

GREEN INFRA STRUCT URE

A vital step to Brilliant Australian cities

01

INTRODUCTION**01**

02

RESEARCH METHODOLOGY**03**

03

MAJOR STEPS AUSTRALIAN CITIES CAN TAKE TO OPTIMISE GREEN INFRASTRUCTURE**04**

Communicate the value of green infrastructure

04

Incorporate green infrastructure in a broad plan for the city

13

Update green infrastructure regulations

16

Apply smart management to green projects

20

04

NEXT STEPS**26**

05

CONTRIBUTORS AND SOURCES**28**

CONTENTS

We acknowledge that there are many different definitions of Green Infrastructure, for the purpose of this report 'Green Infrastructure' focuses on 'photosynthetic infrastructure' - trees, plants and grasses.

INTRODUCTION

Trees and parks transform the **quality of life** in Australian cities, but remain vastly undervalued.

The number of residents in Australian cities is forecast to boom in the next few decades, with Sydney's population expected to nearly double by 2056.¹ Population growth will increase demand for housing and jobs, and will place enormous pressure on health systems and transport. Energy consumption will increase as temperatures rise due to climate change.² As our cities become increasingly crowded, there will be less space for the trees, parks and the other photosynthetic elements we call green infrastructure.

Green infrastructure will be critical to alleviate these pressures. Trees filter air pollution, enhancing our quality of life. They shield buildings from the sun and provide shade for cyclists and walkers. Trees transform urban developments by making them more appealing places to work and raise families.

But we often treat green infrastructure as a cost, not an opportunity to improve the liveability of our cities. Australian regulations and business models don't encourage our transport authorities, energy companies, councils, developers and residents to recognise street trees as essential infrastructure. These organisations focus on concerns about litigation, operating costs and engineering problems, without fully appreciating the value green infrastructure provides to our cities.

We can remedy this by better understanding the many benefits and costs of green infrastructure in our cities. By comparing the costs and benefits, stakeholders can make more effective decisions about green infrastructure. They can do this using new valuation frameworks, including the insights in this report.

AECOM's research deals primarily with street trees because they are the green infrastructure that conflicts most with other infrastructure in our cities. But many of the observations in this report also apply to other forms of green infrastructure. Our research focuses on three Sydney suburbs, where we conservatively estimate that a 10 percent increase in the leaf canopy of street trees could increase the value of properties by an average of \$50,000.

We combined our investigation with insights from interviews with Blacktown City Council, NSW Roads and Maritime Services (RMS), Transport for NSW, an energy company and the property development group Stockland. This informed our understanding of the financial and regulatory challenges involved in optimising green infrastructure.

By combining this information, we have identified four steps cities can take to get the most benefit from green infrastructure. They must first reassess its value as vital infrastructure, then show how it is part of a broader plan for the city. Cities can also harness community support for regulatory change, then apply smarter management of trees, parks and other green infrastructure.



AS OUR CITIES BECOME
INCREASINGLY CROWDED,
THERE WILL BE LESS SPACE
FOR THE TREES, PARKS AND THE
OTHER PHOTOSYNTHETIC
ELEMENTS WE CALL GREEN
INFRASTRUCTURE.

RESEARCH METHODOLOGY

AECOM's research aimed to calculate the **value street trees** provide in Australian cities. Our intent was to gain better insights into their benefits and understand how these could inform discussions about street trees, and other green infrastructure.

We began by considering more than 500 publications, policies, street tree programs and other relevant literature. To test our findings in an Australian context, we then conducted primary research. We analysed the impact of tree canopies on property prices and the average summer temperature in the Sydney suburbs of Annandale, Blacktown, and Willoughby.

While there are many variables affecting land and property prices, our analysis focused on the relationship between the size of the tree canopy, the price of land and property, and temperature. To achieve this, we first calculated the tree canopy coverage in each suburb by inputting aerial

photography and Landsat thermal imagery into a geographic information system. We used property sales information from RP Data to create a data set showing the value of all properties sold in each suburb between September 2012 and September 2016, adjusted to 2016 prices. We compared the size of the canopy cover provided by street trees in each suburb with the value of similar types of properties in the same area that have access to similar services. The analysis then identified trends in the relationship between the canopy size and the price of the land and property.

MAJOR STEPS AUSTRALIAN CITIES CAN TAKE TO OPTIMISE GREEN INFRASTRUCTURE

Governments, public authorities, utility providers, developers and the community **can overcome green infrastructure challenges** by doing the following:

01 / COMMUNICATE THE VALUE OF GREEN INFRASTRUCTURE

Recognise all the advantages of street trees and urban forests

Calculate the total value of green infrastructure

We don't always value trees and other vegetation in financial terms, as we do roads and railways, yet they are worth many millions of dollars to Australian cities.

For example, consider whether homes would command the same prices without trees nearby. By comparing the size of the leaf canopy provided by street trees with the value of properties in the same area,

we can show that street trees can significantly increase the value of homes.

Looking at the Sydney suburb of Blacktown, we found that a 10 percent increase in the size of the canopy across the suburb showed an increase in the value of property of 7.7 percent, or \$55,000 for the average house. Analysing other Sydney suburbs, we found that a 10 percent increase in the canopy aligned with an average increase in property prices of \$33,152 in Willoughby, and \$60,761 in Annandale.

Trees also protect us from extreme weather. Imagine not having shade while enduring the heatwaves that struck various Australian cities in the summer of 2016 and 2017. In Sydney, residents sweltered through the hottest summer in 157 years in 2017³. One study estimated that by doubling the leaf canopy there would be up to 28 percent fewer heat-related deaths.⁴ In Annandale, we measured the air temperature at 4 degrees Celsius lower in streets with 28 percent canopy coverage

than in streets with 20 percent canopy coverage. The surface temperature of concrete and asphalt was also at least 14 degrees cooler in the shade. In one street, the surface temperature of asphalt exposed to direct sunlight was 54.6 degrees, compared with 35.6 degrees in the shade of a tree. Not only can the heat radiating from asphalt make pedestrians uncomfortable, but it can degrade the asphalt quicker.

Street trees also play a part in reducing cardio-metabolic health problems⁵ and contribute positively to our mental wellbeing.⁶ They also provide a more pleasant, shaded environment for pedestrians and cyclists.

It's also easy to overlook the vital role trees play in making our cities healthier, by filtering air and water pollution. Research in London has provided extensive insights into these benefits, showing that trees remove an estimated 2,241 tonnes of carbon each year from the air.⁷ They also hold stormwater in their canopies, where it later reevaporates. Trees absorb more than 3 million cubic metres of water this way in London each year, reducing stormwater runoff and saving £1.5 million in stormwater alleviation costs.⁸

Australian city councils are increasingly using the freely available software i-Tree⁹ to calculate some of the benefits trees provide in their suburbs. In the City of Melbourne, 70,000 trees in streets and parks are estimated to provide \$14 million in value by

offering shade, and capturing and storing carbon.¹⁰ Brisbane City Council estimates its street trees contribute \$1.67 million in value to the city by improving air quality, capturing rain and storing carbon.¹¹

We must also better understand the costs. Street trees can damage roads, footpaths, plumbing and other infrastructure, and energy companies must trim them to protect power lines. But they can also prolong the life of buildings and pavements. A study has shown that trees can protect asphalt pavements, halving the number of times maintenance workers must seal the pavement over a 30-year period.¹²

Some suggest that trees reduce the cost of using air-conditioners to cool buildings. For example, Blacktown City Council informed residents of one street that by adjusting the number and type of street trees, they could eventually reduce the average yearly household electricity bill by \$249. This could take several decades to achieve.¹³

One way to communicate these benefits is to create a master plan for the city. We can then show how green infrastructure contributes to that plan. We explain this on page 13.

THE BENEFITS AND COSTS OF STREET TREES

The benefits and costs of street trees are more complex than some people might think. This diagram demonstrates the relationship between the number of trees and size of canopy and the social, environmental or economic benefits and impacts.

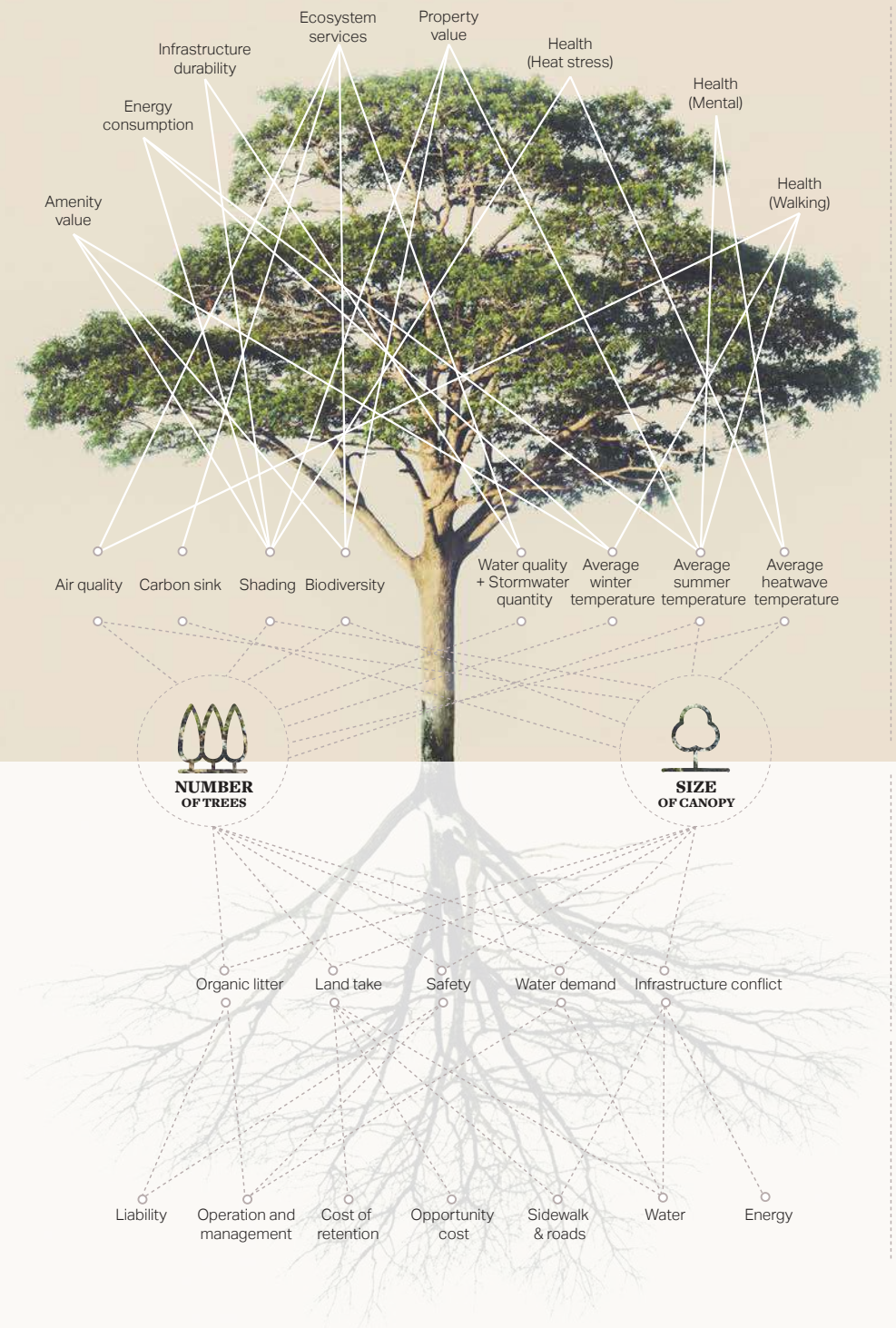
Rebalance the valuation of grey versus green infrastructure

Given the multiple benefits trees, parks and other vegetation provide to cities, it makes sense to treat them as essential infrastructure, not merely decoration. This requires comprehensively accounting for them in the same way that we account for grey infrastructure such as buildings, roads and power lines.

Integrated valuation models make it possible to calculate the financial, social and environmental benefits of green infrastructure in urban design. We used this approach in the design of development projects in Green Square in Sydney and in Huntlee near Newcastle, NSW. See 'A greener approach to urban design' on page 22.

This approach can benefit housing development projects. When clearing land for new houses, trees are often removed that are growing where houses will eventually sit because it is cheaper than trying to build around them. Street trees and other vegetation might also complicate a council's approval of a housing project because the council will eventually shoulder the expense of maintaining the vegetation on public land.

By using a better valuation model for green infrastructure, developers could make more informed decisions about retaining trees. For example, Matthew Napper, National Sustainability Manager at property group Stockland, says the company already measures the value of green infrastructure to the community. It conducts an annual survey that asks residents to identify what makes their communities liveable.



“Our customers consistently tell us that one of the elements that drives liveability in a community is quality design, incorporating a connection to nature,” says Napper. “And we know that when we create liveable communities, our customers recommend them to their friends and family.”

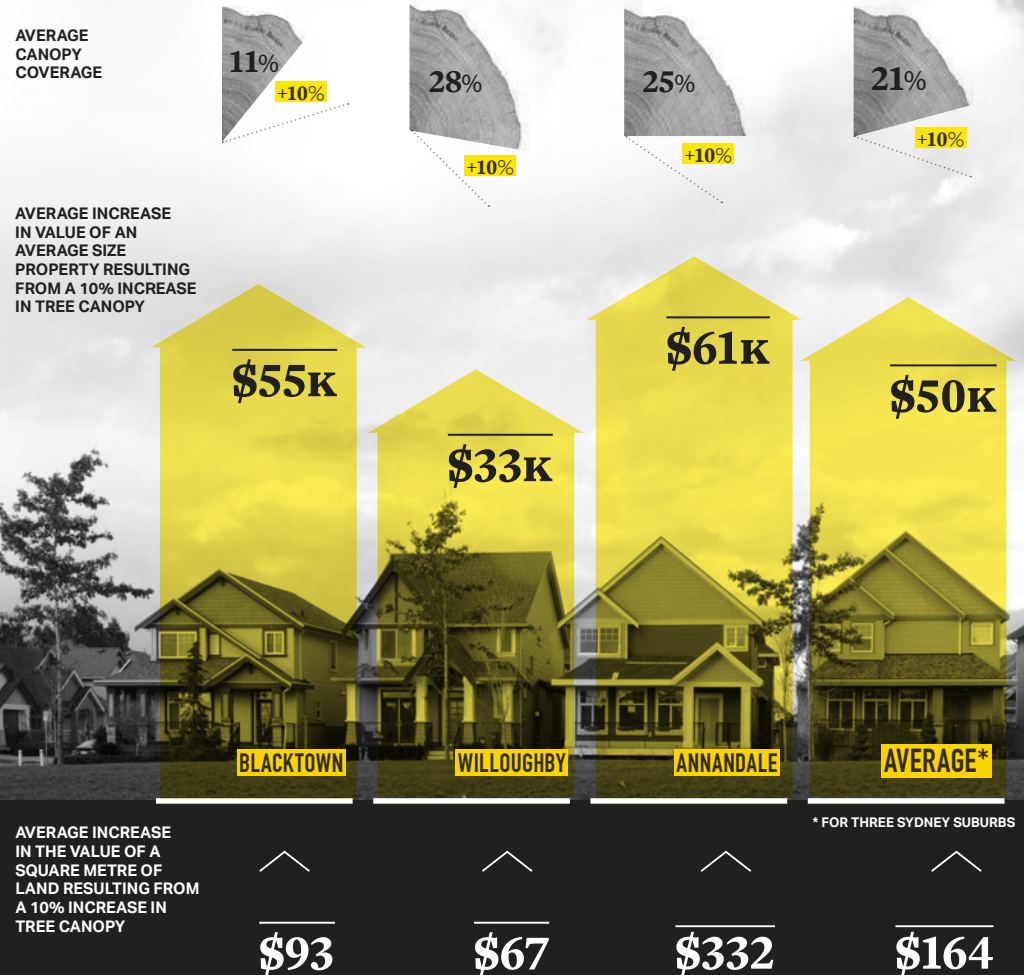
Stockland could also account for the financial benefit trees provide to its business by taking into account their effect on land value.

These benefits must be weighed against the substantial costs of managing green infrastructure. Once developers finish a project, councils, transport authorities and energy companies bear the cost of maintaining trees and shrubs. For example, the City of Sydney spends up to \$5 million each year managing thousands of trees. Ausgrid spends approximately \$43 million each year maintaining vegetation, mostly to maintain public safety, minimise bushfire risk and maintain the reliability of electricity supply.¹⁴ Trees also damage pipes and footpaths, increasing maintenance bills for water authorities and councils.

Wet leaves can also damage roof gutters and exacerbate flooding during storms by blocking drains. Tree leaves and roots can trip pedestrians, while falling branches can damage houses or injure people, resulting in legal liability.¹⁵ Retaining trees might also prevent developers, councils or the community building new infrastructure.

When these costs are compared with the social, environmental, health and economic benefits, it is clear that green infrastructure can provide an overall net benefit to cities. But achieving these benefits is complicated by the fact that the organisations we have mentioned each have different priorities. In the following chapters, we address this and other challenges.

HOW STREET TREES AFFECT LAND AND PROPERTY VALUES IN SYDNEY



28%

estimated reduction in heat-related deaths in Melbourne that would result from doubling the city's tree canopy coverage.²⁰



70,000

number of trees in the City of Melbourne.¹⁹

2050

when the City of Sydney aims to achieve 27% tree canopy coverage of its local government area.¹⁷

42

number of public authorities and agencies that manage street trees, parks and other green infrastructure across greater Sydney.¹⁸

11,000

number of trees and shrubs planted by the City of Sydney since 2006.¹⁶

\$1.67M

estimated value that street trees contribute to the City of Brisbane, by improving air quality, capturing rain and storing carbon.²¹

**STREET TREES:
THE NUMBERS**

02 / INCORPORATE GREEN INFRASTRUCTURE IN A BROAD PLAN FOR THE CITY

Look beyond the short-term costs

Create a master plan for a more liveable city

Another step to unlocking the benefits of green infrastructure is to show how it contributes to a city's liveability. Across Australia, cities are making liveability a goal in an effort to attract investment and skilled workers. For example, the City of Melbourne boasts that its 70,000 trees contribute to Melbourne's status as one of the 'most liveable cities in the world'. Perth lists achieving a 'liveable lifestyle' as one of its goals, while the Greater Sydney Commission has made it part of its plan for the greater Sydney area. It lists green infrastructure as one key to achieving this goal. But what is 'liveability' and what role does green infrastructure play in achieving it?

The Greater Sydney Commission states that 'liveability' refers to "the people who live in an area, the places they then spend time in, their health and quality of life as well as overall community wellbeing".²² Trees and parks can make a city liveable by creating an attractive, relaxing environment, which is one of the goals for developing the Green Square town centre in Sydney.

According to the City of Sydney's Urban Forest Strategy, trees can provide residents with "cleaner air, filtered stormwater and lower city temperatures".²³ Healthier waterways and parks can improve a city's appeal to tourists.²⁴

Reframe green infrastructure decisions within the broader master plan

Once councils and developers have a master plan for a city, precinct or suburb, they can start to coordinate ways to use green infrastructure to enhance liveability, rather than using it only to beautify streets. For example, councils might plant trees as part of a strategy to slow down traffic in urban centres and create more pedestrian-friendly shopping precincts.

As councils put these plans in place, they may find that these goals clash with transport regulations. For example, road planning guidelines often regard street trees as a safety risk to motorists.



12:30

During the lunch break, they might go jogging along a nearby street, again using a shaded 'green grid' to bypass traffic and get to a nearby park.



18:00

After travelling home at the end of the day, the resident might take their children to a nearby park.



19:30

Along the way, they might bump into a neighbour who is out jogging, and discuss plans to meet that weekend for a barbecue in the park.

07:00

Resident might decide to jog or ride a bicycle to a bus station or to walk, taking advantage of shaded road lanes designated for 'active' transport.



14:00

Returning to work, they might stop at a local shopping precinct to buy a coffee. Trees planted in road islands slow down traffic and create a pedestrian-friendly environment.



18:30

Choosing to enjoy a stroll along shaded streets instead of driving.



WHAT WILL LIFE BE LIKE IN A GREENER CITY?

“

WITHOUT AN ENGAGED, COMMITTED AND INFORMED COMMUNITY, URBAN FORESTRY WILL BE JUST ANOTHER UNSUCCESSFUL GREAT IDEA WE HAD BACK IN THE DAY BEFORE CLIMATE CHANGE BECAME A BIPARTISAN COMMITMENT.”

—
**MATTHEW DANIEL,
 DIRECTING PARTNER,
 TREE PRESERVATION AUSTRALIA, MELBOURNE²⁸**

03 / UPDATE GREEN INFRASTRUCTURE REGULATIONS

Solve the disconnect between green goals and the way cities work

Harness public support for regulatory change

Community members can push for more green infrastructure, and help ensure authorities craft new guidelines and legislation carefully. For example, in Vancouver, Canada, more than 35,000 residents participated in writing a plan to make Vancouver the world's greenest city. The local government created 150 separate policy initiatives as a result.²⁵ In the City of Melbourne, authorities held nine precinct-based

community meetings and a forum in the town hall during the creation of the city's urban forest strategy in 2011 and 2012. This was part of the process that led to the creation of urban forest plans for 10 precincts in Melbourne.

Some residents don't want green infrastructure near their homes, but better engagement by councils with residents can improve their understanding of the benefits trees provide. For example, Blacktown City Council ran a pilot program promoting the positive effects street trees

could have on the value of homes, the size of residents' electricity bills and the health of residents in a particular street.²⁶ Cities across the world are also beginning to promote the financial and social benefits of trees – even attaching signs to trees, listing their financial value.²⁷

Call for regulations recognising the full value of green infrastructure

Another critical step is addressing the disconnect between the responsibilities of transport and energy authorities and the green priorities of city planners and the community. For example, transport authorities remove some trees to protect road and rail users and avoid liability for damage to properties. Energy companies trim trees to ensure they don't damage the energy network or other assets. They might understand why green infrastructure is important, and some are adjusting their operating guidelines to reflect this, but making Australian cities greener is not their chief task.

There is also a disconnect between who shoulders the cost of green infrastructure, and who benefits from it. Utility and transport authorities benefit less from street trees than residents, who have limited direct influence over decisions about street trees.

It can be difficult for authorities to satisfy the needs of a broad range of stakeholders and context. “To many people it seems straightforward, but when you weigh up all the different subject matter experts' inputs and the needs of the community, the landscape and the road users, then designing transport infrastructure is a complicated exercise and we have to recognise the often competing objectives,” says Gareth Collins, Principal Manager Centre for Urban Design, Roads and Maritime Services (RMS), NSW Government.

As well as broader societal benefits green infrastructure has very important direct transport benefits in terms of soil erosion, weed control, graffiti deterrence, wayfinding, visual cues and headlight glare avoidance Collins says, and RMS will try to avoid removing green infrastructure or integrate it into design outcomes. If avoidance is not possible, then removal should be

compensated. “But we have to work within our own [guidelines] and Australian guidelines,” he says. There might not be enough room beside a road to plant substantial trees, for example. Collins says planting trees in the clear zone, too close to fast moving vehicles is unsafe, unless the trees are planted behind a protective barrier or are frangible.

Balancing these priorities is important, not only to realise the financial benefits of trees, but so these organisations can avoid reputational damage resulting from tree pruning. Resolving this requires changes to the regulations and guidelines these organisations follow.

This reform could also remove uncertainty about the legal responsibilities of the organisations managing street trees. For example, some people question why trees are often removed from roadsides, even though power poles remain. “These decisions can seem so arbitrary. It is something we're confronting as a council at the moment,” says Matthew O'Connor, Manager, Recreation Planning and Design at Blacktown City Council. “There is uncertainty across the board, no matter who the stakeholder is.” Councils, energy companies and transport authorities will need to collaborate to resolve this.

Regulatory changes could provide more clarity about who is responsible if a tree injures a resident or damages a building. “It's very easy for anyone to say, ‘If that tree falls over and it hurts someone, I'll sue you’. Because there's no clarity that council can manage the risk through regular street sweeping or risk assessments, the tree is chopped down or not permitted to be planted,” says O'Connor.

Better legal guidance might help councils and other organisations understand when it is appropriate to retain trees and work to minimise the risks, and when to remove them. For example, Blacktown City Council has engaged a legal firm to quantify the risk to drivers of planting more trees in certain locations beside roads. Perhaps state and local governments could do more assessments of this nature.

Broader public engagement between city stakeholders and the community can also help all parties understand where the benefits of trees outweigh the safety risks. Ideally, more parties will share the liability, as well as the costs and benefits associated with street trees.

“

AT THE MOMENT IT'S AN EASY ARGUMENT AGAINST TREES. IT'S VERY EASY FOR ANYONE TO SAY, 'IF THAT TREE FALLS OVER AND IT HURTS SOMEONE, I'LL SUE YOU'."

—
**MATTHEW O'CONNOR,
 MANAGER, RECREATION PLANNING AND DESIGN,
 BLACKTOWN CITY COUNCIL**

Reassess funding for green infrastructure

Cities could also benefit from a new approach to funding the maintenance of public green infrastructure. Councils currently shoulder the bulk of the cost of maintaining the trees growing on public land, while energy companies also spend millions of dollars trimming trees to protect power lines and water authorities clear roots from pipes. Adding more trees will increase these costs, and so will putting power lines underground or bundling the wires together to provide more room for tree branches.

"At the end of the day someone has to pay to manage this infrastructure when you pull these levers," says the spokesperson for an energy company. The spokesperson says energy companies would need to further understand this, and then work with stakeholders to determine how the cost would impact the community to manage additional tree infrastructure.

One suggestion is to share green infrastructure maintenance costs and benefits between more government and private organisations. Another idea is to prepare case studies quantifying the cost of bundling power lines or moving them underground. Energy companies and councils will also need a better understanding of what green infrastructure initiatives rate payers and the customers of utility companies are willing to pay for.



Green Square, Sydney



Rouse Hill Landscape Restoration, Sydney

04 / APPLY SMART MANAGEMENT TO GREEN PROJECTS

Adjust operations to maximise value from green infrastructure

Adopt new planting techniques

There are streets in many Australian cities that have large tree canopies, proving it is possible even with overhead power lines and other obstacles.

The street tree master plan for the Sydney suburb of Marrickville provides good examples of how to overcome these physical obstacles. One is extending the kerb to provide a protected area for trees to grow. Where this approach isn't feasible, councils can focus on planting and maintaining trees on the opposite side of the road to power lines, where they have more room to grow.

Councils can minimise obstructions to pedestrians and damage to driveways and houses by carefully choosing where on the road verge they plant these trees. Strategic planting, including careful selection of tree species, can reduce the damage trees cause to roads, footpaths and buildings, and minimise the risk of injuries. This will provide more benefits than maintaining trees planted inappropriately under power lines. Mapping the location of trees can aid in this planning, as the City of Melbourne has done.²⁹

Residents can provide valuable data about green infrastructure. For example, San Francisco residents can use a phone app to record the location and condition of individual trees in the city. Local authorities then use an online map to see the location and condition of each tree. The apps can also be used to assess whether the tree has caused damage to footpaths.³⁰ This can help in planning where to plant trees and ensuring the right mix of tree species. The City of Sydney is developing systems to help it manage its assets better, including trees. This includes the use of tablet computers to collect information about the condition of trees.³¹

Bundling and relocating power lines where possible

Bundling overhead power lines together provides more room for trees and minimises the extent that energy companies must trim trees to keep them away from the power lines. Some councils are partnering with energy companies to do this³², but many city suburbs don't have bundled power lines. This warrants further public discussion.

A more significant step is moving power lines underground. There is a local government planning requirement for developers to do this in new residential developments.³³

Encourage more green infrastructure on private land

As population density increases in our cities, there will be less space available on private land for trees. However, we should still take steps to improve green infrastructure on home owners' land where this is possible. Some leafy streets are actually the result of trees growing just inside the boundaries of private land. Trees can grow taller and develop larger canopies if home owners allow them to grow inside their yards, beyond the reach of power lines. We can do more to encourage home owners to manage this canopy appropriately.

Governments can update the regulations protecting trees on private land. They can also offer incentives to developers, encouraging them to keep and add trees.³⁴ The City of Sydney also uses its register of significant trees to protect trees that "contribute to the environmental, cultural, [and] social character of the City".

More education for home owners and developers is important, because some trees might not provide adequate shade, or their roots could damage footpaths. Some councils now provide lists of tree species they recommend for planting near power lines.³⁵

A greener approach to urban design

It is possible to estimate the effect green infrastructure will have in urban development projects. For example, we have developed a tool that can be used to estimate the extent green infrastructure will affect the financial, social and environmental outcome of urban precinct projects. Originally developed for a sewer system improvement program for the San Francisco Public Utilities Commission (SFPUC), the tool is now also used on other projects.

The two charts on page 25 indicate the potential outcome of two different designs for the Green Square development project in Sydney. The first chart shows the potential result when the tree canopy cover has grown to its full size. The second chart shows the benefits of a design with 50 percent of that tree canopy coverage.

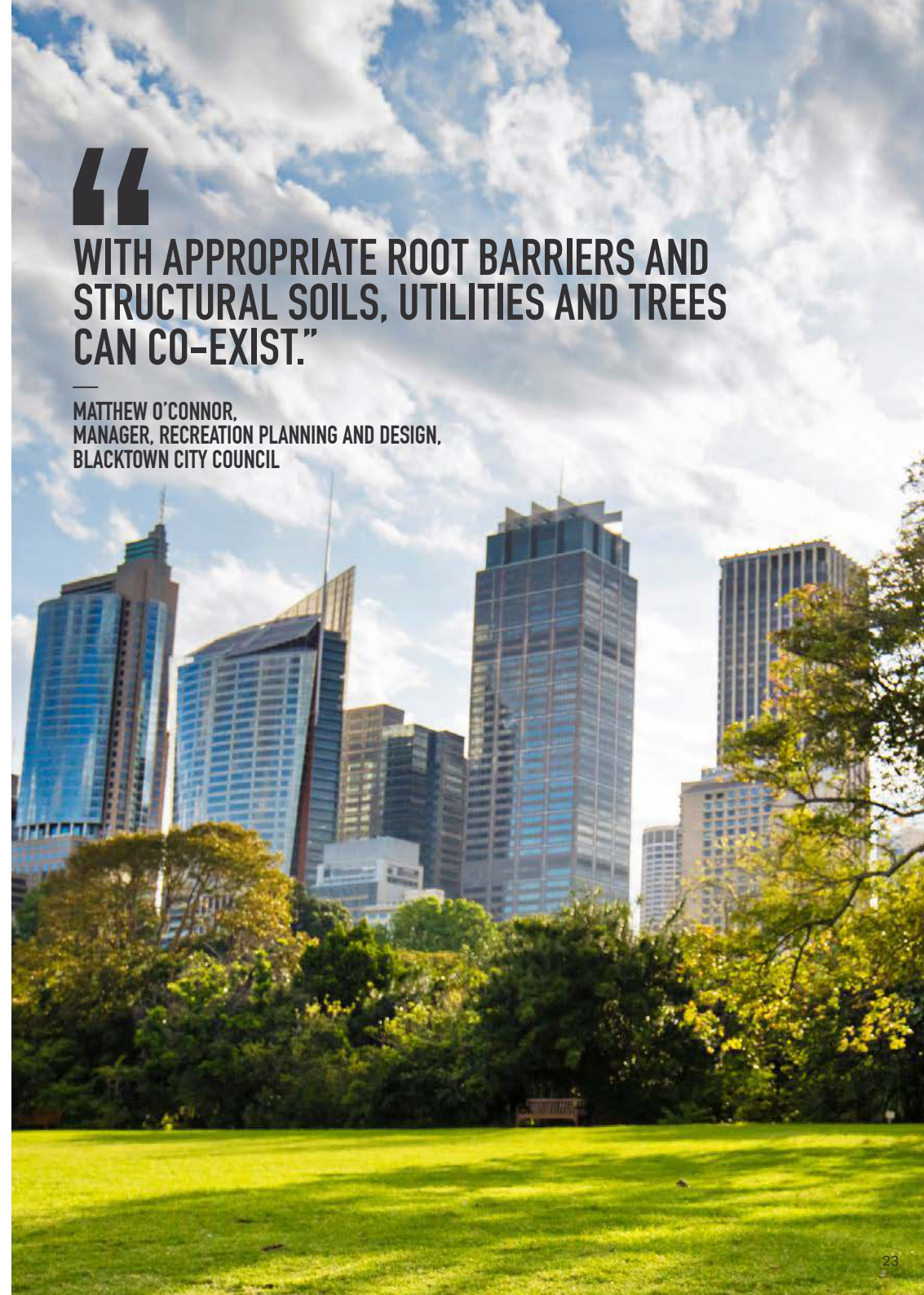
The charts show that doubling the tree canopy can result in a noticeable improvement in property value, energy consumption, biodiversity, health and wellbeing, suitability for walking, amenity, calming of traffic and other factors.

This was achieved through careful consideration and evaluation of value optimising and risk minimising methods. Optimising approaches include; tree planting that considers the quality and size over quantity to improve the return and speed; tree placement with a 'right tree, right location' principle and shading being a key criteria which enhances walkability and cycle way use. To minimise the risks rather than planter boxes the design provided a network of linked trenches along the streets and under parking bays and pedestrian pathways to ensure that trees can live as part of an urban forest community and share soil and water resources through their root systems. Other features to reduce the impact included the placement of trees and smartly selected lighting poles to allow for optimal illuminance.

“

WITH APPROPRIATE ROOT BARRIERS AND STRUCTURAL SOILS, UTILITIES AND TREES CAN CO-EXIST.”

**MATTHEW O'CONNOR,
MANAGER, RECREATION PLANNING AND DESIGN,
BLACKTOWN CITY COUNCIL**



POTENTIAL OUTCOMES FOR GREEN SQUARE DEVELOPMENT, SYDNEY



100%

Full canopy from plan

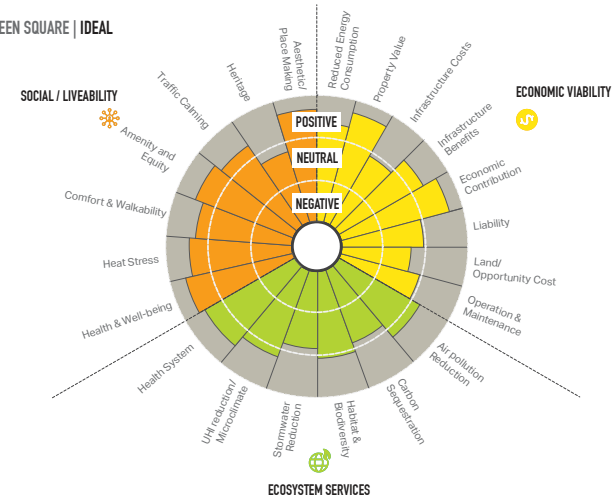


50%

Reduction in canopy

RESULTS OF CANOPY COVERAGE DETERMINED BY THE TRIPLE BOTTOM LINE TOOL

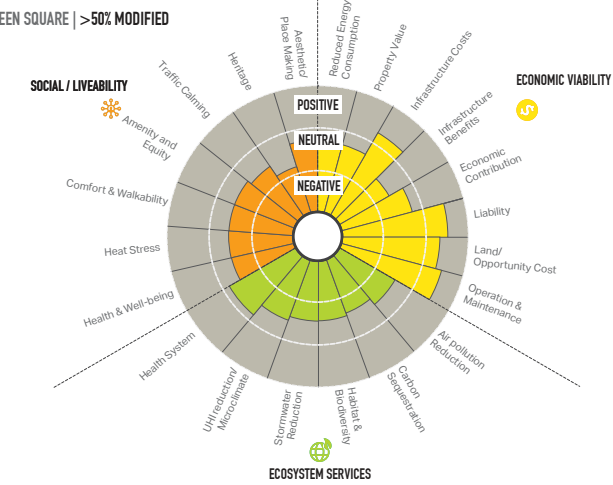
GREEN SQUARE | IDEAL



100%

Full canopy from plan

GREEN SQUARE | >50% MODIFIED



50%

Reduction in canopy

NEXT STEPS

Australian cities can be world leaders in using green infrastructure to create liveable, resilient cities that have healthier residents. While our cities are becoming more crowded, they still have the space to create vibrant urban environments that will rival the greenest cities on the planet.

In the past, our leafiest suburbs were often the result of forward thinking local councils, developers and possibly community action groups. But we can't afford to rely on pockets of green infrastructure any more – not when each Australian city is competing for investment and skilled workers with other cities around the country, and with cities around the globe that have strong green credentials.

Some change is occurring. The transport authorities, developers and councils

we spoke to are all actively updating their green infrastructure guidelines. But we need to solve the disconnect between our society's green goals and the regulations and business models governing these organisations. We need to use a more integrated valuation model for street trees, such as the model discussed in this report. We need to manage safety risks and find funds to increase tree canopies in cities. We can overcome these hurdles, as we have done with many other complicated infrastructure challenges.

Most importantly, we must realise that cities don't need to choose between a greener environment and greater development. In fact, carefully planned green infrastructure supports development by making projects more appealing to residents and businesses. It can improve

the value of homes, reduce energy bills, improve health and wellbeing, and minimise pollution and the effects of extreme weather on the people and the city's infrastructure.

To enjoy all these benefits, we need to treat trees, parks and other natural elements like any other vital infrastructure and comprehensively account for their costs and benefits. Then we need to adjust our regulations and operating procedures accordingly.

City stakeholders that do this will reap the rewards of more vibrant and valuable development projects. Their reputations will benefit, and so will the reputations of Australian cities.

Will your organisation be one of them?



CONTRIBUTORS AND SOURCES

About The Authors

Roger Swinbourne

Technical Director
Urban Systems Advisory, AECOM

Roger is an urban systems adviser with 17 years' experience in urban development planning in Australia and Europe. He leads AECOM's Urban Systems Advisory team in Australia and focuses on major property and infrastructure projects. Roger works closely with the development industry and governments, setting strategies and improving social, economic and environmental outcomes for clients.

James Rosenwax

Market Sector Director
Cities, AECOM

Cities have never been more important, nor the competition among them more intense. At AECOM, we have acknowledged this and have a team of dedicated specialists who connect the best ideas and insights from across the globe and professional backgrounds to help cities overcome their challenges and build brilliant futures. James leads this team across Australia and New Zealand as the Market Sector Director – Cities.

James' philosophy is rooted in his desire to reframe the questions arising when solving the most complex challenges faced by our urban metropolises.

Researchers

Désirée Lucchese

Senior Consultant – Buildings + Places,
AECOM

Désirée is a senior sustainability consultant with in-depth knowledge of environmental systems and innovation, strategic policy development (CSR) and responsible investing. She has extensive experience in managing sustainability projects, she is a passionate advisor committed to the collaborative design and delivery of integrated urban strategies.

Danny Huang

Graduate Urban Systems Advisory, AECOM

Danny is part of AECOM's Urban Systems Advisory team where he continues to improve upon current sustainability practices to achieve cost-effective outcomes for clients whilst maximising environmental and social benefits. He has an interest in the delicate interplay between infrastructure, urban systems, and the triple bottom line of sustainability.

Contributors

Gareth Collins, Principal Manager Urban Design, Roads and Maritime Services, NSW Government

Matthew Napper, National Sustainability Manager, Stockland

Matthew O'Connor, Manager Recreation Planning and Design, Blacktown City Council

Cielo Roldan, Principal Environmental Advisor, Asset Standards Authority, Freight, Strategy and Planning, Transport for NSW

Editor

Jessica Dodds, Cities Marketing Manager, Australia & New Zealand, AECOM

William Maher, Senior Writer & Editor, Editor Group

Creative

Juli Anderson, Principal Creative – Australia, New Zealand & Global Cities, AECOM


Special thanks

AECOM would like to thank the following organisations for participating in a workshop and / or providing information throughout our research phase:

- Ausgrid
- City of Parramatta Council
- City of Sydney
- NSW Government Department of Planning and Environment
- NSW Office of Environment and Heritage
- Sydney Water
- The Greater Sydney Commission
- The University of Sydney
- University of New South Wales

REFERENCES

1. Greater Sydney Commission, Towards our Greater Sydney 2056, 21 November 2016, www.greater-sydney/towards-our-greater-sydney-2056
2. AECOM, Economic Assessment of the Urban Heat Island Effect, prepared for The City of Melbourne, 2012, www.melbourne.vic.gov.au/SiteCollectionDocuments/eco-assessment-of-urban-heat-island-effect.pdf
3. Peter Hannam, 'Sydney weather: Summer confirmed as city's hottest for days and nights in 157 years', The Sydney Morning Herald, 2 March, 2017, www.smh.com.au/environment/weather/sydney-weather-summer-confirmed-as-citys-hottest-for-days-and-nights-in-157-years-20170228-gunqkxk.html
4. Chen et al. 2014, Urban vegetation for reducing heat related mortality
5. Kardan et al. 2015, Neighbourhood greenspace and health in a large urban centre
6. Taylor et al. 2014, Research note: Urban street tree density and antidepressant prescription rates - a cross sectional study in London UK
7. Killicoat, Puzio and Stringer 2002, as referenced in Moore 2009, People, Trees, Landscape and Climate Change
8. Greater London Authority, London i-Tree headline results, www.london.gov.uk/sites/default/files/itree_headline_figures_nov_2015.pdf
9. i-Tree website, www.itreetools.org
10. Denise Gadd, 'Doctor's plea for trees', The Sydney Morning Herald, 19 February, 2009, www.smh.com.au/national/doctors-plea-for-trees-20090218-8bh9.html
11. Brisbane City Council website, www.brisbane.qld.gov.au/environment-waste/natural-environment/plants-trees-gardens/brisbanes-trees/street-trees
12. McPherson 2005, 'Effects of street tree shade on asphalt concrete pavement performance'
13. Gallagher Studio, Cool Streets: Cool the planet, one street at a time, vimeo.com/gallagherstudio/cool-streets
14. Ausgrid, Annual Report 2015/2016, www.ausgrid.com.au/~media/Files/About%20Us/Annual%20reports/Ausgrid%20Annual%20Report%202016.pdf
15. Slater and Gordon, Whose responsibility is it to maintain trees?, 2015, www.slatergordon.com.au/blog/whose-responsibility-it-maintain-trees
16. City of Sydney, 'Urban forest to grow for National Tree Day', 31 July 2016, www.sydneymedia.com.au/urban-forest-to-grow-for-national-tree-day-2/
17. City of Sydney, Urban Forest Strategy 2013, February 2013, www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/132249/Urban-Forest-Strategy-Adopted-Feb-2013.pdf
18. The Green Grid, architecturebulletin.com.au/winter-2015/the-green-grid/
19. City of Melbourne, Urban Forest Visual, melbourneurbanforestvisual.com.au
20. Chen et al., 2014, Urban vegetation for reducing heat related mortality
21. Brisbane City Council website, www.brisbane.qld.gov.au/environment-waste/natural-environment/plants-trees-gardens/brisbanes-trees/street-trees
22. Greater Sydney Commission, Towards our Greater Sydney 2056, 21 November, 2016, www.greater-sydney/towards-our-greater-sydney-2056
23. City of Sydney, Urban Forest Strategy 2013, February 2013, www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/132249/Urban-Forest-Strategy-Adopted-Feb-2013.pdf
24. Greater Sydney Commission, Towards our Greater Sydney 2056, 21 November, 2016, www.greater-sydney/towards-our-greater-sydney-2056
25. WWF International, The Urban Green, 16 March, 2016, www.youtube.com/watch?v=o86Ut6kAEMQ
26. Western Sydney Regional Organisation of Councils Ltd (WSROC), Focus on: Cool Streets Blacktown, 19 December, 2016, <https://wsroc.com.au/media-a-resources/wsroc-news-stories/focus-on-cool-streets-blacktown>
27. Heartland Tree Alliance, bridgingthegap.org/heartland-tree-alliance/
28. Matthew Daniel, Urban Forest Community Engagement, 10 January, 2017, sourceable.net/urban-forest-community-engagement/
29. City of Melbourne, Urban Forest Visual, melbourneurbanforestvisual.com.au/
30. San Francisco Urban Forest Map, urbanforestmap.org
31. City of Sydney, Draft Digital Strategy, sydneyoursay.com.au/digital-strategy/documents/50908/download
32. Lorna Knowles and Alison Branley, ABC, Claims of 'postcode discrimination' over deal to reduce controversial tree lopping, 31 January, www.abc.net.au/news/2017-01-31/claims-of-postcode-discrimination-over-tree-lopping-deal/8225746
33. Ergon Energy, Standard for Vegetation Management, www.ergon.com.au/__data/assets/pdf_file/0005/6359/STNM001-Standard-for-Vegetation-Mgmt.pdf
34. City of Sydney, Urban Forest Strategy 2013, February 2013, www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/132249/Urban-Forest-Strategy-Adopted-Feb-2013.pdf
35. Ergon Energy, Plant smart search, www.ergon.com.au/network/safety/home-safety/trees-and-powerlines/plant-smart-search



ABOUT AECOM

Whether it is helping cities to prioritise capital asset reliability, plan for climate adaptation, protect assets or provide for sustainable economic development, we see the opportunity to not just build resilience but achieve brilliance.

We believe that cities positioned to excel in this time of global change are pursuing broad, integrated strategies to tap hidden value, celebrate ecology and culture, attract people and investment, and overcome financial and operational inefficiencies. These are brilliant cities. Brilliant cities aren't just smart. They are visibly vibrant and delightful. They shine.