Department of **Planning, Lands and Heritage**

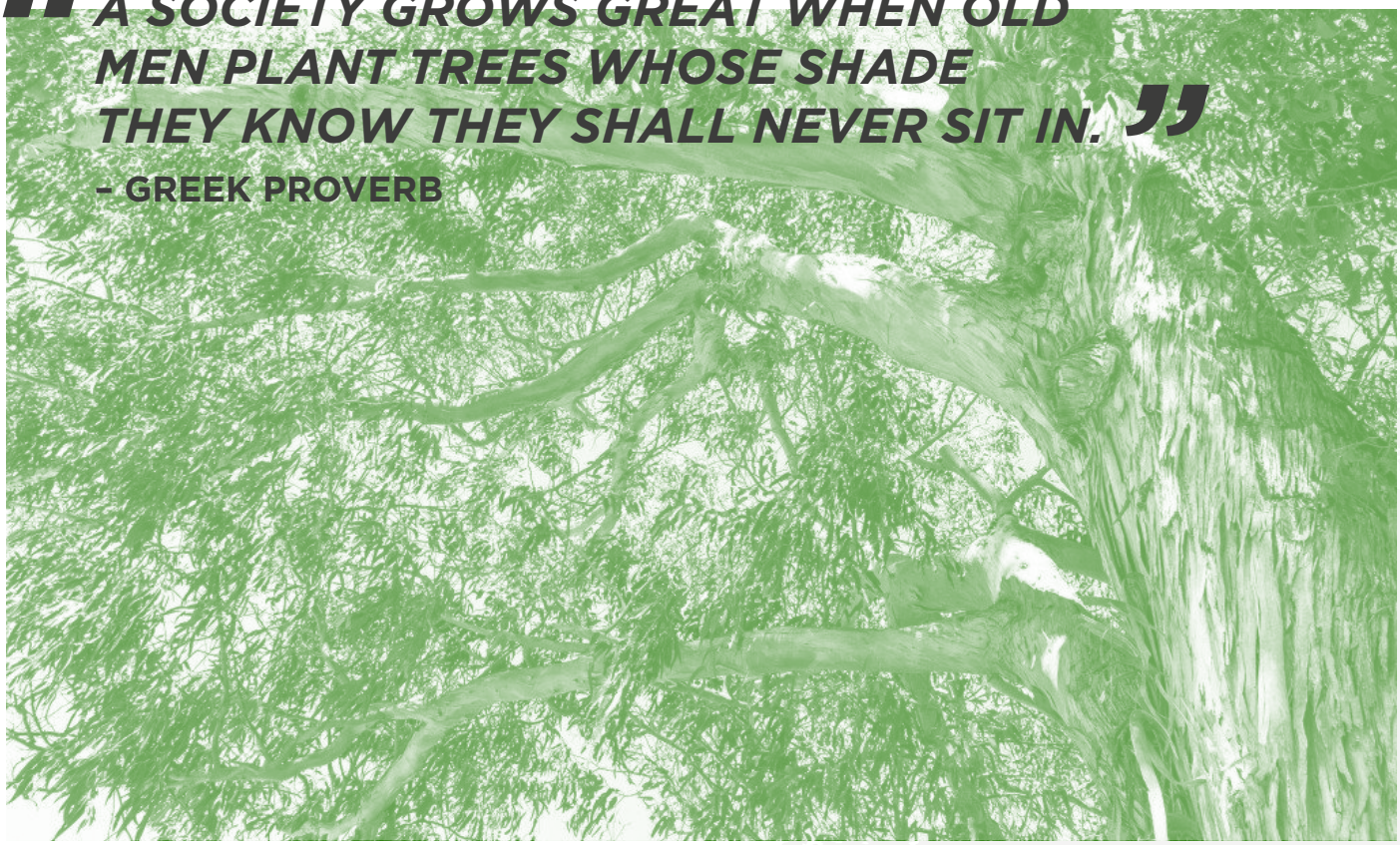
GOVERNMENT OF WESTERN AUSTRALIA

Western Australian Planning Commission

WALGA

BETTER URBAN FOREST PLANNING

A guide to support the enhancement of urban forests in Western Australia



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1.0 INTRODUCTION

Trees and other vegetation are an essential part of the urban fabric, providing a variety of significant social, economic, and environmental benefits to the community.

The protection of a healthy, resilient and diverse urban ecosystem is a shared responsibility across State and Local Governments, landowners, the development industry, businesses and the community. Unfortunately, in many urban areas, there has been a general decline in tree canopy cover and subsequent impacts on the community.

What this means for our cities and town:

- Urban trees are disappearing in many suburbs leading to a decline in amenity and value, with flow on health effects as well as increased energy and water costs.
- Tree canopy inequity exists across suburbs with the least canopy cover often in the most socially disadvantaged areas.
- The loss of trees increases the urban heat island (UHI) effect which has potential physical and mental health implications for children, the elderly and lower socioeconomic groups.
- Poorly planned medium and high density development may result in loss of significant trees on private property and on verges.
- Urban greening is an effective public health tool that leads to improved air quality, greater opportunity to walk and carry out other physical activities and reduced UHI effect.
- Suitable trees on private and commercial properties will shade buildings in summer and let in sun in winter resulting in reduced energy bills. They also increase the amenity of private properties.
- Consideration needs to be given to a number of factors including the useful life expectancy of trees and their appropriate management.
- Each street tree contributes to wellness with about $117,000 benefit over its lifespan, providing a high return on investment.[1]
- In Perth, research shows broad leafed street trees generate an enhanced economic value to residential properties of around $17,000.[2]

To address the decline in trees, Local Governments are developing and implementing urban forest strategies and similar initiatives aimed at reducing the loss of trees and where possible increasing tree canopy cover utilising techniques developed in forestry.

URBAN FOREST PLANNING

Urban forests can be defined as all vegetation growing within the urban environment. This consists of two categories: the understory such as shrubs and hedges up to 3 meters, and the tree canopy which is any vegetation above 3 meters. Urban forest planning considers vegetation from a holistic view, recognising different land uses and tenure to assess and manage infrastructure within a Local Government area. Planning should consider both private and public land including areas that a Local Government has management influence or total authority over.

A common approach to developing and recognising urban vegetation is through an urban forest strategy that considers both existing and future land uses.

WHY WE NEED AN URBAN FOREST

We all have a relationship with the natural environment and need to recognise that nature and greenery are essential to our wellbeing. As well as our intuitive connection with trees, there are proven economic, environmental, psychological and physical benefits.[3]

Some of these benefits include an increase in property values, increased shading and cooling of urban areas, improved aesthetics and social amenity. Trees also add to biodiversity, better air quality, increase resilience to changing climate impacts and the storage of carbon while functioning as a key element in the design of water sensitive cities.

PURPOSE OF THIS GUIDE

The purpose of this guide is to help Local Governments understand, plan for, monitor and manage their urban forests with the view to enhancing their urban tree canopy. Developed by the Department of Planning, Lands and Heritage (DPLH) in partnership with the Western Australian Local Government Association (WALGA) this guide aims to improve the consistency of Local Government urban forest strategies, providing guidance and case studies on:

- urban forests and why they are important;
- Local Government sector key issues;
- the strategic planning of urban forests;
- the importance of community and stakeholder engagement;
- controls within the planning system and how they can be applied and;
- tree canopy and vegetation data management.

[1] Dan Burden. (2006) *Urban Street Trees*: 22 Benefits. Retrieved 2017 from http://www.walkable.org/download/22_benefits.pdf p2.
[2] R Pandit, M Polyakov, S Tapsuwan and T Moran. "The effect of street trees on property value in Perth, Western Australia." *Landscape and Urban Planning*, February 2013. Retrieved from: https://www.sciencedirect.com/science/article/pii/S016920461200299X.

OBJECTIVES OF THIS GUIDE

Strategic objectives for urban forest planning are to:

- prevent the loss of tree canopy in urban areas;
- increase tree canopy cover where possible, especially in areas of low canopy;
- improve biodiversity and allow species movements through urban settings; and
- promote consistency between urban forest policies and strategies developed by different Local Governments.

HOW CAN THIS GUIDE HELP THE URBAN FORESTS

This guide aims to support the planning, enhancement, retention and maintenance of urban trees. It advocates for:

- incorporation of urban trees as an essential, rather than optional, component in the urban development process as advocated in Design WA planning policy;
- increasing the amount of tree canopy coverage in an area over a given time;
- recognition of the benefits and values of existing trees by the entire community and among decision makers;
- protection of established trees in parks, streets, public spaces and private spaces;
- better use of planning controls to protect and incorporate trees into development; and
- increasing the diversity of species planted in the appropriate locations.

Urban forests can also help Local Governments achieve sustainable development goals (SDGs) through contributing to enhanced amenity and quality in urban environments and helping to mitigate and build resilience to climate change.[4]

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[3] Miller, R. W. et.al Urban Forestry Planning and Managing Urban Greenspaces. Waveland Press

[4] SDGs were adopted by world leaders at a United Nations Summit (November 2017) to end poverty, fight inequalities and tackle climate change. Urban forests will also help Local Governments achieve Sustainable Development Goals (SDGs) .The seventeen SDGs were established by the United Nations with the aims to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The protection and growth of urban forests creates more sustainable cities, enhances natural habitat and fosters sustainable economic growth. Goals of particular relevance are SDG 15 that aims to “protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” and SDG 11 that aims to “make cities and human settlements inclusive, safe, resilient and sustainable”.

2.0

LOCAL GOVERNMENT URBAN FOREST ISSUES

GENERAL CANOPY DECLINE

Insensitive development and increased density plus issues such as climate change and some community attitudes towards trees are placing pressure on urban forests.

The 2017 report *Where should all the trees go?* showed a decline in established vegetation across Perth and Peel[5]. Of particular concern was the decline of larger trees on private land and the UHI effect in outer urban areas. The following information pertains to the Perth to Peel Local Governments in Western Australia.

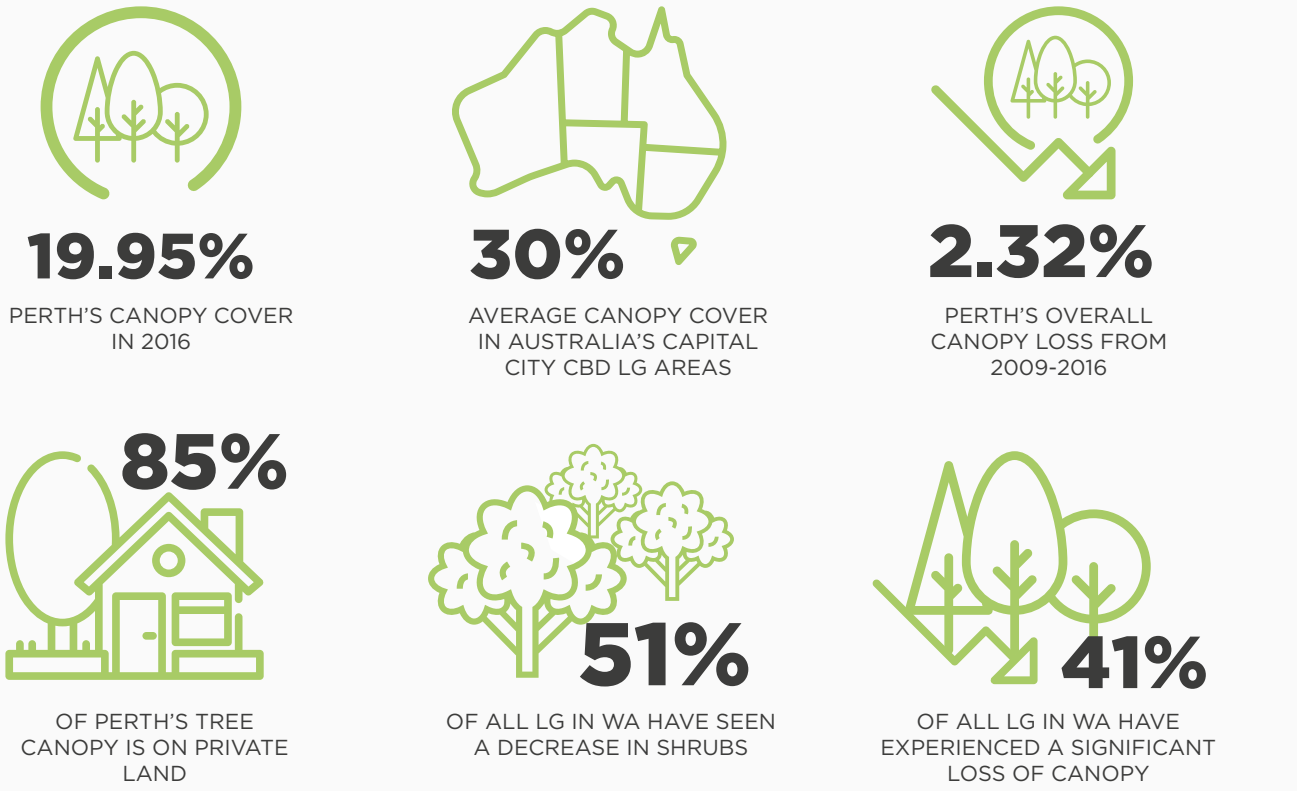

Figure 1. Statistics for Perth and Peel Local Governments in Western Australia. (Adapted from 202020 Vision 'Where should all the trees go? Research Update' September 2017.

[5] 202020 Vision 2017 Where should all the trees go? http://202020vision.com.au/help-hub/the-research-hub/detail/?id=4059

WALGA URBAN FOREST SURVEY SUMMARY

To inform the development of this guide, WALGA surveyed Local Governments in 2017. The results reinforced the findings of previous research and consultation including the 202020 Vision and indicated that tree retention on private land was the most significant matter[6].

Figure 2 shows what Local Government think is important in developing and managing their urban forests.

Generally the survey highlighted that Local Governments are seeking tools, information and changes to policy to protect trees and increase canopy cover on private property and street verges.

The results also indicated a need to promote a shared understanding of the role and value of the urban forest across all levels of government, stakeholders and the community. The provision of consistent and regular data collection and mapping was also highlighted.

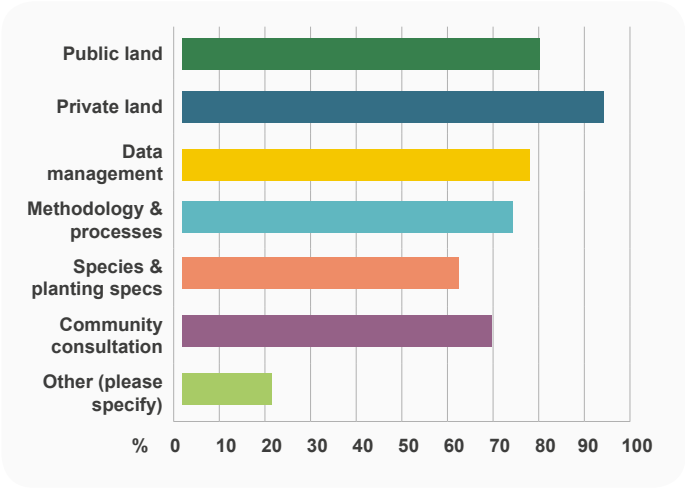

Figure 2. Issues that matter to Local Governments for consideration to include in this guide

KEY STAKEHOLDER ISSUES

The following have been identified by Local Governments as key issues relating to maintaining and enhancing a healthy, resilient, diverse and sustainable urban forest, on both public and private land:

- urban development – historic and current approach to developing land, increasing building footprints, increased residential density, high land values and landowners redeveloping to the maximum allowable building potential;
- Urban Heat Island effect – land clearing and development are resulting in increases in temperatures in urban areas compared to surrounding rural areas;
- climate change - higher average and extreme temperatures and reduced rainfall have a significant impact on tree retention and management;
- tree management – increasing tree planting and having the space to plant, appropriate management needs to consider a number of factors such as tree selection, ageing tree population (useful life expectancy) and soil depths;
- measurement and monitoring – there is a need for regular and standardised data collection and mapping of public and private land to track canopy loss and the distribution of tree cover;
- community and stakeholder awareness – trees impeding views, dropping leaves, safety and liability (insurance) concerns, restricting parking space and general lack of appreciation for trees can result in public trees being vandalised or destroyed and developers and landholders removing trees on private land.

[6] http://202020vision.com.au/help-hub/wsattg/

URBAN DEVELOPMENT

Urban development has an impact on tree canopy loss with increased urban infill, smaller block sizes and the preference for level sites reducing the number of trees on private land. Threats to trees on private and public land are the result of a range of factors including:

LAND AND INFILL DEVELOPMENT

The major proportion of WA's urban trees are lost in development of land, whether it be large scale or single residential. The planning, design and construction of land developments and new housing should prioritise the retention and enhancement of trees in the natural environment.

STREETSCAPE DESIGN & ROAD DEVELOPMENT

Street trees can be affected by new or modified road networks. When replaced, the new trees should be of equal merit and also able to grow to their full size within the existing location.

OVERHEAD POWER LINES

Current policies and practices regarding the management of trees under powerlines to mitigate the safety and fire risks have significantly impacted the location and management of trees within the streetscape.

UNDERGROUND SERVICES

Allocation of space within the verge for underground services is given priority and impacts the space needed for suitable street trees to grow and mature.

THE URBAN HEAT ISLAND EFFECT

The UHI effect is the difference in air temperature between cities and their surrounding rural regions[7]. The temperature differences can be quite large at times depending on weather conditions, physical and geometrical characteristics and human generated heat sources in the area.

An UHI is created by a concentration of heat-absorbing building materials that trap heat during the day and release it more slowly at night than natural vegetation[8]. Cleared ground and areas that lack tree canopy also contribute to the UHI.

Warmer temperatures generated by the UHI can lead to increased demand for water and energy which affects cost of living and has community health implications.

A lack of vegetation and an increase in heat-absorbing materials correlate with UHI effects. In the absence of heat mapping, local knowledge on building density, cleared areas and tree canopy cover can help identify potential heat sinks.

Figure 3. Thermal image of shaded Victoria Avenue in the City of Perth. Ambient air temperature is 31° Celsius. Temperatures range from 14.4° C in the shade to 33° C in unshaded areas. The temperature in shaded areas was an average 6° C cooler.[9]

Urban trees play an important role in reducing the effects of UHI. Canopy trees provide shade, prevent surfaces from trapping heat during the day and help lower night temperatures. Trees also take energy out of the atmosphere and transpire water vapour into the surrounding air, acting as nature's air conditioner. Creating space for shade trees in urban areas on public and private land is important, particularly as urban density increases.

[7] Wenga, Q, D Lub and J Schubringa (2004) Estimation of land surface temperature–vegetation abundance relationship for urban heat island studies. *Remote Sensing of Environment* 89: 467–483.
[8] Harlan, SL, AJ Brazela, L Prashada, WL Stefanovb, L Larsenc (2006) Neighbourhood microclimates and vulnerability to heat stress. *Social Science and Medicine* 63: 2847–2863.
[9] Image courtesy of City of Perth.

Figure 4. Isotherm map depicting an atmospheric night urban heat island. This conceptual map with overlaid isotherms (lines of equal air temperature) exhibits a fully developed night time urban heat island. The dotted red line indicates a traverse along which measurements are taken.[10] In this example the central city core has remained 6 degrees hotter than background temperatures during the night time.

CLIMATE CHANGE

In the southwest of Western Australia climate change is resulting in average air temperatures increasing, average annual rainfall decreasing and more extreme heat events in summer. This is predicted to continue and will have a significant impact on the community and on tree retention and management. Healthy urban trees and forests provide communities and the natural environment with a host of climate-related benefits and urban forests also sequester carbon. Active planning, management, and care of the urban forest can improve resilience to climate change.

Water availability can significantly impact urban eco-systems and is a critical issue for survival and longevity of trees. Consideration needs to be given to fit-for-purpose water supply to irrigate trees. Integrating planning with water-sensitive urban design techniques is also an important step to ensure water availability.

Warmer temperatures generated by the UHI effect can lead to increased demand for water and energy which affects cost of living and has community health implications.

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TREE MANAGEMENT

Trees should be seen as highly valued assets. They improve air quality by absorbing pollutants and releasing oxygen and storing carbon dioxide. Collectively, trees soften urban development, help screen unsightly views, provide privacy and create a sense of identity and security.

Tree management and provision can generate considerable public debate, so consultation and careful planning is crucial. There are a number of factors related to tree management including:

MATURE TREE CANOPY

A mature tree canopy is characterised by its structure, composition and its management regime. The management of public trees in urban areas is one part of urban forestry but publicly owned trees represent only a small proportion of urban trees in the Perth and Peel region. A sizable portion of the urban forest is located on private property. This underscores the role that community education plays in helping support the management of trees on private property. Ultimately much of the structure, composition and maintenance of the urban forest is influenced by individuals and private contractors.

TREE SPECIES

Species selection needs to consider size and scale appropriate to the space available plus longevity and landscape themes or objectives determined for an area. Water availability is also as important as species selection. Some tree species may be less resilient to future climate change. It is desirable to have diversity (native and non-native) in an urban forest to add resilience and mitigate against a range of risk factors.

SOIL DEPTHS

Minimum soil depths are required to allow the trees to sufficiently grow to provide benefits and value to the environment. Root cells are often used under roads or paved areas to increase soil depth and volume and to reduce impacts from roots.

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[10] Reducing Urban Heat Islands: Compendium of Strategies. Urban Heat Island Basics. https://www.epa.gov/sites/production/files/2014-08/documents/basicscompendium.pdf

[11] Perry, C., Kay, R., and Nash, P., Framework for Regional Approach to Climate Change Adaptation (Phase 1) Issues Paper. Report prepared for the South West Group by Makai Enterprises.

MAINTENANCE

Significant tree canopy takes a long time to establish and is a long term investment. It is important to used qualified arborists to undertake tree maintenance to ensure the best long term outcomes for urban trees.

INSURANCE & RISK

A large portion of trees cut down in WA's urban centres are removed due to insurance claims or perceived risk. Some insurance companies request information on urban trees. Educating insurance companies on urban tree and heat impacts is necessary.

TREE STOCK

The ability to source good quality nursery stock of suitable tree species and ensure the tree is planted correctly is a significant issue for Local Government, developers and the community. Improved communication with the nursery industry is needed.

MEASUREMENT & MONITORING

Measuring and monitoring the urban tree canopy includes both developed and undeveloped private and public land. A preliminary assessment of overall canopy in urban areas provides decision-makers with information to plan their urban forest strategies.

For more information on how to measure and monitor an urban forest strategy see *Measurement & Monitoring the Urban Tree Canopy* on Page 32.

COMMUNITY AND STAKEHOLDER ENGAGEMENT

Community and stakeholder engagement and awareness are vital in the planning, development and implementation of healthy and sustainable urban forests.

Some of the pressing communication issues include:

LACK OF UNDERSTANDING OF BENEFITS AND VALUE

Stakeholders and communities are not well informed about the benefits and values that tree canopy provides socially, environmentally and economically.

FEAR/IGNORANCE

In many cases, falling branches, subsidence, fruit drop, poisonous seeds and other natural events caused by trees can all be managed if you select the right location for the right tree species.

VANDALISM

Trees and especially immature trees are prone to vandalism. Good maintenance, education, promotion of benefits and adequate tree protection measures are key in reducing vandalism.

TREE REMOVAL FOR REDEVELOPMENT

Trees on private land are commonly removed with the owner's consent for redevelopment. However, vegetation is commonly at the rear of the lot or on the boundary. Careful site analysis and good building design can reduce the need to remove vegetation during redevelopment.

UNAPPROVED TREE REMOVAL

Unnecessary tree removal and overzealous pruning practices by commercial tree loppers is a common issue for Local Government and the community. Maintenance work for significant trees should be undertaken by qualified arborists or horticulturalists.

For more information on community stakeholders see *Engage With Stakeholders* on Page 14.

3.0

DEVELOPING AN URBAN FOREST STRATEGY

PROCESS TO ESTABLISH AN URBAN FOREST STRATEGY

This section outlines potential steps in the development of an urban forest strategy. These steps may differ depending on the issues, needs and processes of each Local Government.

Figure 5. Key steps in development and implementation of an urban forest strategy.

STEP 1. ESTABLISH A WORKING GROUP

Establish a working group of local residents and business owners who are dedicated to supporting the vision of an urban forest.

This group can help educate the community on the importance of trees, interact with elected members in support of the program, assist in minor tree maintenance work like mulching and watering, participate in new tree plantings, help apply for grants and generate private financial sponsorship.

The group can also provide community-based advice, feedback and ideas to Local Government managers. A working group should serve in an advisory capacity only, and will rely on Local Government to undertake works.

The working group can be developed on an individual or a regional council basis.

STEP 2. ESTABLISH BASELINE OF INFORMATION

Assess the overall tree canopy within the Local Government area and identify significant trees on private land. This will help with the development of a tree register which can be used as a baseline for future measurement and management.

A tree inventory is a survey of publicly owned and managed trees. Data commonly collected during an inventory includes:

- number of trees;
- tree canopy density;
- tree size (including diameter);
- tree age and condition (useful life expectancy);
- species composition;
- location;
- maintenance need and priority;
- proximity to infrastructure such as utility lines, traffic signs and signals;
- footpaths and other hardscape damage;
- insect and disease problems; and
- potential planting sites.

Inventories are usually undertaken by trained and experienced arborists or horticulturalists. Tree attribute and location data are commonly collected using handheld computers, geographic information systems (GIS) data, and/or geographic positioning systems (GPS) equipment.

Advances in GIS and the development of related software for urban forest planning purposes have allowed Local Governments to keep track of trees on both public and private land. Digital aerial data can also be converted into GIS data to capture canopy cover.

In WA, data on the urban tree canopy has been made available by high resolution digital photography modelling, based on the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Urban Monitor™. Urban Monitor™ was initiated by the CSIRO to develop a time-series of urban and environmental indicators including urban tree canopy measures. It offers high resolution monitoring capability to identify changes in land condition and heights at a fine scale.

The CSIRO has worked with the Department of Planning, Lands and Heritage to translate tree canopy information into GIS shape files. This has seen the development of rigorous canopy data for the Perth and Peel regions for use by Local Governments.

Further information on the Urban Monitor™ is included is Section 5 '*Measurement & Monitoring the Urban Tree Canopy*'.

BOX 1: URBAN TREE INVENTORY

Urban Tree Inventories address planting requirements and utilise inventory data to create and guide public tree planting programs. Tree species selection and planting location designations are significant components of an urban forestry program. What and where to plant are critical long-term decisions.

Developing a tree inventory reveals vacant planting sites, the size and types of these locations, the current species distribution and other information. The strategy looks at this information to develop an overall planting strategy and address many issues related to new tree planting and their maintenance. The strategy identifies the areas that present an opportunity for improvement and recommends tree species suited to planting spaces. It may also discuss maintenance plans for newly establishing trees and provide information about correct tree planting techniques.

OUTCOMES

Use the information generated from an inventory to guide the strategy and tree plantings. This will result in improved life expectancies, fewer conflicts with utilities and other infrastructure and will be less expensive to maintain for Local Government.

STEP 3. IDENTIFY LOCAL ISSUES

It is important to understand local issues and trends facing the urban forest within an area and what a future urban forest is likely to look like under business-as-usual conditions. This will help clarify the vision, principles, strategies and targets for the urban forest strategy.

Issues and trends can be categorised under:

- vegetation – issues facing the trees that make up the urban forest;
- management requirements – the resources and likely activities required to manage and maintain the urban forest; and
- community perceptions – how the community perceives the trees, the scope and type of public consultation needed and what policies and management activities the community are willing to accept.

Commonly, this information is understood by officers across a Local Government. Once there is a clear synthesis of this knowledge around the issues and trends, urban forest vision, principles, strategies and targets can be determined.

Sector-wide issues are highlighted in the *Local Government Urban Forest Issues* on Page 6 of this document.

STEP 4. ENGAGE WITH STAKEHOLDERS

Community and wider stakeholder engagement will help create a shared and common vision, assess community values and awareness regarding urban forests and build trust. This will result in improved project outcomes that will support the growth, retention and management of trees.

The actions recommended in an urban forest strategy will generally involve land owned and managed by Local and State Government, private landholders, developers, businesses and other stakeholders.

Planning an engagement process

To help ensure a successful engagement processes it is important to understand the target audience. Communities vary in their ability to engage and participate; and it is important to use a diverse range of communications. Information and key messages should be framed in a way that informs and draws out stakeholder views on urban tree issues.

Before engaging with the community have the following points been considered?

- What is the purpose of the engagement? How will community input inform the development and content of the urban forest strategy?
- Who is the target audience/s? What are their backgrounds, values, influences and priorities? How might an urban forest strategy fit with these?
- What are the negotiable aspects of the urban forest strategy?
- What level of engagement is needed? Is the community being informed, consulted or more actively involved? The IAP2 Spectrum[12] can help determine the correct level of engagement for each community or stakeholder group;
- Are there parts of the community and/or stakeholders who could be particularly interested in, impacted by or who could impact the urban forest strategy? This may include traditional owners, individuals, groups and organisations, businesses and the development industry. Does the engagement strategy meet the needs of these stakeholders? and
- What is the engagement methodology? It is important to provide diverse and innovative opportunities for people to gain information, be involved and provide feedback. Also need to consider how participants will be informed of the outcomes.

Community awareness raising initiatives help the community to appreciate trees and the natural environment, become more comfortable with landscape changes and encourage long-term public support of urban forest expansion. The following initiatives can raise community awareness of trees and encourage ongoing collaboration:

- establish a *Tree Stewardship Program* to improve public awareness and encourage stewardship;
- the appointment of community champions that will promote the benefits of urban forests;
- establish a community *Urban Forest Advisory Committee or Working Group;*
- run tree planting days for residents and businesses; and
- develop self-guided walking tours of significant trees.

Opportunities to partner with community groups and interested stakeholders to promote urban forests and develop implement programs should be maximised. For example;

- promote the value of trees with schools by holding an art competition;
- run an incentive program with landscape industry / businesses for residents that encourages the value and benefits of trees; and
- celebrate events such as National Tree Day to raise the profile of trees and the urban forest.

[12] https://www.iap2.org.au/Home

BOX 2: COMMUNICATION & STAKEHOLDER ENGAGEMENT PLAN

The following may help with the development of a stakeholder engagement plan.

Strategy introduction:
Identify the key communications engagement objectives. For example:

- endorsing a common vision for the urban forest;
- assessing community values;
- building local knowledge, education and awareness;
- creating community champions;
- developing a volunteer base; and
- getting business and institutional support or sponsorship.

Identify stakeholder segments
A 'stakeholder' is any person, group, organisation, or system who affects or can be affected by any actions. Stakeholders can be categorised as primary and secondary and may require different levels of attention and messaging.

Identify engagement mechanisms
There are many different ways to engage with stakeholders. For example, mainstream media for public messaging campaigns, social media, area specific such as websites, online fact sheets, community notice boards, site specific signage, targeted distribution such as mail-outs, newsletters, targeted direct mail, letterbox drop, face-to-face initiatives such as seminars, workshops, community events. Determine which method(s) will provide the best chance of reaching each stakeholder group.

Develop the key messages
This is what needs to be said to the stakeholders and will be used throughout the project and across different engagement mediums. Make sure the messages are short and easy to understand.

Facts and figures
Provide clear, evidence-based information on urban tree and canopy facts, supported by data and research.

Issues - community validation
Identify local issues to assist in developing key messages. Many urban forest related issues are shared across Local Government and some messaging is common.

Create community validation and confirmation of local urban canopy drivers, current issues and potential interventions.

Feedback and refinement
Draft strategy, review, and finalise strategy for endorsement.

STEP 5. DETERMINE VISION, PRINCIPLES, STRATEGIES & TARGETS

The vision, principles, strategies, and targets of the urban forest strategy need to align with the Local Government's broader visions, strategic aspirations and planning. They should provide clarity, focus and actions for developing and maintaining a high level of liveability and wellbeing for the community. The vision and principles should guide urban tree planning, management and decision-making within the Local Government.

Vision

A vision should be an aspirational description of what the strategy would like to achieve in the future. The vision must address the issues of tree canopy change and meet the needs of the Local Government, elected members, the community and stakeholders.

Principles

Principles will guide decision-making to achieve the vision. Before targets are established it is important that principles are established to guide decisions. The principles directly address the local issues and challenges. Principles are summary statements that spell out the general outcomes that drive decision making. The more specific or quantifiable the principles, the easier it is to develop performance indicators. See Box 3 for examples of principles and strategies from the City of Melbourne.

Strategies and targets

Strategies and targets describe how the vision will be achieved. Strategies are more specific than principles.

The setting of canopy targets needs to consider the Local Government's physical attributes, capabilities, finances and community stakeholders.

Factors beyond the influence of Local Government will commonly impact on the capacity to achieve the targets. However, targets can also be reviewed and adjusted.

The benefits of targets are in establishing clear milestones and actions to meet the targets. Having targets, notably based on the goals of minimising the loss of canopy on private land and increasing canopy on public land, allows for the effectiveness of actions to be measured and actions refined in an adaptive management approach.

BOX 3: PRINCIPLES & STRATEGIES FROM THE CITY OF MELBOURNE

Vision: A healthy, resilient and diverse urban forest that contributes to the health and wellbeing of our communities, and to a liveable city that will create better urban environments for everyone.

PRINCIPLES:

Mitigate and adapt to climate change

- Build a resilient urban forest that can tolerate and continue to thrive in future climatic extremes.
- Ensure a diversity of tree species and ages to maximise resilience against pests and diseases.
- Increase overall vegetation biomass to assist in storage and sequestration of carbon.

Reduce the urban heat island effect

- Build a functioning healthy urban forest canopy to provide shade and cooling to reduce heat absorption and emission by the built environment.
- Develop public spaces to improve human thermal comfort and maximise health benefits.
- Capture more stormwater to increase infiltration into the soil and enable maximum evapotranspiration.

Design for health and wellbeing

- Provide cool shaded spaces in summer; sunlight access in winter
- Plan and manage the urban forest to ensure longevity of green spaces for future generations.
- Create well-designed public spaces to encourage outdoor activity, social connectedness, respite, exercise and general sense of wellbeing.
- Create healthier ecosystems.
- Support healthy ecosystems in order to provide . benefits in terms of clean air, water and soils.
- Expand and improve biological and structural diversity.

Design for liveability and cultural integrity

- Design landscapes to reflect the cultural integrity, identity and character of Melbourne and its neighbourhoods.
- Create world class open spaces, parks and streetscapes.
- Design spaces for people to reconnect with nature, create a sense of place and enable reflection and tranquillity.

Become a water sensitive city

- Promote the use of innovative techniques for water sensitive urban design, such as rain gardens, bioswales, underground storage reservoirs and biofilters.
- Use alternative water sources for irrigation to reduce potable water use.
- Ease stormwater flows and peaks by replacing impervious surfaces with porous materials to reduce heat absorption and encourage soil moisture retention.

Position Melbourne as a leader in urban forestry

- Increase Australian-based urban forestry research.
- Inform and involve the community in decision-making for landscape adaptation and change.
- Increase the public profile and understanding of the attributes, role and benefits of the urban forest.

STRATEGIES:

- Increase canopy cover.
- Increase urban forest diversity.
- Improve vegetation health.
- Improve soil moisture and water quality.
- Improve urban ecology.
- Engage with the community.

BOX 4: AREA-SPECIFIC TARGETS

Canopy or other vegetation targets can be developed for specific areas within a Local Government's control or in partnership with stakeholders. Targets could be set for areas such as:

- Private land such as residential, commercial or industrial land in consultation with residents.
- Car parks – this can be challenging because of large areas of impermeable surfaces, however, providing shade in these areas is also an opportunity that allows for great environmental and health benefits to be realised.
- Road reserves and verges – a general target of one canopy tree per lot on residential, commercial or industrial land is encouraged in local road design guidelines. In many cases this could be increased subject to the lot frontage. The design and installation of cross-overs should cater for one tree per lot.
- Public recreational reserves – while sporting space needs to be maintained, increasing canopy on park edges provides further opportunities to enhance parkland amenity.
- Private recreational reserves and landowners, such as golf courses, often cover large areas and provide an opportunity for canopy enhancement
- Land owned by public utilities – these areas commonly contain or are planned to incorporate water, power or telecommunications infrastructure. They also represent opportunities for canopy development in partnership with utilities, subject to specific restrictions.
- Precinct opportunities - a defined precinct that contains a range of land uses and provides an opportunity to enhance canopy cover through redevelopment plans or as a strategy to enhance the public realm.

Other measures can include:

- A reduction in the percentage of canopy lost
- The number of trees planted within specific areas
- Percentage of canopy gained in specific areas.

Specific initiatives geared towards these areas would likely allow Local Governments to reach its canopy cover goals within a shorter timeframe.

STEP 6. DEVELOP THE ACTIONS

The principles, strategies and targets describe the desired outcomes and the actions describe how the outcomes will be achieved. For example; plant trees, conduct workshops, create controls and/or enforce regulations. These are documented along with time frames and responsibilities in an action plan.

See Case Studies for further information.

STEP 7. IMPLEMENT THE STRATEGY

An urban forest strategy will be a community asset and is owned by the Local Government and the community. Integration is the key and everyone has a role.

Strategies may be planned and facilitated by planning or environmental officers but many actions will be implemented by horticulturalists and public works staff with community collaboration.

Implementation plans describe how, what and by whom activities will be carried out and when they will occur. It is important to measure progress including the timeframes and responsibilities for each action. Communication to the wider audience of successes, failures, learnings, adaptations and overall progress is also important.

BOX 5: BUILDING RELATIONSHIPS

Building relationships with other departments within your Local Government, neighboring Local Governments and key stakeholder groups is important for successful buy-in.

Sharing the latest urban forestry research and local success in half yearly or annual performance reports can include:

- the number and types of trees planted and their survival rates;
- progress on outreach and education workshops held;
- updates on projects reviewed;
- policy progress and achievements;
- urban heat island and related health information; and

By communicating, sharing and integrating activities across other departments and key stakeholder groups a common mission and integrated planning evolves, such as the incorporation of urban forest and stormwater management as a catchment planning approach.

STEP 8. REVIEW, MEASURE & EVALUATE

Monitoring is essential to tracking canopy loss and gains to measure progress towards the plan's principles and strategies. When starting to implement an Urban Forest Strategy its progress should be monitored. As actions are implemented, results can be assessed, progress towards outcomes and acceptable standards understood. This feedback provides clarity on how well the various parts of an urban forest strategy are working.

Over the course of a long-term strategy new issues may arise that could not be accounted for during the initial planning phase. By monitoring the urban forest, information can be gathered that allows for actions and plans to be adjusted over time.

Adaptive management encourages decision-making that is flexible. As the issues and outcomes from management actions become better understood, adjustments can be made. Adaptive management is a performance-based system that has the following characteristics:

- monitoring;
- analysis of outcomes and consideration of objectives; and
- the alignment of revised actions.

Monitoring can reveal emerging issues not addressed in the original plan. For example, a new disease or climate change impacts affecting the viability of a tree species. By planning for regular evaluation and revision of a strategy the need for adjustments are identified before a crisis develops.

While adaptive management provides a structured process for learning which actions best meet management objectives, monitoring is best achieved on the ground and through the spatial capture of canopy cover. The Urban Monitor™ spatial data sets provide information at the scale of lots, street blocks, roads and parks. These can be aggregated upwards to allow monitoring at the suburb or Local Government scale. Ideally reviews should be undertaken every two to three years in order to re-examine actions and plans with the objective of adapting these where necessary.

BOX 6: URBAN CANOPY - LAND USE CATEGORY RISKS

Three broad land use categories are suggested to reflect different land use risks relevant to monitoring and include the likely development and infrastructure impacts and responsibilities of State agencies, Local Governments and private land owners.

These risk factors can be mapped by land use and combined with urban canopy data to help prioritise areas for intervention where risk of loss is high and the identification of plantable areas with low canopy and a low or medium risk profile.

Low risk – parks and reserves
Trees within a parkland setting are considered to be low risk because these areas are designated as spaces for biodiversity, recreation and relaxation with few development pressures. Education spaces do not provide the same level of protection for trees as zoned parks and reserves and often have active building programs such as university campus upgrades. However there is generally a greater appreciation, flexibility and duty of care toward tree preservation and active tree planting and maintenance programs in these spaces than in residential, commercial and industrial land uses. For that reason, education spaces are considered in this category too.

Medium risk - road reserves
The road verge provides the opportunity for regular tree planting and maintenance by local authorities to provide continuous and converging tree canopies for shade and aesthetics, often playing a role in the character of a suburb. Road reserves are shared spaces with multiple functions; the road reserve is Crown land or land vested with the Local Government authority for general management. However, State statutory authorities also have authority to use the road reserve.

Tree canopy in road reserves is considered medium risk due to infrastructure maintenance, the increasing size of driveways and crossovers and the impacts of builders undertaking housing renovations of new builds. These activities are known to damage trees.

Road widening can also have a significant impact on established trees and may result in complete removal of existing trees with no space for replacement trees. The benefit of road reserve management that underpins the medium risk status is that infrastructure and maintenance activities are often highly managed in association with Local Government.

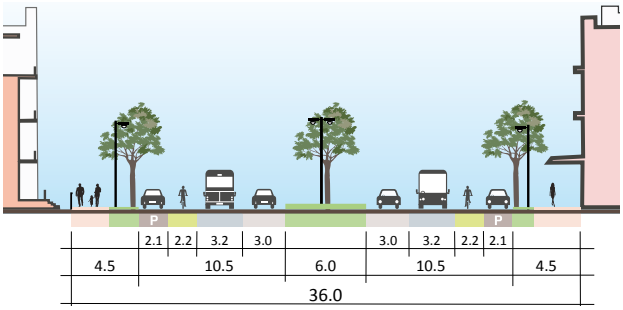
High risk – private lots
Trees on private lots are at the greatest risk from development pressures and have limited protection under current statutory policies. While residential extensions and redevelopments are a common cause for tree felling, trees are be removed on private land at any time for a number of reasons (structural integrity, overhanging limbs, invasive roots and shedding of leaves and nuts are a few reasons). If trees are not properly considered in the development process it is likely that future subdivision will increase subsequent tree canopy loss.

BOX 7: PLANTING OUT STREETSCAPES - LOCAL ROAD ENGINEERING

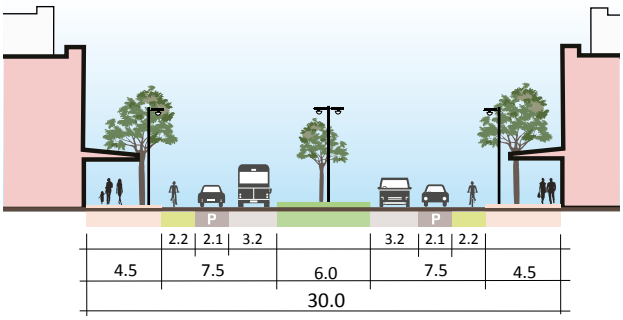
Road design is based on a hierarchy, either as arterials or local streets, with a range of types in each classification. The main function of arterials is to accommodate the movement of regional and district traffic. Local streets and reserves however, provide a wider range of functions in addition to traffic movement, including place-making, lot access; and provision of parking, utilities, drainage, lighting, street trees and street furniture. Local Government are responsible for the management and maintenance of local roads and trees in road reserves and median strips.

Many arterial and local road reserves and median strips have lost or never had trees planted. Local Governments can request State transport agencies plant trees in arterial roads reserves in line with landscape guidelines. As Local Government have control of local road reserves they can directly impact the streetscape on these roads. As a minimum street trees can be planted at a frequency of one tree per lot unless lots are wider than average and additional trees can be planted.

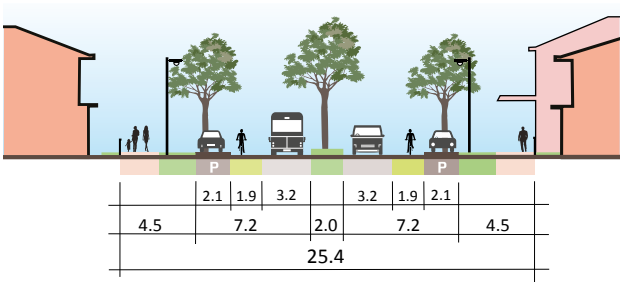
The following cross sections consider the more common street types and placement of trees.



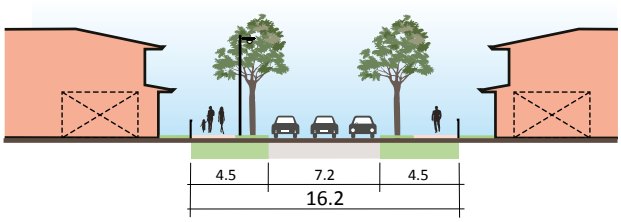
Integrator A Arterial



Integrator B Arterial



Neighbourhood Connector A



Access Street B

4.0

TOOLBOX

This toolbox includes guidance and case studies on statutory and strategic planning mechanisms and community involvement plus a number of links for further reference.

LEGISLATION & STATE PLANNING POLICIES

The *State Planning and Development Act 2005* promotes the sustainable use and development of land in the State and the protection of natural resources including the preservation of trees, vegetation and flora plus the maintenance of ecological process and genetic diversity.

The *State Planning Strategy 2050* requires the demonstration of exemplary built form and environmental excellence while the Environmental Protection Authority's Interim Advice for Perth and Peel at 3.5 Million requires the development of a framework for maintaining and enhancing green space and urban tree canopy in support of Local Government tree retention and management efforts.

The strategic planning document Perth and Peel @3.5million promotes sustainability and urban forests to help reduce air pollution and minimise the impact of urban heat islands, plus the preservation and enhancement of existing landscape values.

This position is supported by statements in State Planning Policies (SPPs) that protect community health and wellbeing along with environmental attributes including the promotion of urban trees and the conservation and protection of native vegetation.

Policies designed to guide urban form and landscapes such as *Liveable Neighbourhoods* include improvement in urban tree canopy and support avoidance of environmental impacts and green infrastructure that contributes to a quality urban environment. Draft *State Planning Policy 7: Design of the Built Environment* is intended to contribute to canopy retention or development through the inclusion of deep soil zones.

The planning policy hierarchy for urban tree canopy is detailed in Figure 6.

PLANNING MECHANISMS SUPPORTING URBAN TREES & FORESTS

There are a number of protection and other mechanisms for Local Government planning instruments that enable the retention of trees on public and private land. Local Governments utilise a combination of mechanisms illustrated in detail in Figure 7.

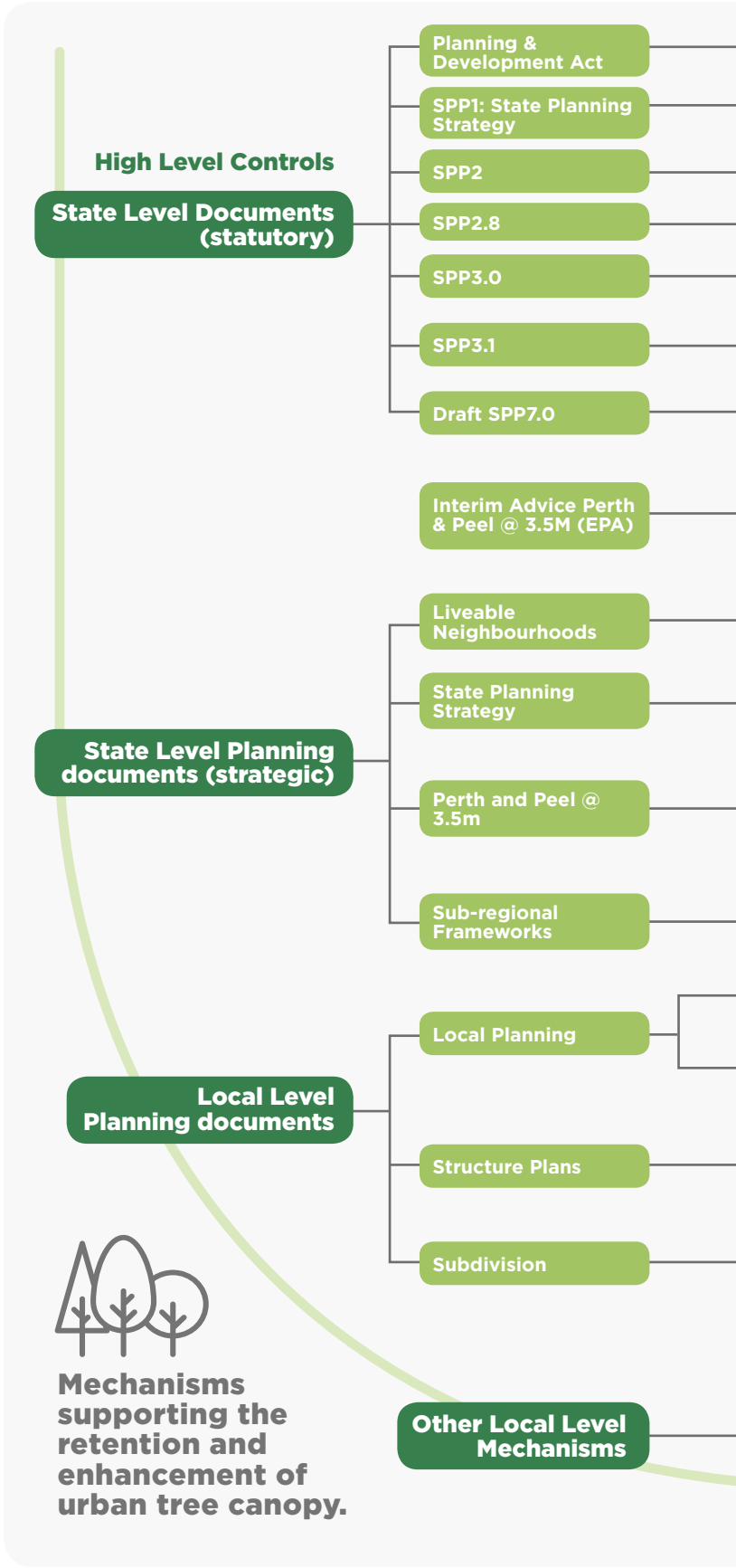


Figure 6. Planning policy hierarchy for urban tree canopy

Schedule 7: Clause 7.4 (2) "The conservation of the natural environment of the scheme area including the protection of natural resources, the **preservation of trees**, **vegetation and other flora and fauna**, and the maintenance of **ecological processes** and **genetic diversity**."

General Principles - Communities – Promoting a range of accessible community resources, including, **open space**, **urban tree canopy,** education, **health**, cultural and community services.

Clause 5.1 (x) – Support **conservation, protection and management of native remnant vegetation** where possible, to enhance soil and land quality, water quality, biodiversity, fauna habitat, landscape, amenity values and ecosystem function. Clause 5.10 (ii) – Support the **retention of existing vegetation and revegetation** in subdivision and development proposals.

Objective - Protect and manage regionally significant **bushland for conservation** purposes.

Clause 5.1 – "…to create sustainable communities, that is, cities, towns and other places which provide for high levels of employment and economic growth; strong, vibrant and socially inclusive communities; **effective protection of the environment**; and the prudent use of resources."

Clause 5.4 –"the protection of key environmental areas and the incorporation of significant cultural." and environmental features of a site into the design of an area;

Clauses within the R-codes which can be utilised to facilitate an improvement in urban tree canopy cover, these include: Clause 5.3.2 P2 & C2 (iii, vi); Clause 5.3.4 C4.3; Clause 5.3.5 P5.2 & C5.3; Clause 6.3.1 C2; Clause 6.3.4 C4.3.

The Design Principles of SPP7.0 include **Landscape** quality and **Sustainability** promoting trees and ecology in the built environment.

There are a number of clauses within the proposed revision of the R-codes which can be utilised to facilitate an **improvement in urban tree canopy cover.** These include increasing setbacks, measures for retaining trees and requirements for deep soil areas and guidance for sustainable landscaping.

WAPC and Local Governments take steps to counteract the air quality, human health and amenity implications from the urban heat island effect through a greening strategy for the Perth and Peel regions. Outcomes include a Green Network and increased canopy in new and existing urban areas.

Action Plan G – A framework for maintaining & enhancing green space and urban tree canopy, support LG strategies for increasing canopy cover.

Principal Aims of the policy, the following touch on green infrastructure assets and their contribution to achieving the aims:
3. Providing a safe, efficient and pleasant walking, cycling and driving environment.
8. Ensuring the avoidance of key environmental impacts and the incorporation of significant cultural and environmental features.
Other clauses within can be use to facilitate an **improvement in urban tree canopy** cover include: 1.3; 2.10; 3.1; 4.14; Element 5.

STRATEGIC GOALS

Sustainable Communities – Resilient communities with social capital & networks that ***demonstrate exemplary built form & environmental excellence.***

Conservation – Conserving the natural environment through sustainable development and prudent use of resources.

STRATEGIC GOALS

Liveable – A city with an enviable quality of life characterised by a community which is diverse and inclusive; engaged and creative; safe and healthy.

Sustainable – Perth will manage its ecological footprint and live within its environmental constraints, while improving our connection with and enjoyment of the natural environment.

Clause 8.3 Urban Forests – Trees in urban areas have social, environmental and recreation benefits, including **reducing air pollution, minimising the impact of heat islands,** *encouraging outdoor activity, providing habitat and support to biodiversity and enhancing local amenity.*

Strategic Goals of Perth and Peel at 3.5 M. **Key Principles** - Avoid, protect and mitigate environmental attributes when allocating proposed land uses.

Objective: Preserve and enhance existing environmental and landscape values of the sub region.

Set Strategic Goals, Actions and Strategy for **urban tree canopy** within the Local Planning Strategy. Allows for the establishment of a framework for local planning and the strategic basis for the local planning scheme over a 10-15 year period.

There are clauses within the Model Scheme Provisions that relate to urban trees, including: **Significant Tree Registry**; Heritage List; Development Area Schedule Provisions.

City of Stirling – Scheme Amendment No.9 – provides an example of an acceptable scheme provision that allows for **the retention of existing Significant Trees** on development sites, and the requirement for new planting in deep-soil zones on new development sites.

Through the design of higher level controls it is possible to influence the design of structure planned areas to achieve better outcomes for urban canopy cover. Consider items such as positioning of POS, interfaces with existing regional open space, and lot levels.

Supporting documentation can be used to make informed decisions, including: Environmental Assessments, Flora and Fauna relocation plan; POS design in LWMS.

Framing the above statutory and strategic framework with a line-of-sight approach allows for the consideration of conditions that benefit good urban tree canopy outcomes.

WAPC Standard Conditions feature many useful conditions that go to the retention of significant vegetation and better environmental outcomes.

Clear understanding within an organisation on the importance of urban tree cover will lead to better outcomes when clearing conditions of subdivision.

- **Urban Forest Strategy**
- **Tree Bond Policy**
- **Local Engineering Standards**
- **Street Tree Planting Policy**

It is important for all officers within an organisation to understand the important of trees in an urban environment, and subsequently value the inclusion of these in non-planning documents.

This is particularly important at the later stages of development where the delivery of the urban fabric is under supervision of officers from other professions.

Cross-disciplinary responsibility greatly assists in the follow-through of the goals of the State and Local Government's strategic vision on urban tree canopy.

FIGURE 7

Local tree protection and management mechanisms

CONTROL	SUPPORTING MECHANISM	DESCRIPTION	EXAMPLE CONDITIONS
Urban Forest Strategy (UFS) & Urban Forest policy.	Local Planning Scheme (LPS). Local Policy (LPP) Significant Tree Registers (STR) Site and Context Analysis Water Sensitive Design	Design objectives for tree canopy and urban greening. UFS are created to guide the establishment of large numbers of additional trees primarily in public land but can extend to support mechanisms for tree retention on private land. An UFS should benchmark progress, identify real value, and inform the community. See Case Study City of Armadale – Green Public Infrastructure.	The local policy and LPS support the UFS to ensure that tree cover is maintained and enhanced where possible in light of development on private land, climate change and aging tree stock. This is mostly concerned with the management of trees on land under the care and control of the LG.
Local Planning Scheme.	*Planning and Development Act* (2005) Planning and Development (Local Planning Schemes) Regulations 2015 Local Planning Manual	Matters relevant to the retention of trees or the maintenance of tree canopy that can be addressed in the LPS (as set out in Schedule 7 of the *Planning and Development Act 2005)* include: Development – • Controls for land or site management • Development standards (including open space and landscaping) • Development controls Preservation & conservation – • The preservation of places and objects of cultural heritage significance, including control of the demolition and alteration of any building, structure or works • The conservation of the natural environment of the scheme area including the protection of natural resources, the preservation of trees, vegetation and other flora and fauna, and the maintenance of ecological processes and genetic diversity • The conservation of water https://www.legislation.wa.gov.au/legislation/statutes.nsf/main_mrtitle_722_homepage.html	Local scheme provisions can to help protect trees on development sites or where appropriate ensure new trees are planted on site or on adjoining road reserves. Provisions for practical tree retention/inclusion can be achieved through: • Landscape Zones • Tree preservation orders • Significant tree registers • Where applicable, conditions of development in order to protect trees • The replacement of trees removed. • Building permits required for demolition Provisions may also include tree planting ratios (and appropriate species) over a specific site area. Landscape Value Zones – City of Busselton. https://www.planning.wa.gov.au/LPS/DATA/Local%20Planning%20Schemes/Stirling%20-%20City%20of%20(Scheme%203)/Scheme%20Text.pdf https://southperth.wa.gov.au/docs/default-source/4-develop/planning/town-planning-scheme/city-of-south-perth-town-planning-scheme-no-6-text.pdf?sfvrsn=ee37fcbd_16
Structure and Local Development Planning (SP)	*Planning and Development Act* (2005) Local Planning Scheme. (LPS) R-Codes	Structure plans provide for the zoning and subdivision of land. A district structure plan may apply to several suburbs or all or part of a townsite. *Liveable Neighbourhoods* is the main subdivision control. It has a number of policy aims relevant to tree retention and site & context requirements that support: • Sustainable development • Safe & pleasant environs • Cultural and environmental features Local development plans address specific design issues for small areas of development that require special design consideration and maybe within a structure plan area. See City of Cockburn – Structure Planning case study.	A structure or local development plan is required to: • Show due regard for State Planning Policies • Show protected environmental and heritage features • Deliver subdivision and development requirements • Outline mechanisms to protect environmental or heritage features

CONTROL	SUPPORTING MECHANISM	DESCRIPTION	EXAMPLE CONDITIONS
Significant Tree Registers (STR)	Local Planning Scheme. (LPS) Local Planning Policy (LPP)	A STR is an initiative under a TPS to protect trees of significance to the community and is supported through the LPS and local policies. The tree/s can be nominated by anybody and can be either native or exotic species growing on private or public land. Once nominations are received, the tree will be assessed against set criteria. http://www.bayswater.wa.gov.au/cproot/8416/2/Significant-Tree-Register-Guidelines.pdf https://www.stirling.wa.gov.au/development/Schemes-policies-codes-and-legislation/Policy%20Manual/6.11%20Trees%20and%20Development.pdf#search=6%2E11	Tree provisions may be addressed in LPP or local tree policies and are read in conjunction with other local polices such as landscaping or cross over policies. STR criteria are commonly referenced in local policies and may include factors under criteria, such as: • Amenity - Visual/Aesthetic Significance • Botanical - Scientific Significance • Ecological Value • Cultural or Social Significance Other practical considerations may include: • The condition (shape, health and structure) and life expectancy of the tree • The proximity to conservation areas and its biodiversity value • Work required for retention and protection of the tree • The location of the tree on the development site • The possibility of safety risks • Any pests, diseases or is it an undesirable species; and • The number of existing trees on site Once an application has been made, and stakeholders including land owners contacted for comment the nominated tree will be assessed for is worthiness by experts, including council officers. LGs generally required a landowner to agree to the listing of a significant tree. A STR criteria is determined by the LG and subject to assessment.
Tree Preservation Orders (TPO)	Local Planning Scheme. (LPS) Local Planning Policy (LPP)	TPOs are one mechanism which allows the LG to serve a notice requiring landholders to preserve a tree or group of trees. The notice prevents landholders from cutting, removing or otherwise destroying any preserved tree unless the LG grants approval or rescinds the notice or order. https://www.armadale.wa.gov.au/tree-preservation-orders See Case Study City of Armadale - Tree protection Orders.	The tree is assessed and must meet at least one significance criteria usually specified in the Local planning policy such as: • Heritage Significance • Aesthetic Quality • Species Significance • Landmark or Landscape Significance If the tree(s) meets one or more of these criteria, the condition of the tree(s) and its existing and potential impacts are assessed. A TPO criteria is determined by the LG and is subject to assessment by nominated experts.
Local Planning Policy (LPP)	Local Planning Scheme. (LPS) Residential Design Codes.	LPPs to help protect trees on development sites should be consistent with scheme and provides greater detail and definitions. https://www.armadale.wa.gov.au/sites/default/files/assets/documents/docs/Planning_and_Land_Use/PLN_2_4_Tree_Preservation.pdf https://southperth.wa.gov.au/docs/default-source/6-about-us/council/policies-delegations/housing-and-land-uses/p350-5-trees-on-development-sites-and-street-verges.pdf?sfvrsn=baf5fabd_2	On development sites a LPP may specify: • A landscape plan that accurately show trees must be submitted to a LG to seek planning approval • The practical retention of existing trees to the LGs satisfaction. • Design to retain existing trees while preserving dwelling density entitlement • Requirements for the removal of a tree and its replacement in a designated location • Protection of registered trees (significant or in preservation clauses) • Variations to R-Code “deemed to comply” provisions, subject to Part 7 (specifically 7.3.1 and 7.3.2) of the Residential Design Codes ,based on building design, dwelling size, heritage and vegetation retention among other criteria • Requirements for planting in street setbacks and verges. • Methods for valuing trees • Tree Protection Zones • Tree Bonds and payments
Development Approval	Local Planning Scheme. (LPS)	Development approvals ensure that development within an LG complies with the Town Planning Scheme, Residential Design Codes and other relevant legislation and policies. Where development approval is required for building works and/or when changing the use of a site.	Accompanying material related to tree preservation may include: • Existing and proposed ground levels • The location, height and type of all existing structures and environmental features, including vegetation • The structures and environmental features that are proposed to be removed • Plans, elevations and sections of any building proposed to be erected or altered • Accompanying arborist report or landscape plan showing retained trees

CONTROL	SUPPORTING MECHANISM	DESCRIPTION	EXAMPLE CONDITIONS
Special Control Areas (SCAs)	Local Planning Scheme. (LPS) Local Planning Policy (LPP)	In addition to zoning and reservation, land may also be subject to other 'special' controls based on the particular characteristics of the land or its surroundings. It may be an area with special character or environmental constraints, in which particular design and development requirements apply. Schedule A https://www.armadale.wa.gov.au/sites/default/files/assets/documents/docs/Planning_and_Land_Use/PLN_2_4_Tree_Preservation.pdf See Case Study City of Melbourne – Exceptional Tree Register.	The identification of areas within the TPS such as landscape and bushland valued areas as SCA's which can serve to protect groups of trees. • The LG may serve notice on an individual landowner or upon a subdivider, requiring the preservation of a tree or group of trees. This restricts a landowner from cutting, removing or destroying any tree unless the LG grants approval or rescinds the notice
Development/ Building Envelopes	Local Planning Scheme. (LPS) Local Planning Policy (LPP)	A development or building envelope is "an area of land within a lot marked on a plan approved by the responsible authority within which all buildings and effluent disposal facilities on the lot must be contained". https://www.armadale.wa.gov.au/sites/default/files/assets/documents/docs/Planning_and_Land_Use/PLN_2_1_Development_Envelopes.pdf	Development or building envelopes are established in accordance with LPS clauses and prohibit the clearing of remnant vegetation outside the designated envelope, except in the following instances: • As necessary for the establishment of an approved vehicular access from the adjacent street to the designated development envelope • As required to satisfy necessary bush fire protection measures as determined by the LG or other relevant authority; or • As approved by the LG A LPP establishes criteria to determine the appropriate location and size of development envelopes and also outlines the minimum submission requirements for applications to either establish a new or amend an existing development envelope. Development envelopes are usually applied on land zoned for rural living (including rural residential) purposes.
Tree Protection Zones (TPZ)	Local Planning Policy (LPP)	TPZ can be used for all demolition and construction works where the developer/ owner is responsible for the root, trunk and canopy protection of any tree to be retained on a development site or road reserve. https://southperth.wa.gov.au/docs/default-source/6-about-us/council/policies-delegations/housing-and-land-uses/p350-5-trees-on-development-sites-and-street-verges.pdf?sfvrsn=baf5fabd_2 https://www.stirling.wa.gov.au/Council/Policies-and-local-laws/Policy%20and%20Local%20Laws/Street%20and%20Reserve%20Trees%20Policy.pdf	Guidelines for a TPZ can include: • A fence that must be installed to create a TPZ at the cost of the applicant • The type of fencing must be in line with the Australian Standard for Protection of Trees on Development Sites • The size of the TPZ will be determined by the LG, dependent on the size of the tree and verge space available • At minimum, the TPZ will cover two metres by two metres around the tree trunk – any lesser exceptions must first be approved by the LG. • The TPZ should not obstruct roads or footpaths unless approved alternatives are in place TPZ are commonly applied with Tree Bonds (below).
Tree Bonds (Local Laws)	Local Planning Policy (LPP) Tree Preservation Orders (PTO) Significant Tree Registers (STR) Tree Protection Zones (TPZ)	Local Laws allow for Tree Bonds where development, works or other activities have the potential to impact on; LG street trees, trees registered under PTOs or STRs or trees in TPZs. A bond for the protection of the street tree can be held by the LGA prior to the commencement of development. Bonds can be incorporated into the existing verge bond, required as part of the verge permit process. The bond will be held for the duration of the works. https://www.boroondara.vic.gov.au/sites/default/files/2017-05/Tree-Protection-Local-Law.pdf See Case Study City of Gosnells – Street Tree Removal.	Guidelines for tree bonds may consider: • If a tree is damaged, dies or is removed as a result of development, without the LG authorisation, the trees value (as determined for example by Helliwell valuation) and tree replacement costs can be deducted from the full bond • Where the tree has a significantly higher value than the retained bond further action can be taken to recover costs • If a tree is damaged or pruned without authorisation, part or all of the bond may be retained dependent on the impact caused to the tree and the condition of the remains of the tree Helliwell tree valuation system - https://www.forestry.gov.uk/PDF/FCRN008.pdf/$FILE/FCRN008.pdf Also http://www.tandfonline.com/doi/abs/10.1080/00037931.1967.10590279?journalCode=tarb19

CONTROL	SUPPORTING MECHANISM	DESCRIPTION	EXAMPLE CONDITIONS
Tree Management Incentives	Local Laws LG Budgets Local Planning Policy (LPP) Tree Preservation Orders (TPO) Significant Tree Registers (STR) Tree Protection Zones (TPZ)	LG have the ability to develop a range of incentives in recognition of public good for protection canopy trees or areas of biodiversity on private land. Incentives can be applied at subdivision or demolition or development approval stage and applied to any private lot or PTO, STR and TPZ. They should be tied to some form of legal agreement and have a long term timeframe. See case Study City of Vincent – Financial Assistance for Significant Tree Owners.	Tree management incentives provide by LG may include but are not limited to: • Rate reductions or an exclusion on rate increases. • Subdivision bonuses (usually biodiversity protection) • Amendments to setbacks or build form restrictions (tree protection) • Fast track approvals • Financial assistance for tree pruning and management • Fines for the removal or damage trees with PTOs or in a STR or TPZ
Site & context analysis - for subdivision and redevelopment.	*State Planning Policy 1 State Planning Framework Policy* *State Planning Policy 2 Environment and Natural* Resources (section 5.9 Landscape) *Liveable Neighbourhoods* *Development Control Policy 1.1 Subdivision of Land* *1.2 - Development Control -* *Local laws and policie*s	Subdivision applications should be submitted with enough detail to enable a decision on an application. Matters relevant to tree retention include but are not limited to: • The size, shape and dimensions of each lot • The services available to each lot • Drainage of the land • Access to each lot • Any relevant planning scheme • Relevant local laws relating to town planning	Site and context analysis identifies vegetation for retention in subdivision and redevelopment. Site responsive design can require: • The lot size and subdivision layouts to respond to the physical characteristics of an area including topography, soils, drainage, vegetation and natural features and views • Lot layouts need to address site constraints and optimise orientation to suit energy efficient housing where possible • Site plans or landscape plan may accompany subdivision layouts and can include tree retention or placement in order to address site responsive design • Site works and management consistent with water sensitive design applied through the urban water management plan
Water sensitive design – In-situ stormwater and vegetation planning.	Better urban water management Developer LG compliance/quality assurance	Subdivision conditions relevant to stormwater construction can include: • Local-scale water balance –options for water re-use and conservation strategy, including required approvals • Construction and management consistent with an urban water management plan and vegetation management	In order to integrate in-situ stormwater and vegetation planning: • Ensuring urban stormwater is directed to public planning and street trees • Specification of design requirements through a developer covenant • In-situ stormwater and vegetation planning consistent with urban water management plan https://www.planning.wa.gov.au/dop_pub_pdf/Better_Urban_Water_Management.pdf
R-Code Variations	*Planning and Development Act* (2005) Structure and Local Development Planning (SP) Local Planning Scheme. (LPS)	The R-Codes are designed to provide a basis for the control of residential development with a core objective of encouraging design that considers social, environmental and economic opportunities while responding to local amenity and place.	R-Code variations may be used to include the practical provision for landscaping, trees or vegetation at a lot scale which may be achieved through changes in the plot ratio, specifications for a deep soil zone or variation to outdoor living areas.

CASE STUDIES

CITY OF ARMADALE – TREE PROTECTION ORDERS

DESCRIPTION

The City of Armadale's Town Planning Scheme No.4 provides a number of mechanisms to protect significant trees or groups of trees. Tree Preservation Orders are one mechanism which allows the City to serve a notice requiring landholders to preserve a tree or stand of trees under their town planning scheme. The notice prevents landholders from cutting, removing or otherwise destroying any preserved tree unless the City grants approval or rescinds the notice or order.

OUTCOMES

The issuing of a Tree Protection Order is used when the tree in question is of such significance that additional protection is warranted. The tree must meet at least one significance criteria as provided in the City's Local Planning Policy PLN 2.4: Tree Preservation, including:

- heritage significance;
- species significance; and
- location, landscape and landmark significance.

If the tree(s) meets one or more of these criteria, the condition of the tree(s) and its existing and potential impacts are assessed. Anyone can request that the City investigate the significance of a tree with a view to issuing a notice under Clause 80A of Schedule A of Town Planning Scheme No. 4.

SOURCE

https://www.armadale.wa.gov.au/tree-preservation-orders

CITY OF ARMADALE – GREEN PUBLIC INFRASTRUCTURE

DESCRIPTION

The City of Armadale's implementation and management plan for the planting of street and reserve trees provides guidance for the implementation and management of trees as public 'green' infrastructure in accordance with the City's Urban Forest Strategy 2014.

The (UFS) implementation plan outlines:

- tree planting guidelines in line with relevant policies and documents;
- the initial five year planting program for street and reserve trees;
- the implementation process and procedure;
- impacts on new residential and commercial development; and
- the ongoing management process and procedures.

The City adopted UFS was created to guide the establishment of large numbers of additional trees in streetscapes. The CoA decided to benchmark progress, identify real value, and capture success of its UFS.

The Parks department holds regular Urban Forest Working Group meetings ensuring all areas of the UFS are well managed. An increase in number of trees is attributed to the UFS.

In the City 2016/17 budget it was agreed to develop and enhance in-house resources to service the establishment of a dedicated Urban Forest Crew.

The City Geographic Information and Parks Officers have also created a data model for capturing tree data and their locations which includes:

- asset tree ID number;
- tree species;
- tree characteristics – evergreen/deciduous;
- size of tree at maturity; and
- shade the tree will cast – summer/winter solstice.

This software has now been used to log proposed tree planting locations for the urban infill street tree planting in future subdivision.

OUTCOMES

The City currently has 46% urban tree canopy cover and a 13.2% increase in canopy since 2011. Hard services have had no significant increase. Grassed surfaces have increased by 6%.

Parks and Communications staff, continue to improve collaboration with the community through the use of several media releases and City Views articles. Many households have received a tree and been provided details and feedback opportunity. Community ownership in the Urban Forest contributes greatly to its value.

The City's Policy ENG 6 – Street Trees was reviewed in August 2016 and formally adopted by Council. The policy refers to the development and management of trees on street verges including their promotion, valuation, retention, protection, planting, maintenance, pruning, removal and mapping.

Urban forests are increasingly recognised as an important part of a city's infrastructure and are emerging as indispensable assets in the creation of liveable cities.

SOURCE

City of Armadale – Parks Technical Operations
https://www.armadale.wa.gov.au/sites/default/files/assets/documents/publications/Urban_Forest_Strategy_-_June_2014_0.pdf

CITY OF COCKBURN – STRUCTURE PLANNING

DESCRIPTION

The City of Cockburn dealt with a proposed structure plan and associated scheme amendment for a unique site in Beeliar, resulting in the preservation of a number of significant trees. These trees were significant both in respect of their local biodiversity, as well as their landscape significance as a key visual marker for the surrounding neighbourhood. The site was a former quarry, revegetated and rehabilitated to various extents and there were substantial threats to the important trees within the normal practice of only 10 per cent open space as a benchmark.

The community expressed concern regarding the loss of important vegetation. The City of Cockburn's recommendation to the Western Australian Planning Commission (WAPC) provided an alternative design which sought to preserve more of the remnant vegetation. The City worked successfully and collaboratively with the applicant, the WAPC and the community to achieve an outcome which has responded to the qualities of the site.

OUTCOMES

The challenge to achieve greater significant tree protection was most impacted by the unique characteristics of the site, effectively having a frame of significant vegetation around the edge. Applying a standard 10 per cent public open space allowance was not able to reflect this site uniqueness. Planning practice needed to consider how to achieve greater open space protection, within a system which generally considered 10 per cent open space as a benchmark, and not as a minimum.

Engagement between the applicant, City of Cockburn and the WAPC focused on the provisions of Policy measure 5.4 of State Planning Policy 3.0 - Urban Growth and Settlement and Element 1 of Liveable Neighbourhoods. Debate and engagement was robust at times, but an desirable outcome was negotiated.

SOURCE

City of Cockburn

CITY OF GOSNELLS – STREET TREE REMOVAL

DESCRIPTION

The City of Gosnells Policy CP 2.3.9 guides decisions regarding the planting, management, maintenance and removal of street trees. If a street tree is removed as part of an approved development application, an amenity value using the Helliwell tree valuation formula will be undertaken. The applicant is required to pay the amenity value of the tree plus the costs incurred to the City for the tree removal. The City will allow removal of street trees, if certain circumstances are met and consider the condition, location or species of the tree.

OUTCOMES

A report is to be provided to the City justifying the request to remove the street tree noting the conditions noted above. The City will then assess the application. Should the application met the criteria, the City undertakes an Amenity Tree Valuation to determine a monetary value. Then, if the application is approved the owner pays the Amenity Value plus the removal cost of the tree.

SOURCE

http://www.gosnells.wa.gov.au/files/sharedassets/public/website/governance/policy/1-2.3.9_street_tree_policy.doc.pdf

Helliwell tree valuation system - https://www.forestry.gov.uk/PDF/FCRN008.pdf/$FILE/FCRN008.pdf.

CITY OF MELBOURNE – EXCEPTIONAL TREE REGISTER

DESCRIPTION

In recognition of around 20,000 trees on private land, the City adopted its Exceptional Tree Register in July 2012. Trees in Local Government parks and reserves and schools, universities and churches are also eligible if they are nominated.

OUTCOMES

Trees on the register are protected through the City'splanning scheme via an environmental significance overlay that applies to any property with an exceptional tree or other properties in the tree protection zone. The environment significance overlay operates in a similar manner to a special control area in Western Australia.

Planning permits are required for any proposed works such as building and works or significant pruning or removal of exceptional trees in the tree protection zone. Potential impacts on the health and values of exceptional trees are considered in the permit application process. Referrals to Arborists and / or horticulturalists may also be required to provide professional advice in this regard.

To assist in the management and recognition of exceptional trees, the City may also offer assistance by offering arboriculture advice, plaques and photography. Furthermore, there may be opportunities for land owners to be involved through open days and feature articles.

SOURCE

http://www.melbourne.vic.gov.au/SiteCollectionDocuments/exceptional-tree-register.pdf

CITY OF MELVILLE – URBAN FOREST STRATEGY COMMUNITY REFERENCE GROUP

DESCRIPTION

The City of Melville's Urban Forest Strategic Plan (Part A) was developed with significant input from an urban forest Community Reference Group that was established by the City. Tasks for the group included identifying the purpose of an urban forest, the priorities for action and how the community could play an active role in making the Strategy a reality at the local level.

OUTCOMES

To ensure that the Community Reference Group membership included people who represented the interests of the community as a whole, the City sent emails to a random sample of residents in each of the four neighbourhoods of the City, inviting them to put in an Expression of Interest to serve on the group. Places were limited to individuals who best complied with the selection criteria, with fourteen being selected.

The purpose of the Strategy as defined by the group is; *"the purpose of the urban forest is in providing a healthy and peaceful environment which nurtures the wellbeing of all natural and human communities to reside within it."*

The City promoted the consultation and development of the plan on their website. This included videos from participants in the Community Reference Group who spoke about their experiences working together on the Strategy (link below).

SOURCE

https://www.melvilletalks.com.au/urbanforest

CITY OF VINCENT– FINANCIAL ASSISTANCE FOR SIGNIFICANT TREE OWNERS

DESCRIPTION

The City of Vincent offers financial assistance for work associated with trees listed on the Trees of Significance Inventory through an incentive fund. The incentive fund can be used for remedial pruning, crown thinning, pest control or the provision of advice from a qualified arborist.

OUTCOMES

Funds are generally provided on a dollar for dollar basis up to a maximum of $2,000 in any 5 year period, although this may be increased at the City's discretion if significant funds are required to maintain a tree. Where the City pays more than $1,000 for any tree, the land owner must enter an agreement to repay the City if the tree is removed within a 5 year period and in the City's opinion the tree could have been retained. Payments are in the form of reimbursement upon presentation of proof of payment and certification by the arborist of approved works. The City may also inspect and photograph trees before and after the approved works.

Fines apply to damage and / or unauthorised removal of trees on the register.

SOURCE

https://www.vincent.wa.gov.au/develop-build/planning/trees-of-significance.aspx

CITY OF STIRLING – TREE BONDS

DESCRIPTION

The City of Stirling requires a bond for the protection of street trees where development or other activities may have a potential impact. The bond is held by the City prior to the commencement of development for the duration of the works and is incorporated into the existing verge bond, required as part of the verge permit process.

OUTCOMES

If a street tree is damaged, pruned, dies or is removed without authorisation, part or all the bond may be retained. The costs borne by the landowner or developer is determined by the following elements.

- removal costs –incurred by the City for physically removing the tree;
- amenity value – calculated in accordance to the City's amenity tree calculation (currently the Helliwell method or other City approved valuation system). If the tree has a higher Helliwell value than the retained bond, further action may be taken to recover costs; and

- reinstatement tree costs – calculated in accordance with the greening required to replace the removal of a tree and include watering costs for two subsequent summers.

When a street tree is approved for removal in relation to a development, the associated contributory costs of the tree and its removal (or pruning) shall be paid by the property owner or representative prior to the removal and commencement of development.

Bond amounts as at January 2018 are as follows.

Verge Description	Bond
No tree on the verge	$1,500 (existing verge bond)
One street tree on the verge up to a Helliwell * value of $6,000	$3,000 (Includes existing verge bond $1,500)
One street tree on the verge over a Helliwell * value of $6,000	$6,000 (Includes existing verge bond $1,500)
More than one tree on the verge	The tree with the higher value sets the minimum bond. Each additional tree requires an additional $1,000 bond per tree. For example: three trees on the verge, the highest value is $10,000. The bond would be $6,000 plus two additional trees at $2000. Total bond (Max: $8000)

SOURCE
https://www.stirling.wa.gov.au/Council/Policies-and-local-laws/Policy%20and%20Local%20Laws/Street%20and%20Reserve%20Trees%20Policy.pdf

CITY OF STIRLING – TREE REMOVAL & REPLACEMENT

DESCRIPTION
The City of Stirling will consider tree pruning or removal on city managed land adjacent to development when no design alternative exists. Where a tree is approved to be removed the landowner/applicant is required to meet the costs associated its removal and replacement.

OUTCOMES
A development approval is required to be lodged for a tree(s) removal and if approved the removal should be arranged with the City. Removal and replacement costs are met by the applicant and factor in the location, significance, biodiversity value, the trees amenity and watering charges for two subsequent summers.

Replacement trees address the following requirements:

- a minimum of one replacement tree planted on the verge adjacent to the development;
- where a number of frontages are created with subdivision, one tree shall be planted on each frontage, space permitting;
- if there is room for more than one tree on each frontage / lot, then multiple trees are planted in relation to the space;
- any additional replacement trees that are not able to be planted on the verge adjacent to the development will be planted elsewhere at the City's discretion; and
- replacement trees are species acceptable to the City.

SOURCE
https://www.stirling.wa.gov.au/Council/Policies-and-local-laws/Policy%20and%20Local%20Laws/Street%20and%20Reserve%20Trees%20Policy.pdf

CITY OF STIRLING – TREES & DEVELOPMENT - Local Planning Scheme & Local Planning Policy

DESCRIPTION
To address declining tree canopy cover, the City of Stirling adopted an amendment to its Local Planning Scheme and Local Planning Policy 6.11 'Trees and Development' in 2016. The Amendment was approved by the Minister for Planning and came into effect in October 2017.

OUTCOMES
The purpose of the amendment and policy is to:

- encourage the retention of Significant Trees on development sites;
- where trees are not retained or none exist, require new trees on-site at a ratio of one tree per 500m² of the site area;
- require a deep soil zone around each tree to sustain its health and growth;
- require the planting of street trees where none exist on adjoining verges; and
- apply these requirements to all development applications with a value over $100,000.

Development applications should comply with the requirements and may need redesign to assist the planting or retention of trees. The City's policy encourages the retention of existing trees with a minimum height of 4m and trunk circumference of 500mm at one metre above ground level (these are referred to as Significant Trees). However, the policy does not mandate the retention of significant trees except in special circumstances (e.g. rare species or of historical significance).

SOURCE
https://www.stirling.wa.gov.au/development/Schemes-policies-codes-and-legislation/Local%20Planning%20Scheme/Trees%20and%20Development%20FAQ%20Sheet.pdf

5.0

MEASUREMENT & MONITORING THE URBAN TREE CANOPY

Comprehensive geographic information system (GIS) data on tree canopy is essential for monitoring, measuring and implementing urban forest strategies. It provides Local Government with an indication of the status of their urban forest, areas of loss & gain and helps to prioritise implementation activities. Maps and graphs derived from this information are also important communication tools for internal and external stakeholders, showing changes in canopy cover over time.

Canopy data also enhances Local Government tree inventories and should be capable of being used with other GIS data bases such as remnant vegetation, land use zoning, demographic and infrastructure information. Other future information is likely to include urban heat and elements of censuses data.

The CSIRO have developed a three dimension high resolution digital photography product called Urban Monitor™. The Department of Planning, Lands and Heritage have collaborated with the CSIRO in the development of Urban Monitor™ as GIS data for measuring tree canopy across the Perth and Peel Regions. Using several years Urban Monitor data will allow tree canopy trends to be tracked over time and across a range of spatial boundaries.

TECHNICAL SPECIFICATIONS – SPATIAL AREAS

Urban Monitor measures vegetation across the following spatial levels:

- **Australian Bureau of Statistics (ABS) mesh-blocks.** These are comprised of the following GIS data feature; other infrastructure, parks, roads, rural, street block and lots. Canopy information is available within these features.
- **Suburbs.** Data is aggregated to each suburb and total tree canopy coverage is calculated at the suburb boundary.
- **Local Government areas**. Data is aggregated to each Local Government area and total tree canopy coverage is calculated at the Local Government boundary.
- **Sub-region**. Data is aggregated to each sub-region and total tree canopy coverage is calculated for the following Perth and Peel sub-regions; Central, North-West, North-East and South Metropolitan Peel.

Note: Suburban and Local Government boundaries are sometimes amended over time, in which case they require further analysis as this can account for statistical variations. Any year to year comparisons should be made on similar areas.

TECHNICAL SPECIFICATIONS – VEGETATION STRATIFICATION

Urban Monitor™ comprises the following vegetation stratifications or data layers across the spatial levels previously described:

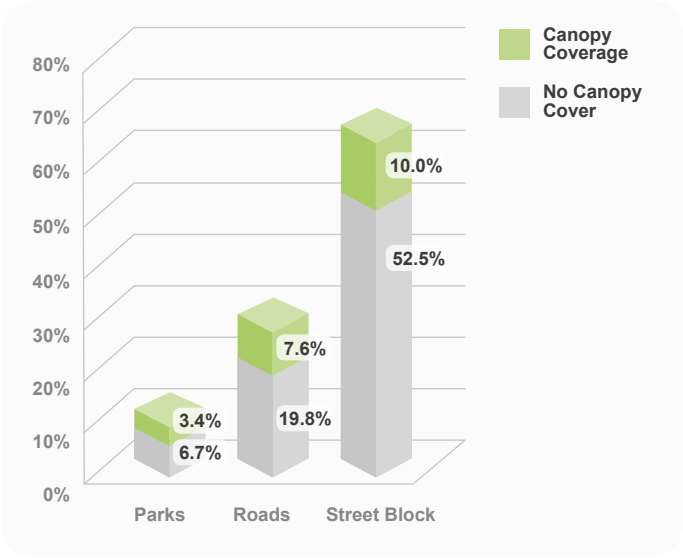
- 0-50 centimeters (proxy for grass)
- 0-3 meters (shrubs and gardens),
- 3-8 meters (canopy),
- 8-15 meters (canopy),
- 15 meters plus (canopy).

The percentage of canopy in a spatial area is calculated at 3 meters and above.

Currently the percentage of grass cover of a spatial area can be estimated from data layers measuring 0-50 centimeters. Urban Monitor does not distinguish between native and exotic vegetation in measuring canopy cover.

Urban Monitor™ allows the development of tree canopy or other vegetation statistics at the various spatial areas. For detailed analytical and urban forest planning purposes mesh block and suburb level data are advisable.

For reporting purposes suburb and Local Government area data would be the most suitable. This can be separated into land uses on public land such as parks, roads plus private land, being street blocks. Further planning and management information can be gained by considering the percentage of land available in these categories within a suburb or Local Government area, as demonstrated below. This data can also be compared over time.



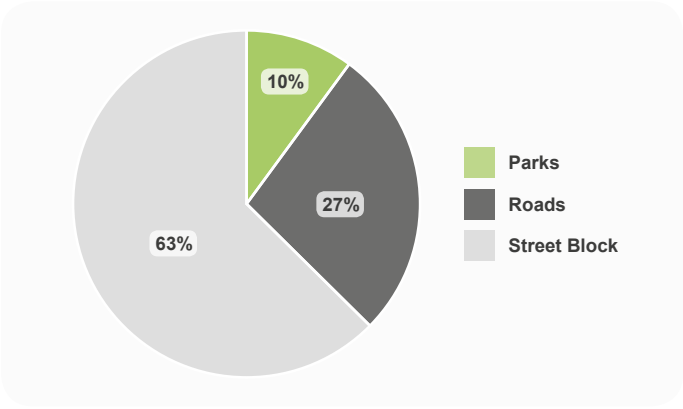


Figure 8a. & 8b. 2016 tree canopy and land use percentages for the City of Subiaco by parks, roads and street blocks.

URBAN MONITOR DATA ACCESS

Urban Monitor™ data is available in Shared Land Information Platform (SLIP) as a Restricted Service:

- Web Map Service (WMS)
- Web Feature Service (WFS); and
- Data download.

These services are easily discoverable at www.data.wa.gov.au site. You need to be a ***registered user*** to be able to access these services.

For access to Web Map Service (WMS), simply search ***Urban Forest*** at www.data.wa.gov.au site.

For access to Web Feature Service (WFS) and data download, you need to request an additional **DPLH Restricted Services** access:

- Login into SLIP Sailpoint
- Select **Join a User Group**
- Use Search Bar to search for **DPLH Restricted Services**
- Click on the tick and this will turn green
- Click the Review button and Submit
- For more information on how to, see: https://www.youtube.com/watch?v=y8YaIvDddHM

The following is a list of some useful sites on how to:

- Getting Started for Data Consumers
- How do I access new SLIP services?
- How do I create an account with SLIP to access geospatial data?
- How To: Using Geospatial Data Web Services in ArcGIS
- How To: Using Geospatial Data Web Services in QGIS

Local Governments can view the 2009, 2014 and 2016 Urban Forest data via Western Australian Local Government Association's Environmental Planning Tool. More information about the Environmental Planning Tool's subscription service is available at https:walga.asn.au/Policy-Advice-and-Advocacy/Environment/Environmental-Planning-Tool.aspx.

CANOPY COVERAGE

The following figures demonstrate the suite of data derived from the CSIROs Urban Monitor that Local Governments can use to develop strategies and monitor their tree canopy over time. The examples range for the regional level to the suburban level which contain more detailed mesh block data.

TOTAL TREE CANOPY COVERAGE PERTH METROPOLITAN AREA

Figure 9: illustrates the total percentage of tree canopy cover for the Perth and Peel Regions. This can be used to show each Local Government's total percentage of cover at a regional scale.

TOTAL TREE CANOPY COVERAGE SUB-REGION

Figure 10: illustrates the total percentage of tree canopy cover for the central Perth metro sub-region. The central sub-region has an overall coverage of 10 to 15 per cent. This data can be used to measure the regional canopy coverage and provide a baseline of information for Local Governments within the region to work together to retain and manage tree canopy.

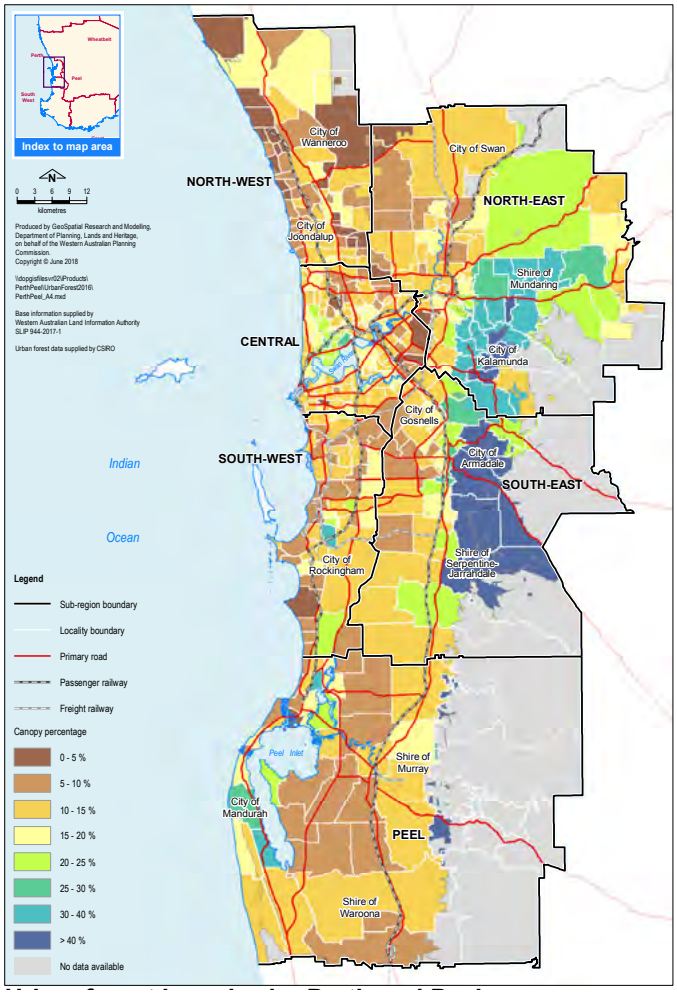


Figure 9. Total tree coverage percentage Perth and Peel Regions.

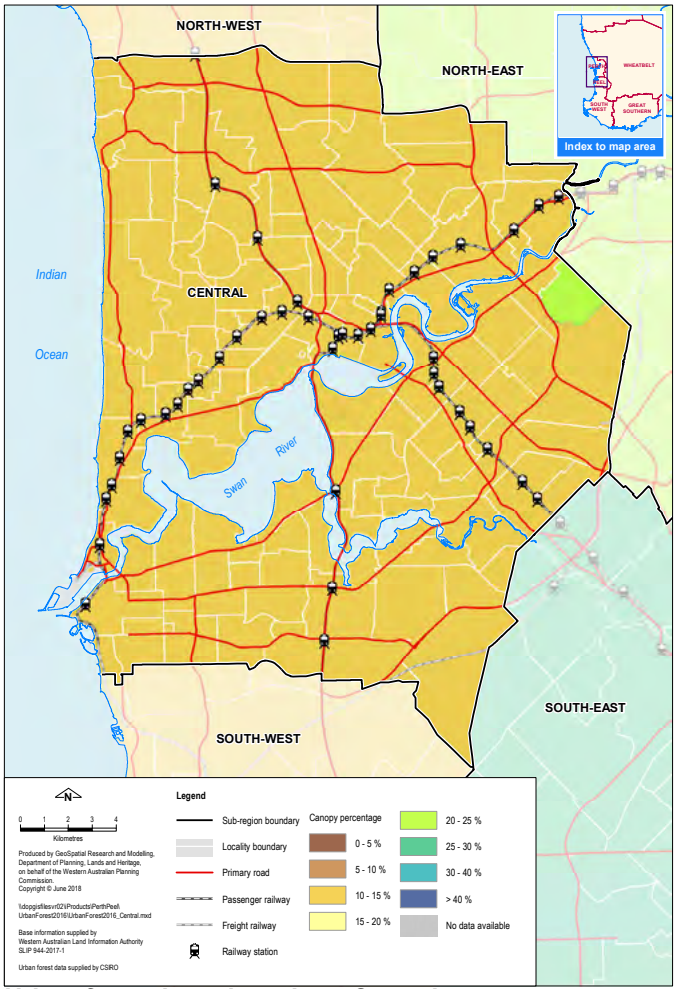


Figure 10. Total tree coverage percentage sub-region

TOTAL TREE CANOPY COVERAGE LOCAL GOVERNMENT AREA

Figure 11: depicts the percentage of tree canopy cover for a Local Government area. The City of Subiaco has an overall coverage of 20-25 per cent in 2016. This data can be used to provide an overall measure of canopy coverage across the Local Government.

This information can be used to measure canopy coverage over time and can be supplemented with tree audit or Significant Tree Register data.

TOTAL TREE CANOPY COVERAGE BY SUBURB

Figure 12: shows the percentage of cover for a given suburb. The suburb of Subiaco had 15 to 20 per cent canopy cover in 2016. This data can be used to measure aspirations and goals of total coverage per suburb and compare suburbs within a Local Government.

This information should be used to describe the total tree canopy coverage within a suburb and as a measure of strategies/policy and regulation implementation.

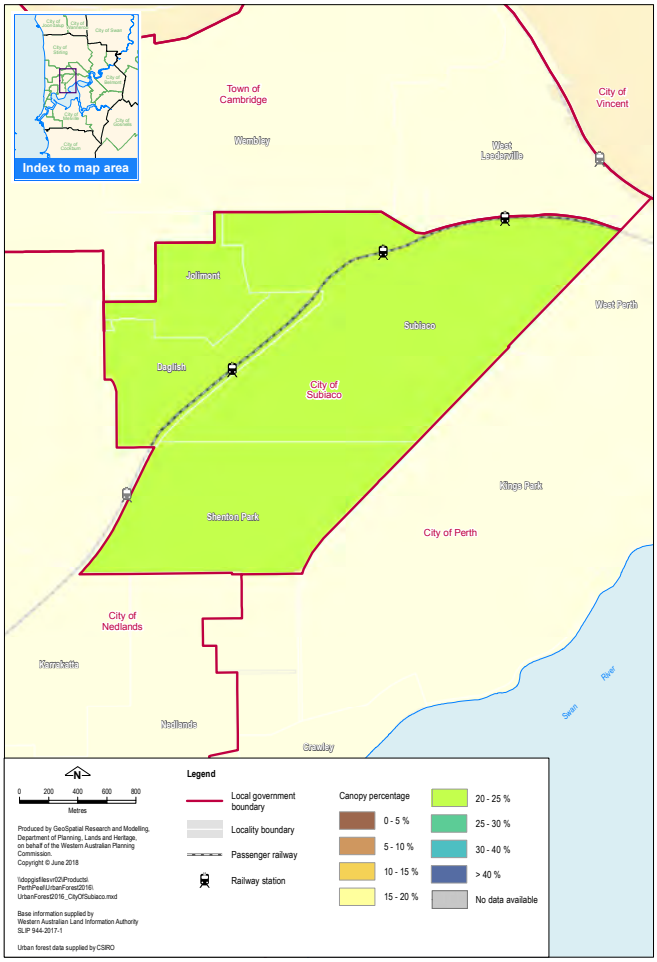


Figure 11. Total Tree Coverage Percentage Local Government area

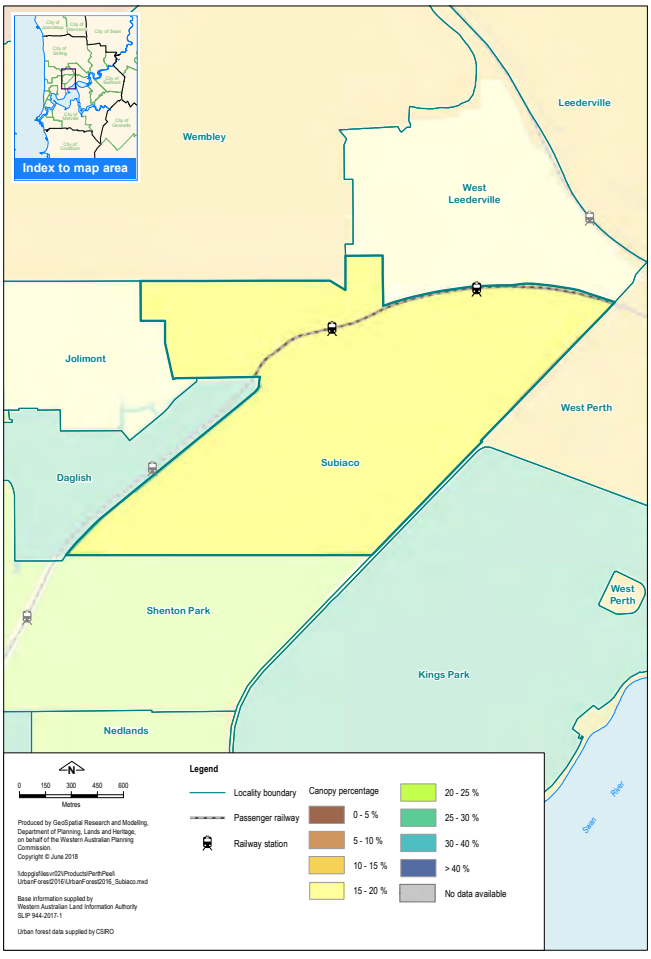


Figure 12. Total tree coverage percentage by suburb

TOTAL TREE CANOPY COVERAGE FOR A MESH BLOCK

Figure 13: shows the overall tree coverage per cent within an Australian Bureau of Statistics mesh block. The suburb of Subiaco has higher coverage in the south and the greatest coverage deficit in the north. This data can be used to compare areas, and prioritise planning and management of the tree canopy in the most needed areas.

This information could be compared with land uses, density and population data to identify the areas which require targeted planning, planting and management of canopy.

TREE CANOPY COVERAGE BY PARK

Figure 14: illustrates the per cent of tree coverage (%) in parks. The suburb of Subiaco parks had a range of canopy from 5-10 per cent to greater than 40 per cent in 2016. This data can be used to plan for the growth in canopy, ecosystem services and enhance shade for recreation activities.

Planting in parks along with car parks is an effective approach to improving tree canopy and community amenity.

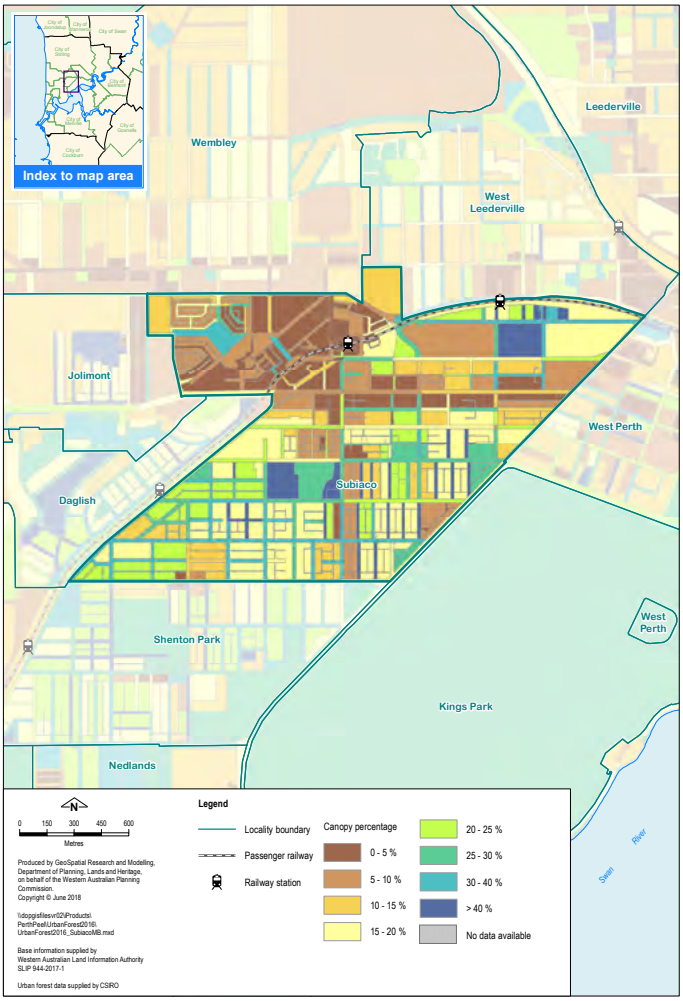


Figure 13. Total tree coverage percentage mesh block

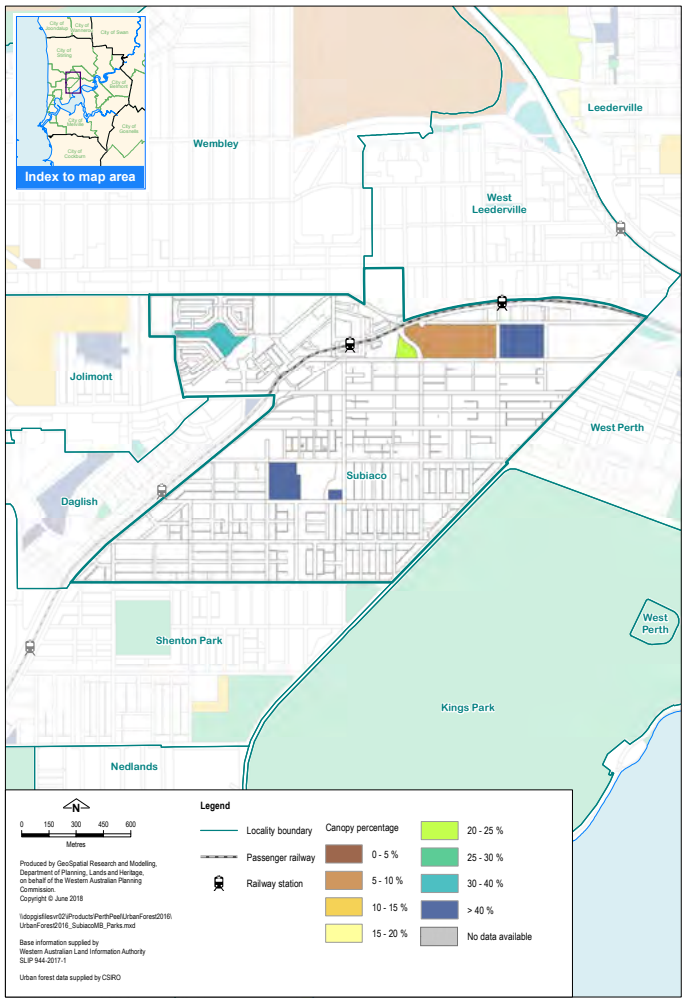


Figure 14. Total tree coverage percentage in parks

TREE CANOPY COVERAGE FOR ROADS

Figure 15: depicts the per cent of tree coverage on road verges. It shows roads in the commercial and retail strips to the north of the suburb had areas of low canopy coverage of 0 to 5 per cent. This data can be used to prioritise areas for growth in canopy, which will enhance shade and mitigate the UHI effect.

This data should be supplemented by individual tree information to plan and manage species diversification, change in street design to increase shade, reduce temperature and improve the amenity of the public realm.

TREE CANOPY COVERAGE ON PRIVATE LAND

Figure 16: illustrates that the suburb of Subiaco has a range of canopy cover in private land with the highest cover towards the south of the suburb. Commercial areas along Rokeby Road and Hay Street have less cover. Figure 8a & 8b show that the largest per cent of the canopy is located in 63 per cent of the City of Subiaco on private land.

This data should be used to add supplementary information to tree registers, development bonds, and design requirements for site analysis during structure planning.

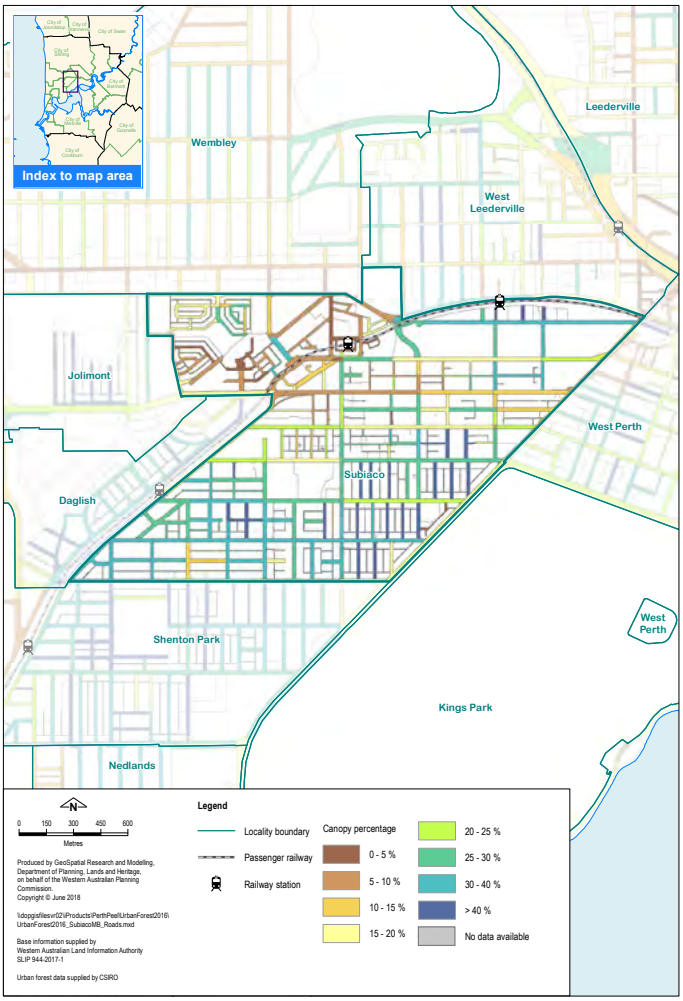


Figure 15. Total coverage percentage along roads

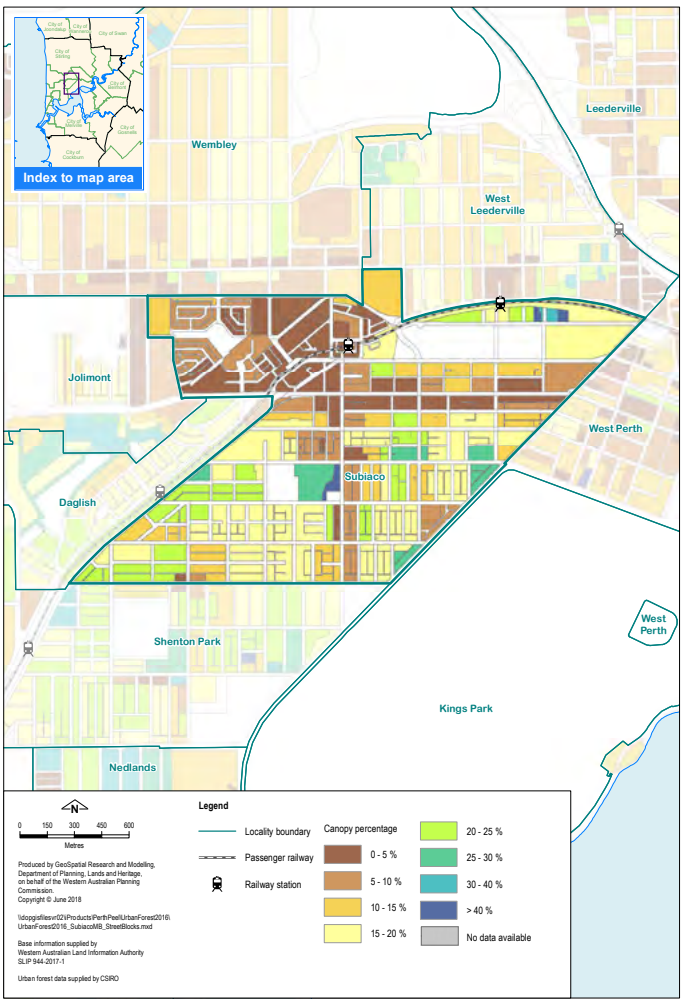


Figure 16. Total tree coverage on private land

GRASS COVERAGE

Figure 17: shows vegetation at 0-50 cm in height. This data can be used as an approximation for the grass coverage percentage across an area. The suburb of Subiaco has limited areas with significant grass cover. This information along with other levels of data can be used to assist in water and nutrient management.

TREE HEIGHT FROM 0 TO 3M COVERAGE PERCENTAGE

Figure 18: illustrates the suburb of Subiaco's overall percentage of vegetation that is 0 to 3 metres in height. This data could be used to inform further analysis of other vegetation (shrubs and understorey) and used to inform future planting strategies on private and public land.

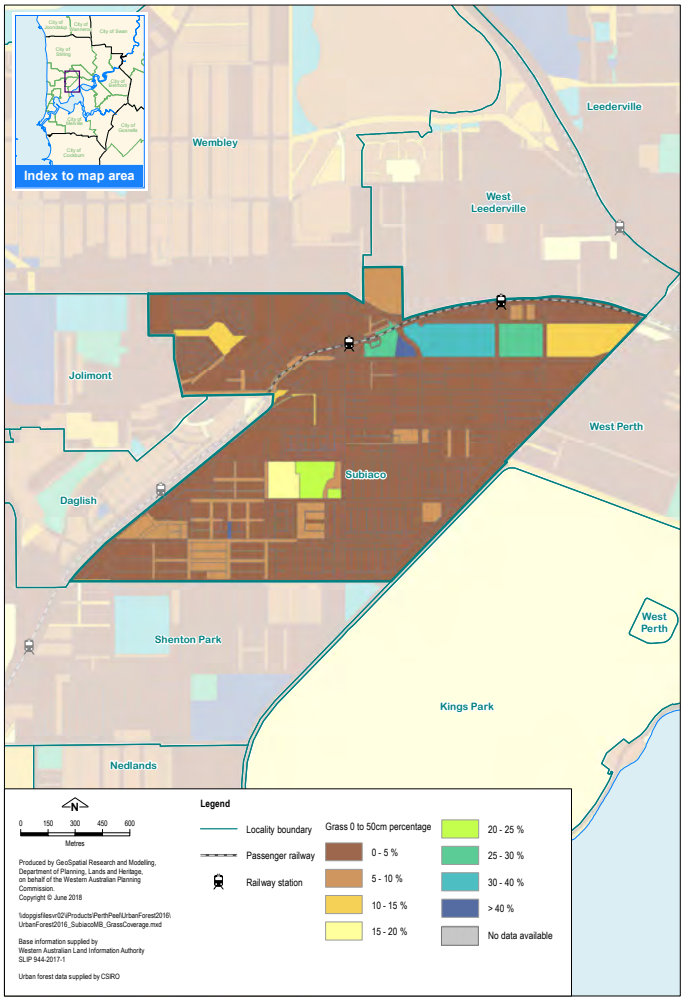


Figure 17. Grass coverage percentage

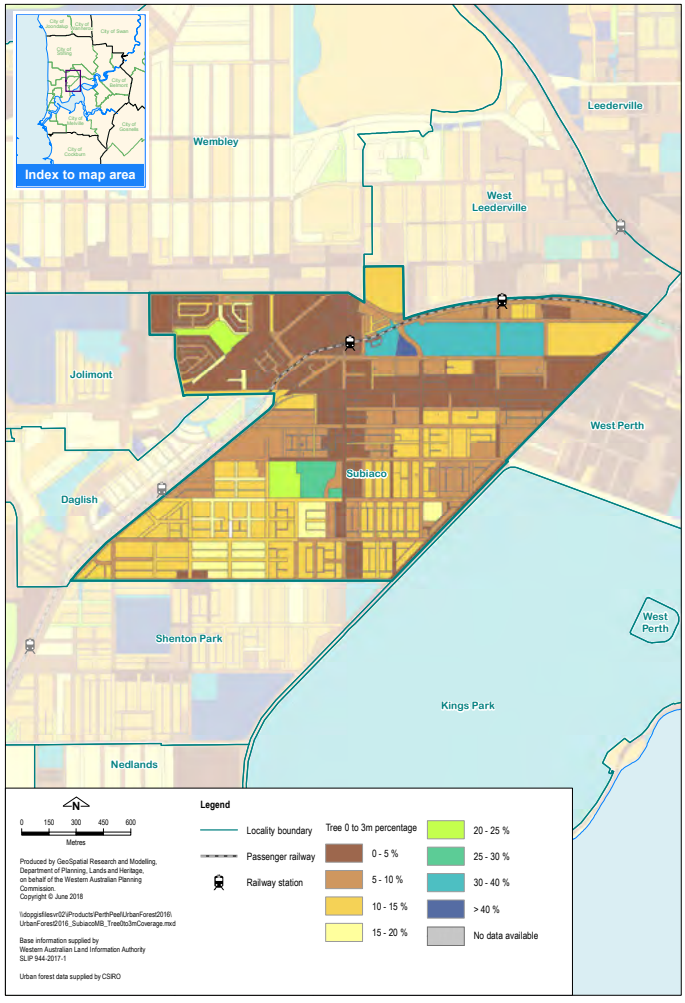


Figure 18. Tree height from 0 to 3m coverage percentage

TREE HEIGHT FROM 3 TO 8M COVERAGE PERCENTAGE

Figure 19: demonstrates the overall low percentage of coverage the suburb of Subiaco has of trees that are 3 to 8 metres in height. In the higher density areas there is a notable absence of canopy of this height.

Similar to previous uses of this data, it could be used to identify priority areas, ensure appropriate regulations are in place to retain the current canopy and plan for generational increase in this canopy height.

TREE HEIGHT FROM 8 TO 15M COVERAGE PERCENTAGE

Figure 20: shows there are pockets of areas which contain high percentages of large trees with canopy 8 to 15 metres. This data could be used to plan for the retention and planting of large trees in appropriate locations such as parks and reserves.

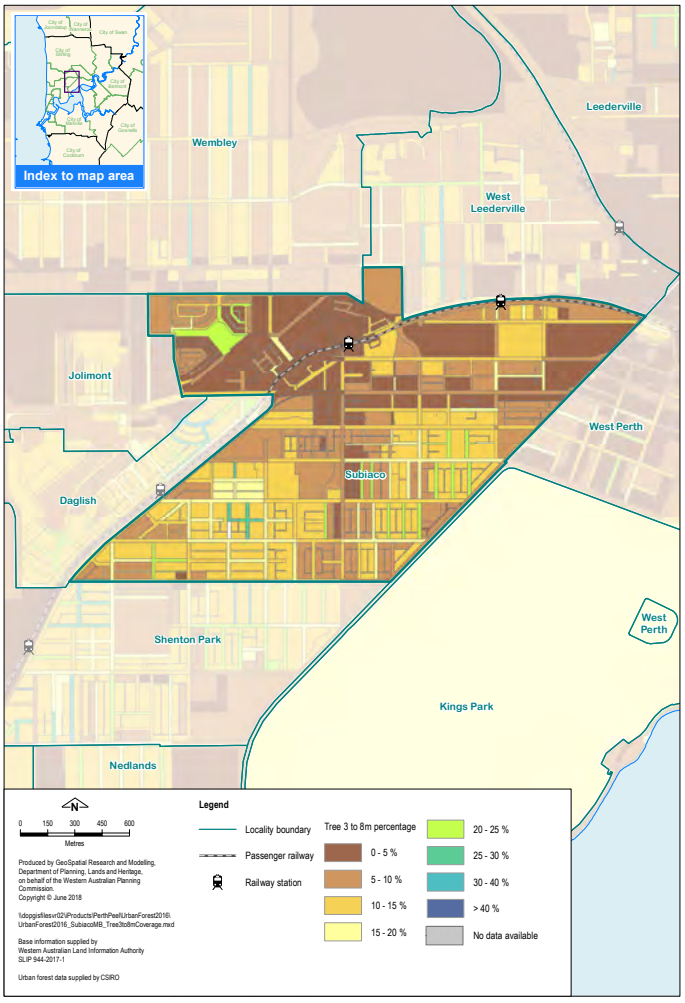


Figure 19. Tree height from 3 to 8m coverage percentage

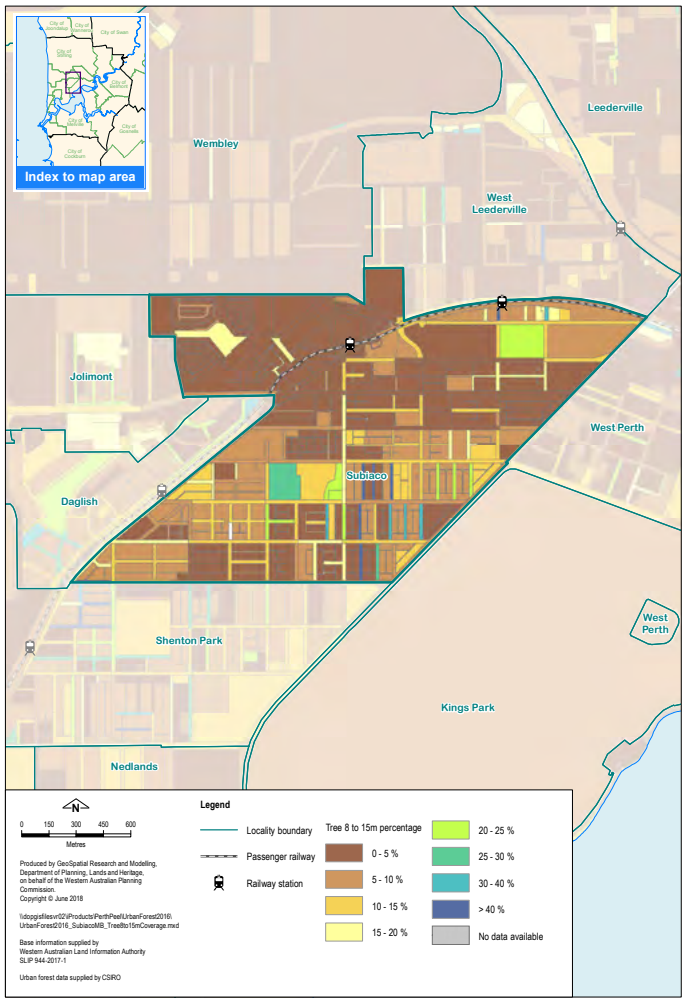


Figure 20. Tree height from 8 to 15m coverage percentage

TREE HEIGHT FROM 15M-PLUS COVERAGE PERCENTAGE

Figure 21: depicts trees with a height over 15 metres, noting that the existing coverage within the suburb of Subiaco is within parks.

Retention of this canopy coverage provides for a range of tree types and different canopy layers.

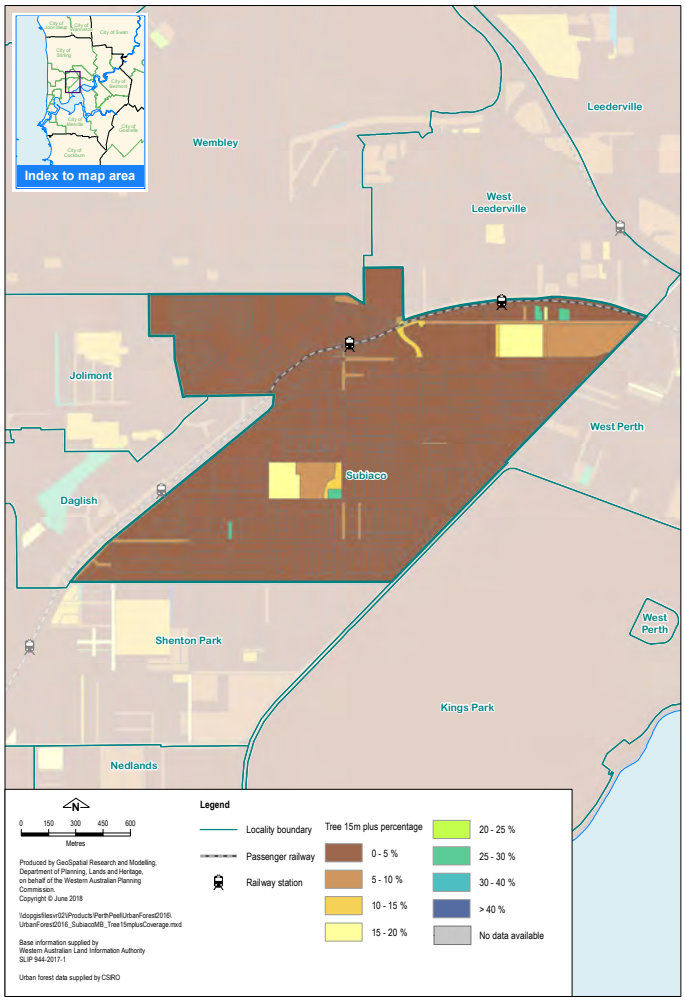


Figure 21. Tree height from 15m-plus coverage percentage

TOTAL TREE CANOPY COVER PERCENTAGE AND THERMAL MAPPING COMPARISON

Figure 22: illustrates correlation of higher temperatures and low tree canopy coverage within the suburb of Subiaco. The temperature in other Local Governments may vary significantly, however generally greater tree canopy coverage generates cooler microclimates.

This analysis can be used to inform planning and planting strategies in areas of greatest need. Targeted planting and retention of tree canopy can mitigate the impact of UHI and increase resilience to heat waves and warming environments.

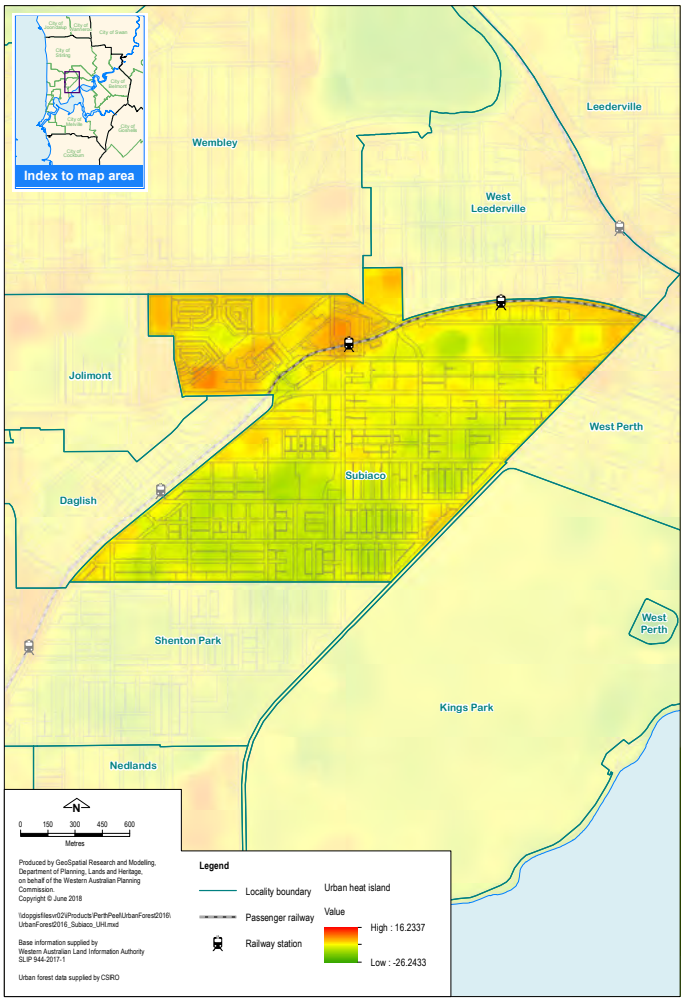


Figure 22. Total tree canopy cover percentage and thermal mapping comparison

6.0

DEFINITION OF TERMS

TERM/ ABBREVIATIONS	DESCRIPTION/MEANING
ABS	Australian Bureau of Statistics
CSIRO	Commonwealth Scientific and Industrial Research Organisation
LG	Local Government
LPP	Local Planning Policy
LPS	Local Planning Scheme
LWMS	Local Water Management Strategy
POS	Public Open Space
SCA	Special Control Area
SLIP	Shared Land Information Platform
STR	Significant Tree Register
TPO	Tree Preservation Order
TPS	Town Planning Scheme
TPZ	Tree Preservation Zone
Tree Inventory	A method of obtaining data about urban trees and organising it into usable management information.[13]
UFS	Urban Forrest Strategy
Urban forest	An “urban forest” refers to all vegetation growing within an urban environment, which is divided into two categories: the understory such as shrubs hedges up to 3 meters, and the canopy which is any vegetation above 3 meters.
Urban forest strategies (UFS)	A high level plan designed to achieve long-term outcomes for trees and vegetation using techniques developed in forestry science.
Urban heat island (UHI) effect	Heat island effect occurs where air temperatures are higher in urban areas than surrounding non-urban areas. Temperatures can be 10 to 15 degrees hotter during the day and 5 to 10 degrees hotter at night as a result of the heat absorption of the built urban form.
Urban monitor	Urban Monitor is a four-band aerial photography monitoring system, based on consistent data and methods that are able to track and communicate changes in features of interest in a way that has previously not been possible. The Urban Monitor initiative has included partners (Urban Monitor consortium) with responsibility for management of vegetation, river and wetland environments, and scheme and self-supply water resources.
Urban tree canopy	Urban tree canopy refers to the upper layer or habitat zone formed by trees. In terms of data and canopy measurement it includes any vegetation above 3 meters in height. Refer to urban forest.
WA	Western Australia
WALGA	Western Australian Local Government Association
WAPC	Western Australian Planning Commission

[13] Sacksteder C, J, &H. D. Gerhold (1979) “A Guide to Urban Tree Inventory systems.” School of Forest Resources Research paper 43, Pennsylvania State University.

BETTER URBAN FOREST PLANNING