Moreton Bay Fig and Small Leaved Fig. While other species seem to be adapting to the effects of climate change, this may change over time.

Car park trees

Only 79 percent of trees planted in the City's surface car parks are in good or excellent health, primarily because of their particularly harsh environment. Over 20 percent of these trees will reach the end of their ULE in 15 years.

Deteriorating structural condition

Some tree species are exhibiting a deteriorating structural condition, partly due to past pruning practices, including the WA Peppermint and Flame Trees in West Perth and the mature London Plane trees on Victoria Avenue and Mounts Bay Road. With future management options being limited, these will require replacement over the next 20 years.

Tree risk

Tree risk is largely addressed through appropriate pruning practices, however, there are a small number of tree species that have a higher potential for branch failure. These species are primarily native trees and include the Northern River, Sugar, Rose and Lemon Scented Gums, the Tuart and Bangalay. Together these trees form less than three percent of the total street and parkland tree population.

Management and maintenance

In some cases, the City's current policies and practices relating to the procurement, planting and after care of juvenile and transplanted trees are contributing to lower levels of health and tree establishment. Mowing practices for example, are causing damage to tree stems and bark, affecting tree health.

Challenge: Developing and implementing appropriate management practices, policies and procedures to maintain and maximise levels of tree health.

Urban forest management

Contemporary urban forestry advocates a long-term, pro-active and strategic approach to the management of the urban forest. This approach focuses on the urban forest as a whole, and considers its overall health, resilience and on-going sustainability as a single entity over the longer term (van Wassenaer, et al., 2012).

At present, there is no overall plan or strategy for the urban forest. Street and parkland trees are managed and maintained on a short term, day-to-day basis that primarily addresses the needs of individual trees. This makes it difficult to assess how the urban forest is performing as a whole and how capable it is of delivering community benefits over the longer term.

Challenge: Developing and implementing a strategic and pro-active approach to managing the urban forest as a whole.

Community awareness of the urban forest

Community support plays a vital role in successful urban forestry (Schwab, 2009). However, there is often a lack of community awareness of the benefits provided. As a result, community concerns about urban trees can often outweigh an appreciation of their importance in ensuring on-going liveability and climate resilience.

People interact with urban trees on a range of different levels, and opinions on the role and value of urban trees can vary widely. Some are concerned about leaf and fruit litter, allergies and the potential of trees to block views and cause damage from invasive roots and limb drop. This, coupled with a lack of awareness of the range of benefits trees provide, can mean that the larger community often undervalues them.

Stage One of the Urban Forest Plan will result in changes to where, when and how trees are planted within the City. This will affect the design of streets, squares and parklands and impact on how the community interacts with urban trees in the future.

The development of the Plan should therefore foster community support for the urban forest by raising awareness on the range of benefits it provides. It should also understand and respond to community values regarding urban trees.

As part of the consultation on the draft Urban Forest Plan the community provided input on their perceptions of the relative importance of urban forest benefits. The findings are summarised in Figure 31 below.

Challenge: Developing community support for the protection, management and expansion of the urban forest.

Figure 31. Community perceptions of urban forest benefits

Murray Street Mall – Perth

4.3 Where we want to go – goals and objectives

The vision for the urban forest will be realised through the delivery of nine goals.

Goal 1: Protect existing trees

Street and parkland trees can take many years to establish and develop mature canopies. One of the most effective strategies to address the challenge of low canopy cover is to protect existing trees, through the following objectives:

Priority objectives

1.1 Review all City practices and procedures, planning policies and design and construction notes to align with the objectives of the City of Perth Urban Forest Plan.

1.2 Develop and implement new policy to protect existing street and parkland trees from damage caused by construction and other works in the City.

1.3 Review and update City of Perth Policy 20.9 "Recognising the Amenity Value of the City's Trees" to include the ecosystem services provided by urban trees.

Other objectives

1.4 Include information on new tree valuations on the City of Perth website to help raise community awareness and appreciation of the level of benefits delivered by the urban forest.

1.5 Develop and implement a strategy to retain and value 'veteran' trees within the population of street and parkland trees.

Goal 2: Replace aging trees

The City will plan for the gradual and timely replacement of street and parkland trees that are reaching the end of their Useful Life Expectancy in the next 15 years. Trees may be replaced by a more suitable species ,guided by the Street Tree Framework.

Priority objectives

2.1 Implement the following replacement planting plan:

Timeframe	Number of trees to be replaced
2017-2020	71 trees replaced annually (limited ULE)
2021-2035	95 trees replaced per annually (short ULE)

Other objectives

2.2 Prioritise replacement planting in City precincts where significan gaps in canopy cover may emerge due to a large proportion of street and parkland trees reaching the end of their ULE concurrently.

Goal 3: Promote sustainable water management

In order to maximise the cooling benefits and ensure the on-going health and resilience of the street and parkland tree population, the City will plan pro-actively for an adequate and sustainable water supply for irrigation. This issue will be addressed as follows:

City of Perth Water Sensitive City Transition Study

This study is being undertaken by the City of Perth as part of the delivery of its Environment Strategy. It aims to develop an integrated water management approach, and is underpinned by the premise that all water resources are supply sources and that water infrastructure and the urban landscape should have an integrated design for function and aesthetics.

Water Sensitive Urban Design (WSUD) initiatives

The City will also continue to pursue and deliver on best practice WSUD initiatives in its management of the urban forest. These measures will help retain water within the landscape and improve storm water management and water quality.

Priority objectives

3.1 Design and implement a pilot project for storm water capture and storage. If successful and feasible, use project findings to promote the development of similar projects throughout the City.

3.2 Prioritise the use of WSUD initiatives, where feasible, in new street and parkland tree planting in the City.

Other objectives

3.3 Complete the Water Sensitive City Transition Study. Amend the Urban Forest Plan to reflect its findings and support its implementation.

3.4 Replace existing impervious surfaces with pervious surfaces where possible.

3.5 Investigate the potential to introduce more efficient and targeted irrigation of street and parkland trees where feasible.

3.6 Monitor soil moisture levels.

Goal 4: Increase canopy cover

Stage One of the Urban Forest Plan aims to increase the level of canopy cover within the public realm from 19 percent to 30 percent within a 30 year timeframe.

This target has been established through an assessment of local conditions and an estimate of the number of new tree planting sites potentially available across the City's public realm.

It assumes the selection and planting of tree species with the capacity to provide a large to medium–large canopy at maturity, taking existing and future environmental conditions into account.

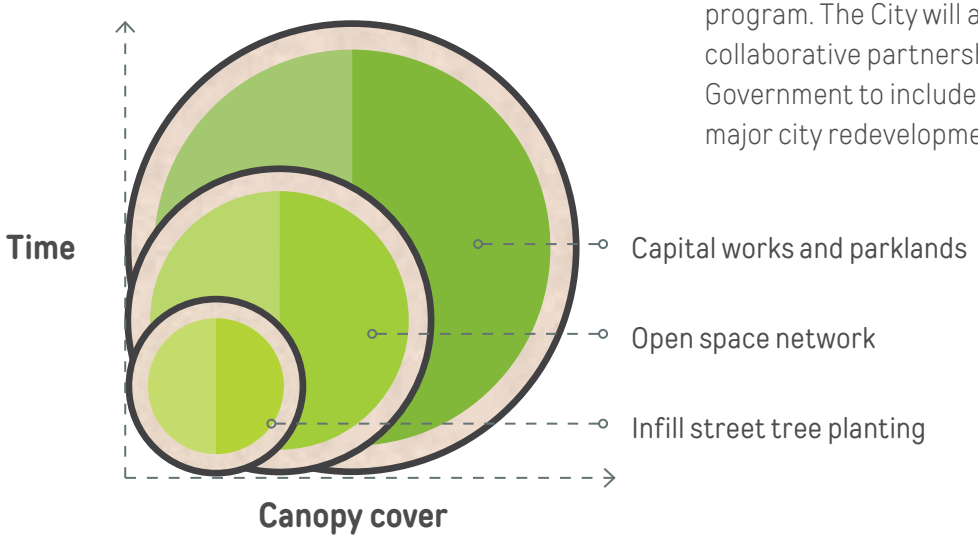


Figure 32. Indicative new tree planting opportunities

New tree planting opportunities will include (see Figure 32):

- Infill street tree planting – a targeted program to plant new trees where there are gaps in existing street tree planting, within each of the City' precincts.
- Open space network – targeted new tree planting programs for key parts of the City's wider open space network.
- City parklands – increasing the level of canopy cover provided by parkland trees on an on–going basis, as part of the development of tree management and maintenance plans.
- Capital works projects – continue to undertake new tree planting as part of the on–going delivery of the City's 10 Year capital works program. The City will also seek to develop collaborative partnerships with State Government to include new tree planting in major city redevelopment projects.

These programs will be delivered on an incremental basis, through the four yearly implementation plans, over the lifetime of the City of Perth Urban Forest Plan.

Priority objectives

4.1 Develop and implement infill street tree planting plans.

4.2 Prepare community based urban forest precinct plans.

4.3 Update tree procurement processes to ensure the timely availability of new trees.

Other objectives

4.4 Continue to ensure opportunities for increased tree planting are factored into City capital works projects from the earliest stages of project planning.

4.5 Progress the development of new tree planting plans for the City's wider open space network.

Goal 5: Prioritise tree planting to help cool public spaces and City 'hot-spots'

The City will maximise the potential of street and parkland trees to help reduce City temperatures and ameliorate existing 'hot-spots', as part of its goal of increasing the level of canopy cover.

Priority objectives

5.1 Prioritise new tree planting in 'hot spot' areas and public spaces with high levels of pedestrian activity.

5.2 Select and plant tree species that have the ability to maximise the urban cooling effect in these areas.

5.3 Ensure an adequate level of irrigation is available to maintain the health and maximise the cooling potential of trees in these areas.

Goal 6: Promote balance and resilience in species composition

The City will seek to establish a street and parkland tree population that meets or exceeds recommended standards in terms of tree diversity. In the future, no more than 10 percent of the total population of street and parkland trees will be from the same tree species, 20 percent from the same tree genus and 30 percent from the same tree family.

Priority objectives

6.1 Review the City of Perth Street Tree Framework to update and reinforce the 'right tree for the right place' philosophy.

6.2 Identify and trial new tree species for future planting in the City's street and parkland spaces.

Other objectives

6.3 Complete the Biodiversity Study, as proposed in the City's Environment Strategy. This study will investigate the challenges and opportunities to manage flora, fauna and habitats within the City. It will include an evaluation of habitat type, location, linkages, city ecosystems, flora and fauna population and distribution. The study will inform key operational and capital plans.

6.4 Update the Street Tree Framework every four years to take account of the outcomes of tree trials and findings from contemporary research.

Goal 7: Maintain tree health

Appropriate management tools will be developed and implemented to deal with the potential effects of climate change and the specific health challenges currently identified for the City's street and parkland trees.

Priority objectives

7.1 Introduce measures for the early detection and treatment of, either an escalation in existing pests and diseases or, the emergence of new ones within the population of street and parkland trees.

7.2 Monitor, report and act on any other health impacts of climate change.

7.3 Select and plant tree species that are well adapted to existing and emerging environmental challenges, as part of the review of the Street Tree Framework.

7.4 Develop and implement practices and procedures for the strategic management of tree risk.

7.5 Bring existing management and maintenance practices and procedures for street and parkland trees in line with best practice, particularly with regard to the issues of:

- the procurement of good quality stock
- tree planting standards
- the aftercare and maintenance of juvenile and transplanted trees

Other objectives

7.6 Prioritise the use of purpose built below ground structural cells where project goals and budgets allow, to help improve the growing environment for new street trees.

7.7 Develop and implement a strategy to improve the health of trees in the City's surface car parks.

7.8 Introduce measures to ensure that staff and contractors are appropriately resourced, trained and supervised in the implementation of updated management and maintenance practices and procedures.

7.9 Develop management options and replacement strategies for significant tree stands with deteriorating structural condition.

Goal 8: Implement a 'whole-of-forest' management approach

The City of Perth Urban Forest Plan represents a first and significant step in promoting a more proactive, strategic 'whole-of-forest' management approach. It sets out a high-level, 20-year vision and associated goals for the protection, management and expansion of the urban forest.

The 'whole-of-forest' management approach is supported by the development of four yearly implementation plan and monitoring frameworks for the urban forest.

Priority objectives

8.1 Finalise the implementation plan and monitoring framework 2016-2020.

8.2 Review and report on the implementation plan and monitoring framework annually.

Other objectives

8.3 Update the City's GIS database to record the findings of the Street and Parkland Tree Audit (2015).

8.4 Maintain the City's GIS database to record on going changes and support monitoring of the City's street and parkland tree population.

8.5 Develop tree management and maintenance plans for the City's parklands and public open spaces.

8.6 Implement an appropriate management structure to support the effective planning and management of the urban forest.

8.7 Build collaborative working relationships with other city agencies that have a stake in the protection, management and expansion of the urban forest.

8.8 Collaborate with appropriate professional and research agencies with expertise and knowledge in urban forest management.

8.9 Complete regular, four yearly audits of street and parkland trees.

8.10 Complete regular, four yearly canopy cover and thermal imaging surveys.

Goal 9: Promote community engagement

The following measures will be undertaken to help raise community awareness on the benefits of the urban forest and promote support for the City of Perth Urban Forest Plan:

Priority objectives

9.1 Develop and implement a program of community engagement to raise awareness of the Urban Forest Plan and facilitate input into its development.

9.2 Update the City of Perth website regularly to enable community access to information on the urban forest and community engagement initiatives.

9.3 Promote meaningful community involvement in the development of the urban forest precinct plans.

Other objectives

9.4 Develop policies and procedures to help address community concerns and provide guidance on the management and maintenance of urban trees.

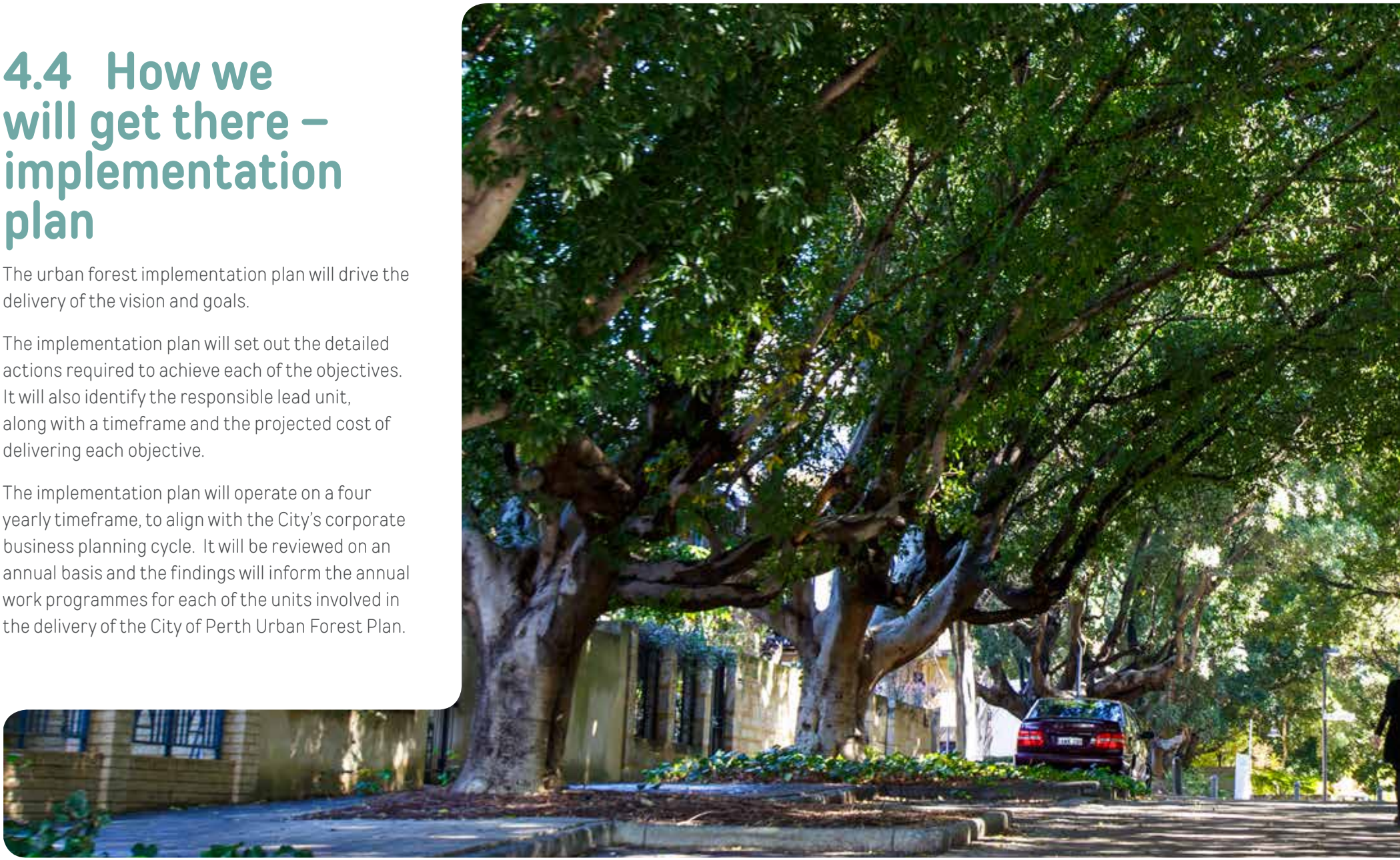
9.5 Continue to work with the community to increase awareness of environmentally sustainable living and deliver positive environmental outcomes through the delivery of an external engagement programme.

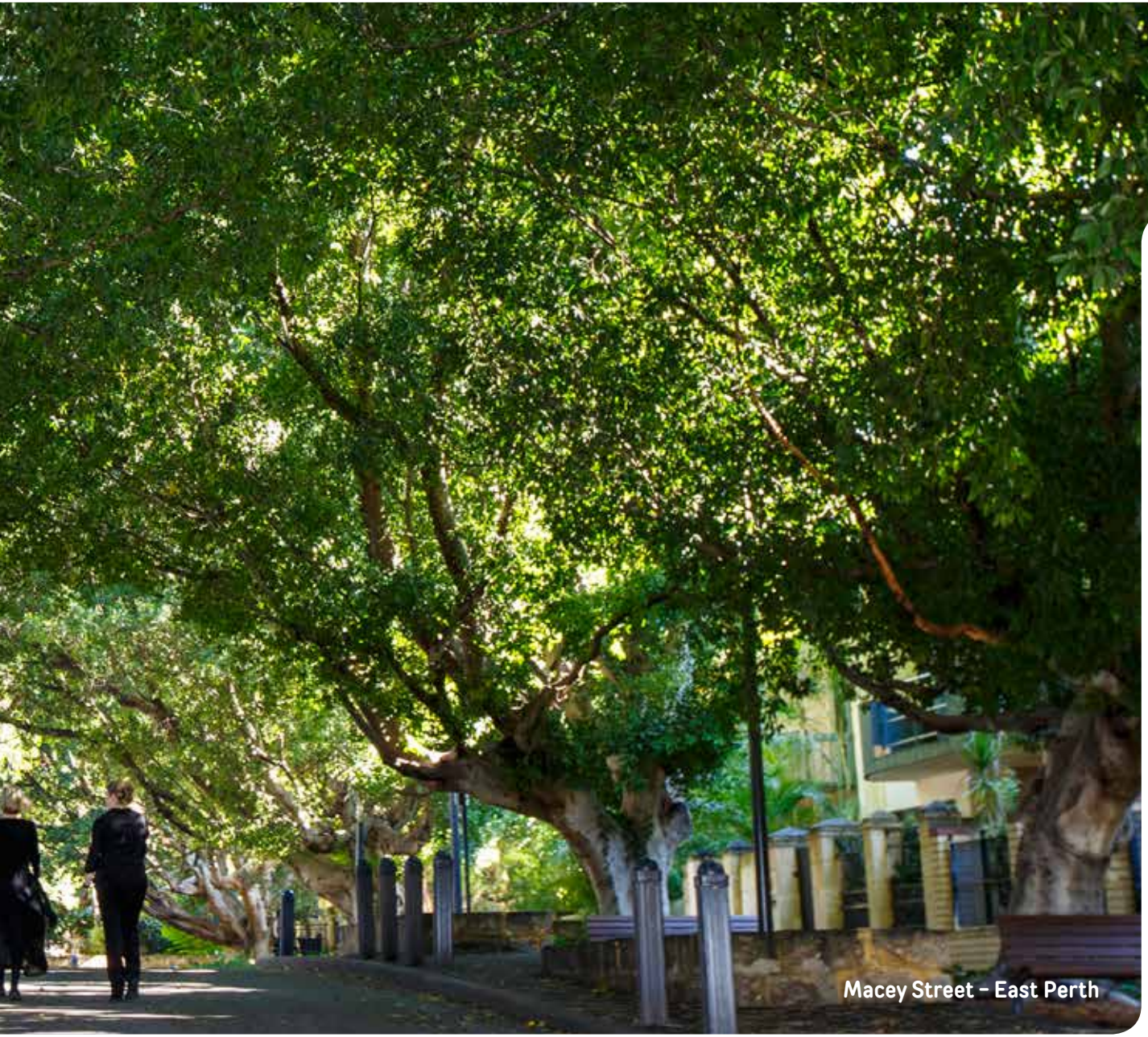
4.4 How we will get there – implementation plan

The urban forest implementation plan will drive the delivery of the vision and goals.

The implementation plan will set out the detailed actions required to achieve each of the objectives. It will also identify the responsible lead unit, along with a timeframe and the projected cost of delivering each objective.

The implementation plan will operate on a four yearly timeframe, to align with the City's corporate business planning cycle. It will be reviewed on an annual basis and the findings will inform the annual work programmes for each of the units involved in the delivery of the City of Perth Urban Forest Plan.





Macey Street - East Perth

4.5 Have we arrived – monitoring framework

The urban forest implementation plan will include a monitoring framework to help track the progress of implementing each of the objectives for the urban forest. The Framework will identify a success measure for each objective and record the degree to which that measure has been achieved within a set timeframe.

The monitoring framework will be reviewed every year, as part of the annual review of the implementation plan. This will allow any difficulties or issues emerging with regard to attaining each of the goals to be identified and addressed early, allowing for adaptive management as implementation of the Urban Forest Plan progresses.

Glossary

Adaptive management

A systematic process for continually improving management by learning from the outcomes of previously employed policies and practices.

Canopy cover

The percentage of urban land covered by tree canopy when viewed from above.

Carbon sequestration

The process by which trees absorb and assimilate carbon dioxide from the atmosphere.

Ecosystem services

Benefits provided to humans by goods and services delivered by ecosystems (Source: Millennium Ecosystem Assessment 2005).

Green infrastructure

The term Green Infrastructure (GI) is used to describe the network of green spaces which intersperse, connect and provide vital life support for humans and other species within urban environments. It includes elements such as green networks and links, cemeteries, community gardens, domestic gardens, roof gardens, green walls, living walls and verges (adapted from AILA).

Rare trees

A tree species that is considered to be a rare species for the Perth metropolitan area. Consideration is given to the frequency of finding the trees' given species in other areas of metropolitan Perth as well as within the City itself.

Tree amenity

A quality, feature, or attribute of the tree that makes it pleasant, attractive, and agreeable which is conducive to the comfort, convenience, and enjoyment of people. It is a physical feature which increases attractiveness and value of a site through contributions to the physical, psychological, or material comfort of people and which facilitates happiness, pleasure, enjoyment and contentment.

Urban forest

An urban forest is broadly defined as the collection of green spaces, trees and other vegetation that grows within an urban area, on both public and private land.

Urban Heat Island (UHI)

Many urban areas experience elevated temperatures compared to their outlying surroundings, this difference in temperature is what constitutes an urban heat island (US EPA, 2008).

Useful Life Expectancy (ULE)

An estimation of the useful life remaining for a given tree taking account of its current health condition and known typical lifespan expected for the species in its given location and situation.

Veteran trees

Trees which are considered to be in excess of 100 years old.

Water Sensitive Urban Design (WSUD)

Integrating water cycle management into urban design processes and outcomes.

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