Adopted Strategy
June 2023

Urban Forest Strategy

The City of Sydney acknowledges the Gadigal of the Eora Nation as the Traditional Custodians of our local area

CITY OF SYDNEY

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This strategy was wholly produced by the City of Sydney urban forest and spatial information teams. The project team included:

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Acknowledgement of Country

Redfern Jarjum College dance performers are pictured during the Acknowledgement of Country sign unveiling ceremony in Reconciliation Park, Redfern. Photo: Katherine Griffiths

The City of Sydney acknowledges the Gadigal of the Eora Nation as the Traditional Custodians of this place we now call Sydney, and we acknowledge their continued connection to Country. We pay respect to Aboriginal and Torres Strait Islander Elders past, present and emerging.

Community and place

These principles support our plans for Sydney's urban forest. They were developed by listening to our communities – Aboriginal and Torres Strait Islander peoples, local residents, school children, city workers and visitors. And they reflect their values.

The world view of Aboriginal peoples guided our principles. They reframe our systemic relationship with the land. Since invasion, the relationship between people and land has been disrupted with little respect for the land, animals, waterways, and First Nations peoples. We've seen the extinction of plants and animals and damage to waterways and land. Aboriginal lives have been lost trying to protect Country. By challenging our approach in this way, we hope to cause no further harm and begin to heal. The City of Sydney has an important role as caretaker of many of these places. We will consciously consider these principles in our decisions for the land we serve. This includes how we maintain, change and manage land.

Aboriginal world view of Country – First Nations workshop participant:

'Country is our identity – spiritually, culturally, physically, and socially. We refer to Country as part of the family. We speak to Country, we sing to Country and we dance for Country. Increasingly, we worry for Country and seek greater protection measures to carry out our cultural obligations to the land and waterways. These are our fundamental rights and cultural responsibilities in protecting Country as First Nations peoples.'

We are on Gadigal Country

This understanding of Country includes the landscape – land, water and sky, the trees, plants, and animals, and the relationship between these. Aboriginal and Torres Strait Islander peoples are responsible for care of Country and the continuation of these relationships. Country has existed in this place for thousands of generations and precedes colonial boundaries. We acknowledge the responsibility that First Nations peoples have in the carriage of their living cultures including access to land for practising culture to bring social, spiritual and economic benefit to First Nations peoples.

We commit to truth-telling and decolonisation

Gadigal Country was never ceded. We recognise the significance of Gadigal land as the site of invasion. We work towards telling the history of these places with honesty and acknowledge the negative impacts caused to Country and to the people. We endeavour to cause no further harm to Aboriginal peoples and the relationship they hold to the land.

We value how important trees and green places are to people's wellbeing

Parks and other open spaces with trees are places of refuge and respite in an intensely urban environment. These places have cultural and community significance to many people. They are places of shared identity and pride, community connection and celebration, protest and social transformation. They must welcome all people to enjoy. We strengthen the connections between and within these places.

We are guided by Country and strive to heal and care for it

We learn about how this Country has been cared for by thousands of generations. We respect the natural landforms, waterways and endemic species. We work to heal places that have suffered degradation. We support these places to play their role in the health of the whole environment.

We protect these places for future generations

We accept our role as caretakers of these places. These places must benefit the community now and in the future. As we face a changing climate and growing population, we make decisions that prepare these places and ensure their continued health into the future.

Guiding documents

– UN Declaration on the Rights of Indigenous Peoples

– Principles of Co-operation with Metropolitan Local Aboriginal Land Council

– City of Sydney Aboriginal and Torres Strait Islander Protocols

Message from the Lord Mayor

Our urban forest is essential to the liveability of our city and to our collective wellbeing. We have been strong advocates for the best possible management of trees and growing the urban forest in our area for many years.

We've planted more than 16,000 trees since 2004. Despite the major urban renewal in our area the tree canopy cover has increased by over 28% providing shading and cooling for more people. These figures make us one of the few councils in Australia to consistently increase canopy over the past decade.

This new version of our urban forest strategy will continue to guide our action and promote a growing and resilient forest for the benefit of us all, now and into the future.

Trees are essential for sustaining our mental and physical health. We are already experiencing the effects of climate change, with heatwaves being Australia's deadliest natural hazard. The impact of extreme urban heat affects us all but the most vulnerable in our community are the most at risk. The equal distribution of adequate tree canopy cover throughout our local area will help to manage this risk, through shading and cooling our homes, streets, and parks.

Trees have the potential to live for many years, but our urban environment can be a challenging place for trees to grow. A changing climate will make these conditions even tougher, with some trees likely to be pushed to their limit. As caretakers of the forest we must do what we can to promote the resilience of the forest and safeguard it's benefits for future generations.

We will overcome these challenges by drawing on the latest science and technology to adapt our forest for the future, while also collaborating with First Nations communities, who successfully cared for this land for millennia. By engaging and working with all members of our community we will ensure that our urban forest will grow to become an even greater resource for us all to enjoy.

Executive Summary

This urban forest strategy outlines how our tree canopy will be managed for the benefit of the entire community and for future generations.

Growth, equity, and resilience

Our vision is for an expanding urban forest canopy, distributed equally for the benefit of all, and managed to ensure it remains a sustainable and resilient asset for our communities.

Our urban forest is all the trees that exist throughout our local area. They are the trees we see every day within our local streets, parks, and private properties.

Cities throughout the world are turning to trees and other nature-based solutions to meet the climate challenge and to enhance the resilience of the environment and society. Trees are now recognised as essential infrastructure, indispensable to the success and liveability of any city. They provide essential shade to reduce high summer temperatures and safeguard our mental and physical wellbeing.

In 2013 we adopted our first urban forest strategy, which established a framework for strategic management and set ambitious targets to increase canopy cover. Since then, we have seen canopy cover increase in streets, parks and properties, with overall canopy cover increasing from 15.5 per cent in 2008 to 19.8 per cent in 2022.

Detailed assessments of how canopy cover is distributed within our local area has allowed us to act where it is most required. Our street tree master plan and other tree planting efforts have seen increases in the number and diversity of our trees.

While it is useful to reflect on past successes, we must also continue to look to the future. As the city changes and develops to meet our needs, the urban forest must also change and evolve to meet our future needs and challenges. Opportunities for improving the quantity and quality of our urban forest must be found and pursued. The four key directions and nine supporting actions of this strategy will provide for a growing and resilient forest for the benefit of all.

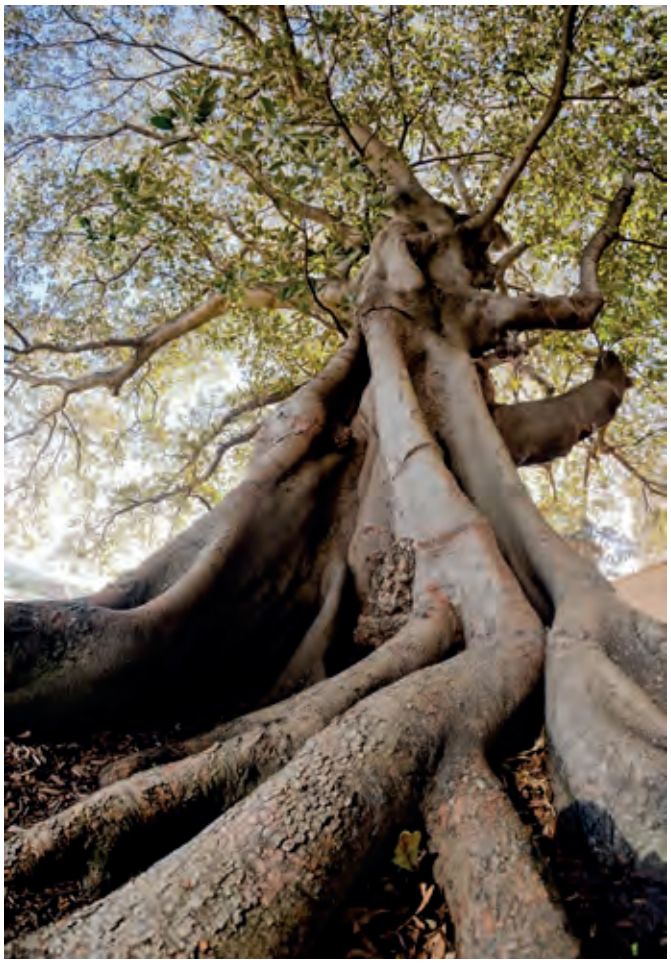


Fig tree at Observatory Hill
Photo: City of Sydney

Morris Grove, Zetland. Photo: Adam Hollingworth/City of Sydney

Direction 1 – An integrated forest

Our forest will be fully integrated within the urban landscape, with coordinated design and implementation of nature-based solutions that will prioritise trees and urban canopy cover. We will optimise connections between grey, blue and green infrastructure to maximise their benefits. Grey infrastructure includes buildings, roads and utilities. Blue infrastructure is the waterways flowing through the urban landscape. Green infrastructure is the plants and trees.

Action 1 – Deliver best practice urban forestry

We will continue to produce and administer best practice policies and programs for the protection, maintenance and management of trees throughout the landscape. We will engage with our communities to highlight their role as caretakers of the forest and to inform them of any emerging risks to the forest and measures taken to mitigate those risks.

Action 2 – Promote an integrated and coordinated approach

Our vision for the urban forest has integrated planning and decision making at its core. The distinct demands for grey, blue and green infrastructure in our city are acknowledged, but the benefits that result from coordinated design and action will be achieved wherever possible.

Direction 2 – A growing forest

This strategy expands on the targets for canopy cover within streets, parks and properties introduced in our Greening Sydney Strategy and builds upon its actions towards a cooler, calmer, and more resilient city.

> Our target is to increase our overall green cover to 40 per cent across the local area, including a minimum of 27 per cent tree canopy by 2050.
>
> Greening Sydney Strategy 2021

Action 3 – Monitor change

We will continue to measure canopy cover using reliable methods and monitor any gains or losses throughout our local area and within specific land uses. We will monitor changes in land use over time to assess any influence of these changes on canopy cover within streets, parks and properties.

Action 4 – Achieve canopy cover targets

We will achieve a minimum of 23 per cent canopy cover by 2030 and 27 per cent canopy cover by 2050. We will identify streets where tree planting and the provision of canopy cover should be prioritised over other uses and continue to identify opportunities for new and replacement tree planting in streets and parks. We will encourage tree planting within private property and ensure minimum tree planting requirements are met during development.

Fig in Turruwul Park Rosebery. City of Sydney

Harold Park, Forest Lodge. Adam Hollingworth

Direction 3 – A forest for all

Trees are essential and all should benefit from the numerous benefits they provide. Issues of equity and fairness arise when there is a large disparity in canopy cover between neighbourhoods. This strategy will promote a just and fair city through prioritising action towards the more equitable distribution of trees and canopy cover.

Action 5 – Look beyond boundaries

Trees and canopy exist throughout the urban landscape, and management issues such as equitable access, diversity and resilience extend across local area and suburb boundaries, and can vary significantly within them. We will apply spatial analysis techniques to our urban forest that allow us to look beyond these boundaries, provide greater insight, and better manage the urban forest for everyone.

Action 6 – Distribute canopy equitably

We aim to distribute the benefits of canopy cover equally across the local area. We will monitor future changes to the community's access to canopy cover at local and regional scales, and adapt tree planting or other management programs to maintain trends that favour greater equity.

Action 7 – Prioritise action

Trees take time to grow, so when planning our investment and effort towards increasing canopy cover, we need to consider where the greatest need exists and areas of greatest opportunity. Streets, parks and properties will all need to reach their capacity for tree canopy to achieve our targets and the best possible outcomes for everyone.

Direction 4 – A resilient forest

The urban forest can be vulnerable to changes in the environment. Climate change has the potential to reduce the quality and quantity of our urban forest due to the different abilities of tree species to cope with environmental changes or stresses. We must manage for the present but also for future generations. In our role as caretakers of the urban forest, we will identify existing or future vulnerabilities and risks, and act where necessary to mitigate them, ensuring the urban forest of the future is more resilient than the urban forest of today.

Action 8 – Manage for sustainability

Our urban forest is a broad mix of different tree ages and sizes. We aim to manage our trees in streets and parks in a sustainable way, minimising any excessive highs or lows in the number of trees removed or planted. This will ensure that the resources required to maintain and manage the urban forest remain relatively constant over the long term.

Action 9 – Promote diversity

A more diverse urban forest is more resilient to the impacts of pest or disease outbreaks and environmental changes like climate change. A more diverse forest can also provide a better range of habitat for wildlife and other environmental benefits. We will manage risk by distributing it across a larger number of more resilient species. We will monitor diversity over time at the neighbourhood and local government area scale to identify and address areas of low diversity.

Environment

cool

calm

sustainable

healthy

City of Sydney

manage

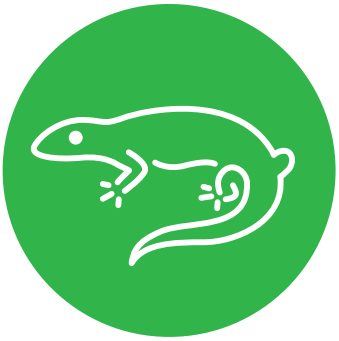
grow

govern

promote

protect

urban forest



Wildlife

ecosystems

habitat

diverse

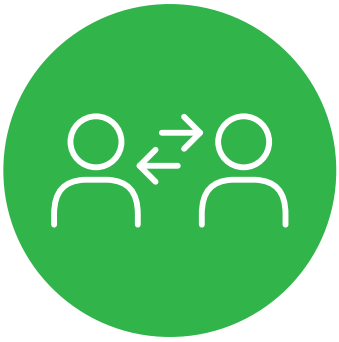
Community

learn

respect

connect

care



Cultural Knowledge Holders

Care for Country

Share knowledge

Practice culture

Figure 1: Urban forest relationships.

Our urban forest overview

34,500 street trees	14,000 park trees	40,000 private trees (estimated)
Current canopy cover 19.8% (2022)	2030 target canopy cover 23%	2050 target canopy cover 27%
In 2022 17.6% of our area has access to more than 30% canopy cover within 100m	In 2050 at least 30% of our area will have access to more than 30% canopy cover within 100m	6 tonnes of pollution removed each year
16,000 tonnes of carbon stored	440 tonnes of carbon sequestered each year	8 Olympic swimming pools worth of storm water runoff intercepted each year

Urban forest and environmental metrics as at 2022 unless indicated otherwise. Carbon storage and other environmental benefits estimated for street and park trees only using iTree eco software.

Light rail on George Street, now a pedestrian boulevard. Credit: Mark Metcalfe/City of Sydney

Figure 2: Aerial view of the City of Sydney Local Government Area.

The urban and policy context

Challenges of an urban environment

Cities are complex urban environments where people live, work and visit. Sydney's metropolitan population is projected to grow by more than two million in the next 20 years to 6.4 million people. Following this trend, the City of Sydney has been one of the fastest growing areas in Australia, with continued growth expected to accommodate an additional 115,000 people by 2036, and many more workers and visitors using our public spaces and services.

Along with growth comes challenges. As cities grow and develop there is increased competition for limited space. Chronic stressors and acute shocks test a city's resilience. Conflicting and competing priorities for land use must be planned for and overcome, to maintain and enhance our quality of life and ensure long term sustainability.

Co-workers gather in Hyde Park during their lunch break. Credit: Mark Metcalfe/City of Sydney

The benefits of urban greening

Cooler roofs as a result of green roofs increase photovoltaic collector efficiency.

Green roofs extend the opportunity for habitat, increase building insulation, store and slow rainfall runoff and drastically reduce urban heat build up during the day and night.

People tend to shop, dine and linger longer in attractive green environments improving commercial returns.

Permeable pavements and raingardens slow and collect rain water that can then support urban greening and remove pollutants.

Vine covered shade structures and green fascades provide shade to buildings, reduce urban heat, increase visual appeal and privacy. They can also be used where spaces don't allow tree planting.

Views of trees and lower level greenery increases the value of residential and commercial property.

Shading of road and other pavements increases their longevity and drastically reduces ambient heat buildup and radiation at night.

Shade provided by trees helps reduce air conditioning costs.

Canopy coverage of at least 30% reduces mental health issues and leads to better perceptions of overall health. It also reduces employee sick leave, improves employee and student concentration.

Trees and other greenery increase habitat, shelter and food for animals.

Trees provide shade that reduces overall urban heat, improves the walkability of streets and reduces incidences of skin cancer. Use of deciduous trees can also allow winter sun and thereby reduce heating costs in winter and facilitate use of parks in cooler months.

Leaves and foliage provide shade, filter and absorb pollutants and capture and slow rainfall. They also release scents and aromas that can create a positive emotional response.

Leaves and timber from pruned and removed trees can be recycled as mulch to improve soil, nutrients and water holding of soils.

Tree and vegetation roots retain soil, preventing erosion and absorb water.

Quality green spaces and tree canopy cover create a greater sense of community and increase opportunities for physical activity, socialisation and connections to nature. They generally improve mood and restore our minds from stress and fatigue.

Irrigated lawns and gardens reduce urban heat and increase infiltration of rainwater.

Trees and greenery and other permeable pavements help decrease stormwater runoff and recharge groundwater supplies and provide passive irrigation to make more resilient and longer lived trees.

Figure 3: The benefits of urban greening.

The Sydney skyline in 2019. Credit: Katherine Griffiths/City of Sydney

Growth is not the only challenge that cities face. Addressing urban heating has been identified as a key challenge for the future planning of Sydney towards 2050 (Cooling Sydney Strategy 2019). Urban areas become significantly warmer than surrounding less developed areas when there is less green cover and more hard surfaces that absorb, store and radiate heat. Microclimates are created, known as urban heat islands. Prolonged periods of extreme heat such as heatwaves cause the temperatures within urban heat islands to become a significant community health issue.

The United Nations describes climate change as the defining issue of our time. In June 2019 the City of Sydney declared that climate change poses a serious risk to the people of Sydney and should be treated as a national emergency. A changing climate has the potential to degrade the liveability of cities, with more frequent extreme heat and other severe weather events likely to test the resilience of communities, and natural and built environments.

The Covid-19 pandemic has presented a variety of challenges, including those related to mental health. Concerns about the virus itself, the various measures that have restricted social and physical interaction, combined with uncertainty or sudden loss of employment have impacted the mental health of many Australians (Australian Institute of Health and Welfare 2021). The pandemic has highlighted the natural environment and green spaces as an essential respite and escape for many (Berdejo-Espinola et al. 2021). Covid recovery programs can recalibrate the relationship between cities and nature, in ways that benefit mental and physical health (UNEP 2021).

The City of Sydney, like all cities, is a mixture of grey infrastructure, blue infrastructure and green infrastructure. Grey infrastructure is the buildings, roads and utilities that shelter us and service our needs. Blue infrastructure is the water flowing through the urban landscape. Green infrastructure is all the vegetation, plants and trees that are the foundation of our natural environment. Enhancing and optimising the interactions between these elements is key to a city's resilience, liveability and success (FAO 2016).

Cities throughout the world are exploring the potential for nature-based solutions as actions towards this goal and to meet the climate challenge. Nature-based solutions can be cost-effective approaches to green infrastructure that provide multiple benefits: climate resilience, healthy populations, sustainable economies, green jobs, and biodiversity conservation (UNEP 2021).

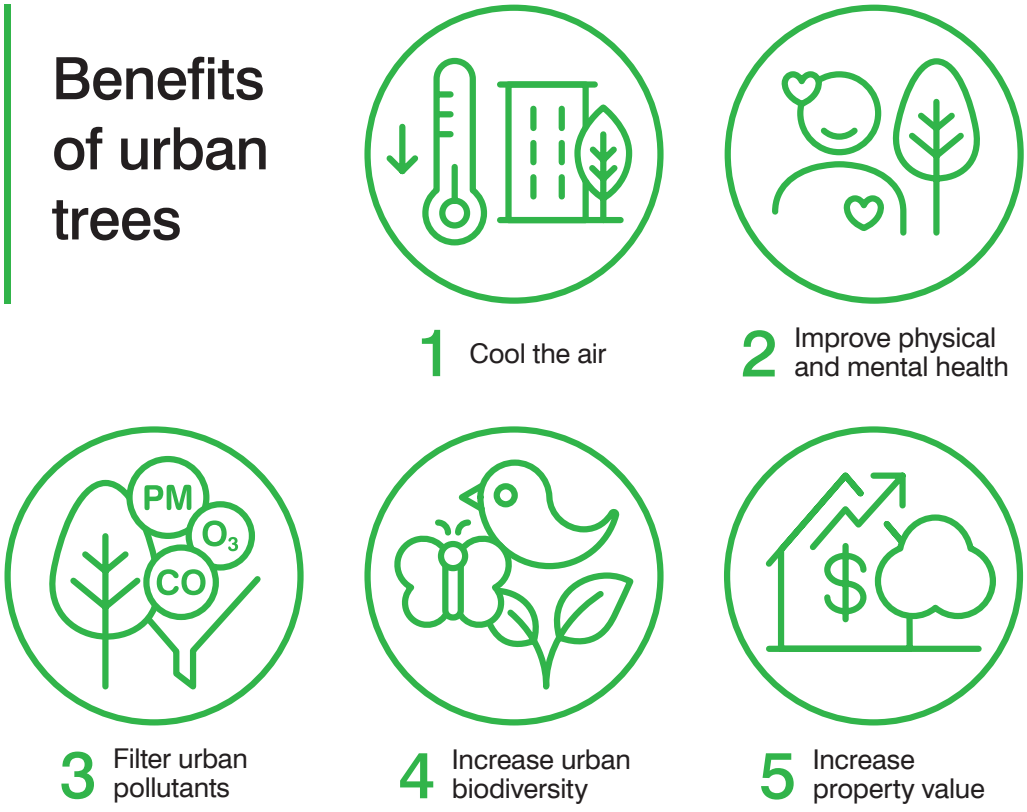


Figure 4: Benefits of urban trees. Credit Food and Agriculture Organisation of the United Nations / City of Sydney

Trees: essential green infrastructure

Trees are the largest living things in the urban environment and are the biggest contributors to vital green infrastructure, a city's natural life support system.

Trees are essential in cities. Their environmental, social, cultural and economic benefits are well established and beyond doubt.

Trees are a cost-effective nature-based solution. They shade and cool our streets, parks and homes. They increase biodiversity, improve our mental and physical health, and enhance economic activity and property values.

Local research has shown that higher urban tree canopy cover is associated with improved mental and physical health outcomes (Astell-Burt & Feng 2019).

All trees provide benefits but not all trees are equal. A large tree provides exponentially more benefits than a small tree (Turner-Skoff & Cavender 2019). The spreading canopy of a large tree has greater potential to shade buildings and cool the spaces around it. Large trees offer more habitat for increased biodiversity and are the prominent features of our most loved landscapes and spaces.

The benefits of trees do not come without some costs or compromises (Roman et al 2020). We must invest in planting and establishing new trees in our city. We must maintain them as they grow and remove them when they reach the end of their useful life. We must also live with any inconveniences or disservices that result from them. Trees can drop leaves and flowers, and their roots can damage infrastructure if not built to accommodate them. Minimising the costs and inconveniences, while also maximising the benefits, is key to successful integration and management of trees in the urban landscape. Through adhering to the basic principle of the right tree for the right place, we will continue to achieve a favourable balance for our communities now and for future generations.

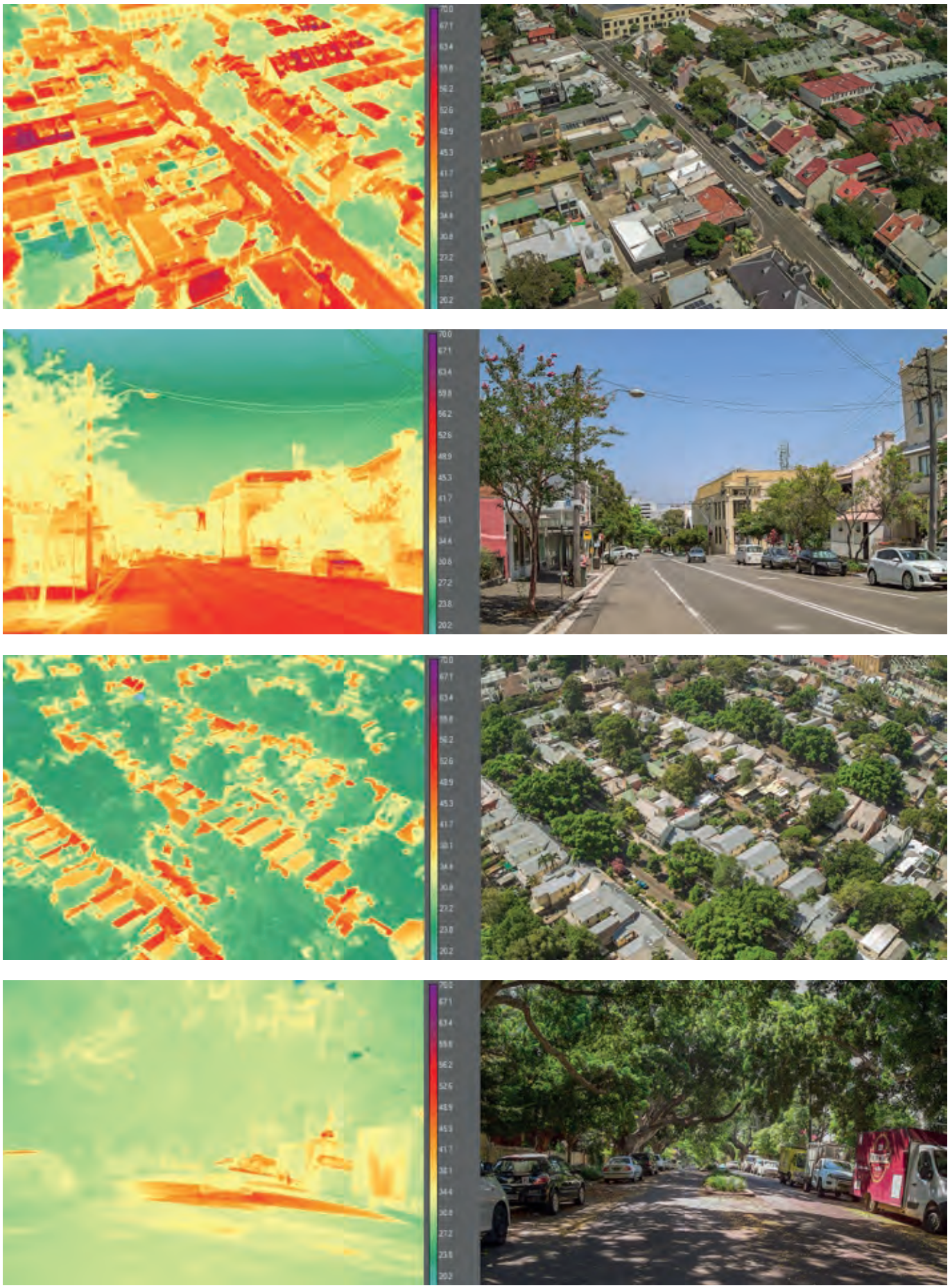


Figure 5: Aerial view of St Johns Road and Westmoreland Street Glebe, showing the temperature difference due to tree canopy (25 January 2019).

An altered landscape

The original vegetation of the local area was a diverse mix of trees, shrubs and other plants uniquely adapted to various habitats and ecosystems that had evolved for millennia. These included the estuarine and freshwater wetlands, open woodlands on steep sandstone scarps, heaths and Banksia scrubs on old sand dunes and forests on the richer shale-derived soils of the higher ridges and plateaus.

The natural landscape was substantially and irreversibly altered in 1788 when the British established a convict outpost on the shores of Sydney Harbour. Vegetation was cleared as the outpost grew and now remnants only exist as rare and isolated individual trees.

A new landscape was planted following imported European traditions and sensibilities. The larger parklands such as the Royal Botanic Garden and The Domain, and later Hyde Park, provided the only significant green elements at the core of the growing city. The Port Jackson fig and the Moreton Bay fig came to be prominent within public landscapes due to their size and longevity.

Detailed aerial photos taken in 1943 show very little tree canopy in private properties or streets at this time. In the 80 years since, the area has become gradually greener. Planting trees in streets increased after the war with brush box and London plane trees commonly used. The 1970s and 80s saw a mix of other native and introduced trees planted within streets, parks and gardens as environmental awareness increased. Today our urban forest is a broad mix of both native and introduced tree species, a legacy of these historic plantings and trends.

Trees today must contend with a disturbed and altered landscape. Natural soil profiles are rare and paved surfaces interrupt the infiltration of water and nutrients. Roads, buildings and other grey infrastructure combine to change local growing conditions, with reflected heat and wind tunnels a common constraint in many parts of the city. Urban trees, especially street trees, must be tough and capable of withstanding these harsh conditions.

A changing climate is an added challenge that will further test the resilience of trees in the city. Tree species that originally occurred here, or that currently tolerate Sydney's urban landscape, may not be so well adapted to our future climate. As our area develops and its climate changes, the urban forest must also change and evolve to suit the conditions.

The best available knowledge must be used to select tree species that will thrive and meet the needs and challenges of the future. A wide variety of complex factors must be considered to ensure the Right Tree is planted in the Right Place and at the Right Time.

Figure 6: Post war greening in Baptist and Kepos streets, Redfern. 1943, 1984, and 2021

Policy context

Our strategies and polices ensure the network of green infrastructure is adequately governed, planned for and strategically managed. The subject of this strategy is the City's tree canopy, defined as the urban forest – the sum of all trees in the City of Sydney local government area.

The City recognises the importance of significant trees and their contribution to our canopy cover, heritage landscapes and built form, through our Register of Significant trees.

Shrubs, ground covers and other plants are managed through other strategies and policies, such as the Urban Ecology and Strategy Action Plan, Green Roofs and Walls Policy, and the Landscape Code.

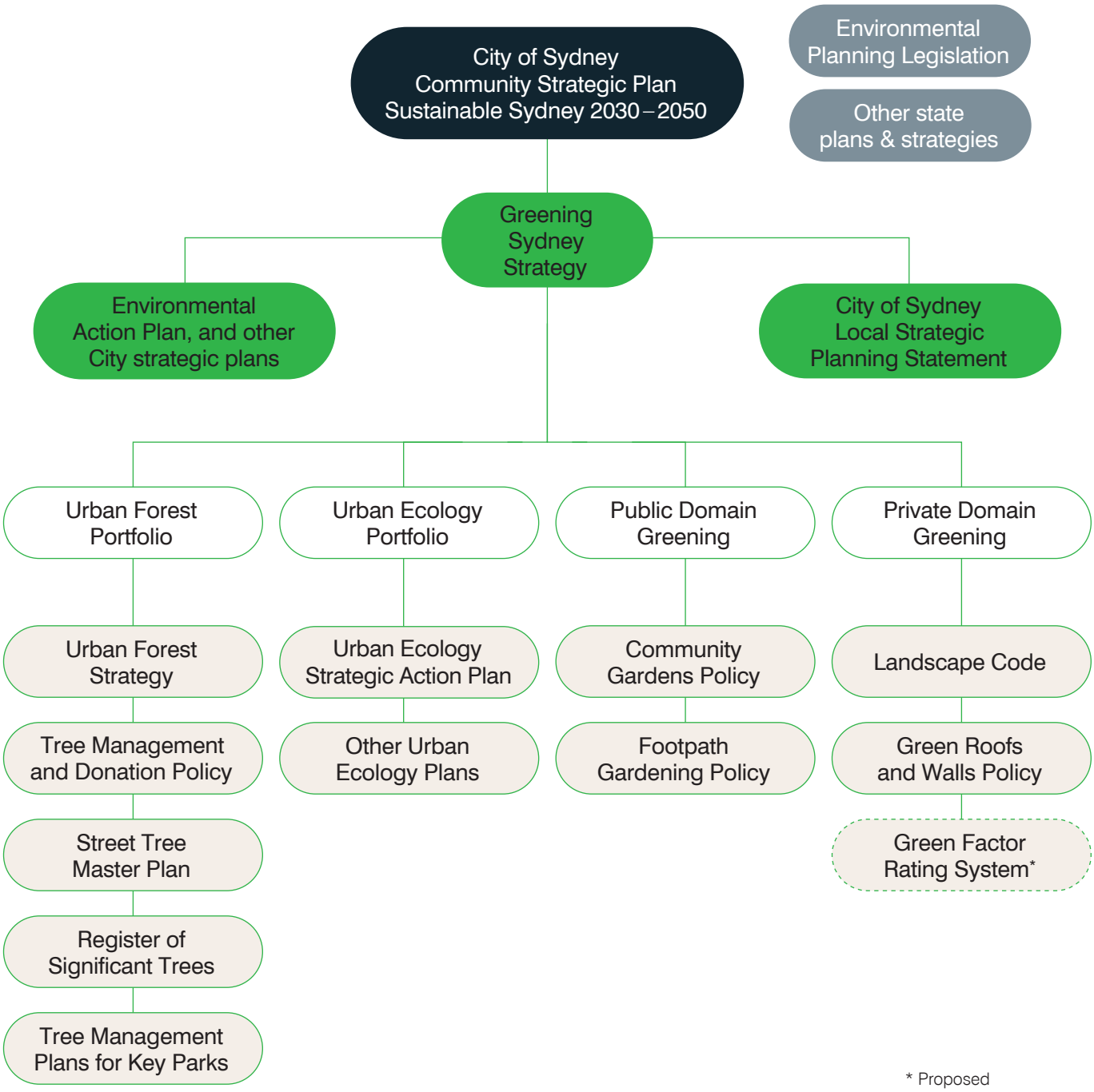
This urban forest strategy is informed and guided by the Greening Sydney Strategy 2021, and its vision for a greener city that is cool, calm, and resilient. The specific directions and actions of the Greening Sydney Strategy most relevant to this urban forest strategy are outlined below

This strategy also follows and builds upon the first urban forest strategy 2013 and its targets for canopy cover and tree species diversity. The review period for this strategy is 10 years, to ensure the latest scientific knowledge and any new innovative methods of spatial analysis are employed to govern and manage the forest in the best possible way.

Community engagement and participation is integral to many of the specific directions and actions of this strategy and is woven throughout the relevant parts of this strategy rather than being addressed within a specific section.

Direction 1 - Turn grey to green	**Action 1** - Achieve the targets **Action 3** - Harness innovation, technology and inspiration
Direction 2 - Greening for all	**Action 4** - Distribute greening equitably **Action 6** - Adapt for climate
Direction 3 - Cool and calm spaces	**Action 8** – Cool the hot spots
Direction 4 - Greener Buildings	**Action 11** - Green factor Score **Action 13** - Planning ahead
Direction 5 – Nature in the city	**Action 14** – Recognise and support Indigenous ecological knowledge
Direction 6 – Greening together	**Action 19** - Greening Sydney Fund **Action 20** - Increase our community engagement

Strategic Framework



* Proposed

Direction 1
An integrated forest

Urban forests are defined as all the trees, or groups of trees, that exist in urban areas. They include trees in parks, streets and those growing within private or public properties (FAO 2016).

Trees combine to enrich spaces that serve society in many ways. The habitat and biodiversity they provide is a foundation for healthy ecosystems. We appreciate how they soften urban landscapes, provide shade, mark the change of seasons, and connect us to nature. For children trees are opportunities to play and learn. For Aboriginal people as Traditional Custodians trees represent significant connections to Country and lore.

A forest may be considered as the sum of all individual trees, but in many ways an urban forest is much more than this. The United Nations Food and Agriculture Organisation guidelines on urban forestry state that urban forests should be viewed as crucial infrastructure providing tangible benefits and values that enhance quality of life, safety and public health. They also suggest that the return on investment in urban forests far exceeds the cost of installation and maintenance compared with grey infrastructure and should be considered a smart deal for authorities and the public.

Our forest will be fully integrated within the urban landscape. The coordinated design of nature-based solutions that prioritise trees and urban canopy cover will optimise the connections between grey, blue and green infrastructure, and promote resilience and benefits for all society.

It will also be a forest integrated with the community, recognised as an essential part of our physical and mental wellbeing, and providing tangible benefits for everyone.

Benefits of urban forests

Urban issue	Benefits of urban forests
Urban poverty	Create jobs & increase income
Soil & landscape degradation	Improve soil conditions & prevent erosion
Reduced biodiversity	Preserve and increase biodiversity
Air & noise pollution	Remove air pollutants & buffer noise
Greenhouse gas emissions	Sequester carbon and mitigate climate change, improve local climate & build resilience
Energy shortage	Save energy through shading/cooling
Heat island effect	Cool the built environment through shade and evapotranspiration
Limited accessible green space	Provide more accessible natural green space
Public health	Improve the physical and mental health of residents
Flooding	Mitigate stormwater runoff and reduce flooding
Limited recreational opportunities	Provide opportunities for recreation and environmental education
Limited water resources	Enable infiltration & the reuse of wastewater
Lack of community & social cohesion	Provide distinctive places for formal & informal outdoor interaction

Tote Park, Zetland. Adam Hollingworth

Tree pruning in Surry Hills. City of Sydney

Action 1 – Deliver best practice urban forestry

Urban forestry is the science and art of managing trees, forests and natural ecosystems in, and around urban communities to maximise the physiological, sociological, economic and aesthetic benefits that trees provide society (Schwab 2008). We demonstrate our commitment to urban forestry, and our role as caretaker of the urban forest, through this urban forest strategy and our many tree management programs and projects.

An urban forest provides social, economic and environmental benefits at a scale well beyond that of individual trees. It is the entire community, our society as a whole, that must act as caretakers of the forest to ensure these benefits are maintained or enhanced for future generations. The City of Sydney, acting on behalf of the community, is the caretaker of the forest within streets, parks and other public spaces.

Other institutions or government agencies also have an important role to play as caretakers of trees within their boundaries. Trees within private property may be inherited when a property is sold to a new owner. Property owners are the caretakers of the trees on their land, but we also have a governing role to ensure the urban forest within private land is managed appropriately.

We will continue to maximise the benefits of the forest through appropriate policies, procedures and controls for trees under public and private management. We will ensure that trees are adequately protected, valued and maintained, and will permit the removal of trees when appropriate to do so. We will continue to plant trees wherever possible to expand our forest and to spread the benefits of tree canopy throughout our area.

To promote urban forestry best practice we will:

– engage with our communities to highlight their role as caretakers, and to inform them of any emerging risks to the forest and measures taken to mitigate those risks

– look for opportunities for our communities to establish connections and caretaker relationships with the urban forest, acknowledging the role of Traditional Custodians to help guide us all along this path

– continue to produce and administer best practice policies and programs for the protection, maintenance and management of trees throughout the landscape

– share the progress and results of urban forestry and tree management programs with our communities, using digital platforms to share relevant data about their local area

– exchange ideas and information with other urban foresters, related professionals and interested stakeholders, both locally and internationally, to build and develop a community of best practice.

Action 2 – Promote an integrated and coordinated approach

Our vision for the urban forest has integrated planning and decision making at its core. The distinct demands for grey, blue and green infrastructure in our city are acknowledged, but the benefits that result from coordinated design and application must be achieved wherever possible.

Existing trees of high value should be retained and protected whenever possible and incorporated into landscapes as they are redeveloped. Adequate space must be provided for all essential infrastructure, including trees.

The various stakeholders that help to shape our city including public and civic leaders, civil and water engineers, architects, strategic planners, urban foresters, and many others must work towards providing cohesive and coordinated outcomes that maximise the returns and outcomes our communities desire.

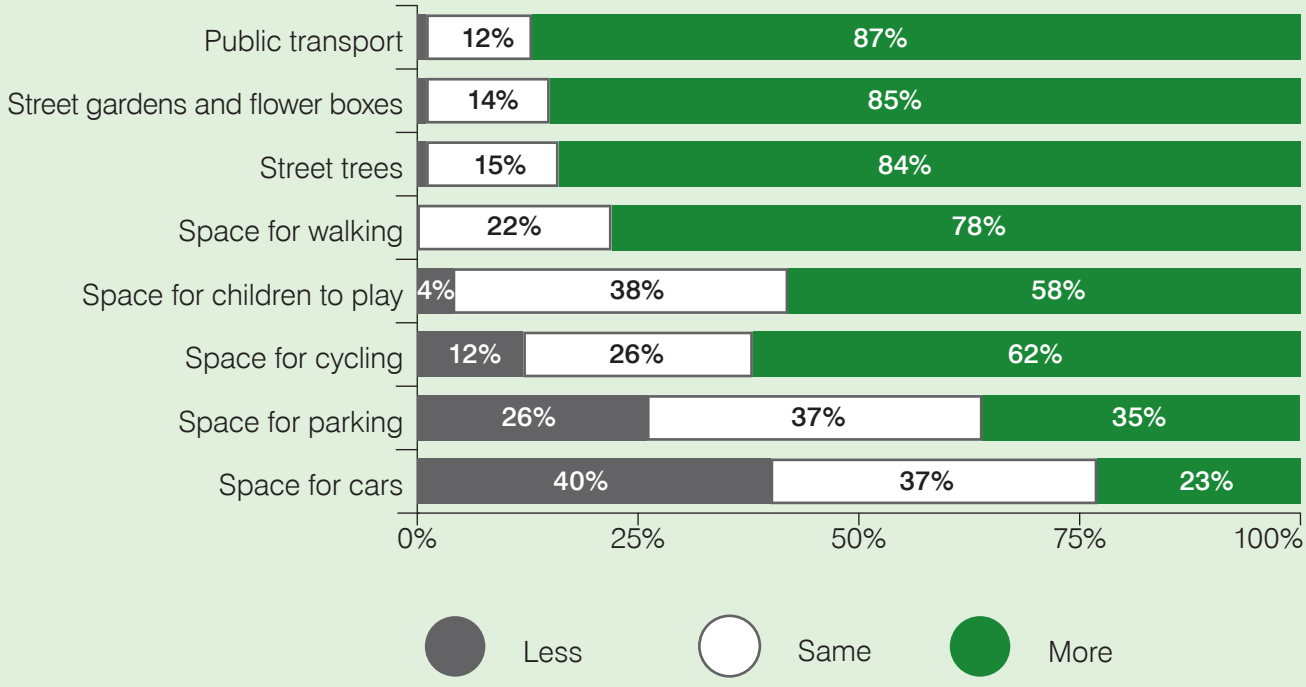
To ensure a coordinated approach for urban forest outcomes we will:

- explore ways to better protect existing trees and integrate tree planting or tree replacement work with the renewal of other assets, such as footpaths, roads or drainage
- promote knowledge sharing and cooperation between disciplines and look for opportunities to coordinate designs, share resources and celebrate successes
- continue to experiment with methods to combine trees and other infrastructure towards more coordinated and holistic outcomes, such as capturing and diverting stormwater for passive irrigation of street trees
- continue to engage with the owners and managers of public utilities to ensure opportunities for tree planting are not adversely affected when their assets are installed or renewed.

In focus: Congested streets

As part of planning for 2050, we heard our communities want streets that are green and pleasant, with trees and free of congestion (Astrolabe Group & City of Sydney 2019). As shown below, our communities would like to see more trees and more space for walking, playing and cycling. To achieve this adequate space must be allocated for trees and other greening, and a lower priority given to less desired uses.

Survey: What would you like to see more of in your local streets?



Direction 2
A growing forest

Urban forests are typically measured and compared by the amount of canopy cover they provide. Canopy cover is the area of land covered by tree canopy when viewed from above. Special cameras are mounted to aircraft to capture high-resolution multispectral images of our local area.

Areas of vegetation are detected from these images and categorised based on their height above ground. This method allows us to detect and monitor areas of tree canopy, defined as all vegetation measured to be three metres or more above ground level.

Canopy cover is expressed and summarised as a percentage of a land area: the sum of tree canopy area, divided by the sum of land area. Canopy cover is reported at the local government area scale to give an overall measure of canopy cover within our administrative boundary. Additional canopy cover metrics are reported for specific land uses and at smaller scales to demonstrate the community access to canopy cover. This is explored further in Direction 3.

While it is important to understand past and current trends in canopy cover growth or decline, it is also important to look to the future. This strategy expands on the targets for canopy cover within streets, parks and properties introduced in our Greening Sydney Strategy and builds upon its actions towards a cooler, calmer and more resilient city.

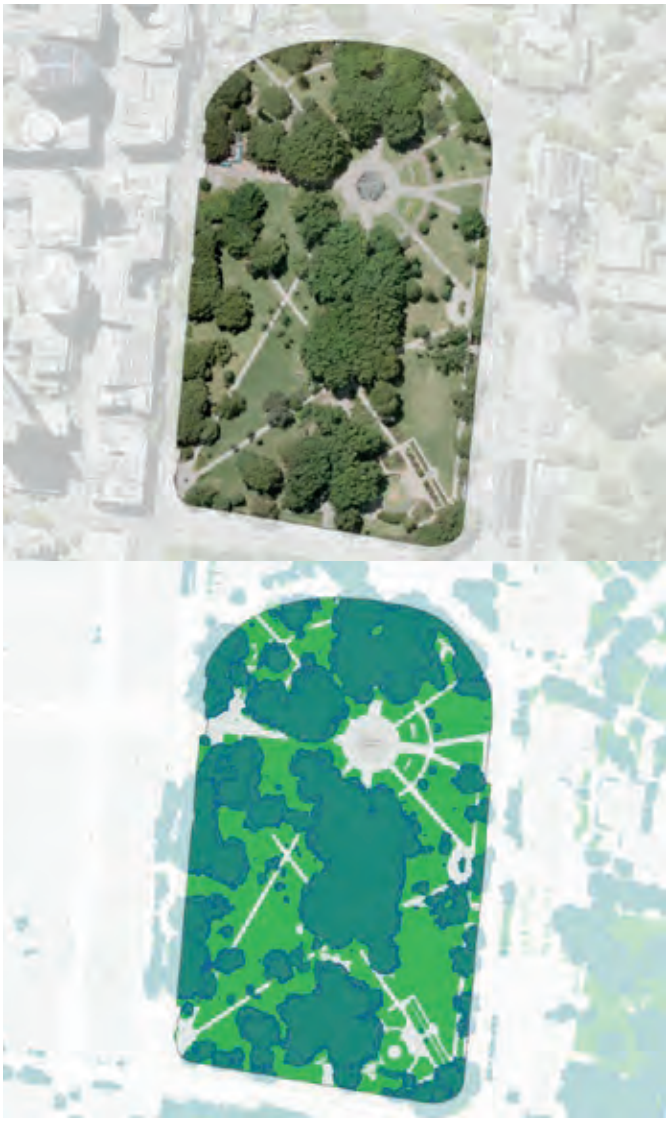


Figure 7: Aerial image of Hyde Park north, with areas of tree canopy shown in blue and other vegetation shown in green.

Our target is to increase our overall green cover to 40 per cent across the local area, including a minimum of 27 per cent tree canopy by 2050.

Greening Sydney strategy 2021

Canopy cover is measured for all land within our area, regardless of who owns the land or manages it. Repeated measurements using a consistent and accurate method allow tree canopy increases or decreases to be calculated and monitored over time and allow outcomes of policies and programs to be quantified and evaluated.

We use three primary land use themes to frame the analysis of data: streets, parks and properties. Using categories such as these helps to organise and interpret urban forest data and assists to inform management strategies and actions (Pregitzer et al. 2019).

Upper Fort Street, Millers Point . Photo: Tyrone Branigan / City of Sydney

Figure 8: The City of Sydney local area showing the 3 primary land use categories: streets, parks and properties. When each is overlayed, the entire area is accounted for.

Action 3 – Monitor change

The canopy cover of the City of Sydney was first measured in 2008 to establish a baseline from which future action and measurements can be compared. This 2008 baseline canopy cover, as an average over the entire area, was 15.5 per cent.

Our urban forest strategy 2013 stated:

> The City will increase the average total canopy cover from the current 15.5 per cent to 23.25 per cent by 2030, and then to 27.13 per cent by 2050, through targeted programs for trees located in streets, parks and private property.

Since that time, our urban forest management and maintenance programs have seen the average canopy cover gradually increase to 19.8 per cent in 2022 (Figure 9).

When assessed within each of the primary land use themes as distinct sub-sets of the local government area, canopy cover has gradually increased within each of the street, park and property portfolios. (Figure 10).

The city is constantly changing, and since the canopy cover is based on land use areas, it is important to understand and acknowledge if significant changes in land use have influenced the accounting of canopy cover. Analysis has found that land use within each of the primary land use themes has been relatively constant throughout the 2008 to 2022 reporting period.

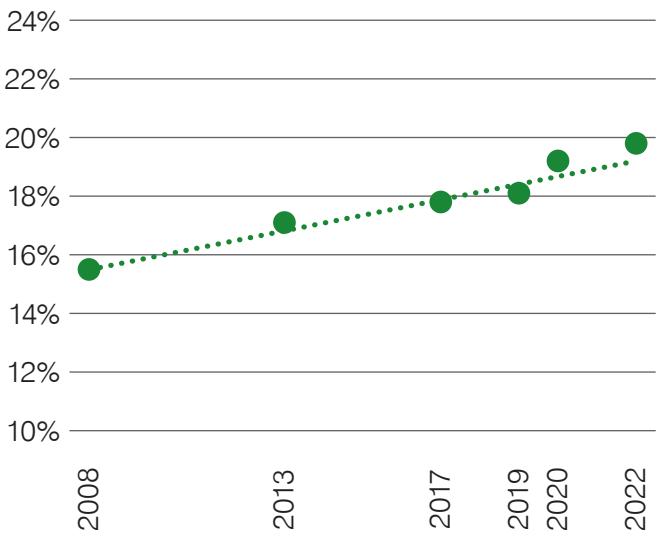


Figure 9: Growth in canopy cover within the City of Sydney local government area 2008 to 2022. Canopy cover is presented as a percentage of the total local government area. Dotted line is the linear trend.

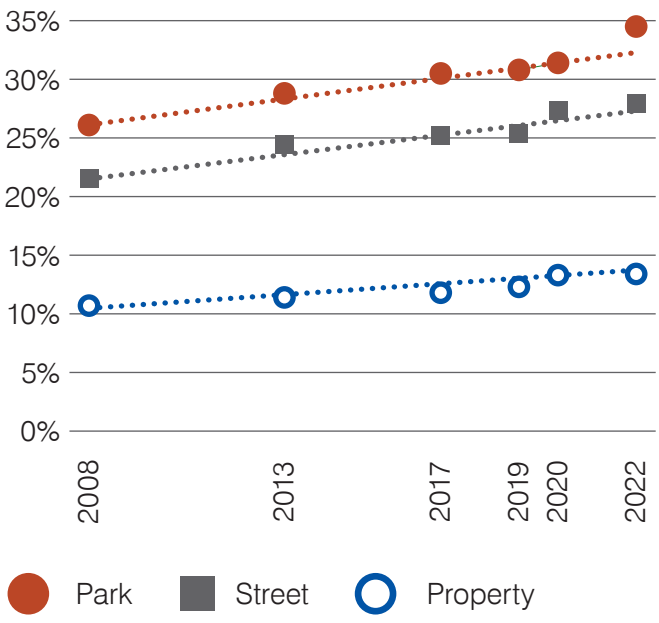


Figure 10: Growth in canopy cover within streets, parks and properties from 2008 to 2022. Canopy cover is presented as a percentage of the primary land use category area. Dotted lines are linear trends.

Morton Bay Fig tree trunk and buttress roots. Photograph: City of Sydney

Each tree under our direct management and control is inspected each year as part of routine maintenance programs. This data is a rich and valuable resource to monitor how our trees change over time. The count of street trees has been increasing year on year, with a 13% increase from 2014 to 2022 (Figure 11).

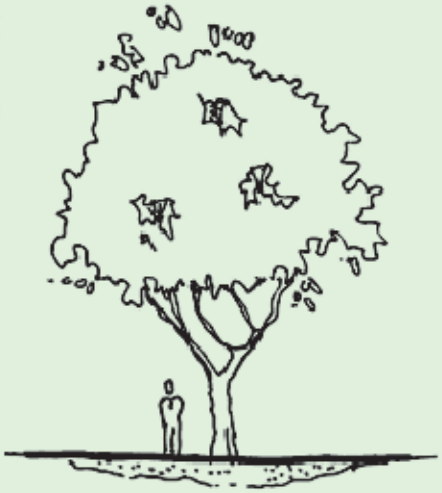
The overall size or biomass of street trees has also been increasing. The sum of street tree basal areas was calculated from measurements of each tree's stem/trunk diameter. It is a useful indicator to complement tree count as it correlates with attributes such as overall tree size, leaf surface area, and biomass (Galle et al. 2021). Larger trees provide more benefits. The basal area of street trees has increased by 8% from 2014 to 2022, indicating that the overall biomass or size of street trees has not been compromised by their increasing number (Figure 11).

To monitor changes to the urban forest and promote achieving canopy cover targets we will:

– continue to acquire accurate aerial assessments of canopy cover every 2 years, using a consistent and reliable method comparable with previous assessments, and use this data to drive outcomes within each of the land use portfolios
– refine future canopy cover data through excluding rooftop vegetation from the analysis and calculation of tree canopy cover
– continue to monitor changes in land use over time to assess any influence of these changes on canopy cover within streets, parks and properties
– continue to monitor changes to the size and structure of urban forest we manage, using a variety of accurate asset management data
– investigate emerging and alternative technologies for cost effective aerial canopy cover acquisition and urban forest monitoring, such as artificial intelligence for canopy detection and alternative ground-based technologies to automatically acquire tree data
– investigate and test alternative methods to categorise the distribution, structure and connectivity of the urban forest, such as morphological spatial pattern analysis, and apply these methods to prioritise actions that enhance canopy connectivity, for improved wildlife corridors and cooling effects.

In focus: basal area and tree size

Trees can be measured in many ways. We can measure their height, canopy spread or even estimate their leaf surface area. We can also calculate the cross-sectional area of a tree's trunk from measurements of its trunk diameter. This cross-sectional area is known as the basal area. The basal area is commonly used in forestry because it is simple and easy to use, and increases in this measurement align with increases in other measurements of tree size and the overall biomass of the tree.



Small tree		Medium tree		Large tree	
Height	3m	Height	6m	Height	12m
Canopy	spread 1m	Canopy spread	4m	Canopy spread	8m
Trunk diameter	4cm	Trunk diameter	20cm	Trunk diameter	50cm
Basal area	0.001m^2	Basal area	0.031m^2	Basal area	0.2m^2

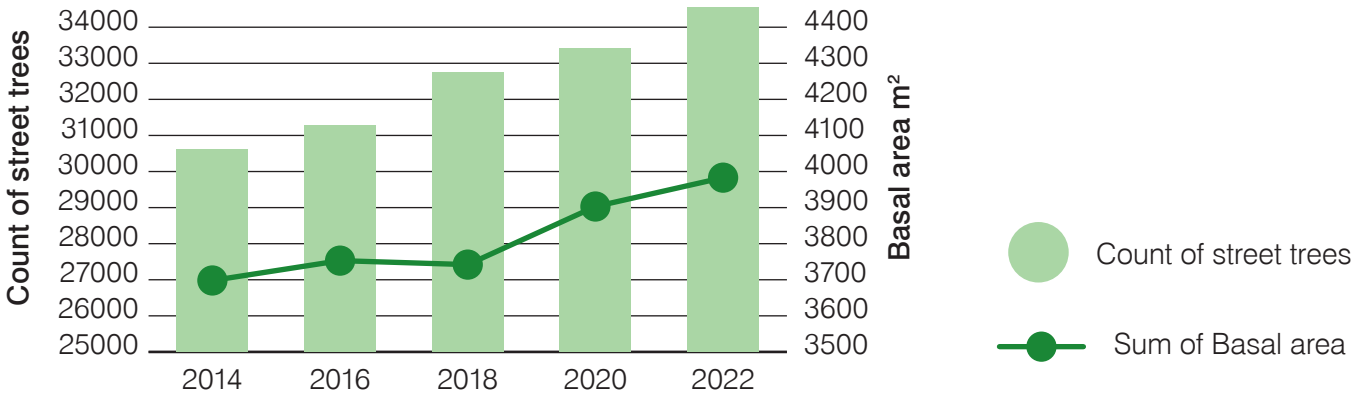


Figure 11: The count and sum of basal area of street trees, 2014 to 2022.

Action 4 – Achieve canopy cover targets

Targets for future canopy cover help to focus ambition and action towards a cool, calm and resilient city. The greening Sydney strategy 2021 states that the minimum overall green target for the city is 40 per cent, including an overall canopy target of 27 per cent.

Our canopy target is the result of detailed analysis of land use across the city, at the individual street, park and property scale. These categories were chosen due to the different management and governance frameworks that apply to each. Secondary land use categories were listed to further break down these categories into street types, park types and land use zonings (see Table 1).

The capacity or opportunity for tree canopy within each of these secondary land use categories was modelled or tested, and the resulting canopy areas used to give **totals** able to be provided within each of the street, park and property portfolios. A more detailed explanation of the methods used to establish our targets is in Appendix 2. The results of the analysis are a valuable data resource, helping to identify specific locations and priorities for increasing canopy cover.

A sustainable urban forest has trees of diverse ages. Not all trees can be mature at all times.

There will be some streets with mostly mature canopy trees and other streets where young or semi-mature trees are more common. Age diversity was factored into the analysis to establish the canopy targets to ensure the they are realistic and sustainable over the long term.

The primary and secondary land use canopy targets within streets are summary targets, and since they assume an age diverse group of trees, they should not be applied to any new street design. The future mature canopy cover provided by a newly designed and built street would need to be higher than the target since the trees are all considered in their mature state (not age diverse). More guidance about how to interpret and deliver actions towards achieving the targets can be found in Appendix 3.

Sydney Park. Credit: Jennifer Leahy/City of Sydney

Where we need to be – 2050

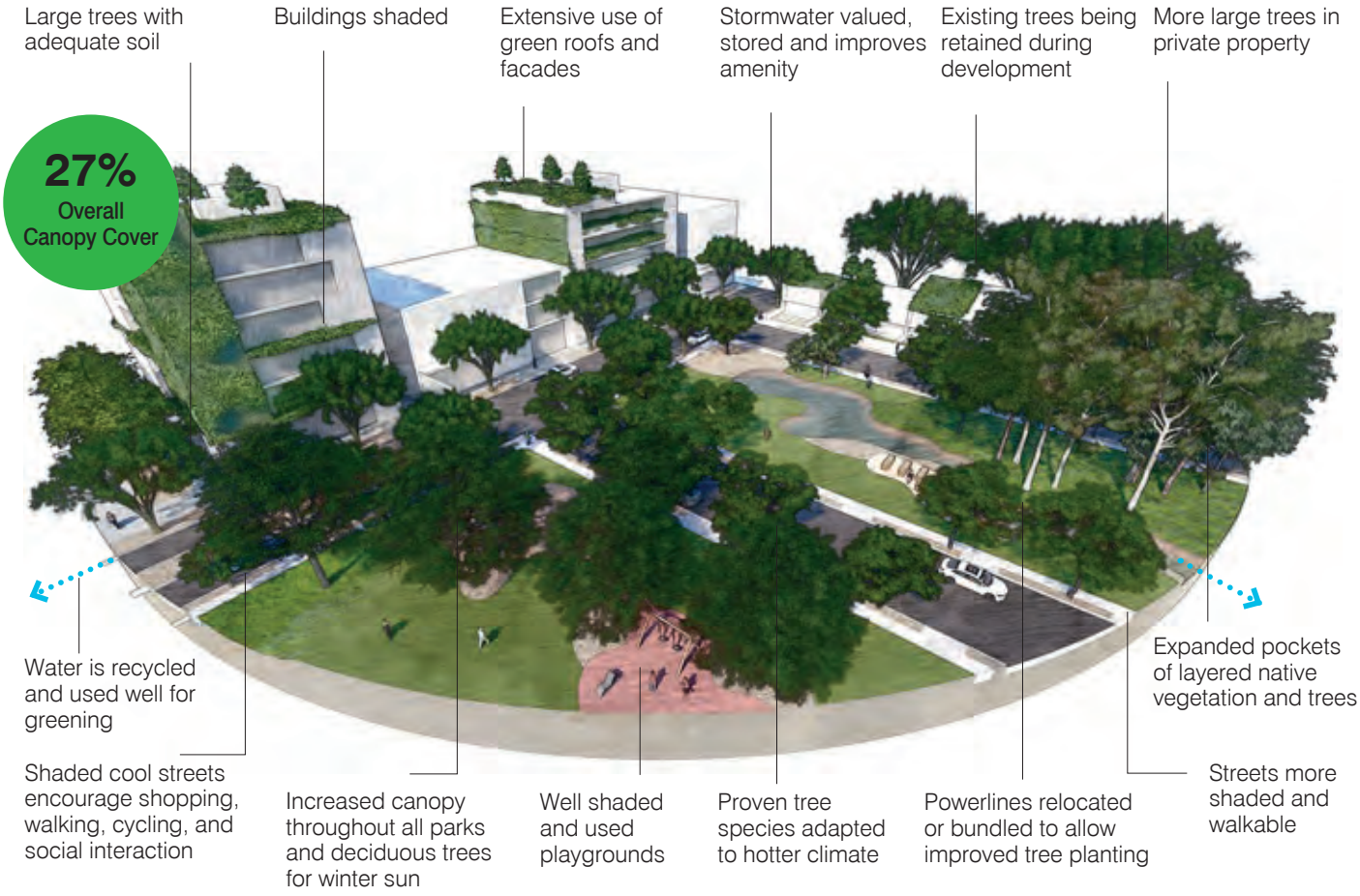


Figure 12: Our target for tree canopy cover by 2050.

Summer Streets event in Redfern. Credit: Adam Hollingsworth/City of Sydney

In focus: land uses

Considering land uses within defined categories can help to understand how tree canopy is distributed within our area and specific zones. It can also guide our action to improve canopy cover within those areas. The overall target for the whole area is a direct result of what can be achieved within each of the primary and secondary land use categories described below.

Streets

– state roads such as Botany, Parramatta and Gardeners roads. Prioritised for vehicle traffic.

– regional roads, including Bathurst Street, Foveaux Street and Glebe Point Road

– local roads that are all local access streets, not classed as state or regional roads and have the most potential for tree planting

– laneways such as narrow streets, typically at the rear of properties, historically used for access and servicing.

Parks

– Iconic parks, such as Hyde Park, Redfern Park, Prince Alfred Park

– neighbourhood parks such as Alexandria Park, Harry Noble Reserve, Green Park

– pocket parks: the many small parks that serve local residents

– civic spaces: mostly paved spaces used for civic functions

– sports fields: playing surfaces such as Waterloo Oval, Erskineville Oval

– golf courses: Moore Park Golf Course.

Properties

– City of Sydney local environment plan development zonings, such as residential (R1), mixed use (B4)

– action towards achieving the canopy targets within private property will be through the development control plan and requirements specific to development types.

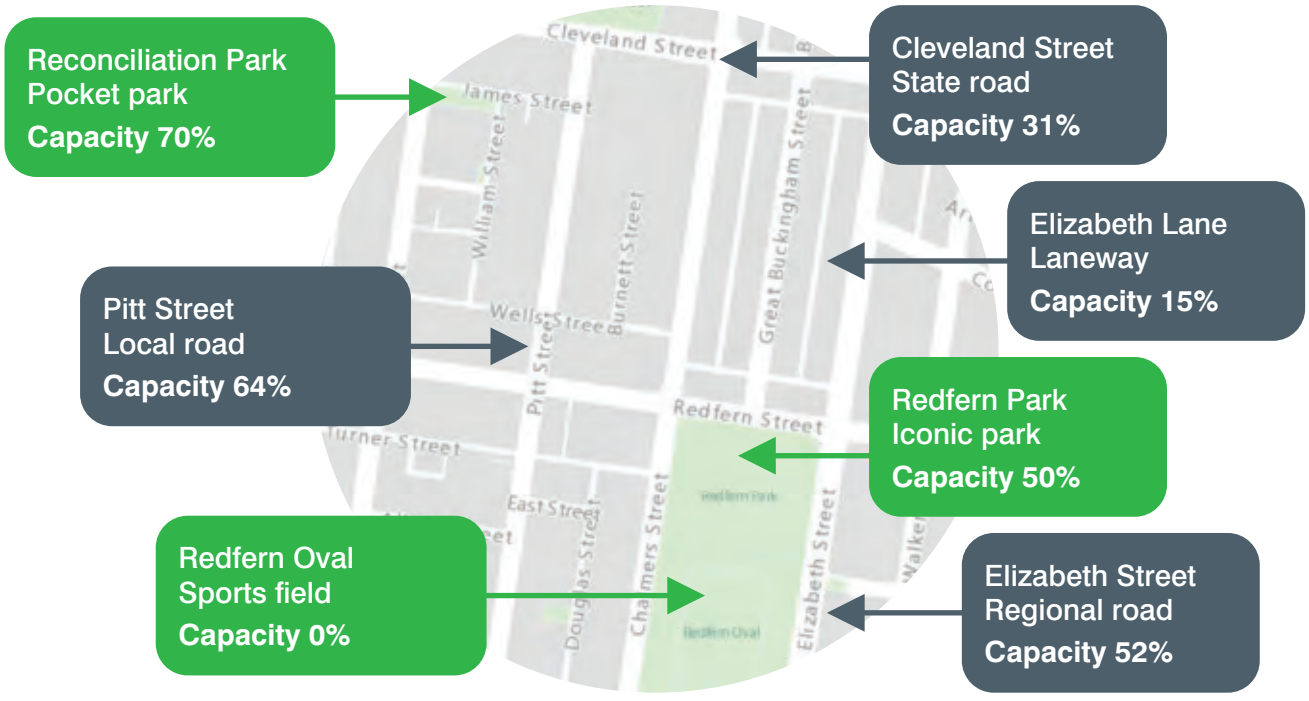


Figure 13: Example of the theoretical capacities of various land uses as calculated towards the setting of overall targets for each land use category.

Table 1: Primary and secondary land use categories with details of their total land use areas, existing canopy cover, and target canopy areas and percentages. Targets are applied to the categories, not individual sites. For guidance on site specific action towards achieving targets see Appendix 3.

Primary land use category	Secondary land use category	Land use area (ha)	Land Use area, % of total LGA area	2019 canopy area (ha)	2019 canopy cover, % of total portfolio land use area	2050 target canopy area (ha)	2050 target canopy cover, % of total portfolio land use area
STREET	State Road	111.28	4%	19.65	18%	26.92	24%
	Regional Road	65.19	2%	15.63	24%	19.71	30%
	Local Road	392.36	15%	114.84	29%	149.56	38%
	Laneway	38.31	1%	6.69	17%	9.58	25%
	Street subtotal	608.80	23%	156.81	26%	205.77	34%
PARK	Iconic	248.96	9%	79.86	32%	124.48	50%
	Neighbourhood	33.75	1%	12.41	37%	18.56	55%
	Pocket	37.19	1%	17.31	47%	26.04	70%
	Civic	2.90	0%	0.93	32%	1.45	50%
	Sports field	34.58	1%	0.29	1%	0.00	0%
	Golf Course	44.32	2%	8.42	19%	13.30	30%
	Park subtotal	401.70	15%	119.30	30%	183.82	46%
PROPERTY	General Residential (R1)	414.07	16%	84.31	20%	103.52	25%
	Low Density Residential (R2)	50.97	2%	6.35	12%	20.39	40%
	Business and Mixed (B4-B7)	487.69	18%	36.58	8%	73.15	15%
	Local and Neighbourhood Centre (B1&B2)	56.26	2%	4.90	9%	8.44	15%
	Commercial Core and Metropolitan Centre (B3&B8)	163.69	6%	7.67	5%	8.18	5%
	Special Activities and Infrastructure (SP1&SP2)	163.22	6%	31.47	19%	40.80	25%
	General industrial (IN1)	71.66	3%	2.92	4%	7.17	10%
	Public Recreation (RE1)	22.11	1%	5.28	24%	6.63	30%
	Other	222.11	8%	23.52	11%	55.53	25%
	Property subtotal	1651.76	62%	203.00	12%	323.81	20%
	LGA TOTAL	2662.26	100%	479.12	18%	713.41	27%

Properties account for over 60 per cent of the land area in the local government area (LGA). Gains or losses in canopy cover within this land use category can significantly influence the overall canopy cover of our area. Canopy may be gained through large urban renewal developments where land changes from industrial uses to residential. Canopy can be lost in areas where alterations and additions to existing dwellings results in tree removal. A balance between the competing needs of development, the retention of existing trees, and the provision of space for the planting of new trees is required to increase tree canopy to the levels desired by the community.

Local environment plan zonings were used to categorise the property land use to a finer grain. However, action towards meeting the canopy targets within properties will be driven through minimum tree planting requirements for specific development types.

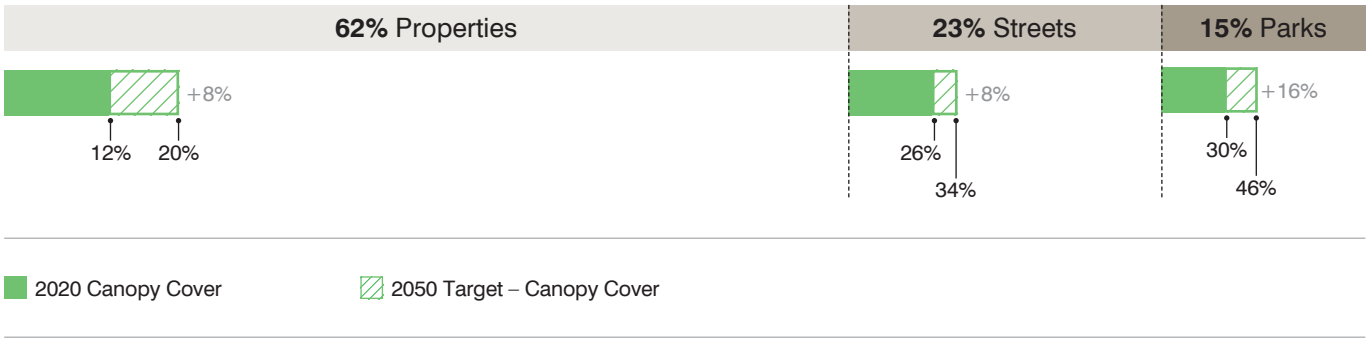


Figure 14: Primary land use categories relative to existing canopy cover and future targets.

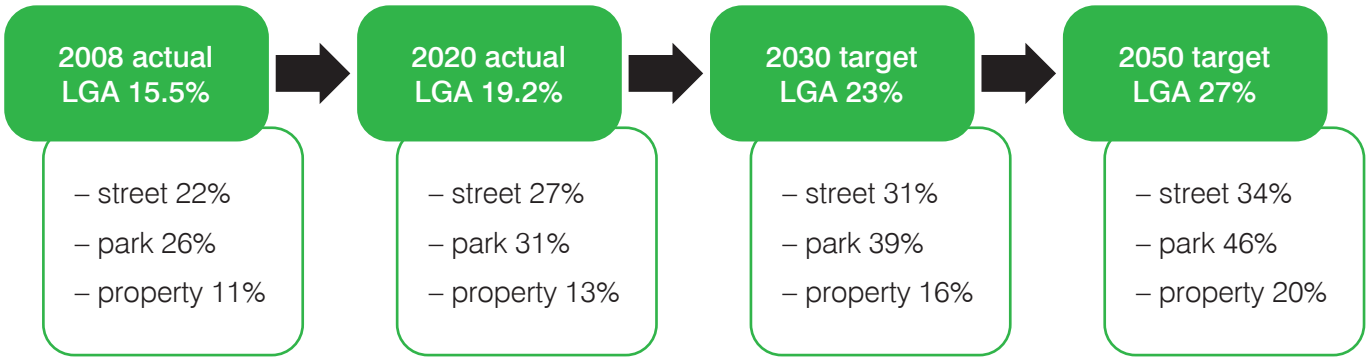


Figure 15: Past measures of canopy cover and targets for future canopy cover in 2030 and 2050, for local government area as a whole and the primary land use categories.

DESIGN TESTING AND OBSERVATIONS

DEVELOPMENT APPLICATION		
Deep soil	0.0m2	0.0%
Deep soil canopy	0.0m2	0.0%
Structure canopy	0.0m2	0.0%
Total canopy	0.0m2	0.0%
SDCP deep soil control	Non-compliant	10% / 3m
SDCP canopy control	Non-compliant	15%
GS2050 canopy target	Non-compliant	15%

ALTERNATIVE APPROACH		
Deep soil	346.8m2	15.1%
Deep soil canopy	475.3m2	20.7%
Structure canopy	0.0m2	0.0%
Total canopy	475.3m2	20.7%
SDCP deep soil control	Compliant	10% / 3m
SDCP canopy control	Compliant	15%
GS2050 canopy target	Compliant	15%

- Existing building site coverage 100%
- Development within constraint of existing factory walls
- Centralised basement car park is located beneath courtyard
- No trees of minimum size (5m) in planting on structure

- Reconfigured perimeter car park to provide deep soil centrally
- Building separation used for deep soil and canopy cover
- Tall trees can be provided with a wide crown above the building
- Potential for rooftop planting

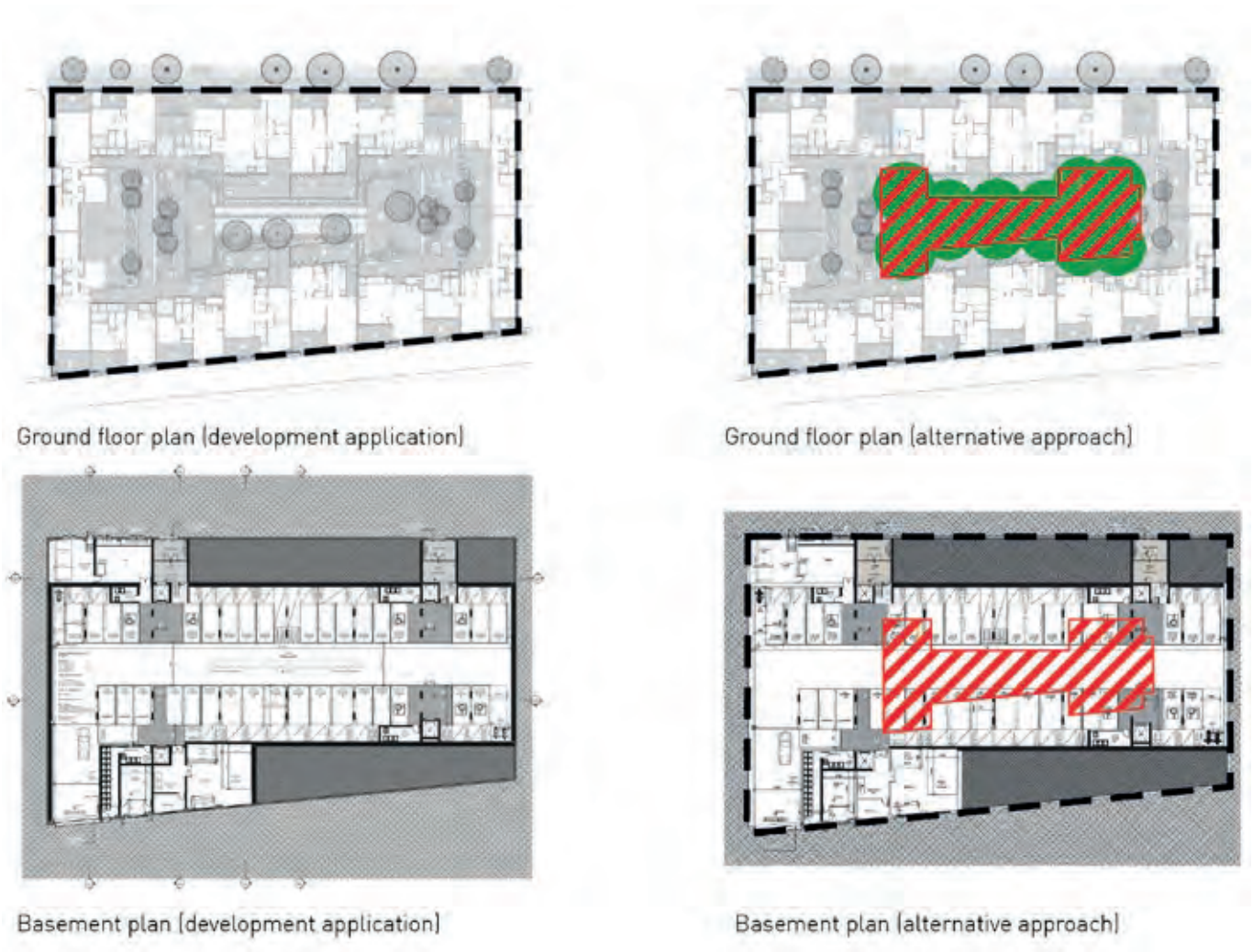


Figure 16: Example of testing for the provision of canopy cover within the residential apartment development type (Zanardo & Gallagher 2021).

Pleasant Avenue, Erskineville. Photo Katherine Griffiths

The results of our analysis indicate we can realistically aim to achieve an average total canopy cover within our area of 27 per cent by 2050. The additional 3 per cent required to reach 30 per cent is 80 hectares of tree canopy, an area equivalent to 42 Sydney Cricket Grounds. The current allocation of land use within our area does not provide adequate space for this additional 80 hectares of canopy.

Achieving the canopy cover targets will take a sustained and coordinated effort, with all owners and managers of land in our area required to play their part to provide new tree canopy.

To ensure our canopy targets are achieved, we will:

– identify streets where tree planting and providing canopy cover should be prioritised over other uses of public space, such as on-street car parking and other road space that is underused. Develop a program to prioritise planting based on need and opportunity
– continue to identify opportunities for new and replacement tree planting in streets and parks and deliver best-practice tree planting and establishment programs. Ensure trees are planted in the best locations to optimise canopy cover
– ensure the mature size of trees planted in streets and parks is the most appropriate for the space available. Park planting plans will be developed and the street tree master plan will be comprehensively reviewed to ensure tree species selection is optimised
– improve soil and tree pit growing conditions in streets to ensure the trees planted thrive to mature size
– engage with planners, landscape architects, engineers and other practitioners to guide them in how best to plan and deliver projects on private or public property that contribute towards meeting the canopy targets
– drive canopy cover growth on private land through revised provisions within the Sydney Development Control Plan, including minimum tree planting requirements for specific development types
– engage with the owners or managers of large land areas within our area to explain our targets for canopy cover and encourage action within their land towards achieving those targets
– review the targets as new research becomes available, technology improves, especially for aerial canopy measurement, and as the city develops and changes over time.

Direction 3
A forest for all

Issues of equity and fairness arise when there is a large disparity in canopy cover between neighbourhoods. With the expected increase in the number of hot days, one group of residents should not experience temperatures 10°C hotter than other groups due to tree and green cover not being prioritised for our most vulnerable and impacted areas.

The Greening Sydney Strategy promotes a just and fair city through its directions and actions aimed at the equitable distribution of greening. The link between tree canopy and the mental and physical health of the community is well established.

To safeguard our future wellbeing we need to ensure all the community has access to the benefits of trees and canopy cover, and that all streets, parks and properties contribute towards achieving the canopy cover targets.

Prioritising action where it is most needed will be vital to improve and maintain equity.

We will analyse all relevant data to gain the information necessary to monitor our progress towards achieving this outcome.

Woomerah Park Darlinghurst. Photo by Renee Nowytarger / City of Sydney

Action 5 – Look beyond boundaries

The analysis and interpretation of location-based (spatial) data has become an important tool for urban forest practice and management.

Boundaries divide land into manageable pieces. At the broader scale these may be local government area boundaries, suburb boundaries, and at the smaller scale boundaries may define properties or census blocks. Urban foresters have typically used these boundaries and areas to summarise and present data related to canopy cover.

However, trees and canopy exist throughout the urban landscape, and management issues such as equitable access, diversity, and resilience extend across these artificial boundaries and can vary significantly within them. The variable size of suburbs or census blocks can prevent a uniform and consistent approach.

We have applied new spatial analysis techniques to our urban forest that allow us to look beyond these boundaries, provide greater insight, and better manage the urban forest for the entire community. The method involves establishing a grid of uniformly spaced reference points spread across our entire area. At each of the reference points data is gathered and summarised from a buffer radius area surrounding it. The method is explained in more detail within Appendix 4 and forms the basis for much of the data analysis and mapping to support our actions towards improved equity and resilience.

The method allows us to use data at different spatial scales by varying the buffer radius by which it is collated and analysed. A small radius, such as 100m, allows us to assess the urban forest at the local scale or about the size of a city block. A larger radius allows us to assess broader regional trends.

The analysis looks beyond the area boundary when necessary, using publicly available canopy cover data to provide a true representation of how canopy cover is distributed across the area to meet the needs of our communities.

A 2019 Australian study, 'Association of urban green space with mental health and general health among adults in Australia' by Professor Astell-Burt and Dr Feng considered the amount of canopy cover available to people within 1.6km of where they lived. They found that access to canopy cover of 30 per cent or more was associated with better mental and physical health outcomes.

Figure 17 displays the amount of canopy cover available at the 1.6km scale throughout the area. The west and south of our area has comparatively less access to canopy cover at this scale than the east.

Other studies have shown the amount of canopy cover immediately surrounding a location has a significant effect on reducing temperatures and the mitigation of extreme heat (Ziter et al 2019, Lin et al 2016). The daytime temperature is substantially reduced, especially on the hottest days, when there is more canopy cover at the scale of a typical city block.

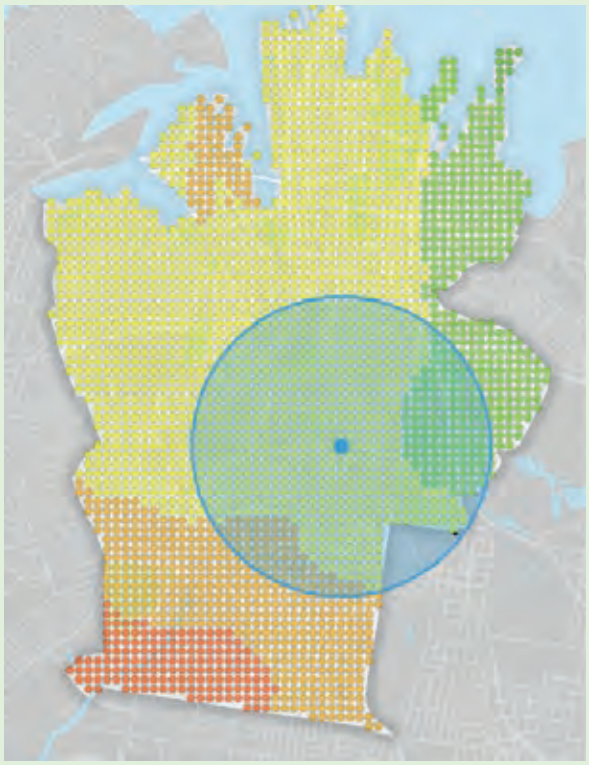
The amount of canopy cover available within a 100m radius, about the size of a city block is shown in Figure 18. The more leafy neighbourhoods and locations with more or less access to canopy cover are easily identified.

To progress this new way of assessing the urban forest and gain greater value from the analysis we will:

– continue using this method to track changes in canopy distribution and equal access over time
– engage with landowners and managers within and beyond our area, and where possible acquire canopy cover and tree asset data to aid and refine the analysis
– capture vegetation and canopy data beyond our area to gain a more accurate assessment of the distribution and availability of canopy cover to neighbourhoods located near the edge of our area.

In focus: why does scale matter?

The scale at which we consider our access to canopy cover can be tailored to specific purposes. We use a 1,600m and 100m scale as outlined below. We have produced an online story-map to assist you in understanding how much canopy cover is in the area surrounding where you live or work.



– 1,600m scale
– large area covering multiple suburbs
– scale used for regional trends in canopy cover and the influence of canopy cover on mental and physical health outcomes.

– 100m scale
– small area covering a typical city block
– scale used for local trends in canopy cover and the influence of canopy cover on moderating high temperatures.

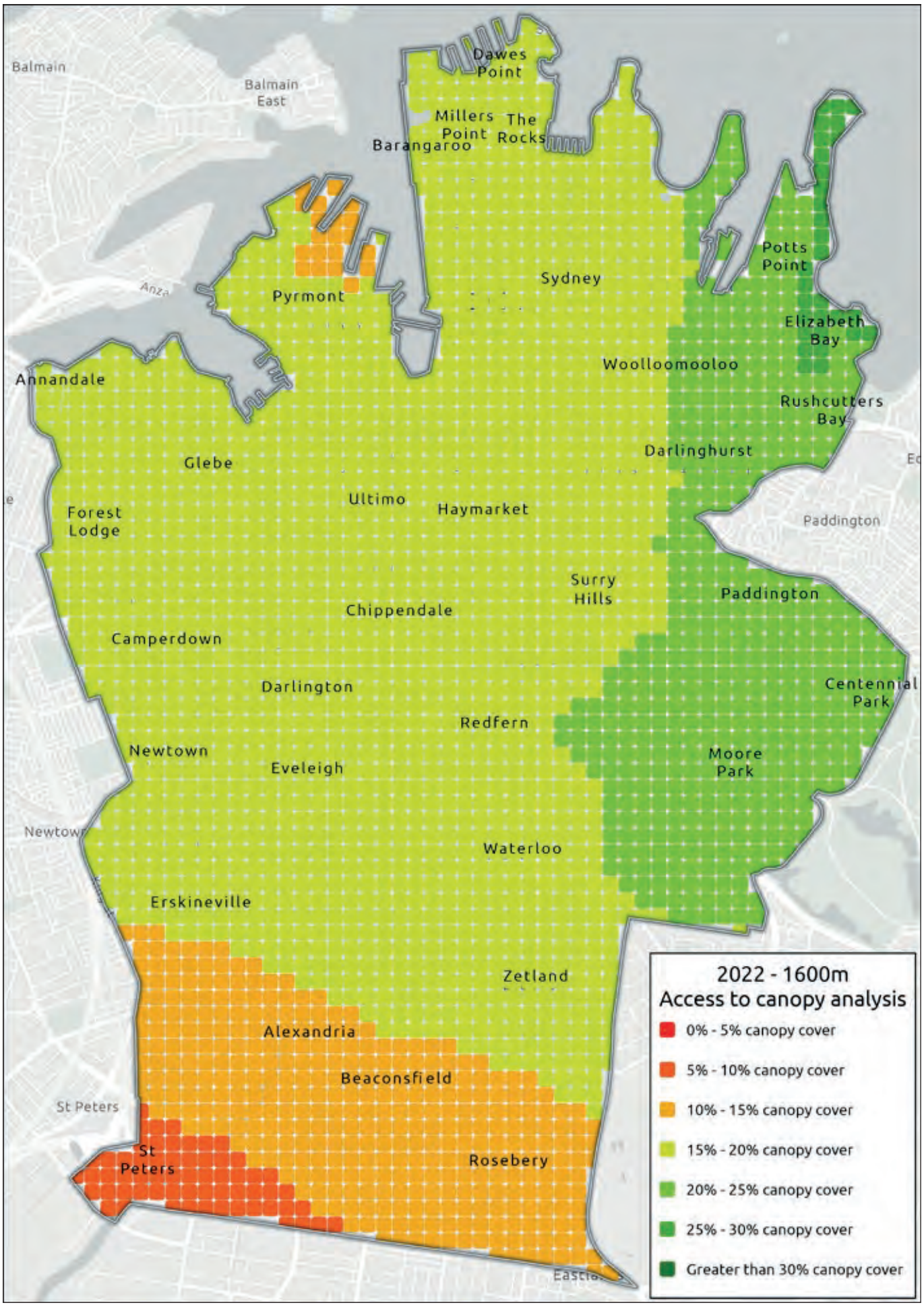


Figure 17: Access to canopy cover within a 1,600m radius in 2022.

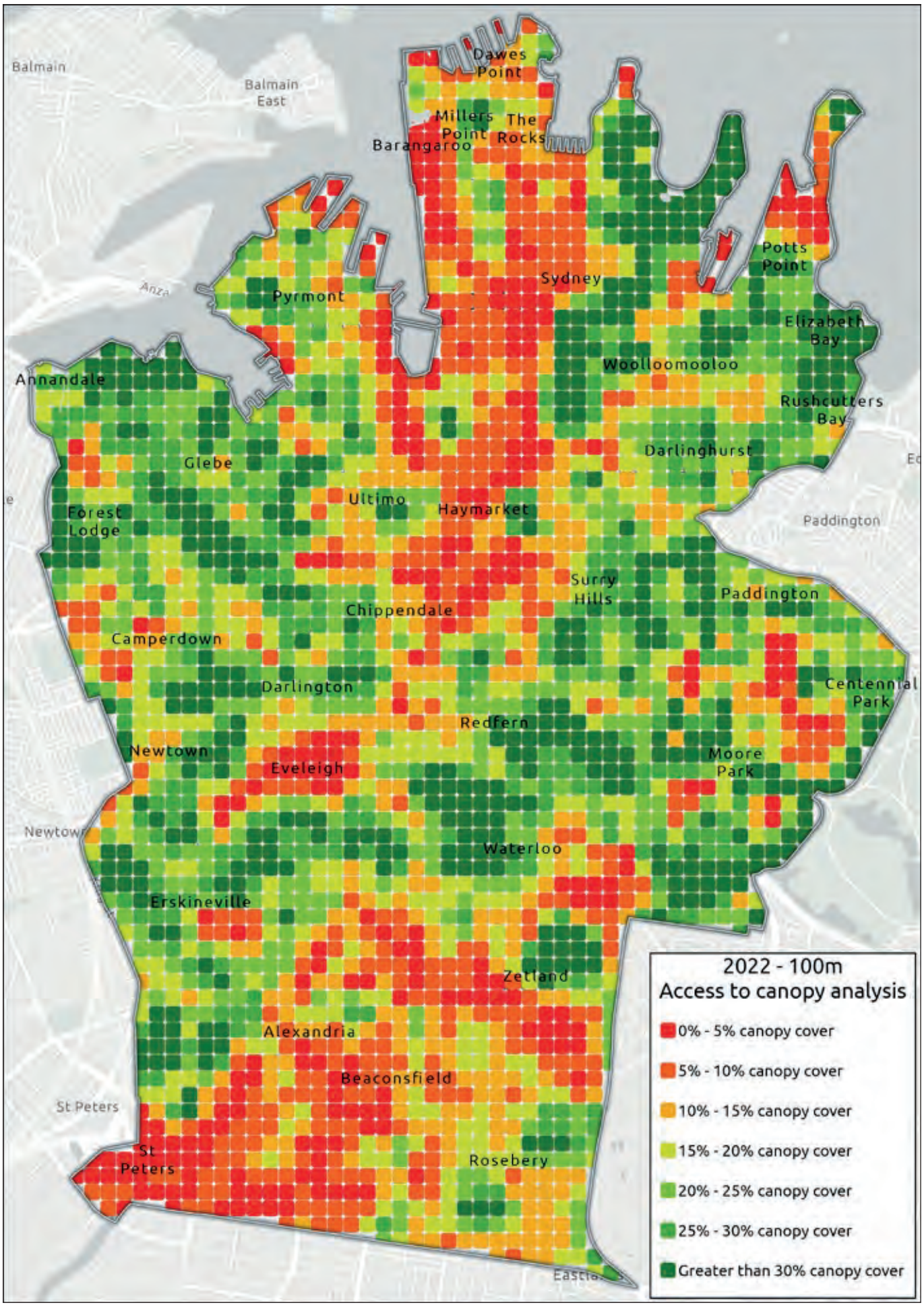


Figure 18: Access to canopy cover within a 100m radius in 2022

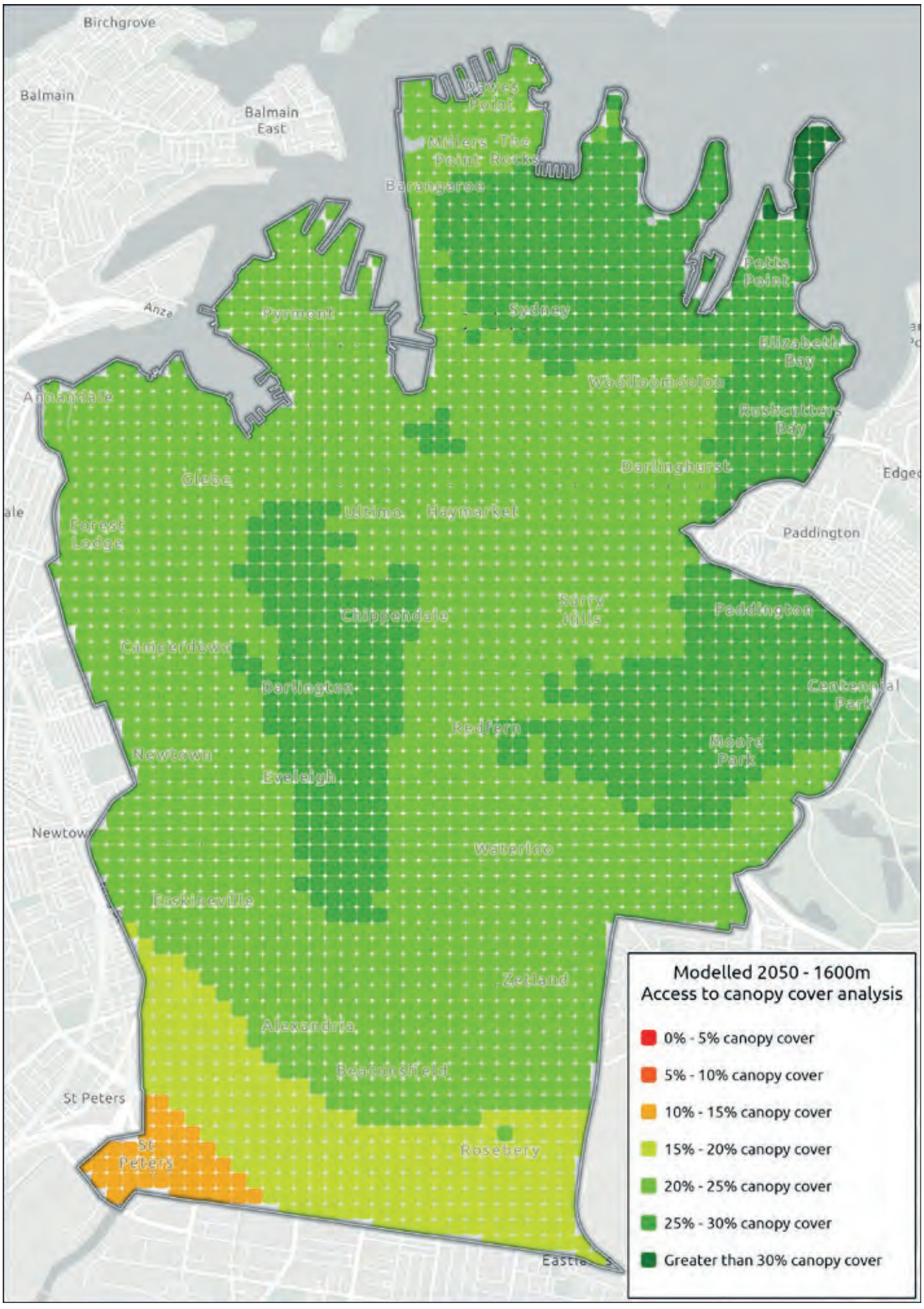


Figure 19: The modelled access to canopy cover at the 1,600 scale in the year 2050, once our targets for canopy cover are achieved.

Action 6 – Distribute canopy equitably

The City of Sydney aims to distribute the benefits of canopy cover equitably across our local government area. However, differences in land use and the capacity of land to accommodate trees and canopy cover can undermine and challenge this goal.

While acknowledging these inherent constraints, we will monitor the community's access to canopy cover to track and report on our progress towards more equitable outcomes.

In line with our targets to increase canopy cover, we aim to have more of our area benefiting from these increases.

Figures 20 and 21 show that the proportion of our area with access to relatively high amounts of canopy cover have been trending upwards since 2008.

Access to more than 20 per cent canopy cover within a 1,600m radius has increased from less than 10 per cent in 2008 to over 35 per cent in 2022. Similarly, access to more than 30 per cent canopy cover within a 100m radius has grown from 10 per cent in 2008 to over 17 per cent in 2022.

Our goal is to maintain this positive trend, so in future more of our area will have access to high levels of canopy cover. Modelling suggests that once canopy targets are achieved, at least 31 per cent of our area will have access to more than 30 per cent canopy cover within a 100m radius of their location. When focusing on areas of low canopy cover, modelling suggests that once the targets are achieved less than 16 per cent of our area will experience less than 20 per cent canopy cover within 100m of their location, and less than 1 per cent of our area will have access to less than 10 per cent canopy cover.

We must also look to parts of the city with low access to canopy cover and work to reduce areas that experience this disadvantage. By doing so we will contribute to improving the health and wellbeing of the community and reducing the heat island effect and help to mitigate the risk of extreme heat.

Figures 20 and 21 show that since 2008 the areas experiencing low access to canopy cover has reduced. At the 1,600m regional scale the proportion of our area having access to less than 10% canopy cover has dropped from 5 to just over 1 per cent. At the 100m city block scale there is a similar trend, with the percentage decreasing from 35 to less than 25 per cent. These results demonstrate that our increases in canopy cover have been distributed throughout our area, with increases in canopy cover in areas of historically low cover.

Areas where access to canopy cover at the 100m scale has been gained and lost are shown in Figure 22. Gains can be seen throughout many parts of our local area. Losses are shown in St Peters, Green Square, Moore Park and Barangaroo due to major infrastructure and urban renewal developments. Tree planting associated with these projects will replace the lost canopy cover over time. Losses in Glebe are likely to be due to the gradual removal of the weed tree Chinese hackberry and development within properties. The replacement of canopy loss associated with development will be a focus of our development controls and assessment.

To monitor our progress towards the equitable distribution of canopy cover we will:

– share the data and results to educate our communities about access to canopy cover in their local area and promote their understanding of urban forest management issues
– track changes to canopy cover over time at local and regional scales and adapt tree planting or other management programs to maintain favourable trends
– use the analysis to identify where specific land uses may be a major constraint to equitable canopy distribution and consider options to address these constraints over the long term.

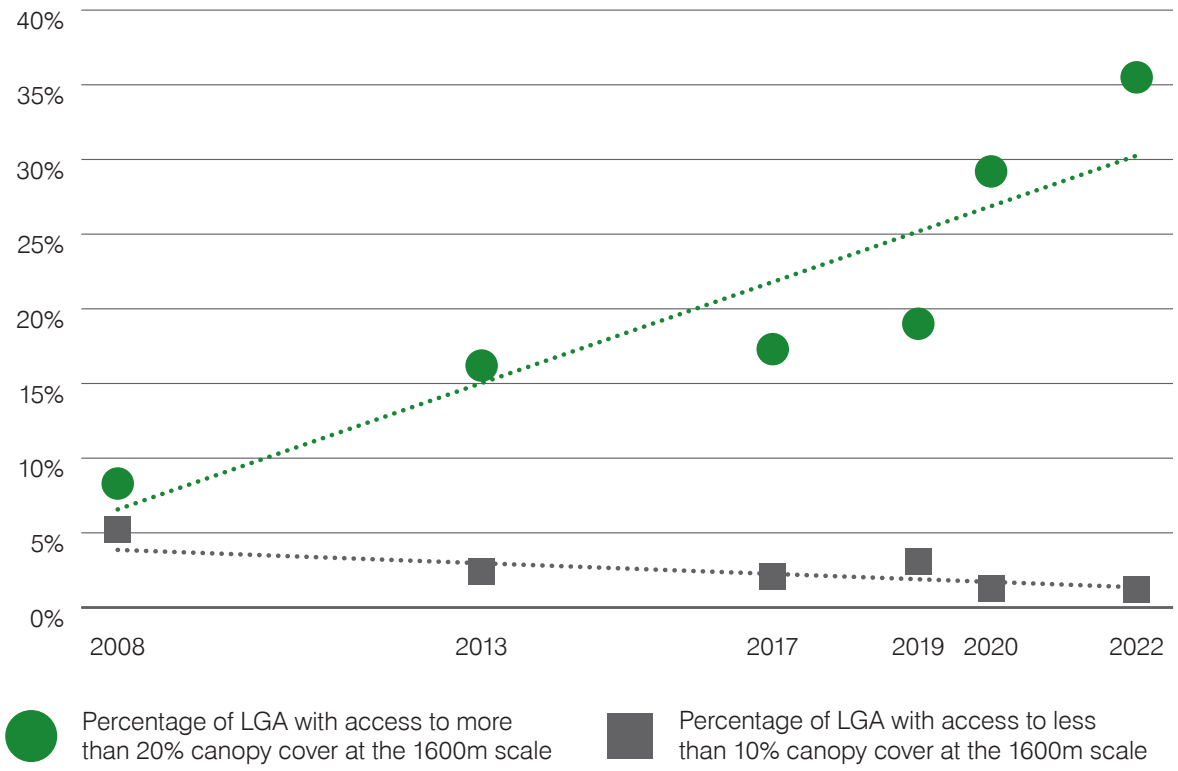


Figure 20: Percentage of our area with access to more than 20% canopy cover and access to less than 10% canopy cover at the 1,600m scale. Trend lines show access to low amounts of canopy cover are reducing and access to greater amounts of canopy is increasing.

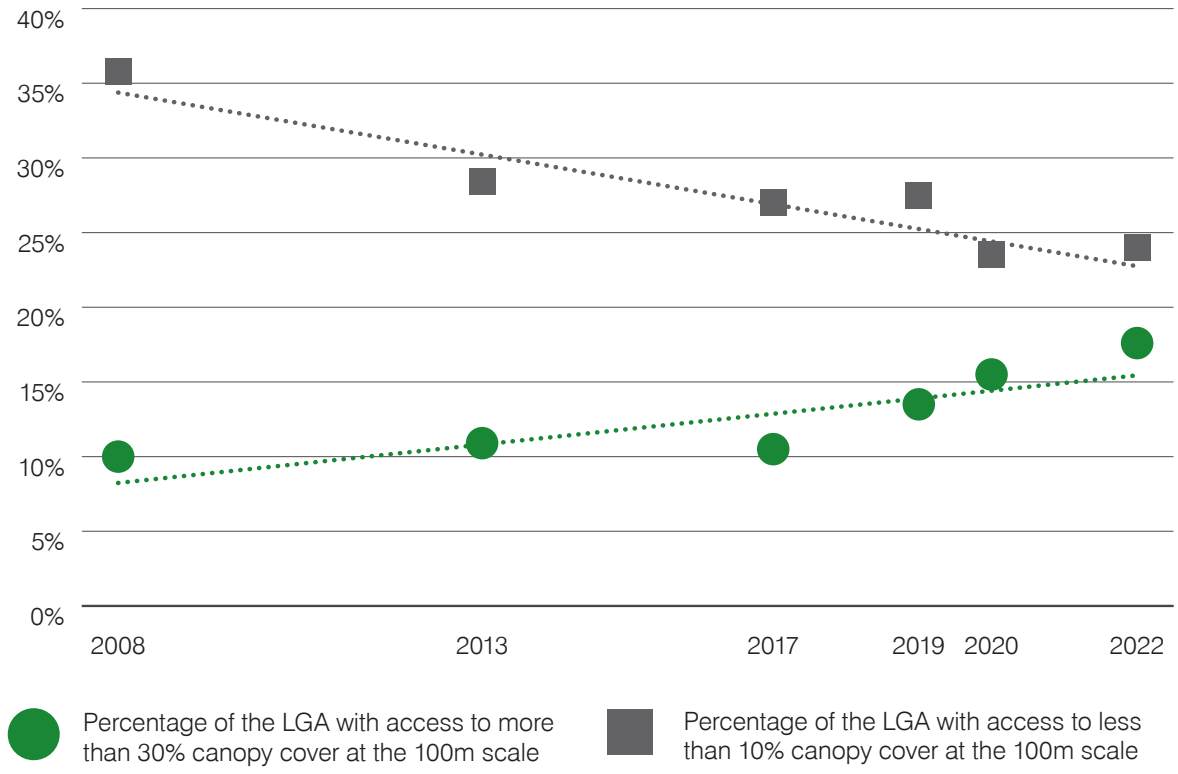


Figure 21: Percentage of our area with access to more than 30% canopy cover and access to less than 10% canopy cover at the 100m scale. Trend lines show access to low amounts of canopy cover are reducing and access to greater amounts of canopy is increasing.

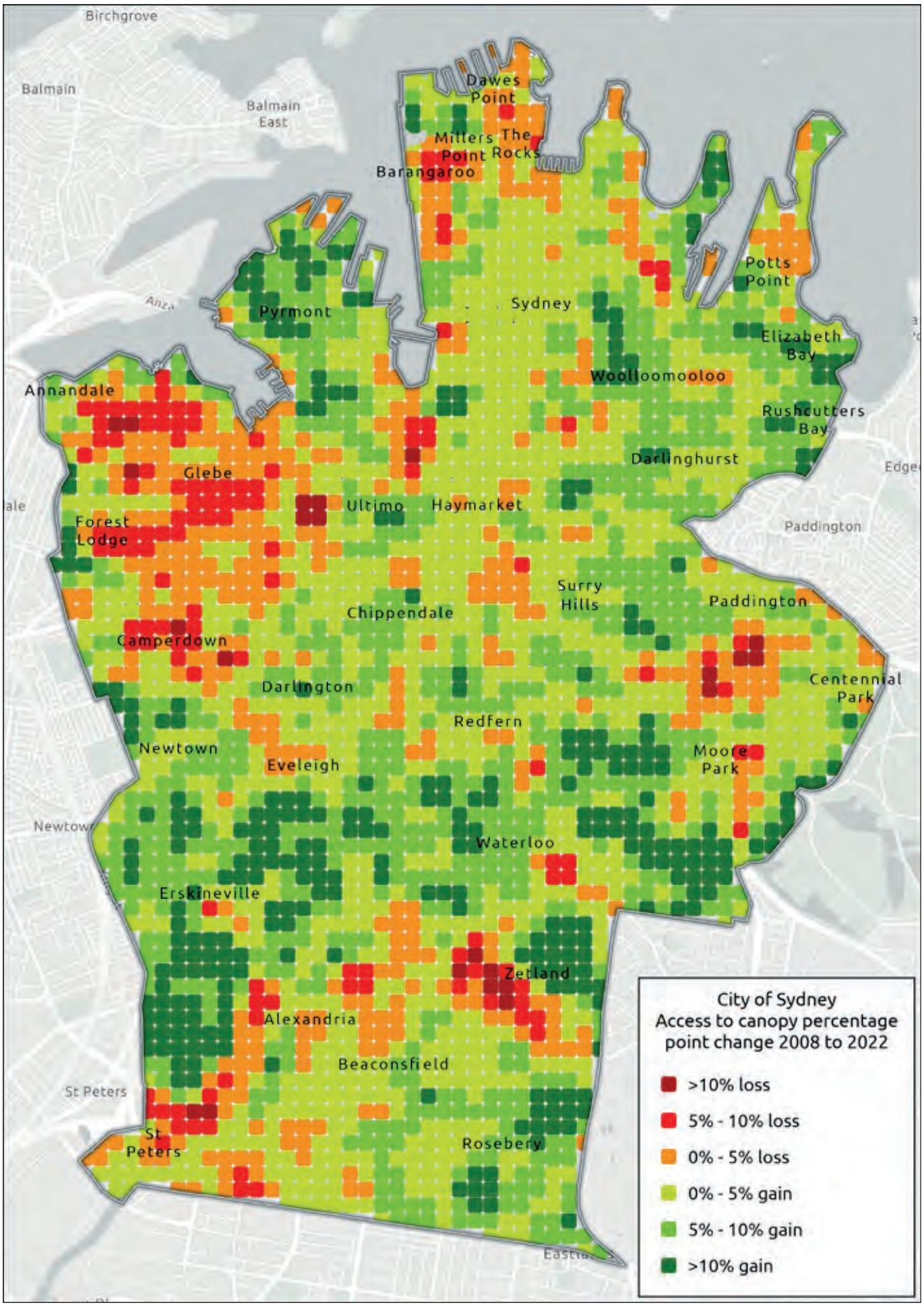


Figure 22: The gain and loss of access to canopy cover at the 100m radius buffer scale throughout our local area from 2008 to 2022.

In focus: changes in canopy cover, Zetland and Green Square

The renewal of urban areas can be an opportunity to plant more trees as private and public properties are redeveloped. Zetland has been transformed over the past 20 to 30 years, from a suburb dominated by industrial properties to an area that includes the two new residential precincts of Victoria Park and Green Square.

Residents of Victoria Park now have access to green spaces and good levels of canopy cover, which will further increase as the trees mature. While some trees were lost through the development of Green Square, many more have been planted that will see this area also have good future tree canopy cover within well designed and functional landscapes.

1991

2021

Fig trees along Joynton Avenue and Mary O'Brien Reserve. Photo Katherine Griffiths

Tree planting in streets. Photo: City of Sydney

Action 7 – Prioritise action

Trees take time to grow, so when planning our investment and effort towards canopy cover, we need to effectively prioritise based on need and opportunity.

The greatest areas of need for canopy cover in our area are those where the community is less equipped to withstand heatwaves. The NSW Government publishes data that identifies areas where populations in the Greater Sydney Metropolitan Area are more vulnerable to the adverse effects of urban heat. This heat vulnerability index is calculated from indicators for exposure, sensitivity and adaptive capacity. The City of Sydney has adapted the mapping of this index to present it with other data in the same format as our other urban forestry maps.

The opportunity for canopy cover exists wherever there is capacity to plant a tree. When developing the targets for canopy cover, we analysed land use and the capacity for canopy cover that each land use presents. Through comparing this analysis of capacity for canopy cover with the actual existing canopy cover we identified areas of greatest opportunity for canopy cover increases. Combining the data for heat vulnerability and the potential for canopy cover increases on a single map allows us to identify where the areas of greatest need intersect with the areas of greatest opportunity (Figure 23).

To effectively prioritise and promote more equitable distribution of canopy cover we will:

– prioritise and promote action across all land use categories. Streets, parks and properties will all need to reach their capacity for tree canopy to achieve canopy targets and outcomes
– identify and implement projects and programs of work to increase canopy cover in priority areas
– engage with other landowners and managers in our area wherever the analysis of need and opportunity has identified a priority exists and action on that land is appropriate
– use new or additional socio-economic or environmental data as it becomes available to help refine or review our priorities over time.

The best time to plant a tree was 50 years ago. The second-best time is right now.

Chinese proverb

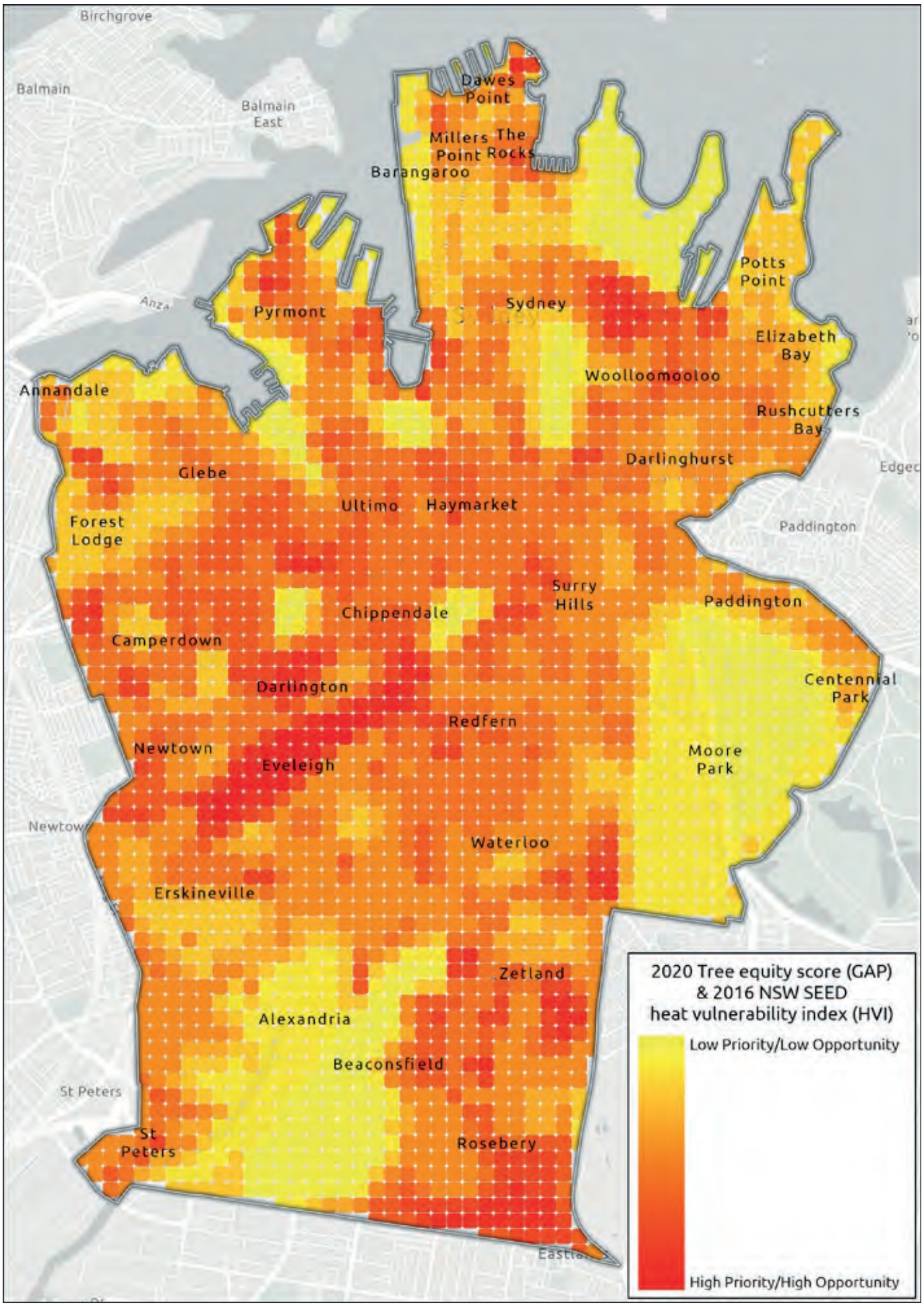


Figure 23: Areas where the community is vulnerable to heat combined with of opportunity for canopy cover increase. Heat vulnerability data acquired from the NSW SEED (https://www.seed.nsw.gov.au/).

Direction 4
A resilient forest

Resilience is the ability to withstand adversity. It may be considered in the context of our society, environment, or our city as a combination of both. Through a resilience framework we can consider and manage for the capacity of individuals, communities, institutions, businesses and our environment to survive, adapt and thrive in the face of chronic stresses and acute shocks. Urban forests support resilience through the cooling, health, and many other environmental and social benefits they provide.

However, the urban forest itself is also vulnerable to changes in the environment. Climate change has the potential to reduce the quality and quantity of the urban forest due to the different abilities of individual tree species to withstand changes in temperature or rainfall. A change in climate may also favour the establishment or spread of pests and diseases that can affect specific tree species or larger groups of trees and be a risk to the overall health of the forest.

Trees are long lived and must be managed for the present, but also for future generations. In our role as caretakers of the urban forest, we must identify existing or future vulnerabilities and risks, and act where necessary to mitigate them, ensuring the urban forest of the future is more resilient than the urban forest of today.

Westmoreland Street, Glebe, City of Sydney

New residential apartments pictured on Joynton Avenue in Zetland. Adam Hollingworth/City of Sydney

Action 8 – Manage for sustainability

Our urban forest is not a uniform group of trees. It is a mix of different tree ages and sizes, also known as structural diversity. The consideration and management of structural diversity is important for the long-term sustainability of the urban forest and for maximising the ongoing benefits for our communities (Morgenroth et al 2020).

The numbers of trees that are removed and planted can influence the overall age of the tree population over time.

If trees are not removed at the end of their useful lives the urban forest can become old, accumulating an excess of overly mature trees. This would require large numbers of trees to be removed at a future time and would also lead to increased risk associated with having to manage a declining tree population that's past its prime. An unbalanced population can also occur if trees are not planted to replace those that are removed.

We aim to manage trees in streets and parks in a sustainable way, minimising excessively high or low numbers of trees removed or planted each year. This will ensure the resources required to maintain and manage the urban forest remain relatively constant over the long term.

The number of street trees we have removed and planted since 2013 has been relatively consistent, as presented in Figure 24. More trees are planted than removed to grow our canopy cover as new opportunities for tree planting arise, and to allow for trees that are removed prematurely due to storm damage, poor health or other reasons.

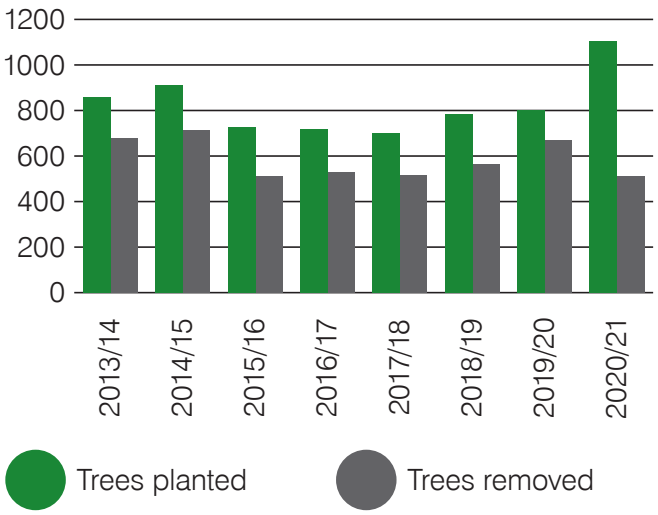


Figure 24: Annual number of street trees planted and removed, 2013 to 2021.

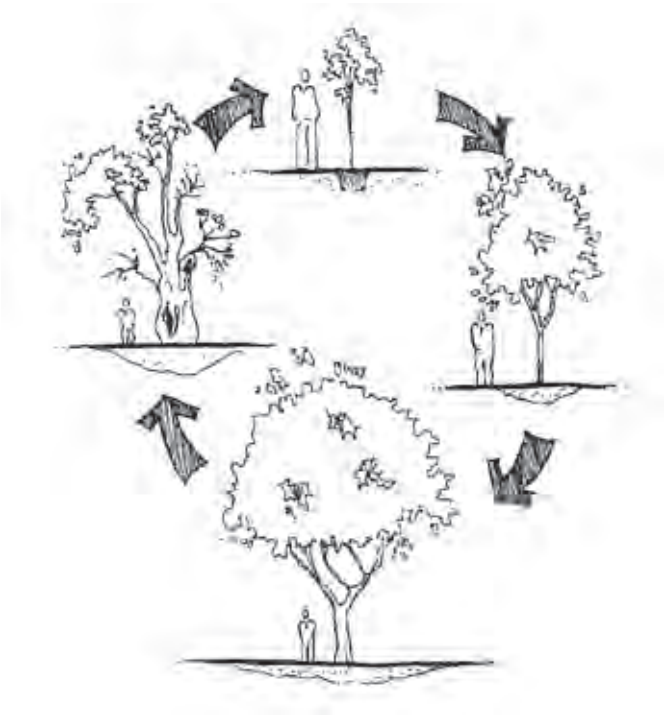
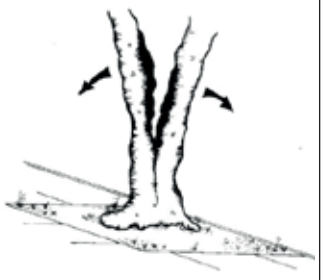


Figure 25: Many trees are long lived, but like all living things they cannot be expected to live forever. The removal and replacement of trees is a routine part of managing an urban forest.

In focus: tree health and condition

We manage and protect the urban forest to ensure the optimal health and condition of trees. Tree health and any defects are monitored as part of an annual inspection of each street and park tree. This data is used to monitor conditions or factors that may be impacting on tree health and to manage our programs of tree removal and replacement. Ratings of tree health and condition are presented below, with the proportion of trees we manage assigned to each rating in 2022.

Tree Health	
High 	65%
Medium 	30%
Low 	4%
Very Low / Dead 	Less than 1%

Tree Defects	
None 	62%
Minor 	37%
Major 	Less than 1%
Significant 	Less than 1%

An assessment of tree size alone is not adequate to manage the structural diversity of the urban forest due to the wide range of species, their expected lifespans and different sizes at maturity. To overcome this and to monitor the relative age of our urban forest, we classify and describe trees based on their stage of maturity (or age class) being young, semi-mature, mature or over-mature. We routinely record and update the age class of all street and park trees and have established indicative targets for each as a proportion of the overall tree population.

The overall objective is to balance the need to remove mature trees towards the end of their useful life with the need to maximise the benefits that these larger mature trees provide (Pretzsch et al 2021). Our benchmarks for age classes are a balance of these two needs and are based on the specific circumstances of our urban forest.

Street trees fall within the benchmark ranges for each of the age classes when considered at the local government area scale, while there is a slight lack of young trees in parks (Table 2). Current and future planting programs in parks will address this issue in coming years.

Table 2: Tree age classes and their application to street and park tree management.

Age Class	Description	Indicative tree of 50-year lifespan. Years within age class and percentage of life span	City of Sydney benchmark range Percentage of tree population	Percentage of street tree population 2022	Percentage of park tree population 2022
Young	Approximately the same size as nursery-grown advanced sized stock, easily replaceable	Years 0–5 10%	8–12%	9%	5%
Semi-mature	Not yet achieved a mature appearance and are still actively increasing in biomass, not easily replaceable from regular nursery stock	Years 6–20 30%	24–36%	34%	32%
Mature	Have grown to a size where biomass remains relatively constant	Years 21–50 60%	48–72%	56%	63%
Over-mature	Static or declining biomass and repeated symptoms of decline		Less than 1%	0.05%	0.5%

Best practice is to monitor and manage age diversity at the neighbourhood scale as well as the overall local government area scale, to ensure any localised issues are identified and managed (Leff 2016).

We have applied our spatial analysis techniques to assess the distribution of tree age classes for street and park trees collectively, using an 800m radius buffer to reflect the neighbourhood scale. The analysis helps to show where there is an overabundance of young or mature trees and can help to guide the management of the urban forest in these areas (Figure 27).

The analysis shows that overall, 16% of our area meets all the age class benchmarks when measured at the neighbourhood scale. Adherence within each of the age class benchmarks is listed in Table 3. Achieving the benchmark ranges at the neighbourhood scale throughout the entire area is unlikely to be possible due to the many new trees recently planted in some areas.

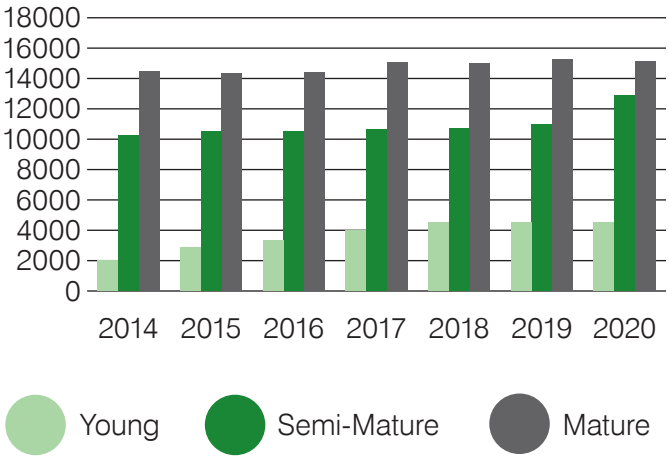


Figure 26: Number of street trees in each age class, 2014 to 2021.

Table 3: Compliance with benchmark ranges for age classes when measured at the neighbourhood scale (800m radius buffer, all street and park trees managed by the City of Sydney).

Age Class	Percentage of the local area compliant with age class benchmark range when measured at neighbourhood scale
Young	33%
Semi-mature	72%
Mature	92%
Over-mature	99%

To ensure the ongoing sustainability of the urban forest we will:

– continue to monitor the age of the urban forest at the local government area and neighbourhood scale

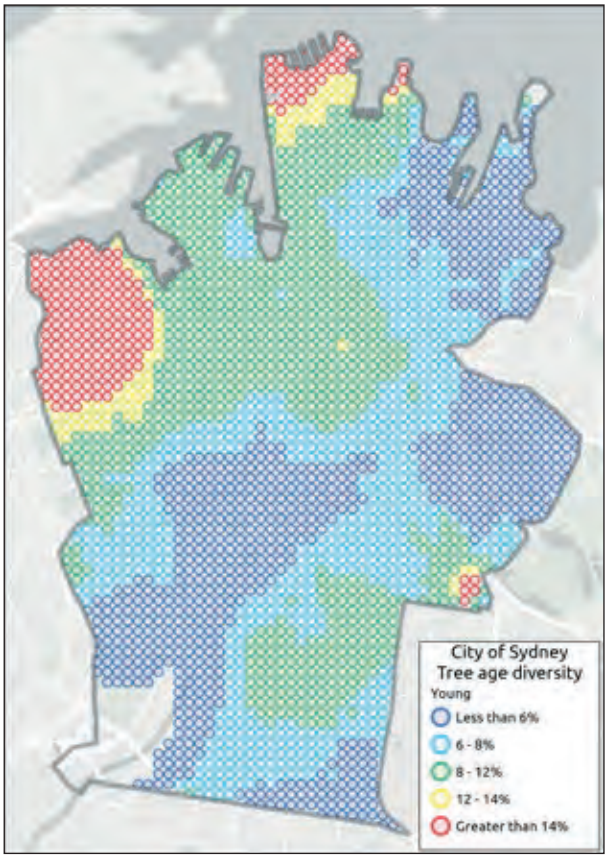
– gain insight from the age diversity data to adapt tree removal and replacement programs to address any significant issues within specific areas

– continue to monitor and enhance the health and condition of the urban forest and maximise the longevity and benefits of mature trees through best practice tree protection and cultural practices

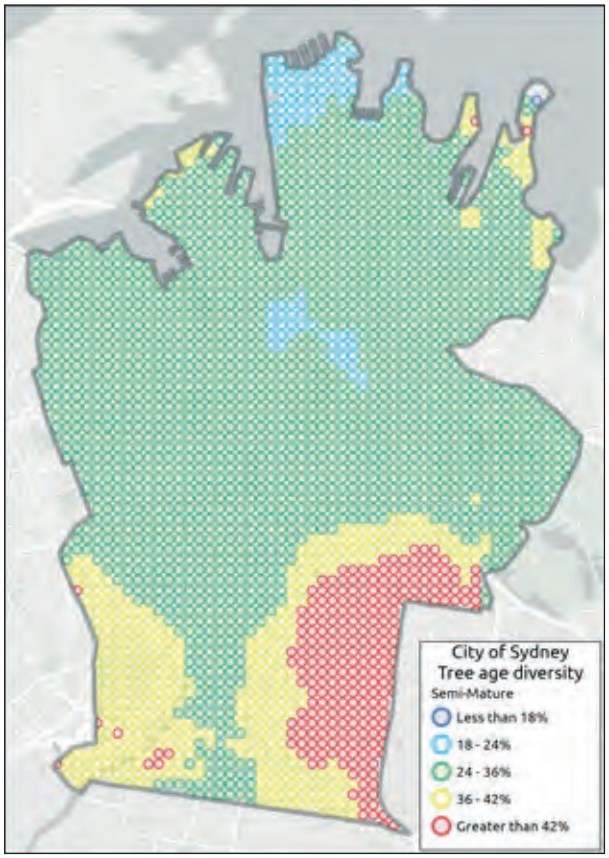
– continue to monitor tree establishment rates to ensure the most effective replacement of trees that are removed

– promote, enable and enforce tree planting on private property to ensure the ongoing replacement of any trees that are removed.

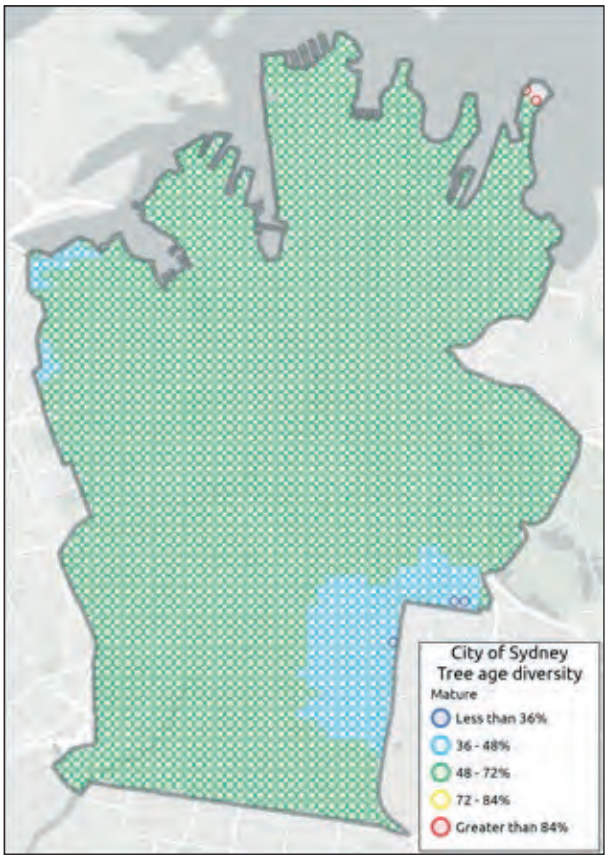
Young



Semi-Mature



Mature



Over-mature

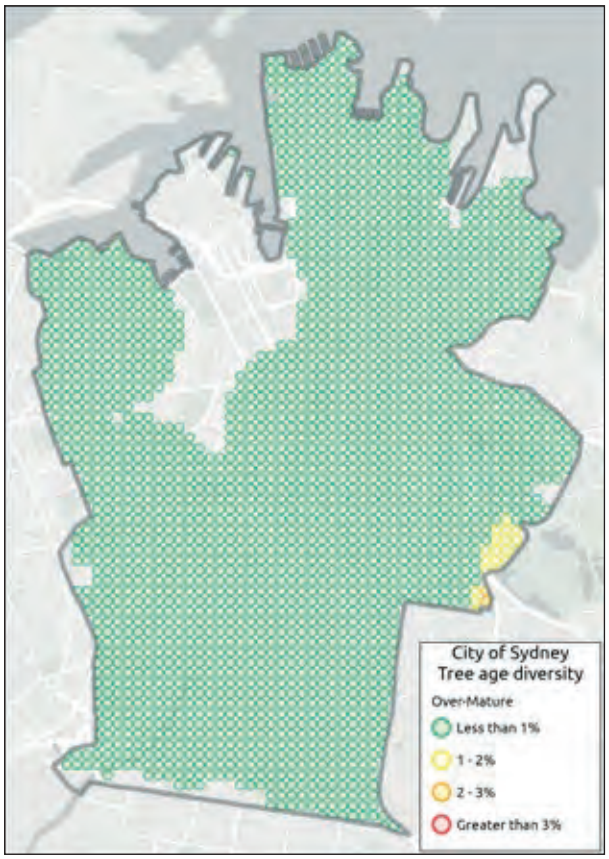
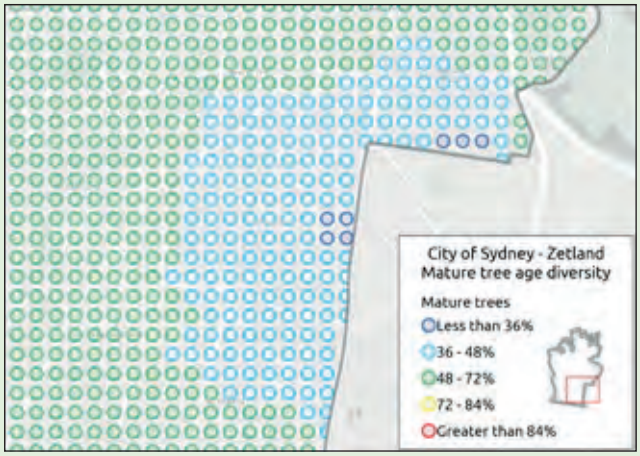


Figure 27: Compliance with young, semi-mature, mature and over-mature age class benchmark ranges at the neighbourhood (800m) scale. Green indicates areas that are within the benchmark ranges. Blue tones indicate areas where the age class is below the benchmark range, and yellow/red tones indicate areas that exceed the benchmark ranges. All street and park trees managed by the City of Sydney in 2022.

In focus: forest age in Zetland

Many streets and properties in Zetland were transformed in the early 2000s, changing from industrial sites to multistorey residential developments. Many trees were planted in this area from 2000 to 2010 and have now established to become semimature trees, leading to a relative overabundance of trees in this age class. The number of mature trees in this area is below the benchmark now but will gradually increase as the semi-mature trees continue to grow and mature, leading to further increases in canopy cover and benefits for the local community.



Age class	City of Sydney tree population benchmarks	Age classes in Zetland, measured at the neighbourhood scale
Young	8–12%	10%
Semi-mature	24–36%	54%
Mature	48–72%	35%
Over-mature	Less than 1%	0%

Action 9 – Promote diversity

A more diverse urban forest is generally considered to be more resilient to the impacts of pest or disease outbreaks and environmental changes like climate change (Morgenroth et al 2016). If most trees are of a single species, and that species suffers a major decline, the quality of the entire forest would be significantly affected. An increased diversity helps to manage the risk by distributing it across a larger number of species. A diverse forest can also provide a better range of habitat for wildlife and other environmental benefits.

However, the hardiness and resilience of the individual tree species is also critically important. If we plant a broader range of trees, but those trees are less able to withstand the difficult urban growing conditions, the overall resilience of the forest would be reduced. Selecting a broad range of trees that are well suited to the local urban environment is the best approach.

In focus: Tree Species List

We have developed a list of tree species considered to be appropriate for future planting within our local area. The ability of species to adapt and thrive in our predicted future climate were key factors in developing the new list. The list was developed with the assistance of professional arboricultural consultants, academics, landscape architects, an Indigenous consultant and experienced urban forest practitioners.

The City of Sydney Tree Species List will be a valuable resource and reference, to assist in the future selection and planting of trees within public and private land. The list will help to promote a more diverse and resilient urban forest through awareness of the wide variety of species suited to the future climate of our local area and the most appropriate site conditions for their establishment and growth.

For further information refer to Appendix 5 for the Tree Species List - Development and Use report, or the City's website for the Tree Species List.

We use a combination of methods to measure and monitor diversity over time, for street and park trees collectively and separately, and at different spatial scales. Diversity may also be considered relative to the number of trees in each group (stem count) or the basal area of trees in each group. The basal area is calculated based on the trunk diameter and reflects the different biomass of each tree species and their relative contributions to the overall services the forest provides. Galle et al (2021) suggest that ideally both stem count and basal area be used for comprehensive studies of urban forest diversity.

A benchmark typically used for measuring and monitoring urban forest diversity relates to the taxonomic groups of species, genus and family. The 10/20/30 rule of thumb, established in the early 1990s, states that municipal forests should comprise no more than 10 percent of any particular species, 20 per cent of any one genus or 30 per cent of any single family. While this rule provides a good basis for an assessment of diversity, more recent consideration suggests that a more nuanced approach is needed that responds to local conditions and circumstances (Kendal et al 2014).

Our urban forest strategy 2013 adjusted the benchmark to suit our context, setting the goal that the forest should comprise no more than 40 per cent of any single family, recognising that Myrtaceae is a very common family within the selection of native trees used in Sydney and a lower benchmark would be too restrictive on the use of native species.

In focus: Native versus exotic

Our urban forest is a mix of trees native to Australia and trees that are introduced from other parts of the world. Cities can be tough places for trees to grow, with paved surfaces and buildings reflecting light and heat, and soil that is often disturbed or compacted. This altered and challenging environment requires a wide variety of trees to suit a wide variety of conditions.

Already our area has many native trees and they will always be a major part of the urban forest. Seven out of the 10 most common species are native to Australia, but other introduced species also have an important role to play. Deciduous trees are preferred in some locations since they shade streets from the summer heat, but allow access to light and heat in inner city homes and public spaces in winter.

Studies suggest a native species only approach places the resilience of the urban forest at risk and that cities generally cannot afford to exclude non-native species (Sjöman et al 2016). Local research has also shown that many native trees are just as vulnerable to climate change as exotic trees (Esperon-Rodriguez et al 2019). To meet the current and future challenges that face our city, the urban forest will continue to be a mix of native and exotic tree species, ensuring the future resilience of the forest and a liveable city.

The top 10 species, genus, and families and their percentage of the total number of street and park trees are listed in Table 4. Seven of the top 10 species are Australian native trees and three are introduced species.

In recent years the brush box (Lophostemon confertus), a tree native to eastern Australia has overtaken the London plane tree as the most common tree in streets and parks in our area. The most common species and genus are both within the accepted benchmarks of 10 per cent and 20 per cent. The Myrtaceae family represents just over 40 per cent of the total tree population. This family includes many of the most common native trees, such as the Lophostemon, Eucalyptus, Corymbia, Melaleuca, Tristaniopsis, and Angophora. Moderating the future use of trees in this family will be important to ensure the forest does not become too reliant on them and less resilient as a result.

Table 4: The 10 most common species, genus, and families by stem count within the total population of street and park trees managed by the City of Sydney, with their percentage of the total number of all trees in 2022.

Count of trees

Species		Genus		Family	
Lophostemon confertus	8.9%	Platanus	9.5%	Myrtaceae	41.6%
Platanus acerifolia	8.5%	Melaleuca	8.9%	Platanaceae	9.5%
Melaleuca quinquenervia	7.6%	Lophostemon	8.9%	Moraceae	4.9%
Tristaniopsis laurina	4.5%	Eucalyptus	6.7%	Fabaceae	4.2%
Corymbia maculata	3.7%	Corymbia	5.2%	Casuarinacaea	3.5%
Jacaranda mimosifolia	3.1%	Ficus	4.9%	Sapindaceae	3.5%
Robinia pseudoacacia frisia	2.9%	Tristaniopsis	4.5%	Bignoniaceae	3.1%
Cupaniopsis anacardioides	2.4%	Casuarina	3.2%	Arecaceae	3.1%
Angophora costata	2.3%	Jacaranda	3.1%	Oleaceae	2.9%
Casuarina cunninghamiana	2.2%	Robinia	2.9%	Ulmaceae	2.8%

Table 5: The 10 most dominant species, genus and families by basal area within the total population of street and park trees managed by the City of Sydney, with their percentage of the total basal area of all trees in 2022.

Basal area of trees

Species		Genus		Family	
Melaleuca quinquenervia	16.9%	Ficus	22.2%	Myrtaceae	40.2%
Platanus acerifolia	11.9%	Melaleuca	17.4%	Moraceae	21.9%
Ficus macrophylla	7.8%	Platanus	12.7%	Platanaceae	12.7%
Lophostemon confertus	7.5%	Eucalyptus	8.8%	Arecaceae	2.6%
Ficus microcarpa var hillii	7.2%	Lophostemon	7.5%	Casuarinacaea	2.3%
Ficus rubiginosa	5.6%	Corymbia	2.5%	Salicaceae	2.0%
Eucalyptus microcorys	3.7%	Casuarina	2.1%	Ulmaceae	1.9%
Corymbia maculata	1.9%	Populus	2.0%	Bignoniaceae	1.8%
Jacaranda mimosifolia	1.8%	Jacaranda	1.8%	Hamamelidaceae	1.7%
Liquidambar styraciflua	1.6%	Liquidambar	1.7%	Fabaceae	1.6%

If we consider the relative dominance or biomass of species, genus and families based on their basal areas (Table 5) we find that the broad-leafed paperbark (Melaleuca quinquenervia) is by far the most dominant species and Ficus is the most dominant genus. Myrtaceae remains the most dominant family.

This analysis for all trees in our area helps us to understand the overall composition of the urban forest and consider options for long-term species selection and planting. A closer look at diversity at the neighbourhood scale can assist in identifying areas where certain tree species are more concentrated than other areas and helps to guide specific action to manage diversity over the long term. We have applied neighbourhood scale analysis to identify areas where the most common species represents over 10 per cent of all trees we manage with an 800m buffer scale (Figure 28). The results show that the London plane tree (Platanus acerifolia), the Brush box (Lophostemon confertus) and the broad-leafed paperbark (Melaleuca quinquenervia) are most common within specific regions of our area.

When the same neighbourhood scale analysis was done using the basal area to account for the relative biomass or dominance of trees within an area the larger growing fig species are the most dominant within some northern parts of our local area (Figure 29).

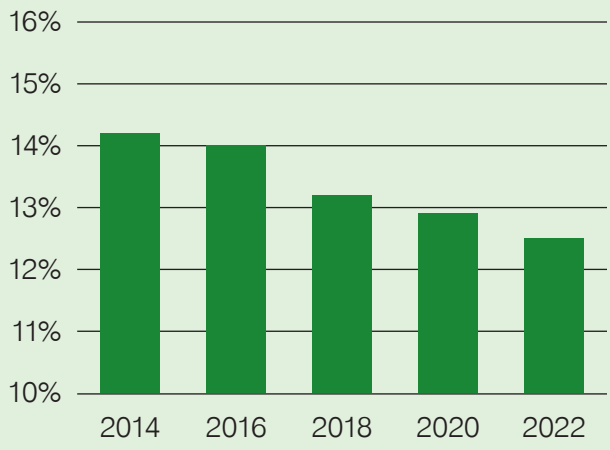
In focus: London plane trees

The past planting of London plane trees in the city centre and surrounding suburbs contributes greatly to the tree canopy over streets. As large mature trees they form many of the historic and significant avenues of trees and contribute to the sense of place in many residential and commercial areas. Being deciduous they moderate summer heat but also allow sun filter through their canopies to light and warm public spaces and private homes during winter.

Many people are not in favour of London plane trees as they are an introduced species and there is a perception they cause hay fever symptoms in spring. However, studies have shown that they are not usually the primary allergen or cause (Sercombe et al 2011). While their pollen may not be a major cause of hay fever, the small hairs on the buds and leaves called trichomes can sometimes become airborne and be a cause of irritation for some people.

We will continue to reduce our reliance on London plane trees and consider alternative species when appropriate, especially in areas where they are most common. The number of London plane trees as a percentage of the total street tree population has decreased from 14.2 percent in 2014 to 12.5 percent in 2022.

London Plane trees as per cent of all street trees



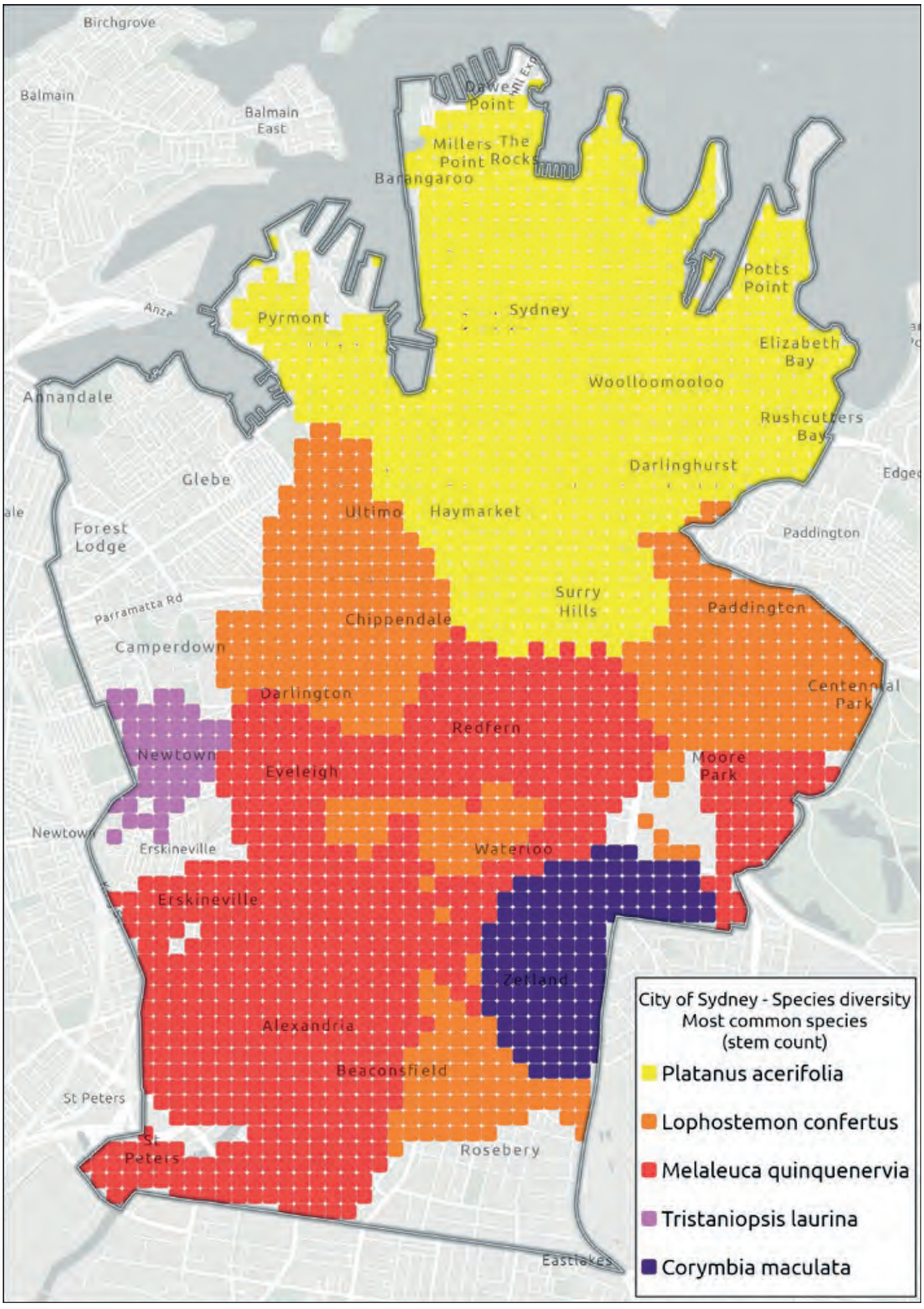


Figure 28: 2022 distribution of tree species where the most common species by stem count is over 10% of the total trees within an 800m buffer radius area.

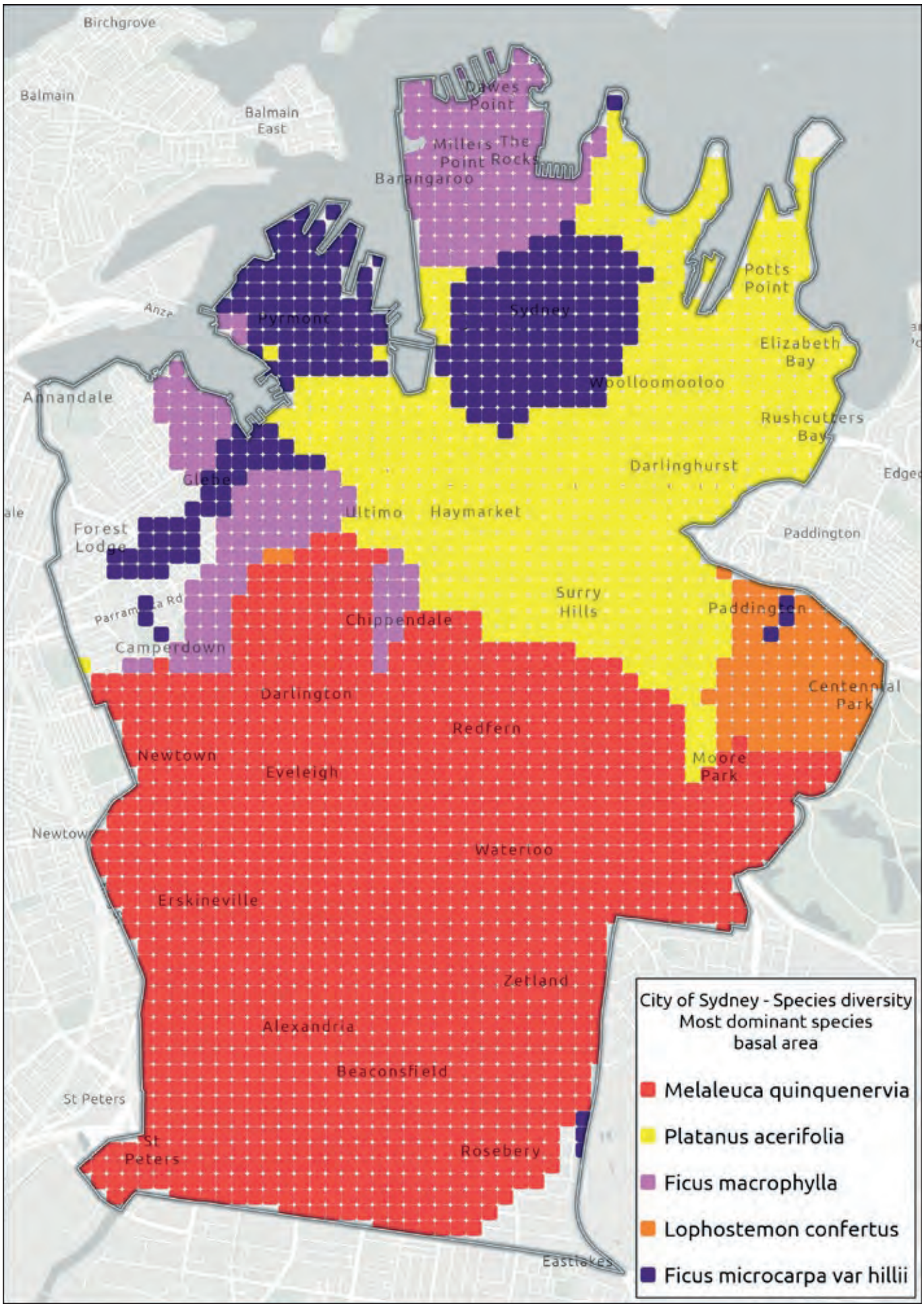


Figure 29: 2022 distribution of tree species where the most dominant species by basal area is over 10% of the total trees within an 800m buffer radius area.

Biodiversity indices have also been applied to urban forestry as a more concise indication of diversity (Kendal et al 2014, Galle et al 2021). The Shannon Index is related to the number of species present (species richness) and the relative abundance (evenness) of those species. The Shannon Index increases with diversity, with typical values ranging from 1 (low diversity) to 3.5 (high diversity). The index may also be calculated based on the number of trees of each species (stem count) or using the tree basal areas. We have calculated the index for our street and park trees, with results shown in Table 6. It is common for trees in parks to have higher diversity scores due to more favourable growing conditions and more diverse design requirements.

When compared to other cities throughout the world as reported by Galle et al (2021) and Kendal et al (2016), the diversity of the City of Sydney urban forest compares relatively well. The Shannon Index and 10/20/30 benchmark results both indicate a more diverse urban forest than many other cities.

Monitoring changes to the distribution of diversity over time will help us to understand the long-term results of tree planting and removal programs

Table 6: The Shannon Index calculated using stem counts and basal areas at the species level, for street trees, park trees, and all street and park trees combined.

Shannon Index	Street trees	Park trees	All street and park trees
Stem count	3.78	4.37	4.12
Basal area	3.17	3.48	3.52

The Shannon index also allows us to track changes to diversity over time. Figure 30 shows that our street trees have become gradually more diverse since 2014 as a result of our street tree master plan.

Applying the Shannon Index at the neighbourhood scale (800m buffer) displays trends in diversity across the city. Figure 31 shows relatively high diversity exists in some areas. Monitoring changes to the distribution of diversity over time will help us to understand the long-term results of tree planting and removal programs and will be a valuable source of data to guide future strategy and operations.

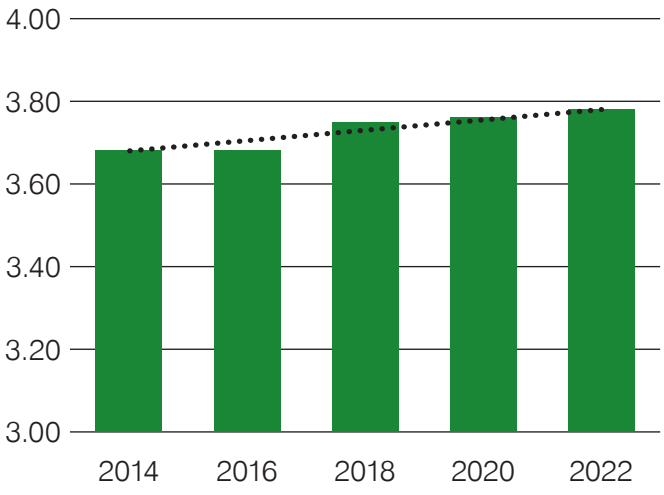


Figure 30: Increases to street tree diversity as calculated using the Shannon index and tree stem counts (dotted line is the linear trend).

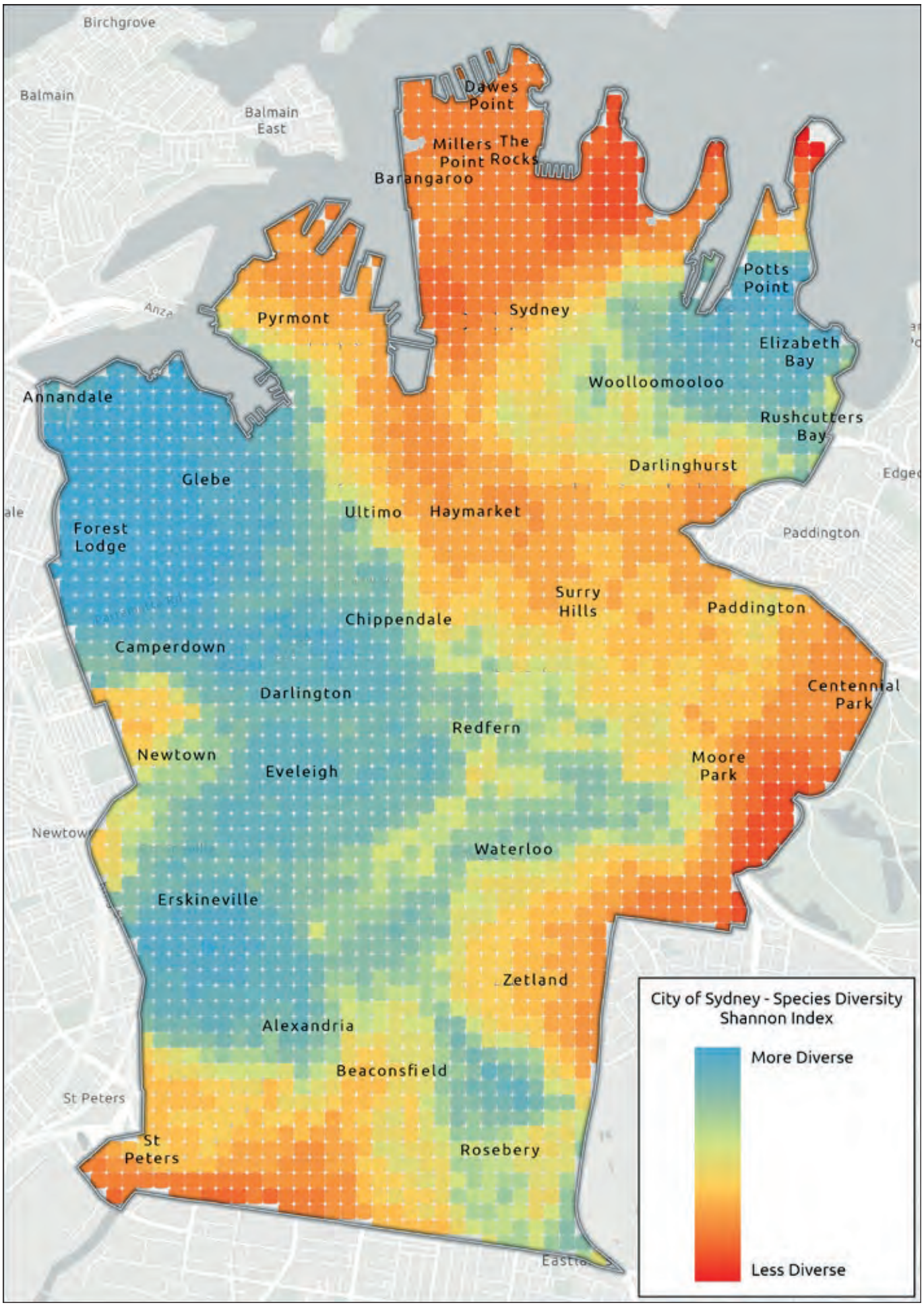


Figure 31: The Shannon Index applied to City of Sydney managed street and park tree stem counts in 2022 at the neighbourhood scale (800m buffer radius), indicating areas of high diversity in blue through to areas of comparatively lower diversity in orange and red.

To promote diversity and safeguard the future resilience of the urban forest we will:

– continue to monitor the diversity of the urban forest using best practice methods and techniques, at both the local government area and neighbourhood scales
– aim for the ongoing achievement of the benchmark of no more than 10% of any one species, 20% of any one genus and 40% of any one family at the local government area scale, and use this benchmark to identify opportunities to improve diversity at the neighbourhood scale
– use the best available research and advice to regularly review the list of locally indigenous, Australian native and exotic trees suited to local conditions and Sydney's future climate
– use the list of suitable species to inform updates to the street tree master plan, continued tree planting in parks, and to produce a list of trees suited for planting within private properties
– use our analysis of the distribution of forest diversity to assist in selections for tree planting, as part of a right tree, right location approach
– engage neighbouring councils and with managers of large land areas within our area, where large groups of trees may influence the diversity and resilience in our area, and seek to share tree inventory information towards gaining a more detailed understanding of urban forest diversity.

Picnic at The Domain. Katherine Griffiths

Victoria Park Parade, Zetland, Adam Hollingworth / City of Sydney

Our future forest

Cities throughout the world are investing in planting trees, to cool their cities and safeguard the wellbeing of their people and environment against a changing climate and population growth. The NSW Government has listed greening the city and increasing tree canopy as a premier's priority, towards reducing the effects of urban heat islands and enhancing local amenity and recreational opportunities.

Our urban forest is an integral and essential part of our environment and is highly valued by our communities. In response to a survey, 77% of respondents wanted a green city, with parks, trees and nature.

There is a broad understanding and acceptance that trees and canopy cover are essential for society and our environment to thrive and prosper. The nine key actions under the four broad directions of this strategy will ensure we will continue to act as the leading caretaker of our urban forest.

As the city changes and develops to meet our needs the urban forest must also change and evolve to meet our future needs and challenges. We will increase our canopy cover by prioritising space for tree planting wherever possible. We will distribute canopy equitably throughout our area, prioritising investment and action to ensure those most in need gain the shade, cooling and health benefits that trees and canopy cover provide. We will promote a sustainable and resilient forest fit for the future.

Scene from Hyde Park. Photos by Mark Metcalfe for City of Sydney

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Appendix 1 – Implementation plan

We will implement this urban forest strategy over the next 10 years. Many units in the City of Sydney will cooperate and contribute towards the various actions, but the tree management team within the City Services division will play the leading role.

A review of this strategy will be completed by 2032 and will include an assessment of newly developed research or practices that may benefit our trees and canopy. Progress towards targets will be reviewed and reported on in detail, and targets reviewed to ensure an adequate, healthy and resilient forest for the community.

Strategic direction	Action	Lead Responsibility	Implementation (years)			
			1-2	3-5	5+	On-going
Direction 1 An integrated forest	Action 1 – Deliver best practice urban forestry	City Services – tree management				✓
	Action 2 – Promote an integrated and coordinated approach	All units				✓
Direction 2 A growing forest	Action 3 – Monitor change	City Services – tree management	✓			
	Action 4 – Achieve canopy cover targets	City Services – tree management				✓
Direction 3 A forest for all	Action 5 – Look beyond boundaries	City Services – tree management		✓		
	Action 6 – Distribute canopy equitably	City Services – tree management			✓	
	Action 7 – Prioritise action	City Services – tree management	✓			
Direction 4 A resilient forest	Action 8 – Manage for sustainability	City Services – tree management				✓
	Action 9 – Promote diversity	City Services – tree management				✓

Appendix 2 – Canopy target methodology

Introduction

Urban local areas differ in their capacity to accommodate tree canopy. The relative proportions of streets, parks and other built or open spaces is a major influence on this capacity. The City of Sydney has endeavoured to develop targets for canopy cover that are ambitious, yet also achievable and relative to the current and future opportunities provided by the specific composition of land uses within our local area. Consideration was also given to research that suggests minimum amounts of canopy cover is required for community health or cooling outcomes.

In the process of setting targets for tree canopy, all land in our area was considered and assessed, including all public and private land regardless of ownership or accessibility. The capacity and opportunity for tree canopy was quantified and assessed at the scale of individual land parcels using techniques specific to their land use type.

Analysis at such a fine scale allows for the data to be aggregated in many different ways, but for the purpose of setting canopy targets it was summarised under 3 broad land-use categories: streets, parks and properties. Overall targets for canopy cover for the entire city were produced as a sum of these parts.

Our stratified approach to the development of targets provides a rich dataset that may be used to guide site-specific actions towards their achievement. This approach also promotes accountability within each of the 3 land-use themes, encouraging land managers to strive to meet the targets specific to the land or site.

To allow the targets to be directly compared and assessed against current or future aerial measurement of vegetation areas, the analysis of land parcels included only those that are visible from the air. Road tunnels and street segments beneath bridges or viaducts were not assessed. Similarly, parcels of property that exist above or below the surface, such as private basements beneath roads, were also excluded from the analysis.

Figure 32: Example of street, park and property land parcels, each with a unique site code identifier overlayed on aerial image and aerial acquisition of vegetation height strata.

Street methodology

The city's road network is a sum of 4,915 individual road segments, covering a total of 608.8 hectares (or 23 per cent) of the city's land area.

Most street segments follow a conventional layout, with road pavement areas allowing movement of heavy traffic and roadside verge or nature strip areas between the road pavement and other land parcels being the space for typical street tree planting. Attributes and measurements of these street segments were used as inputs to formulas to calculate the capacity of each street segment to host tree canopy. The aim was to quantify the potential canopy area that may be achieved within the boundary of each street segment under real world conditions and model the potential for additional canopy based on specific scenarios.

Data used

The following road segment attributes and measurements were compiled or calculated from existing City of Sydney datasets:

– segment code, name, location, suburb

– street segment type (street section or street intersection)

– street classification (state, regional, local, laneway, motorway)

– street segment area (m^2)

– street segment length (m)

– street segment width (m, derived from area and length)

– road pavement width (m)

– street verge width (m, derived from road segment width and road pavement width)

– percentage of existing trees impacted by overhead power lines.

The optimal mature size of tree suitable for planting in each street segment was determined based on the available street verge width in line with our street tree master plan guidelines.

Street verge width	Mature tree size	Mature tree canopy diameter
Less than 1.3m	Unable to plant	-
1.3m – 1.8m	Small	5m
1.8m – 3m	Medium	8m
Greater than 3m	Large	12m

The number of trees able to be planted within each street segment was calculated using the following formula:

$$Tree\ Quantity = 2(P - V)\left[\left(\frac{L - 10}{S}\right) + 1\right]$$

Where:

P = Planting Optimisation Rate (expressed as a decimal)

V = Panting Site Vacancy Rate (expressed as a decimal)

L = Street Segment Length (m)

S = Tree Spacing (m)

The formula assumes typical street segments have two single rows of trees and a 10m tree setback on approach to intersections. Tree spacing is proportional to the size of tree suitable for the street segment and was equal to the mature tree canopy diameter. The planting optimisation rate is an indication of the reduced proportion of trees able to exist due to conflicts within the streetscape (for example, driveways, poles, shop awnings). The general rate applied in the city was 0.8 (or 80 per cent), however a lower rate (0.7) was applied in the city centre due to a greater prevalence of awnings and below ground utility conflicts. The vacancy rate is the proportion of planting sites that may be expected to be vacant at any point in time. The rate used by the City of Sydney, based on historical data, is 0.015 (or 1.5 per cent).

Street intersection segments were treated in a similar way but assumed one row of trees only and a reduced optimisation rate of 0.5. All street segments defined as motorways were assigned a tree quantity of zero to reflect the inability to plant trees in roads of this type in the city.

Age diversity

Not all trees in our streets are mature. Therefore, a diversity of tree ages was factored into the analysis before the quantity of trees was used to calculate the canopy area. A percentage age class distribution was used to represent the expected distribution of age classes for the entire population of street trees. For the city this was determined to be 60% mature (including over-mature), 30% semi-mature, and 10% juvenile, based on the current age distribution of our tree assets and expected future removal and planting rates. The canopy diameter for semi-mature and juvenile trees were defined as 75% and 25% of the mature canopy diameter respectively. These relative proportions and size parameters were applied to the quantity of trees in each street segment to calculate a realistic and sustainable total canopy area produced by trees located in each street segment.

Infrastructure impacts

Data on the proportion of existing street trees in each street segment impacted by overhead power lines was used as a factor in the analysis to reflect the reduced potential of trees beneath such infrastructure. Within relevant street segments, the proportion of impacted large, medium and small sized trees were assumed to achieve 60, 50 and 80% of their respective potential canopy area. This analysis enabled the modelling of reduced impact scenarios, such as exposed low voltage power lines being converted to insulated bundled cables or the complete removal of overhead wires.

Canopy calculations

The total canopy capacity for each street segment was calculated as the sum of each tree canopy area, factoring in the above considerations, using simple formula for the area of a circle. Since canopy cover is measured and aggregated according to boundaries between land use types it was necessary to calculate the areas of canopy overhanging other land parcels adjacent to the road segment and subtracted these from the total canopy capacity area. This was done by applying a trigonometric formula for the area of a circle segment, where the known parameters are the circle segment height and circle radius. The circle segment height was derived from the width of the road verge and the typical tree setback from the road kerb for each tree size.

In-road planting scenarios

The planting of trees within the road pavement area is an opportunity to increase tree canopy within the street network above that provided by typical planting within the verge. Three different in-road tree planting scenarios were modelled and added to the base canopy capacity calculation for relevant sites:

1. Tree planting within parking lanes. Within local road segments wider than 12m, every third tree located within the verge is replaced with a large sized tree planted within the parking lane.
2. Tree planting within laneways. Within local road segments or laneways wider than 6m, having narrow verges unable to accommodate conventional tree planting, a single row of trees is planted within the parking lane at the side of the road. If the road pavement width was wider than 10m the tree size was large. If less than 10m it was medium.
3. Tree planting within medians. Within local roads wider than 15m, an additional row of large sized trees is planted within a median island.

If more than one modelled scenario applied to any single street segment, the scenario that produced the highest amount of canopy was used.

Overall street targets

The canopy capacity areas overhanging each street segment were summed to provide an overall canopy capacity for the entire city street network. This total canopy area was divided by the total area of the street network to give a percentage canopy target for the city's streets. Since the overall target is an aggregate of individual site analyses, the overall target is a summary and cannot be applied to any specific site. Each individual street segment has a site-specific canopy target equal to its theoretical calculated capacity.

Park methodology

Parks are parcels of land dedicated for public open space and recreation. The City of Sydney area has 421 parks covering a total of 401.7 hectares (or 15% per cent). They are owned and managed by a number of government agencies including the City of Sydney, The Royal Botanic Garden and Domain Trust, Greater Sydney Parklands and Property NSW. They must provide for a range of competing uses and may serve a variety of functions including active and passive recreation, heritage conservation, wildlife habitat and other environmental services. The expected uses and functions of a park influence the amount of tree canopy cover that is appropriate for the space, and therefore parks with similar uses and functions are assumed to have similar potential for canopy cover. An analysis of the parks was undertaken, with the aim being to determine the most appropriate amount of tree canopy for each park type.

Park classifications

All parks were grouped into one of the following park types: iconic, neighbourhood, pocket, civic, sports field or golf course. These park types were existing functional categories used by the City of Sydney for park asset management. Within each category parks were ranked by their existing canopy cover percentages (2019 aerial canopy measurement). The median and percentiles above and below the median (15, 25, 75 and 85%) were plotted over the ranked distribution of parks. This analysis was then used to identify and select five examples within each of the park types, each having different levels of canopy cover. Consideration was given to the age of the parks and maturity of trees when selecting each of the examples.

Qualitative survey

A survey was developed asking respondents to score each of the examples on a scale of 1 (least appropriate) to 5 (most appropriate) in terms of the amount of canopy cover being appropriate for the type of park. Aerial images were used to present the examples within the survey. Professional employees of the City of Sydney familiar with park management issues were invited to participate, including professionals in park and tree management, landscape architecture and city design. Employees less involved with parks management also participated, including strategic planning and engineering. Forty-six responses to the survey were received. The survey results were used to consider and identify the most appropriate target for canopy cover for each park type.

Overall park targets

Target percentages were also identified for green cover for each park type based on the function and design expectations for their spaces. The relevant target percentages were applied to each park, with target canopy and greening areas calculated and summed to determine an overall target amount of canopy area and percentage canopy cover for the entire parkland-use area of the city.

Property methodology

For the purposes of this analysis, property was considered to be any land parcel not classified as a street or a park. It included 26,527 individual parcels of land covering 1,651 hectares (or 62%) of the city land area. A wide variety of uses, ownership arrangements, and controls apply to this large group of land parcels. They range from small single lot private residences through to large commercial city centre properties, and large tracts of government owned land used for transport infrastructure or education.

Estimating private open space

Analysis was undertaken to estimate the amount of open space potentially available for tree planting within these land parcels. Data gathered from our floor space and employment survey was used to calculate an approximate building footprint area per land parcel, with the remaining unbuilt portion of each land parcel then used to assess the potential for tree canopy.

The area of private open space required to accommodate trees was determined to be 20–25m^2 for a small sized tree, 25–60m^2 for a medium sized tree, and >60m^2 for a large sized tree. Areas of private open space less than 20m^2 were considered as inadequate spaces for any tree. If a land parcel had greater than 200m^2 of open space, multiple large trees were assigned to the parcel with each requiring at least 200m^2 of space.

A consideration of age diversity was factored into the analysis (using the same method as the street tree analysis) to estimate the potential canopy area for each private land parcel.

The potential canopy areas for each land parcel, along with the measured amount of existing tree canopy per parcel, were aggregated by the City of Sydney local environment plan land zonings to assess and consider potential targets for tree canopy cover for each zoning and the private land use overall.

Assumptions and limitations

The above analysis for private land is based on a number of assumptions that make it less reliable than the capacity analysis used for the street land area. The analysis inaccurately assumes that any open space not occupied by a building is available for tree planting, and that tree canopy is unable to overhang buildings. It is also based on existing land development only, with no consideration for how properties may change or be developed in future.

Overall property targets

For the reasons outlined above, the analysis was used as a guide to indicate existing potential only, and to compare and contrast the existing potential between different zonings and specific areas such as heritage conservation areas, urban renewal areas, and the city centre.

The future development and potential for canopy and greening, along with our ambition for greener development of private open spaces were important considerations when setting overall targets for properties.

Towards future achievement of targets

Analysis at the scale of individual land parcels has resulted in a detailed comparison of existing and target canopy cover. The analysis highlights sites that are over or under achieving, and provides insight to drive site-specific projects and programs aimed towards achieving targets. It will also help to highlight specific land where removing canopy will compromise the ability to achieve targets. Combining the site-specific analysis with our asset management data will provide further opportunity to better manage our tree assets in streets and parks.

Within a 10-year period, a comprehensive review of these greening and canopy targets will be undertaken as new research, technology and other tools become available. This will include improved technology for acquiring aerial canopy cover data. Further, as the city develops and changes over time, we will closely review any land use changes over time – such as new parks, streets and changes to planning controls for properties.

These targets are based on current land use. As these change over time, so too will the potential extent of canopy cover. We will need to ensure that canopy is a key consideration in those changes, to provide a cool, calm and resilient Sydney.

Appendix 3 – Guidance on applying canopy targets

Streets

The overall target for streets was based on analysis of all street sites within the City of Sydney local area, using a model to calculate the capacity for long-term sustained tree canopy, factoring in urban forest management principles and assumptions such as age diversity, vacancy rates and achieving the optimal sized tree for the available space.

Since the overall target and street type targets are a summary total of all streets as a collective, they cannot be applied to any single individual street.

Instead the goals set out below are based on the analysis but are provided as benchmarks to design towards. They should be achievable in most circumstances, but of course site-specific factors will determine what is possible at each street.

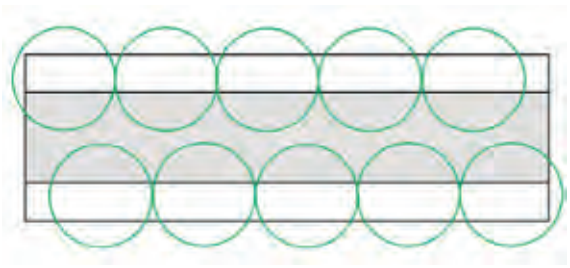

Figure 33: Example of simple tree layout in a street used for calculating canopy cover.

Minimum benchmarks for new streets

New streets within our area are typically those designed and constructed as part of major urban renewal projects. They provide the best opportunity to plan and accommodate the optimum amounts of canopy cover. The future canopy cover percentage provided by a new street design can simply be calculated based on the number of trees in the design, the future mature canopy area of each tree, and the total area of the street.

For example, for the simple tree layout below in Figure 33 assume the road length is 60m and width is 20m, giving a total area of 1,200m^2. The diameter of the mature canopy for the nominated species is 12m. Therefore, each tree will have a mature canopy area of 113m^2, the total canopy area will be 1130m^2, and the percentage canopy cover is 94%. For this exercise and the sake of simplicity, canopy that may extend and overhang outside of the street site is included in the percentage (in contrast to how the capacity was calculated for the overall target).

When calculated in this way, the minimum benchmarks for new streets, based on their street type, are set out in the table below.

Street type	Minimum canopy cover benchmark for new designed streets
State road	60%
Regional road	70%
Local street	80%

Guidance for existing streets

An existing streetscape can be a mix of infrastructure of varying ages and conditions, with trees that may vary in species, age, health and size. This variation presents a challenge and makes a universal benchmark unreasonable. Instead, opportunities for increased tree planting for future canopy cover must be considered and implemented based on the review of site-specific factors and priorities.

However, the canopy cover benchmarks for new streets can be used as a rough guide to how well an existing street is performing against the canopy targets. This may be done by considering each of the existing trees at their mature size for their species. The percentage area of the mature tree canopy can then be calculated and compared to the benchmark.

It is expected that increases in tree canopy are explored during any upgrade or introduction of new infrastructure and prioritised in areas of greatest need.

Parks

Parks account for 15% of our total area. The target for parks as a collective land use area is a minimum of 46% canopy cover. This overall target for parks was based on analysis of individual park types and the amount of canopy considered to be appropriate for each. Targets specific to park types have been developed to help guide future projects and development and are listed in the table below.

Park type	Canopy cover target
Iconic	50%
Neighbourhood	55%
Pocket	70%
Civic	50%
Sports field	0%
Golf course	30%

The targets for each park type represent the minimum percentage tree canopy cover that is considered to be appropriate based on the usage and other general qualities of that park type, and the communities need and desire for a greener environment.

Existing and proposed trees within a park should be considered in their mature state. If designing a new park or upgrades to an existing park, the targets for tree canopy need to be considered in context to the relative age of the existing trees and if there is potential for these existing trees to grow and contribute to the canopy target as they mature. The future canopy area of proposed tree planting can be estimated based on their expected canopy spread.

It is expected that increases in canopy cover must be balanced with use of the space and other priorities that may exist. Opportunities for canopy to complement or coexist with other design or functional elements should be investigated. For example, the use of deciduous trees may allow solar access for turf growth and park use in winter, while also providing the canopy cover required to mitigate extremes of summer heat. Trees can be situated to shade exposed pathways or buildings to increase the green cover of the park.

Canopy data and further information

An ArcGIS story map has been produced to further detail of canopy cover within specific areas and guide action towards achieving our targets.

Appendix 4 – Spatial analysis methodology

Introduction

The analysis and interpretation of spatial data has become an essential aspect of urban forest strategy and management. Administrative boundaries divide land into manageable and recognisable pieces. At the broader scale these may be local government areas, suburbs or wards, and at the smaller scale they may distinguish roads from parks and private lots. Historically urban foresters have used these boundaries to summarise and present data related to the trees and canopy they manage.

However, these boundaries can often be restrictive, as trees exist throughout the urban landscape, and priorities for management such as equitable access, diversity and resilience extend across and beyond these artificial boundaries. The City of Sydney has developed and applied novel spatial analysis techniques to look beyond these boundaries, gaining greater insight into trends of distribution and the community's access to urban forest benefits and services.

Managing large populations of trees requires a variety of spatial datasets. Two common sources of data are aerial assessments of tree canopy cover and inventories of tree assets, with each able to be used in different ways to gain insight into the urban forest. Both data sources usually have a spatial component, in that they are typically represented on maps as either areas or dot point coordinates.

Boundaries are also represented on maps, dividing land and data into manageable pieces. Boundaries are used to define land for a variety of purposes or contexts, including governance and administrative, legal or environmental. They can provide a useful common basis for summarising and presenting all types of spatial data. Urban foresters have typically used these boundaries, and the land areas they define, to summarise and present data related to canopy cover or trees they manage. Boundaries also exist at a variety of different scales. At the broader scale these may be, local government areas, catchments, suburbs or wards. At a smaller scale, boundaries may distinguish roads from parks and private lots.

Figure 34: Aerial assessment of canopy cover and tree inventories as examples of spatial data.

Figure 35: Grid of 2660 sample reference points overlaid across the City of Sydney local government area (left) and close up to show 100m grid spacing (right)

Within urban forest plans or strategies produced by local governments over the past 10 to 15 years it is typical to find aerial assessments of canopy cover and other tree data summarised to the suburb scale. For example, tables, charts or maps are used to present the percentage canopy cover within each suburb or neighbourhood, as a subset of the overall canopy cover for the entire local government area. While this is useful to portray large scale variations in canopy cover over a large area, it does not accurately reflect the amount of tree canopy an individual has access to in their local area. The percentage canopy cover is presented for the suburb as a whole, with variations within suburbs not presented. It's possible for most canopy within a suburb to be concentrated within parkland, with very little in the immediate area where people live or work. Similarly, if an individual lives close to a suburb boundary, they may question which canopy cover data is most relevant to them. These issues and questions prompt the analysis and summary of canopy cover data at smaller scales, such as census blocks or even individual land parcels.

An alternative approach – the 'urban tapestry' method

A heat map is a data visualisation technique used to display spatial data over a uniform matrix of coloured cells. The cells are coloured to visualise aspects of the underlying data. The City of Sydney has adapted this general technique into something we have called the urban tapestry method. The method involves establishing a grid of uniformly spaced reference points spread across the entire local government area. A 100m grid spacing was chosen to provide a total of 2,660 reference points (Figure 35).

At each of the reference points, data is gathered from a buffer radius area surrounding it. The size of the buffer radius is variable and may be customised to suit the type of data and purpose of the analysis being undertaken. Data within each buffer area is analysed to produce summary statistics for each point location, with the reference points coloured to visualise the results. Where reference points are located close to the boundary of the local government area, the buffer areas may extend beyond our borders to consider the influence of the neighbouring council areas using publicly available canopy cover data published by the NSW Department of Planning, Industry and Environment (Figure 36). The urban forest does not end at our boundary, so it is important to assess the canopy cover that exists beyond it, which our residents also have access to, and may rely on.

The technique provides a consistent but also flexible method to summarise and compare data uniformly across an area, without any of the disadvantages associated with administrative boundaries and variations in the size of land being assessed. It allows us to look beyond these artificial borders, to explore issues such as equitable access to canopy cover and the resilience of our urban forest.

Radius buffer scales

Various scales are used to summarise data that surround each reference point, depending on the purpose of the analysis and nature of the data.

A 1,600m scale was used to present regional trends in canopy cover distribution and access to canopy cover for mental and physical health benefits, reflecting the research of Astell-Burt & Feng 2019.

A 100m scale was used to present local access to canopy cover at the city block scale, reflecting the research of Ziter et al 2019 and the effect of tree canopy on reducing heat at the city block scale.

For a neighbourhood scale assessment of urban forest diversity, tree inventory data was gathered at an 800m scale to approximate the size of an average suburb.

Greening analysis point ID 924

Canopy Coverage Analysis - 1600m buffer analysis

Class	Value
Canopy coverage % (land covered areas only)	17%
Land area within 1600m buffer	8043263m²

Canopy area/coverage within LGA - 2019 CoS data

Class	Value
Canopy area (within LGA)	931473.21m²
Canopy coverage (within LGA)	11%

Canopy area/coverage outside the LGA - 2016 SEED data

Class	Value
Canopy area outside of LGA boundary (SEED)	473429m²
Canopy coverage outside of LGA boundary (SEED)	5%

NB: Canopy data within the LGA boundary calculated using 2019 CoS Vegetation data.Areas outside the LGA calculated using SEED's 2016 data.

Figure 36: Example of canopy cover analysis results for a single sample point

Appendix 5 – Tree species list: development and use

Introduction

Trees are the largest living things in the urban environment and are the biggest contributors to vital green infrastructure, a city's natural life support system. Trees are essential in cities. Their environmental, social, cultural and economic benefits are well established and beyond doubt.

The City of Sydney Tree Species List (the list) is a list of trees considered to be appropriate for planting within our local area. The list was developed with the assistance of professional arboricultural consultants, academics, landscape architects, an Indigenous consultant and experienced urban forest practitioners. It is hoped that the list will be a valuable resource and reference, to assist in the future selection and planting of trees on public and private land.

Why have a list?

Strategic and policy context

The production of the list aligns with many of the directions and actions listed within the City's Greening Sydney Strategy and Urban Forest Strategy.

A tool to assist selection

Selecting the most appropriate tree to be planted is an important process. It can be crucial to the long-term success of a landscape. To get the best results for the City or your project, the right tree must be planted in the right place, and at the right time. It can also be complicated, with many factors to be considered and balanced before arriving at a decision.

The data presented in the list will help to narrow down the potential options, to arrive at tree species that are most appropriate, based on the various site conditions, the design attributes, and any personal preferences.

A reference list of trees

The list will also serve as a resource to inform and educate, describing each tree and its preferred growing conditions through a variety of attributes and descriptive data.

Adapting to climate change

As Australia's climate changes over the next 50 to 100 years, the species of trees and plants used in our city today may not be suited to the range of conditions presented by the future climate. Research has found that Sydney's climate is likely to be more like Grafton (North Coast NSW) by 2050.

The urban forest can be vulnerable to changes in the environment. Climate change has the potential to reduce the quality and quantity of our urban forest due to the different abilities of tree species to cope with environmental changes or stresses. We must manage for the present but also for future generations, identify existing or future vulnerabilities and risks, and act where necessary to mitigate them, ensuring the urban forest of the future is more resilient than the urban forest of today.

Promoting urban forest resilience

A more diverse urban forest is generally considered to be more resilient to the impacts of pest or disease outbreaks and environmental changes like climate change. Increased diversity helps to manage the risk by distributing it across a larger number of species. A diverse forest can also provide a better range of habitat for wildlife and other environmental benefits.

However, the hardiness and resilience of the individual tree species is also critically important. If a broader range of trees is planted, but those trees are less able to withstand the difficult urban growing conditions, the overall resilience of the forest would be reduced. Similarly, poor outcomes are to be expected if we restrict our selections to a narrow range of species that are not well adapted to the predicted future climate for our area. Selecting a broad range of trees that are well suited to the local urban environment, both now and into the future, is the best approach.

The list may help to promote a more diverse and resilient urban forest through awareness of the wide variety of species suited to our local area and the site conditions that are most appropriate for them.

Who will use the list?

It is expected the list will be used by a wide variety of interested people involved in the design or care of private or public open spaces, landscapes, or gardens, including:

– Landscape architects or designers, to specify designs for new developments

– Arborists and other related industry professionals

– Property owners and other land managers

– Anyone interested in planting trees and wanting to learn more.

Disclaimer

The data and information contained within this document and the list are provided as general information only and should not be relied upon as professional advice. Users may refer to and rely on the list at their own risk. The City will not be liable for any actions, claims, losses, damages (whether direct or indirect), liabilities or expenses arising from or associated with relying on this document or the list.

Method

An iterative and collaborative approach was used, with various experienced professionals used at various stages in the drafting, development, and review of the list.

Reference material and collation of data

An initial draft list of potential tree species was collated from various sources, including:

– The City of Sydney inventory of street and park trees

– The trees listed within the City's Street Tree Master Plan

– Historical lists used for tree planting work associated with projects and upgrade work

– Lists used by the City to inform local residents of trees that may be suitable for planting on their property

– Publicly available lists used by other authorities in regions that currently have a climate that is similar to the future climate the City is predicted to have (e.g. The City of San Diego Street Tree List, Yamba Street Tree Guide)

– Lists used by arborists and landscape architects in their professional practice.

The tree species from the various sources were developed into a draft list by an experienced professional consulting arborist, along with informative data fields related to their origin, mature size, physical characteristics, and preferred growing considerations.

Peer review

A range of experienced and knowledgeable individuals were engaged to undertake a peer review of the draft list, with feedback helping to develop and refine various aspects of it. People involved in the peer review included:

– Professional consulting arborists

– Landscape architects

– Specialist in climate change and urban transformation

– An Indigenous consultant

– Tree management and urban forest practitioners

– The City's tree maintenance service providers.

The peer review process also assisted in identifying species that should potentially be excluded from the list, and additional species that should be included. Tree species excluded from the list are included with brief reasoning in Attachment A.

Resilience to future climate scenarios

Sydney's changing climate

Climate is the average pattern of weather over a long period of time. Sydney's climate is classified as warm and temperate but recent observations and long-term empirical data suggest that Sydney's climate is changing, with these changes having the potential to affect everyday weather phenomena, such as rainfall frequency, increases in maximum and minimum temperatures and the frequency and intensity of floods and drought.

The effects of climate change are already being experienced throughout Australia. As a result of these changes, Sydney's climate is likely to have further increases in average temperatures and more frequent and extreme weather events. For example, when heatwaves occur, they will be hotter and last for longer.

These climate changes will impact the current urban tree population of Sydney and will likely affect rates of tree survival and tree species choices in the future.

Summary of the method for assessing future climate suitability

An assessment of tree species future climate suitability was performed by an academic who is a specialist in this field, engaged as a consultant to the City. The method involved an assessment of the climatic niche for each species and their tolerance to extreme climatic conditions. This assessment of each species was then compared with the future climate projections of the City of Sydney local area.

Occurrence records for tree species were collated from global and Australian sources and were filtered and cleaned to remove any results that could lead to miscalculation of climate niches.

Climate data was collated to establish a baseline of average climatic conditions (from 1979-2013) along with the future climate scenario for 2050. Two climate variables representing the extremes in temperature and precipitation were selected for use in the analysis, these being the maximum temperature of the warmest month (MTWM) and the precipitation of the driest quarter (PDQ).

For each species, climate values of MTWM and PDQ were extracted from all occurrence records to characterise their realised climate niches under baseline climatic conditions based on the global geographic range for each species.

The upper and lower limits of the temperature and precipitation values across the species range were used to determine whether the climate of Sydney will likely exceed species' limits. For this, the threshold of the 95th percentile threshold was selected for the MTWM and the 5th percentile threshold was selected for the PDQ. These thresholds were used to assess the extremes of these variables as indicative of a species' thermal and drought stress tolerance for survival and growth.

Finally, a species safety margin was used as an index of tolerance. The safety margin was calculated as the difference between the species' climatic tolerance (for baseline climatic conditions) and the City of Sydney's future climatic conditions for the MTWM and PDQ parameters. The safety margin indicates how much warmer or drier a city could become before the realised climate niches of its resident species have been exceeded.

The climate suitability and tolerance assessment were used to exclude species that were identified as being clearly unsuitable for the future climate of our local area and to frame guidance within the list relating to vulnerability to maximum temperature extremes and drought conditions.

Other climate suitability references

The results of the species assessments were cross-referenced against other recently published sources of climate suitability data, including the online Which Plant Where database, to identify any disparities.

The real-world observations and experience of practicing arborists and urban foresters were also used to moderate the application of the results and form the guidance within the list.

How to use the list

Right tree in the right place

The success of every tree planting project, either large or small, is reliant on the right tree being chosen to match the site conditions and constraints. The various attributes of tree species need to be considered against the physical site conditions and any preferred design criteria and future desired outcomes. As a most simple example, the mature size of a tree must be appropriate for the available space.

Tree species selection

A range of tree attributes are presented in the list to help describe the physical characteristics of the trees, the functions they may perform in the landscape, and the conditions they prefer or be vulnerable to. A large amount of data is provided for each tree species in the list, however, not all characteristics of the species may be relevant depending on the proposed planting location. When selecting from the list, the most useful or important attributes relevant to the successful establishment and long-term viability of the tree for a particular location should be prioritised.

For large scale or high value tree planting projects it is recommended to consult with an experienced arborist, landscape designer, or landscape architect, so they may apply the list when developing the design and specifications for the project. However, it is intended that home gardeners or anyone with an interest in planting trees on their property may use the list and find it helpful in guiding their tree planting choices.

Figure 1: List attributes

The following table outlines the attributes of tree species as presented in the list, with guidance to assist with interpreting the data.

Attribute	Description
Family **Genus** **Species** **Variety**	The taxonomic (scientific) name of each tree is presented along the specific variety if relevant.
Common Name	The most used or recognised common name in our local area is presented.
Origin	– Locally indigenous refers to those species which naturally occurred in the Sydney Basin (including the metropolitan area) – Australian native refers to those species which naturally occurred in Australia – Exotic refers to all species which originate outside of Australia and have been introduced The current list includes 21% locally indigenous trees, a further 34% native to Australia, and 45% exotic.

Attribute	Description
Size Classification	Size Classification allocates tree species into a size range considered typical for the species and is based nominal height and spread attributes and the tree size categories as defined in the City of Sydney DCP (Draft 2023). Palms, fruit trees and ferns are the exception due to their limited canopy.
Nominal Height	Nominal Height is based on the typical mature height of the species in a suitable urban growing environment.
Nominal Spread	Nominal Spread is based on the typical mature canopy width of the species in a suitable urban growing environment.
Shape	Shape refers to the natural habit of the tree when it is unencumbered by constraints such as inadequate space or light. Note: The habit of certain species may cross over between the categories listed and the habit of many species will change as the tree reaches maturity. The various habits are listed and illustrated below.

 Conical/Columnar/ Upright	 Pyramidal
 Vase	 Weeping
 Oval	 Rounded
 Spreading	 Open
 Irregular	 Palm

Attribute	Description
Growth Rate	Relates to the typical rate of development to be expected in a suitable urban growing environment. – Slow – Moderate – Fast
Special Amenity Value	Identifies outstanding characteristics often valued from an amenity perspective. – Prominent Flowers – Prominent Fruit – Interesting Foliage – Interesting Bark
Dormancy	Refers to the characteristic of certain species to shed foliage during a seasonal dormant period (typically over winter or early spring, species dependent). Within the list, species dormancy relates specifically to the Sydney area as dormancy characteristics may vary in other regions. – Evergreen – Deciduous winter – Deciduous other
Light	Refers to a species tolerance to low light conditions, if relevant. A blank or no data indicates the species requires a sunny position. – Shade – Part shade
Exposure	Refers to the species tolerance to harsh growing conditions associated with exposed sites. Note: blank or no data indicates the species performs best in a moderately protected site, where not exposed to salt and/or wind. – Salt – Wind – Salt + Wind
Soil Moisture	Refers to a species tolerance to low or high soil moisture. Note: blank or no data indicates the species performs best in a moist free draining soil. Some species may also be adapted to a range of conditions. – Dry – Wet

<table>
<tr><th>Attribute</th><th>Description</th></tr>
<tr><td>Reliability</td><td>A somewhat subjective attribute, based on practical observation, highlighting species current performance in the Sydney region in a range of environmental conditions.
– Very reliable
– Somewhat reliable
– Unreliable
– Unknown</td></tr>
<tr><td>Availability</td><td>How readily available the species is at major wholesale nurseries based on a review of current availability lists and communications with nurseries.
– Common
– Advanced Procurement
– Unknown</td></tr>
<tr><td>Vulnerable to maximum temperature extremes</td><td>Use only at sites with a suitable microclimate or conditions, such as relatively cool, shaded and/or irrigated sites, protected from reflected heat.</td></tr>
<tr><td>Vulnerable to drought</td><td>Use only at sites with a suitable microclimate or conditions, such as sites with reliable soil moisture or irrigation.</td></tr>
<tr><td>Recommended Usage</td><td>A guide to how species should be considered and used in the landscape to support and enhance urban forest management.
<table>
<tr><th>Guidance</th><th>Explanation</th></tr>
<tr><td>Increase use</td><td>Species has proven to be a perform well, or has good potential, and should be used more commonly than it currently is</td></tr>
<tr><td>Maintain current usage</td><td>No specific reason or justification exists to increase or decrease current usage patterns</td></tr>
<tr><td>Limit use</td><td>Species is currently over abundant, unreliable, or has specific issues that warrant a reduction is use</td></tr>
<tr><td>Trial</td><td>Species that are currently rarely planted but show potential as urban trees and warrant special effort to trial within the landscape.</td></tr>
</table></td></tr>
</table>

Future work and development

The list will be refined and developed over time, to suit the needs of users and to respond to any new data or urban forest management issues that may arise.

Feedback from Indigenous communities will be sought to help guide the presentation of any culturally relevant information.

Credits and Acknowledgements

The City of Sydney wish to credit and acknowledge the following people and organisations for their contribution to the development and review of the tree species list.

Draft list production

– Anna Hopwood
Director, TreeiQ
Consultant specialising in tree management and urban forestry

Specialist Peer Review

– Doctor Manuel Esperon-Rodriguez
Research Fellow - Urban Transformation and Climate Change
Hawkesbury Institute for the Environment, Western Sydney University

– Ciaron Dunn, Indigenous Consultant
Djaambulgu Girrin Cultural Ecology

General Peer Review

– Robert Smart, Arterra Design Pty Ltd
(consultants in landscape architecture and arboriculture)

– Active Tree Services, tree maintenance service provider

– Treescape Australasia, tree maintenance service provider

– City of Sydney Tree Management, Landscape Assessment and Parks Services teams

List development and finalisation

– Karen Sweeney, Urban Forest Manager, City of Sydney

– Phillip Julian, Urban Forester – Strategy and Systems, City of Sydney

Attachment A

The species included in the Tree Species List is presented in the table below.
More detail on the attributes of each species is outlined in the full Tree Species List.

Tree Species	Common Name
Acacia floribunda	Gossamer Wattle
Acacia podalyrifolia	Queensland Silver Wattle
Acacia melanoxylon	Blackwood
Acacia longifolia	Sydney Golden Wattle
Acacia fimbriata	Brisbane Golden Wattle
Acacia binervia	Coast Myall
Acacia decurrens	Green Wattle
Acer palmatum	Japanese Maple
Acer buergerianum	Trident Maple
Acmena ingens	Red Apple
Acronychia imperforata	Logan Apple
Afrocarpus falcatus	Outeniqua Yellowwood
Agathis moorei	Moore's Kauri
Agathis robusta	Queensland Kauri
Albizia julibrissin	Silk Tree
Albizia lebbeck	Siris Tree
Alectryon coriaceus	Beach Birds Eye
Alectryon tomentosus	Woolly Rambutan
Allocasuarina torulosa	Forest Oak
Allocasuarina littoralis	Black She-Oak
Alloxylon flammeum	Queensland Tree Waratah
Alphitonia excelsa	Red Ash
Alphitonia petriei	White Ash
Angophora hispida	Dwarf Apple
Angophora costata	Sydney Red Gum
Angophora floribunda	Rough-Barked Apple
Araucaria heterophylla	Norfolk island Pine
Araucaria cunninghamii	Hoop Pine
Araucaria bidwillii	Bunya Pine
Araucaria columnaris	Cook Island Pine

Tree Species	Common Name
Arbutus unedo	Irish Strawberry Tree
Arbutus menziesii	Madrone
Arbutus canariensis	Canary Island Strawberry Tree
Arbutus andrachnoides	Hybrid Strawberry Tree
Archidendron mullerianum	Veiny Lace Flower
Archontophoenix cunninghamiana	Bangalow Palm
Archontophoenix alexandrae	Alexander Palm
Argyrodendron actinophyllum	Black Booyong
Auranticarpa rhombifolia	Diamond Leaf Pittosporum
Backhousia myrtifolia	Grey Myrtle
Backhousia citriodora	Lemon Myrtle
Bambusa sp.	Bamboo
Banksia serrata	Old Man Banksia
Banksia ericifolia	Heath Banksia
Banksia integrifolia	Coast Banksia
Banksia robur	Swamp Banksia
Banksia aemula	Wallum Banksia
Barringtonia asiatica	Barringtonia
Bauhinia blakeana	Hong Kong Orchid Tree
Bauhinia variegata	Orchid Tree
Beilschmiedia obtusifolia	Blush Walnut
Betula nigra	Black Birch
Bismarckia nobilis	Bismarck Palm
Brachychiton rupestris	Bottle Tree
Brachychiton acerifolius	Illawarra Flame Tree
Brachychiton populneus	Kurrajong
Brachychiton discolor	Queensland Lacebark
Brachychiton x roseus	Kurrajong Flame
Buckinghamia celsissima	Ivory Curl
Butia capitata	Blue Palm
Caesalpinia ferrea	Leopard Tree
Calliandra haematocephala	Red Powder Puff
Callicoma serratifolia	Black Wattle
Callistemon salignus	Willow Bottlebrush
Callistemon citrinus	Crimson Bottlebrush
Callistemon viminalis	Weeping Bottlebrush

Tree Species	Common Name
Callitris columellaris	White Cypress Pine
Callitris endicheri	Black Cypress Pine
Calodendrum capense	Cape Chestnut
Camellia japonica	Common Camellia
Carya illinoinensis	Pecan
Cassia fistula	Golden Shower
Cassia brewsteri	Leichhardt Bean
Castanospermum australe	Blackbean
Casuarina glauca	Swamp She-Oak
Casuarina cunninghamiana	River She-Oak
Catalpa bignonoides	Southern Catalpa
Cedrus libanni	Lebanese Cedar
Cedrus deodara	Deodar Cedar
Ceiba speciosa	Silk Floss Tree
Celtis australis	Southern Hackberry
Celtis paniculata	Native Hackberry
Ceratonia siliqua	Carob
Ceratopetalum apetalum	Coachwood
Ceratopetalum gummiferum	NSW Christmas Bush
Cercis canadensis	Eastern Redbud
Chamaerops humilis	Mediterranean Dwarf Palm
Citharexylum spinosum	Florida Fiddlewood
Citrus limon	Lemon
Combretum erythrophyllum	River Bush Willow
Cornus capitata	Evergreen Dogwood
Corymbia eximia	Yellow Bloodwood
Corymbia gummifera	Red Bloodwood
Corymbia maculata	Spotted Gum
Corymbia citriodora	Lemon-Scented Gum
Corymbia ficifolia (inc. varieties over 5m tall)	Red Flowering Gum
Corymbia variegata	Northern Spotted Gum
Cupaniopsis anacardioides	Tuckeroo
Cupressus sempervirens	Mediterranean Cypress
Cupressus macrocarpa	Monterey Cypress
Cupressus arozonica	Arizona Cypress

Tree Species	Common Name
Cupressus torulosa	Himalayan Cypress
Cyathea australis	Rough Tree Fern
Cyathea cooperi	Lacy Tree Fern
Davidsonia pruriens	Davidsons Plum
Delonix regia	Royal Poinciana
Dracaena draco	Canary Islands Dragon Tree
Drypetes deplanchei	Yellow Tulip
Dypsis lutescens	Golden Cane Palm
Dypsis decaryi	Triangle Palm
Elaeocarpus reticulatus	Blueberry Ash
Elaeocarpus obovatus	Hard Quandong
Elaeocarpus grandis	Blue Quandong
Elaeocarpus eumundi	Eumundi Quandong
Eucalyptus piperita	Sydney Peppermint
Eucalyptus pilularis	Blackbutt
Eucalyptus longifolia	Woollybutt
Eucalyptus robusta	Swamp Mahogany
Eucalyptus paniculata	Grey Ironbark
Eucalyptus grandis	Flooded Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus saligna	Sydney Blue Gum
Eucalyptus punctata	Grey Gum
Eucalyptus haemastoma	Scribbly Gum
Eucalyptus botryoides	Bangalay
Eucalyptus rossi	Inland Scribbly Gum
Eucalyptus propinqua	Small Fruited Grey Gum
Eucalyptus elata	River Peppermint
Eucalyptus resinifera	Red Mahogany
Eucalyptus fibrosa	Red Iron Bark
Eucalyptus mannifera	Brittle Gum
Eucalyptus moluccana	Grey Box
Eucalyptus crebra	Narrow-Leaf Ironbark
Eucalyptus melliodora	Yellow Box
Eucalyptus macrorhyncha	Red Stringybark
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus baueriana	Blue Box

Tree Species	Common Name
Eucalyptus microcarpa	Grey Box
Eucalyptus racemosa	Narrow-Leaved Scribbly Gum
Eucalyptus maidenii	Maiden's Gum
Eucalyptus sideroxylon 'Rosea'	Mugga Ironbark
Eucalyptus camaldulensis	River Red Gum
Eucalyptus calophylla	Marri
Eucalyptus globulus ssp. bicostata	Southern Blue Gum
Eucalyptus saligna x botryoides	Sydney Blue Gum
Ficus obliqua	Small-Leaved Fig
Ficus coronata	Sandpaper Fig
Ficus benjamina	Weeping Fig
Ficus macrophylla	Moreton Bay Fig
Ficus virens	White Fig
Ficus microcarpa 'var Hillii'	Hills Weeping Fig
Ficus superba Henneana	Cedar Fig
Ficus rubiginosa	Port Jackson Fig
Ficus religiosa	Sacred Fig
Ficus lyrata	Fiddle Leaf Fig
Flindersia australis	Crows Ash
Flindersia xanthoxyla	Yellowood Ash
Flindersia brayleyana	Queensland Maple
Flindersia schottiana	Silver Ash
Flindersia bennettiana	Bennett's Ash
Fraxinus pennsylvanica	Green Ash
Fraxinus angustifolia sub sp oxycarpa Raywoodii	Claret Ash
Fraxinus griffithii	Evergreen Ash
Fraxinus velutina	Arizona Ash
Geijera parviflora	Wilga
Gleditsia tricanthos 'Shademaster'	Honey Locust
Gleditsia tricanthos 'Sunburst'	Honey Locust
Glochidion ferdinandi	Cheese Tree
Gmelina leichhardtii	White Beech
Grevillea baileyana	Brown Silky Oak
Guioa semiglauca	Wild Quince
Hakea francisiana	Bottlebrush Hakea

Tree Species	Common Name
Harpephyllum caffrum	Harpephyllum
Harpullia pendula	Tulipwood
Hibiscus syriacus	Syrian Ketmia
Hibiscus rosa-sinensis	Chinese Hibiscus
Hibiscus tiliaceus	Coast Hibiscus
Howea forsteriana	Kentia Palm
Hymenosporum flavum	Native Frangipani
Jacaranda mimosifolia	Jacaranda
Jubaea chilensis	Chilean Wine Palm
Koelreuteria paniculata	Golden Rain Tree
Koelreuteria bipinnata	Chinese Rain Tree
Lagerstroemia indica x fauriei cv.	Crepe Myrtle
Lagerstroemia indica	Crepe Myrtle
Lagerstroemia speciosa	Pride of India
Laurus nobilis	Bay Tree
Leptospermum trinervium	Flakey Barked Tea Tree
Leptospermum petersonii	Lemon-Scented Tea Tree
Leptospermum laevigatum	Coast Tea Tree
Liquidambar styraciflua	Liquidambar
Liquidambar formosana	Chinese Sweet Gum
Liriodendron tulipifera	Tulip Tree
Livistona australis	Cabbage Tree Palm
Livistona chinensis	Chinese Fan Palm
Lophostemon suaveolens	Swamp Turpentine
Lophostemon confertus ‘Variegatus’	Variegated Brush Box
Lophostemon confertus	Brush Box
Macadamia integrifolia	Macadamia
Magnolia grandiflora	Bull Bay Magnolia
Magnolia grandiflora ‘Exmouth’	Southern Magnolia/ Bull Bay Magnolia
Magnolia grandiflora ‘Little Gem’	Bull Bay Magnolia
Magnolia x soulangeana	Saucer Magnolia
Magnolia figo	Port Wine Magnolia
Magnolia liliiflora ‘Nigra’	Mulan Magnolia
Magnolia doltsopa	Magnolia
Magnolia champaca	Himalayan Magnolia
Melaleuca linariifolia	Snow-In-Summer

Tree Species	Common Name
Melaleuca styphelioides	Prickly-Leaf Paperbark
Melaleuca ericifolia	Swamp Paperbark
Melaleuca quinquenervia	Broad-Leaf Paperbark
Melaleuca bracteate 'Revolution Gold'	Black Tea-Tree
Melaleuca bracteata	Black Tea-Tree
Melaleuca armillaris	Bracelet Honey Myrtle
Melaleuca leucadendra	Weeping Paperbark
Melicope elleryana	Pink Flowered Doughwood
Meryta denhamii	Mertya
Metasequoia glyptostroboides	Dawn Redwood
Michelia alba	White Sandalwood
Murraya paniculata	Orange Jessamine
Nyssa sylvatica	Tupelo
Olea europaea subsp. europaea	European Olive
Pararchidendron pruinosum	Snow Wood
Persea americana	Avocado
Photinia glabra	Red Photinia
Photinia serrulata	Taiwanese Photinia
Pinus halepensis	Aleppo Pine
Pinus canariensis	Canary Island Pine
Pinus roxburghii	Chir Pine
Pistacia chinensis	Chinese Pistachio
Platanus x acerifolia	London Plane Tree
Platanus occidentalis	American Sycamore
Platanus orientalis	Oriental Plane Tree
Platanus orientalis 'Digitata'	Oriental Plane Tree
Platanus orientalis 'Insularis'	Oriental Plane Tree
Plumeria obtusa	Singapore Frangipani
Plumeria acutifolia	Frangipani
Podocarpus elatus	Plum Pine
Podocarpus henkelii	Henkels Yellowood
Polyalthia longifolia	Indian Mast Tree
Polyscias elegans	Celery Wood
Polyspora axillaris	Fried Egg Plant
Populus deltoides	Cottonwood
Populus simonii	Simon Poplar

Tree Species	Common Name
Pyrus calleryana ‘Chanticleer’	Callery Pear
Pyrus calleryana	Callery Pear
Pyrus nivalis	Snow Pear
Quercus phellos	Willow Oak
Quercus x heterophylla	Bartram Oak
Quercus virginiana	Live Oak
Quercus coccinea	Scarlet Oak
Quercus acutissima	Sawtooth Oak
Quercus palustris	Pin Oak
Quercus ilex	Holm Oak
Quercus cerris	Turkey Oak
Quercus suber	Cork Oak
Quercus lusitanica	Portuguese Oak
Quercus canariensis	Mirbeck’s Oak
Quercus agrifolia	California Live Oak
Rapanea howittiana	Brush Muttonwood
Robinia pseudoacacia ‘Frisia’	Golden Robinia
Rodosphaera rhodanthema	Deep Yellowwood
Rothmannia globosa	Rothmannia
Sapium sebiferum	Chinese Tallow Tree
Schinus areira	Peppercorn Tree
Schizolobium parahyba	Brazilian Fern Tree
Stenocarpus sinuatus	Firewheel Tree
Styphnolobium japonicum	Japanese Pagoda Tree
Syncarpia glomulifera	Turpentine
Synoum glandulosum	Scentless Rosewood
Syzygium moorei	Coolamon
Syzygium smithii	Common Lilly Pilly
Syzygium luehmannii	Riberry
Syzygium floribundum	Weeping Lilly Pilly
Syzygium paniculatum	Magenta Lilly Pilly
Syzygium jambos	Rose Apple
Syzygium australe	Brush Cherry
Tabebuia impetiginosa	Pink Trumpet Tree
Taxodium distichum	Bald Cypress
Tibouchina urvilleana	Glory Bush

Tree Species	Common Name
Tibouchina granulosa	Purple Glory Tree
Tibouchina macratha	Glory Bush
Tilia cordata	Small-leaved Lime
Toona ciliata	Australian Red Cedar
Tristaniopsis laurina ‘Luscious’	Water Gum
Tristaniopsis laurina	Water Gum
Ulmus parvifolia ‘Todd’	Chinese Elm
Ulmus parvifolia	Chinese Elm
Washingtonia robusta	Mexican Fan Palm
Washingtonia filifera	Desert Fan Palm
Waterhousea floribunda ‘Green Avenue’	Weeping Lilly Pilly
Waterhousea floribunda	Weeping Lilly Pilly
Wodyetia bifurcata	Foxtail Palm
Wollemia nobilis	Wollemi Pine
Xanthostemon chrysanthus	Golden Penda
Xylosma japonicum	Logwood
Zelkova serrata	Japanese Zelkova
Zelkova serrata ‘Green Vase’	Japanese Zelkova

Attachment B

A list of species excluded from the Tree Species List is presented in the table below, along with a brief explanation as to reasoning or justification.

Tree Species	Common Name	Reasoning
Acer negundo	Box Elder	Tendency to be weedy
Acer negundo 'Variegatum'	Variegated Box Elder	Tendency to be weedy
Acer platanoides	Norway Maple	Unlikely to be suited to future climate
Acer rubrum 'October Glory'	Red Maple	Unlikely to be suited to future climate
Acokanthera oblongifolia	Bushman's Poison	Shrub
Agathis australis	Kauri	Unlikely to be suited to future climate
Alectryon excelsus	Titoki	Unlikely to be suited to future climate
Alnus jorullensis	Evergreen Alder	Short-lived in Sydney
Banksia marginata	Silver Banksia	Unlikely to be suited to future climate
Cedrus atlantica	Atlas Cedar	Unlikely to be suited to future climate
Celtis occidentalis	Common Hackberry	Tendency to be weedy
Celtis sinensis	Chinese Hackberry	Weed species
Chamaecyparis lawsoniana	Port Orford Cedar	Unlikely to be suited to future climate
Chamaecyparis obtusa 'Crippsii'	Japanese Cyprus	Unlikely to be suited to future climate
Cinnamomum camphora	Camphor Laurel	Weed species
Cordyline australis	Cabbage Palm	Unlikely to be suited to future climate
Cotinus coggygria	European Smoke Tree	Unlikely to be suited to future climate
Davidia involucrata	Dove Tree	Unlikely to be suited to future climate
Eriobotrya japonica	Loquat	Tendency to be weedy
Erythrina crista-galli	Cockspur Coral Tree	Tendency to be weedy
Erythrina sykesii	Common Coral Tree	Tendency to be weedy
Euphorbia pulcherrima	Poinsetta	Short-lived in Sydney, sap poisonous
Ficus elastica	Rubber Fig	Tendency to be weedy
Fraxinus angustifolia	Narrow Leaved Ash	Unreliable performance
Fraxinus excelsior Aurea	European Ash	Unlikely to be suited to future climate
Fraxinus excelsior	European Ash	Unlikely to be suited to future climate
Ginkgo biloba	Maidenhair Tree	Unlikely to be suited to future climate
Koelreuteria elegans subsp. formosana	Golden Rain Tree	Tendency to be weedy

Tree Species	Common Name	Reasoning
Leptospermum cilliatum	Purpureostemon	Unreliable performance
Ligustrum lucidum	Broad-Leaf Privet	Weed species
Ligustrum ovalifolium Aurea	Korean Privet	Weed species
Ligustrum sinense	Chinese Privet	Weed species
Metrosideros excelsa	New Zealand Christmas Tree	Highly susceptible to borer
Morus nigra	Black Mulberry	Tendency to be weedy
Morus alba 'Pendula'	White Mulberry	Tendency to be weedy
Nerium oleander	Oleander	Shrub
Olea europaea subsp. 'Cuspidata'	African Olive	Tendency to be weedy
Parrotia persica	Persian Ironwood	Unlikely to be suited to future climate
Paulownia tomentosa	Princess Tree	Unlikely to be suited to future climate
Phoenix canariensis	Canary Island Date Palm	Susceptible to fusarium wilt, tendency to be weedy
Phoenix dactylifera	Date Palm	Susceptible to fusarium wilt
Phoenix reclinata	Senegal Date Palm	Susceptible to fusarium wilt, tendency to be weedy / spread
Phoenix roebelenii	Dwarf Date Palm	Susceptible to fusarium wilt
Phoenix rupicola	Cliff Date Palm	Susceptible to fusarium wilt
Phoenix sylvestris	Silver Date Palm	Susceptible to fusarium wilt
Pinus patula	Patula Pine	Unreliable performance
Pinus radiata	Monterey Pine	Tendency to be weedy
Pittosporum eugenioides	Lemonwood	Unlikely to be suited to future climate
Populus alba 'Pyramidalis'	Silver Poplar	Unreliable performance
Populus alba	Silver Poplar	Unlikely to be suited to future climate
Populus nigra 'Italica'	Lombardy Poplar	Unlikely to be suited to future climate
Populus simonii 'Fastigiata'	Simon Poplar	Unreliable performance
Populus x canadensis 'Aurea'	Canadian Poplar	Unreliable performance
Populus x canadensis	Canadian Poplar	Unlikely to be suited to future climate
Populus yunnanensis	Chinese Poplar	Unlikely to be suited to future climate
Prunus cerasifera 'Nigra'	Purple-Leaf Cherry Plum	Unlikely to be suited to future climate
Prunus cerasifera	Cherry Plum	Unlikely to be suited to future climate
Prunus x blireana	Purple-Leaf Cherry Plum	Unreliable performance
Pyrus communis	European Pear	Unlikely to be suited to future climate
Pyrus ussuriensis	Manchurian Pear	Unlikely to be suited to future climate

Tree Species	Common Name	Reasoning
Quercus robur	European Oak	Unlikely to be suited to future climate
Robinia pseudoacacia	Black Locust	Thorny uncultivated rootstock
Schefflera arboricola	Dwarf Umbrella Tree	Tendency to be weedy
Spathodea campanulata	African Tulip Tree	Tendency to be weedy
Strelitzia nicolai	Giant White Bird of Paradise	Tendency to be weedy
Syagrus romanzoffiana	Cocos Palm	Tendency to be weedy
Thevetia peruviana	Yellow Oleander	Tendency to be weedy
Thuja plicata	Western Red Cedar	Unreliable performance
Trachycarpus fortunei	Chinese Windmill Palm	Unlikely to be suited to future climate
Ulmus glabra 'Lutescens'	Scots Elm	Unlikely to be suited to future climate, susceptible to Dutch elms disease
Ulmus glabra	Scots Elm	Unlikely to be suited to future climate, susceptible to Dutch elms disease
Ulmus procera	English Elm	Unlikely to be suited to future climate, susceptible to Dutch elms disease
Ulmus x hollandica 'Vegeta'	Dutch Elm	Susceptible to Dutch elms disease