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Future Cities

Planning for our growing population

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REFORM SERIES

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Cover: Melbourne city aerial view

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Contents

Executive Summary

Australia's largest cities are facing a watershed moment in their growth and development. In the coming 30 years the size of the Australian population will grow substantially. Between 2017 and 2046, Australia's population is projected to increase by 11.8 million people.[1] That's equivalent to adding a new city, roughly the size of Canberra, each year for the next 30 years.

About 75% of this growth will occur in Sydney, Melbourne, Brisbane and Perth.[2] Growth on this scale will transform these cities. A growing population is an exciting opportunity to increase our national economic prosperity and liveability. The potential benefits are immense.

But Australians face a complex set of choices regarding what this change will look like. Are our cities going to grow out or up? How do we align the location of jobs with the needs of our changing economy? How do our infrastructure networks need to change to accommodate more demand? How can we ensure the world-class liveability of our cities is maintained and enhanced?

These are difficult decisions, with each requiring trade-offs and compromise. But inaction is not an option, nor is business as usual. If we fail to effectively anticipate and respond to growth, the likely results will be declining economic productivity, increasing environmental pressures and a marked reduction in each city's quality of life.

We must act now to preserve and enhance the elements of each city that make them such attractive places to live and work.

This paper identifies the choices facing our largest cities and the best pathways to respond. It:

1. provides independent advice to Australian governments on how to respond to the challenges and opportunities of growth
2. provides the community with accessible information on the potential outcomes of growth and change in their cities
3. demonstrates the value of more innovative strategic planning tools and calls on Australian governments to increase the sophistication of their long-term planning practices.

The future development of Australian cities, big and small, was a major focus of the *Australian Infrastructure Plan*

Infrastructure Australia published the *Australian Infrastructure Plan* in February 2016. It outlines an evidence-based pathway towards more efficient and productive infrastructure for Australia's future. The Plan explored some of the key challenges facing Australian cities in the context of population growth:

"Population growth will transform our cities. Our four largest cities are set to undergo a higher density urban transformation. Our aim for these cities should be to deliver high-quality, higher density living, connected by world-class infrastructure services. In our smaller cities, we should ensure their many and diverse advantages are maximised. The opportunity exists to ease the pressure on our larger cities by growing the populations of the smaller ones. Delivering these solutions will require us to reform how we plan and govern our cities."[3]

This paper builds on the direction set in the Plan, by seeking to provide governments and the community with an accessible evidence base and reform agenda, with which to prepare Australia's largest cities for population growth and change over the coming 30 years.

While Australia's smaller cities will not grow at the same scale as our largest cities, they are home to a large number of Australians, and will experience the same challenges over a longer timeframe. Future Infrastructure Australia research will examine the unique opportunities facing our smaller cities and the options to capitalise on them to deliver national benefits.

Australia's prosperity is intrinsically linked to the successful development of its largest cities

More than ever before, Australia's long-term prosperity is linked to the performance of our cities. Cities are increasingly the generators of Australia's wealth, where a growing number of Australians choose to live and businesses choose to locate. This trend is not unique to Australia, many countries around the world are also rapidly urbanising, and taking advantage of the economic and social opportunities that growing cities can bring.

In 2015-16 Australia's four largest cities contributed just over 60% of our national Gross Domestic Product (GDP).[4] Over time this contribution is expected to increase. Since the middle of the 20th Century, the focus of the national economy has gradually shifted from agriculture, manufacturing and more recently resources, towards largely knowledge-intensive service sectors, which now make up over 60% of the nation's economy and around 20% of exports.[5] Cities are the ideal location for these sectors, which typically locate in large employment centres, enabling collaboration and ready access to skilled labour.[6]

At the same time, cities are where a large number of Australians choose to live and work, with the trend set to increase in coming decades. Over the next 30 years the percentage of the population living in Australia's four largest cities will increase from 58% to 64%.[7] This trend reflects the increasing number of businesses, and in turn jobs, located in Australia's largest cities, and shifting preferences, among some sections of the community, towards a metropolitan lifestyle.

Australia's largest cities are facing a future of fundamental growth and change

Australia's largest cities are undergoing a period of profound change. In coming decades, they will each experience fundamental shifts in their structure and operation.

Population growth is a central driver of this change. In the next 30 years, Sydney's population is projected to increase by 2.4 million people, growing to be a city of 7.4 million. Over the same period, Melbourne is projected to grow by 2.7 million people, to be a city of 7.3 million. The growth of Brisbane and Perth, while on a smaller scale, will still bring substantial change to both cities. Between now and 2046, Brisbane is projected to grow by 1.6 million people and Perth by 2.2 million people, delivering cities of just under 4 million and 4.3 million, respectively.[8]

This means the Brisbane and Perth of tomorrow will become cities the size of Melbourne and Sydney today. While Melbourne and Sydney will become cities comparable to the current size of some of the world's most significant urban economies, operating more like the Hong Kong, New York and London of today.

The growth and development of Sydney, Melbourne, Brisbane and Perth will create exciting opportunities for Australia. But to effectively capitalise on these opportunities, the structure and operation of these cities will need to change.

To meet the demands of population growth, these four cities must rapidly increase the delivery of well-located housing supply and ensure that housing remains affordable to a broad cross-section of the community. Each city will be required to plan for and appropriately locate an expanding jobs market. The capacity and efficiency of each city's infrastructure networks will also need to be increased. Road and public transport networks will need to be upgraded in line with demand. Additional pressure on utility infrastructure, namely water, telecommunications and energy, will need to be understood and accounted for. The capacity of key social infrastructure facilities, such as hospitals, schools and green space, will need to be increased.

Growth alone though is not the only challenge faced by Australia's cities. The convergence of fundamental shifts across several sectors has an as-yet-unknown but potentially significant impact on the structure and operation of our cities in coming decades, and particularly on the infrastructure required to support them.

These shifts include:

- **The ageing population:** Over the next 40 years the proportion of the Australian population aged 65 and over will significantly increase, while the proportion of working-age people will decrease. This means Australia's governments will face increasing fiscal gaps, which will impact on funding availability for the necessary infrastructure upgrades and additions required to support Australia's growing population.
- **Rapid technological transformation:** Technological change across a range of sectors within the Australian economy is fundamentally disrupting how goods and services are provided, regulated, consumed and paid for. This will have implications for the planning, design and operation of Australian cities both now and in the future, including our transport networks.
- **The increasing urban freight task:** According to the 2015 *Australian Infrastructure Audit*, Australia's containerised freight task is projected to experience substantial growth, increasing by 165% by 2031,[9] with cities being a primary location for this growth. This will have implications for our urban freight networks, in particular first and last mile transport and handling, which will impact the future structure of our cities.
- **The impacts of climate change:** The changing global climate is driving shifts in short-term weather patterns, including increased extreme weather events, and long-term climate trends. At the same time, Australia's cities are a key source of emissions, and are located in areas which are at risk from climate change impacts. Policy and regulatory responses from governments to climate change will therefore have significant implications for the operation of Australian cities, particularly the larger ones.
- **The shifting structure of national and global economies:** The national economy is in a state of transition. As the mining investment boom winds down, the focus of the economy is shifting towards service and knowledge-intensive activities. Cities are the ideal location for these agglomerating economies, enabling collaboration and easy access to skilled labour.[10] This has implications for the spatial structure of our cities, and the infrastructure which supports them.
- **Changes to the nature and location of work:** Technological innovation, including ongoing developments in communications, robotic technology and artificial intelligence, are enabling changes to the way we work. These changes will have implications for the nation's key employment centres, primarily located in our cities, with flow-on impacts for infrastructure networks and social equity across our cities.

The implications of technology, demographic, and economic changes within Australian cities are currently unknown. Many of these changes are contingent on the trajectory of technological development, market uptake, and significant policy and regulatory reform.

The community and decision makers need better tools to understand their future city

In the context of rapid growth and uncertain change, there is a clear case for evolving our planning and governance practices to improve the evidence base available to decision makers and better inform and involve the community. Meeting the demands of a growing population within our largest cities over coming decades will require communities to make a series of choices regarding the type of city they want to live in.

Current long-term planning processes for Australia's largest cities generally draw on population and employment projections to produce a metropolitan vision, which paints a high-level picture of what it will be like to live and work in the city in coming decades. These visions are supported by corresponding delivery milestones and policy objectives, such as location-specific targets for the zoning of land to support new housing or the creation of new jobs or the identification of new or upgraded infrastructure.

Under traditional long-term planning practices there has been limited public discussion about what population growth practically means for the current and future residents of our cities. The community does not have easy access to the necessary tools and analysis to understand the scale of prospective growth, the potential pathways to cater for this growth, and, most importantly, the relative trade-offs associated with different decisions about how each city should grow. For example, living in a low-density area with large homes and backyards, but further away from jobs and amenities, or living in a higher density area with smaller

homes and more shared space, but closer to jobs and amenities.

As a result, there are often understandable reservations in parts of the community regarding the potentially adverse impacts of population growth and corresponding land-use outcomes, such as increased housing density or longer travel times.

Scenario planning tools can provide the community and decision makers with a more robust picture of what the future could look like

Scenario planning is a strategic tool that presents the public and decision makers with a range of different options for what the long-term development of a city could look like. Each scenario is a potential portrait of the future, which details how the city could perform under a unique set of conditions. The use of scenarios is based on a recognition that the future is difficult to predict with certainty, and that several outcomes are possible and should be considered.

The process has two clear benefits for cities facing significant and uncertain change:

- It allows decision makers, as part of the process of articulating and implementing a long-term vision for a city, to consider a range of possibilities and build necessary flexibility into policy and investment decisions.
- It enables a more transparent public discussion of the choices and trade-offs inherent within different approaches to growth. This can help governments to have a more holistic public discussion about what growth means and provides a more transparent process for defining preferred future directions.[11]

While Australian governments are increasingly using scenario tools, it has yet to become an established practice when planning for our cities, and there has been only a limited sample of this work made publicly available.

Infrastructure Australia has used scenario planning to evaluate the trade-offs inherent within potential long-term growth pathways for Melbourne and Sydney to 2046

Infrastructure Australia has developed six hypothetical growth scenarios, three each for Melbourne and Sydney. The scenarios seek to test commonly posed questions about how Australian cities could grow and change, including:

- Should our cities expand outwards, at a low density, or consolidate inwards at a higher density?
- Should we seek to locate jobs in centres or distribute them more evenly across the metropolitan area?
- What mix of modes and network structure is best suited to meet the needs of a larger city?

They assume consistent metropolitan boundaries and common population and employment growth totals for each city. They then focus on three variables, which differ across the scenarios:

- Where each city's additional population lives and the intensity and style of development they live in
- Where each city's additional jobs are located
- The future structure of the transport network.

The scenarios, tailored to match the unique characteristics of Melbourne and Sydney, are:

1. **The Expanded Low Density scenario:** This scenario tests a future in which population growth is distributed with the aim of minimising the impact on existing urban areas. In essence, the scenario directly caters to the desire of some in the community for the character of their immediate environment to remain unchanged.
2. **The Centralised High Density scenario:** This scenario tests a higher density, inner-city growth future which aims to enable more people to live and work closer to existing transport infrastructure and major employment centres. The scenario envisages a lifestyle shift for many in these suburbs, with increased apartment living, active and public transport use and a greater reliance on shared (rather than private) services and spaces becoming the norm.
3. **The Rebalanced Medium Density scenario:** This scenario aims to rebalance each city's spatial structure by distributing new housing and employment more evenly across the whole city. It seeks to test the feasibility and outcomes of first, locating jobs closer to where people live, and second, more evenly distributing the impact of new housing, by focusing development at a medium density across the city.

By focusing on Melbourne and Sydney, the paper does not disregard the significant level of growth set to occur in Australia's other large cities, namely Brisbane and Perth. Instead Melbourne and Sydney are presented as case studies of the choices and trade-offs that will be faced across Australia's four largest cities as they each grow and change in coming decades.

Precisely predicting the future is an impossible task and the three scenarios presented in this paper should not be viewed as an exact vision of the future. In reality, a complex interplay of policy decisions and unforeseen factors will shape the long-term development of Australia's cities. This could include the decentralisation of population growth to neighbouring cities, such as Geelong (VIC), Wollongong (NSW), the Gold Coast (QLD) or Peel (WA), or deviations from the projected population growth levels because of external factors such as changes to migration policy, or shifting domestic or global economic conditions.

What the scenarios do not address

Like all future visioning exercises, scenario planning is necessarily a simplified version of the future. However, cities develop and change in response to a broad range of complex and interdependent factors, some of which are beyond the scope of this paper. The scenarios in this paper **do not** specifically address:

- **Changing demographics:** For example, the ageing population, policy interventions to incentivise decentralisation of population growth away from our larger cities, or other changes to regional, interstate or international migration patterns.
- **Rapid technological transformation:** For example, significant uptake of battery storage, electric and autonomous vehicles, further development and implementation of intelligent transport systems, or changes to key sectors such as health and education from technological disruption.
- **The increasing urban freight task:** For example, investment and reform to enhance and upgrade urban freight networks in line with a growing population.
- **The impacts of climate change:** For example, increased extreme weather events, long-term climate changes, and policy interventions impacting on the energy sector.
- **Changes to the structure of national and global economies:** For example, collapses or booms, and shifts within sectors.
- **Changes to the nature and location of work:** For example, changes as a result of automation and more people working from home due to communications technology innovation.
- **The impact of population growth on other infrastructure sectors:** For example, investment and reform to enhance and upgrade energy, telecommunications and water infrastructure.

The exclusion of these variables is not a reflection of their importance. Their exclusion reflects the inherent uncertainty that surrounds them and the bounds of what can be feasibly modelled and considered within one report.

The performance of each scenario has been modelled and analysed according to a suite of five indicators

Infrastructure Australia has compared the performance of the three hypothetical scenarios within each city by modelling their respective impact on the performance of each city's infrastructure, using a suite of five indicators.

The Victorian Government's Victorian Integrated Transport Model (VITM) and the New South Wales Government's Sydney Strategic Travel Model (STM) were used to model each city's transport network performance and environmental impact. Arup's Transport Travel Time Analysis (T3a) tool was used to model demand for and access to social infrastructure and green space under each scenario. **Table 1** provides a summary of the five indicators used.

Table 1: Summary of indicators used to compare the relative performance of scenarios

Indicator	Description
Performance of the transport network	Uses a range of data points to identify how different configurations of the public transport and road networks perform, including mode share, congestion and travel times, under each scenario.
Access to jobs	Identifies how access to jobs changes in different parts of the city under each scenario.
Environmental performance of the road network	Calculates the relative CO_2 emissions of the road network under each scenario.
Access to and demand for social infrastructure	Identifies how the demand for and access to existing key social infrastructure assets such as hospitals, schools, and tertiary education facilities, change under each scenario.
Access to and demand for green space	Identifies how the demand for and access to existing green space, such as parks and gardens, change under each scenario.

Findings from the scenario analysis and *Australian Infrastructure Plan* have informed an urban reform agenda for Australia's largest cities

Nine key findings have emerged from the scenario analysis of Melbourne and Sydney. These provide valuable insights for all Australian cities experiencing rapid population growth and change, regardless of the future growth scenario that is followed. Infrastructure Australia has combined this evidence base with analysis from the *Australian Infrastructure Plan* to develop 15 recommendations and an urban reform agenda for Australia's largest cities.

This agenda provides all levels of government with advice on how to successfully meet the demands of population growth in Sydney, Melbourne, Brisbane and Perth in coming decades, through changes to urban planning, policy, investment and delivery processes.

The findings and corresponding recommendations are:

Finding 1

Unplanned growth delivers the worst outcomes for Australia's fastest growing cities. The scenario analysis shows that well-planned cities, where the location of jobs, homes and their supporting infrastructure networks are coordinated to maximise accessibility and liveability, will deliver the best outcomes for Australian communities. For both Melbourne and Sydney, the scenario which delivers the greatest proportion of greenfield development, the lowest population densities, and the lowest integration between land use and infrastructure has poorer job and infrastructure access outcomes for future residents. This makes clear that if our largest cities are going to successfully respond to growth, changes to their structure and operation, and the processes used to deliver these, will be needed.

Recommendation

The Australian Government should establish a consistent framework of incentives to drive the delivery of national benefits within our cities at the project, place and reform level, such as National Partnership and Project Agreements, City Deals and Infrastructure Reform Incentives.

Recommendation

Australia's largest cities should establish institutions and processes which enable the delivery of metropolitan-scale governance.

Recommendation

Australian governments should improve the flexibility, transparency and sophistication of current strategic planning tools and practices to improve decision making and deliver better planning outcomes for the long-term growth of our cities.

Recommendation

Australian governments should improve the quality and accessibility of community engagement at the strategic planning stage of a city's development.

Recommendation

Australian governments should focus on outcomes rather than outputs when developing the policy and regulatory frameworks that respond to changing technologies and services.

Recommendation

In the context of climate change, Australian governments should prepare metropolitan resilience strategies which establish clear policy, regulation and guidelines for strengthening the resilience of the planning, coordination and construction of our cities as they grow.

Finding 2

Public transport is crucial to improving accessibility in Australia's largest cities. Under all scenarios, the use and performance of public transport services across the cities improves. Even as our largest cities grow by over two million people, both the public transport mode share, and the proportion of jobs that can be accessed by public transport, increase. This shows that public transport is well-suited to moving large volumes of people, particularly in higher density environments.

Recommendation

Australian governments should increase investment in public transport infrastructure in cities experiencing significant population growth. Investment in mass transit is crucial to reducing congestion, increasing accessibility and reducing the rate of emissions growth.

Recommendation

The Australian Government should encourage state and territory governments to focus and prioritise efforts toward achieving full accessibility compliance across public transport networks in Australia's largest cities within defined timeframes.

Finding 3

Cars continue to play an important role in our cities. However, across all scenarios, congestion significantly increases, and adding new roads is only part of the solution. The scenario analysis indicates that private vehicles continue to be used for the majority of trips within our largest cities, and the total number of trips on our roads increases significantly. Construction of new roads alone cannot accommodate this demand and alleviate congestion at the same time. Land-use planning and transport network investment will need to be complemented by other approaches, including demand management mechanisms such as road user charging, and public transport investment.

Recommendation

Consistent with the *Australian Infrastructure Plan*, Australian governments should work together to progressively introduce a national heavy and light vehicle road user charging regime within 10 years, as part of a broader demand management strategy.

Finding 4

We need to use existing infrastructure in our largest cities more efficiently. The scenario analysis shows that population growth, particularly in established areas, will increase the demand on existing economic and social infrastructure. New infrastructure will be needed to support growth, but governments should also maximise the return on investment from existing assets. 'Sweating' existing assets can be more financially effective and less disruptive to the community than building new infrastructure. This could include ensuring appropriate maintenance, renewal, technology upgrades and demand management strategies are in place.

Recommendation

Australian governments should routinely review the capacity of economic and social infrastructure within our cities and develop strategies to 'sweat' existing assets to extract greater value for communities.

Finding 5

As demand increases, coordinating and prioritising additional or upgraded infrastructure between and within governments will be a challenge. The scenario analysis shows increases in demand for transport, health services, schools and tertiary education facilities, which will require new and upgraded infrastructure. Governments

and the community will face a series of choices about the sequencing, type and location of infrastructure to support growth. Problems arise when new developments and infrastructure are planned and delivered in isolation. A place-based approach which considers interrelated elements and the broader needs of an area can deliver better community outcomes.

Recommendation

Australian governments should adopt a place-based approach when translating metropolitan visions into the sequencing and delivery of development with infrastructure.

Finding 6

Well-planned infrastructure to service employment centres enhances the job accessibility of our cities and can deliver national benefits. The three scenarios present a spectrum of economic geographies ranging from single central business districts to several distributed employment centres. Across the scenarios, the analysis shows that access to jobs is improved when cities are serviced by an established set of employment centres, particularly when connected by public transport, rather than a dispersed employment structure, requiring private vehicle access.

Recommendation

Australian governments should take an active role in supporting employment centres in our largest cities, serviced by public transport.

Finding 7

Land-use and infrastructure planning can help to address inequality of access across our largest cities, but supporting social and economic policies are also required. Spatial inequality, in terms of access to jobs, health services, education and green space, is evident within all scenarios, and particularly stark for those who live on the outskirts of our cities. Across both cities, the scenario which sees housing and jobs distributed more evenly across the city delivers the most equitable level of access in traditionally job-poor areas. However, disparities are still present, indicating that complimentary social and economic policies, alongside land-use and infrastructure changes, are required to effectively address this issue as our cities grow.

Recommendation

Australian governments should focus on improving the access to jobs, health services, education and green space for the outer areas of our largest cities.

Finding 8

As our largest cities grow and densify, green and public spaces play an increasingly important role in maintaining liveability. The scenario analysis shows that regardless of the way in which these cities grow, population growth on the scale projected will see access to private space decrease while demand for green and public space increases. This transition will place a much greater emphasis on each city's public realm. It is critical that these assets are protected and enhanced to ensure that the liveability of Australia's largest cities is maintained.

Recommendation

As our cities grow, Australian governments should focus on maintaining and enhancing green infrastructure and the public realm to ensure they remain liveable.

Finding 9

Land-use changes can play some role in addressing the amount of carbon emissions our cities generate. Australian cities are the principal generators of Australia's carbon emissions and, without significant change, the growth of these cities will only increase this trend further. The scenario analysis shows that different land-use and transport infrastructure choices can improve the environmental performance of our cities' transport networks. Higher density spatial patterns that encourage mode shift away from private vehicles towards active and public transport generate lower carbon emissions, reducing the city's impact on the environment.

Recommendation

Australian governments should work collaboratively to establish a stable national framework to respond to climate change and reduce emissions in line with our international commitments.

The aim of this analysis is to support the work of governments

The purpose of this paper is to test and better understand strategic ideas about the impacts of types of growth. As a result, each scenario is deliberately hypothetical and strategic in focus, and does not specifically reflect the current long-term metropolitan visions for these cities.

Defining and implementing visions for our cities is the responsibility of state and territory governments, supported by the Australian and local governments. Infrastructure Australia acknowledges that the Victorian and New South Wales Governments are finalising and implementing metropolitan plans. This paper does not argue whether these plans are 'right' or 'wrong', rather the scenario analysis contributes to the ongoing government and community discussions about planning our cities.

Specifically, this paper aims to:

- Provide the community with accessible information on the relative trade-offs that are inherent in any decision regarding how cities accommodate population growth. This will help to increase the sophistication of the community's engagement with the processes of change. The three scenarios provide the community with a set of examples against which they can compare their current experiences of their city, increase their understanding of how their city might change in coming decades and better interrogate the long-term strategies for their city.
- Provide advice to decision makers across governments regarding the future development of Australia's fastest growing cities. The analysis of the three 30-year scenarios for Melbourne and Sydney and supporting recommendations provide governments with an insight into how cities of Melbourne and Sydney's future size might grow, and the outcomes delivered by different land-use, employment, and infrastructure decisions.
- Demonstrate the inherent value of more innovative strategic planning tools. It advocates for more sophisticated planning practices to meet the challenges and opportunities of the coming decades.

A guide to reading this paper

This paper is split into six chapters:

1. **Background and Methodology:** Identifies the scale of change set to take place in our largest cities and provides an overview of the paper's underpinning methodology.
2. **Melbourne today and in 2046:** Provides an overview of the history of Melbourne's planning and development, outlines the current state of play in the city and explains how the three hypothetical growth scenarios have been developed and applied to the city.
3. **Melbourne scenario analysis:** Evaluates the performance of Melbourne under the three future scenarios, using the five indicators. Identifies a set of key findings regarding the relative outcomes delivered by the different spatial structures.
4. **Sydney today and 2046:** Provides an overview of the history of Sydney's planning and development, outlines the current state of play in the city and explains how the three hypothetical growth scenarios have been developed and applied to the city.
5. **Sydney scenario analysis:** Evaluates the performance of Sydney under the three future scenarios, using the five indicators. Identifies a set of key findings regarding the relative outcomes delivered by the different spatial structures.
6. **A reform agenda for Australia's fastest growing cities:** Draws on the scenario analysis to present a reform agenda for Australia's fastest growing cities, including recommendations for all levels of government regarding action that is required now to prepare these cities for growth in the future.

Each chapter begins with an 'At a glance' box. These provide the reader with a snapshot of the content and structure of the forthcoming chapter.

Appendices provide further detail on the modelling inputs and outputs used in this paper:

Appendix A – Scenario development assumptions

Appendix B – Assumed transport networks

Appendix C – Transport network modelling

Appendix D – Green space and social infrastructure modelling

The maps presented in this paper can be viewed in more detail at www.infrastructureaustralia.gov.au.


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Background and methodology

At a glance

- Australia is set to experience sustained population growth. Sydney, Melbourne, Brisbane and Perth are expected to be primary locations of this growth. At the same time, the convergence of fundamental shifts across several aspects of city life has the potential to rapidly change the operation of our cities. The scope and outcome of these changes is currently unknown.
- In the context of rapid growth and some uncertainty about the pace and direction of change within Australia's largest cities, current long-term planning practices need to evolve. Scenario planning presents governments with an opportunity to increase the evidence base available to decision makers and enable a more transparent public discussion about the choices inherent within different growth pathways.
- Infrastructure Australia has used scenario planning techniques to evaluate the impact of three growth scenarios for Melbourne and Sydney over the next 30 years. The purpose of the analysis is to provide the community with accessible information about the choices and trade-offs associated with different development paths, to create an evidence base for decision makers, and to demonstrate the inherent value of more innovative strategic planning tools.

1.1 The population growth trajectory of Australia's four largest cities

According to the Australian Bureau of Statistics (ABS), as of 30 June 2016, the Australian population totalled 24.2 million people.[12] **Table 2** shows that Australia is an urban country, with just over two thirds (67.06%) of Australians living in a capital city.

The distribution of the population is further dominated by the four largest cities (Sydney, Melbourne, Brisbane and Perth) which are home to just under 60% of the national population. Of these four cities, Melbourne has grown the most in recent years, adding almost an additional million people between 2006 and 2016, while Perth has grown the fastest, increasing its population by 28% over the same period.[13]

Looking to the future, Australia is set to experience sustained growth in the size of its population. According to the ABS medium level population projections, the national population will grow by an additional 11.8 million people in the 30 years between 2016 and 2046. The role of our cities will increase over this time, as our four largest cities will be primary locations for this growth.[14]

In the next 30 years, the ABS projects that Sydney's population will increase by 2.4 million people, growing to be a city of 7.4 million. Over the same period, Melbourne is projected to grow by 2.7 million people, to be a city of 7.3 million. The growth of Brisbane and Perth, is on a smaller scale, with Brisbane projected to grow by 1.6 million people and Perth by 2.2 million people, delivering cities of just under 4 million and 4.3 million, respectively.[15]

However, long-term population projections are an inherently complicated undertaking. **Table 3** compares the difference between the ABS 2013 medium level population projections for 2016, and the provisional observed ABS 2016 estimated resident population for Australia's four largest cities.

Table 2: Provisional Estimated Resident Population at 30 June 2016[16]

Indicator	NSW	VIC	QLD	WA	SA	TAS	ACT	NT	Australia
Capital city population	5,029,768*	4,725,316	2,360,241	2,022,044	1,324,279	224,462	403,468	145,916	16,235,494
State/ territory balance	2,709,506	1,453,933	2,488,636	536,907	388,775	293,126	NA	99,824	7,970,707
State/ territory total population	7,739,274	6,179,249	4,848,877	2,558,951	1,713,054	517,588	403,468	245,740	24,210,809**
Capital city percentage of state/ territory population	64.99%	76.47%	48.68%	79.02%	77.31%	43.37%	100.00%	59.38%	67.06%
Capital city percentage of national population	20.77%	19.52%	9.75%	8.35%	5.47%	0.93%	1.67%	0.60%	67.06%

* The ABS definition of the Greater Capital City Statistical Area for Sydney includes the Central Coast

** National population estimate includes Other Territories (including Jervis Bay Territory, Christmas Island and Cocos (Keeling) Island), which are counted separately to the states and territories.

Table 3: Difference between ABS 2013 medium level population projections for 2016, and ABS 2016 provisional estimated resident population[17]

	Melbourne	Sydney*	Brisbane	Perth
ABS 2013 medium level population projections (for December 2016)	4,605,993	4,986,714	2,397,068	2,181,194
ABS 2016 provisional estimated resident population (for June 2016)	4,725,316	5,029,768	2,360,241	2,022,044
Difference	+119,323	+43,054	-36,827	-159,150
Percentage difference	Underestimated by 2.59%	Underestimated by 0.86%	Overestimated by 1.54%	Overestimated by 7.30%

* The ABS definition of the Greater Capital City Statistical Area for Sydney includes the Central Coast

This comparison demonstrates the difficulty of accurately determining the future through projections. In the case of Melbourne and Sydney, the 2013 population projections for 2016 under-estimated the level of experienced population growth, with Melbourne and Sydney growing by an additional 119,323 and 43,054 residents, respectively, above the 2013 projections. In contrast Brisbane and Perth, most likely reflecting the tapering off of the investment phase of the mining boom, grew below the 2013 projections by 36,827 and 159,150, respectively. This demonstrates that while, on balance, projections provide a reasonable indication of the future, they need to be developed and used carefully, particularly during times of shifting national and global economic conditions.

Regardless of these potential sensitivities, it is clear that Australia's four largest cities are very likely to grow substantially. Population growth on the scale projected will transform our largest cities. Brisbane will add the equivalent of a third of its population. Even if Perth does not double in size, as projected by the ABS, it will still grow rapidly over coming decades. Melbourne and Sydney will become global cities, comparable to the current size of some of the world's most significant urban economies.

The growth of Sydney, Melbourne, Brisbane and Perth will create exciting opportunities for Australia. A growing population is a powerful source of economic dynamism. Growth increases the size and skill base of our labour force, which is particularly important in the context of an ageing population. It will create a larger domestic market for businesses, creating real opportunities to enhance our national prosperity. A growing population is also an opportunity to enhance the vibrancy of our communities. It will facilitate the injection of new people and new ideas, increasing the diversity of these already multi-cultural centres.

But to effectively capitalise on these opportunities, the structure and operation of our largest cities will need to change. Each city will need to rapidly increase the supply of housing to meet the demands of a larger population. Additional jobs will need to be created to ensure each city's increased population is as productive and prosperous as possible. The capacity and efficiency of infrastructure will also need to be enhanced to ensure that each city's expanded population is provided with the necessary infrastructure service levels required to live happy and productive lives. Finding innovative, efficient and timely solutions to these challenges will be key to ensuring the population growth story within our largest cities is a positive one.

1.2 Australian cities are experiencing a period of fundamental change and uncertainty

The ongoing development of cities is the result of a range of interdependent and complex factors. Alongside population growth, Australia's largest cities are also in the midst of a period of rapid change resulting from the convergence of fundamental shifts across several sectors. These shifts have the potential to rapidly change the operation of our cities in coming decades and have a material impact on the infrastructure required to support them.

Many of these shifts are contingent on ongoing technological development, market uptake, and significant policy and regulatory reform. As a result, there is a high degree of uncertainty about the outcomes of these trends, which in turn makes it difficult to predict and plan for their impact on Australian cities.

Key areas of change include:

- **The ageing population:** Over the next 40 years the proportion of the Australian population aged 65 and over will significantly increase, while the proportion of working-age people will decrease. This means Australia's governments will face increasing fiscal gaps, which will impact on funding availability for the necessary

infrastructure upgrades and additions required to support Australia's growing population.

- **Rapid technological transformation:** Technological change across a range of sectors within the Australian economy is fundamentally disrupting how goods and services are provided, regulated, consumed and paid for. In the infrastructure sector, the advent of new technologies such as electric and autonomous vehicles, battery storage, intelligent transport systems and disruptive smart phone apps and services are shifting demand for infrastructure and changing patterns of supply. This will have implications for the planning, design and operation of Australian cities both now and in the future.
- **The increasing urban freight task:** According to the 2015 *Australian Infrastructure Audit*, Australia's containerised freight task is projected to experience substantial growth, increasing by 165% by 2031.[18] Cities will be a primary location for this growth. As the populations of our cities also grow, so too will the demand for goods. This will have implications for our urban freight networks, in particular first and last mile transport and handling, which will impact on the future structure of our cities.
- **The impacts of climate change:** The changing global climate is driving shifts in short-term weather patterns, including increased extreme weather events, and long-term climate trends. At the same time, Australia's cities are home to the bulk of the Australian population, and are generally located in coastal areas. They are therefore a key source of emissions, and are at risk from climate change impacts. Policy and regulatory responses from governments to climate change will therefore have significant implications for the operation of Australian cities, particularly the larger ones.
- **The shifting structure of national and global economies:** The national economy is in a state of transition. As the mining investment boom winds down, the focus of the economy is shifting to service and knowledge-intensive activities. At the same time, the growth of the Asia Pacific region is driving increased demand for our goods and services. Cities are the ideal location for these sectors, enabling collaboration and easy access to skilled labour.[19] This has implications for the spatial structure of our cities, and the infrastructure which supports them.
- **Changes to the nature and location of work:** Technological innovation, including ongoing developments in communications, robotic technology and artificial intelligence, are enabling changes to the way we work. While these developments could deliver substantial productivity and efficiency improvements to a number of sectors, they will have fundamental implications for the nation's key employment centres, primarily located in our cities, with flow-on impacts on infrastructure networks and social equity across our cities.

1.3 Current long-term planning practices need to evolve to deal with the scale of prospective growth and change

In the context of rapid growth and uncertain change, there is a clear case for evolving our planning and governance practices to improve the evidence base available to decision makers and better inform and involve the community. Meeting the demands of a growing population within our largest cities over coming decades will require communities to make a series of choices regarding the type of city they want to live in.

Current long-term planning processes for Australia's largest cities for Australia's largest cities have followed a broadly similar pattern of development. Long-term population and employment projections are used to generate a high-level picture of what it will be like to live and work and move around in the city in coming decades. These visions are supported by corresponding delivery milestones and policy interventions, such as location-specific targets for the delivery of new housing or the creation of new jobs, the identification of new or upgraded infrastructure, or the development of policy reforms required to support implementation of the future vision. Visions are also communicated to supporting departments, and other levels of government, who play a contributing role in implementing the vision at the local level.

These processes and practices have delivered many positive results for Australian cities. Many of our cities are world-renowned as attractive places to live and work, and are routinely listed on global indices for liveability and quality of life. However, in the context of the expected pace of growth and change over the coming decades, there is a clear case for evolving these practices.

The complexity of city systems means that the articulation and implementation of a single long-term vision for a city is a difficult process. It runs the risk of setting in place a process of path dependency which may materially constrain decision makers' ability to be flexible and adapt policy as circumstances change over time. This often means plans have short life-spans, with new plans replacing old ones, beginning the visioning process again. The academic Raymond Bunker has identified this risk in his analysis of Australian metropolitan planning:

> *"The metropolitan strategy is constructed as a finely articulated and detailed picture of what the city will be a generation hence. There are intricate connections between its component parts as population and workforce distributions are calculated in different kinds of realms and places… The problem with this approach*

is that the failure of any major component causes dislocations and adjustments elsewhere… Eventually the reality becomes so divorced from the intent of the strategy that another plan is drawn up."[20]

The content and evidence of long-term planning practices therefore needs to evolve to ensure that these long-term visions are supported by the necessary level of flexibility, which enables decision makers to adapt planning, policy and investment in response to change, within a broad long-term vision.

At the same time, there is a clear need for long-term planning to better inform the community about what the future means for their day to day lives. Meeting the demands of a growing population within our largest cities will require communities to make a series of choices regarding the type of city they want to live in. Traditional long-term planning practices provide limited opportunities for public discussion about what population growth practically means for the current and future residents of Sydney, Melbourne, Brisbane and Perth. The community does not have easy access to the necessary tools and analysis to understand the scale of prospective growth, the potential pathways to cater for this growth, and, most importantly, the relative trade-offs associated with different decisions about how each city could grow.

As a result, there are understandable reservations in parts of the community regarding the potentially adverse impacts of population growth and corresponding land-use outcomes, such as increased housing density and longer commute times. The outcome is that the community is currently not well-prepared for the magnitude of change set to occur. This increases the risk that important but challenging decisions are delayed or altered due to community concern, and our cities fail to respond appropriately to the opportunities of a growing population and economy.

1.4 Scenario planning provides the community and decision makers with a fuller picture of what change could mean, the choices available and the trade-offs involved

Scenario planning is a strategic tool that presents the public and decision makers with a range of different options for what the long-term development of a city could look like. Each scenario is a potential portrait of the future, which details how the city could perform under a unique set of conditions. The use of scenarios is based on a recognition that the future is difficult to predict with certainty, and that several outcomes are possible and should be considered.

The process has two clear benefits for cities facing significant and uncertain change:

1. It allows decision makers, as part of the process of articulating and implementing a long-term vision for a city, to consider a range of possibilities and build necessary flexibility into policy and investment decisions.
2. It enables a more transparent public discussion of the choices and trade-offs inherent within different approaches to growth. This can help governments to have a more holistic public discussion about what growth means and provides a more transparent process for defining preferred future directions.[21]

Cities such as London, Hong Kong, Chicago, Madrid and Singapore, which are facing challenges similar to those in Australian cities, have begun to use scenario planning to increase the robustness of their long-term city plans. While Australian governments are increasingly using scenario tools, it has yet to become an established practice when planning for our cities, and there has been only a limited sample of this work made publicly available.

1.5 Scenario planning can help Australia's fastest growing cities better understand the challenges and opportunities they face

Infrastructure Australia has advocated the case for scenario planning in the past. In this paper, scenario planning techniques have been used to evaluate the impact of three spatial scenarios each on Melbourne and Sydney over the next 30 years. The timeframe and scenarios have been developed separately to the NSW and Victorian governments and do not represent their respective policies or urban plans.

By focusing on Melbourne and Sydney, the paper does not disregard the significant level of growth set to occur in Australia's other large cities, namely Brisbane and Perth. Instead Melbourne and Sydney are presented as case studies of the choices and trade-offs that will be faced across Australia's four largest cities as they each grow and change in coming decades.

The analysis paints a picture of what it would be like to live and work under the three different futures, and the relative trade-offs inherent between the scenarios. The paper also delivers a series of key findings and corresponding recommendations regarding how Australia's fastest growing cities will need to be planned and structured to effectively meet the demands and opportunities associated with population growth.

Importantly, the paper does not identify one scenario over the others as the optimal future for Melbourne and Sydney. Defining and implementing a vision for our cities is the responsibility of state and territory governments, supported by the Australian and local governments. Infrastructure Australia seeks to enhance and support, rather than duplicate, that important work of governments. The paper aims to:

- Provide the community with accessible information on the relative trade-offs that are inherent in any decision regarding how cities accommodate population growth. This will help to increase the sophistication of the community's engagement with the processes of change. The three scenarios provide the community with a set of examples against which they can compare their current experiences of their city, increase their understanding of how their city might change in coming decades and better interrogate the long-term strategies for their city.
- Provide advice to decision makers across governments, regarding the future development of Australia's fastest growing cities. The analysis of the three 30-year scenarios for Melbourne and Sydney and supporting recommendations provide governments with an insight into how cities of Melbourne and Sydney's future size might grow, and the outcomes delivered by different land-use, employment, and infrastructure decisions.
- Demonstrate the inherent value of more innovative strategic planning tools and advocates for an evolution in the sophistication of planning practices to meet the challenges and opportunities of the coming decades.

1.6 Methodology overview

The paper's analysis of the three long-term scenarios for Melbourne and Sydney, and the identification of supporting recommendations for Australia's fastest growing cities, is under-pinned by a four-part methodology:

1. Scenario development
2. Scenario application
3. Scenario performance
4. Identifying an urban reform agenda for Australia's fastest growing cities.

Scenario development

Infrastructure Australia has developed six hypothetical growth scenarios, three each for Melbourne and Sydney. The scenarios seek to test commonly posed questions about how Australian cities could grow and change, including:

- Should our cities expand outwards, at a low density, or consolidate inwards at a higher density?
- Should we seek to locate jobs in centres or distribute them more evenly across the metropolitan area?
- What mix of modes and network structure is best suited to meet the needs of a larger city?

They assume consistent metropolitan boundaries and common population and employment growth totals for each city. They then focus on three variables, which differ across the scenarios:

- Where each city's additional population lives and the density and style of development they live in
- Where each city's additional jobs are located
- The future structure of the transport network.

For practical purposes, and to ensure the scenarios for each city compare 'like with like', the total population and employment numbers used are based on the respective state government projections, and remain constant across the three scenarios for each city.

The scenarios are tailored to match the unique characteristics of Melbourne and Sydney. **Table 4** outlines the key characteristics of the three scenarios.

Table 4: Overview of Infrastructure Australia growth scenarios for Melbourne and Sydney

2046 Scenarios	Key themes	Distribution of population and housing	Distribution of employment	Structure of the transport network
Expanded Low Density scenario (2046)	Tests a future in which the largest proportion of development (compared to other scenarios) is placed in outer greenfield areas, with the aim of minimising the impacts of growth on existing areas.	**Melbourne** 60% infill 40% greenfield **Sydney** 70% infill 30% greenfield Greenfield areas are grown to their fullest extent, at a density comparable to current new suburban development.	The distribution of employment follows the existing patterns of the city's economic geography.	Additions to the network are structured with a focus on connecting the city's expanded geographic footprint. As a result, the network is relatively road focused, but there is also investment in public transport.
Centralised High Density scenario (2046)	Tests a higher density, inner-city growth future which locates people closer to existing transport infrastructure and major employment centres.	**Melbourne** 80% infill 20% greenfield **Sydney** 90% infill 10% greenfield New housing is focused in inner and middle ring areas at high-medium densities, close to high capacity transport nodes.	Employment is intensified around existing major employment centres, particularly the inner-city CBD and surrounding areas.	By concentrating development at key transport nodes the scenario aims to capitalise on areas already well-serviced by infrastructure. Additional investments are required, however, to expand the capacity of the existing network.
Rebalanced Medium Density scenario (2046)	Tests the outcomes of rebalancing a city's spatial structure by spreading the impact of new jobs and houses more evenly across the metropolitan area, around key centres.	**Melbourne** 70% infill 30% greenfield **Sydney** 80% infill 20% greenfield New housing is distributed more evenly across the metropolitan area, at a medium density, along public transport corridors.	The economic geography of the city is altered, with a proportion of job growth being moved to new employment centres. The aim of this scenario is dispersing new jobs closer to where the population lives.	The city's transport network is enhanced to connect the city's expanded economic and demographic geography.

Appendix A outlines Infrastructure Australia's assumptions underpinning the scenario development in further detail. It is important to note none of the scenarios represent Victorian or NSW government policy.

What the scenarios do not address

Like all future visioning exercises, scenario planning is necessarily a simplified version of the future. However, cities develop and change in response to a broad range of complex and interdependent factors, some of which are beyond the scope of this paper. The scenarios in this paper **do not** specifically address:

- **Changing demographics:** For example, the ageing population, policy interventions to incentivise decentralisation of population growth away from our larger cities, or other changes to regional, interstate or international migration patterns.
- **Rapid technological transformation:** For example, significant uptake of battery storage, electric and autonomous vehicles, further development and implementation of intelligent transport systems, or changes to key sectors such as health and education from technological disruption.
- **The increasing urban freight task:** For example, investment and reform to enhance and upgrade urban freight networks in line with a growing population.
- **The impacts of climate change:** For example, increased extreme weather events, long-term climate changes, and policy interventions impacting on the energy sector.
- **Changes to the structure of national and global economies:** For example, collapses or booms, and shifts within sectors.
- **Changes to the nature and location of work:** For example, changes as a result of automation and more people working from home due to communications technology innovation.
- **The impact of population growth on other infrastructure sectors:** For example, investment and reform to enhance and upgrade energy, telecommunications and water infrastructure.

The exclusion of these variables is not a reflection of their importance to the future development of Australia's largest cities. Similarly, the fact that they have not been included does not mean they are inconsistent with the scenarios tested. A combination of these factors and others will very likely have a material long-term impact on the development of Australian cities. Instead, their exclusion is a reflection of the inherent uncertainty that surrounds them and the bounds of what can be feasibly modelled and considered within one report.

Energy, telecommunications and water infrastructure

All four economic infrastructure sectors – energy, telecommunications, water and transport – are critical to the productivity of cities, and to the way of life for urban residents. Of these sectors, transport has the strongest influence on the planning decisions made by governments, and on the decisions made by individuals about where they live, work and socialise. While not a focus of the modelling and analysis presented in this paper, energy, telecommunications and water infrastructure will also play an important role in shaping the future of our cities.

These sectors are undergoing a range of transformational changes that will influence how services are delivered to growing urban communities. Similarly, changes in urban housing patterns, such as increasing densification, are likely to change patterns of demand for these services, and may place legacy assets under increasing strain. Meeting the changing needs of our growing cities across all forms of infrastructure requires governments to anticipate these changes, and plan to ensure supply can efficiently and sustainably meet demand into the future.

In the energy sector, the current national challenge is to provide affordable and reliable electricity to a growing population while transitioning to a more sustainable generation mix. Beyond the technical challenges of providing energy in growing cities, governments also face a range of social considerations. For example, people living in apartments or renting their homes may not have the physical or financial capacity to invest in household solar and storage systems. Changes to policies, laws and standards are likely to be required to provide residents with greater access to commonly owned rooftops, cooperative arrangements for investing in localised generation, and peer-to-peer electricity trading within communities.

Our telecommunications infrastructure will be influenced by further advances in technologies which are already changing the way we travel, work and communicate. As our cities grow, it will become increasingly important for our telecommunications infrastructure to provide reliable, accessible and affordable services to connect us to each other and to increasingly complex and digital city systems. As with energy assets, existing telecommunications infrastructure may be placed under pressure from increased demand, particularly in denser inner-cities, and will require planning and coordination to enhance and upgrade networks to meet demand.

For urban water systems, growing populations and changing urban environments bring new challenges. While the proportional growth in apartments has reduced water consumption per dwelling, this shift has also concentrated demand in smaller areas. Continued growth in urban populations will put increasing strain on sources of supply near our major cities and on legacy distribution networks within them. The majority of cost-effective sites for dams and wastewater treatment near cities have been used, and changes in rainfall patterns may reduce the available supply. In growth areas on the fringes of our cities, the challenge will be to use planning, green spaces and natural local features efficiently and sustainably. For infill areas, smart urban design is required to ensure developments make the most of smaller spaces and integrate water management within building layouts.

Scenario application

The scenarios have been tailored to match the unique geographic, historical and social characteristics of Melbourne and Sydney. **Chapter 2** and **Chapter 4** of the paper outline in more detail how the scenarios have been applied, including the distribution of population and employment, and changes to transport infrastructure for each city.

Infrastructure Australia commissioned SGS Economics and Planning to develop unique population and employment projections to underpin each city-specific scenario. To do this, they used the New South Wales and Victorian Governments' baseline population and employment projections and, for each scenario, moved projected growth (between now and 2046) to different parts of the city according to the strategic themes of the scenario.

It is important to emphasise the existing location of population and employment remains largely the same (with the exception of some small redistributions) under all scenarios. The difference is largely in the location of projected growth. This is designed to reflect the role that the existing structure of our cities' housing and employment patterns will have on the future structure of both cities.

Table 5 and **Table 6** present the state government baseline projections that were applied in the scenario application process for the two cities.

Table 5: Sydney – New South Wales Government population projections[22]

	2016	2046	Change 2016–46	Percentage change
Population	4,680,000	7,340,000	2,650,000	57%
Employment	2,440,000	3,730,000	1,290,000	53%

Note: Population and employment rounded to the nearest 10,000. Change and percentage change is calculated using more detailed underlying data and then rounded.

Table 6: Melbourne – Victorian Government population projections[23]

	2015	2046	Change 2015–46	Percentage change
Population	4,460,000	7,260,000	2,800,000	63%
Employment	2,290,000	3,880,000	1,590,000	69%

Note: Population and employment rounded to the nearest 10,000. Change and percentage change is calculated using more detailed underlying data and then rounded.

The process of redistribution applied by SGS Economics and Planning reflected the strategic direction set by Infrastructure Australia, through the identification of a series of 'change areas' for each scenario. A 'change area' is a select geography within either Sydney or Melbourne, which translates the high-level strategic vision for that scenario to the geographic level. For example, for the Centralised High Density scenario, a series of 'change areas' were identified around high frequency public transport interchanges in Melbourne and Sydney's inner and middle suburbs, and under that scenario an increased proportion of the growth in the population was distributed to these areas.

The population and employment projections informed transport network assumptions. For both cities, the existing networks, committed projects (defined as projects under construction or with money for construction in the latest budget) and projects on Infrastructure Australia's Infrastructure Priority List are included in each 2046 scenario. The assumed transport networks are intended to support the land-use patterns under each scenario. For example, in Sydney's Rebalanced Medium Density scenario there is more investment in public transport projects than the other two scenarios, in order to connect economic clusters (change areas) across the city. Lists of the major additions to the road and public transport networks for each scenario for Melbourne and Sydney are available at **Appendix B.**

This paper does not address the cost of delivering the assumed transport networks for each scenario in Melbourne and Sydney, or the differences between scenarios. Infrastructure Australia recognises the potentially significant costs associated with delivering upgrades and new transport networks in cities, particularly as urban populations grow, and that different combinations of networks will have different funding implications for governments. These implications will need to be considered and appropriately assessed by state governments as part of their own planning and investment strategies.

Scenario performance

Infrastructure Australia has compared the performance of the three hypothetical scenarios within each city by modelling their respective impact on the performance of each city's infrastructure, using a suite of five indicators. **Table 7** provides a summary of the five indicators used.

Table 7: Summary of indicators used to compare the relative performance of scenarios

Indicator	Description
Performance of the transport network	Uses a range of data points to identify how different configurations of the public transport and road networks perform, including mode share, congestion and travel times, under each scenario.
Access to jobs	Identifies how access to jobs changes in different parts of the city under each scenario.
Environmental performance of the road network	Calculates the relative CO_2 emissions and fuel use of the road network under each scenario.
Access to and demand for social infrastructure	Identifies how the demand for and access to existing key social infrastructure assets such as hospitals, schools, and tertiary education facilities, change under each scenario.
Access to and demand for green space	Identifies how the demand for and access to existing green space, such as parks and gardens, change under each scenario.

Infrastructure Australia engaged Arup to use different models to evaluate the relative performance of the scenarios across the five indicators. The purpose of the modelling is focused on the implications of different land-use and transport network decisions. The two modelling exercises included:

1. **Transport network modelling:** Arup used the population and employment distributions for each scenario to model the impact of each on the demand for and performance of the hypothetical Melbourne and Sydney transport networks, and the environmental impact of the road networks. To complete this work, Arup used the Victorian Government's Victorian Integrated Transport Model (VITM) and the New South Wales Government's Sydney Strategic Travel Model (STM). Further details on this modelling can be found at **Appendix C.**
2. **Green space and social infrastructure modelling:** Arup used their Transport Travel Time Analysis (T3a) tool and the results of the transport modelling above to identify the impact on relative demand for and access to existing green space and social infrastructure under the different scenarios. This analysis is underpinned by Australian, New South Wales and Victorian Governments' data identifying the distribution of existing public green space and key social infrastructure assets. Further details on this modelling can be found at **Appendix D.**

The analysis of the results produced from these modelling exercises for Melbourne and Sydney can be found in **Chapter 3** and **Chapter 5** (respectively).

It is important to note that the modelling results for Melbourne and Sydney scenarios reflect different data sets and models. Given they apply to different cities, the VITM and STM have different inputs and assumptions, and use different mechanisms to calculate the performance of their unique transport networks. Similarly, the baseline population and employment projections for each city, and the green space and social infrastructure data sets used reflect different assumptions and methodologies. As a result, it is important that the outcomes of the scenario performance analysis between the two cities are not compared. Instead, the analysis aims to draw out comparisons and trade-offs between the three scenarios within each city.

Findings from the scenario analysis and *Australian Infrastructure Plan* have informed an urban reform agenda for Australia's largest cities

The scenario analysis provides an evidence base for the impact that population growth will have on the function and liveability of our cities. Nine key findings have emerged from the scenario analysis of Melbourne and Sydney. These provide valuable insights for all Australian cities experiencing rapid population growth and change, regardless of the future growth scenario that is followed.

The recommendations which follow draw upon this evidence base, and the *Australian Infrastructure Plan,* to propose a wider urban reform agenda which provides all levels of government with advice on how they can update their planning, policy, investment and delivery processes to successfully meet the demands of population growth in Sydney, Melbourne, Brisbane and Perth in coming decades.

The urban reform agenda is divided into four key reform programs:

1. **Deliverability:** Australia's governments will play a central role in delivering the planning, policy, regulation and funding to respond to the growth and change in Australia's fastest growing cities. This section identifies several recommendations for governments on how to update the tools they use to deliver change in order to ensure the best outcomes are delivered.
2. **Economic performance:** The relationship between where people live, where jobs are located, and the performance of the transport network in connecting the two, have a material impact on the economic prosperity of our largest cities. This section outlines several reforms focused on ensuring these relationships operate as efficiently as possible in the context of a much larger population and associated pressure on infrastructure networks.
3. **Equity of access:** While the economic success of our cities is crucial, it can also increase the cost of living and contribute to equity divides between those who can afford to access the opportunities, services and amenity of the city and those who cannot. This presents a challenge, to balance success with providing housing and, access to jobs and opportunities, for the diversity of people required to make our cities function. Without intervention from government, the structural inequities present in our cities today will be reinforced as they grow. This section identifies a set of reforms focused on ensuring our largest cities remain accessible to all as they grow.
3. 4. **Liveability and resilience:** As our largest cities grow in size, many of the features which define the high quality of life enjoyed by residents, will be placed under pressure. This section identifies the key actions required from governments to maintain and upgrade the infrastructure and services that support the liveability and resilience of our cities.

The full set of recommendations and their supporting rationale can be found in **Chapter 6.**

Melbourne today and in 2046

At a glance

- Melbourne is Australia's second largest city. It is well-known for its liveability, vibrancy and cultural attractions. However, rapid growth of the city in recent years has placed pressure on its infrastructure and key services, challenging the quality of life for which the city has become world-renowned.
- Melbourne is projected to grow by about 2.8 million people over the next 30 years. The rate of growth, combined with the challenges the city is already facing, means it is important to think about how and where this growth could occur. To test this, Infrastructure Australia has adapted and applied three 30-year growth scenarios to Melbourne's specific social, economic and geographic features.

2.1 Melbourne today

Today, Melbourne is Australia's second largest city, home to around 4.4 million people. It is a fast growing capital city, having increased its population by around a quarter, or one million people, since 2006.[24] It covers around 9,990km^2.

The city is located on land originally inhabited by the Kulin people, a collection of five Indigenous tribes, who lived on the land for approximately 40,000 years prior to European settlement. European exploration began in the late 1700s and the city was settled in 1825. From its early days, Melbourne was a planned city. In 1827, Governor Bourke appointed Robert Hoddle to develop a plan for the growing city. The plan became known as the 'Hoddle Grid', which today is the city's central business district.

The spatial structure of the city is focused around its city-centre, which sits on the banks of the Yarra River, north of Port Phillip Bay. The surrounding greater metropolitan region extends a significant distance from the city to Wallan in the north, Healesville and Bunyip in the east, southward to the Mornington Peninsula and westward to Bacchus Marsh and Werribee.

The city is world-renowned for its liveability, vibrancy and cultural attractions. But the rapid growth of Melbourne has placed pressure on the city's key assets and poses a number of challenges, which, left unaddressed, could impact on liveability, productivity and social equity.

Housing: a city of detached homes

By international standards, Melbourne is a low-density city, with a large geographic footprint. An urban growth boundary was introduced in 2002, and this along with urban consolidation, has slowed the geographic expansion of the city, with significant densification in Melbourne's centre. Nevertheless, detached low-density housing remains the city's dominant built form, with close to 70% of the population living in detached homes and around 15% living in apartments.[25]

Almost two million people live more than 15 kilometres from Melbourne's city-centre.[26] Residential densities are lowest in outer areas, particularly in the west, and gradually increase towards the city-centre. Greenfield development on the fringe of the city is dominated by large, detached homes.

Middle ring suburbs, located 10 to 15 kilometres from the centre, are predominantly occupied by detached houses on quarter acre blocks. Older, inner suburbs have generally retained higher density development, with homes such as terraces, semi-detached houses and apartments.

An increasingly unaffordable housing market is reinforcing the dispersal of the city's housing. Between June 2012 and June 2017, the median detached house price for the city increased by 33% (adjusted for inflation), with a compound annual growth rate of 6%.[27] This is compared to substantially lower national wages growth of 12% over the same period, with a compound annual growth rate of 2%.[28] The result is that there are a growing number of people living in the city who are unable to enter the housing market. Price rises have been particularly strong in areas, generally located in the inner and middle, which have good quality access to transport, high value jobs and lifestyle amenity.

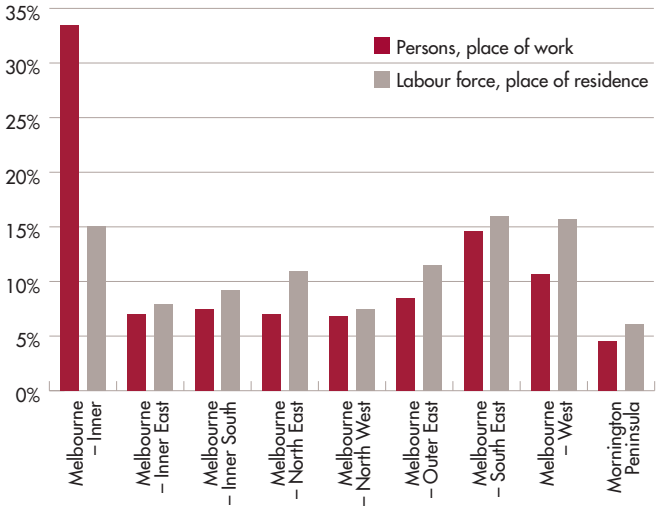
Employment: a centralised jobs market driven by agglomeration

Melbourne is Australia's second largest urban economy, accounting for about 18% of Australia's GDP.[29] The city's economy has been shifting away from its traditional focus on manufacturing since the 1990s, towards knowledge-intensive service sectors. Since 2000, over two thirds of Melbourne's job growth has occurred in five sectors: health and social assistance, professional, scientific and technical services, education and training, construction, and retail trade.[30]

The shift from dispersed manufacturing jobs, to service sector jobs has reversed a long-term decline in inner-city job numbers. From 1961 to 2001, the percentage of metropolitan jobs in inner-Melbourne almost halved. However, from 2006 to 2008, Melbourne City Local Government Area (LGA) added over 50,000 jobs, a growth rate of 7% per annum.[31]

The extent to which inner-Melbourne dominates employment is shown in **Figure 1,** which compares the proportion of jobs and the place of residence of Melbourne's labour force, by Statistical Area Level 4 (SA4).[32] About 33% of jobs are in inner-Melbourne, which is more than twice the percentage of Melbourne's labour force that resides in that area.

Figure 1: Melbourne – Share of metropolitan employment, and labour force place of residence, by SA4[33]



The centralisation and concentration of the city's economic geography has resulted in an increasing mismatch between where people live and work. The city's radial rail and tram networks play an important role in bridging this gap. In 2011, about 65% of public transport commuter trips in Melbourne involved travel to a workplace in the CBD.[34]

However, access to the public transport network is limited in outer suburbs and often uncompetitive in terms of trip duration, compared to private vehicle travel. This means residents of these areas have less access to economic opportunities. This is particularly the case for access to well-paid, knowledge-intensive jobs that have agglomerated in the city-centre.

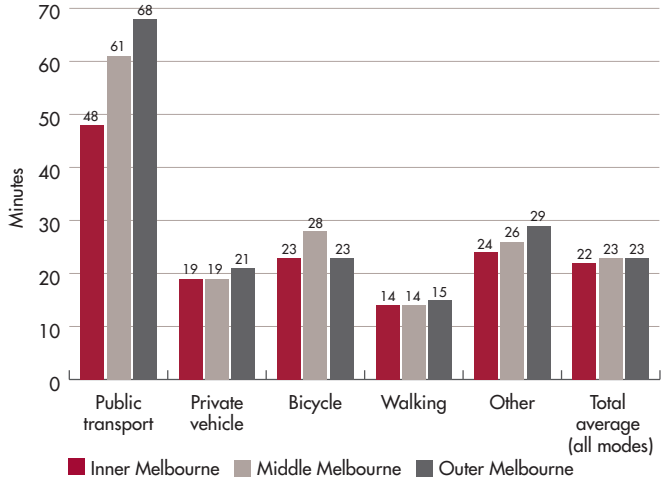
Transport: uncompetitive public transport and unequal access

Melbourne is served by an extensive radial rail network and the world's largest tram system. The city also has a high-quality grid of roads and a bus network, which feeds into railway stations as well as serving trips to major centres and the central business district.

The vast majority of trips in Melbourne are taken by private vehicle, with 72% of all weekday trips within the city taken by private vehicle.[35] This places substantial pressure on the city's road network. *The Australian Infrastructure Audit* found that congestion was costing the Melbourne-Geelong region $2.8 billion annually in 2011, and that without action, this would increase to $9 billion by 2031.[36]

The dominance of private vehicles is enhanced by uncompetitive travel times, compared to private vehicles, provided by public transport. **Figure 2** shows average trip times in inner, middle and outer-Melbourne, by mode. It shows significantly higher trip times for public transport than any other mode. This is partially because public transport journeys are skewed to commuting, which are generally longer than leisure trips. Journeys by private vehicle also tend be for a broader range of purposes, such as short trips to the local shops, which would reduce average times. Nevertheless, in order to increase its mode share, public transport will increasingly need to compete with private vehicles. To do this, travel times will need to improve.

Figure 2: Melbourne – Average trip times, by mode and region[37]



Not only are public transport travel times uncompetitive, but access to public transport across Melbourne is unequal. **Figure 3** shows the percentage of the population within walking distance of a medium-high frequency public transport service. The highest proportion (80%-100%) closely reflects Melbourne's tram network. Accessibility gradually declines with distance from the city-centre and there are significant outer-urban areas where less than 20% of the population have access to frequent public transport. This indicates that a level of spatial inequality is evident across the city. The historical development of the transport network means access to the network is good in inner and middle areas of the city, but limited in outer suburbs. This means the benefits of the network, which like all public transport in Australia is heavily subsidised, largely flows to those who can afford to live in inner and middle areas.

2.2 The Victorian Government's long-term vision for Melbourne's growth

Plan Melbourne 2017-2050 is the city's long-term metropolitan planning strategy, setting out the Victorian State Government's vision for Melbourne to 2050.[38] Its infrastructure components are closely linked to Infrastructure Victoria's *Draft 30 Year Infrastructure Strategy*, which provides recommendations for improving the provision, operation, maintenance and use of the state's infrastructure.[39]

Plan Melbourne 2017-2050 envisions that Melbourne's existing land-use structure will be strengthened. Melbourne's west is set to accommodate the majority of the city's population growth, following recent trends. This will be complemented by urban renewal in the inner areas of the city, increasing the delivery of housing around existing jobs, amenities and infrastructure.

Across Melbourne, the Victorian Government aims to create 20-minute neighbourhoods, supported by social infrastructure and urban design investment, which will enable people to access services and amenity within residential neighbourhoods, addressing inequality and reducing the need for some travel across the city.

Melbourne's economy will continue to be driven by the central business district and inner-city. *Plan Melbourne 2017-2050* aims to grow the city to be Australia's largest commercial and residential centre by 2050. Key suburban employment centres will also be supported to grow, including the National Employment and Innovation Clusters at Sunshine, Monash and La Trobe, and new locations at Dandenong, Parkville and Werribee. This approach delivers on the aim identified in *Plan Melbourne 2017-2050* to move jobs closer to where people live.

The transport network will be significantly upgraded and extended to support growth to 2050. New transport infrastructure will focus on supporting balanced city

growth, both in the inner-city and employment centres, and connecting outer suburbs, particularly in the west, to services, jobs and amenities. This includes providing high-quality public transport access to employment centres, improving arterial road connections and enhancing local transport connections to support 20-minute neighbourhoods.

Plan Melbourne 2017-2050 also aims to increase the supply of social and affordable housing across the city, including by using public land more efficiently, and transition the city towards a low-carbon future through increased renewable energy use and improved environmental performance.

2.3 Applying the three growth scenarios to Melbourne

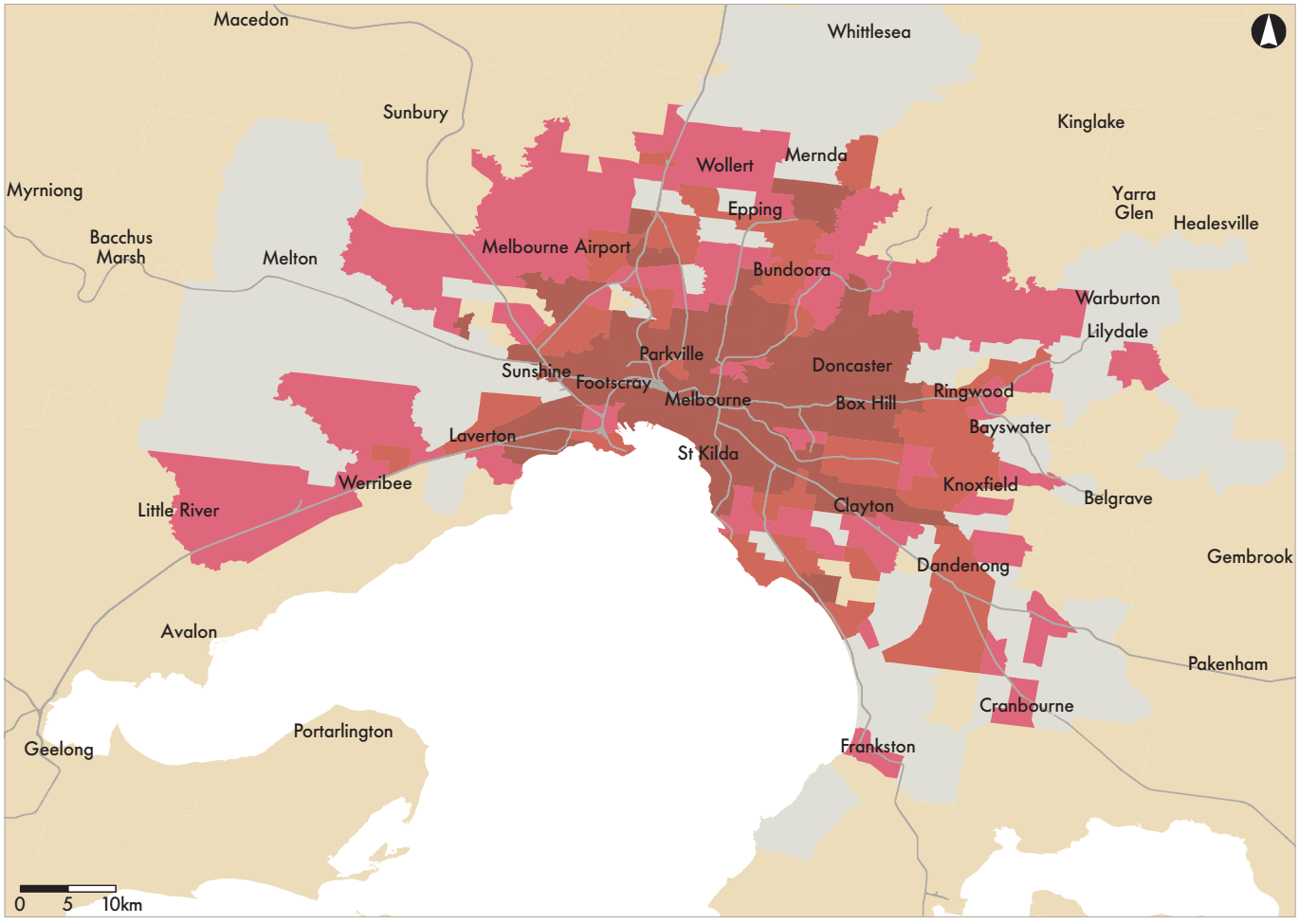
Infrastructure Australia has developed three distinct scenarios which project how Melbourne could grow over the next 30 years.

The following five assumptions have been applied across all three scenarios, based on Victorian Government data:[40]

- The metropolitan boundary of Greater Melbourne reflects the Victorian Department of Environment, Land, Water and Planning's (DELWP) definition which covers 31 LGAs, and a portion of Mitchell LGA
- The reference case year is 2015
- Melbourne's population will total 7.3 million in 2046, an increase of 2.8 million people from 2015
- Jobs in Melbourne will total 3.9 million in 2046, an increase of 1.6 million jobs from 2015
- The location of Melbourne's existing population and employment remains largely the same between 2015 and 2046, the scenarios focus on the redistribution of growth.

Each scenario differs based on a unique set of assumptions developed by Infrastructure Australia, applied to the following areas:

Figure 3: Melbourne – Walking access to medium-high frequency public transport, by SA2[41]



Note: Medium-high frequency is defined as four or more services per hour. Walking access is defined as an 800-metre walk for railway stations and 400-metre walk for bus and tram stops.

- The location of the additional 2.8 million people living in Melbourne, and the density and type of housing they live in
- The location of the additional 1.6 million jobs
- The structure of the transport network required to support each scenario's different land-use patterns.

2.4 The Expanded Low Density scenario

This scenario aims to minimise the impact of population growth on the existing population of Melbourne. It reflects a potential future which is shaped by the existing community's concerns about growth and densification changing the character and performance of existing areas The scenario focuses growth on low-density development, such as detached homes with private backyards, and private vehicles as the primary mode of transport. This is achieved by maximising the location of population growth (and associated 'population-serving' jobs) in outer, greenfield areas. The existing economic structure of the city is reinforced, with new jobs being located in and around the inner-city.

Figure 4 provides a metropolitan schematic of Melbourne's structure under this scenario.

Distribution of population growth

This scenario sees 40% of the city's population growth between 2015 and 2046, equalling approximately 1.1 million additional people, located in greenfield growth areas located on the outskirts of Melbourne, focused in the western, northern and southern subregions. This location of greenfield housing is consistent with Victorian Government projections[42], however the proportion of growth to be located in greenfield areas is higher in this scenario than projected by the Victorian Government. The style of housing in greenfield growth areas is principally low-density, detached housing, with some higher density development around key centres.

The remaining 60% of population growth, equalling approximately 1.7 million additional people, is dispersed throughout Melbourne's established areas. This growth is delivered through medium and high-density development, focused on existing centres and transport hubs. Higher density renewal is principally in and around the central city and committed major urban renewal sites, such as Fisherman's Bend.

Figure 4: Melbourne – Expanded Low Density scenario

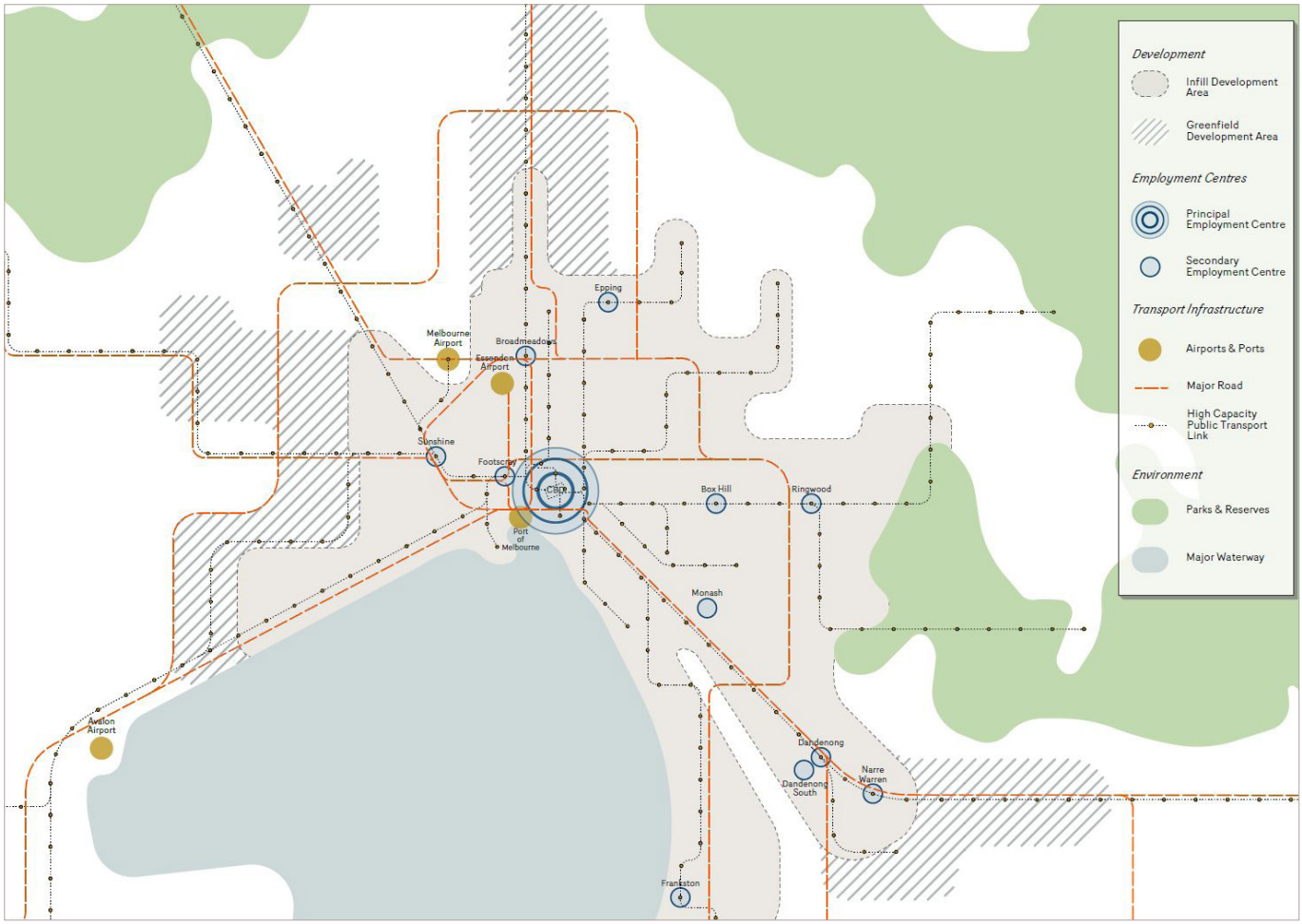


Table 8 provides an overview of how Melbourne's additional population growth is distributed under this scenario. It shows the total population for each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 8: Melbourne – Expanded Low Density scenario – population by planning subregion

Planning subregion*	Reference Case (2015)	Expanded Low Density scenario (2046)	Percentage change
Central	520,000	930,000	80%
Eastern	1,070,000	1,390,000	31%
Northern	900,000	1,590,000	76%
Southern	1,230,000	1,870,000	53%
Western	750,000	1,470,000	96%
Total population	**4,460,000**	**7,260,000**	**63%**

* as defined by the Victorian Department of Environment, Land, Water and Planning
Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Distribution of new jobs

The current structure of Melbourne's economic geography will be maintained under this scenario. As the city's post-industrial economy continues to develop towards knowledge-intensive industries, agglomeration around the city-centre and inner-city is reinforced, with a 79% increase in the number of jobs in this subregion from 2015. These additional jobs are accommodated by increased densities. The number of jobs also grows, albeit to a lesser extent, in other major centres such as the Dandenong corridor (particularly Monash), Box Hill and La Trobe.

In addition, some population-serving jobs are located in outer-urban areas where there is substantial population growth. Growth in jobs in the western region is still significant, with a 69% increase between 2015 and 2046, largely driven by population-serving industries such as retail and healthcare.

Table 9 provides an overview of how Melbourne's additional jobs are distributed under this scenario. It shows the total number of jobs in each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 9: Melbourne – Expanded Low Density scenario – employment by planning subregion

Planning subregion	Reference Case (2015)	Expanded Low Density scenario (2046)	Percentage change
Central	780,000	1,390,000	79%
Eastern	490,000	780,000	59%
Northern	320,000	540,000	72%
Southern	470,000	760,000	62%
Western	240,000	410,000	69%
Total employment	**2,290,000**	**3,881,000**	**69%**

Note: Employment rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

Under this scenario the structure of the transport network has been expanded, with the aim of better connecting the increased population living in the outer suburbs of the city to centralised employment centres.

The road network is upgraded and extended to better connect population growth in the outer areas of the city to employment centres, particularly the central business district. This includes upgrades to connections from the south-east, north-west and airport into the city. Significant new links are added, including better connections for outer south-eastern areas into the city, local connections for key economic centres, and connections between existing freeways in the north-east. Level crossings are removed across the city to improve local congestion around stations. New local and regional roads are built in outer growth areas to support significant population growth and connect these areas to the rest of the city. A new orbital link and upgrades to the city ring road better connect outer growth areas and provide additional capacity for cross-city and intercity travel.

The public transport network is also enhanced, supporting large numbers of people travelling into and out of the city-centre for work from outer areas. New rail links connect the city to the airport and northern suburbs, and extensions to existing rail links in the north and south-east provide additional connections for outer growth areas into the city. Key rail links between the city and the south-east and inner-east are upgraded. Significant upgrades and capacity enhancements are made to rail links connecting the city to the west, particularly in outer-western growth areas. The capacity of rail in the inner-city is enhanced by adding a new underground link and splitting the city loop. Existing regional rail links connecting into the city are also upgraded, providing additional suburban connections. Extensions are made to the tram network in the north, outer-east and inner-west areas. Existing local and regional bus links across the city are enhanced through service and route improvements.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

2.5 The Centralised High Density scenario

This scenario presents a compact, higher density vision for Melbourne, focused on the inner-city. Population and employment growth is largely located within 15 kilometres of the city-centre, along existing tram and train routes. This brings people closer to jobs, transport and services. The scenario involves material changes to the urban fabric of Melbourne's existing inner suburbs, while the outer suburbs remain largely unchanged.

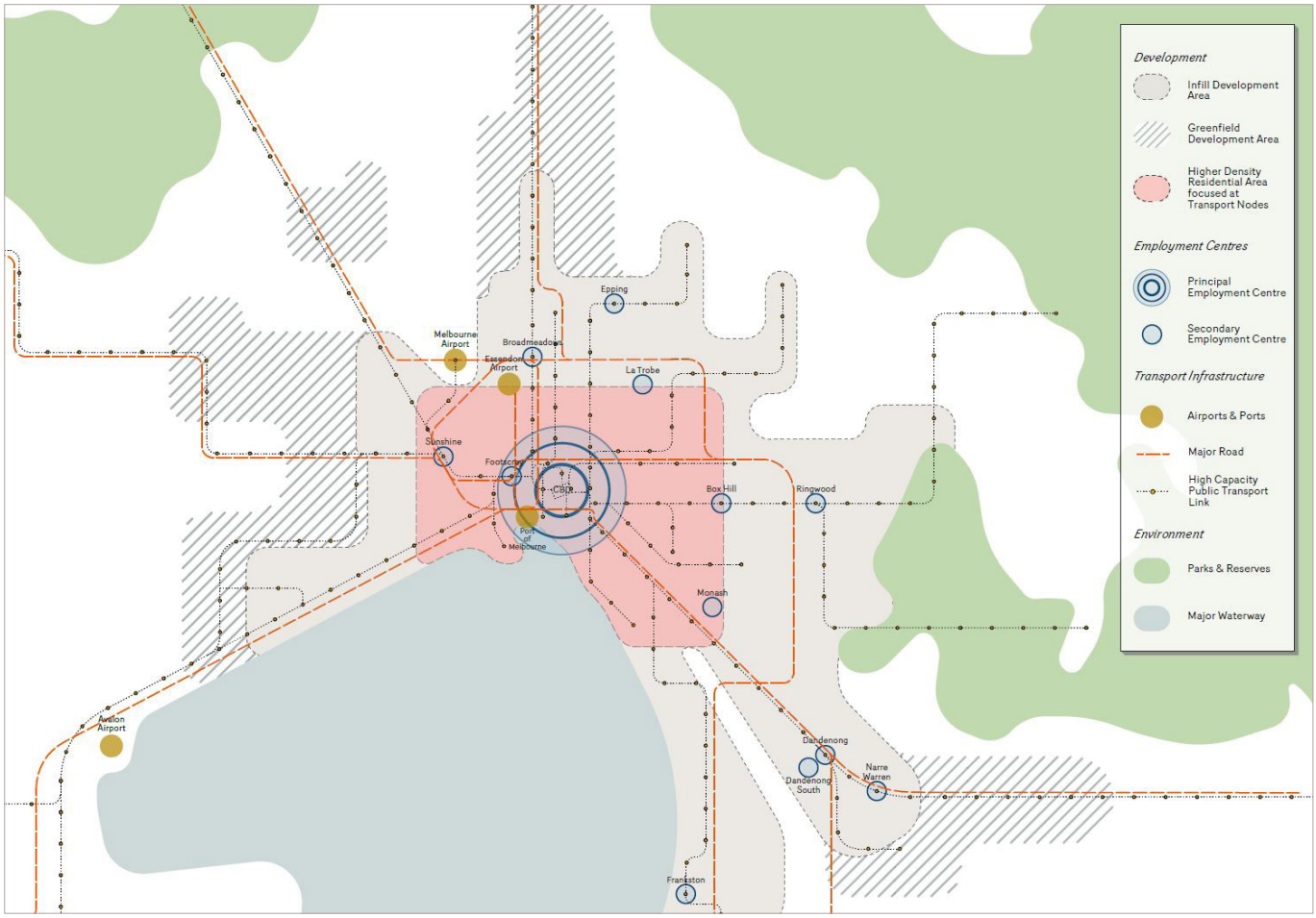
This scenario tests the assumptions implicit in recent planning strategies. These include *Plan Melbourne 2017-2050*, which argues that higher density neighbourhoods can have social, economic, environmental and transport-related benefits, and notes that greater densities should be supported where it optimises the use of existing infrastructure. In addition, *Transforming Australian Cities,* published in 2009 by the then Victorian Department of Planning and City of Melbourne, investigated the potential for existing tram and bus corridors to house future growth and found between 1 and 2.5 million people could be accommodated by this approach.[43] This also builds on the recommendations made in the 2016 *Australian Infrastructure Plan,* which called for the increased delivery of 'higher quality, higher density development within established areas in Australian cities'.[44]

Figure 5 provides a metropolitan schematic of the city's structure under this 2046 scenario.

Distribution of population growth

Under this scenario, 80% of population growth, equalling roughly 2.2 million additional people, is located in established areas, with new housing predominantly located at medium to high density in centres along existing public transport routes. For these inner suburbs, the scenario envisages significant change with apartment living becoming the norm and a shift in focus from private backyards to higher quality green and public space. Population distribution in this scenario delivers greater infill development than the Victorian Government has

Figure 5: Melbourne – Centralised High Density scenario



projected. *Plan Melbourne* projects 65 to 70% of all new housing will be located in infill areas between 2015-51.[45] The remaining 20% of population growth, totalling roughly 600,000 additional people, is located in greenfield areas at a lower density, focused in the western, northern and southern subregions of Melbourne.

Table 10 provides an overview of how Melbourne's additional population growth is distributed under this scenario. It shows the total population for each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 10: Melbourne – Centralised High Density scenario – population by planning subregion

Planning subregion	Reference Case (2015)	Centralised High Density scenario (2046)	Percentage change
Central	520,000	1,090,000	111%
Eastern	1,070,000	1,490,000	40%
Northern	900,000	1,540,000	71%
Southern	1,230,000	1,810,000	48%
Western	750,000	1,320,000	76%
Total population	**4,460,000**	**7,260,000**	**63%**

Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Distribution of new jobs

Under this scenario, employment growth is focused largely in the inner-city, with the central business district extended to take in areas in North Melbourne, Fisherman's Bend, Dynon Road and Footscray. There is also some employment growth in areas outside the city-centre that have development potential and access to transport, such as Sunshine, and population-serving employment growth around suburban centres.

The concentration of employment in the city is designed to complement the overarching narrative of a higher density central Melbourne. Under this scenario, service sector and 'knowledge-industry' jobs continue to benefit from agglomeration and therefore co-locate in the central city. The increased residential population in the centre, combined with Melbourne's radial public transport network, maximises employers' access to skilled labour.

Table 11 provides an overview of how Melbourne's additional jobs are distributed under this scenario. It shows the total number of jobs in each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 11: Melbourne – Centralised High Density scenario – employment by planning subregion

Planning subregion	Reference Case (2015)	Centralised High Density scenario (2046)	Percentage change
Central	780,000	1,580,000	104%
Eastern	490,000	720,000	48%
Northern	320,000	500,000	58%
Southern	470,000	670,000	44%
Western	240,000	400,000	68%
Total employment	**2,290,000**	**3,880,000**	**69%**

Note: Employment rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

This scenario focuses employment and population growth in existing areas in order to capitalise on areas of the city already well-serviced by infrastructure, and in particular encourage increased public transport use. Nonetheless, there are several upgrades and extensions made to the transport networks aimed at supporting increased housing and jobs within the inner and middle suburbs of Melbourne.

The road network is upgraded and extended to enhance connections into the city-centre. This includes upgrades to connections from the south-east, north-west and airport into the city. Significant new links are added, including better connections for outer south-eastern areas into the city, local connections for the Monash economic centre, and connections between existing freeways in the north-east. Level crossings are removed across the city to improve local congestion around stations. New local and regional roads are built in outer growth areas to support significant population growth and connect these areas to the rest of the city. Upgrades to the city ring road better connect outer growth areas and provide additional capacity for cross-city and intercity travel.

The public transport network is also enhanced, supporting larger movements around the city-centre and surrounding economic centres. The capacity of rail in the inner-city is enhanced by adding a new underground link and splitting the city loop. Signalling upgrades are made to links between the inner-east and the city. Extensions are made to the tram network in the north, outer-east and inner-west areas. New rail links connect the city to the airport and northern suburbs, and extensions to existing rail links in the north and south-east provide additional connections for outer growth areas into the city. Significant upgrades and capacity enhancements are made to rail links connecting the city to the west, particularly in outer-western growth areas. Existing local and regional bus links across the city are enhanced through service and route improvements. Existing regional rail links connecting into the city are also upgraded, providing additional suburban connections.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

2.6 The Rebalanced Medium Density scenario

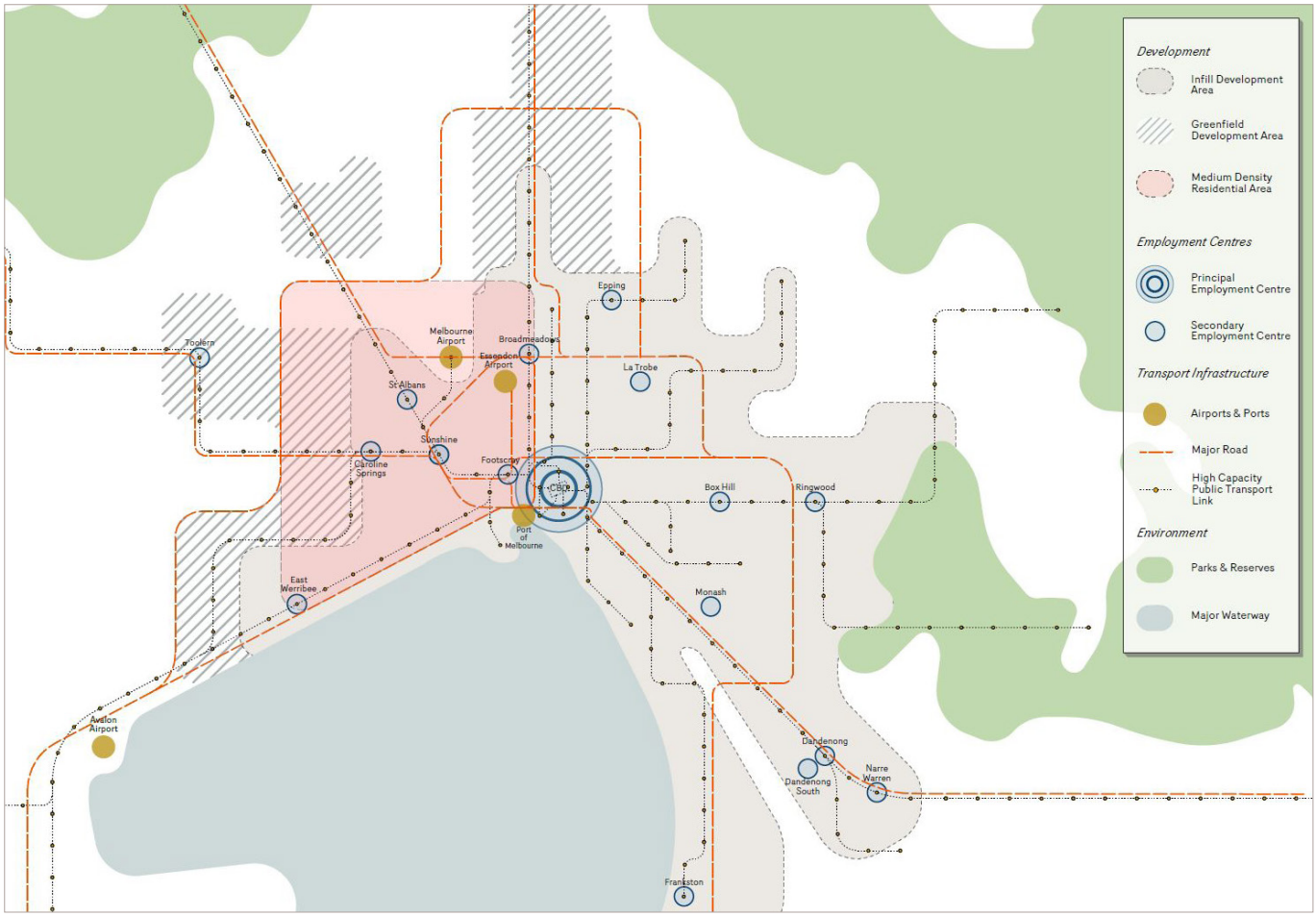
This scenario tests a future where growth is managed with the aim of locating a proportion of job growth closer to where people currently live, and more evenly distributing the impact of population growth, towards Melbourne's west. Melbourne has historically developed more in the CBD, eastern and northern suburbs. The eastern, northern and southern subregions currently each have higher shares of Melbourne's population and employment than the western subregion. In addition, these areas generally have better access to Melbourne's public transport network and suburbs

in Melbourne's inner-east and south also have higher average incomes than the west.

However, Melbourne's western suburbs have recently experienced strong population growth. This growth is projected to continue, with the Victorian government projecting that between 2015 and 2051 the subregion will add more dwellings than any other (385,000).[46] This scenario tests accommodating further significant population at medium densities in the west, alongside employment growth, supported by infrastructure enhancements.

Figure 6 provides a metropolitan schematic of the city's structure under this 2046 scenario.

Figure 6: Melbourne – Rebalanced Medium Density scenario



Distribution of population growth

Under this scenario, 70% of population growth to 2046, roughly two million additional people, will be delivered within Melbourne's established areas. This is achieved by focusing infill development in the western subregion, which grows by a total of 120% (900,000 people). The bulk of new housing is assumed to be medium-density and is situated around railway corridors in the west, such as Sunshine, Footscray, Essendon airport and other large industrial sites with significant redevelopment potential. This tests the impact of delivering significant growth in the west at higher densities than currently anticipated, in order to locate homes closer to transport and services, and enable the delivery of a more diverse supply of housing choice in this area.

The remaining 30% of the city's population growth, roughly 800,000 additional people, will be delivered as lower density detached greenfield development, primarily in the western, north-western and northern subregions of Melbourne. There is minimal greenfield development in the east and south, resulting in a more balanced urban structure.

Table 12 provides an overview of how Melbourne's additional population growth is distributed under this scenario. It shows the total population for each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 12: Melbourne – Rebalanced Medium Density scenario – population by planning subregion

Planning subregion	Reference Case (2015)	Rebalanced Medium Density scenario (2046)	Percentage change
Central	520,000	980,000	89%
Eastern	1,070,000	1,390,000	30%
Northern	900,000	1,630,000	80%
Southern	1,230,000	1,620,000	32%
Western	750,000	1,650,000	120%
Total population	**4,460,000**	**7,260,000**	**63%**

Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Distribution of new jobs

The distribution of employment in this scenario focuses economic growth in Melbourne's west. The centre of Melbourne has long been the city's focus for economic activity, supported by eastern centres such as Latrobe and Monash. This scenario aims to rebalance this focus by locating jobs growth in the western areas of the city, close to population growth. Employment in the western subregion grows by 105%, with significant job intensification in Werribee, Sunshine and the Brooklyn-Tottenham Industrial Precinct. While the central subregion remains the largest employment centre, jobs shift to the western areas of this subregion, with growth that exceeds baseline projections in Footscray, Maribyrnong and Tottenham.

Table 13 provides an overview of how Melbourne's additional jobs are distributed under this scenario. It shows the total number of jobs in each district of the city under this scenario, and the percentage change between 2015 and 2046.

Table 13: Melbourne – Rebalanced Medium Density scenario – employment by planning subregion

Planning subregion	Reference Case (2015)	Rebalanced Medium Density scenario (2046)	Percentage change
Central	780,000	1,390,000	79%
Eastern	490,000	750,000	52%
Northern	320,000	540,000	70%
Southern	470,000	715,000	53%
Western	240,000	490,000	105%
Total employment	**2,290,000**	**3,880,000**	**69%**

Note: Employment rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

The transport network under this scenario is extended and enhanced in order to provide connections to new western population and employment centres, and strengthen connections into the inner-city and inner-west.

The road network is upgraded and extended to better connect population growth in the outer areas of the city, to employment centres, particularly the CBD. This includes upgrades to connections from the north-west, airport and south-east into the city. New local and regional roads are built in western growth areas to support significant population growth and connect these areas to the rest of the city. New links are added, including local connections for the Monash economic centre, and connections between existing freeways in the north-east. Level crossings are removed across the city to improve local congestion around stations. A new orbital link and upgrades to the city ring road better connect outer growth areas and provide additional capacity for cross-city and intercity travel.

The public transport network is also enhanced, supporting larger movements around the city-centre and surrounding economic centres. Significant upgrades and capacity enhancements are made to rail links connecting the city to the west, particularly in outer-western growth areas. The capacity of rail in the inner-city is enhanced by adding a new underground link and splitting the city loop. Signalling upgrades are made to links between the inner-east and the city. Extensions are made to the tram network in the north, outer-east and inner-west areas. New rail links connect the city to the airport and northern suburbs, and extensions to existing rail links in the north provide additional connections for outer growth areas into the city. Existing local and regional bus links across the city are enhanced through service and route improvements. Existing regional rail links connecting into the city are also upgraded, providing additional suburban connections.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

Melbourne scenario analysis

At a glance

- Infrastructure Australia has tested and compared the performance of the three 30-year scenarios for Melbourne by modelling their impact on transport and social infrastructure.
- The results of this analysis are organised under five indicator themes: the performance of the transport network, access to jobs, the environmental performance of the road network, access to and demand for social infrastructure, and access to and demand for green space.
- The chapter concludes with a summary of the key findings for Melbourne resulting from the scenario analysis, which apply to the city regardless of which long-term growth pathway is followed.

Evaluating the three future scenarios

Infrastructure Australia has compared the performance of the three scenarios by modelling the impact of each on the performance of the city's key infrastructure assets.

Two separate models have been used to complete this analysis:

1. **Transport network modelling:** Each scenario has been modelled using the Victorian Government's Victorian Integrated Transport Model (VITM) to identify the relative impact of each on demand for and performance of the 2046 networks, and the environmental impact of the road networks. Further information about this modelling can be found at **Appendix C.**
2. **Green space and social infrastructure modelling:** The three scenarios have been modelled using Arup's Transport Travel Time Analysis (T3a) tool and the transport modelling results to identify how each scenario impacts the relative demand for and access to green space and social infrastructure. Further information about this modelling can be found at **Appendix D.**

The modelling results have been organised into five indicator themes which together draw out the relative future trade-offs that exist for Melbourne under the different scenarios. These results are summarised in **Table 14.**

Table 14: Melbourne – Summary of key performance indicators (best performance is bolded)

Key statistics	Reference Case (2015/2016)[a]	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Transport performance				
Road congestion[b]	5%	7%	9%	**6%**
Public transport mode share[c]	14%	21%	**22%**	21%
Access to jobs in 30 minutes[d]				
Car	22%	18%	17%	**18%**
Public transport	2%	3%	**4%**	3%
Access to jobs in 60 minutes[e]				
Car	64%	53%	53%	**54%**
Public transport	24%	25%	**29%**	26%
Access to hospitals[f]				
Percentage of population with access	87%	78%	**82%**	80%
Access to schools[g]				
Percentage of population with access	95%	86%	**90%**	87%
Access to green space[h]				
Percentage of population with access	38%	31%	**33%**	32%

Note: Indicators are rounded to the nearest whole percent. This means some scenarios appear to show the same result even though there are differences in performance. More detail is provided in the relevant sections of this chapter.

Note: Care should be taken when comparing the reference case to the scenarios. This is particularly the case with green space, school and hospital access indicators, where no new infrastructure was added in addition to the reference year.

(a) Population and employment reference case year is 2015 for transport modelling. Reference case year is 2016 for social infrastructure and green space modelling

(b) Measured as the percentage of vehicle kilometres travelled where volume of traffic exceeds road capacity in the AM peak

(c) The percentage of trips by public transport in the AM peak

(d) The percentage of jobs accessible in 30 minutes during the AM peak

(e) The percentage of jobs accessible in 60 minutes during the AM peak

(f) Within a 20-minute drive or 30 minutes by public transport of a major hospital in the AM peak

(g) Within a five-minute drive or 20 minutes by public transport or a 40-minute walk of a primary or secondary school in the AM peak

(h) Within a five-minute walk of any green space.

3.1 Performance of the transport network

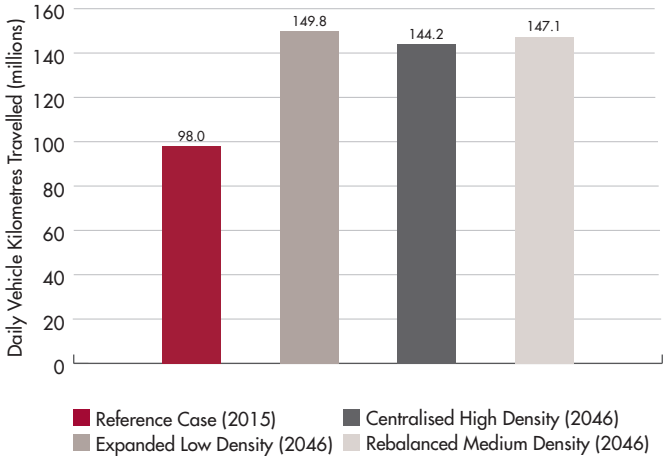
Transport infrastructure is an enabler of economic activity, health and education services as well as leisure. It allows workers and businesses access to each other, goods to be moved from ports to shop fronts and people to access key services. Without a functioning transport network, the key advantage of urban living, accessibility, is undermined.

As cities grow so does the demand for transport, resulting in potential congestion and a reduction in accessibility and liveability. Where Melbourne chooses to place its additional population and jobs in the coming years, and the associated policy settings and transport networks will have a significant impact on how the city functions.

Under all scenarios, private vehicle use and road congestion increase

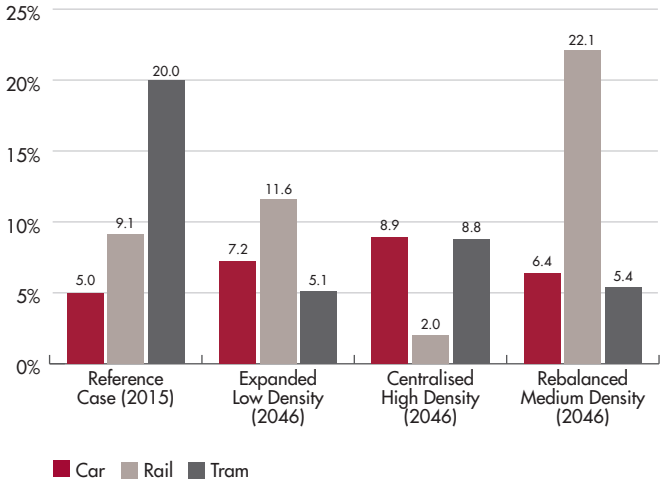
Despite the important role of land-use and transport planning, it is clear that in the next 30 years private vehicle use in Melbourne will grow substantially, regardless of urban form. The scenario analysis shows that daily vehicle kilometres grow between 47% and 53% between now and 2046, depending on the scenario. **Figure 7** shows the difference in vehicle use between the reference case and the three 2046 scenarios.

Figure 7: Melbourne – Daily Vehicle Kilometres Travelled, 2015 to 2046 scenarios



The increase in demand across all scenarios affects road and public transport congestion levels. **Figure 8** shows the percentage of vehicle kilometres travelled (for road) and passenger kilometres travelled (for public transport) where the volume exceeds the capacity of the network. The data shows that in contrast to public transport, additions to the road network under the three scenarios do not decrease overall congestion from the reference case. This indicates that while targeted road construction remains important, the scale of capacity enhancements required to meet demand and in turn to moderate congestion, particularly during the peak, is not achievable through construction alone.

Figure 8: Melbourne – Percentage of Passenger Kilometres Travelled (public transport) and Vehicle Kilometres Travelled (cars) where volume exceeds capacity in the AM peak, by mode



It is important to note that the location and intensity of congestion differs under the three scenarios, indicating that there are trade-offs regarding the spatial structure of the city and the performance of the road and public transport networks. In scenarios where total congestion is lower, there can still be areas of localised, acute congestion, reflecting the complexities in transport network investment and performance.

Figure 9 shows the primary location of congestion - measured by a volume/capacity ratio, which is the volume of private vehicles or passengers travelling compared to the capacity available on the network. 'Over' utilisation refers to sections where volume exceeds capacity.

The road network under the Rebalanced Medium Density scenario is the least congested because western Melbourne has substantial road capacity. Any future in which western Melbourne is developed significantly would likely result in a reliance on the road network, given its low congestion levels contrast with the comparatively limited access to public transport in this area. In contrast, the Centralised High Density scenario has the greatest level of congestion due to development being focused on an area that already has high traffic volumes. Road congestion in high-density centres is common and can be addressed by enhancing the public transport network and introducing policy settings that manage demand.

Despite the growth in vehicle use and congestion under all scenarios, it is also clear that there are significant differences between the scenarios, with some spatial patterns better suited to reducing car use through better integrating land-use and transport planning. For example, the daily vehicle kilometres travelled are 5.6 million greater (about 4%) under the Expanded Low Density scenario than the Centralised High Density scenario.

Figure 9: Melbourne – Road network congestion in the AM peak

Reference Case (2015)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

Network Utilisation — Low — Medium — Over

The public transport network is used most efficiently when population and employment are increased in inner-Melbourne

With significant planned capacity enhancements, including Melbourne Metro, the city's public transport network will generally have capacity to handle projected population growth under all scenarios. However, the performance of the public transport network is generally better under the Centralised High Density scenario.

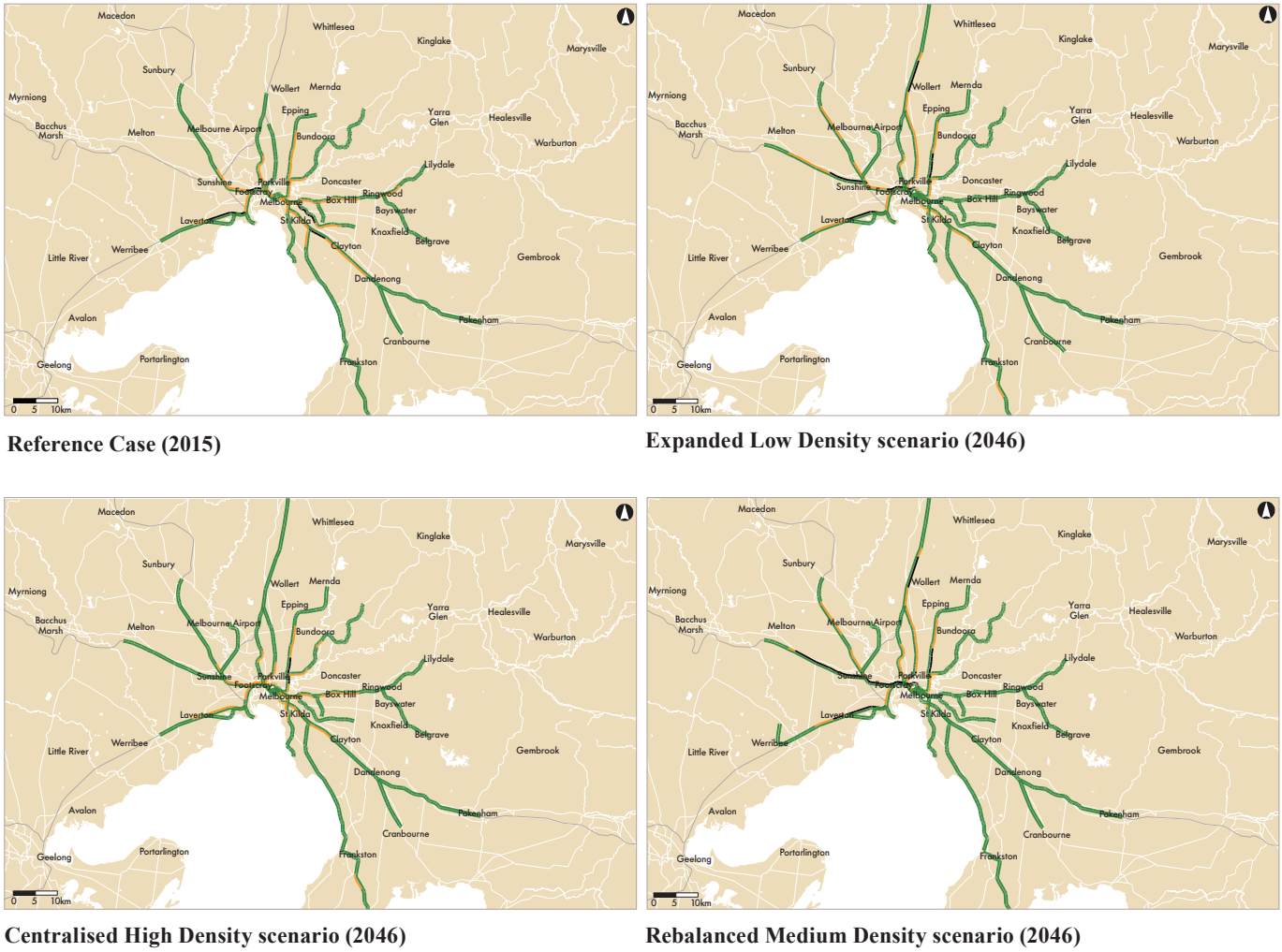
Table 15 shows the city-wide average proportion of rail passenger kilometres experiencing congestion in the morning peak across Melbourne, under the different scenarios. **Figure 10** shows the location of this congestion. Crowding is measured by volume/capacity ratios, which is the volume of passengers travelling compared to the capacity available on the network. In the mapping, 'over' utilisation means volume is exceeding capacity.

The data and maps show that there is substantially lower congestion on Melbourne's rail network under the Centralised High Density scenario and higher congestion in the Rebalanced Medium Density scenario.

Table 15: Melbourne – Percentage of rail passenger kilometres experiencing congestion during the AM peak

	Reference Case (2015)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Percentage of rail passenger kilometres experiencing congestion during AM peak	9%	12%	2%	22%

Figure 10: Melbourne – Rail network congestion in the AM peak



Reference Case (2015)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

Network Utilisation — Low — Medium — Over

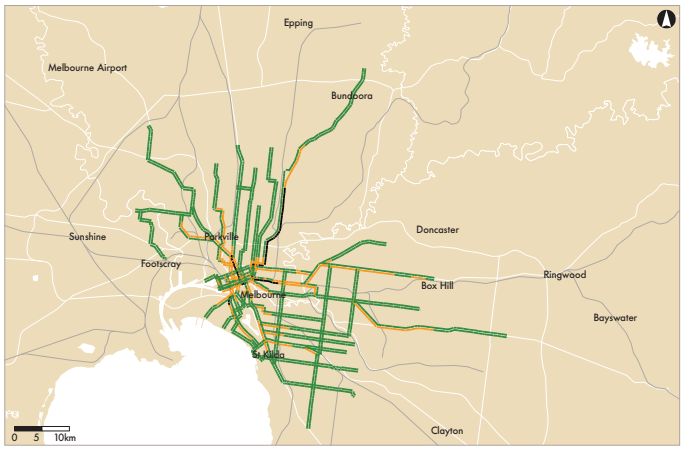
In contrast, the tram network experiences the highest level of congestion under the Centralised High Density scenario. This is in part due to tram boardings being 23% higher than the other two scenarios, indicating a mode shift towards trams, which have a dense network of lines in Melbourne's inner-city.

Figure 11 shows the location of tram network congestion under the reference case and 2046 scenarios.

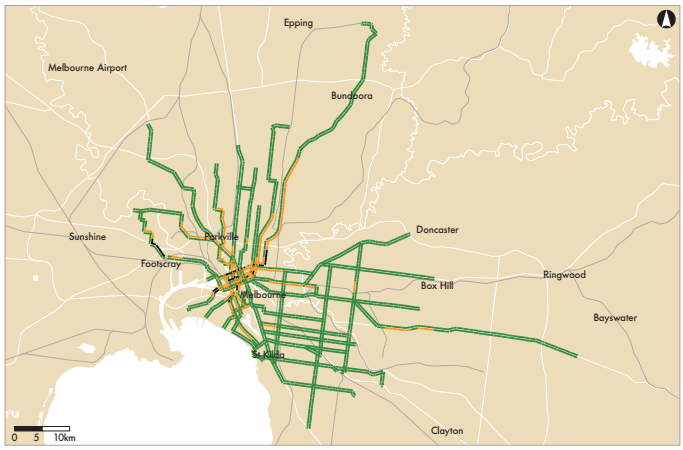
The performance of the rail and tram networks under the Centralised High Density scenario are a function of:

- **Significant network investment:** Planned capacity enhancements are a key factor in why crowding decreases from the reference case. Both the rail and tram networks benefit from significant investment including an expansion of the tram network and significant capacity enhancing projects on the heavy rail network such as Melbourne Metro. This also applies to improvements for public transport under the alternative scenarios (relative to 2015). A list of major projects and service extensions is at **Appendix B.**
- **Substantial heavy rail capacity in the inner-city:** Transport investments are similar across the 2046 scenarios, so the difference in crowding between scenarios is explained by the location of demand resulting from the distribution of population and employment under the Centralised High Density scenario. When greater housing is focused in the inner-city, crowding decreases on the heavy rail network because it means that demand is being placed where the most network capacity exists. Melbourne's heavy rail network is radial, with lines from the outer suburbs converging as they approach the city loop. This means frequencies and capacity grow closer to the city. Increasing demand in the inner-city also means there is less demand in the outer suburbs, so trains travelling toward the city take longer to become crowded and the number of congested passenger kilometres travelled declines.

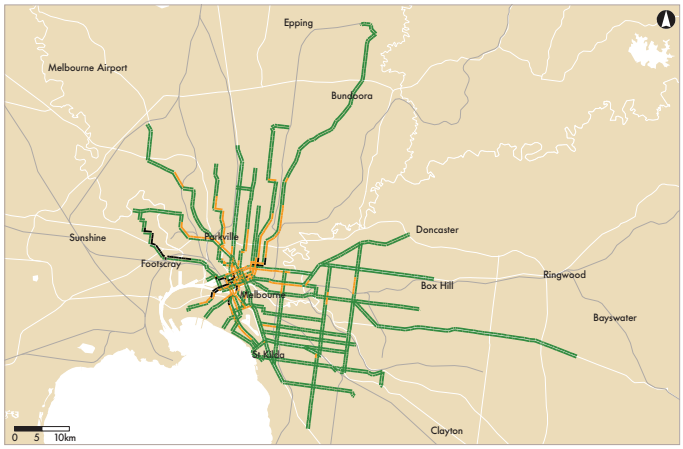
Figure 11: Melbourne – Tram network congestion in the AM peak



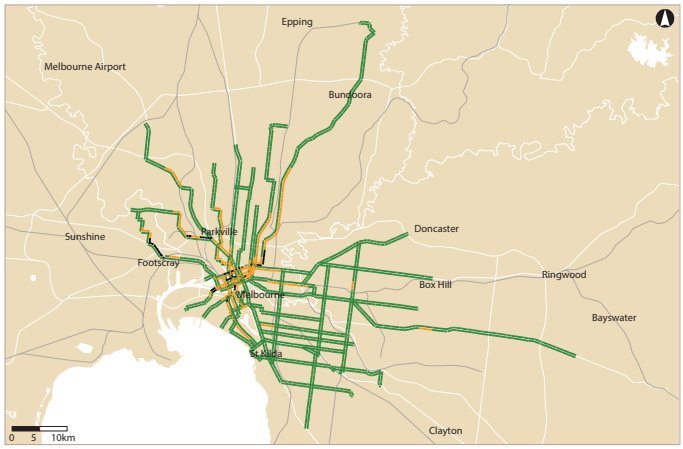
Reference Case (2015)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

Network Utilisation — Low — Medium — Over

- **Demand burden shifting to trams:** The shift in demand to the inner-city results in a significant increase in boardings for trams, which are better suited to making short trips in inner-Melbourne. This results in growing congestion on the tram network under this scenario.
- **Definition of congestion and capacity:** The congestion data are highly sensitive to the interpretation of congestion. In **Table 15**, services become congested when the volume of passengers exceeds capacity. In the Centralised High Density scenario, only about 2% of passenger kilometres travelled (PKT) on the rail network fall into this category. However, almost a quarter of PKT have a volume/capacity ratio of 0.71 to 0.8, where passenger volumes are up to 80% of capacity. The definition of capacity is between 'seated' and 'crush' capacity, so a train that is 80% full would still be very busy and would likely be standing room only. For the Centralised High Density scenario, the definition of congestion used in this paper potentially exaggerates the extent to which congestion is lower than the other scenarios. For further detail about capacity see **Appendix C**.

In contrast to the Centralised High Density scenario, greater levels of congestion on the rail network are evident under the Rebalanced Medium Density scenario and the Expanded Low Density scenario, indicating an increased proportion of housing and jobs are being placed in areas where the public transport network does not have the necessary capacity to meet demand.

For example, **Figure 10** indicates that western Melbourne's rail coverage and capacity is limited. In the Rebalanced Medium Density scenario and, to a lesser extent, the Expanded Low Density scenario, population growth is focused on western Melbourne. This results in significant congestion on the lines in that area. Any plans to significantly develop western Melbourne would therefore require greater rail capacity expansion than has been canvassed in any of the scenarios put forward in this paper.

3.2 Access to jobs

Accessibility refers to the ease with which residents within a city can reach their desired destination.[47] Well-connected cities have a tangible impact on quality of life, enabling residents to access the places, services and communities they need to lead satisfying and productive lives. There is also a clear link between accessibility and the strength of the metropolitan economy. A city that provides high levels of access to residents also enables greater connections between firms and employees, contributing to the creation of deep labour markets and improved job matching, which in turn enhances the productivity of the city.[48]

Access to jobs, a key component of a city's broader accessibility, is fundamentally determined by the economic geography of a city, which is defined as the location and intensity of economic activity relative to where people live. At the heart of a well-functioning city lies a transport network providing people with easy access to economic activity by either placing them near employment and/or providing fast and efficient transport networks.

Infrastructure Australia's three scenarios test how different urban forms affect people's access to work, and which parts of the city are affected.

The economic structure the three scenarios test are:

1. **People live further away from work (the Expanded Low Density scenario).** This scenario involves residential urban sprawl, particularly to the north and west, with economic activity continuing to be focused on the CBD. There is also continued growth in smaller centres such as along the Dandenong Corridor (particularly Monash), Box Hill and La Trobe.
2. **People move closer to jobs (the Centralised High Density scenario):** This scenario focuses residential and employment growth in inner-Melbourne. New jobs are largely based in the CBD, which expands to North Melbourne, Fisherman's Bend, Dynon Road and towards Footscray.
3. **Underutilised areas are developed (the Rebalanced Medium Density scenario).** This scenario develops western Melbourne with new housing and infill development focused on the region. Under this scenario, the economic geography of Melbourne is shifted towards the west. The central subregion remains the largest employment centre, but jobs shift to the western areas of this region, with growth that exceeds baseline forecasts in Footscray, Maribyrnong and Tottenham.

This section compares the level of accessibility between the reference case and the three 2046 scenarios for Melbourne using two measures: percentage of jobs that can be accessed in 30- and 60-minute time budgets by road and public transport, and average journey to work travel times.

The 30-minute city is a difficult accessibility benchmark for a city of Melbourne's size, particularly for public transport users

The concept of the 30-minute city is an accessibility measure which posits that no matter where a person lives, they can easily access the places they need to visit on a daily basis (for example, their job or school, childcare, healthcare, food, and entertainment) within 30 minutes.[49]

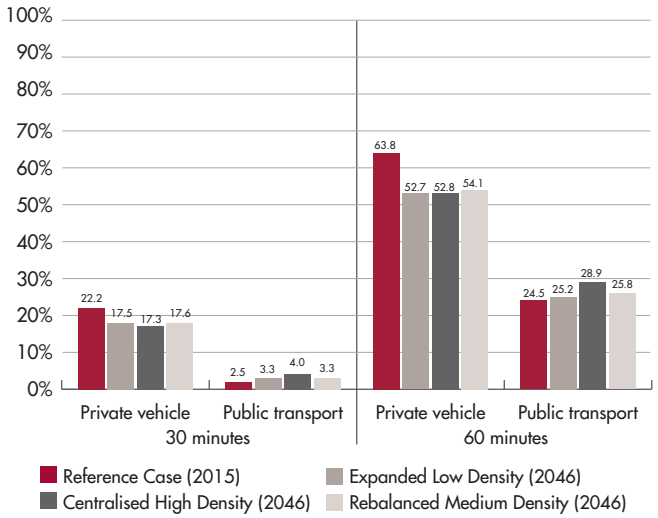
This framework has gained recent prominence in Australia with the Australian Government, state and territory governments and academics[50] advocating for its use as a benchmark against which the accessibility of Australian cities should be measured. The Victorian Government

has presented a similar approach, using a 20-minute neighbourhood benchmark for Melbourne, which aims to ensure people can access the services and amenity they require within 20 minutes of their home.

While the concept of the 30-minute city or 20-minute neighbourhood is an admirable goal, the accessibility results for all scenarios analysed in this paper indicate that in a city of Melbourne's future size, the expectation that one can easily access key destinations within 20 to 30 minutes, no matter where you live, is challenging.

Figure 12 graphs the percentage of jobs accessible by private vehicle and public transport at a city-wide level under 30- and 60-minute time budgets, for the reference case and the three 2046 scenarios.

Figure 12: Melbourne – Percentage of jobs accessible within 30 and 60 minutes in the AM peak, by private vehicle and public transport



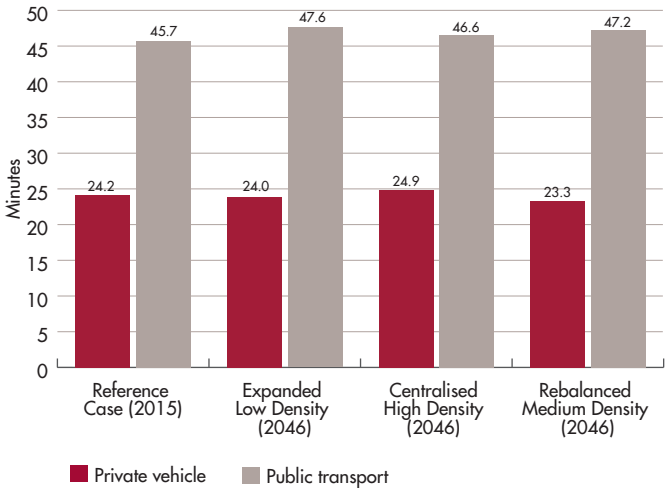
The graph demonstrates that now and under the 2046 scenarios, the proportion of jobs that are accessible within 30 minutes is quite low. In contrast, the time budget of 60 minutes provides much greater levels of accessibility across the city.

It is important to note this is only one indicator of accessibility. The measure calculates the percentage of all jobs across Melbourne that are accessible within a travel time budget (30 or 60 minutes) from each model zone (which represents a geographic location). The data is then aggregated to SA3 level and a population-weighted average is used for the city-wide metric. The measure is therefore a weighted geographic measure, which indicates how well the shape of the city, its transport network and location of population employment, impacts accessibility. There are alternative, equally valid measurements, such as calculating the proportion of people who are within 30 minutes of key employment centres, which would likely yield a higher result.

Another indicator is average travel time, which remains largely consistent between the 2015 reference year and all 2046 scenarios. **Figure 13** shows average journey to work travel times. This result shows that population growth does not necessarily mean significantly longer travel times. There are likely numerous reasons for this.

New residential developments generally attract new 'population-serving jobs', meaning there are always a proportion of people who live near work. In addition, using the average as a measure has limitations as it may fail to capture significant but localised variations in travel time between scenarios. The travel time consistency also indicates the extent to which people will tend to move their residential location or change job so that, at least in some measure, they fit their journey to work within a reasonable travel time budget.

Figure 13: Melbourne – Average journey to work travel time in the AM peak, by mode



However, moving to access work comes with costs. A greater proportion of jobs, particularly well-paid work, is located in the CBD and surrounding suburbs. Expecting people to move to access these economic opportunities is inequitable, with housing costs significantly higher closer to the city-centre. The result is that while average trip times remain largely constant, access to jobs in the CBD will be easier for those who can afford to live nearby.

There are plenty of other reasons people can have difficulty moving, including family ties, children at local schools and social networks in their immediate suburb. As much as possible, a liveable and fair city should aspire to maximise accessibility so people aren't forced to move to access work.

A final reason for travel time remaining mostly constant is that, under each scenario, there is significant investment in the transport network that matches land-use patterns. To a certain extent, additional investment is inevitable as cities grow. But governments cannot afford to become complacent, and investments need to be well-planned and targeted to ensure the best outcome for travellers and the taxpayer.

Expanded public transport networks and increased inner-city densities result in better accessibility outcomes for Melbourne

Across all three scenarios, the level of job accessibility provided by public transport services improves in comparison to the levels of accessibility provided now (in part due to additional investment). In contrast, the accessibility for private vehicles across the three scenarios decreases.

Figure 14 graphs the percentage of jobs accessible within 60 minutes by private vehicle and public transport across Melbourne for the reference case and the three 2046 scenarios.

Figure 14: Melbourne – Percentage of jobs accessible by private vehicle and public transport within 60 minutes in the AM peak

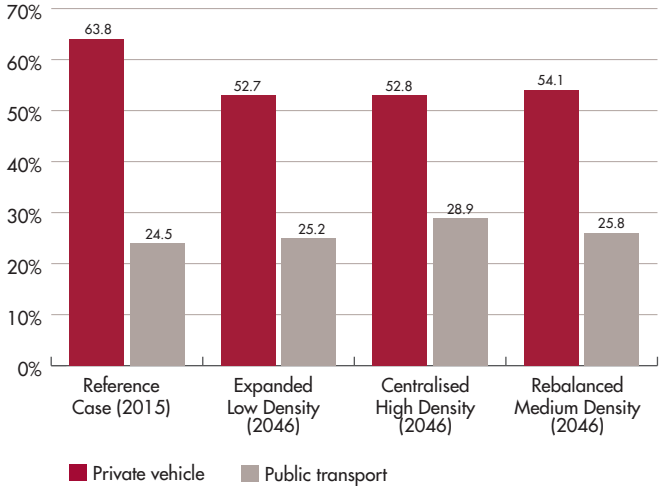
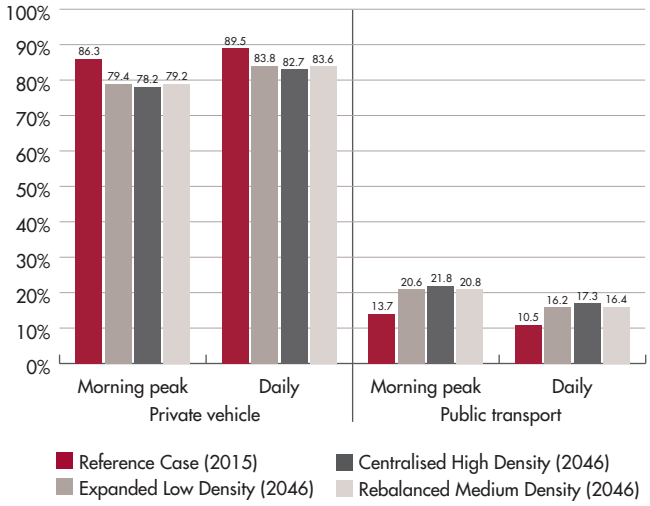


Figure 15 compares changes in mode share between the reference case and three 2046 scenarios. A number of factors, including changes to the location of people and jobs, and the relative performance of public and road transport networks, influences these changes in mode share.

Figure 15: Melbourne – Mode share, by time of day



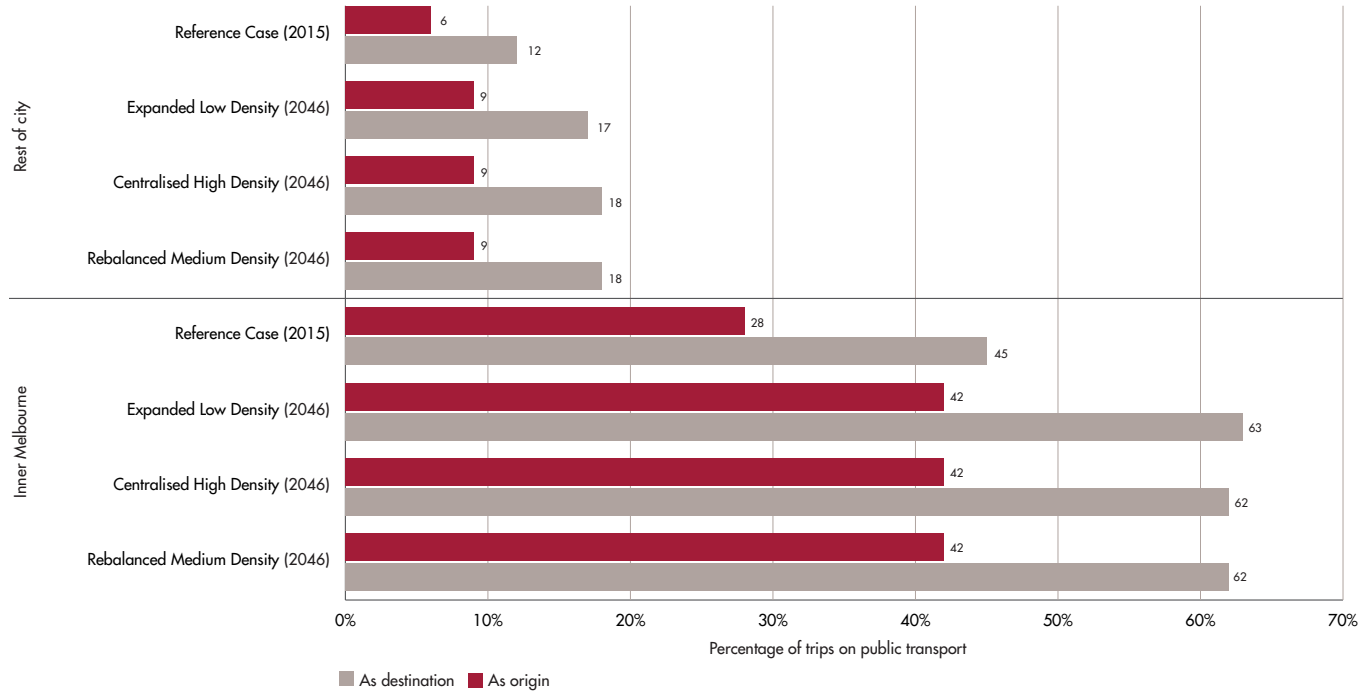
These graphs show that the Centralised High Density scenario is the most effective scenario in improving city-wide accessibility. This scenario focuses growth in areas that are already well-served by public transport and have significant capacity enhancements planned. As a result, a greater proportion of the population live near work and/or public transport services.

The relative increase in the level of accessibility provided by public transport, compared to the relative decline in access provided by private vehicles, demonstrates the symmetries between the capacity and service levels provided by public transport and the demands of catering to a city of Melbourne's future size.

However, it is important to note that under all scenarios Melbourne remains a largely car-based city. Depending on the scenario and time of day, private vehicle mode share ranges between 78% and 84%.

This mode share varies significantly depending on location. **Figure 16** illustrates the significantly higher mode share for public transport in inner-Melbourne than the rest of the city. The variation across Melbourne reflects the need for a nuanced transport policy, where public transport and road investment, as well as demand management (for example road user charging), each play a role in the city's future network.

Figure 16: Melbourne – Public transport mode share in the AM peak, Inner Melbourne SA4 compared to the rest of city



The spatial distribution of access to jobs remains unequal across all scenarios

Access to work, and the economic opportunities it presents, is distributed unevenly across the city under all scenarios. **Figure 17** and **Figure 18** compare job accessibility within 60 minutes by private vehicle and public transport across the 2015 reference case and the three 2046 scenarios.

This mapping indicates that each scenario has advantages and disadvantages in terms of the spatial distribution of access:

1. **The Centralised High Density scenario has the best accessibility for public transport overall, but is worst for private vehicles, particularly in western Melbourne.** Under this scenario, accessibility by public transport is highest in the inner suburbs and eastern suburbs. However, relative to the other scenarios, accessibility by private vehicle is poorest in an arc from northern Melbourne down to the western suburbs. Governments would need to be aware of potential equity problems under this scenario, where jobs are concentrated in inner-Melbourne at the expense of outer suburbs that generally have cheaper housing.

2. **The Rebalanced Medium Density scenario improves accessibility in Melbourne's north-west and south-east for drivers.** Employment growth in the western and north-western suburbs, combined with the construction of the Melbourne orbital road increases accessibility in Melbourne's north-west. Accessibility also improves in the south-east under this scenario, which is likely due to less development resulting in lower congestion levels.
3. **The Expanded Low Density scenario has the lowest aggregate accessibility scores of the three scenarios, but improves access in Melbourne's west and south-east.** Although differences in the mapping may be difficult to identify, this scenario scores lowest on aggregate for both public transport and private vehicles. However, especially for drivers, accessibility improves in Melbourne's west and south-east.

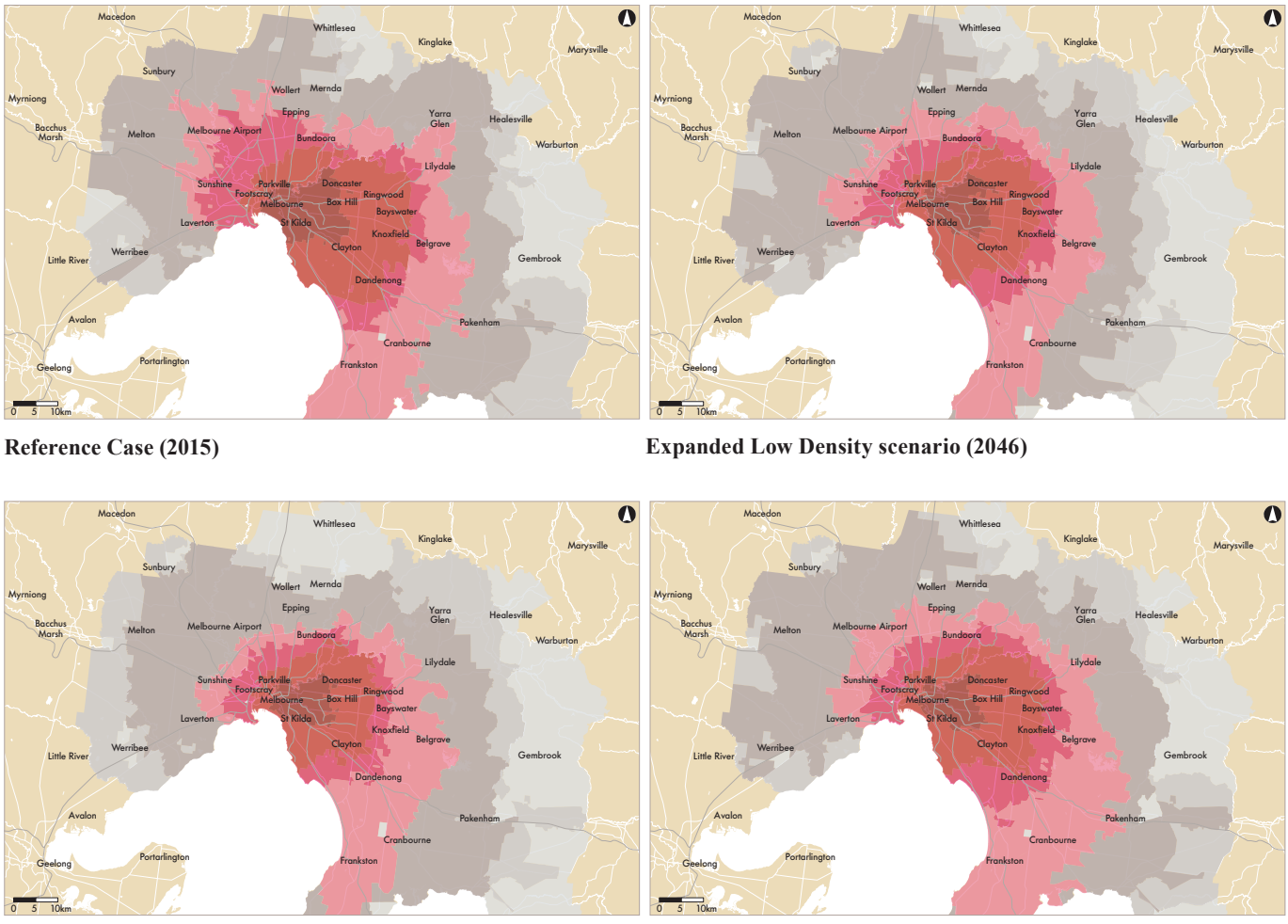
For all scenarios and transport modes, the inner-city and eastern suburbs have significantly higher accessibility to jobs than elsewhere. This reflects the degree to which Melbourne's history will continue to shape its future. The city's primary job markets, transport network and centres of wealth have historically focused on the CBD and inner-eastern suburbs. At a metropolitan-wide level, these areas will continue to dominate the city's economic structure regardless of where future growth is directed.

Suburban employment centres can improve accessibility, particularly for drivers

Accessibility mapping illustrates the dominance of Melbourne's CBD and inner-east, but because of the level of aggregation in the mapping, it doesn't show the benefits that a network of well-planned centres can have for local job accessibility outside the CBD.

The modelling results indicate a possible link between accessibility, for both private vehicles and public transport, and the number of jobs in employment centres. **Figure 19** shows the amount of AM peak trips to employment centres and the percentage of jobs accessible within 60 minutes.

Figure 17: Melbourne – Percentage of jobs that can be accessed by private vehicles within 60 minutes in the AM peak

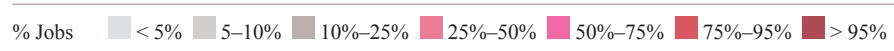


Reference Case (2015)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)



While the Centralised High Density scenario is clearly the best performer for public transport users, the Rebalanced Medium Density scenario performs best for drivers. This is because of the development of western Melbourne employment centres at Sunshine and Werribee under this scenario.

In the context of a rapidly growing, but job-poor region, developing centres in the city's west could make Melbourne's economic geography more equitable. However, any policy aimed at improving equity would need to be complemented by a range of policies in areas such as education, welfare and housing. Planning is not as simple as locating jobs near homes. People must be able to afford to live closer to work and/or transport and have access to the right types of jobs and services.

The location of jobs, population and supporting transport networks will invariably involve trade-offs. Finite resources and economic opportunities mean planning decisions will often result in parts of the city that benefit at the expense of others. The key for governments is to ensure their planning is guided by strategic policy priorities.

Figure 19: Melbourne – Percentage of trips to employment centres and jobs accessible in 60 minutes in the AM peak, by private vehicle and public transport

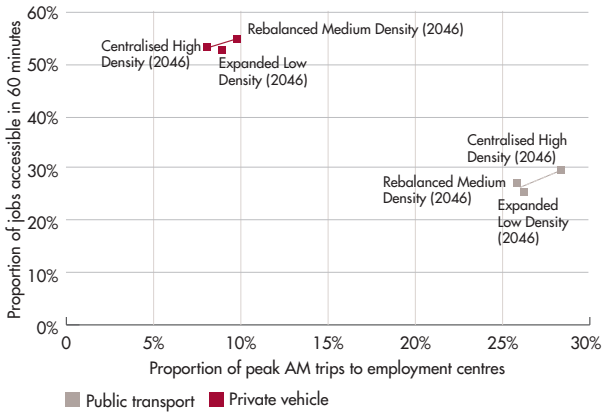
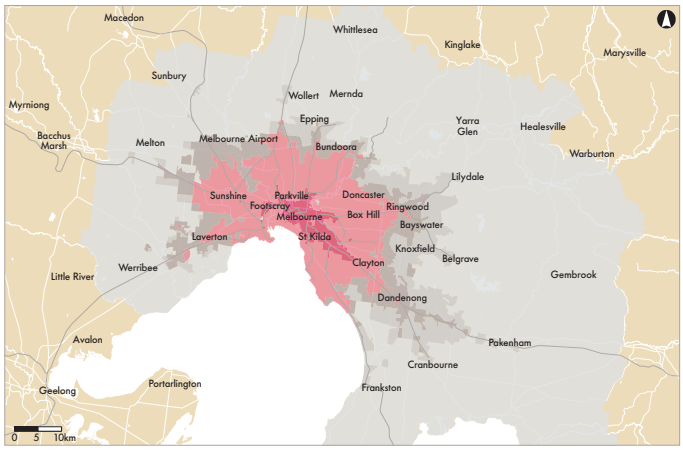
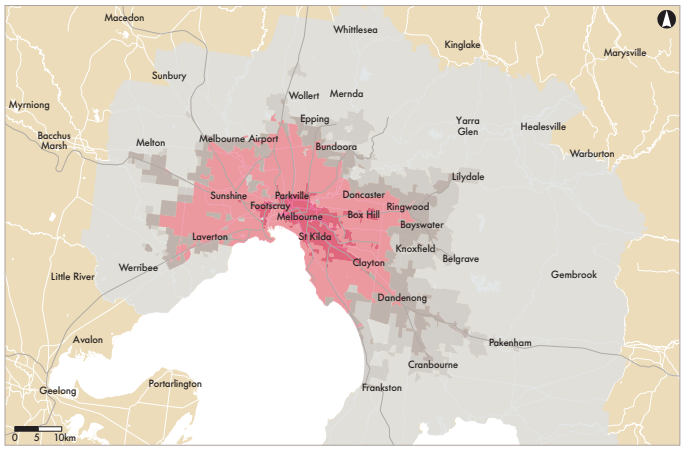


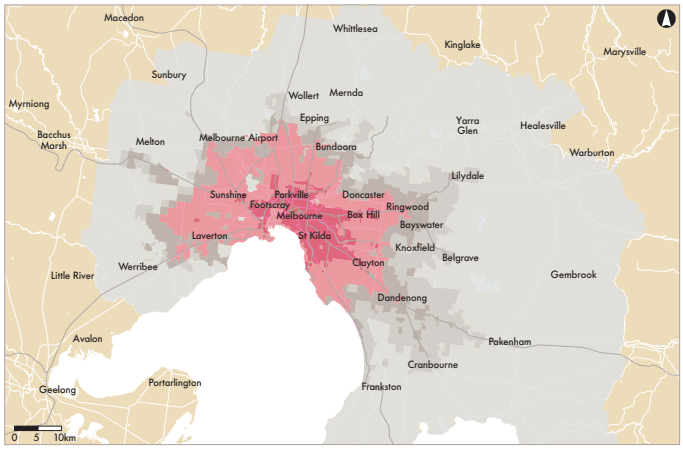
Figure 18: Melbourne – Percentage of jobs that can be accessed by public transport within 60 minutes in the AM peak



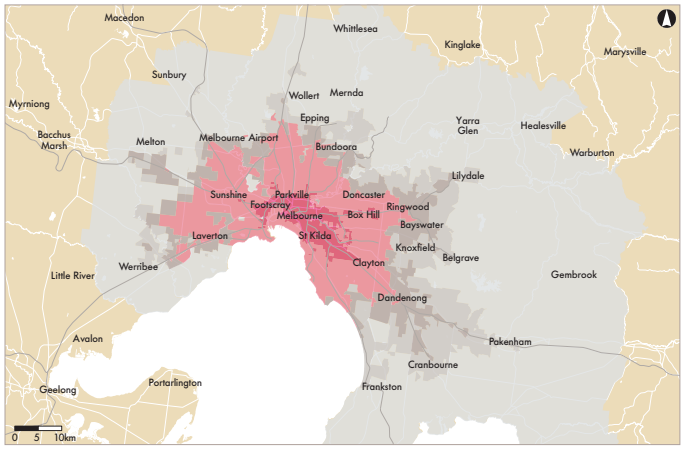
Reference Case (2015)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

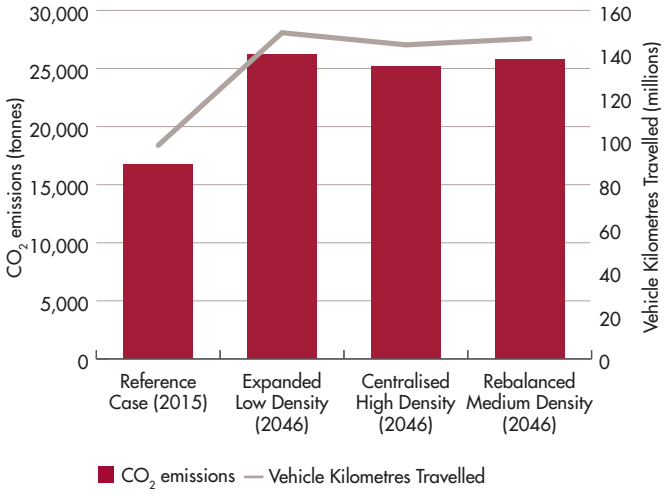
3.3 Environmental performance of the transport network

Cities are significant consumers of resources and generators of emissions. The transport modelling undertaken for Melbourne measured the tonnes of CO_2 emissions from road traffic (including light and heavy vehicles). The modelling does not take into account any change in the fuel efficiency of private vehicles over time or change in the proportion of private vehicles that are electric. Significant shifts in these factors would change these results.

Environmental performance of the transport network is strongest under a centralised city structure

At an aggregate level, CO_2 emissions increase significantly to 2046 under all scenarios, which aligns with increases to vehicle kilometres travelled. Metropolitan-level results for tonnes of CO_2 emitted by all vehicles over a 24-hour period and total Vehicle Kilometres Travelled (VKT) for each scenario are shown in **Figure 20.**

Figure 20: Melbourne – CO_2 emissions and Vehicle Kilometres Travelled



The largest increase in emissions occurs under the Expanded Low Density scenario (a 57% increase from 2015), which can be explained by this scenario having the highest private vehicle use of the three scenarios. As people drive more and further, the emissions from vehicles increases.

3.4 Access to and demand for social infrastructure

As Melbourne grows, the city's essential social services and the infrastructure that supports them will experience an unprecedented increase in demand. Infrastructure Victoria has projected that between 2016 and 2046 the number of people in the state aged 85 or over will grow by 220%, placing increased pressure on infrastructure and supporting services, particularly healthcare.[51] Over the same period, the state's school age population is projected to increase by around 450,000 students.[52] Funding and policy change focused on meeting demand, including increasing capacity, will be required to effectively meet increased demand. The future spatial structure of Melbourne will be a key determinant in how these reforms are identified, designed and implemented. The location of future housing will determine where demand is created and the level of accessibility provided to existing facilities and services.

This section explores the spatial implications of population growth for Melbourne's existing social infrastructure. For the purposes of the report, social infrastructure covers hospitals, schools and tertiary education facilities. It is important to note no additional social infrastructure was included for this modelling, beyond existing assets. This section therefore tests where pressure could be placed and additional infrastructure required, under different land-use structures. In addition, the population and employment reference case year in the social infrastructure modelling is 2016 (one year later than the transport modelling).

The performance of health and education infrastructure is measured using two indicators: changes in accessibility (measured as percentage of the population within a certain area who can access a facility within a defined travel time budget and mode choice) and changes in demand (measured as population per infrastructure facility within a particular area).

Appendix D provides further details on the data and underlying assumptions for this modelling.

Across all scenarios, access to existing hospitals declines, particularly in the outer suburbs

In 2016, metropolitan-level access to hospitals was relatively high, with 87% of Melbourne's population being able to reach a facility within a 20-minute drive or 30-minute public transport trip. However, in 2046, this access declines across all scenarios with the lowest average being 78% in the Expanded Low Density scenario, and highest at 82% in the Centralised High Density scenario.

Table 16 shows the percentage changes in city-wide access to hospital facilities between the reference case and the three 2046 scenarios.

Table 16: Melbourne – Percentage of people with access to hospital facilities

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to a hospital facility	87%	78%	82%	80%

* Ability to reach a hospital facility within 20-minute drive or 30-minute public transport trip

This decline can be attributed to population increases occurring in locations that are far away from existing facilities and there being no additional hospitals added in the scenarios.

Declining access is particularly stark in western Melbourne. Access in this area drops significantly under all scenarios. Melton – Bacchus Marsh sees a 48% decline from 2016 under the Expanded Low Density scenario, which means that only 30% of the population in this area have adequate access to hospitals in 2046. Under the same scenario, Whittlesea – Wallan in the city's north experiences a 42% decline in access from 2016, resulting in 44% of the population being able to access hospitals in 2046 within the time criteria noted above.

Figure 21 maps the distribution of accessibility to hospital facilities at the SA3 level for the reference case and the three 2046 scenarios. The mapping demonstrates the need, regardless of scenario, to cater for population growth by better connecting outer growth areas to essential health services, by either strengthening transport connections to existing institutions, or locating new or relocated facilities close to new growth areas.

Demand for hospitals increases across all scenarios and is particularly strong in the northern and western suburbs

Demand for existing hospital facilities increases significantly from 2016, across all 2046 scenarios. At a metropolitan level, this aligns with increases in total population over 30 years. However, demand differs across scenarios according to the distribution of people in relation to the location of existing facilities.

Table 17 shows the metropolitan average percentage change in demand for hospitals across the scenarios between 2016 and 2046. This measures the spread of demand, with a lower number generally indicating a more even distribution, and lower pressure on facilities.

The particular transport network and distribution of people in the Expanded Low Density scenario delivers the greatest amount of demand for existing hospital facilities, with a substantial average increase of 87%. In contrast, the Centralised High Density scenario better distributes population relative to existing hospitals, showing a 63% increase in average demand across the city.

Table 17: Melbourne – Change in demand for hospital facilities between 2016 Reference Case and 2046 scenarios

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per hospital facility (within SA3s)	+87%	+63%	+85%

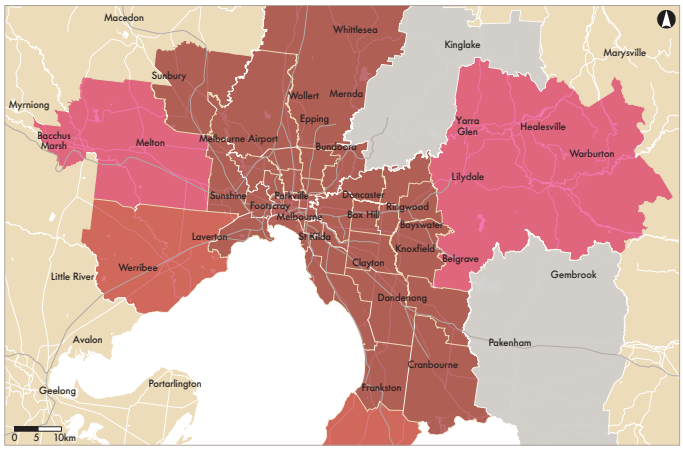
Figure 22 maps the distribution of this demand. There is a significant increase in demand for hospitals in the growth areas to the north (Whittlesea – Wallan), west (Sunbury, Melton – Bacchus Marsh) and south-west (Wyndham) of the city, particularly under the Expanded Low Density and Rebalanced Medium Density scenarios.

These results illustrate the need to deliver adequate infrastructure to support the needs of communities as they grow. Investments should broadly follow demand, with new healthcare facilities being located in areas identified for substantial growth.

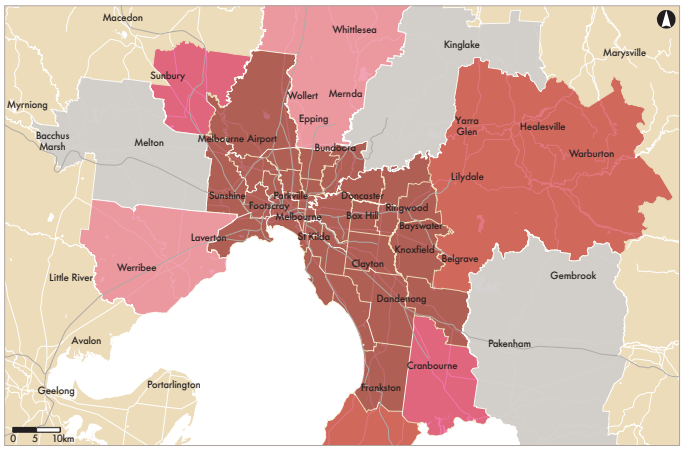
Across all scenarios, demand for schools increases substantially which demonstrates the need for integrated planning for new and upgraded facilities

The Victorian Government is currently responsible for the education of over 600,000 students (this does not include catholic and independent schools) and the ownership and maintenance of about 1,500 school facilities. A large portion of these students and facilities are based in Melbourne.[53]

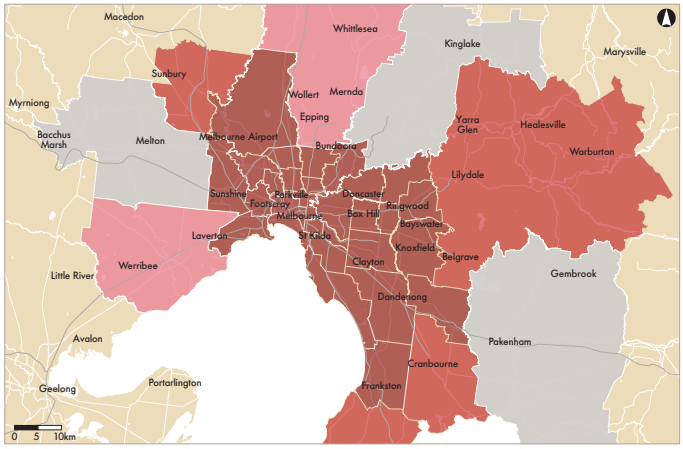
Figure 21: Melbourne – Access to hospital facilities within 20-minute drive or 30-minute public transport trip, by SA3



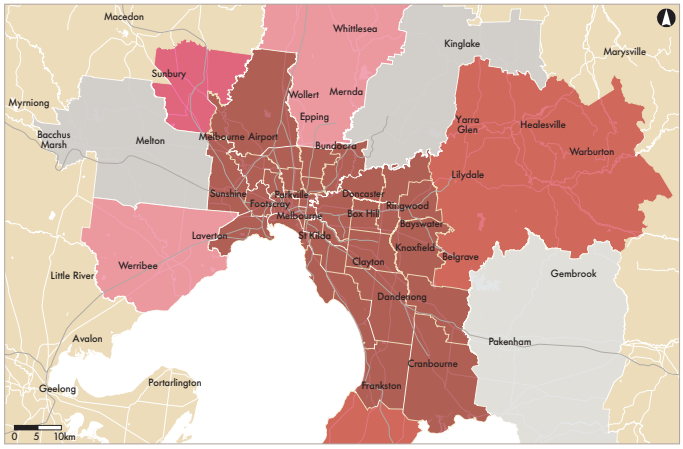
Reference Case (2016)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

The modelling undertaken for this report indicates that across all scenarios, Melbourne is going to experience a large increase in demand for school facilities. Across the three scenarios, average population per existing school will increase by between 74% and 79% from today's numbers.

Access to schools remains relatively stable across scenarios, ranging from 86% to 90%, as schools are generally evenly dispersed because they are planned to serve population catchments. Accessibility decreases from the reference year, but this is because no additional schools are provided in the modelling. This means that areas of population growth in the model that are further away from existing facilities have lower accessibility rankings.

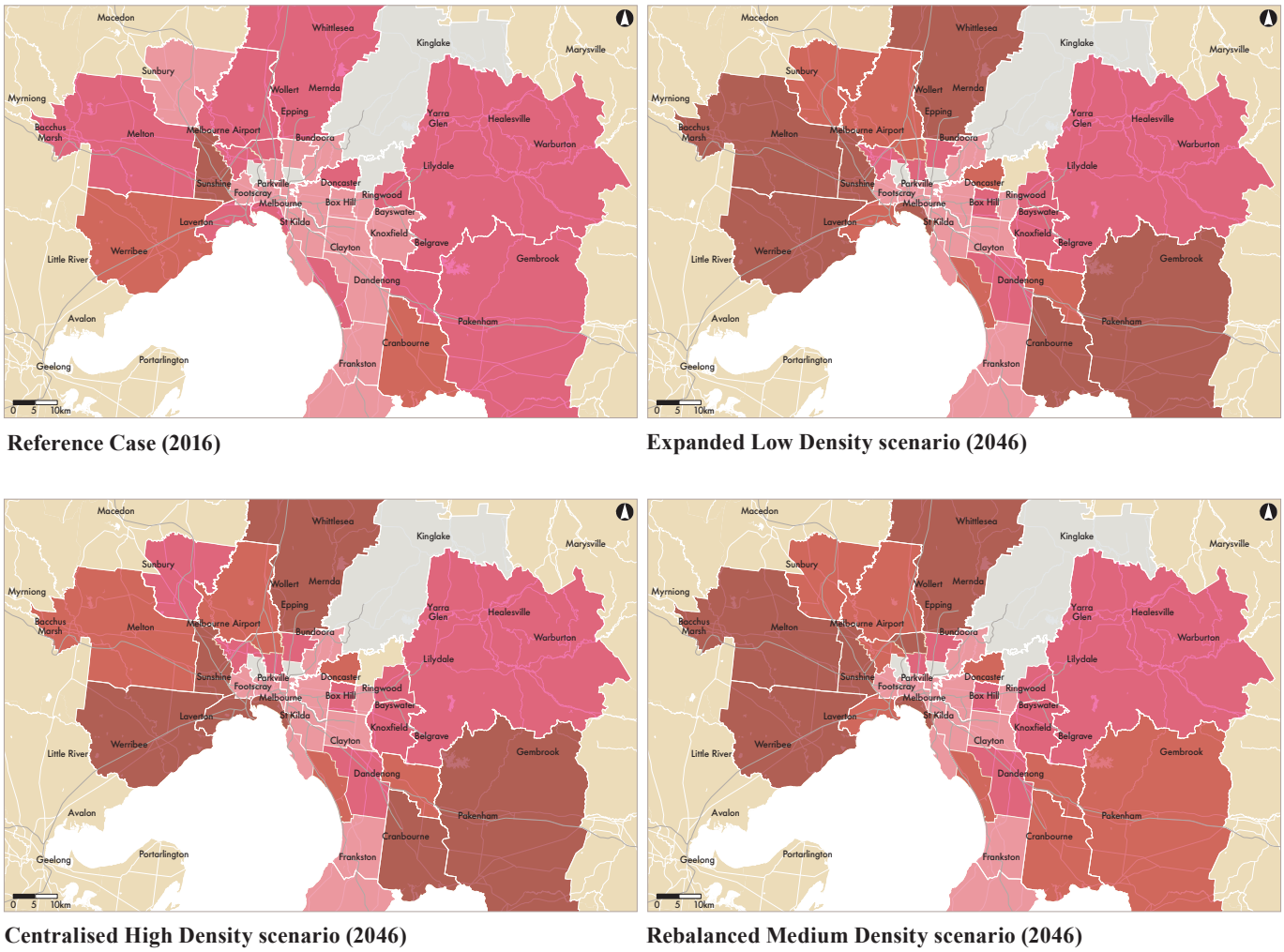
Table 18 shows the change in average population per school, and access to schools, between the 2016 reference case and the three 2046 scenarios, by SA3.

Table 18: Melbourne – Change in demand for schools between 2016 Reference Case and 2046 scenarios

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per school (within SA3s)	NA	+75%	+74%	+79%
Average percentage of population with access* to a school	95%	86%	90%	87%

* Ability to reach a primary or secondary school within a five-minute drive, 20 minutes by public transport or a 40-minute walk

Figure 22: Melbourne – Demand for hospital facilities, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

People per Hospital 0 (no hospitals) <= 50,000 51,000–100,000 101,000–150,000 > 150,000

It is clear that under any future scenario, funding and policy change focused on increasing the capacity of education infrastructure will be required to effectively meet this challenge. However, the content and direction of these actions will be in part determined by the spatial structure of the city. **Figure 23** maps the average population per school across Melbourne at the SA3 level.

The maps demonstrate that the areas of significant growth in population per school and the corresponding implications for investment in upgrading or providing new facilities are:

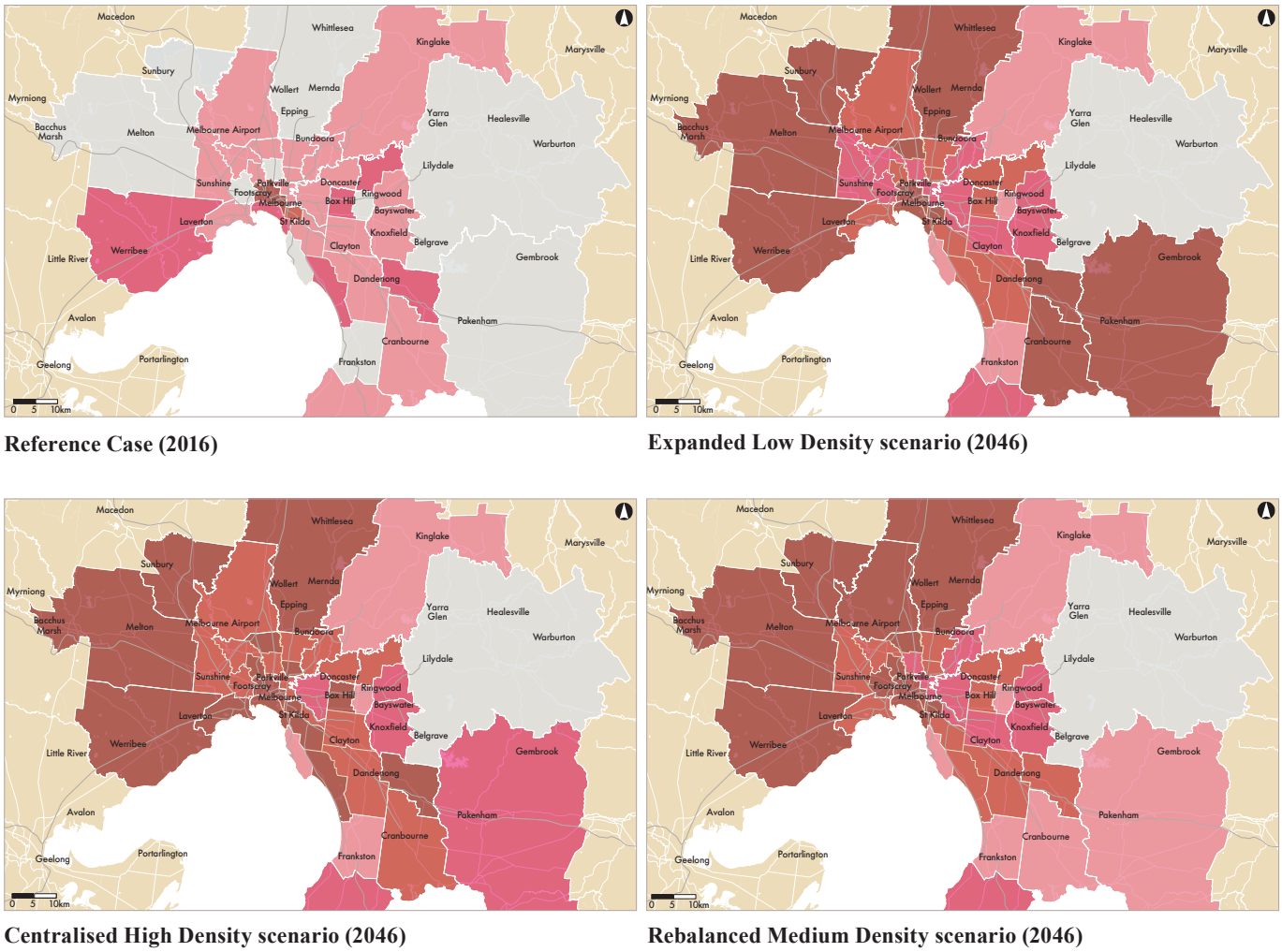
- **West and north-west areas:** Under all scenarios, demand for schools will grow substantially in these areas, leading to very high population per school unless new facilities are built.
- **Inner suburbs:** for all scenarios, schools from St Kilda heading west to Footscray will have very high population per school. For the Centralised High Density scenario, this demand is intensified and extends south-east and west. Due to limited space, the focus in these areas would be to increase the capacity of existing facilities and, where possible, re-purpose land.
- **South-eastern areas:** In the Expanded Low Density scenario, schools in the SA3s of Cardinia, Casey and Casey North experience high levels of demand indicating that new or upgraded facilities would be required.

The Centralised High Density scenario provides the highest level of access and distributes demand most efficiently for tertiary education

Across all scenarios, it is clear that the demand for tertiary education infrastructure, which includes university campuses and Technical and Further Education (TAFE) institutes, will increase as the population of Melbourne grows over the next 30 years.

Table 19 shows the average percentage change in demand for tertiary education facilities across the scenarios from the reference case. The relative differences in demand between

Figure 23: Melbourne – Population per school, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

People per School <= 3,000 3,001–4,000 4,001–5,000 5,001–6,000 > 6,000

the three scenarios reflects the alignment of population growth and the location of existing infrastructure.

The Centralised High Density scenario sees the greatest number of people located in SA3s which are well-serviced by existing tertiary education infrastructure. As a result, demand is spread between facilities and it experiences the lowest average increase in population per facility.

In contrast, the Expanded Low Density and Rebalanced Medium Density scenarios see a large portion of growth located in areas of the city, such as the west and north of Melbourne, where there are relatively few tertiary education campuses.

These dynamics are also evident when looking at changes to accessibility. Currently, metropolitan-wide average access to tertiary education is quite high for Melbourne. About 87% of people can access a university within a 60-minute public transport trip and 79% of people can access a TAFE within a 20-minute drive or 30-minute public transport trip. This shows that the location of transport connections to the city's existing tertiary education institutions is relatively well-suited to the current population distribution.

In 2046, each scenario experiences a drop in overall access from 2016, with the Expanded Low Density scenario experiencing the largest reduction in access of the three scenarios. **Table 20** shows the percentage of the population with access to tertiary education facilities.

Table 19: Melbourne – Change in demand for tertiary education facilities between 2016 Reference Case and 2046 scenarios

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per TAFE (within SA3s)	+63%	+48%	+63%
Average percentage change in population per university (within SA3s)	+89%	+56%	+106%

Table 20: Melbourne – Percentage of people with access to tertiary education facilities

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to a TAFE (within SA3s)	79%	72%	76%	73%
Average percentage of population with access^ to a university (within SA3s)	81%	75%	80%	76%

* Ability to reach a TAFE within 20-minute drive or 30-minute public transport trip
^ Ability to reach a university within 60-minute public transport trip

Figure 24 and **Figure 25** map the distribution of accessibility to TAFE and university facilities at the SA3 level. The mapping illustrates the pattern discussed above, where access to facilities decreases on the outskirts of the city, particularly in the Expanded Low Density and Rebalanced Medium Density scenarios.

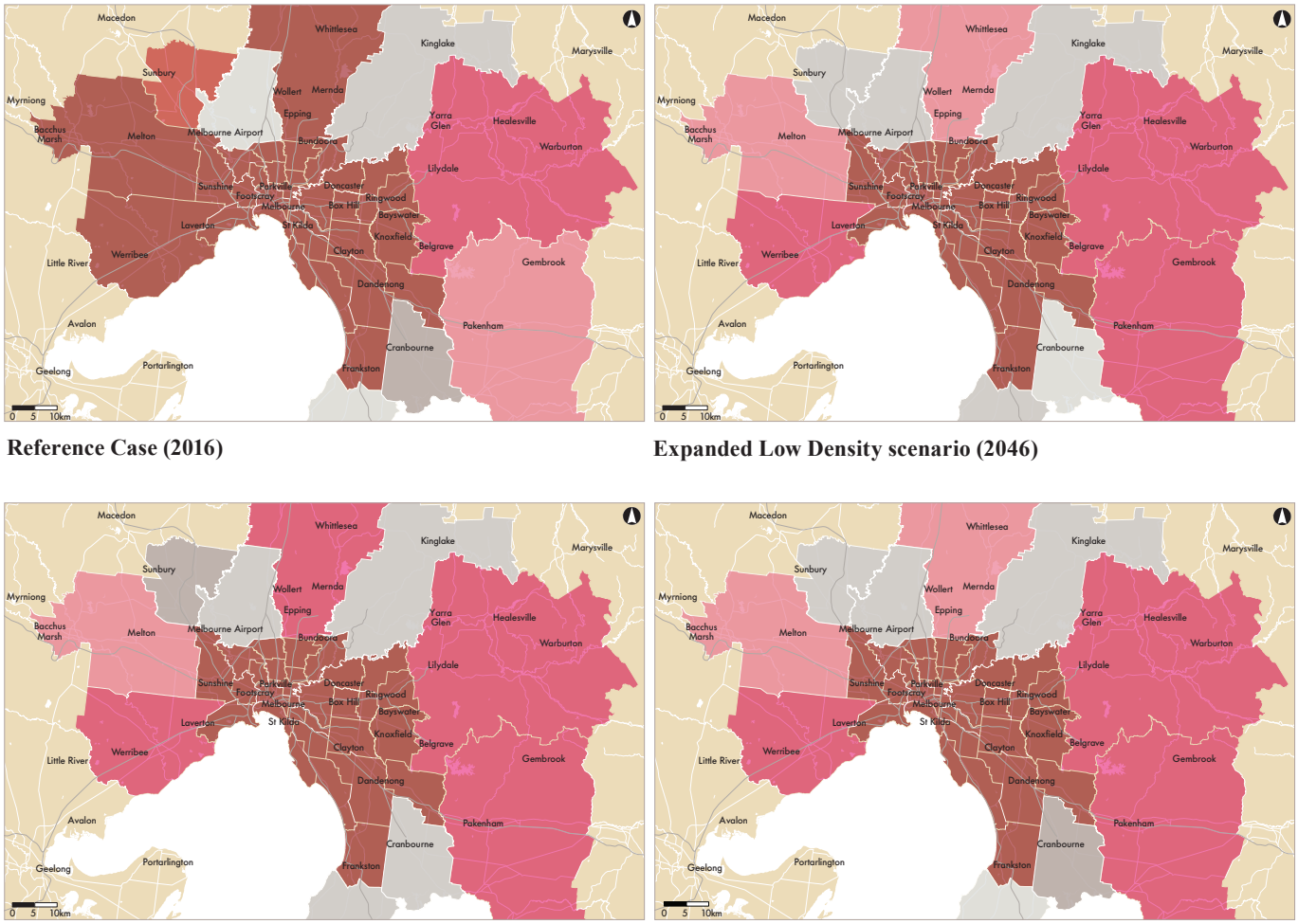
Unlike schools, it is not critical that every local community have immediate access to a tertiary education facility. Instead, university and TAFE campuses tend to locate in centres and draw students from across the metropolitan area. However, significant gaps in access on the outskirts of a city, as indicated most clearly under the Expanded Low Density scenario, have ongoing social equity implications.

3.5 Access to and demand for green space

Melbourne already has a large number of parks, civic spaces and green corridors. Existing spaces are well-distributed in line with its population, with significant pieces of district and regional green space across the city, including clusters in the south-east, south-west, north-west, and inner-city. These spaces not only connect the city to the natural environment, providing space for flora and fauna and enhancing its environmental performance, but they can also function to mitigate the impacts of climate change and provide health and liveability benefits.

The performance of green space is measured using two indicators: changes in accessibility (measured as percentage of the population within a certain area who can access certain types of green space within a defined time budget) and changes in demand (measured as hectares of green space per 1,000 residents). The modelling uses state government green grid data that is split into numerous categories. The results in this report are for areas that are primarily for public use. This means that spaces deemed mostly for private use, such as cemeteries, zoos and sporting facilities are not included. It is important to note green space categorisation is based on underlying state government definitions and spatial mapping so what is included and excluded differs between

Figure 24: Melbourne – Access to university facilities within 60-minute public transport trip, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

% Population < 20% 20–30% 30%–40% 40%–50% 50%–60% 60%–70% > 70%

Melbourne and Sydney. It is therefore important to not compare the two cities.

The green spaces used in the modelling reflect only existing spaces, as defined and mapped by the Victorian Government. This means that planned green space, or potential green space is not included. In reality, governments will deliver new green space alongside development, and will upgrade and enhance existing green spaces, over the next 30 years. As such, the analysis should be viewed as an indication of where demand and accessibility constraints could be located under the different scenarios, rather than an analysis of realistic performance in 2046. It is also important to note that the capacity constraints of existing green space were not taken into consideration for the modelling.

Appendix D provides further details on the data and underlying assumptions for this modelling.

Across all scenarios access to green space decreases significantly for outer growth areas

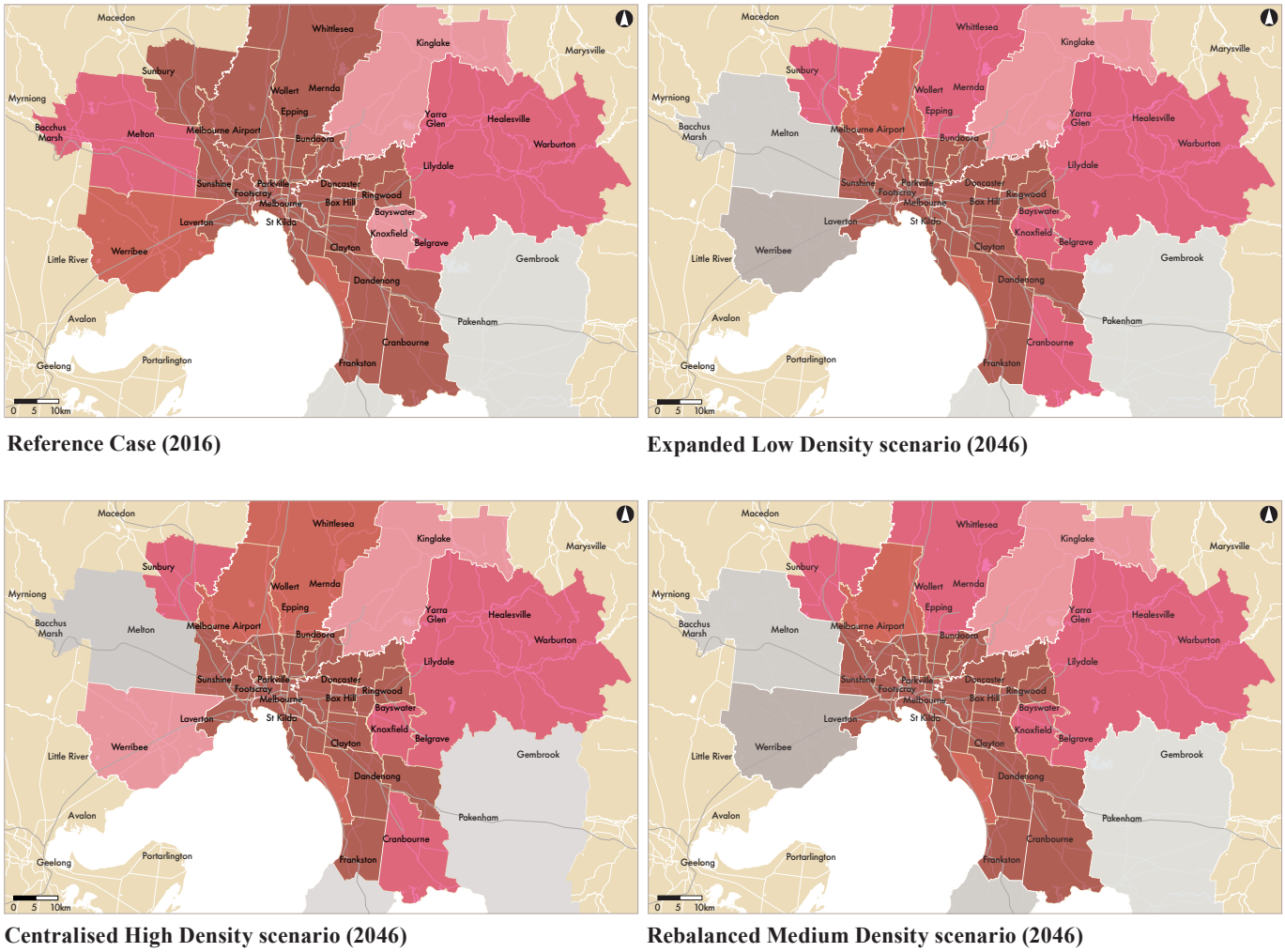
Across the 2046 scenarios, access to green space declines slightly from 2016. **Table 21** shows metropolitan-level aggregate results for access to green space across the reference case and the three 2046 scenarios.

Table 21: Melbourne – Percentage of people with access to green space

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to green space	38%	31%	33%	32%

* Ability to reach any type of green space within a five-minute walk

Figure 25: Melbourne – Access to TAFE facilities within 20-minute drive or 30-minute public transport trip, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

% Population < 20% 20–30% 30%–40% 40%–50% 50%–60% 60%–70% > 70%

The Centralised High Density scenario has the highest level of access to all types of green space across the 2046 scenarios. This is because the scenario focuses future growth in established suburbs – most of which already have parklands. In contrast, the Expanded Low Density scenario has the lowest level of access, reflecting the significant population growth on the city's outskirts, which is further away from existing green space.

Figure 26 shows the percentage of the population within each SA3 that can access any type of green space within a five-minute walk. It shows that under all scenarios, the principal areas where access declines are in the west and north.

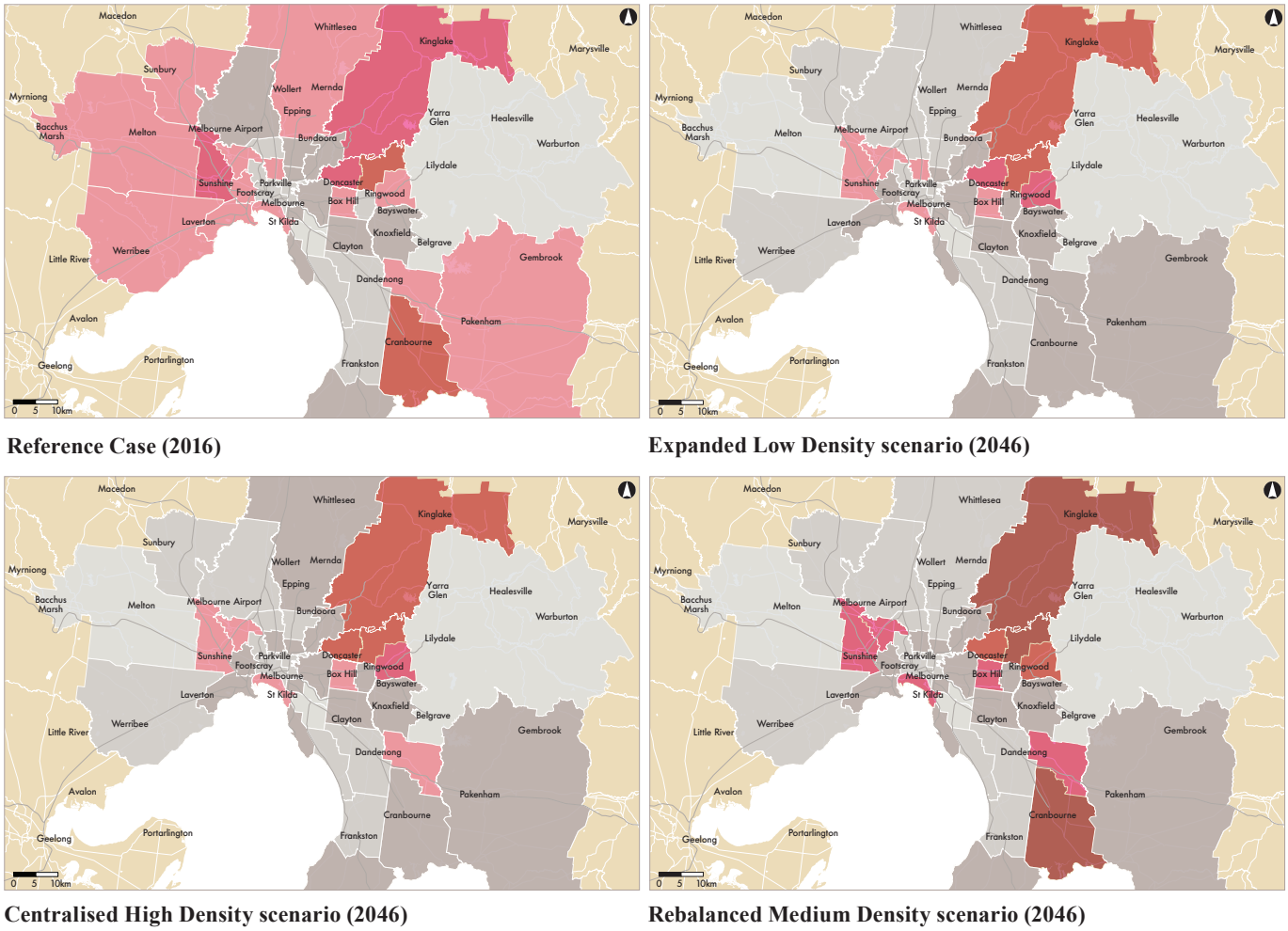
Greenfield areas on the outskirts of the city, while surrounded by 'open' space, still require publicly accessible, useful and high-quality green space to meet the needs of surrounding communities. This means that regardless of the spatial distribution of Melbourne's population into the future, governments will need to focus on delivering accessible green space alongside new greenfield development in the outer areas of the city.

Demand for green space increases for all areas across all scenarios, most significantly in inner-city and outer growth areas

Demand for green space at the metropolitan level is measured by calculating the hectares of green space per 1,000 residents in each SA3 and then taking a weighted average. At an aggregate level, demand for green space increases significantly between 2016 and 2046. This is to be expected, as the population grows without additional green space being added (for the purposes of modelling).

However, the distribution of population growth between the scenarios results in different levels of demand for existing space. The Rebalanced Medium Density scenario provides a slightly higher ratio of hectares of green space per 1,000 residents (i.e. there is more green space for each person) than the other two scenarios. **Table 22** shows the metropolitan-level average demand for green space for the reference case and the three 2046 scenarios.

Figure 26: Melbourne – Access to green space within 5-minute walk, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

% Population < 20% 20–30% 30%–40% 40%–50% 50%–60% 60%–70% > 70%

Table 22: Melbourne – Demand for green space

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average hectares of green space per 1,000 residents (within SA3s)	13.44	9.59	9.63	9.76

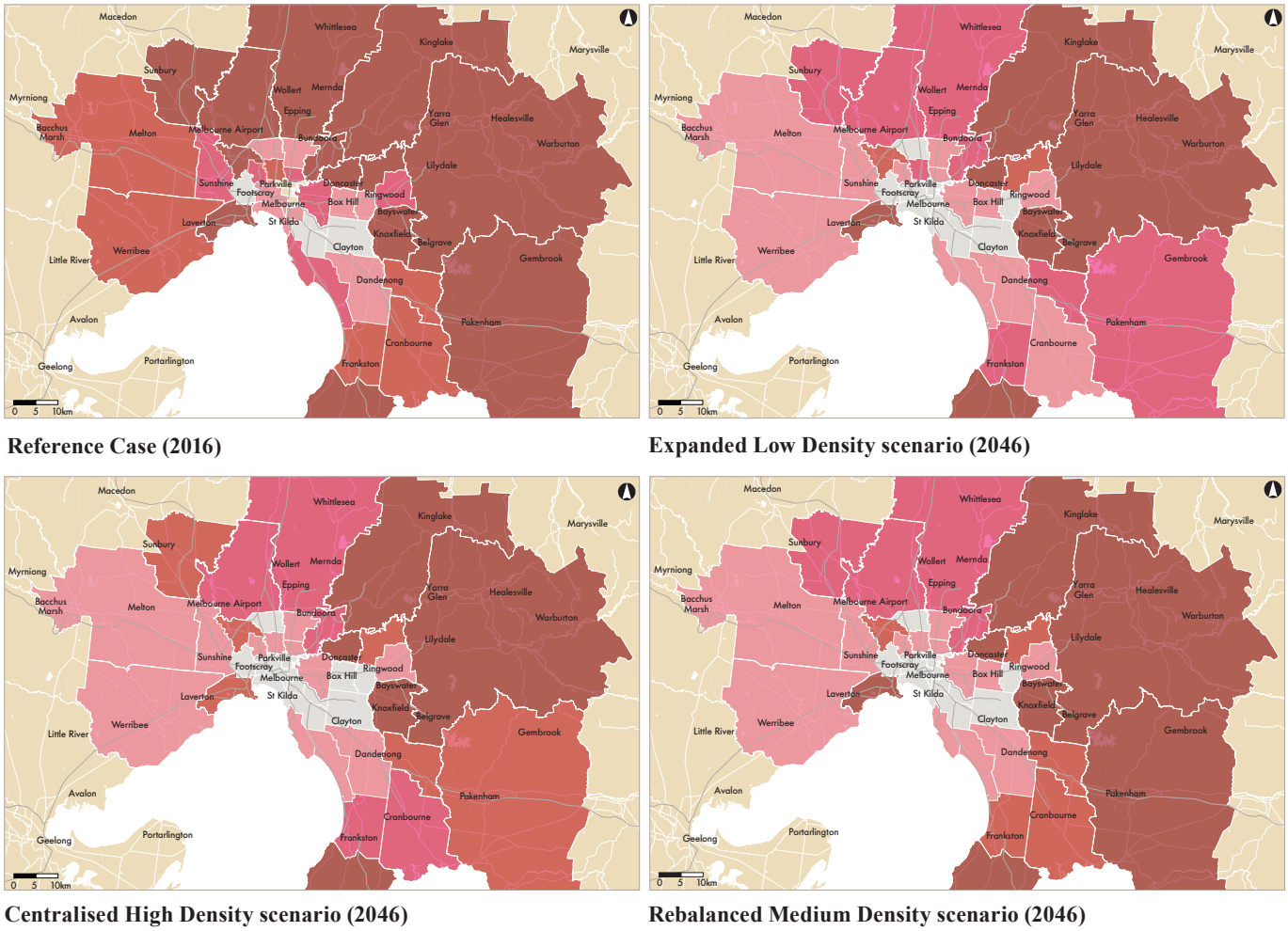
Across the scenarios, the most significant decreases in per capita green space occurs in the western and northern suburbs. These are locations where significant growth occurs, particularly in the Expanded Low Density and Rebalanced Medium Density scenarios.

Figure 27 maps the spatial distribution of this demand, as hectares of green space per 1,000 residents across Melbourne at the SA3 level.

The mapping reflects two important aspects of future demand:

- **Hectares of green space per 1,000 residents will decrease in the outer suburbs:** As the western and northern suburbs grow, the amount of green space per capita will decline unless land is reserved for future parkland.
- **Pressure on inner-city parkland will grow:** The inner-city already had less green space due to higher residential and employment density. Existing parkland will get more crowded as the city grows, meaning management, strategic land acquisition and repurposing will be critical.

Figure 27: Melbourne – Demand for green space, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

Hectares per 1,000 Residents <= 2.0 2.1–4.0 4.1–6.0 6.1–8.0 > 8.0

3.6 Key findings for Melbourne

The scenario analysis in this chapter demonstrates how land use and transport futures will shape the performance and everyday experience of living in Melbourne in coming decades. The indicator results for transport, environment, accessibility, social infrastructure and green space show that a substantial increase in demand for services will require responses from governments, including careful planning, considered investments and targeted policy reform by governments. The following is a list of key findings for Melbourne drawn from the analysis.

1. **Unplanned growth delivers the worst outcomes for Melbourne.** The Expanded Low Density scenario most closely resembles a future of minimal planning intervention within existing areas, with low-density development taking place in outer growth areas away from key employment centres, and with minimal investment in mass transit beyond what is committed. This scenario performed the worst across most indicators. This shows that well-functioning cities, which provide good access to work, crucial services and leisure, require careful planning to locate and connect employment centres, residential development, social services, and green and public spaces.
2. **Public transport is crucial to improving accessibility in a city of Melbourne's future size**. Under all scenarios, the use and performance of public transport services improves. Even as Melbourne grows by more than two million people, both the public transport mode share, and the proportion of the city's jobs that can be accessed by public transport, increase. This shows that public transport is well-suited to moving large volumes of people, particularly in higher density environments.
3. **Private vehicles will continue to play an important role in Melbourne. However, across all scenarios congestion significantly increases, and adding new roads is only part of the solution.** The scenario analysis indicates that private vehicles continue to be used for the majority of trips within Melbourne, and the total number of trips on our roads increases significantly. Congestion also increases. While strategic additions and capacity enhancements to the road network provide congestion relief on parts of the road network, it is evident that other approaches are required to meet the scale of demand, including demand management mechanisms such as road use charging, and public transport investment.
4. **Melbourne can use its existing infrastructure more efficiently.** The scenario analysis indicates that different land-use changes provide opportunities to extract greater value from existing infrastructure across Melbourne. The Centralised High Density scenario shows that placing development around existing public transport infrastructure can deliver accessibility benefits. While new infrastructure will need to be delivered over the next 30 years to support population growth in Melbourne, 'sweating' existing assets can also deliver significant benefits.
5. **Different growth patterns for Melbourne require trade-offs in terms of coordinating and prioritising additional or upgraded infrastructure.** The scenario analysis shows that growth focused on the outskirts, such as Melbourne's north and west, places increased demand on fewer facilities, indicating the need for investment in new, more accessible infrastructure, while demand on infill development indicates the need for upgrades to the capacity of existing facilities. Governments and the community will face a series of choices about the sequencing, type and location of infrastructure to support growth.
6. **Increasing inner-city density, supported by coordinated transport investment, improves Melbourne's job accessibility.** Melbourne's CBD is the city's dominant employment centre and the focal point of its public transport network. The scenario analysis shows that increasing inner-city residential densities moves people closer to jobs and takes advantage of Melbourne's radial transport system, improving job accessibility. Employment centres that are supported by strong transport networks help to improve job accessibility, thereby deepening labour markets for employers and allowing workers to further their skills and experience.
7. **Land-use and infrastructure planning can help to address inequality of access across Melbourne, but supporting social and economic policies are also required.** Land-use and infrastructure planning can help to improve access to jobs and increase economic activity in traditionally disadvantaged areas, such as Melbourne's west. However, the benefits of growth will also need to be distributed using government policy intervention in other portfolios such as education, health and social services.

8. **As Melbourne grows and densifies, green and public spaces play an increasingly important role in maintaining the city's liveability.** The scenario analysis shows that regardless of the way in which these cities grow, population growth on the scale projected sees pressure placed on the public realm. Higher densities mean people have less private space such as backyards, and rely more on existing green and public space which needs to be well-maintained and managed. On the city's outskirts, planning for new suburbs needs to include new green and public space which adds to existing assets.
9. **Land-use changes can play some role in addressing the amount of carbon emissions our cities generate.** Australian cities are the principal generators of Australia's carbon emissions and, without significant change, the growth of these cities will only increase this trend further. The scenario analysis shows that different land-use and transport infrastructure choices can improve the environmental performance of Melbourne's road network. In particular, higher density spatial patterns that encourage mode shift away from private vehicles towards active and public transport generate lower carbon emissions, reducing the city's impact on the environment.

Maps can be viewed in more detail at www.infrastructureaustralia.gov.au.

Sydney today and in 2046

At a glance

- Sydney is Australia's largest city. It is routinely ranked as one of the most attractive destinations in the world and plays a significant political and economic role, both nationally and on a global scale. However, like many growing cities, Sydney is experiencing issues resulting from increasing transport congestion, and costs of living.
- Sydney is projected to grow by around 2.7 million people over the next 30 years. The rate of growth, combined with the challenges the city is already facing, means it is important to think about how and where this growth could occur. To test this, Infrastructure Australia has adapted and applied three 30-year growth scenarios to Sydney's specific social, economic and geographic features.

4.1 Sydney today

Today, Sydney is a leading global city. It covers approximately 10,500km^2 and is home to around 4.7 million people, having grown by around half a million people over the last decade.[54]

The city is located on land originally inhabited by the 29 indigenous clans of the Eora Nation, who lived on the land for at least 30,000 years prior to European settlement. European settlers arrived in the late 1700s, establishing Sydney as a British penal colony. Sydney's initial growth was rapid and unplanned, from the inner-city in the east, towards the north-west and south, Sydney evolved based on its geography and history, rather than as a planned city.

The spatial structure of the city is focused around its central business district, which sits to the south of Sydney Harbour, on the far-eastern side of the city. The surrounding metropolitan area extends to the natural borders of the Pacific Ocean to the east, Woronora Plateau to the south, Blue Mountains and Nepean River to the west, and Hawkesbury Plateau and River to the north. It is partially divided into north and south by Sydney Harbour and the Parramatta River.

The city is routinely ranked as one of the most liveable and attractive destinations in the world, and it plays a significant economic and cultural role nationally and increasingly within the wider Asia Pacific region. But the rapid growth of Sydney has placed pressure on the city's key assets and poses a number of challenges, which, left unaddressed, could impact on liveability, productivity and social equity.

Housing: a sprawled city, starting to densify

Despite being Australia's largest city, Sydney is a low-density city by international standards. Residential densities are lowest in outer-western areas of the city, particularly for greenfield development, and gradually increase towards the inner-city.

Recent trends toward densification have been seen in inner areas. Today, around 43% of Sydney's homes are attached dwellings, an increase from 39% in 2011.[55] Apartment construction has been a significant part of this trend and

has largely occurred in inner-urban areas and along key public transport routes. Despite these trends, the majority of Sydney's population still lives in low-density housing, with 57% of the population living in detached homes.[56]

Over two million people live more than 20 kilometres away from Sydney's central business district.[57] Greenfield development on the fringe of the city is dominated by large, detached homes. Middle ring suburbs, located 15 to 20 kilometres from the centre, are predominantly occupied by detached houses on quarter acre blocks. Older, inner suburbs have generally retained higher density development, with homes such as terraces, semi-detached houses and apartments.

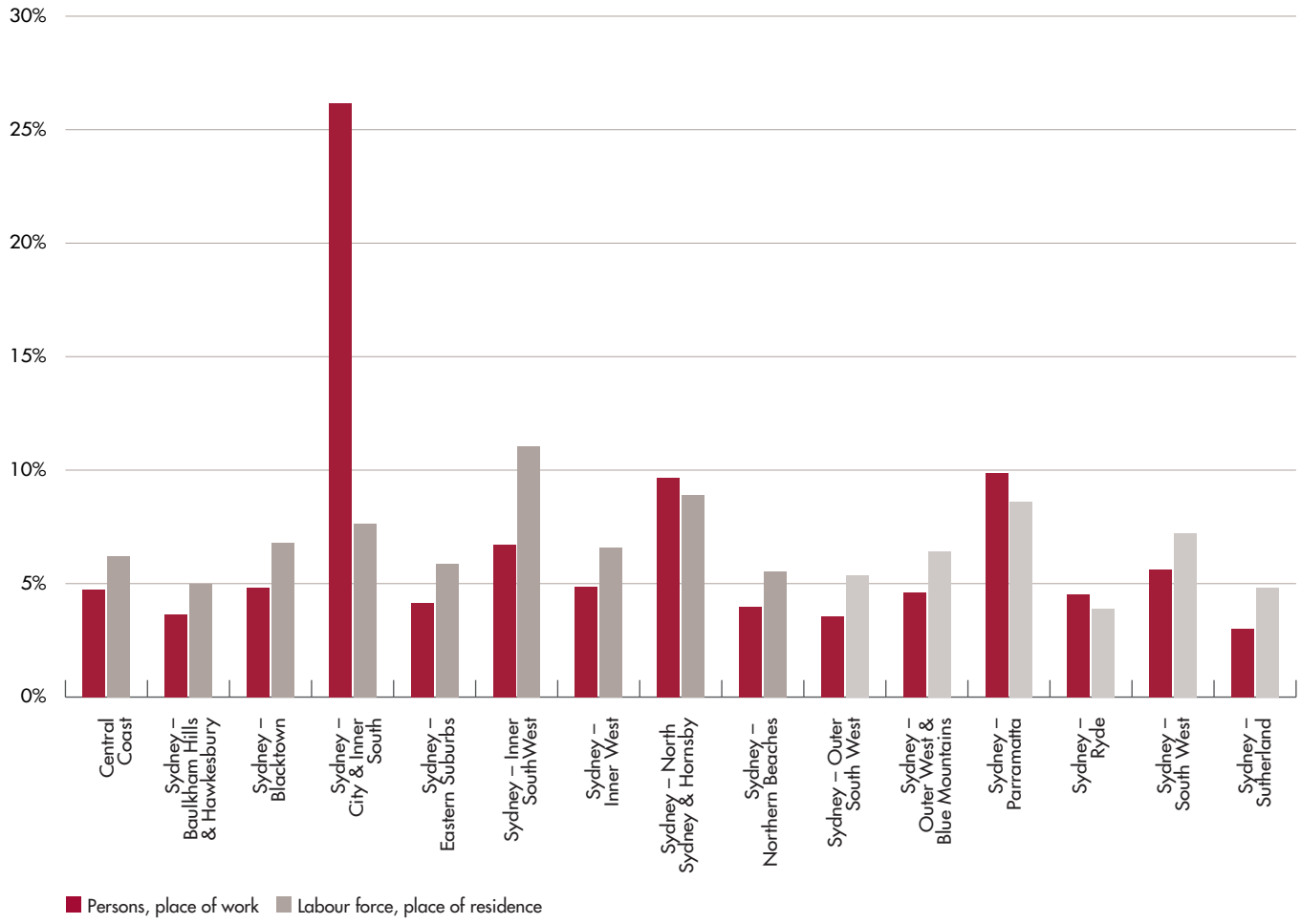
The dispersed nature of housing in Sydney is reinforced by an increasingly unaffordable housing market. Sydney is currently the most expensive place in Australia to buy a home. Between June 2012 and June 2017 the median house (detached dwelling) price for the city increased by 53% (adjusted for inflation). This represents a compound annual growth rate of 9%.[58] Over the same period, wages have grown nationally by a total of 12%, with a compound annual growth rate of 2%.[59] This means there is an increasing number of people who are unable to enter the housing market in Sydney. Particular affordability pressure is placed on certain suburbs, generally in the inner and middle areas, which have good quality access to transport, high value jobs and lifestyle amenity.

Employment: a centralised jobs market with polycentric potential

Sydney leads Australia's economy, having accounted for around 40% of national GDP growth, and 24% of total GDP in 2015-16.[60] The city is also at the centre of Australia's shifting economic focus, from resources and manufacturing toward services, finance and innovation. Over the period from 1996-2016, Sydney's industry structure changed significantly. Manufacturing, which had led the city's economy in previous decades, more than halved, while the focus shifted towards knowledge and professional services industries, supported by health services and construction. Today, manufacturing makes up 5.7% of Sydney's economy, while financial, insurance and professional services make up 24.4%.[61]

This shift towards the knowledge economy has reinforced the role of the central business district in Sydney's economy and encouraged a growing mismatch in the location of jobs and homes. **Figure 28** compares the percentage of jobs and labour force that are based in each SA4 across Sydney. It demonstrates the significant role that the inner-city (Sydney City and Inner-South) plays in Sydney's economy, accounting for about 26% of all jobs. However, only 8% of the city's workforce live in this area, meaning the vast majority of people commute from elsewhere to work in there.[62] Sydney is also the only Australian city with significant job centres outside of the central business district. Other centres, such as Parramatta, North Sydney and Ryde (including Macquarie Park), draw a substantial balance of residence and employment. This provides a strong foundation for Sydney to grow further as a polycentric city.

Figure 28: Sydney – Share of metropolitan employment, and labour force place of residence, by SA4[63]



Proximity to jobs in Sydney correlates with the distribution of wealth across the city. Areas that are either close to or have good access to job-rich centres, such as the inner-city, eastern and northern suburbs, have the highest income levels. Areas with lower average incomes are generally those where the resident workforce is larger than the number of jobs. Residents in Sydney's west and south-west earn roughly 75% of the average income of those living in the east and north.[64] These areas are further away from significant job centres and also have lower access to public transport, meaning their access to economic opportunities is likely to be poorer.

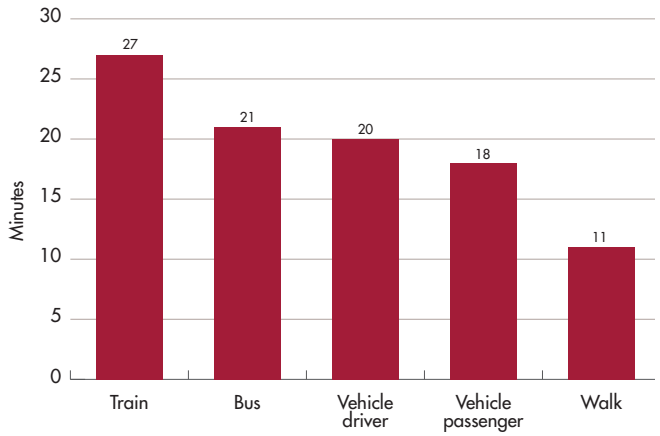
Transport: the cost of congestion and unequal access to public transport

Greater Sydney is served by an extensive and diverse transport network. The road, bus and railway networks cover areas across the city, while inner and middle areas are also served by ferries and light rail.

Despite being home to Australia's largest urban passenger rail network by patronage, with 361 million trips in 2015-16, the dominant mode of travel across Sydney is private vehicle. 69% of trips taken on an average weekday are by private vehicle.[65] The dominance of private vehicles means that Australia's largest city is also its most congested. The *Australian Infrastructure Audit* found that seven of the nation's 10 most congested roads were in Sydney.[66] It also found the cost of congestion in the Sydney – Newcastle – Wollongong conurbation was about $5.6 billion per year, almost double the cost of road congestion in the Melbourne – Geelong conurbation.[67]

Uncompetitive travel times for public transport, especially in comparison to private vehicles, are an important factor in its relatively low mode share in Sydney. Trips via public transport are often longer in duration than those taken by private vehicle, as shown in **Figure 29.**

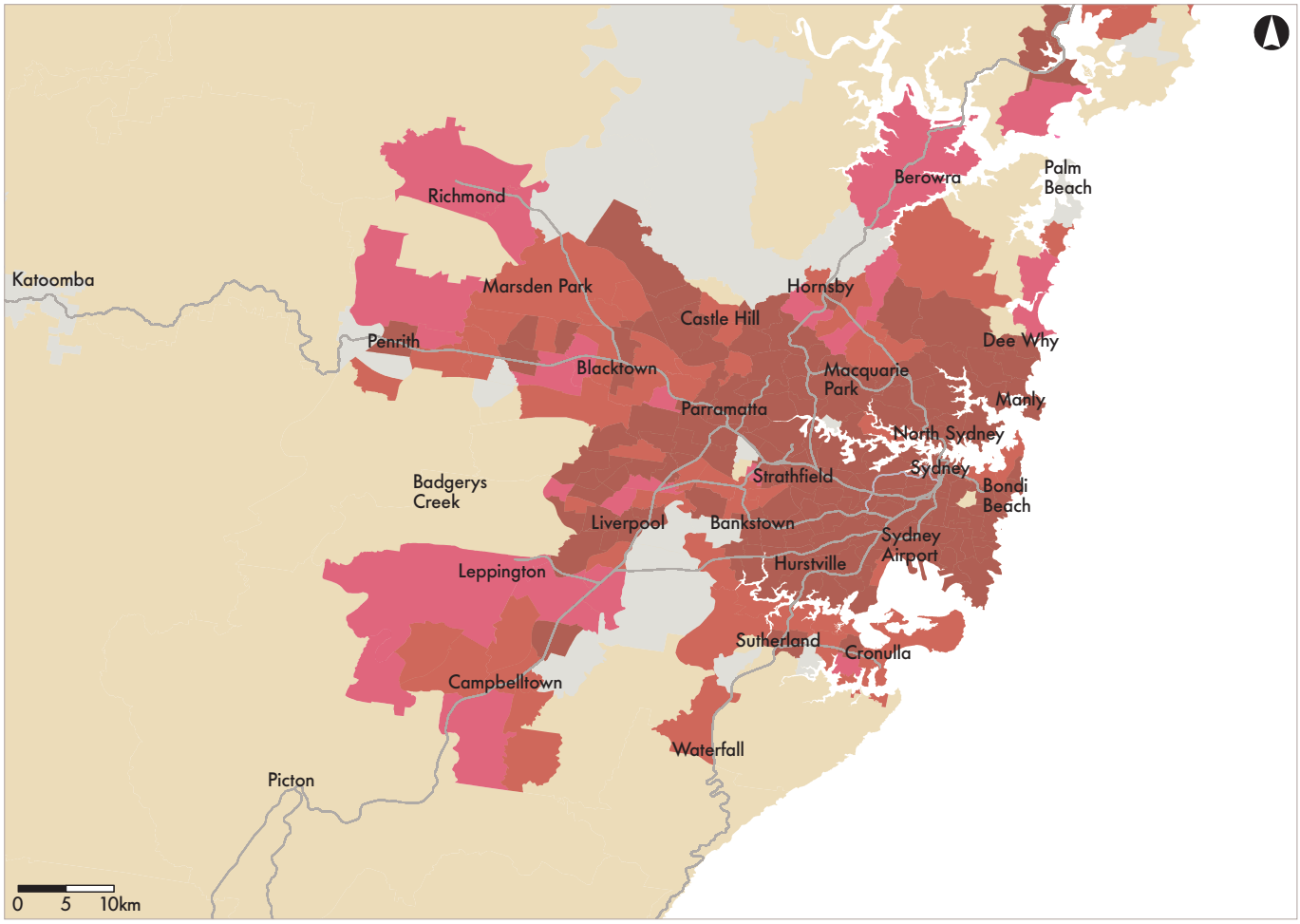
Figure 29: Sydney – Average weekday trip times, by mode[68]



Despite the disparity between public transport and car-based journey times and its relatively small mode share, public transport still plays an important role in making Sydney function, and enhancements to the network that extend its reach, reliability and accessibility can in turn take pressure off roads and alleviate congestion.

Access to transport across Sydney is defined by clear geographic disparities. The historical development of the transport network means access to the network is good in inner and middle areas of the city, but limited in outer suburbs. This means the benefits of the network, which like all public transport in Australia is heavily subsidised, largely flows to those who can afford to live in inner and middle areas. **Figure 30** demonstrates this pattern. It shows the percentage of the population within walking distance of a medium-high frequency public transport service. Accessibility gradually declines with distance from the city-centre and there are a number of outer areas where only 20%-40% of the population have access to frequent public transport. This contributes to a higher mode share for private vehicles in outer areas of the city than in inner areas, as there are fewer public transport options.[69]

Figure 30: Sydney – Walking access to medium-high frequency public transport, by SA2[70]



% Population < 20% 20–40% 40%–60% 60%–80% > 80%

Note: Medium-high frequency is defined as four or more services per hour. Walking access is defined as an 800-metre walk for railway stations and 400-metre walk for bus and tram stops.

4.2 The New South Wales Government's long-term vision for Sydney's growth

Sydney is on the threshold of significant transformation to its metropolitan vision for future growth. In October 2017 the recently established Greater Sydney Commission, an independent government organisation tasked with leading metropolitan planning for Greater Sydney, released its draft *Greater Sydney Region Plan*. This draft will be followed in 2018 by a final 40-year metropolitan strategy for Sydney, developed in conjunction with a new technology and customer-focused state transport strategy, and a new state infrastructure strategy.[71] This process is the first time long-term infrastructure and land-use planning have been developed in concert for Sydney.

The draft *Greater Sydney Region Plan* builds on the city's polycentric foundations, presenting a future structure for the city as a 'metropolis of three cities' consisting of the established eastern city, around the existing central business district; the developing central city, around Parramatta; and an emerging western city around the new Western Sydney Airport.[72]

This structure is driven by the opportunity of the Western Sydney Airport, and the forthcoming City Deal between local governments, the New South Wales Government and the Australian Government that aims to better integrate and target investment across governments within the western Sydney region.[73] This structure aims to shift employment and population growth across metropolitan Sydney, supported by significant investments in transport infrastructure.

Medium-density housing will be encouraged in existing areas which are well-serviced by transport and jobs, while significant growth will still occur in the north-west, west and south-west greenfield growth centres. More jobs will be located in the west, focusing on the development of health and education precincts in the central and western cities. The growth of these areas will be supported by significant road and rail upgrades, and connections to new centres, such as the Western Sydney Airport.[74]

The draft *Greater Sydney Region Plan* also calls for the New South Wales Government to increase the delivery of affordable housing, create a more efficient and resilient city and work to minimise the impacts of climate change.[75]

4.3 Applying the three growth scenarios to Sydney

Infrastructure Australia has developed three distinct scenarios that project how Sydney could grow over the next 30 years.

The following five assumptions have been applied across all three scenarios, based on NSW Government data:[76]

- The metropolitan boundary of the Greater Sydney Region reflects the area covered by the Greater Sydney Commission. It is defined by 33 LGAs from Pittwater in the north, Blue Mountains in the west and Wollondilly in the south
- The reference case year is 2016
- Sydney's population will total 7.3 million people in 2046, an increase of 2.7 million people from 2016
- Jobs in Sydney will total 3.7 million in 2046, an increase of 1.3 million jobs from 2016
- The location of Sydney's existing population and jobs that make up the 2016 reference case remains largely the same between 2016 and 2046, the scenarios focus on the redistribution of growth.

Each scenario differs based on a unique set of assumptions developed by Infrastructure Australia, applied to the following areas:

- The location of the additional 2.7 million people living in Sydney, and the density and type of housing they live in
- The location of the additional 1.3 million jobs
- The structure of the transport network required to support each scenario's different land-use patterns.

4.4 The Expanded Low Density scenario

It reflects a potential future which is shaped by the existing community's concerns about growth and densification changing the character and performance of existing areas. The scenario focuses growth on low-density development, such as detached homes with private backyards, and private vehicles as the primary mode of transport. This is achieved by maximising the location of population growth (and associated 'population-serving' jobs) in outer, greenfield areas. The existing economic structure of the city is reinforced, with new jobs being located in and around the inner-city.

Figure 31 provides a metropolitan schematic of Sydney's structure under this 2046 scenario.

Distribution of population growth

This scenario sees 30% of the city's population growth between 2016 and 2046, equalling roughly 796,000 people, located in greenfield growth areas located on the outskirts of Sydney, in the north-west and south-west in particular. Housing within these growth areas extends to the full geographic boundaries of the areas and is built at a low density, primarily through the delivery of detached housing. This proportion of greenfield development is derived from analysis of Sydney's reasonable capacity for further

outward expansion. Unlike other Australian cities, Sydney's growth is constrained by the geographic factors of the city's surrounding areas, such as mountains to the west, the ocean to the east, and national parks located to the north and south.

The remaining 70% of population growth and corresponding new housing, equalling roughly 1.9 million people, is dispersed throughout Sydney's established areas, focusing where possible along rail corridors and at key urban renewal sites. New housing in these existing areas ranges from higher densities around train stations, employment centres and other well-serviced locations, to more medium-density attached and dual occupancy housing in suburban locations.

Table 23 provides an overview of how Sydney's additional population growth is distributed under this scenario. It shows the total population for each district of the city, and the percentage change between 2016 and 2046.

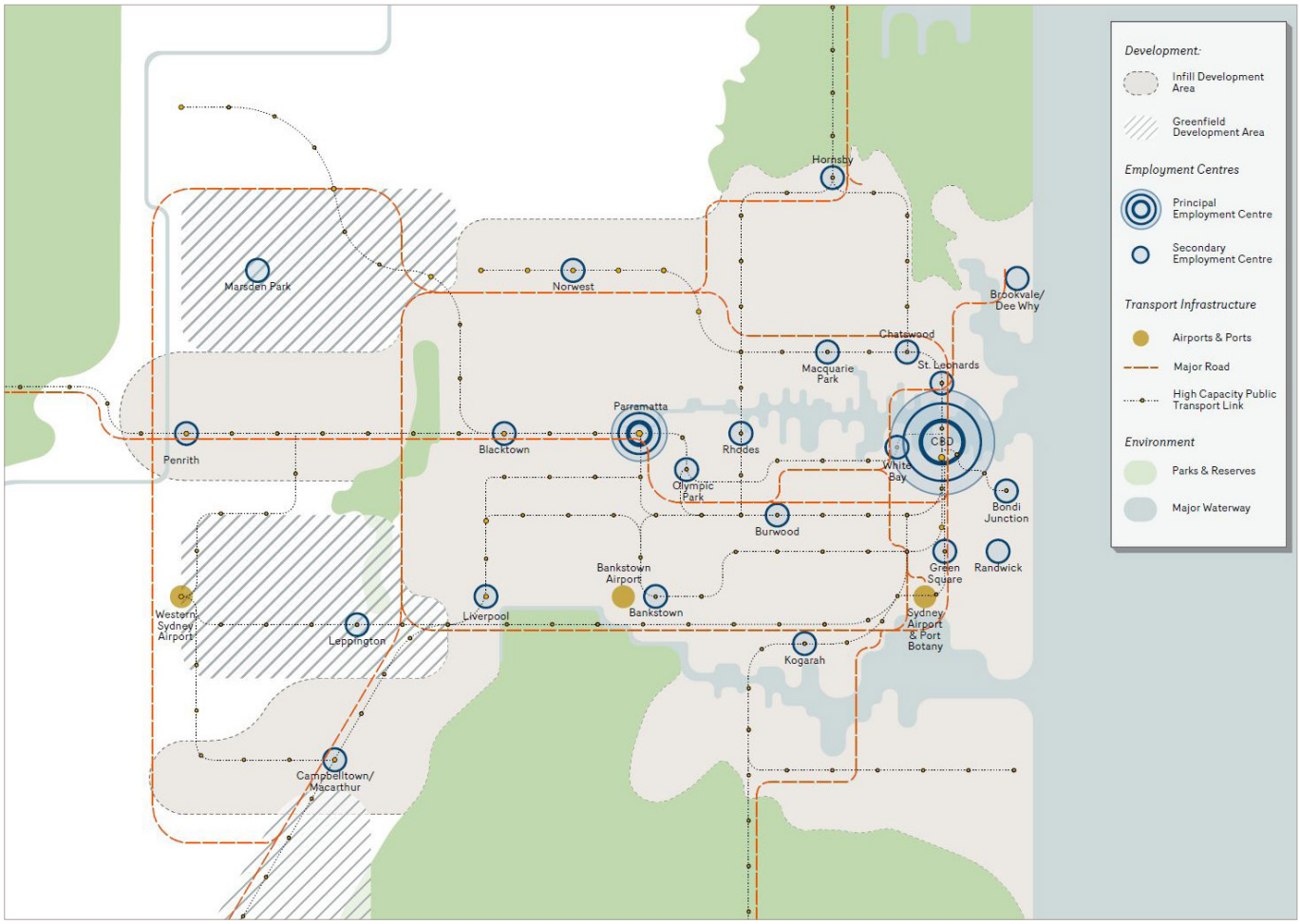
Table 23: Sydney – Expanded Low Density scenario – population by district

District*	Reference Case (2016)	Expanded Low Density scenario (2046)	Percentage change
Central	1,010,000	1,430,000	41%
North	890,000	1,170,000	32%
South	740,000	1,030,000	38%
South West	720,000	1,430,000	100%
West	350,000	490,000	37%
West Central	970,000	1,800,000	85%
Total population	**4,680,000**	**7,340,000**	**57%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016[77]

Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Figure 31: Sydney – Expanded Low Density scenario



Distribution of new jobs

The current structure of Sydney's economic geography will be maintained under this scenario. The major employment destination for the city is the central business district. The capacity of the central business district is increased to accommodate new jobs and economic activity is extended south along the Central to Eveleigh corridor. In line with current trends Parramatta also sees a significant number of additional jobs located within its growing CBD. Other key secondary employment centres such as, Macquarie Park, North Sydney and Liverpool also experience growth. The Western Sydney Airport is established, however, there is limited economic growth beyond airport-supporting jobs in the surrounding precinct.

In addition, some population-serving jobs, such as retail and healthcare, are located in outer urban areas where there is substantial population growth. Growth in the south-west district is significant, with an increase in jobs of 96% between 2016 and 2046, largely driven by population-serving industries.

Table 24 provides an overview of how Sydney's additional employment growth is distributed under this scenario. It shows the total employment for each district of the city, and the percentage change between 2016 and 2046.

Table 24: Sydney – Expanded Low Density scenario – employment by district

District*	Reference Case (2016)	Expanded Low Density scenario (2046)	Percentage change
Central	900,000	1,260,000	39%
North	480,000	690,000	42%
South	240,000	340,000	42%
South West	240,000	460,000	96%
West	130,000	220,000	62%
West Central	440,000	770,000	74%
Total employment	**2,440,000**	**3,730,000**	**53%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016

Note: Employment rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

The structure of the transport network is expanded under this scenario to better connect large populations living in the outer areas of the city to centralised employment centres.

The road network is upgraded and extended to better connect population growth in the outer areas of the city, to employment centres, particularly the central business district. This includes significant new links which connect the city to the central-west, south-west, south, port and airport, north-west and north-east. Upgrades are focused on outer-western roads, particularly in the south-west and north-west, to support significant population growth in these areas. A new orbital link between the south-west and the north-west better connects areas within western Sydney and provides additional capacity for intercity travel. New local and regional roads are built to support the establishment of the Western Sydney Airport.

The public transport network is also enhanced, supporting large numbers of people travelling into and out of the central business district for work from outer areas. New high capacity rail links connect the central-west, north-west, south-west into the city, and Western Sydney Airport to other centres in the west. Light rail and rapid bus links connect the city and the inner-east, and the Parramatta region. Existing local and regional bus links, particularly in the inner-city, north-east, central-west and north-west, are also enhanced.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

4.5 The Centralised High Density scenario

This scenario presents a compact, higher density vision for Sydney. It reflects a potential future that aims to make more efficient use of the existing structure of the city, by locating people and jobs close to existing infrastructure and amenities. The scenario delivers material changes to the urban fabric of Sydney's existing inner and middle suburbs. This is achieved by focusing new housing in inner areas, around existing transport hubs and employment centres, increasing the density of people and activity in these areas. Outer suburbs remain relatively unchanged. New jobs are located in existing employment centres, with a particular focus on the central business district and Parramatta.

The scenario aims to test the quality of outcomes delivered by this higher density approach. This builds on the recommendations made in the 2016 *Australian Infrastructure Plan* that called for the increased delivery of 'higher quality, higher density development within established areas in Australian cities'.[78]

Figure 32 provides a metropolitan schematic of the city's structure under this 2046 scenario.

Distribution of population growth

Under this scenario, 90% of Sydney's additional population equalling 2.4 million additional people is delivered through the renewal and densification of Sydney's inner and middle suburbs in the east, inner-west, inner-north and inner-south of the city. Development is focused in the areas surrounding rail and light rail stations and high frequency bus interchanges. It is delivered at high densities, with multi-unit apartment buildings the predominant style of dwelling. The scenario envisages a lifestyle shift for people living in these inner areas, with smaller private spaces, increased active and public transport use and a greater reliance on shared public spaces becoming the norm. The remaining 10% of additional population equalling 265,000 people is delivered in greenfield areas at a lower density, focused in south-west and north-west growth areas.

Table 25 provides an overview of how Sydney's additional population growth is distributed under this scenario. It shows the total population for each district of the city, and the percentage change between 2016 and 2046.

Figure 32: Sydney – Centralised High Density scenario

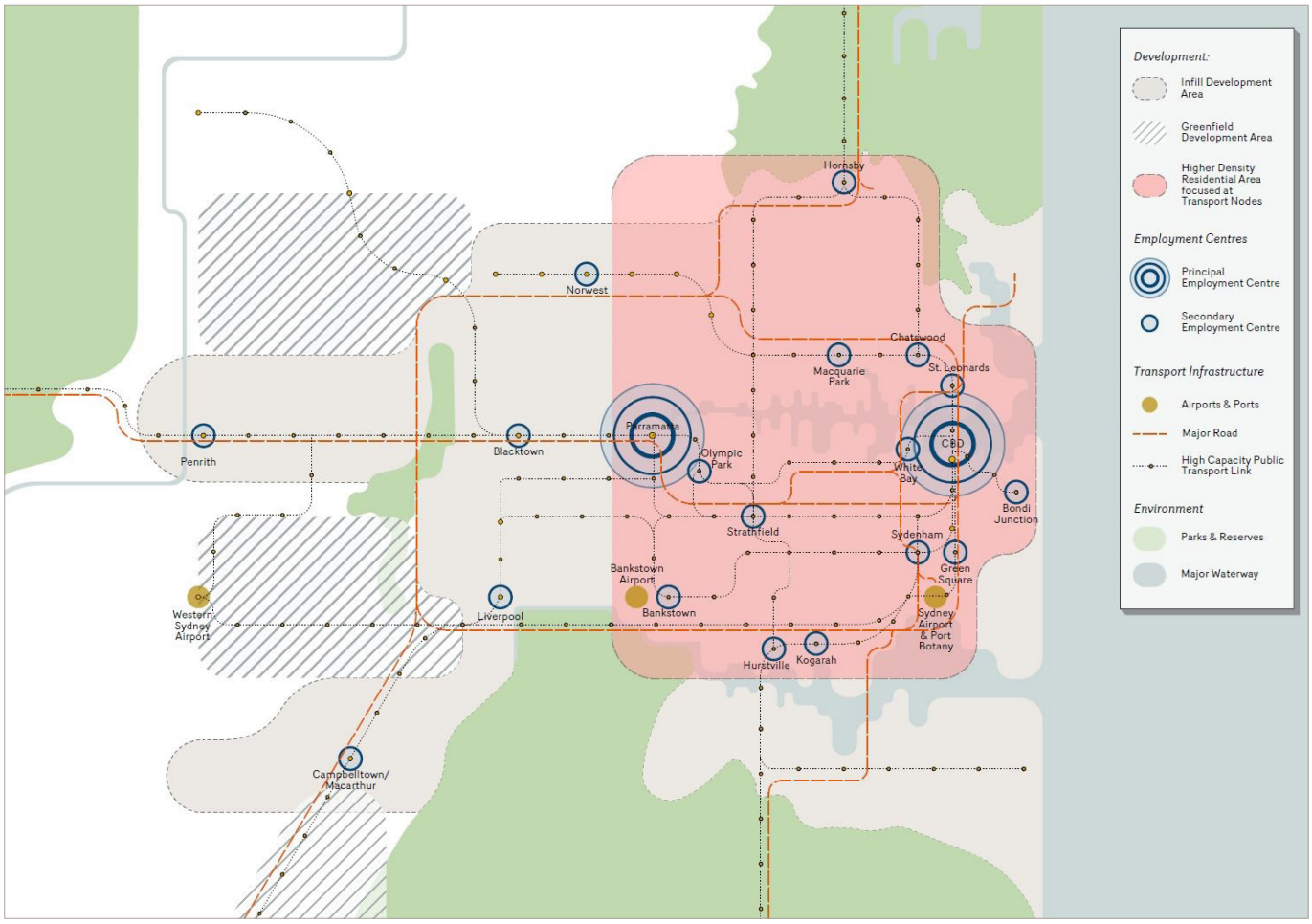


Table 25: Sydney – Centralised High Density scenario – population by district

District*	Reference Case (2016)	Centralised High Density scenario (2046)	Percentage change
Central	1,010,000	1,650,000	63%
North	890,000	1,240,000	40%
South	740,000	1,100,000	49%
South West	720,000	1,120,000	57%
West	350,000	490,000	36%
West Central	970,000	1,740,000	78%
Total population	**4,680,000**	**7,340,000**	**57%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016
Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Distribution of new jobs

The economic geography of Sydney shifts under this scenario, with Parramatta becoming a mature second city-centre alongside the city's historically dominant eastern centre. Sitting at the geographic centre of Sydney, Parramatta is already experiencing sustained revitalisation and employment growth.[79] However, to date it has not reached a scale to contend with the dominance of the current central business district. Under this scenario Parramatta's role grows significantly, supported by transport enhancements. The eastern central business district also grows, extending to the Bays Precinct in the west and the Central to Eveleigh corridor in the south to increase capacity.

Other secondary employment centres such as Macquarie Park, Hornsby, Chatswood, St Leonards and Sydney Olympic Park also grow with the support of an improved public transport network. Secondary employment centres outside of the higher density residential area, such as Liverpool, Blacktown, Penrith, and Campbelltown/Macarthur, grow to the New South Wales Government's baseline forecast. In addition, a small number of population-serving jobs are located in outer-urban areas to support limited population growth in these areas.

Table 26 provides an overview of how Sydney's additional employment growth is distributed under this scenario. It shows the total employment for each district of the city, and the percentage change between 2016 and 2046.

Table 26: Sydney – Centralised High Density scenario – employment by district

District*	Reference Case (2016)	Centralised High Density scenario (2046)	Percentage change
Central	900,000	1,490,000	64%
North	480,000	670,000	39%
South	240,000	320,000	32%
South West	240,000	310,000	32%
West	130,000	160,000	24%
West Central	440,000	780,000	76%
Total employment	**2,440,000**	**3,730,000**	**53%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016
Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

This scenario locates population growth in areas of Sydney already well-serviced by infrastructure, concentrating development at key public transport hubs in particular. New transport infrastructure and upgrades to existing networks are therefore focused on enhancing the capacity of existing networks, and better connecting people to the two key employment centres, the central business district and Parramatta.

The road network is upgraded and extended to better connect population growth in the outer areas of the city, to employment centres, particularly the central business district. This includes significant new links which connect the city to the central-west, south-west, south, port and airport, north-west and north-east. Upgrades to outer-western roads support limited population growth in these areas, and new local and regional roads are built to support the establishment of the Western Sydney Airport.

The public transport network is also enhanced, supporting large numbers of people travelling into and out of the central business district for work from outer areas. New high capacity rail links connect the central-west, north-west, south-west into the city, the inner-south to the greater Parramatta region, and Western Sydney Airport to other centres in the west. Light rail and rapid bus links connect the city and the inner-east, and the greater Parramatta region. Existing local and regional bus links, particularly in the inner-city, north-east and central-west are also enhanced.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

4.6 The Rebalanced Medium Density scenario

The scenario tests a future where growth is managed with the aim of locating jobs closer to where people currently live, and more evenly distributing the impact of population growth. Sydney has traditionally been dominated by its eastern central business district and inner-city suburbs, with the majority of the city's high-value economic activity originating in this eastern half of the city. At the same time, much of Sydney's population growth is happening in the western and outer areas of the city.

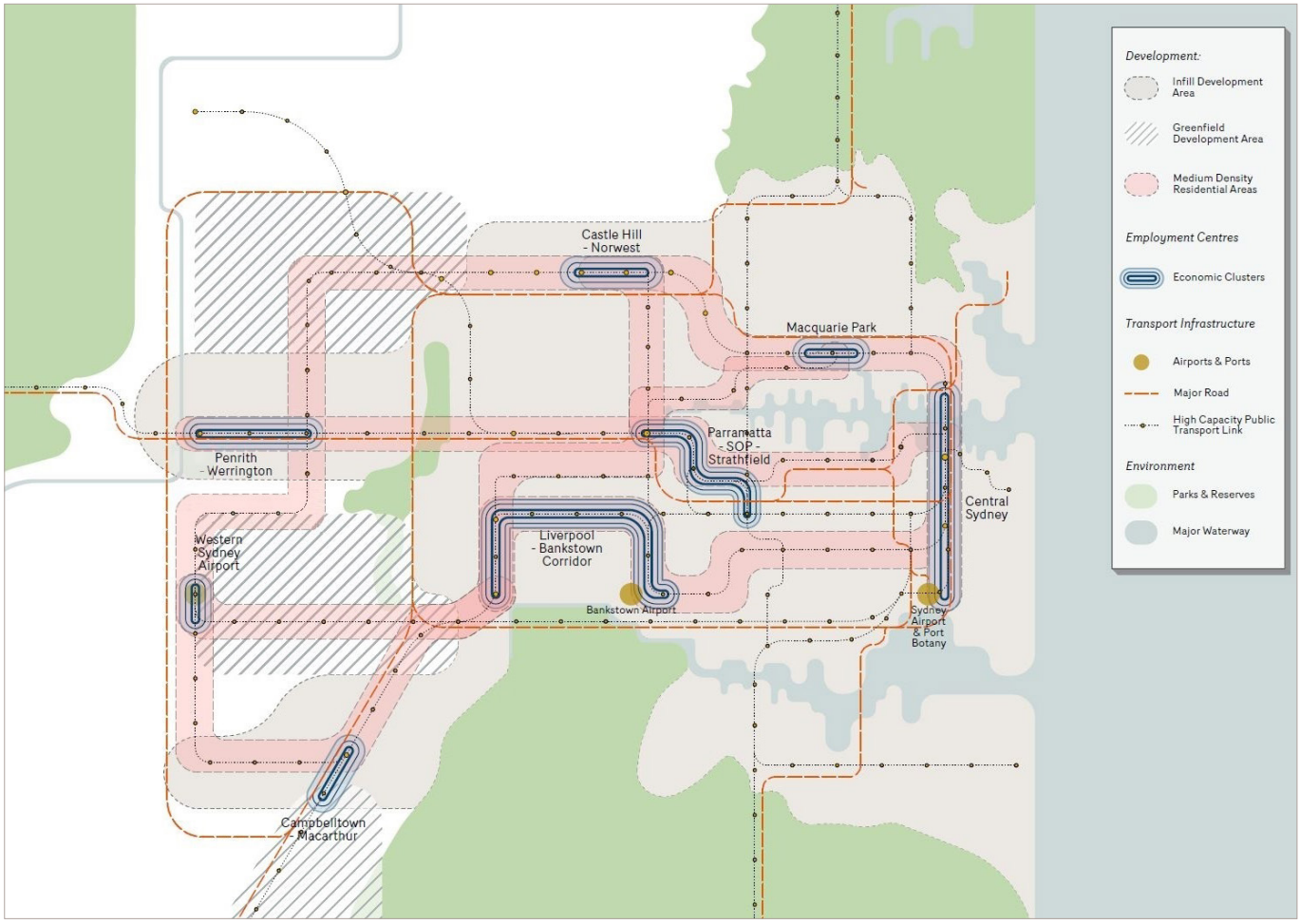
This scenario seeks to re-adjust this imbalance, drawing on and reinforcing Sydney's existing polycentric potential. It distributes new housing more evenly across the city at a medium density, and restructures the city's economic geography to focus on eight new and existing economic clusters spread across the metropolitan area. **Figure 33** provides a metropolitan schematic of the city's structure under this 2046 scenario.

Distribution of population growth

Under this scenario, 80% of the population growth to 2046 will be delivered within Sydney's established areas. The location of this housing will align with a more polycentric economic structure. New housing will be focused around the eight employment clusters and along the major transport corridors linking the clusters. The dominant style of development surrounding these clusters will be medium density attached housing (duplexes and terraces) and low-rise apartment development. This tests the impact of spreading new housing across the city at a medium density.

In practice this means that the entire metropolitan area experiences new development, rather than development being localised to a series of high-density precincts. It also reflects the more positive response communities often have

Figure 33: Sydney – Rebalanced Medium Density scenario



to medium-density development in their area, over higher density development, as the smaller scale of development is viewed as having a relatively lower impact on the look and feel of existing neighbourhoods. It can also enable the delivery of a more diverse supply of housing choice. The remaining 20% of the city's new housing will be delivered as low-density detached greenfield development in western, south-west and north-west growth areas.

Table 27 provides an overview of how Sydney's additional population growth is distributed under this scenario. It shows the total population for each district of the city, and the percentage change between 2016 and 2046.

Table 27: Sydney – Rebalanced Medium Density scenario – population by district

District*	Reference Case (2016)	Rebalanced Medium Density scenario (2046)	Percentage change
Central	1,010,000	1,520,000	50%
North	890,000	1,190,000	34%
South	740,000	1,050,000	41%
South West	720,000	1,280,000	79%
West	350,000	500,000	40%
West Central	970,000	1,800,000	86%
Total population	**4,680,000**	**7,340,000**	**57%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016
Note: Population rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Distribution of new jobs

Over recent decades, new housing growth in Sydney has predominantly been delivered west of Parramatta, while the majority of new jobs, in particular high value knowledge-intensive jobs, have been created in the city's east.[80] This structure has been reinforced by the continued decline of the Australian manufacturing sector, which has seen the level of manufacturing jobs in western Sydney, previously the region's key economic driver, decline.[81] The result is that an increasing number of western Sydney's residents, in particular those working in the high value knowledge jobs, are either unable to access high value jobs, or otherwise are required to commute relatively large distances, from the west to east of the city, to reach jobs.

This scenario seeks to redress the current imbalance in Sydney's economic geography by creating a future where the distribution of jobs is structured around a polycentric city, which aims to deliver jobs closer to where residents live to enable increased self-containment and reduced travel costs. It presents the most significant restructuring of Sydney's economic geography. 50% of the city's new jobs are spread between eight employment clusters located across Sydney's entire metropolitan area, with a particular focus in the west. This aims to address a current divide between the number of jobs located in the city's eastern half relative to its western half.

The eight clusters are:

- An expanded central business district, which takes in employment centres such as North Sydney and Green Square, to its north and south
- An expanded Parramatta which includes Olympic Park and Strathfield
- Macquarie Park
- A north-west employment corridor between Castle Hill and Norwest
- An expanded south-west employment cluster taking in Liverpool and Bankstown
- An expanded outer south-west employment cluster taking in Campbelltown-Macarthur
- An expanded western employment cluster taking in Penrith and Werrington
- A new employment centre around the Western Sydney Airport.

Table 28 provides an overview of how Sydney's additional employment growth is distributed under this scenario. It shows the total employment for each district of the city, and the percentage change between 2016 and 2046.

Table 28: Sydney – Rebalanced Medium Density scenario – employment by district

District*	Reference Case (2016)	Rebalanced Medium Density scenario (2046)	Percentage change
Central	900,000	1,330,000	47%
North	480,000	630,000	30%
South	240,000	280,000	15%
South West	240,000	450,000	90%
West	130,000	220,000	69%
West Central	440,000	820,000	86%
Total employment	**2,440,000**	**3,730,000**	**53%**

* Original Greater Sydney Districts, as defined by the Greater Sydney Commission in 2016
Note: Employment rounded to the nearest 10,000. Percentage change is calculated using more detailed underlying data and then rounded.

Structure of the transport network

Sydney's transport is significantly expanded to support the altered spatial structure of this scenario. New and upgraded transport infrastructure supports the growth of eight economic and population centres across the geographic extent of the city.

The road network is upgraded and extended to better connect population growth in the outer areas of the city to employment centres, particularly the central business district. This includes significant new links which connect the city to the central-west, south-west, south, port and airport, north-west and north-east. Upgrades are focused on outer-western roads, particularly in the south-west and north-west, to support significant population growth in these areas. A new orbital link between the south-west and the north-west better connects areas within western Sydney and provides additional capacity for intercity travel. New local and regional roads are built to support the establishment and significant growth of the Western Sydney Airport.

The public transport network is also enhanced, supporting large numbers of people travelling across the city between the eight economic clusters. New high capacity rail links connect the central-west, north-west, south-west into the city, the inner-south to the greater Parramatta region, and Western Sydney Airport to other centres in the west. Light rail and rapid bus links connect the city and the inner-east, and the greater Parramatta region. Existing local and regional bus links, particularly in the inner-city, north-east, central-west and north-west, are also enhanced.

A list of the major additions to the road and public transport networks for this scenario is available at **Appendix B.**

Sydney scenario analysis

At a glance

- Infrastructure Australia has tested and compared the performance of the three 30-year scenarios for Sydney by modelling their impact on transport and social infrastructure.
- The results of this analysis are organised under five indicator themes: the performance of the transport network, access to jobs, the environmental performance of the road network, access to and demand for social infrastructure, and access to and demand for green space.
- The chapter concludes with a summary of the key findings for Sydney resulting from the scenario analysis, which apply to the city regardless of which long-term growth pathway is followed.

Evaluating the three future scenarios

Infrastructure Australia has compared the performance of the three Sydney-specific scenarios by modelling the impact of each scenario on the performance of the city's key infrastructure assets.

Two separate models have been used to complete this analysis:

1. **Transport network modelling:** Each scenario has been modelled using the New South Wales Government's Sydney Strategic Travel Model (STM) to identify the relative impact of each scenario on the demand for and performance of the 2046 networks, and the environmental impact of the road networks. Further information about this modelling can be found at **Appendix C.**
2. **Green space and social infrastructure modelling:** The three scenarios have been modelled using Arup's Transport Travel Time Analysis (T3a) tool and the transport modelling results to identify how each scenario impacts the relative demand for and access to green space and social infrastructure. Further information about this modelling can be found at **Appendix D.**

The modelling results have been organised into five indicator themes which together draw out the relative future trade-offs that exist for Sydney under the different scenarios. These results are summarised in **Table 29.**

Table 29: Sydney – Summary of key performance indicators (best performance is bolded)

Key statistics	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Transport performance				
Road congestion[a]	15%	**28%**	30%	28%
Public transport mode share[b]	26%	32%	**35%**	35%
Access to jobs in 30 minutes[c]				
Car	13%	**9%**	9%	9%
Public transport	2%	2%	**2%**	2%
Access to jobs in 60 minutes[d]				
Car	43%	35%	**36%**	36%
Public transport	13%	18%	**23%**	22%
Access to hospitals[e]				
Percentage of population with access	80%	71%	**76%**	74%
Access to schools[f]				
Percentage of population with access	97%	92%	**95%**	94%
Access to green space[g]				
Percentage of population with access	62%	54%	**58%**	56%

Note: Indicators are rounded to the nearest whole percent. This means some scenarios appear to show the same result even though there are differences in performance. More detail is provided in the relevant sections of this chapter.

Note: Care should be taken when comparing the reference case to the scenarios. This is particularly the case with green space, school and hospital access indicators, where no new infrastructure was added from the reference year.

(a) Measured as the percentage of vehicle kilometres travelled where volume of traffic exceeds road capacity in the AM peak

(b) The percentage of trips by public transport in the AM peak

(c) The percentage of jobs accessible in 30 minutes during the AM peak

(d) The percentage of jobs accessible in 60 minutes during the AM peak

(e) Within a 20-minute drive or 30 minutes by public transport of a major hospital in the AM peak

(f) Within a five-minute drive or 20 minutes by public transport or a 40-minute walk of a primary or secondary school in the AM peak

(g) Within a five-minute walk of any green space.

5.1 Performance of the transport network

Transport infrastructure is an enabler of economic activity, health and education services as well as leisure. It allows workers and businesses access to each other, goods to be moved from ports to shop fronts and people to access key services. Without a functioning transport network, the key advantage of urban living, accessibility is undermined.

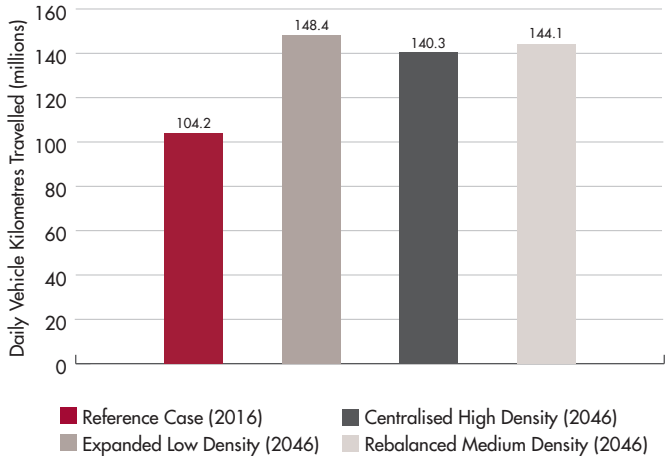
As cities grow so does demand for transport, resulting in potential congestion and a reduction in accessibility and liveability. Where Sydney chooses to place its additional population and jobs in the coming years, and the associated policy settings and transport network investments will have a significant impact on the how the city functions.

Under all scenarios, private vehicle use increases substantially

Despite the important role of land-use and transport planning, it is clear that in the next 30 years private vehicle use in Sydney will grow substantially, regardless of urban form. The scenario analysis shows that daily vehicle kilometres grow between 38% and 42% between now and 2046, depending on the scenario.

Figure 34 shows the difference in vehicle use between the reference case and the three 2046 scenarios.

Figure 34: Sydney – Daily Vehicle Kilometres Travelled, 2016 to 2046 scenarios

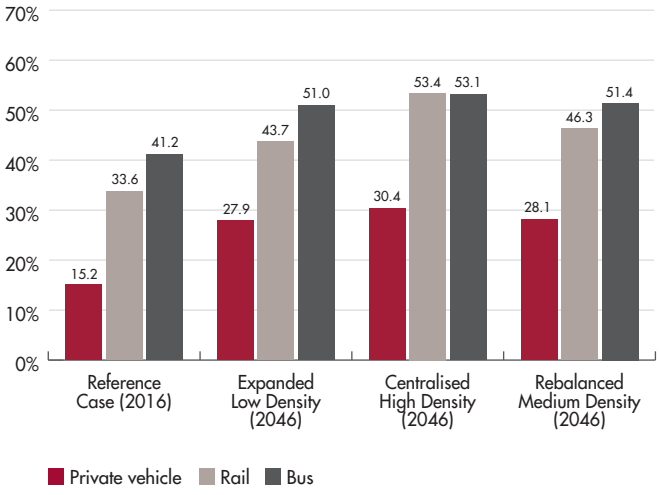


The difference between private vehicle use in each scenario reflects the impact that differences in land use can have on transport patterns. The scenario with the highest vehicle use (the Expanded Low Density scenario) produces over eight million more daily vehicle kilometres travelled than the Centralised High Density scenario. Although this is only 6% more traffic, it could make significant differences in localised congestion and the required transport investment by taxpayers.

Congestion is greatest in sectors of the city where growth is concentrated, showing that transport networks must complement land use

Reflecting the growth in demand, road and public transport congestion increases significantly under all scenarios. **Figure 35** shows the proportion of vehicle kilometres travelled (for road) and passenger kilometres travelled (for rail and buses) where the volume of passengers/vehicles exceeds the available capacity during the morning peak.

Figure 35: Sydney – Percentage of Passenger Kilometres Travelled (public transport) and Vehicle Kilometres Travelled (cars) where volume exceeds capacity in the AM peak, by mode



Unsurprisingly, the location of this congestion is generally consistent with areas where housing and population growth is concentrated. **Figure 36** and **Figure 37** indicate the location of congestion levels on Sydney's road and rail networks by 2046 under the three different scenarios. Networks are congested when volume exceeds capacity (which is defined as over utilised in the mapping).

It is important to note the maps represent average volume/capacity on segments of road and rail, and have been generated using the STM, which is a strategic rather than project level transport model. Readers therefore shouldn't concentrate on the performance of specific road and rail segments, but rather the network as a whole.

Although average congestion is widespread across all scenarios, it is generally greater in areas of the city where population and employment growth are concentrated. The most notable patterns of congestion are:

- **Central Sydney:** Under the Centralised High Density and Rebalanced Medium Density scenarios, congestion on the road network is highest in Central Sydney. Under all scenarios, congestion on the rail network is significant on lines leading to the city-centre. The high and medium density scenarios show marginally higher levels of rail congestion on inner-city lines including the North Shore Line and Sydney Metro West.
- **North-western Sydney:** This includes the North-West Priority Growth area, which will experience a substantial increase in population and employment under all scenarios. The Expanded Low Density scenario has the most significant growth in north-western Sydney and, under this scenario, road congestion is also greatest in this area.
- **North-eastern Sydney:** This district includes significant growth centres at Chatswood, Macquarie Park and Epping. Under all three scenarios, this area experiences significant levels of road congestion. The pattern is repeated for the rail network, where the North Shore line is more congested under the two higher density scenarios.

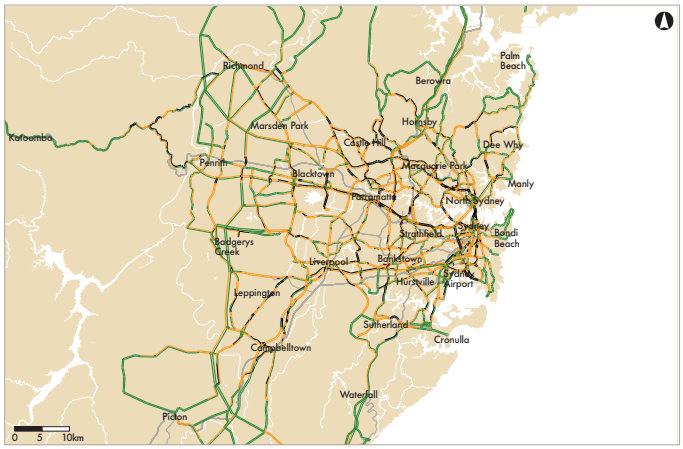
The concentration of congestion in areas of significant growth illustrates the importance of integrating planning and investment for the transport network to land-use changes. This point is demonstrated by the level of congestion experienced under the Centralised High Density scenario, which sees the highest level of congestion across all modes. This is particularly the case for rail, where adding employment and population in 'Eastern Sydney' (roughly between Parramatta in the west, the CBD in the east, Hornsby in the north and Hurstville in the south) places greater pressure on the existing rail network. The data shows that in Sydney, simply increasing densities around existing public transport nodes will not reduce congestion. Increasing densities can be good planning practice, but must be accompanied by commensurate improvements to the network's capacity and service levels if good outcomes are going to be delivered.

Figure 36: Sydney – Road network congestion in the AM peak

Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

Network Utilisation — Low — Medium — Over

5.2 Access to jobs

Accessibility refers to the ease with which residents within a city can reach their desired destination.[82] Well-connected cities have a tangible impact on quality of life, enabling residents to access the places, services and communities they need to lead satisfying and productive lives. There is also a clear link between accessibility and the health of the metropolitan economy. A city which provides high levels of access to residents also enables greater connections between firms and employees, contributing to the creation of deep labour markets and improved job matching, which in turn enhances the productivity of the city.[83]

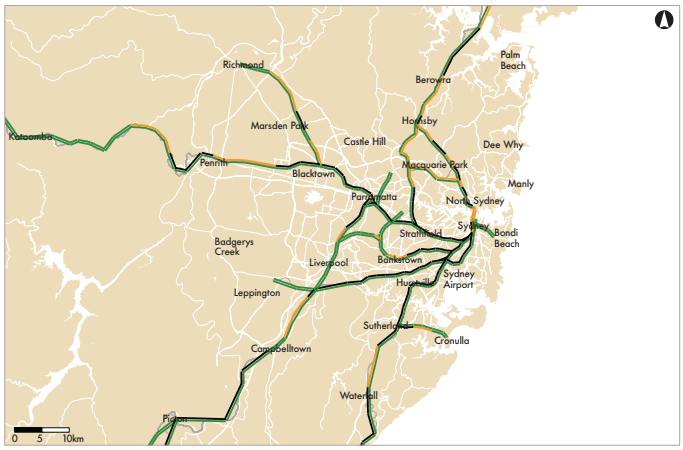
Access to jobs, a key component of a city's broader accessibility, is fundamentally determined by the economic geography of a city, which is defined as the location and intensity of economic activity relative to where people live. At the heart of a well-functioning city is providing people with easy access to economic activity by placing them near employment and/or providing fast and efficient transport networks.

Infrastructure Australia's three scenarios test how different urban forms affect people's access to work, and which parts of the city are affected.

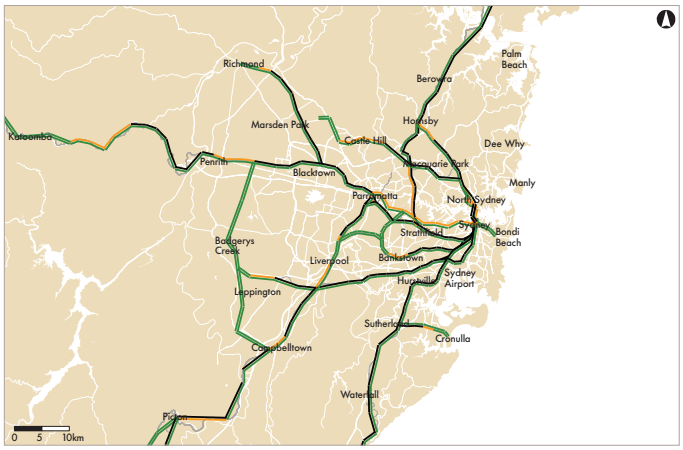
The economic structure the three scenarios test are:

1. **People live further away from work (the Expanded Low Density scenario).** Under this scenario, people live further away from work, as residential greenfield areas are developed while employment remains largely concentrated in the Sydney CBD and, to a lesser extent, Parramatta.
2. **People move closer to jobs (the Centralised High Density scenario):** In this scenario, people are moved closer to jobs by significantly increasing residential densities east of Parramatta and maintaining the bulk of economic activity in Sydney's CBD and Parramatta.

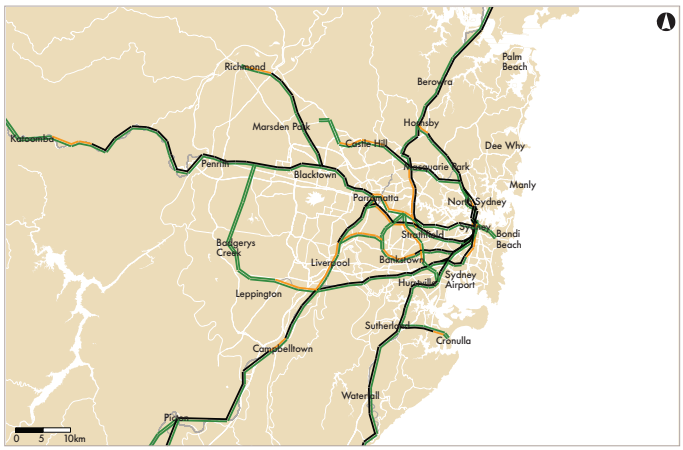
Figure 37: Sydney – Rail network congestion in the AM peak



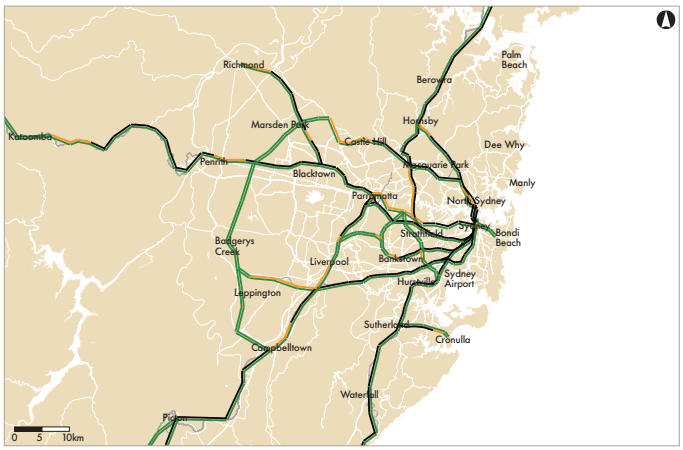
Reference Case (2016)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

Network Utilisation — Low — Medium — Over

3. **Jobs are moved closer to people (the Rebalanced Medium Density scenario).** This scenario moves jobs closer to people by establishing eight employment centres across the metropolitan area.

This section compares the level of accessibility between the reference case and the three 2046 scenarios for Sydney using two measures: percentage of jobs that can be accessed in 30- and 60-minute time budgets by road and public transport, and average journey to work travel times.

The 30-minute city is a difficult accessibility benchmark for a city of Sydney's size

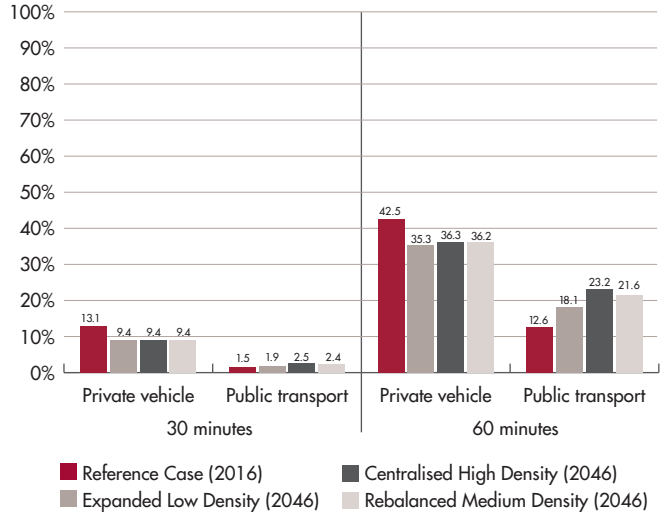
The concept of the 30-minute city is an accessibility measure which posits that no matter where a person lives, they can easily access the places they need to visit on a daily basis (for example, their job or school, childcare, healthcare, food, and entertainment) within 30 minutes.[84]

This framework has gained recent prominence in Australia with the Australian Government, state and territory governments and academics[85] advocating for its use as a benchmark against which the accessibility of Australian cities should be measured. The Greater Sydney Commission has indicated that the 30-minute city is a key framework for land use and infrastructure prioritisation under its three city vision for greater Sydney.

While the concept of the 30-minute city is an admirable goal, the accessibility data for all of the 30-year growth scenarios analysed in this paper indicate that in a city of Sydney's future size, the expectation that one can easily access key destinations, no matter where you live, is challenging.

Figure 38 graphs the percentage of jobs accessible by private vehicle and public transport at a city-wide level under 30- and 60-minute time budgets, for the reference case and the 2046 scenarios.

Figure 38: Sydney – Percentage of jobs accessible in 30 and 60 minutes, by private vehicle and public transport in the AM peak



The graph demonstrates that now and under the 2046 scenarios, the proportion of jobs that are accessible within 30 minutes is very low. In contrast, the time budget of 60 minutes provides much greater levels of accessibility across the city.

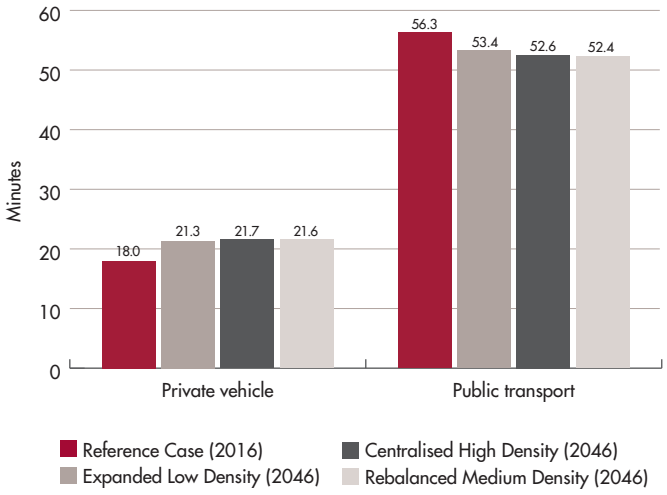
It is important to note this is only one indicator of accessibility. The measure calculates the percentage of all jobs accessible within a travel time budget (30 or 60 minutes) from each model zone (which represents a geographic location). The data is then aggregated up to SA3 level and a population weighted average is used for the city-wide metric. The indicator is useful in determining how each scenario impacts access to jobs (economic opportunities). There are alternative, equally valid measurements, such as calculating the proportion of people who are within 30 minutes of key centres. The Greater Sydney Commission performed this calculation as part of the Draft Greater Sydney Regional Plan and found 39% of people are currently within 30 minutes of a centre.

Another indicator is average travel times that remain largely consistent across all 2046 scenarios. **Figure 39** shows average journey to work travel times.

The consistency across scenarios is likely a result of numerous factors. New residential developments generally attract new 'population-serving jobs', meaning there are always a proportion of people who live near work. In addition, using the average as a measure has limitations as it may fail to capture significant but localised variations in travel time between scenarios.

The travel time consistency also indicates the extent to which people will tend to move their residential location or change job so that, at least in some measure, they fit their journey to work within a reasonable travel time budget.

Figure 39: Sydney – Average journey to work travel time in the AM peak, by mode



However, moving to access work comes with costs. A greater proportion of jobs, particularly well-paid work, is located in the CBD and surrounding suburbs. Expecting people to simply move to access these economic opportunities is inequitable, with housing costs significantly higher closer to the city-centre. The result is that while average trip times remain largely constant, access to jobs in the CBD will be easier for those who can afford to live nearby.

There are plenty of other reasons people can have difficulty moving, including family ties, children at local schools and social networks in their immediate suburb. As much as possible, a liveable and fair city should aspire to maximise accessibility so people aren't forced to move to access work.

Expanded public transport networks result in better accessibility outcomes for Sydney

Across all three scenarios, the level of job accessibility provided by public transport services improves in comparison to the levels of accessibility provided now (in part due to additional investment). In contrast, the accessibility for private vehicles across the three scenarios decreases.

Figure 40 graphs the percentage of jobs accessible within 60 minutes by private vehicles and public transport across Sydney for the reference case and the three 2046 scenarios.

Figure 40: Sydney – Percentage of jobs accessible by private vehicles and public transport within 60 minutes in the AM peak

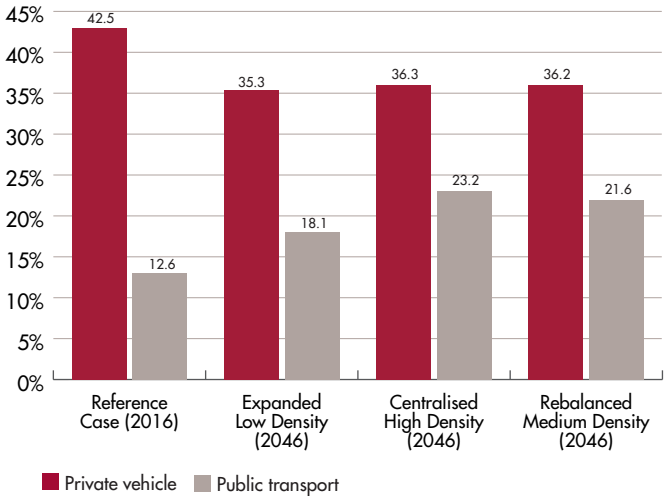
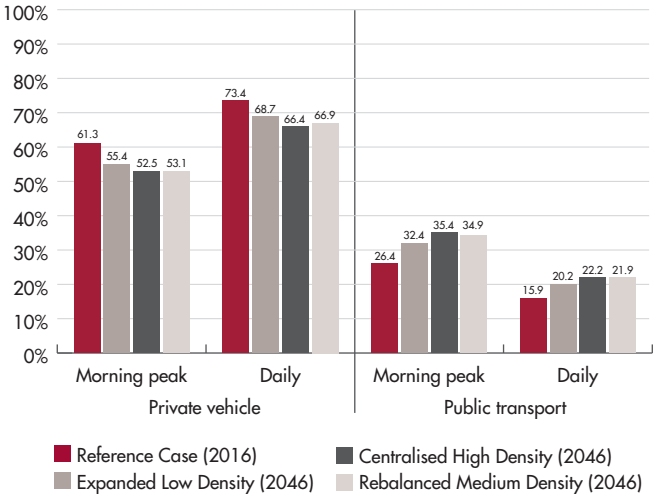


Figure 41 compares changes in mode share between the reference case and the three 2046 scenarios. A number of factors, including changes to the location of people and jobs, and the relative performance of public and road transport networks, influences these changes in mode share.

Figure 41: Sydney – Mode share, by time of day



The increase in the level of accessibility provided by public transport compared to the decline in access provided by private vehicles indicates that public transport, in general, becomes increasingly suitable as a city grows.

However, it is important to note that under all scenarios Sydney remains a largely car-based city. Across the scenarios, private vehicle mode share varies between 53-55% in the AM peak and 66-69% over the 24-hour period.

Strategic road investments will still be necessary to ease localised congestion, but the projected increase in vehicle kilometres travelled indicate that road construction will not be sufficient. This reflects the need for a nuanced transport policy, where public transport and road investment, as well as demand management (including road user charging), each play a role in the city's future network.

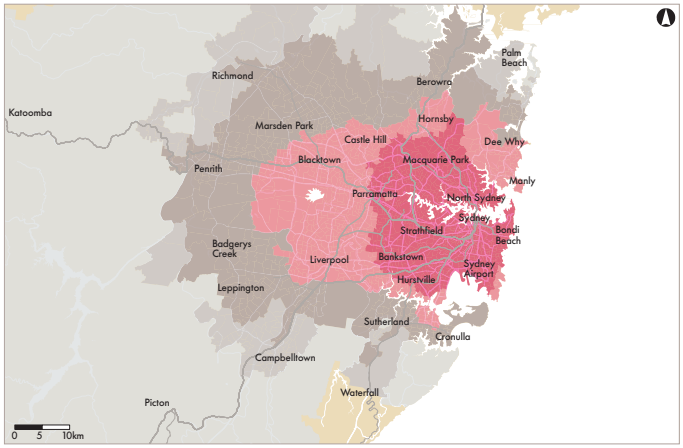
The spatial distribution of access to jobs remains unequal across all scenarios

Access to work, and the economic opportunities it presents, is distributed unevenly across the city under all scenarios. **Figure 42** and **Figure 43** compare the spatial distribution of job accessibility within 60 minutes by private vehicles and public transport across the reference case and the three 2046 scenarios.

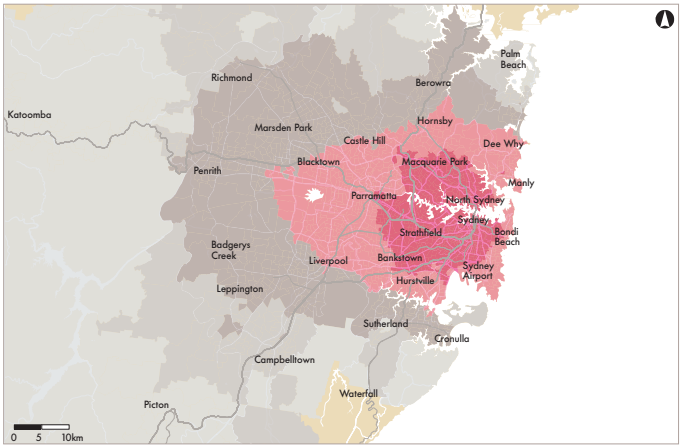
This mapping indicates that each scenario has advantages and disadvantages in terms of the spatial distribution of access:

1. **The Expanded Low Density scenario is a car-based scenario**: It would provide Sydney with a relatively high degree of job accessibility by private vehicle across the city, with the city's inner, middle and a selection of outer suburbs, able to access between 25 to 75% of Sydney's jobs within 60 minutes. In contrast, the scenario offers a relatively low level of access across the city by public transport. Under the scenario, the city's inner and a selection of middle suburbs, located along key rail routes, can access between 25 to 50% of jobs. The scenario also offers improved accessibility to key centres in Sydney's outer suburbs, such as Badgerys Creek, Penrith and Marsden Park, with these areas able to access between 10 to 25% of the city's jobs.
2. **The Centralised High Density scenario improves inner-city public transport access:** The scenario offers the highest spread of jobs access by public transport, with the city's inner and middle suburbs, in particular those close to the city's rail infrastructure, able to access a high percentage of the city's jobs. However, the scenario provides Sydney with the lowest level of job access by private vehicle.
3. **The Rebalanced Medium Density scenario represents a middle ground between the future scenarios:** It offers the residents of Sydney a relatively high percentage of job access by both private vehicle and public transport. The scenario offers the most even distribution of job accessibility by private vehicle across the city. Public transport accessibility, while slightly lower than scenario two, again is spread more evenly across the city as a whole.

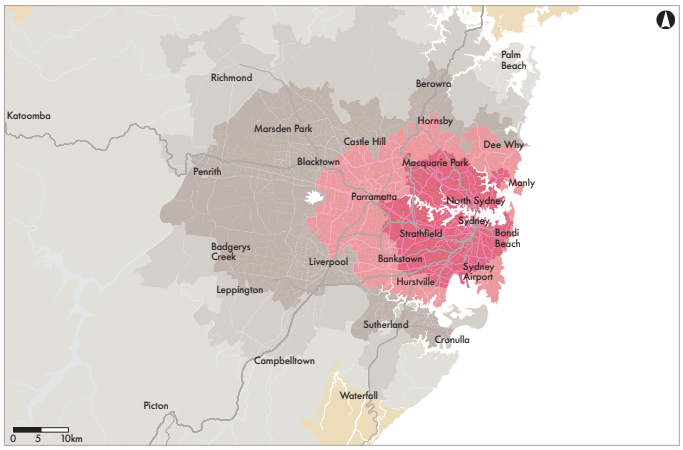
Figure 42: Sydney – Percentage of jobs that can be accessed by private vehicles within 60 minutes in the AM peak



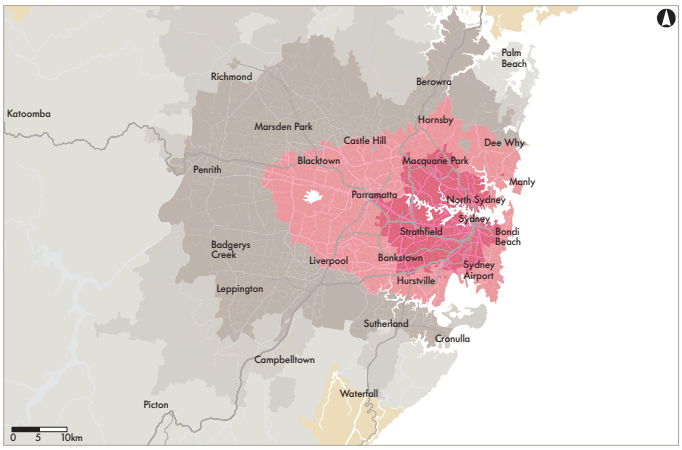
Reference Case (2016)



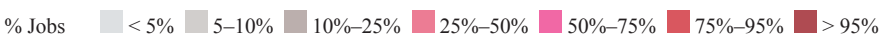
Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)



For all scenarios and transport modes, the inner-city has significantly higher accessibility scores than elsewhere, which generally decline with distance from the CBD.

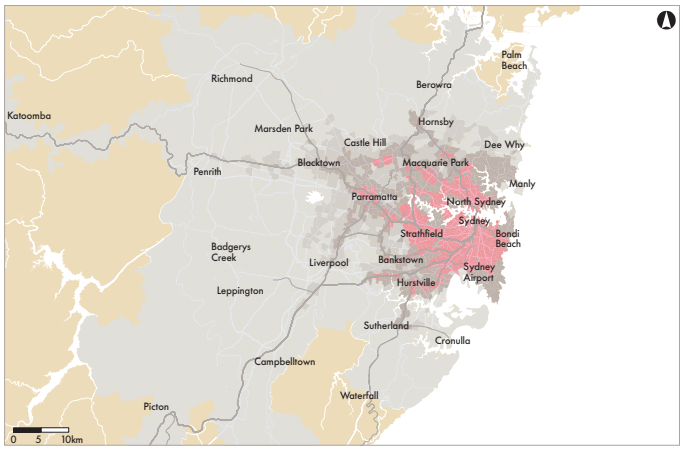
The persistence of higher accessibility scores for the inner-city and lower scores on the outskirts illustrates the degree to which Sydney's economic structure will continue to be dominated by the CBD and inner-urban areas, regardless of where future growth is directed. Sydney has historically developed outward from the CBD, with transport networks primarily geared towards moving people in and out of this centre. There has been considerable success in Sydney directing job growth to alternative centres, such as Macquarie Park and Parramatta, but the CBD has, and will continue to remain Sydney's dominant centre.

Developing alternative centres can improve economic opportunities in outer suburbs

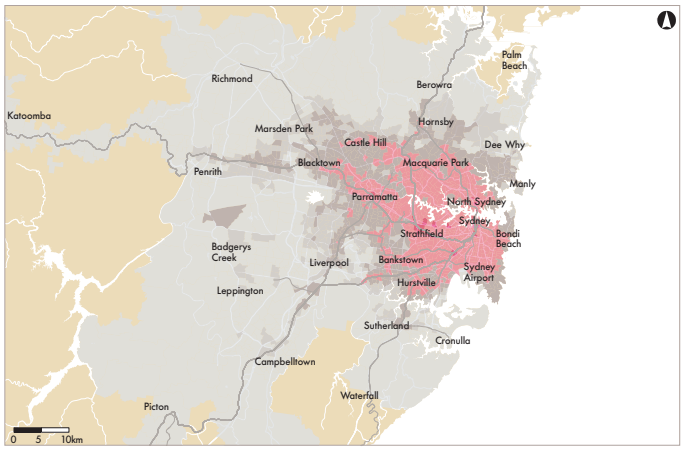
The job accessibility mapping is limited in its ability to show the impact of suburban employment centres on the local community. This is because the measure is aggregated to the proportion of total metropolitan jobs, meaning that relatively large secondary centres, such as the future Western Sydney Airport, have little impact on mapping because it remains a relatively small part of the total jobs market.

Locating more jobs in centres at Castle Hill, Liverpool – Bankstown, Penrith, Campbelltown and Western Sydney Airport can have a material impact on access to economic opportunities in Sydney's outer suburbs. **Figure 44** shows the number of jobs in selected employment centres in Sydney's west under each scenario.

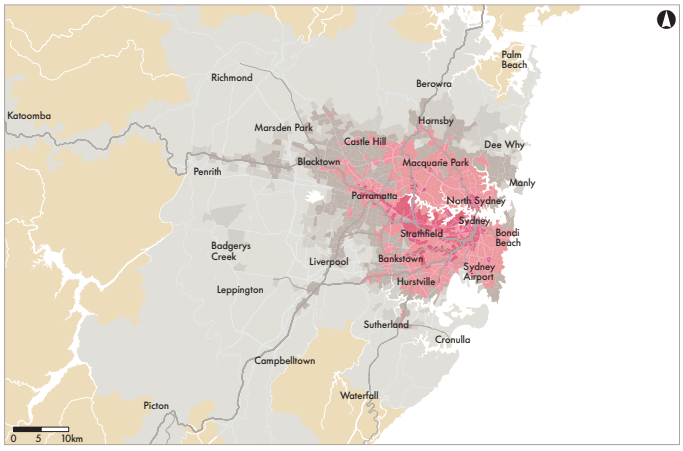
Figure 43: Sydney – Percentage of jobs that can be accessed by public transport within 60 minutes in the AM peak



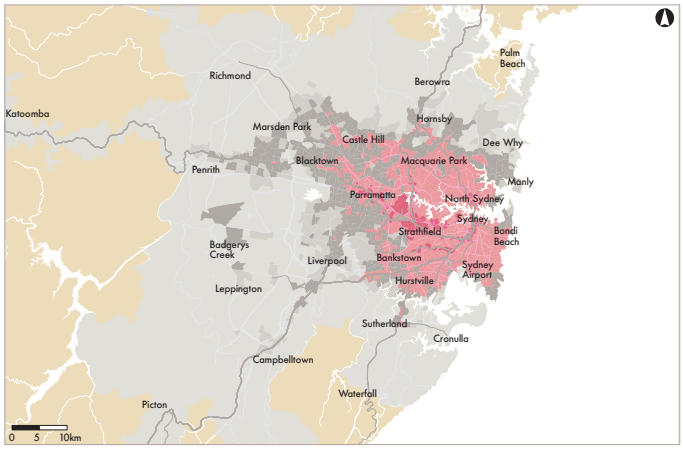
Reference Case (2016)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

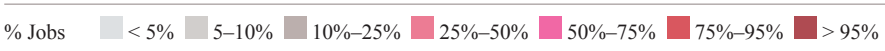


Figure 44: Sydney – Number of jobs in selected employment centres

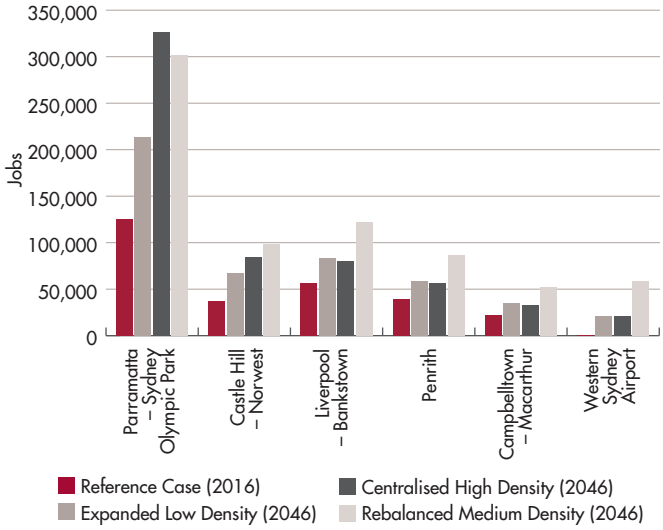
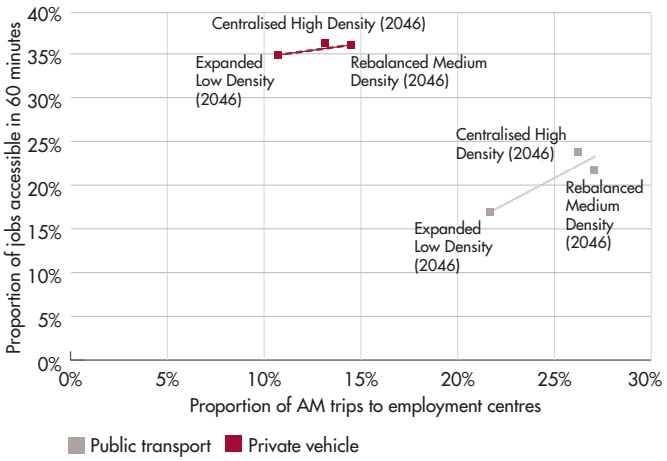


Figure 45: Sydney – Percentage of trips to employment centres and jobs accessible in 60 minutes in the AM peak, by private vehicle and public transport



Planning for employment centres can have a significant impact on the local jobs market. The Rebalanced Medium Density scenario adds close to 60,000 jobs at the Western Sydney Airport, which is more than double the alternative scenarios. There are also between 15% and 60% more jobs in the other centres (with the exception of Parramatta).

Placing jobs in employment centres correlates with an increase in the percentage of jobs accessible by both private vehicle and public transport. The Rebalanced Medium Density and Centralised High Density cities are both designed to locate employment into centres, as opposed to the Expanded Low Density scenario which has a more dispersed employment market.

The correlation illustrates a very simple principle: bringing people and jobs closer together improves accessibility. In broad terms, this can be done by moving people closer to jobs (The Centralised High Density scenario) or moving jobs closer to people (The Rebalanced Medium Density scenario).

Moving people closer to jobs improves aggregate accessibility more because the public transport network is structured to carry people into and out of the inner-city, meaning it already has an accessibility advantage. However, **Figure 45** shows that growing suburban employment centres close to where people live that are well-served by public transport can also significantly improve accessibility. It would likely have greater equity impacts by bringing jobs to traditionally job poor areas, but it would also involve significant capital investment.

This analysis demonstrates that the location of job centres invariably involves trade-offs. The High Density scenario has the highest level of accessibility and economic activity in the city-centre, but lower levels on the outskirts. In contrast, the Rebalanced Medium Density scenario improves job accessibility in the outer suburbs, but lower job density in the inner-city could reduce the benefits that flow from agglomeration. Although both scenarios have strengths and weaknesses, they outperform the Expanded Low Density scenario.

The location and size of employment centres have a very real impact on the accessibility of jobs and the equity with which economic opportunities are distributed. Governments need to plan their employment centres and their supporting transport networks on the basis of their policy priorities.

5.3 Environmental performance of the transport network

Cities are significant consumers of resources and generators of emissions. The transport modelling undertaken for Sydney measured the tonnes of CO_2 emissions from road traffic (including light and heavy vehicles). The modelling does not take into account any change in the fuel efficiency of private vehicles over time or change in the proportion of private vehicles which are electric. Significant shifts in these factors would change these results.

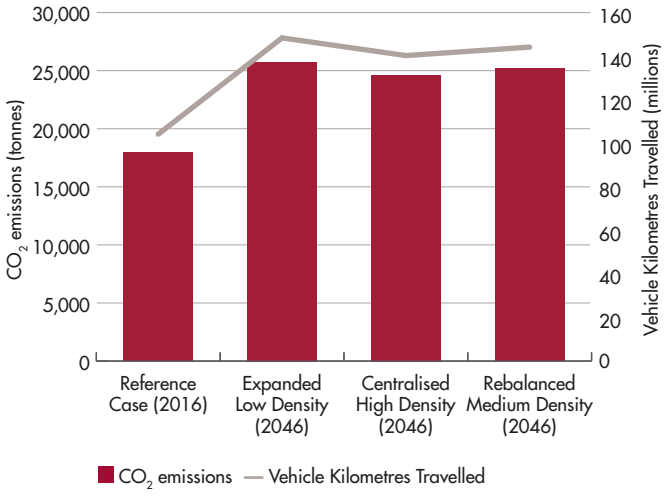
The modelling does not take into account any change in the fuel efficiency of private vehicles over time or change in the proportion of private vehicles which are electric. Significant shifts in these factors would change these results.

Private vehicle CO_2 emissions increase significantly across all scenarios, in line with increased vehicle kilometres travelled

At an aggregate level, CO_2 emissions increase significantly to 2046 under all scenarios, which aligns with increases to vehicle kilometres travelled. Metropolitan-level results for tonnes of CO_2 emitted by all vehicles over a 24-hour period and total Vehicle Kilometres Travelled (VKT) for each scenario are shown in **Figure 46.**

The largest increase in emissions occurs under the Expanded Low Density scenario (a 43% increase from 2016), which can be explained by this scenario having the highest private vehicle use of the three scenarios. As people drive more and further, the emissions from vehicles increases.

Figure 46: Sydney – CO_2 emissions and Vehicle Kilometres Travelled



5.4 Access to and demand for social infrastructure

As Sydney grows, the city's essential social services and the infrastructure that supports them will experience an unprecedented increase in demand. New South Wales Department of Health projections indicate that demand for acute services within the state will grow by 48% between now and 2031.[86] Over the same period, it is projected that 173,000 additional students will attend public schools in the state, with 80% of this growth projected to occur in Sydney.[87] The future spatial structure of Sydney will be a key determinant for where and how this demand is accommodated. The location of future housing will determine where demand is created and the level of accessibility provided to existing facilities and services.

This section explores the spatial implications of population growth for Sydney's existing social infrastructure. For the purposes of the report, social infrastructure covers hospitals, schools and tertiary education facilities. It is important to note no additional social infrastructure was included for this modelling, beyond existing assets. It therefore tests where pressure could be placed and additional infrastructure required, under different land-use structures.

The performance of health and education infrastructure is measured using two indicators: changes in accessibility (measured as percentage of the population within a certain area who can access a facility within a defined travel time budget and mode choice) and changes in demand (measured as population per infrastructure facility within a particular area).

Appendix D provides further details on the data and underlying assumptions for this modelling.

Across all scenarios, access to existing hospital facilities decline, particularly in Sydney's west

In 2016, metropolitan-level access to hospitals was relatively high, with 80% of Sydney's population being able to reach a facility within a 20-minute drive or 30-minute public transport trip. However, in 2046, this access declines across all scenarios with the lowest average being 71% in the Expanded Low Density scenario, and highest at 76% in the Centralised High Density scenario.

Table 30 shows average access to hospital facilities across the reference case and the three 2046 scenarios.

Table 30: Sydney – Percentage of people with access to hospital facilities

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to a hospital facility	80%	71%	76%	74%

* Ability to reach a hospital facility within 20-minute drive or 30-min public transport trip

This decline can be attributed to population increases occurring in locations that are far away from existing facilities and there being no additional hospitals added in the scenarios.

Figure 47 maps the distribution of accessibility to hospital facilities at the SA3 level for the reference case and the three 2046 scenarios. Declining access is particularly stark in western Sydney. Access in this area drops significantly under all scenarios, but particularly under the Expanded Low Density scenario. Bringelly-Green Valley sees a 75% decline from 2016 under this scenario, which means that only 13% of the population have access to hospitals in 2046. Under the same scenario, Blacktown North experiences an 81% decline in access from 2016, with only 8% of the population being able to access hospitals in 2046.

It is clear that in future, additional investment will be required to increase the capacity of Sydney's hospital facilities in line with the city's population growth in terms of both scale and location. Adequate access to hospitals is a critical requirement for all people across our cities, regardless of where they live. Providing appropriate upgraded, new or relocated healthcare facilities, or better connections to existing facilities as Sydney grows, particularly in the west, is essential.

Patterns of hospital demand reflect the need for investment to align with population growth

Demand for existing hospital facilities increases from 2016 across all 2046 scenarios, however the distribution of demand can affect how efficiently existing infrastructure is used.

Figure 47: Sydney – Access to hospital facilities within 20-minute drive or 30-minute public transport trip, by SA3

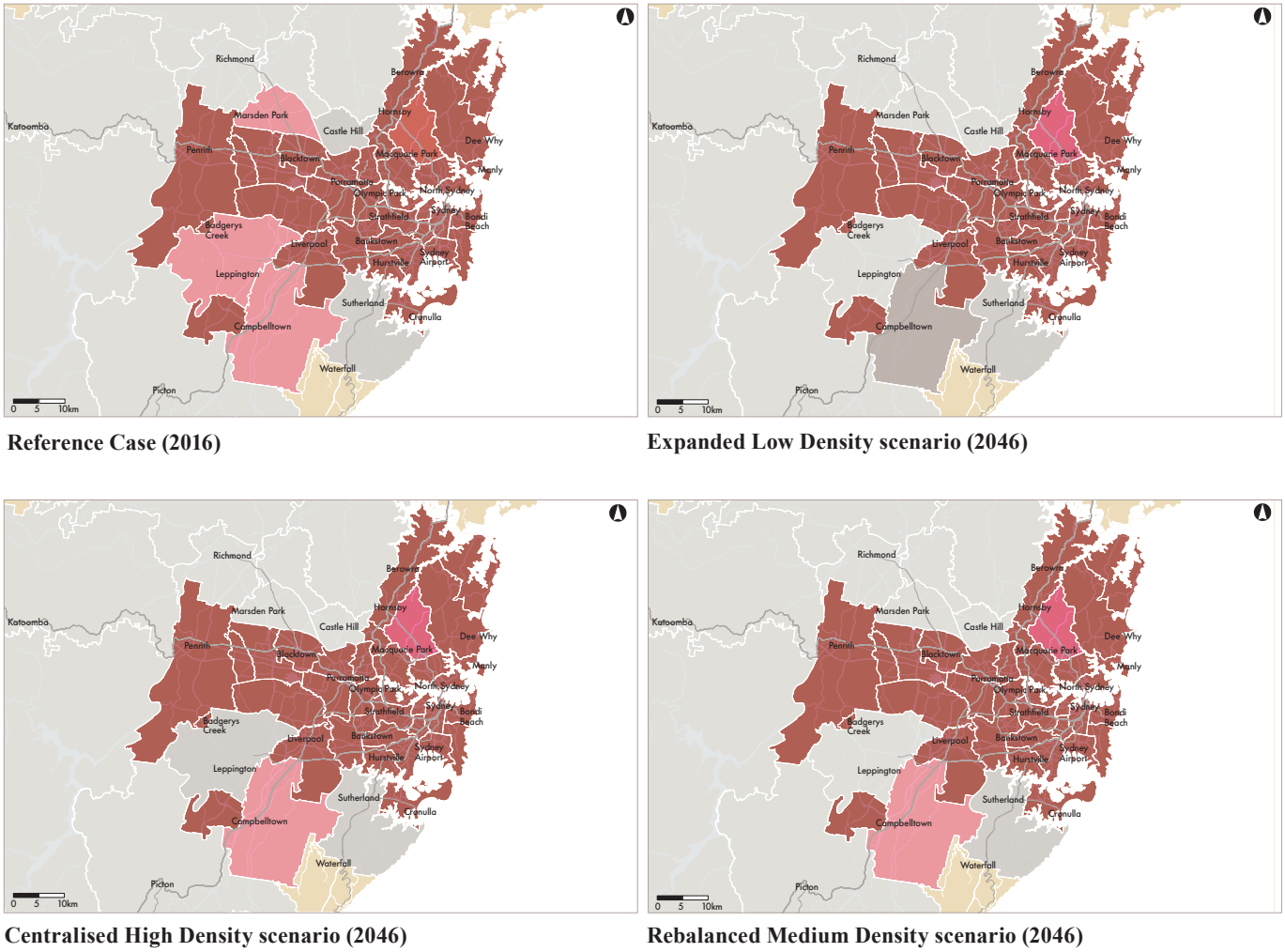


Table 31 shows the average percentage change in demand for hospitals across the scenarios between 2016 and 2046 per SA3. The average is calculated by measuring demand for hospitals in each SA3 and then taking a population weighted average. This is a measure of the spread of demand.

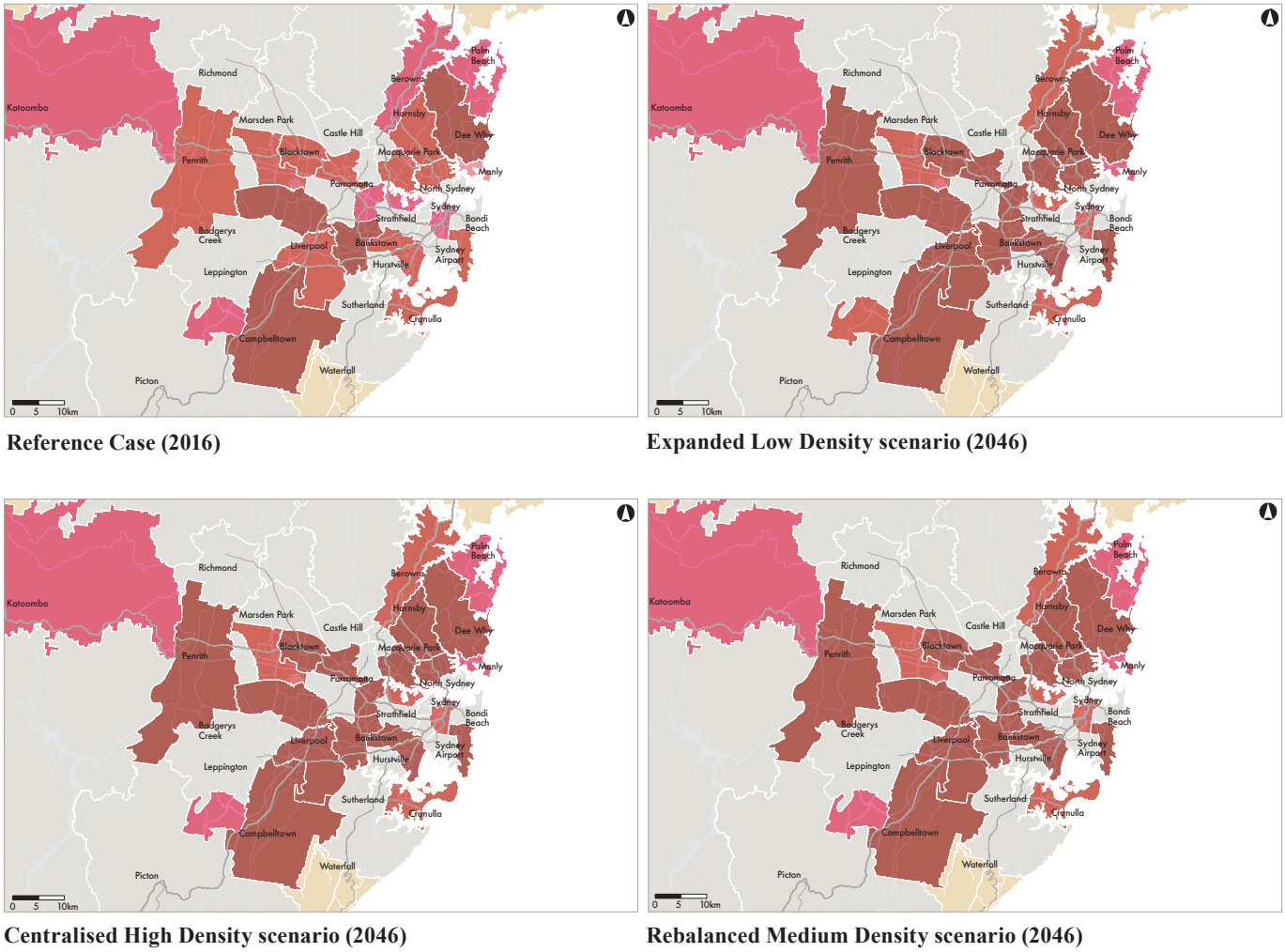
The Centralised High Density scenario sees the greatest number of people per existing facility, placing an average of 47% more pressure on services within SA3s. In contrast, the Expanded Low Density scenario shows only a 31% increase in average demand.

The results for the latter should be read with caution. The Expanded Low Density scenario data are skewed by there being no facilities in key SA3 growth centres. For example, Bringelly-Green Valley, Blacktown North and Rouse-Hill-McGraths Hill each have significant population growth under the Expanded Low Density scenario, but return no growth data due to there being no emergency hospitals in these SA3s.

Table 31: Sydney – Change in demand for hospital facilities between 2016 Reference Case and 2046 scenarios

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per hospital facility (within SA3s)	+31%	+47%	+42%

Figure 48: Sydney – Demand for hospital facilities, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

People per Hospital 0 (no hospitals) <= 50,000 51,000–100,000 101,000–150,000 > 150,000

Figure 48 maps the spatial distribution of this demand, as average population per hospital facility across Sydney at the SA3 level. It shows strong increases around key population centres such as Auburn, Parramatta and Inner-Sydney, particularly under the Centralised High Density scenario (over 80% increase). Under the Expanded Low Density scenario, areas such as Camden and Campbelltown, and Auburn again, experience significant increases in demand for hospitals.

There is a geographic disparity to both access and demand across Sydney. For certain outer-western areas of Sydney, access declines significantly under each scenario, and demand also increases substantially. This trend is likely even stronger than the data suggests, given key SA3 growth centres do not currently have emergency departments, and therefore do not feature on the map.

The demand data illustrates the need to deliver adequate infrastructure to support the needs of communities as they grow. Investments should broadly follow demand, with a low-density city attracting expenditure on new greenfield hospitals, and a high-density city requiring investments to expand existing facilities.

Across all scenarios, demand for schools increases substantially which demonstrates the need for integrated planning for new and upgraded facilities

The New South Wales Government is currently responsible for the education of 780,000 students and the ownership of over 2,000 schools across the state, including about 1,600 primary schools, 400 secondary schools and 60 combined primary and secondary schools.[88] A large portion of these students and facilities are based in Sydney.

Sydney is going to experience a substantial increase in demand for school facilities. Across the scenarios, average population per school at the SA3 level will increase by between 65% to 77% from today's numbers.

Access to schools remains relatively stable across scenarios, ranging from 92% to 95%, as schools are generally evenly dispersed because they are planned to serve population catchments. Accessibility decreases from the reference year, but this is because no additional schools are provided in the modelling. This means that areas of population growth in the model that are further away from existing facilities have lower accessibility rankings.

Table 32 shows the percentage increase in average population per school and the percentage of the population with access to schools, between 2016 and the three 2046 scenarios.

It is clear that under any future scenario, funding and policy will be focused on providing new schools in greenfield areas and expanding capacity of facilities in existing centres. **Figure 49** maps the average population per school across Sydney at the SA3 level.

The maps demonstrate that despite the different spatial structures of the city, the areas of significant growth are largely consistent. These include:

- **North-west and south-west growth centres:** Under all scenarios, demand in these two centres are within the highest band. These areas currently have low populations and demand and therefore fewer schools. New schools will need to be constructed to cater for planned population growth.
- **A number of established centres:** These include the inner-city, Botany, Bankstown, Auburn and Canada Bay. The challenge in these centres is to expand existing schools and, where possible, re-purpose land for new schools to cater for population growth.

Greenfield development provides the lowest levels of access and highest concentration of demand for tertiary education

Across all three scenarios, it is clear that the demand for tertiary education infrastructure, which includes university campuses and Technical and Further Education (TAFE) institutes, increases as the population of Sydney grows over the next 30 years.

Table 32: Sydney – Change in demand for schools between 2016 Reference Case and 2046 scenarios

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per school (within SA3s)	NA	+77%	+65%	+70%
Average percentage of population with access* to a school	97%	92%	95%	94%

* Ability to reach a primary or secondary school within a five-minute drive, 20 minutes by public transport or a 40-minute walk

Table 33 shows the average percentage changes in demand for tertiary education facilities across the scenarios between 2016 and 2046 by SA3. The differences in demand between the three scenarios reflects the relative alignment of population growth and the location of existing infrastructure.

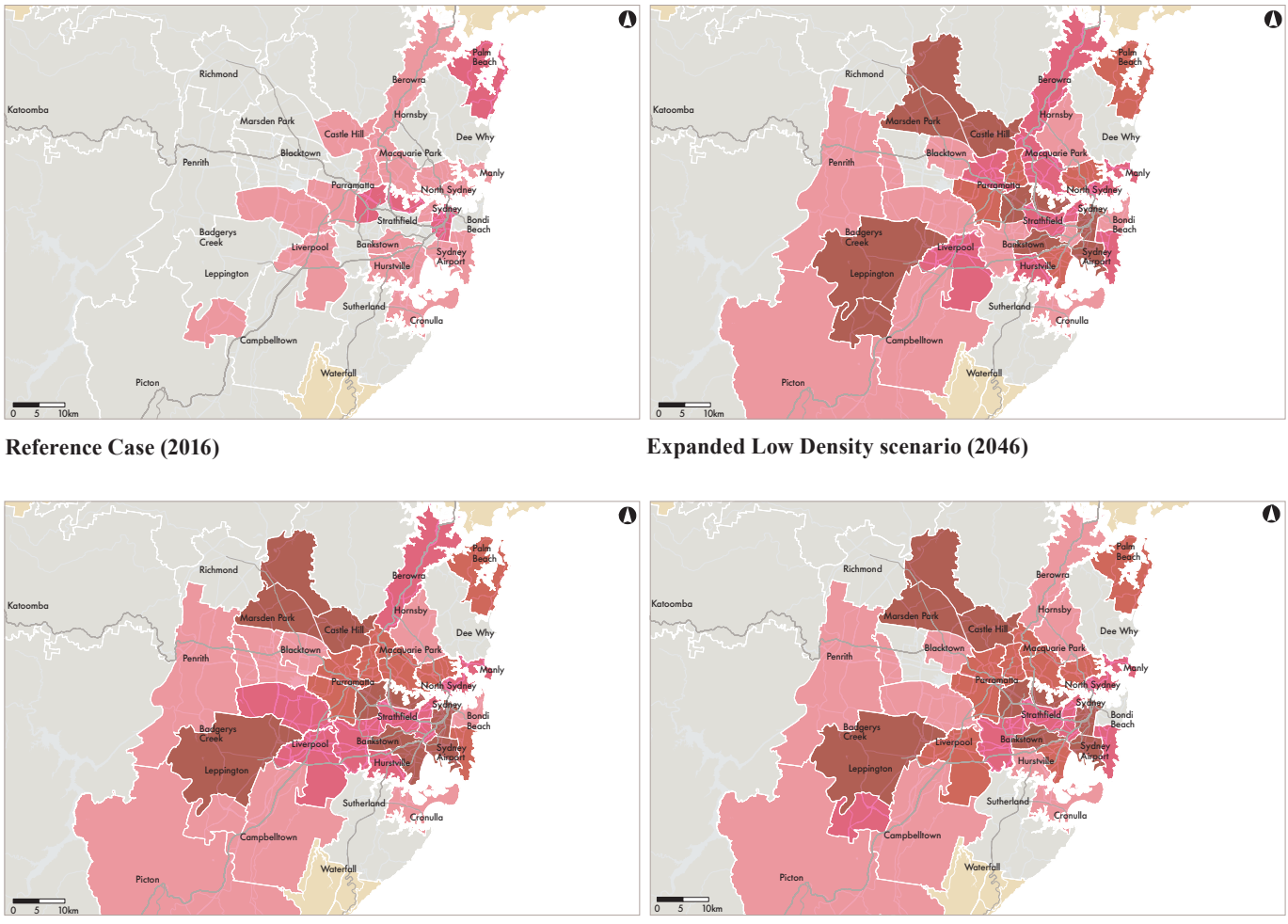
The Centralised High Density scenario sees the greatest number of people located in SA3s which are well-serviced by existing tertiary education infrastructure. The large number of facilities in these areas mean demand is spread evenly between them, therefore decreasing the average population per facility.

In contrast, the Expanded Low Density scenario sees the largest portion of growth located on the outskirts of the city, where there are relatively few existing tertiary education campuses. This means demand per facility becomes concentrated, pushing up the average under this scenario.

Table 33: Sydney – Change in demand for tertiary education facilities between 2016 Reference Case and 2046 scenarios

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage change in population per TAFE (within SA3s)	+90%	+58%	+70%
Average percentage change in population per university (within SA3s)	+122%	+81%	+98%

Figure 49: Sydney – Population per school, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

People per School <= 3,000 3,001–4,000 4,001–5,000 5,001–6,000 > 6,000

These dynamics are also evident when looking at changes to accessibility. Currently, metropolitan-wide average access to tertiary education is quite high for Sydney. 91% of people can access a university within a 60-minute public transport trip and 87% of people can access a TAFE within a 20-minute drive or 30-minute public transport trip. This shows that the location of transport connections to Sydney's existing tertiary education institutions is relatively well-suited to the current population distribution.

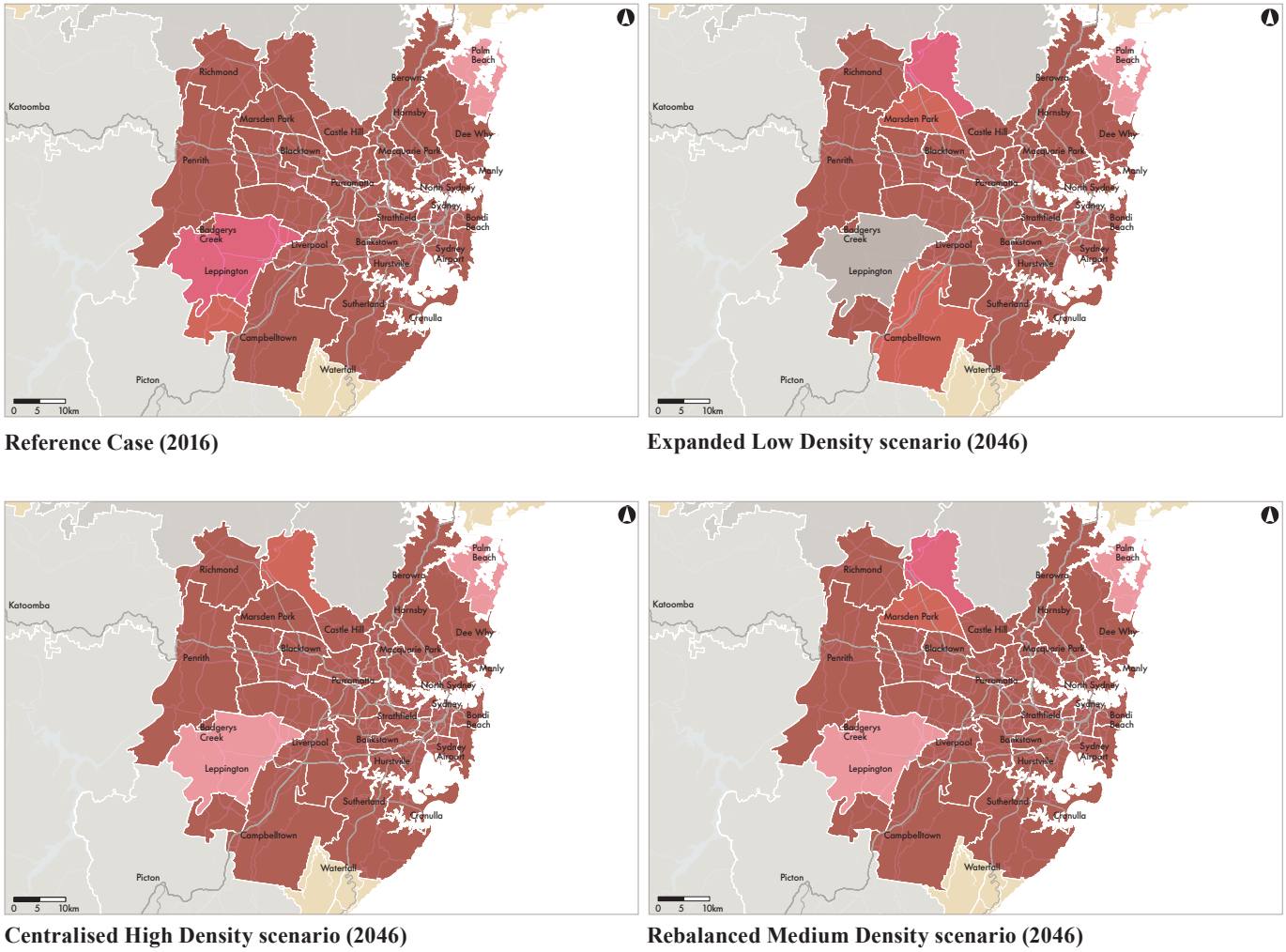
In 2046, each scenario experiences a decrease in overall access from 2016, with the Expanded Low Density scenario experiencing the largest reduction in access of the three scenarios. **Table 34** shows the percentage of population with access to tertiary education facilities.

Table 34: Sydney – Percentage of people with access to tertiary education facilities

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to a TAFE (within SA3s)	87%	80%	85%	83%
Average percentage of population with access^ to a university (within SA3s)	91%	86%	90%	89%

* Ability to reach a TAFE within 20-minute drive or 30-minute public transport trip
^ Ability to reach a university within 60-minute public transport trip

Figure 50: Sydney – Access to university facilities within 60-minute public transport trip, by SA3



Reference Case (2016)

Expanded Low Density scenario (2046)

Centralised High Density scenario (2046)

Rebalanced Medium Density scenario (2046)

% Population < 20% 20–30% 30%–40% 40%–50% 50%–60% 60%–70% > 70%

Figure 50 and **Figure 51** map the distribution of accessibility to university and TAFE facilities, respectively, at the SA3 level for the reference case and the three 2046 scenarios.

The mapping helps to identify two key points:

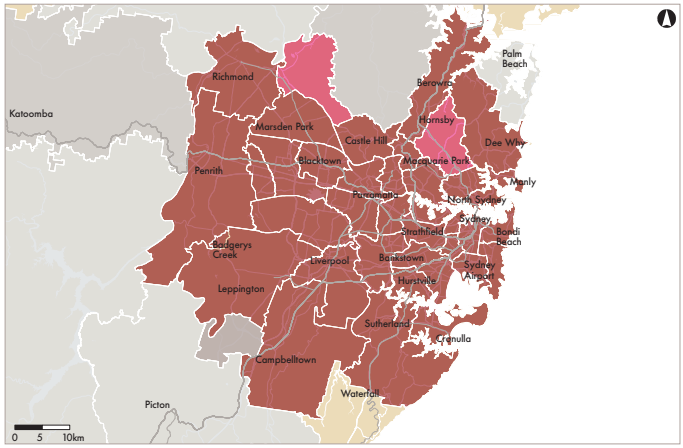
1. **The Centralised High Density scenario has the highest level of access:** Under this scenario, people are placed closer to existing facilities, meaning accessibility increases. In a high-density city, capacity constraints at existing facilities would likely become a focus for governments and universities.
2. **The north-west and south-west of Sydney have comparably poor access:** Under all scenarios, but particularly the Expanded Low Density scenario, population growth on the city outskirts will reduce accessibility in these areas unless new facilities or better transport connections are built.

Unlike other social infrastructure, such as schools, it is not critical that every local community have immediate access to a tertiary education facility. Instead, university and TAFE campuses tend to locate in centres and draw students and employees from across the metropolitan area. However, significant gaps in access on the outskirts of a city can have social equity implications.

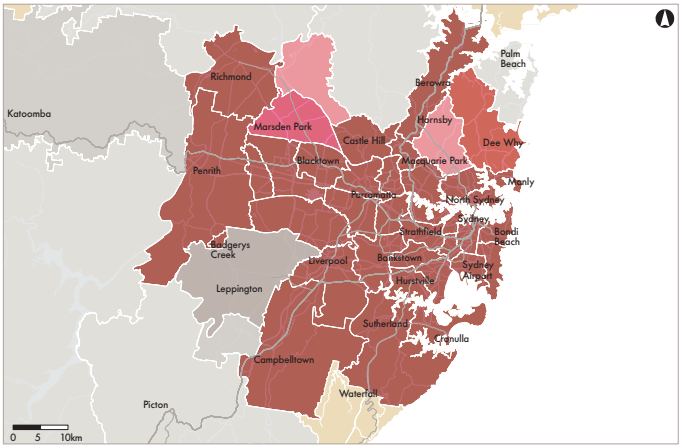
5.5 Access to and demand for green space

Green space is already a valuable asset in Sydney. As the city grows, space will become more scarce and valuable. This means land will be converted to new uses, such as housing. Denser housing across Sydney will be required for a growing population, and so more people will be living in smaller homes with reduced private space. This means green and public spaces will play a more significant role in supporting the city's liveability.

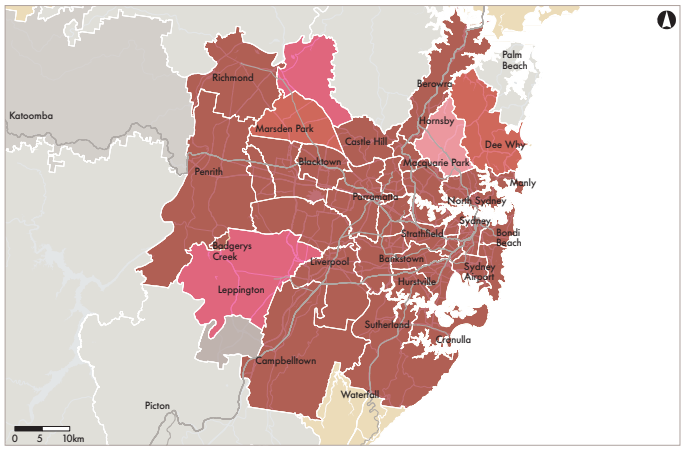
Figure 51: Sydney – Access to TAFE facilities within 20-minute drive or 30-minute public transport trip, by SA3



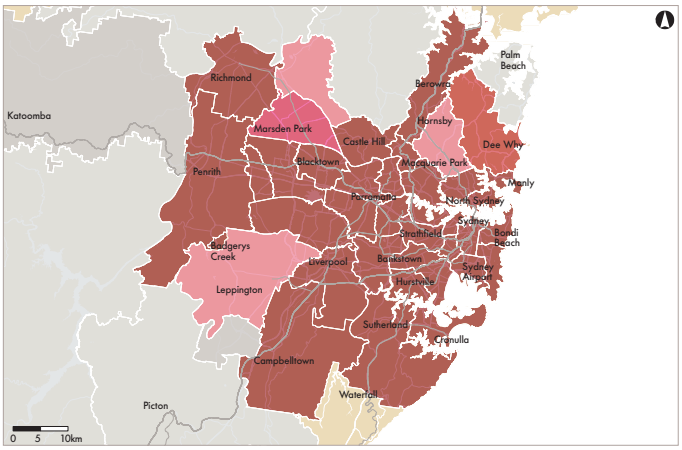
Reference Case (2016)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

The performance of green space is measured using two indicators: changes in accessibility (measured as percentage of the population within a certain area who can access certain types of green space within a defined time budget) and changes in demand (measured as hectares of green space per 1,000 residents).

The results in this report are for open green spaces that are primarily for public use. This means that spaces deemed mostly for private use, such as cemeteries, zoos and sporting facilities are not included. In addition, the data does not include national parks and bushland areas because they are not defined as open recreational space. It is important to note green space categorisation is based on underlying state government definitions and spatial mapping so what is included and excluded differs between Melbourne and Sydney. It is therefore important to not compare the two cities.

The green spaces used in the modelling reflect only the existing spaces, as defined and mapped by the New South Wales Government. This means that planned green space, or potential green space is not included. In reality, governments will deliver new green space alongside development, and will upgrade and enhance existing green spaces, over the next 30 years. As such the analysis should be viewed as an indication of where demand and accessibility constraints could be located under the different scenarios, rather than an analysis of realistic performance in 2046. It is also important to note that the capacity constraints of existing green space were not taken into consideration for the modelling. **Appendix D** provides further details on the data and underlying assumptions for this modelling.

Access to green space decreases on the city's outskirts, showing new development needs to be supported by transport and new parklands

Across the 2046 scenarios, access to green space declines slightly from 2016. **Table 35** shows metropolitan-level aggregate results for access to green space across the scenarios.

The Centralised High Density scenario has the highest level of access to all types of green space across the scenarios. This is because the scenario focuses future growth in established suburbs – most of which already have substantial parklands. In contrast, the Expanded Low Density scenario has the lowest level of access, reflecting the significant population growth on the city's outskirts, which is further away from existing green space.

Figure 52 shows the percentage of the population within each SA3 that can access green space within a five-minute walk. It shows that under all scenarios, the principal areas where access declines are the south-west and north-west of Sydney.

Greenfield areas on the outskirts of the city, while surrounded by 'open' space, still require publicly accessible, useful and high-quality green space to meet the needs of surrounding communities. This means that regardless of the spatial distribution of Sydney's population into the future, governments will need to focus on delivering accessible green space (particularly at a local 'five-minute walk' scale) alongside new greenfield development in the outer areas of the city.

Demand for green space increases across all scenarios. Higher densities need to be supported by management and expansion of existing parks

Demand for green space at the metropolitan level is measured by calculating the hectares of green space per 1,000 residents in each SA3 and then taking a weighted average. At an aggregate level, demand for green space increases significantly between 2016 and 2046. This is to be expected, as the population grows without additional green space being added (for the purposes of modelling).

However, the distribution of population growth between the scenarios results in different levels of demand for existing space. Demand is lowest (i.e. on average there are more hectares of green space per 1,000 residents) in the Centralised High Density scenario, while the Expanded Low Density scenario shows the greatest demand (almost double that of 2016).

Table 36 shows the metropolitan-level average demand for green space for 2016 across the three scenarios.

Figure 53 maps the spatial distribution of this demand, as hectares of green space per 1,000 residents across Sydney at the SA3 level. The mapping reflects two important aspects of future demand:

1. **Hectares of green space per 1,000 residents will decrease in western Sydney:** As the area grows due to development of the Western Sydney Airport, South-West and North-West Growth centres, parkland will need to be reserved early.
2. **Pressure on inner-city parkland will grow:** The eastern half of Sydney already has the lowest amount of green space per person (due to higher densities). Existing parkland will get more crowded as the city grows, meaning management, strategic land acquisition and repurposing will be critical.

Table 35: Sydney – Percentage of people with access to green space

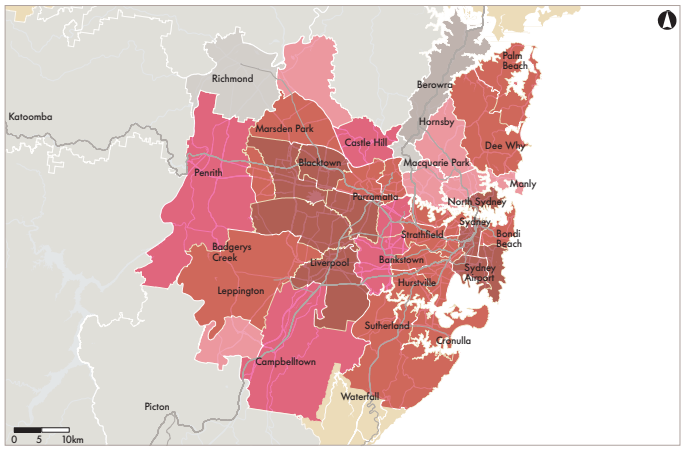
	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average percentage of population with access* to green space	62%	54%	58%	56%

* Ability to reach any type of green space within a five-minute walk

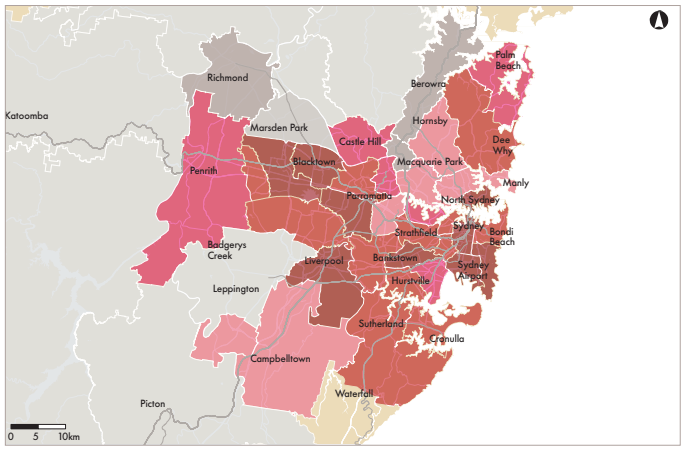
Table 36: Sydney – Demand for green space

	Reference Case (2016)	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Average number of hectares of green space per 1,000 residents (within SA3s)	8.07	4.11	5.11	4.53

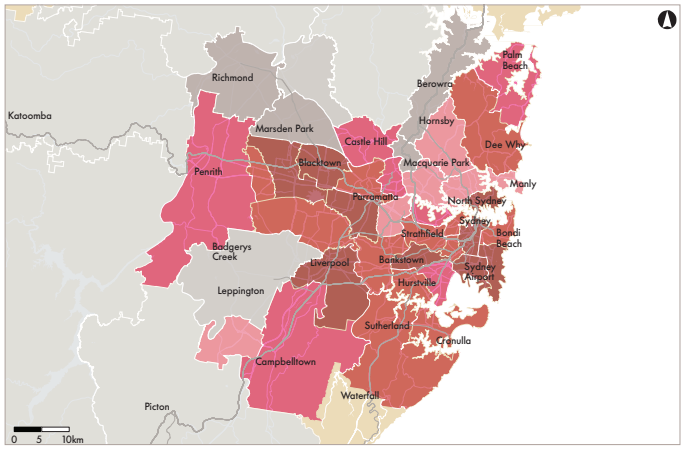
Figure 52: Sydney – Access to green space within 5-minute walk, by SA3



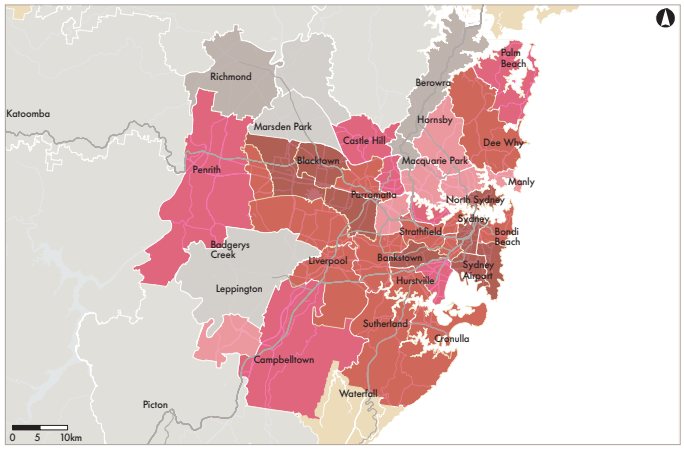
Reference Case (2016)



Expanded Low Density scenario (2046)



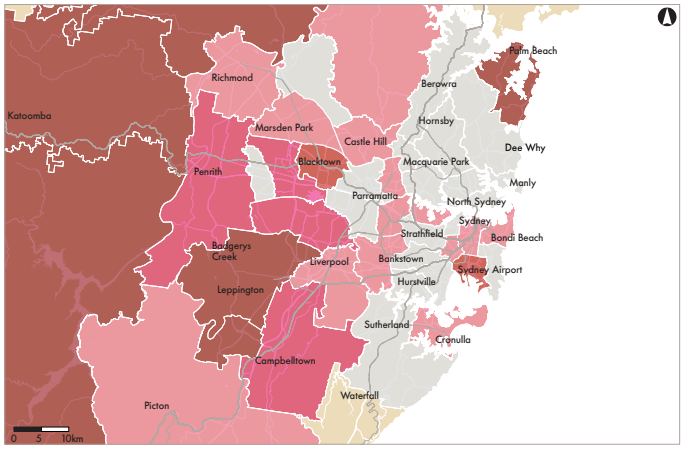
Centralised High Density scenario (2046)



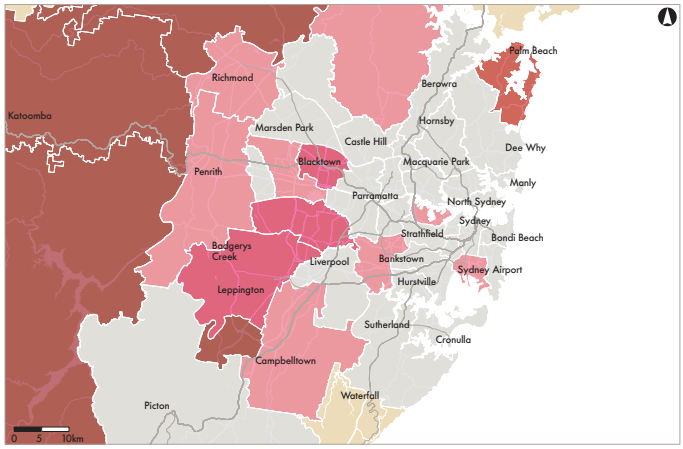
Rebalanced Medium Density scenario (2046)

% Population < 20% 20–30% 30%–40% 40%–50% 50%–60% 60%–70% > 70%

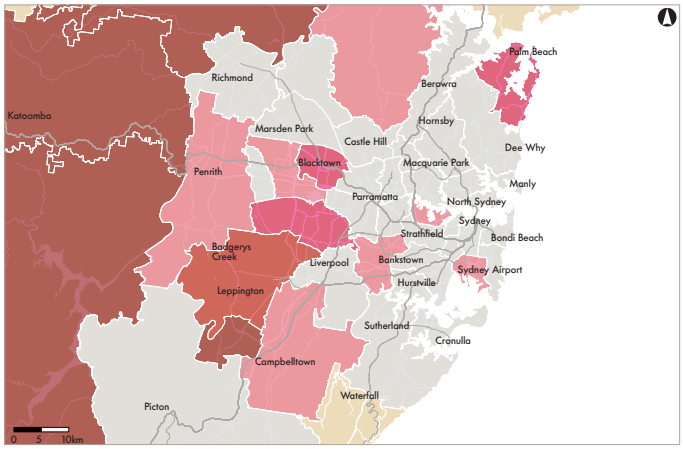
Figure 53: Sydney – Demand for green space, by SA3



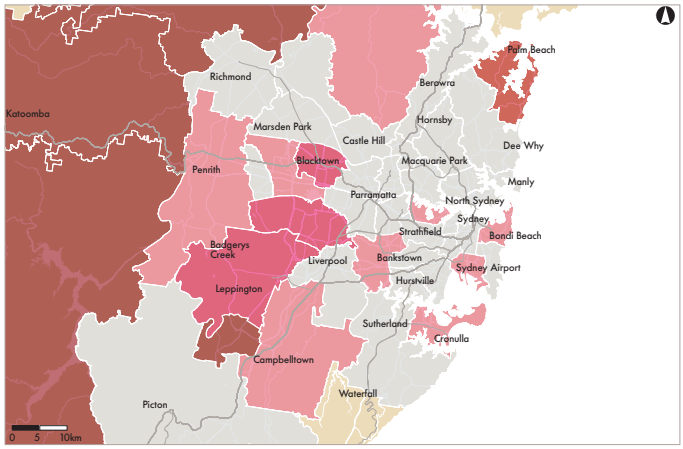
Reference Case (2016)



Expanded Low Density scenario (2046)



Centralised High Density scenario (2046)



Rebalanced Medium Density scenario (2046)

Hectares per 1,000 Residents < 2.0 2.1–4.0 4.1–6.0 6.1 –8.0 > 8.0

5.6 Key findings for Sydney

The scenario analysis in this chapter demonstrates how land use and transport futures can shape the performance and everyday experience of living in Sydney in coming decades. The indicator results for transport, environment, accessibility, social infrastructure and green space show that a substantial increase in demand for services will require responses from governments, including careful planning, considered investments and targeted policy reform. The following is a list of key findings for Sydney drawn from the analysis.

1. **Unplanned growth delivers the worst outcomes for Sydney.** The Expanded Low Density scenario most closely resembles a future of minimal planning intervention within existing areas, with low-density development taking place in outer growth areas away from key employment centres, and with minimal investment in mass transit beyond what is committed. This scenario performed the worst across most indicators. This shows that well-functioning cities that provide good access to work, crucial services and leisure, require careful planning to locate and connect employment centres, residential development, social services, and green and public spaces.
2. **Public transport is crucial to improving accessibility in a city of Sydney's future size.** Under all scenarios, the use and performance of public transport services improves. Even as Sydney grows by more than two million people, both the public transport mode share, and the proportion of the city's jobs that can be accessed by public transport, increase. This shows that public transport is well-suited to moving large volumes of people, particularly in higher density environments.
3. **Private vehicles continue to play an important role in Sydney.** However, across all scenarios congestion significantly increases, and adding new roads is only part of the solution. The scenario analysis indicates that private vehicles continue to be used for the majority of trips within Sydney, and the total number of trips on our roads increases significantly. Congestion also increases. While strategic additions and capacity enhancements to the road network provide congestion relief for parts of the road network, it is evident that other approaches are required to meet the scale of demand, including demand management mechanisms such as road use charging, and public transport investment.
4. **Sydney can use its existing infrastructure more efficiently.** The scenario analysis indicates that different land-use changes provide opportunities to extract greater value from existing infrastructure across Sydney. The Centralised High Density scenario shows that placing development around existing public transport infrastructure can deliver accessibility benefits. While new infrastructure will need to be delivered over the next 30 years to support population growth in Sydney, 'sweating' existing assets can also deliver significant benefits.
5. **Different growth patterns for Sydney require trade-offs in terms of coordinating and prioritising additional or upgraded infrastructure.** The scenario analysis shows that growth focused on the outskirts, such as Sydney's north-west and south-west growth centres, places increased demand on fewer facilities, indicating the need for investment in new, more accessible infrastructure, while demand on infill development indicates the need for upgrades to the capacity of existing facilities. Governments and the community will face a series of choices about the sequencing, type and location of infrastructure to support growth.
6. **Well-planned employment centres enhance Sydney's job accessibility and can deliver national benefits.** The scenario analysis shows that job accessibility is improved in Sydney when key employment centres are supported by strong transport networks, thereby deepening labour markets for employers and allowing workers to further their skills and experience. Job centres also encourage agglomeration economies by allowing employers to co-locate near each other. As Australia's largest city, well-functioning employment centres in Sydney are crucial for the country's prosperity.
7. **Land-use and infrastructure planning can help to address inequality of access across Sydney, but supporting social and economic policies are also required.** Land-use and infrastructure planning can help to improve access to jobs and increase economic activity in traditionally disadvantaged areas, such as Sydney's south-west. However, the benefits of growth will also need to be distributed using government policy intervention in other portfolios such as education, health and social services.

8. **As Sydney grows and densifies, green and public spaces play an increasingly important role in maintaining the city's liveability.** The scenario analysis shows that regardless of the way in which these cities grow, population growth on the scale projected sees pressure placed on the public realm. Higher densities mean people have less private space such as backyards, and rely more on existing green and public space that needs to be well-maintained and managed. On the city's outskirts, planning for new suburbs needs to include new green and public space which adds to existing assets.

9. **Land-use changes can play some role in addressing the amount of carbon emissions our cities generate.** Australian cities are the principal generators of Australia's carbon emissions and, without significant change, the growth of these cities will only increase this trend further. The scenario analysis shows that different land-use and transport infrastructure choices can improve the environmental performance of Sydney's road network. In particular, higher density spatial patterns that encourage mode shift away from private vehicles towards active and public transport generate lower carbon emissions, reducing the city's impact on the environment.

Maps can be viewed in more detail at www.infrastructureaustralia.gov.au.

An urban reform agenda for Australia's fastest growing cities

At a glance

- Infrastructure Australia has used the key findings from the scenario analysis of Melbourne and Sydney and the *Australian Infrastructure Plan* to inform the development of 15 recommendations. These recommendations aim to provide all levels of government with advice on how Australia's fastest growing cities should update their planning, policy and delivery processes to successfully meet the demands of population growth.
- The recommendations are divided into four areas:
  1. **Deliverability:** Advice on updating the tools governments use to deliver change within Australia's cities.
  2. **Economic performance:** Advice on improving the relationship between where people live, where jobs are located and the transport networks which connect them, which together have a material impact on the prosperity of our cities.
  3. **Equity of access:** Advice on a set of reforms to ensure our largest cities remain accessible to all as they grow.
  4. **Liveability and resilience:** Advice on the key actions required to maintain and upgrade the key infrastructure and services, which support the liveability and resilience of our cities.

Identifying an urban reform agenda for Australia's fastest growing cities

While the effects of population growth within Australia's largest cities will be experienced incrementally over the coming 30 years, many of the key decisions required to successfully cater for change are happening right now. We must ensure that Australia's governments are equipped with the necessary tools and processes to deliver the planning, policy, regulation and funding required to successfully respond to the population growth.

The scenario analysis for Melbourne and Sydney presented in this paper provides nine key findings that are relevant to Australia's four largest cities.

The findings are:

- Unplanned growth delivers the worst outcomes for Australia's fastest growing cities.
- Public transport is crucial to improving accessibility in Australia's largest cities.
- Cars continue to play an important role in our cities. However, across all scenarios, congestion significantly increases, and adding new roads is only part of the solution.
- We need to use existing infrastructure in our cities more efficiently.
- As demand increases, coordinating and prioritising additional or upgraded infrastructure between and within governments will be a challenge.

6

- Well-planned infrastructure to service employment centres enhances the job accessibility of our cities and can deliver national benefits.
- Land-use and infrastructure planning can help to address inequality of access, but supporting social and economic policies are also required.
- As our largest cities grow and densify, green and public space plays an increasingly important role in maintaining liveability.
- Land-use changes can play some role in addressing the amount of carbon emissions our cities generate.

This analysis provides an evidence base for the impact that population growth will have on the function and liveability of our cities. This paper presents recommendations that draw upon this evidence base to propose a wider urban reform agenda to address the impacts of growth on our cities.

The series of **15 recommendations** aim to provide all levels of Australia's government with advice on how to better use governance, planning, policy and delivery processes to successfully meet the demands of population growth in Sydney, Melbourne, Brisbane and Perth in coming decades.

In total, the recommendations represent a clear urban reform agenda for Australia's fastest growing cities.

6.1 Deliverability

A central finding of the scenario analysis is that the unplanned growth of Australia's four largest cities, meaning the delivery of growth without a significant step change in the structure and operation of these cities, will deliver the worst outcomes for both current and future residents. In practice, this means that the planning, policy and regulatory frameworks which underpin our cities will need to be updated to successfully accommodate materially larger populations. Australia's governments will be tasked with leading the design and delivery of this change, in partnership with the community and private sector.

Our governments have a strong track record of delivering good outcomes within Australian cities. Our cities are world-renowned as attractive places to live and work. However, in the context of significant growth and change, the tools used by governments to deliver change will need to be enhanced, to ensure our communities are effectively supported.

Infrastructure Australia has identified several areas where existing governance and delivery processes should be updated to ensure they are better structured to meet the complex challenges facing some Australian cities.

These include:

- Capitalising on the role of the Australian Government to drive nationally significant reform in our cities
- Establishing metropolitan governance
- Enhancing the sophistication and flexibility of strategic planning tools and processes
- Taking a place-based approach to better deliver change at the local level
- Increasing the quality of community engagement at the strategic planning stage
- Implementing outcome-based regulation to support innovation.

Capitalising on the role of the Australian Government to drive nationally significant reform in our cities

The Australian Government has a clear stake in the successful development of our cities. For example:

- Australia's largest cities are an important source of Australia's productivity gains. In 2015-16 Australia's five largest cities, contributed 65.5% of Australia's GDP. Of that 65.5%, Melbourne and Sydney alone contributed 42.4%.[89]
- Australian cities are where the bulk of Australians choose to live and work. This means that changes in the performance of our cities have a tangible impact on the day-to-day lives of millions of Australians, and can in turn impact the quantum of welfare support required from the Australian Government.
- Reducing the environmental impact of Australian cities is a significant opportunity to reduce Australia's emissions as a whole, in line with the Australian Government's international commitments.

The role of the Australian Government in our cities is determined by the structure of the Australian federation.

State, territory and local governments play a direct role in the planning and operation of cities. State and territory governments are charged with setting the long-term strategic direction for cities. They are responsible for long-term metropolitan planning, the approval and delivery of state-significant projects and the delivery of key government services, including transport, health, education, land-use planning, social services and regulation in other areas, such as water. Local governments are responsible for delivering the metropolitan vision at the local level. This entails the approval of local development, the delivery of local infrastructure upgrades and the delivery of key local services, such as waste collection, community development, and maintaining public spaces.

In contrast, the Australian Government is relatively removed from the day-to-day operation of cities. Instead it has a number of levers available to influence the development of cities in line with national objectives. These include levying taxes, implementing policy and regulation reform, overseeing net migration levels and the distribution of funding, including the deployment of a significant infrastructure budget.

The Australian Government is also responsible for Australia's overall economic performance, which is a function of productivity. Cities are a driver of Australia's productivity, and improving urban efficiencies is a key tool for improving the nation's performance.

Since the end of World War II, the Australian Government has used its position in the federation to influence the development of cities, ranging from the provision of loans to state and territory governments to deliver housing in the 1940s to directly funding urban renewal projects in the 1990s under the Building Better Cities program. Despite this good work, to date there has not been a consistent role established for the Australian Government in the development of Australian cities.

Given the significant level of growth projected for our cities and the corresponding level of infrastructure funding that will be required, there is a strong case for the Australian Government to better capitalise on their position within the federation and establish a consistent hierarchy of incentives, which tie infrastructure funding to the delivery of city-based reforms.

The current Australian Government is in part already doing this. At the project level, the Australian Government uses National Partnership and Project Agreements to align the delivery of infrastructure payments with state, territory and local governments meeting important project milestones.

At a spatial level, the Australian Government has recently begun negotiating a series of City Deals, as part of its 2016 *Smart Cities Plan*.[90] The Deals are place-based funding agreements with state, territory and local governments, and community and private sector partners, covering a range of different policy domains relating to the development of a city or sections of a city. The agreements are to be structured around nationally and locally informed objectives, with conditional Australian Government funding linked to meeting specific objectives.

However, there is currently no single incentive structure focused on driving the delivery of city-wide reforms that create national benefits. The *Australian Infrastructure Plan* called on the Australian Government to establish 'Infrastructure Reform Incentives', which would see additional Australian Government funding provided to states and territories – over and above existing and projected allocations – in return for the delivery of agreed infrastructure reforms. The *Australian Infrastructure Plan* specifically identified the applicability of this incentive structure to drive the delivery of reforms aimed at improving the productivity, liveability and affordability of Australian cities.

There is a compelling case for the Australian Government to evolve the existing incentive structures to articulate a hierarchy which drives change in our cities at the project, place and reform levels. The introduction of Infrastructure Reform Incentives, alongside the continued use of National Partnership Agreements and City Deals would provide the Australian Government with a robust platform to do this. To be successful the design and implementation of these incentives would need to occur in conjunction with each other, and be informed by a well-evidenced national investment and urban reform agenda for Australian cities.

Recommendation 1

The Australian Government should establish a consistent framework of incentives to drive the delivery of national benefits within our cities at the project, place and reform level. The new framework would include a hierarchy of three incentive types:

- **National Partnership and Project Agreements** which make project funding contingent on meeting specified outcomes across the project lifecycle and demonstrated economic benefit
- **City Deals** which apply a series of locally and nationally informed objectives to a city or part of a city, and make infrastructure payments for the area contingent on meeting those objectives
- **Infrastructure Reform Incentives** which would provide additional infrastructure funding above existing allocation in return for the delivery of policy and regulatory reform focused on improving the productivity, liveability and affordability of Australian cities.

Establishing metropolitan governance

As Australia's largest cities grow, integrated governance and leadership at a metropolitan level will become a key indicator of success.

For most of Australia's largest cities, both state and local governments manage different aspects of planning, infrastructure and services. State governments are generally responsible for metropolitan and regional planning, regulating other economic infrastructure such as energy and water, planning and delivering social infrastructure such as healthcare, education and emergency services, and large-scale infrastructure such as public transport and main roads. However, local governments also play a critical role in the planning and development of Australian cities. They implement the bulk of planning policies and approval processes at the local scale, and deliver key services and local infrastructure. As our largest cities grow and change in coming decades, the responsibilities of local governments will increase, as they become a central vehicle for delivering and coordinating change at the suburb and street level.

However, the large number of small local councils in many of our major cities has resulted in cases of fragmented governance, and disjointed infrastructure and service delivery. While state and territory governments have introduced various processes of local government reform, many LGAs do not currently have the necessary scope and scale to effectively meet the demands of rapidly growing urban populations.

The establishment of metropolitan-scale governance provides cities with an opportunity to improve outcomes for local communities and deliver wider benefits for the city as a whole.

Larger governing entities, with sufficient scale, can employ a wider range of skilled staff, enabling them to undertake more efficient infrastructure delivery and operation, and strategic planning. These institutions can also more easily partner with state, territory and federal agencies in the strategic planning and management of their wider cities and regions, increasing their ability to advocate for local and city-wide issues.

Beyond local boundaries, metropolitan governance can deliver wider benefits for the national economy. The Organisation for Economic Cooperation and Development (OECD) has found the degree of fragmentation in a city's governance structure directly impacts the productivity of the economy. In metropolitan areas with similar sized populations, those with twice the number of LGAs are associated with around 6% lower productivity.[91]

Around the world, cities comparable in size and stature to Australia's fastest growing urban centres have introduced systems of metropolitan-scale governance:

- In 1999, the national government in the United Kingdom established the Greater London Authority, led by a democratically elected mayor. It is charged with setting the strategic direction for London's 33 local boroughs, and planning and delivering key city-wide services such as transport, emergency services, and urban development.[92]
- Closer to Australia, in 2010 the New Zealand national government consolidated eight local authorities into a single metropolitan council, the Auckland Council. The new city-wide council, is led by a single mayor, and has responsibility for Auckland's land-use and transport planning.[93]
- The City of Brisbane is Australia's largest LGA by population, covering around 1.1 million residents, which is roughly half of the wider Brisbane metropolitan area.[94] The City was established in the 1920s after the amalgamation of a number of smaller LGAs. Its scale allows it to contribute significantly to the strategic metropolitan-regional planning of South-East Queensland across land-use and infrastructure sectors.[95]

There is a strong case for Australia's fastest growing cities, as they reach a certain size, to establish institutions or processes which enable the increased delivery of metropolitan-scale governance. Reflecting the examples of London, Auckland and Brisbane listed above, there are a number of pathways that this reform can take, ranging from the establishment of intermediary agencies charged with championing a metropolitan focus across governments, to the amalgamation of councils to drive greater scale and efficiency. Each reform process will be different and should be tailored to match the unique size, geography, governance structure and economy of the individual city.

Progress has been made towards metropolitan governance in Melbourne, beginning in the 1990s, and in Sydney, with more recent local government amalgamations. In addition, in 2015, the NSW Government took a significant step towards metropolitan-level governance with the establishment of the Greater Sydney Commission. The organisation leads metropolitan planning for Greater Sydney and is responsible for delivering the Greater Sydney Region Plan.

There is a case for the Australian Government to support these and other processes that support reform, using the hierarchy of incentives outlined in **Recommendation 1.**

Recommendation 2

Australia's largest cities should establish institutions and processes which enable the delivery of metropolitan-scale governance. There are a number of pathways this reform can take, ranging from the establishment of new metropolitan-focused agencies, to the amalgamation of existing local councils. The approach adopted should be tailored to match each city's unique characteristics.

Enhancing the sophistication and flexibility of strategic planning tools and processes

Current long-term planning processes for Australia's largest cities have followed a broadly similar pattern of development. Long-term population and employment projections are used to generate a high-level picture of what it will be like to live and work and move around in the city in coming decades. These visions are supported by corresponding delivery milestones and policy interventions, such as location-specific targets for the delivery of new housing or the creation of new jobs, the identification of new or upgraded infrastructure, or the development of policy reforms required to support implementation of the future vision. Visions are also communicated to supporting departments, and other levels of government, who play a contributing role in implementing the vision at the local level.

The existing approach has an important and enduring role. Governments will always be required to provide a consistent vision to the community. The complexity of city systems means that the articulation and implementation of a single long-term vision for a city is a difficult process. It runs the risk of setting in place a process of path dependency which may materially constrain decision makers' ability to be flexible and adapt policy as circumstances change over time. This often means plans have short life-spans, with new plans replacing old ones, beginning the visioning process again. At the same time, the articulation of a single vision, informed by sometimes opaque data and modelling, can limit the quality and outcomes of community engagement.

Australia's governments have an opportunity to widen the scope of the evidence and tools they use to inform strategic planning. The scenario analysis for Melbourne and Sydney presented in this paper showcases the value that a wider range of strategic planning tools can provide, by building greater sophistication and flexibility into the strategic planning process.

More flexible planning tools, like scenario planning, enable decision makers to better consider the uncertainty facing Australian cities, and test potential future investments and policies against a range of potential long-term outcomes. There is also an opportunity to use these tools to increase the quality and transparency of community engagement processes, which would allow members of the public to better understand and test the proposals put forward by governments.

Recommendation 3

Australian governments should improve the flexibility, transparency and sophistication of current strategic planning tools and practices to improve decision making and deliver better planning outcomes for the long-term growth of our cities. Key actions include:

- Using more flexible planning tools, such as scenario planning, which account for uncertainty, and rigorously test the feasibility of future options against a range of different long-term outcomes
- Increasing the transparency of the assumptions, data and models which inform long-term planning tools to ensure communities can appropriately understand and test the proposals put forward by governments.

Taking a place-based approach to better deliver change at the local level

Changes to the metropolitan-level size, structure and operation of our largest cities will also mean tangible change to the functioning and character of the local environment for many residents. Done right, these changes can deliver many benefits for the community.

At the metropolitan level, a bigger and more diverse city can increase productivity, raise incomes and enhance a city's social and cultural diversity. At a local level, increased housing and jobs, alongside new or upgraded supporting infrastructure and community amenities, can enhance liveability.

However, past experience indicates that these local outcomes are not always achieved. The development of Australian cities has been marked by examples of a lack of coordination between different levels of government, and across the different departments and agencies of a single level of government. As a result, there have been instances of new development being delivered without the necessary upgrades to surrounding infrastructure and services. The end result is that the community can be understandably suspicious of change, based on legitimate concerns that additional people and development within their suburb could place pressure on existing infrastructure and services, contributing to a decline in the amenity of their local area.

Examples of poor coordination result when there is a lack of communication and collaboration in the process of translating the long-term metropolitan vision for a city to the local level. Historically, the process for delivering change within Australian cities begins at the state or territory level, where metropolitan land-use, infrastructure and economic plans are developed. These plans identify macro-level changes to the structure and operation of the city required to accommodate the long-term aspirations of the city as a whole.

Once completed, the new metropolitan vision for the city will be translated to the local level by a range of government, private and community actors using a range of mechanisms, including:

- The prioritisation and funding of new infrastructure.
- The rezoning of land for different development scales and uses.
- The upgrading of public and private utilities, services and facilities.
- The implementation of new policies and regulation.

Problems arise in this process when key actors, often focused on a single sector, deliver change within a local area, in isolation from each other, meaning that the needs of an area as a whole are not effectively addressed. For example, there have been cases within Australian cities where increased housing densities are approved for delivery, without corresponding consideration of necessary upgrades to the area's schools, hospitals and transport infrastructure.

An evolved approach is needed. Around the world, governments are seeking to improve the outcomes of urban change at the local scale, by adopting place-based approaches to managing growth. A place-based approach sees governments design and implement change using frameworks and processes that take account of the local geographic context in which change is being delivered. The focus on a specific place, rather than individual projects, requires governments to consider the interrelated elements and actors driving the development of a city and its composite parts, in turn promoting the delivery of integrated responses to change.

State, territory and local governments should explore opportunities to upgrade their existing processes to better reflect the interrelated context in which change is being delivered within local communities, including:

- **Planning:** the preparation of intermediate planning documents which identify how metropolitan-wide goals for the growth of a city will be translated to the local level and outline an integrated approach for how increased demand for key infrastructure, services and amenities will be addressed.
- **Community engagement:** updating engagement tools to provide the community with information on proposed changes to their area as a whole rather than with regards a specific land-use development or infrastructure project. This would allow the community to understand the broader context in which change is taking place and provide the government with an opportunity to communicate how pressure on existing infrastructure and services will be addressed.
- **Governance and delivery:** the establishment of coordinating governance structures, which draw together the key actors and agencies charged with delivering change within a local area, and identify an integrated approach for the sequencing, prioritisation and delivery of infrastructure, housing and economic development within the area.

Many of these processes are currently being applied at varying scales and levels of maturity across Australia's cities. State, territory and local governments should explore opportunities to embed this existing good work by increasing the use of these tools and the consistency of their application.

Recommendation 4

Australian governments should adopt a place-based approach when translating metropolitan visions into the sequencing and delivery of development with infrastructure. Opportunities exist for this approach to be applied to the planning, community engagement and governance processes currently used for delivering change at the local level.

Increasing the quality of community engagement at the strategic planning stage

The diverse local communities that make up Australia's cities have a central role to play in evaluating and ultimately living with the changes that are set to occur across our cities in coming decades. Governments are increasingly understanding and embracing the idea that genuine community engagement is fundamental to the success of urban planning and change.

Community engagement across Australian cities currently takes a number of different forms and occurs at a variety of stages in the planning, design and delivery process, with varied success. While community engagement practices have taken significant strides over recent years, there are challenges with the current approach, including:

- **Timing:** community engagement processes are generally focused at the design and delivery stage, whether it be for a new infrastructure project, the rezoning of an area, or the re-development of a residential site. In many cases less attention is given to involving the community earlier, at the strategic planning stage, when important decisions are made regarding the direction of the city as a whole, and how change will be accommodated at different geographic scales. As a result, many communities are not effectively engaging with the broader context of change occurring in their city and as a result they are often opposed to the corresponding local changes in their area that result from broader strategic directions.
- **Objectives and processes:** while each process is different, there is a tendency for engagement to be focused on informing, rather than consulting, the community about the change that is going to occur, with the scope for input often limited to small-scale details of the design and implementation. In practice, this means governments fail to capitalise effectively on the potential for communities to contribute valuable local knowledge regarding what problems exist in their areas, and the range of potential solutions to solve them. The community is also more likely to oppose change based on a legitimate feeling that they have not been appropriately involved in the decision-making process.

The implications of poor practice are substantial. Research completed by the University of Melbourne's Next Generation Engagement Project has found that around $20 billion in infrastructure projects have been delayed, cancelled or mothballed due to community opposition over the past decade.[96]

The process of engaging communities will always be complex. Communities are understandably wary of change which could have material impacts on their day-to-day lives. Furthermore, communities have become increasingly sceptical of tokenistic or rhetorical engagement to help legitimise a forgone conclusion. At the same time, governments, while being sympathetic to local impacts, must progress outcomes that deliver long-term benefits for the city as a whole.

A greater focus on engaging the community early, when analysis is being undertaken to identify long-term strategic challenges and decisions are being made about the future shape of the city, provides government with an opportunity to rethink existing approaches and draw on different sources of knowledge. Early engagement which provides the community with a real opportunity to influence outcomes will enable governments to arm stakeholders with important information about the challenges and opportunities facing their city. This engagement can also enhance the quality of change when it is delivered at the local level, as it will more likely reflect local perspectives, values and concerns.

To be successful, these processes will need to be accessible to the general community and transparent about the data and analysis underpinning key decisions. Governments will also need to ensure that the process provides the community with a genuine opportunity to identify options for change and contribute to the decision-making process. By harnessing local knowledge through this kind of authentic participation, governments can not only strengthen decision making but help to establish a genuine social licence to operate.

Recommendation 5

Australian governments should improve the quality and accessibility of community engagement at the strategic planning stage of a city's development. Engaging communities at an early stage in a strategic discussion about the options for how their city could grow and change provides them with a genuine opportunity to shape and influence the solutions proposed and increase their understanding of the changes underway in their city. This not only increases the likelihood of support for change at local levels when it happens, but can also enhance the quality and impact of the outcomes delivered.

Implementing outcome-based regulation to support innovation

Technological and business model innovation is re-shaping the day-to-day operation of our cities. Alongside population growth, it will be one of the major drivers of change in coming decades. Advances in the collection and storage of data, increasing innovations in energy storage, and the emergence of new disruptive services and applications, are some of the many changes which have transformed the way we use infrastructure. These changes, while often difficult to predict and plan for, can increase convenience for users and enable communities to extract more from the infrastructure we already have.

Government has an important role to play in this process. While technological innovation can deliver many benefits, it is important that the community is protected from adverse outcomes. Government should act as a buffer to prevent the community from being exposed to the safety risks of unproven technologies or patterns of supply. At the same time, it is critical that the actions of government do not stall or prevent the development and deployment of new technology with valuable applications.

While Australia's governments have generally been supportive of technology change and corresponding innovation, in some cases slow moving regulatory and policy settings, based on an historic understanding of what mechanisms deliver desired public outcomes, have acted as a potential handbrake on change.

Technology is a fast-moving frontier. As a result, it is likely that rigid regulation will remain at least one step behind such change. Under a business as usual approach, new businesses will likely be constrained by artificial limitations on their capacity to innovate, or be forced to operate in legal limbo until their concept is proven. Existing businesses and parts of the community may feel uncomfortable with what they may see as unsafe practices or unfair competition. Where market access is restricted, others in the community may be unhappy that they cannot access services that are available elsewhere.

A more flexible regulatory model which regulates based on outcomes, rather than just outputs, is a viable pathway forward for governments to overcome this dynamic. By examining the impact of a new product or piece of technology on the service delivery outcomes sought by users (such as safety, efficiency or reliability, among many others), regulators can focus their attention on what matters most to the community. Regardless of how a new technology delivers a service, so long as it does not do harm to the community or deliver unfair competitive advantage in the market, it should be given the opportunity to prove itself. This would protect users, but allow markets to innovate in finding lower cost, user-friendly means of achieving a mutually beneficial outcome.

Recommendation 6

Australian governments should focus on outcomes rather than outputs when developing the policy and regulatory frameworks that respond to changing technologies and services. The focus of governments should be on ensuring outcomes important to the community, such as safety, accessibility and reliability, are achieved, while allowing markets to innovate in creating low-cost, user-friendly means of delivering these outcomes.

6.2 Economic performance

The growth of Australian cities is an exciting economic opportunity for the nation. As cities grow, businesses take advantage of larger and more skilled labour markets and workers are given more opportunities to develop and broaden their skill base. Population growth in cities is often outstripped by GDP growth, with a doubling of population estimated to produce a 120% increase in city GDP.[97] The economic performance of our cities therefore matters not just at the local level, but for the nation's productivity.

There is a spatial dimension to the way urban economies operate. The location of jobs and people, and their supporting infrastructure networks, can contribute to or hinder a city's economic performance.

The current spatial structure of Australia's largest cities, generally defined by a central core surrounded by low-density, spread-out growth, can be closely linked to Australia's changing urban economies over time. Our cities developed their core centres as trade and agricultural hubs in the early 1900s, when people and businesses co-located in the dense inner-cities. During the manufacturing era of the 1950s to the 1980s, jobs gradually moved from the inner-city to new outer areas where land prices were cheaper. This decentralisation was enabled by significant growth in private vehicle ownership, which meant the workforce was more mobile and able to access jobs which were not near public transport. Decentralised jobs and private mobility also enabled people to live further away from the city-centre, encouraging the expansion of residential development on the fringes.

In recent decades, the focus of our urban economies has shifted away from manufacturing towards more knowledge-intensive and service sectors. Rather than decentralising, these sectors agglomerate in centres usually at high densities.[98] As a result, there is now an increasing disconnect between the legacy spatial structure of Australia's largest cities and the shifting focus of our metropolitan economies. This has resulted in a dynamic where a significant proportion of our cities' populations do not have easy access to major employment centres and the economic opportunities they present. It also means firms' access is limited to a smaller percentage of the labour market, potentially reducing their efficiency and capacity.

As our largest cities grow, it is critical that the reach and capacity of infrastructure networks, and the relative location of housing and jobs, better align to trends in urban economies.

The scenario analysis provides Australia's governments with a number of insights for how they can achieve this alignment. The relevant findings from the scenario analysis include:

- Well-planned infrastructure to service employment centres enhances the job accessibility of our cities and can deliver national benefits
- Public transport is crucial to improving accessibility in Australia's largest cities
- We need to use existing infrastructure in our cities more efficiently
- Cars continue to play an important role in our cities. However, across all scenarios, congestion significantly increases, and adding new roads is only part of the solution.

Infrastructure Australia has used these key findings to inform the recommendations identified in this section.

Moving people and jobs closer together – taking a more active role in supporting the city's economic geography

The scenario analysis indicates that well-planned employment centres can help to improve job accessibility. For both Melbourne and Sydney, the analysis suggests a potential link between the proportion of morning peak trips to job centres and the percentage of accessible metropolitan jobs. In other words, as more jobs are located in employment centres, accessibility generally increases. Locating jobs in centres which are well-served by transport networks, and minimising the distance that people need to travel to these centres, is good planning practice because it makes it easier for people to get to work, increases the number of jobs available to people and the proportion of the workforce accessible to businesses.

Planning for employment centres is therefore crucial for the economic performance of our cities. This is because it facilitates their key competitive advantage – access to economic opportunities. A well-planned network of employment centres can help improve access to work, develop traditionally job poor suburbs, improve connectivity between centres and make transport patterns more sustainable.

This will be different for each city, as legacy transport networks and residential patterns differ. However, in broad terms, it will likely involve a combination of:

- Increasing residential densities around existing employment hubs – bringing people closer to jobs
- Developing new employment centres around residential growth areas – bringing jobs closer to people.

Investing in transport infrastructure, particularly public transport, can also help to connect key employment centres and residential growth areas.

Governments have had recent success in increasing residential densities in our largest cities, particularly in the inner-city. However, the development of suburban employment centres has proved more challenging. While several metropolitan strategies for Australian cities have outlined detailed plans for the economic geography of their city, in practice the delivery of these visions have faced challenges. For example, a study by the Bureau of Infrastructure and Transport Economics (BITRE) found that since 2001, there has been limited progress in growing employment in targeted suburban centres and concentrating overall employment growth to selected areas in Australia's four largest cities.[99]

Redistributing employment to targeted centres can be complex because it is often contrary to prevailing market conditions. Employers can be reluctant to move from existing, accessible areas such as the CBD, where the benefits from agglomeration are substantial. In addition, centres that are accessible, have good transport links and sufficient scope for redevelopment are often more attractive for residential purposes. In recent years, due to the rapid growth of Australia's urban housing markets, residential development has often competed with offices for space.[100]

To overcome these constraints, governments need to take an active role in delivering the economic visions they set for their cities. This requires using new tools and mechanisms. Traditional statutory planning tools such as rezoning and relaxing development restrictions may not be sufficient in influencing the location of economic activity in cities. A broad range of policy instruments and settings are required to ensure underlying conditions make redevelopment and relocation, for jobs and people, an attractive option.

Recommendation 7

Australian governments should take an active role in developing employment centres in our largest cities. A well-planned network of employment centres can help to improve a city's economic performance, but directing the location of jobs in large cities can be difficult. Governments have an opportunity to make better use of tools and levers to achieve their strategic economic plans and enable labour and capital to access one another efficiently. Key levers include:

- Providing strategic transport infrastructure to ensure employment centres are easily accessible
- Providing fiscal incentives for employers to move to strategic urban centres, subject to appropriate assessment to ensure this use of taxpayer money benefits the city
- Strategically re-purposing underutilised government land to support the growth of new employment centres.

Improving connections between jobs and people by investing in public transport infrastructure

Population growth, particularly on the scale Australia's largest cities are expected to experience, poses challenges for our cities' transport networks. The scenario analysis shows that road congestion and transport emissions increase under all growth patterns, for both Melbourne and Sydney. While there is no single solution to this challenge, investing in public transport is an important part of the answer.

As our cities and the demand for transport grows, so will people's reliance on public transport. The scenario analysis shows that under all scenarios, public transport mode share increases, particularly for journeys to work. The analysis also found that while the percentage of jobs accessible by road decreases, accessibility by public transport increases. Mass transit is particularly important for cities, to support employment centres and allow workers and businesses to efficiently access each other. It is also able to use space more efficiently than road-based transport and move larger volumes of people.

The *Australian Infrastructure Audit* found that our cities' transport networks are already struggling to deal with demand and without action, this trend will continue. Congestion is not only inconvenient, it can lessen the benefits of agglomeration by reducing access to jobs and skilled labour. Current trends of congestion would cost the Australian economy $53.3 billion by 2031 if no action were taken.[101]

To address current congestion and ensure our cities capitalise on the benefits of population growth, governments at all levels need to coordinate investment to expand and upgrade our transport networks to cater for demand. Private vehicles will continue to play a critical role and targeted investment in roads will be necessary to move vehicles off suburban streets and deal with localised bottlenecks and congestion.

However, in large cities, public transport will play an increasingly important role in transporting people to jobs, education and leisure activities. Along key trunk routes, where large numbers of people have common destinations (such as an employment centre), the most effective way to transport people is through mass transit. These trunk routes also need to be integrated with public transport feeder services, active transport and road users. As our cities grow, governments will need to increasingly focus on investments that increase the reach, capacity and sustainability of our public transport networks.

Recommendation 8

Australian governments should increase investment in public transport infrastructure in cities experiencing significant population growth. Investment in mass transit is crucial to reducing congestion, increasing accessibility and reducing the rate of emissions growth. This is particularly relevant for higher density areas where space is limited. Governments should prioritise:

- High-capacity public transport trunk routes linking key centres and transport nodes
- Regular and reliable feeder public transport routes, designed to connect to trunk routes and maximise the reach of the network
- Prioritisation of road space for high occupancy vehicles including trams and buses
- Walking and cycling as principal means of transport within centres and to transport nodes.

Ensuring the benefits of existing infrastructure are maximised

The scale of projected population growth and natural constraints of Australia's largest cities will make it challenging for them to continue growing in geographic size. The majority of development over the next 30 years will need to be in established areas. Even under Infrastructure Australia's Expanded Low Density scenarios for Melbourne and Sydney, 60% to 70% of population growth is accommodated in infill areas. This will increase demand on infrastructure in these locations. One of the most efficient, financially effective and least disruptive ways governments can cater for population growth in established areas is to 'sweat' existing economic and social infrastructure assets. This can be achieved through maintenance programs, enhancing networks through technology and service upgrades, demand management strategies and land-use mechanisms.

Over recent decades, governments' infrastructure strategies have generally focused on construction and delivery of physical outputs: on time, to budget and to specification. While governments will need to continue building and delivering new infrastructure to meet increased demand there should be a focus on maximising the return on investment from existing assets, particularly around infill development.

The *Australian Infrastructure Plan* found there are examples in Australia's cities of well-planned and well-delivered infrastructure, from which the full benefits have not been extracted. In the context of governments facing increasing fiscal constraints, 'sweating' existing assets can also be preferable to building new infrastructure. This is because the ongoing operational costs of infrastructure assets are often many multiples of the funding required to plan and build them. Given the high costs of physical infrastructure, ensuring existing assets deliver the appropriate benefits can be a low-cost activity that delivers high value over long timeframes.

In managing existing assets, governments should focus on clearing maintenance backlogs, upgrades and expansions where appropriate, and developing demand management strategies to improve utilisation. Strategic land-use planning should support more direct mechanisms, by identifying areas for growth which are well-serviced by existing infrastructure, with additional capacity, or upgrades delivered, to meet increased demand.

Recommendation 9

Australian governments should routinely review the capacity of economic and social infrastructure within our cities and develop strategies to 'sweat' existing assets. This will help to ensure the return on investment is maximised and, benefits are shared across the community.

Increasing the efficiency of the road network – the role of demand management

While investment in public transport infrastructure will be crucial to the performance of future cities, it will be only part of the solution to congestion. The scenario analysis found that for both Melbourne and Sydney, private vehicle use (measured in vehicle kilometres travelled) increases substantially under all scenarios. This means that regardless

of the land-use and transport network scenario modelled, road use and congestion increases.

While this does not mean strategic planning and infrastructure investment cannot influence congestion levels, it does indicate that these approaches must be accompanied by other mechanisms to manage demand, such as road user charging.

Road networks are significantly more extensive than public transport, meaning they serve many more origins and destinations, with the added convenience of being able to travel at a time of the driver's choosing. This flexibility is particularly important for the significant proportion of the residents in our cities who do not live or work in centres that are easily accessible by public transport. The road network also carries about 35% of the domestic freight task and this share is much higher in cities.[102]

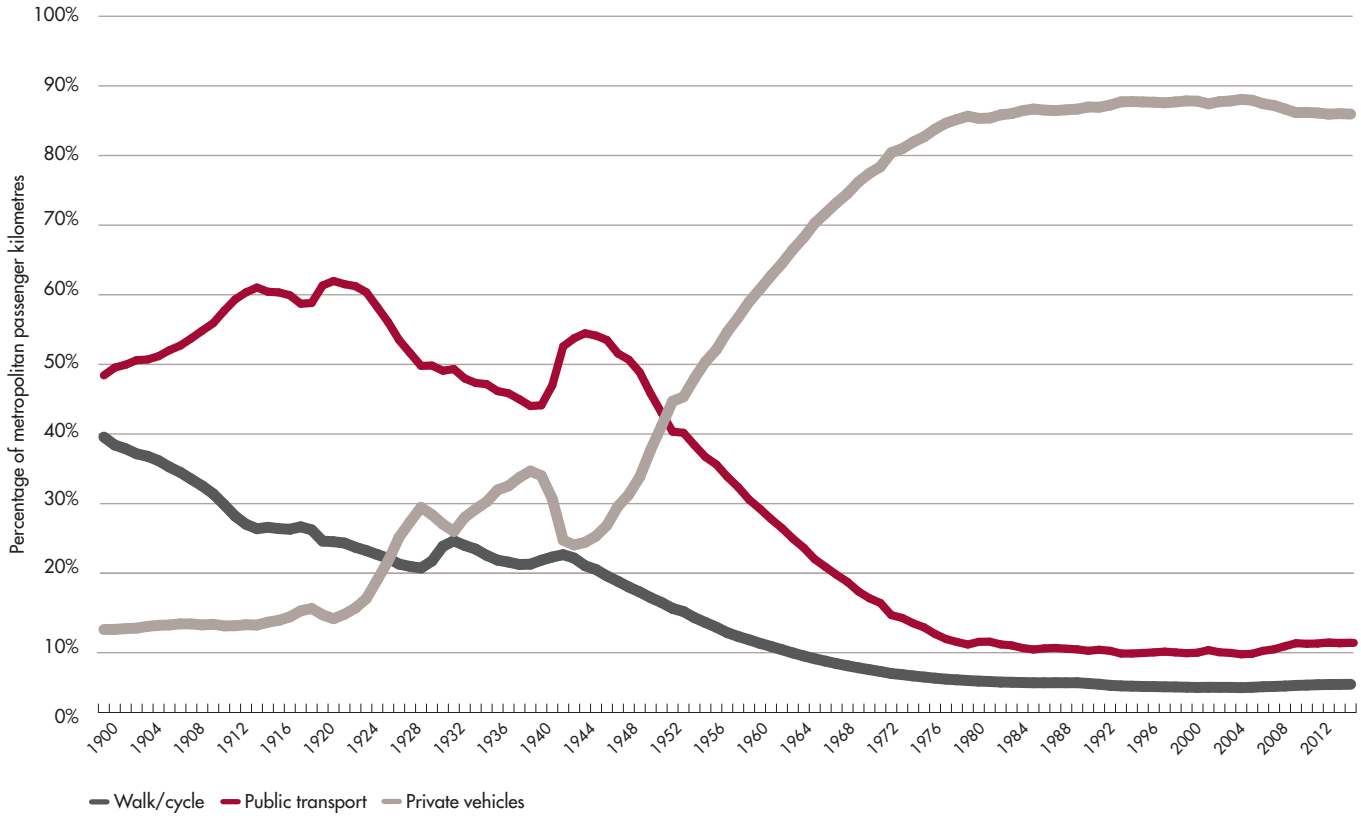
Figure 54 shows estimated capital city mode share since 1900. The mode share for private vehicles has stabilised in recent years, potentially because of shifts to public transport in larger cities. However, flexibility and convenience, combined with the existing structure of our major cities, means light vehicles remain the dominant mode of transport. Private vehicles account for close to 90% of passenger kilometres travelled. Even with substantial mode shift, driven by new investment or policy changes, private vehicles will likely remain a major contributor to urban mobility.

The dominance of private vehicle travel highlights the need to ensure roads are delivered, operated and funded efficiently.

Investment in new roads will be crucial to the development of our cities. However, road construction alone would be an ineffective and inefficient means of catering for growth.

The current approach of road user charging in Australia largely consists of vehicle registration and licence fees (collected by state/territory governments) and fuel excise (collected by the Australian Government). The *Australia Infrastructure Plan* found this approach to charging for and investing in roads is unfair, unsustainable and inefficient.

Figure 54: Capital city passenger task mode share[103]



The issue of efficiency is particularly acute in our cities where road networks suffer from substantial congestion in peak periods while remaining relatively underutilised over the full 24-hour cycle. Better management of demand for our roads, through pricing, could encourage more efficient use of existing assets and minimise or delay the need for costly new investment. A comprehensive road user charging model offers opportunities to reduce congestion in our cities and make the current system fairer, more sustainable and more efficient.

At a conceptual level, road user charging reform would see all existing taxes and fees removed and replaced with direct charging that reflects each user's own consumption of the network, including the location, time and distance of travel, and the individual characteristics of their vehicle such as weight and environmental impact.

Road user charging reform would support more efficient use of the road system – and broader transport networks. Location and time-based charging parameters enable providers to actively manage supply and demand. For instance, demand could be managed through changes to pricing, such as incentivising off-peak use or charging a premium to use congested roads during peak periods.

Reform would also necessarily require all charging revenue be hypothecated – that is, quarantined and directed – to investment in the road network. This differs from the current approach where taxes and charges enter consolidated revenue and are allocated to various government spending priorities – both in transport and other areas. This is a more sustainable approach to funding because, provided the charging framework captures the full cost of road provision, funding would increase commensurate with demand.

Although road user charging is a complex reform, the scenarios analysed in this report demonstrate it will be a necessary component of improving the efficiency of our transport networks and ensuring our cities continue to thrive into the future.

Recommendation 10

Consistent with the *Australian Infrastructure Plan*, Australian governments should work together to progressively introduce a national heavy and light vehicle road user charging regime within 10 years as part of a broader demand management strategy. A reformed road user charging framework could complement road and public transport infrastructure investment by efficiently managing demand, reducing congestion and delivering a sustainable funding stream.

6.3 Equity of access

Providing equal access to housing, jobs, education and services for all people in a city is an important, but challenging goal. Ultimately governments must prioritise and make tough decisions to be able to pay for and deliver the necessary infrastructure to support urban populations in the most efficient way.

The result is a hierarchy of access across different infrastructure assets and types. For example, while not everyone in our cities can expect to (or would want to) live next door to a major train station, university, hospital, or national park, they should be able to reach these facilities within a reasonable travel time. At the local level there is an expectation that communities have access to key amenities and services such as local transport networks, schools, basic healthcare services, and local parks.

The scenario analysis of Melbourne and Sydney indicates that different approaches to land use can produce varying levels of access to jobs, education, healthcare and green space for different areas of our cities. This has broad implications for the city. The quality of access provided to a household has consequences beyond practical considerations such as journey times. Research completed by the Grattan Institute has found that there is a negative correlation between the location of housing and connecting infrastructure in the outer areas of cities, and the achievement of key social indicators such as workforce participation, income levels, education attainment and long-term health outcomes.[104]

Strategic land-use and infrastructure planning, along with targeted investment can go some way to improving accessibility and the corresponding social outcomes resulting from disparities in access. In particular, Infrastructure Australia sees a role for governments to address two key aspects:

- Improving accessibility for people living in outer-urban areas
- Ensuring public transport infrastructure is accessible for all.

Better connecting communities on the outskirts of cities

The scenario analysis for Melbourne and Sydney presented in this paper indicates that access to jobs, education and health facilities, particularly by public transport, is significantly lower in outer areas than inner and middle suburbs across all scenarios.

The Centralised High Density scenario tends to be the poorest performer for access to jobs in outer suburbs because economic activity becomes more centralised. However, the Expanded Low Density scenario, which sees the greatest proportion of people living in the outskirts of both cities, delivers the lowest levels of accessibility to hospitals, tertiary education and green space, as people move further away from existing facilities. Improving the accessibility to jobs, education and services in outer areas is a crucial task for governments, regardless of how growth is accommodated.

The poor accessibility of these areas can be broadly attributed to two interrelated factors: poor transport connections and dispersed social infrastructure and jobs.

Although there are significant differences within and between Australia's cities, outer-urban public transport is generally characterised by:

- **Low levels of access:** Outer suburbs are dispersed over very large geographic areas. This means the coverage of public transport networks, relative to more compact and higher density inner suburbs, is usually lower.
- **Poor frequencies:** Radial transport networks often mean frequencies increase as routes merge closer to the city-centre.
- **Longer travel times:** This is generally because accessibility to the network is poorer and travel distances are longer. Disparities in public transport travel times are particularly prevalent for journeys to key employment centres.

Poor public transport connections in outer suburbs have a tangible impact on the quality of life and prosperity of these communities because it limits access to employment, education and other social infrastructure within reasonable travelling time.

Access is further diminished by the dispersed nature of social infrastructure in outer suburbs. Populations are generally less dense on the outskirts of cities, meaning infrastructure like hospitals, universities and schools are more spread out and people need to travel further.

Although there is a clear case for improving accessibility in these areas, the specific solution is not necessarily clear-cut. Significant investments in transport infrastructure, particularly mass transit systems, can be difficult to justify in outer suburbs because they are generally best suited to routes where a lot of people travel from one point to another. Lower capacity, flexible and on-demand transport may be more suitable for areas with dispersed travel patterns and relatively small employment centres.

A blended approach, which balances a range of different actions is required. This would include:

- Increasing investment and enhancing transport planning to improve transport connections, particularly public transport, from outer areas to employment centres, and key health and tertiary education facilities. This could include increasing the frequency and spread throughout the day of existing services, upgrading and expanding networks, and enhancing mode integration in outer areas, for example improving the connection between heavy rail services and local feeder bus networks.
- Better integrating and sequencing planning processes (across and within jurisdictions) to ensure the delivery of new residential development is aligned with supporting infrastructure, particularly social infrastructure services such as local healthcare services, schools and parks.

Recommendation 11

Australian governments should focus on improving the access to jobs, education and services for the outer areas of our largest cities. A blended approach, which balances a range of different actions, is required. This includes: improving transport connections, particularly public transport, from outer areas to employment centres, and key health and tertiary education facilities, and better sequencing the delivery of supporting infrastructure alongside new residential development in outer areas.

Making cities accessible for all

Cities should be accessible for all, including those with limited mobility or disability, parents with young children, and older people. This is particularly true of public transport networks in our cities. There is not only an imperative on the basis of social inclusion and equality to ensure public transport networks are accessible for all, there is also an economic dividend for cities which are open to a diversity of people and provide services for all. Enabling more people to access the opportunities, and jobs, of a city contributes to its productivity and makes it a more attractive place for both people and businesses.

Accessible design can also enhance the quality of public transport networks in general, for example by providing larger, more people-friendly and safer spaces and thoroughfares, and better integrating route and mode interchanges.

The Commonwealth Government introduced the *Disability Standards for Accessible Public Transport* (DSAPT) in 2002. It aims to make public transport accessible for people with a disability by prescribing minimum requirements that transport operators and providers are to meet, and includes performance requirements and timeframes for compliance. States and territories are currently working on mobility upgrades to ensure compliance for the majority of the standards, across modes and geographies, by the end of 2022 (with some exceptions).[105]

The Australian Government should encourage state and territory governments to focus and prioritise efforts toward achieving the full accessibility compliance across public transport networks in Australia's largest cities. This could form part of broader policy frameworks such as the Australian Government's City Deals.

Alongside these upgrades, states and territories should also improve their use of data and technology to provide information to customers, particularly the progressive upgrading of facilities across networks so that passengers can efficiently plan and conduct trips in the interim.

Recommendation 12

The Australian Government should encourage state and territory governments to focus and prioritise efforts toward achieving full accessibility compliance across public transport networks in Australia's largest cities within defined timeframes. This could form part of broader policy frameworks such as the Australian Government's City Deals.

Housing affordability

While not a focus of the modelling presented within this paper, Infrastructure Australia recognises the growing impacts of increasing house prices in Australian cities, particularly in Melbourne and Sydney. As our cities grow, issues of housing affordability will become more acute. It is critical that all levels of Australia's governments ensure that Australia's largest cities are liveable for a diverse mix of people.

There are a number of potential actions for different levels of government to address housing affordability in our cities. These include:

- **Taxation:** Land taxes and concessions play a significant role in the cost of housing by providing incentives for people to behave in certain ways in the housing market. Infrastructure Australia's recent research paper *Capturing Value: Advice on making value capture work in Australia* (2016) recommended that a broad-based land tax (replacing existing land taxes) would provide the most efficient, fair and sustainable way to manage land use in Australia, and in particular capture value from infrastructure investment. The paper also recognises the role that a broad-based land tax could play a role in addressing housing affordability in our cities, by more effectively reflecting the value of land, and reducing the transactional costs of purchasing and selling property, encouraging a more productive use of land, particularly in our cities.[106]
- **Supply:** Providing enough housing in our cities for current and future residents is essential. Our cities will need to deliver significant amounts of new dwellings to accommodate growing populations in the near and long term. This supply needs to be diverse and meet the needs of the community in terms of type and location, responding to changing demographic trends and demands, particularly an ageing population, smaller household sizes, and an increasing preference for the amenity and convenience provided by metropolitan living. Housing supply can be increased through a number of mechanisms. These include reform to planning legislation and regulation, improved processes for sequencing supporting infrastructure alongside new development, stronger community engagement processes, and improved construction methods and materials.
- **Tenure:** A mix of homes which can be purchased, rented either on the market or as affordable homes (at sub-market rates), and social housing are all required in our cities. 'Affordable housing' plays a particularly important role in our cities, as an intermediate type of tenure, between social and market rental, in an increasingly expensive housing market. Affordable housing can provide for those workers essential to the city's functions who are earning lower incomes, and are not eligible for public housing but cannot afford to enter (or live sustainability in) the private market. The supply of affordable housing can be increased in our cities in a number of ways, including by introducing inclusionary zoning, improving developer contributions mechanisms, increasing national, state and territory funding programs, and strengthening the community housing sector to deliver and maintain affordable homes.

6.4 Liveability and resilience

Quality of life is a critical comparative advantage of Australian cities. They are world-renowned as attractive places to live and work. The combination of our spectacular natural environment, cultural diversity and relaxed lifestyle, sees our capital cities routinely listed on global indices ranking them among the world's most 'liveable' cities.

Liveability in our cities can differ for people, according to where they live, how much they own and what they value being able to do in in their life. In general, the liveability of our cities is measured by factors such as sustainability, walkability, access to public transport, design and accessibility of the public realm and the cost of living.

While internationally recognised for their quality of life, Australia's largest cities are already beginning to face challenges in delivering adequate liveability standards today (for example, due to the impacts of heatwaves, housing unaffordability and low levels of walkability in neighbourhoods). Significant growth will place these cities under further pressure in the future.

Several findings resulting from the scenario analysis of Melbourne and Sydney, indicated that under all spatial options tested, core aspects of each city, which contribute to the health of the natural environment and the liveability of each city, will be challenged.

Key challenges include:

- Our cities generate a large proportion of Australia's emissions, and this is set to increase as our cities grow in size and become denser. A stable national framework to respond to climate change is required if our cities are going to meaningfully contribute to reducing Australia's greenhouse gas emissions to achieve our international commitments, and improve liveability.

- Australia's largest cities are already experiencing an increase in the frequency of extreme weather events and long-term stresses as a result of climate change. As our cities grow, these risks will be compounded and affect larger numbers of people. Our urban systems and networks, particularly our infrastructure, will need to be resilient to manage these long-term stresses and potential extreme shocks.
- Green infrastructure and the public realm contribute significantly to the liveability of our cities. Population growth in our cities will place increasing demand for existing green and public spaces. Governments will need to respond to these pressures and maintain and enhance high-quality, flexible public spaces to ensure our cities remain liveable.

Governments must work to maintain and enhance the high quality of life enjoyed today into the future. There are opportunities to act now to address these challenges, and both mitigate the impacts on urban quality of life from population growth and climate change, and enhance our cities to be more liveable, efficient and resilient.

Enabling cities to contribute meaningfully to emissions reductions by establishing a stable national framework

In line with our international commitments, Australia must reduce emissions in order to mitigate the increasing short and long-term impacts of climate change, including increased temperatures, sea level rises, environmental degradation, increases in extreme weather events and increased pressure on resources.

Australia has one of the highest rates of greenhouse gas emissions per capita in the world and it is in our largest cities where the bulk of these emissions originate.[107] The scenario analysis presented within this paper makes clear that, without intervention, our cities will continue to be an increasing source of emissions as they grow in size and scale.

Australia is a signatory to the UN Framework Convention on Climate Change 2015 Paris Agreement, under which it has committed to reduce greenhouse emissions to 26-28% on 2005 levels by 2030.[108] Achieving this commitment will require a significant shift to the way we use energy in Australia. But efforts are currently being hampered by ongoing uncertainty regarding how Australia will respond to meeting its current and future international commitments.

Our cities will play a central role in supporting this transition. The Climate Council has indicated that cuts to emissions in cities could deliver up to 70% of the nation's required reductions under the Paris Agreement.[109] However, the structure of the Australian federation means that cities cannot act alone in responding to climate change. A national and stable approach is required to provide certainty and enable state, territory and local governments, the community and the private sector to make the changes required to achieve the necessary reductions.

Recommendation 13

Australian governments should work collaboratively to establish a stable national framework to respond to climate change and reduce emissions in line with our international commitments. A clear policy direction will provide certainty and stability to both public and private sectors, enabling our cities to play a central role in supporting Australia's transition to a lower emissions economy.

Implementing urban resilience strategies to better manage the increasing impacts of climate change

Climate change is driving shifts in the short-term weather patterns and longer term climate trends across the world. Australia's largest cities are not immune to the impacts of these trends, particularly given their location in coastal areas, and are already experiencing more frequent extreme weather events (such as storms and bushfires), rising sea levels, reduced rainfall and warmer temperatures.[110] This places pressure on our urban systems and networks, particularly our infrastructure. As our cities grow in size, their ability to withstand these impacts and pressures will be tested even further.

Our cities will need to become more resilient, to ensure they are able to operate through minor disruptions and recover quickly from major disruptions.[111] State and territory governments, in collaboration with local governments, should prepare metropolitan resilience strategies which establish clear policy, regulation and guidelines for strengthening the resilience of the planning, coordination and construction of our cities as they grow.

There are costs – both upfront and ongoing – in making our cities more resilient. However, upfront costs represent an opportunity to invest in our future and secure our wellbeing, and can often reduce long-term costs by improving the efficiency of operation and maintenance, while optimising

benefits for the community and environment, making our cities more liveable.[112]

Building resilience requires collaboration and strategy across cities. This includes integrated governance, robust physical infrastructure, systems and processes, and engaged communities. Cities should undertake analysis to understand the unique risks they face, and the changes they can implement which will make them more resilient to such impacts whilst enhancing liveability.

Recommendation 14

Australian governments should prepare metropolitan resilience strategies which establish clear policy, regulation and guidelines for strengthening the resilience of the planning, coordination and construction of our cities as they grow. This will assist in enabling cities to operate through minor disruptions and recover quickly from major disruptions.

Investing in green infrastructure and the public realm to maintain and enhance liveability in our cities

The quality, flexibility and utility of green infrastructure (such as parks, sporting fields and walking tracks) and public spaces (such as squares and footpaths) contribute significantly to the liveability of a city.

Population growth poses a challenge to the future of these spaces in Australian cities. Across all scenarios, the demand for existing green space increases dramatically, as more people are wanting to access parks and sporting fields across both Melbourne and Sydney. At the same time, access to green space reduces across all scenarios, particularly in outer areas where greenfield development occurs away from established green and public spaces. These results highlight the need to prioritise the sequencing of local and accessible green and public space alongside development as our cities grow, in both outer and infill areas.

These pressures will be compounded by other issues as our cities grow, including an increased pressure to convert green and public spaces to new uses, as more homes and buildings will be required to house and service extra people and, the increased scarcity of land in cities which will make it challenging and expensive to create new spaces, particularly in dense areas.

In addition, the delivery of new housing to accommodate growing populations will need to be, on average, at a higher density than the existing housing in our cities today. This will likely result in a lifestyle shift, with more people having less private space than today. Green and public spaces will therefore play a more important role in their lives, for socialising, physical activity, and recreation. This will in turn increase the maintenance and upgrade requirements for our green infrastructure and public realm, including cleaning, safety requirements such as lighting and monitoring, and water requirements for parks and sporting fields.

Enhanced green infrastructure and public realm will make our cities more attractive places for people to live and work, contributing to economic success not only city-wide but for local businesses. A well-designed and connected public realm can also help to increase the 'walkability' of neighbourhoods, which can contribute to improved health outcomes and increases in active and public transport use, reducing pressure on other transport networks. These places also play an important role in developing social and community connections in large cities, which will become more important as our cities grow.

As our cities grow, state and territory governments should focus on maintaining and enhancing our green infrastructure and the public realm. This could be achieved through a combination of taxation, policy and regulatory approaches, including upgrading and expanding existing green and public spaces, creating new spaces, and prioritising the shared use of spaces such as public school playgrounds and golf courses.

Recommendation 15

As our cities grow, Australian governments should focus on maintaining and enhancing green infrastructure and the public realm to ensure they remain liveable. This could be achieved through a combination of taxation, planning incentives, and policy and regulatory reforms, including upgrading and expanding existing green and public spaces, creating new spaces, and making better use of existing assets.

List of Recommendations

1. **The Australian Government should establish a consistent framework of incentives to drive the delivery of national benefits within our cities at the project, place and reform level.** The new framework would include a hierarchy of three incentive types:
   - **National Partnership and Project Agreements** which make project funding contingent on meeting specified outcomes across the project lifecycle and demonstrated economic benefit
   - **City Deals** which apply a series of locally and nationally informed objectives to a city or part of a city, and make infrastructure payments for the area contingent on meeting those objectives
   - **Infrastructure Reform Incentives** which would provide additional infrastructure funding above existing allocation in return for the delivery of policy and regulatory reform focused on improving the productivity, liveability and affordability of Australian cities.
2. **Australia's largest cities should establish institutions and processes which enable the delivery of metropolitan-scale governance.** There are a number of pathways this reform can take, ranging from the establishment of new metropolitan-focused agencies, to the amalgamation of existing local councils. The approach adopted should be tailored to match each city's unique characteristics.
3. **Australian governments should improve the flexibility, transparency and sophistication of current strategic planning tools and practices to improve decision making and deliver better planning outcomes for the long-term growth of our cities.** Key actions include:
   - Using more flexible planning tools, such as scenario planning, which account for uncertainty, and rigorously test the feasibility of future options against a range of different long-term outcomes
   - Increasing the transparency of the assumptions, data and models which inform long-term planning tools to ensure communities can appropriately understand and test the proposals put forward by governments.
4. **Australian governments should adopt a place-based approach when translating metropolitan visions into the sequencing and delivery of development with infrastructure.** Opportunities exist for this approach to be applied to the planning, community engagement and governance processes currently used for delivering change at the local level.
5. **Australian governments should improve the quality and accessibility of community engagement at the strategic planning stage of a city's development.** Engaging communities at an early stage in a strategic discussion about the options for how their city could grow and change provides them with a genuine opportunity to shape and influence the solutions proposed and increase their understanding of the changes underway in their city. This not only increases the likelihood of support for change at local levels when it happens, but can also enhance the quality and impact of the outcomes delivered.

6. **Australian governments should focus on outcomes rather than outputs when developing the policy and regulatory frameworks that respond to changing technologies and services.** The focus of governments should be on ensuring outcomes important to the community, such as safety, accessibility and reliability, are achieved, while allowing markets to innovate in creating low-cost, user-friendly means of delivering these outcomes.

7. **Australian governments should take an active role in developing employment centres in our largest cities.** A well-planned network of employment centres can help to improve a city's economic performance, but directing the location of jobs in large cities can be difficult. Governments have an opportunity to make better use of tools and levers to achieve their strategic economic plans and enable labour and capital to access one another efficiently. Key levers include:
   - Providing strategic transport infrastructure to ensure employment centres are easily accessible
   - Providing fiscal incentives for employers to move to strategic urban centres, subject to appropriate assessment to ensure this use of taxpayer money benefits the city
   - Strategically re-purposing underutilised government land to support the growth of new employment centres.

8. **Australian governments should increase investment in public transport infrastructure in cities experiencing significant population growth.** Investment in mass transit is crucial to reducing congestion, increasing accessibility and reducing the rate of emissions growth. This is particularly relevant for higher density areas where space is limited. Governments should prioritise:
   - High capacity public transport trunk routes linking key centres and transport nodes
   - Regular and reliable feeder public transport routes, designed to connect to trunk routes and maximise the reach of the network
   - Prioritisation of road space for high occupancy vehicles including trams and buses
   - Walking and cycling as principal means of transport within centres and to transport nodes.

9. **Australian governments should routinely review the capacity of economic and social infrastructure within our cities and develop strategies to 'sweat' existing assets.** This will help to ensure the return on investment is maximised and, benefits are shared across the community.

10. **Consistent with the *Australian Infrastructure Plan*, Australian governments should work together to progressively introduce a national heavy and light vehicle road user charging regime within 10 years as part of a broader demand management strategy.** A reformed road user charging framework could complement road and public transport infrastructure investment by efficiently managing demand, reducing congestion and delivering a sustainable funding stream.

11. **Australian governments should focus on improving the access to jobs, education and services for the outer areas of our largest cities.** A blended approach, which balances a range of different actions, is required. This includes: improving transport connections, particularly public transport, from outer areas to employment centres, and key health and tertiary education facilities, and better sequencing the delivery of supporting infrastructure alongside new residential development in outer areas.

12. **The Australian Government should encourage state and territory governments to focus and prioritise efforts toward achieving full accessibility compliance across public transport networks in Australia's largest cities within defined timeframes.** This could form part of broader policy frameworks such as the Australian Government's City Deals.

13. **Australian governments should work collaboratively to establish a stable national framework to respond to climate change and reduce emissions in line with our international commitments.** A clear policy direction will provide certainty and stability to both public and private sectors, enabling our cities to play a central role in supporting Australia's transition to a lower emissions economy.

14. **Australian governments should prepare metropolitan resilience strategies which establish clear policy, regulation and guidelines for strengthening the resilience of the planning, coordination and construction of our cities as they grow.** This will assist in enabling cities to operate through minor disruptions and recover quickly from major disruptions.

15. **As our cities grow, Australian governments should focus on maintaining and enhancing green infrastructure and the public realm to ensure they remain liveable.** This could be achieved through a combination of taxation, planning incentives, and policy and regulatory reforms, including upgrading and expanding existing green and public spaces, creating new spaces, and making better use of existing assets.

Appendix A –
Scenario development assumptions

Infrastructure Australia engaged SGS Economics and Planning to assist in the development of the three scenarios for each Melbourne and Sydney. This involved:

- Preparing three scenarios each for Melbourne and Sydney, distributing population and employment growth to 2046 and defining supporting transport infrastructure
- Developing individual population and employment projections for each city's three scenarios as inputs for the transport modelling.

Metropolitan areas

The population and employment distributions are within defined metropolitan areas:

- **Sydney:** Greater Sydney is defined as a collection of 2,345 travel zones. This is consistent with the New South Wales Department of Planning and Environment definition of the metropolitan area, and the original boundaries defined by the Greater Sydney Commission Act 2015 No 57. The district boundaries were revised in late 2017. These changes were not incorporated into this report as modelling was already underway.
- **Melbourne:** Greater Melbourne is defined as a collection of 3,098 travel zones. The metropolitan and subregion boundaries are the VITM representation of Plan Melbourne 2014. The actual Plan Melbourne boundaries are slightly broader than the VITM representation, incorporating Wallan in the Northern Subregion and the Yarra Ranges SLA in the Eastern Subregion. A refresh of Plan Melbourne was released in 2017 that changed the boundary definitions. The new boundaries were not included in this report as modelling was already underway.

State government population and employment projections

Each scenario prepared for this research maintains a control total, consistent with each state government's official population and employment baseline projections at the metropolitan level. These baseline projections represent the most likely urban future based on current data, trends and an understanding of expected policy or structural changes. The baseline datasets used for each city are:

- **Sydney:** 2016 Land-Use Forecasts (LU16). Dataset years 2016-2056
- **Melbourne:** 2016 Small Area Land-Use Projections (SALUP 2016) for green space and social infrastructure modelling (dataset years are 2016-2056). For the transport modelling reference year, population and employment data are from VITM reference case 2015, which aligns with Victoria in Future 2014 data. Population and employment reference year data has since been superseded.

Population and employment distributions

The distribution of population and jobs is based on the strategic vision for each scenario. The scenarios were developed based on an understanding of the underlying trends and economic geographies of each city. They generally define the distribution of population of employment by the:

- Proportion of population growth in greenfield versus established areas
- Density of development (lower, medium and higher density approaches)
- Clustering of development around strategic locations.

It is important to note that the development of these scenarios involves the theoretical re-allocation of future population and employment *growth*. That is, the scenarios distribute the change between 2016 and 2046. The location of existing population and employment remains largely the same with the exception of some minor redistributions.

Defining change areas

The modelling assumes a number of 'change areas'. These are based on select geographies, or collections of travel zones, that define locations according to their land-use characteristics. That is, centre typology, proximity to transport, greenfield or infill locations. They are locations that are assumed to see an alternate distribution in population or employment than the baseline data. This redistribution will be based on growth between 2016-2046, not total jobs/population in 2046. This allows the scenarios to model change areas 'growing slower'.

Each scenario is then developed by applying a range of methods, depending on the scenario being developed and the change area being considered. The change areas that these are applied to are described under each scenario. The methods include:

- Increase in total value for targeted areas, meaning total population or employment increases by a specified target
- Applying a growth rate, meaning total population or employment increases by applying an assumed growth rate
- Based on a percentage share of total growth, meaning the targeted area takes up more or less of total growth between 2016 and 2046.

Summary of key assumptions applied across all scenarios

- Population and employment distributions are within defined metropolitan areas.
- Metropolitan population and employment control totals are kept constant under each scenario.
- Distribution of population and employment is largely based on change from 2016 to 2046.
- Scenarios involve the theoretical reallocation of future growth. That is, by assuming growth occurs in different locations. In a small number of cases some redistribution of existing population and employment has been applied.
- The drivers of the spatial distribution of employment informs the redistribution.
- Population-serving jobs are included in residential growth areas to ensure residents are sufficiently serviced.
- The total number of jobs by four industry types remains the same as the baseline data across the metropolitan area [four job type industry categories: industrial, population-servicing, knowledge-intensive and health and education jobs].
- The redistribution defines 'change areas', select geographies according to land-use characteristics.
- Increases in population generally apply longer term growth from the baseline data (i.e. growth to 2056 or 2051 brought forward to 2046). This approach maintains consistency with capacity assumptions in the baseline data.
- Increases in employment or population in urban-renewal precincts are based on an analysis of comparative locations.

Appendix B –
Assumed transport networks

The population and employment projections for each 2046 scenario informed transport network assumptions. For both cities, the existing networks, committed projects at the time of writing, and projects on Infrastructure Australia's Infrastructure Priority List are included in each 2046 scenario. The transport projects assumed by Infrastructure Australia for these scenarios are intended to match the land-use patterns under each scenario. None of the scenarios represent Victorian or NSW government policy.

Table 37, Table 38, Table 39, Table 40 and **Table 41** provide lists of these assumed transport networks for each scenario, for Melbourne and Sydney.

Melbourne

Table 37: Melbourne – Assumed major road projects, by scenario

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Calder Freeway Upgrades	Included	Included	Included
East West Link	Included	Included	Included
Koo Wee Rup Road Freeway Connection	Included	Not Included	Not Included
Monash Freeway Upgrades	Included	Included	Included
Mordiallic Bypass	Included	Included	Included
M80 Ring Road Upgrades	Included	Included	Included
North-East Link	Included	Included	Included
Outer Metropolitan Ring Road	Included	Not Included	Included
Tullamarine Freeway Upgrades	Included	Included	Included
Westall Road Extension	Included	Included	Included
Western Port Road Freeway Connection	Included	Included	Not Included
West Gate Tunnel	Included	Included	Included
50 Level Crossing Removals	Included	Included	Included
Numerous upgrades to existing arterial roads	Included	Included	Included
New local road connections in growth areas	Included	Included	Included

Table 38: Melbourne – Assumed major public transport projects, by scenario

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Heavy Rail			
Baxter Rail Extension	Included	Included	Not Included
City loop Reconfiguration	Included	Included	Included
Clyde Extension	Included	Not Included	Not Included
Cranbourne Pakenham Line Upgrade	Included	Included	Included
High Capacity Signalling – Clifton Hill Group	Included	Included	Included
Hurstbridge Duplication	Included	Included	Included
Melbourne Airport Rail Link	Included	Included	Included
Melbourne Metro Rail Tunnel	Included	Included	Included
Melton Duplication & Electrification	Included	Included	Included
Mernda Extension	Included	Included	Included
Sunshine – Deer Park Quadruplication	Included	Included	Included
Upfield Link	Included	Included	Included
Wallan Extension	Included	Included	Included
Wyndhamvale Rail Extension	Not Included	Not Included	Included
Regional Upgrade & Stations	Included	Included	Included
Light Rail/Buses			
Fishermans Bend Light Rail Extension	Included	Included	Included
Melbourne wide bus service improvement package	Included	Included	Included

Table 39: Melbourne – Assumed additional and extended tram services (included in all scenarios)

Route	2015	2046
Extended Services		
3	East Malvern – Melbourne University	Chadstone – Melbourne University
5	Malvern – Melbourne University	Darling – Melbourne University
11	Victoria Harbour Docklands – West Preston	Garden City via Fishermans Bend – Reservoir
30	Etihad Stadium Docklands – St Vincent's Plaza	Waterfront City Docklands – North Richmond (Hoddle St)
48	Victoria Harbour Docklands – North Balwyn	Victoria Harbour Docklands – Doncaster Park and Ride
57	City – West Maribyrnong	City – Highpoint
64	Melbourne University – East Brighton	Melbourne University – Malvern Station
70	Waterfront City Docklands – Wattle Park	Footscray – Wattle Park
72	Camberwell – Melbourne University	Gardiner – Melbourne University
75	Etihad Stadium Docklands – Vermont South	Footscray – Knox City
78	Balaclava – North Richmond	Footscray – Knox City
82	Moonee Ponds – Footscray	Maribyrnong Defence Site – Footscray
86	Waterfront City Docklands – Bundoora RMIT	Waterfront City Docklands – South Morang
New Services		
2	–	Melbourne University – Caulfield
73	–	Doncaster Park and Ride – Caulfield
80	–	Kew – East Brighton

Sydney

Table 40: Sydney – Assumed major road projects, by scenario

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Beaches Link	Included	Included	Included
Bringelly Road Upgrade – Stage 2	Included	Included	Included
M5 West Upgrade	Included	Not Included	Included
NorthConnex	Included	Included	Included
Northern Road Upgrade	Included	Included	Included
Outer Sydney Orbital	Included	Not Included	Included
Southern Connector Motorway	Included	Included	Included
WestConnex Stage 1–3	Included	Included	Included

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Western Harbour Tunnel	Included	Included	Included
Western Sydney Infrastructure Plan	Included	Included	Included

Table 41: Sydney - Assumed major public transport projects, by scenario

	Expanded Low Density scenario (2046)	Centralised High Density scenario (2046)	Rebalanced Medium Density scenario (2046)
Rail/Metro and High Capacity			
Bankstown – Liverpool High Capacity Upgrade	Included	Not Included	Included
Hurstville – Olympic Park Rail Link	Not Included	Included	Included
Sydney Metro Northwest, City and Southwest	Included	Included	Included
West Metro	Included	Included	Included
Western Sydney Airport – Campbelltown/Macarthur Link	Included	Not Included	Included
Western Sydney Airport – Leppington Heavy Rail Connection	Included	Included	Included
Western Sydney Airport – St Mary's	Included	Included	Included
St Mary's – Rouse Hill Link	Not Included	Not Included	Included
Light Rail			
CBD & South-East Light Rail	Included	Included	Included
South-East Light Rail Extension to Malabar	Included	Included	Included
Green Square – CBD Light Rail Connection	Included	Included	Included
Parramatta Light Rail Extension 1	Included	Included	Included
Parramatta Light Rail Extension 2	Not Included	Included	Included
Bus Network Upgrades and BRT			
Castle Hill – Penrith BRT	Included	Not Included	Included
Northern Beaches, Victoria Road & Parramatta Road BRT	Included	Included	Included
Parramatta – Macquarie Park BRT Link	Included	Included	Included
CBD, Regional, Western Sydney, South-West Growth Centre Bus Network service upgrades	Included	Included	Included

Appendix C –
Transport network modelling

State transport models

This paper uses the Victorian and New South Wales governments' transport models to analyse future growth scenarios for Melbourne and Sydney. Each model is different, but are developed for a common purpose – for strategic planning, to project travel patterns under different land-use, transport and pricing scenarios. These models form the basis of transport planning and investment decisions in their respective states. However, it is important to note the models are strategic in nature and any outputs from this modelling should not be used to assess the benefits or performance of individual projects.

Table 42 and **Table 43** provide further information on details of these models.

Table 42: Features of the Victorian Integrated Transport Model (VITM)

Owned and managed by	Victorian Government – Department of Economic Development, Jobs, Transport, and Resources
Area covered	Victoria. However for this report, modelling was restricted to the VITM representation of the metropolitan and subregion boundaries in Plan Melbourne 2014.
Software	Cube Voyager
Structure of the model	4-step model
Transport modes included (Demand)	Private vehicle Rail (Metro, Regional) Tram Bus
Time periods	Morning peak (7:00–9:00) Inter-peak (9:00–15:00) Evening peak (15:00–18:00) Off-peak (18:00–7:00)
Road assignment	All time periods
Public transport assignment	All time periods
Measure of capacity	A volume/capacity ratio of 1.0 is reached when a vehicle reaches its "estimated capacity". The estimated capacity for rolling stock in 2046 generally falls between 'seated' and 'crush' capacity. The estimated capacity by mode are presented in ranges as it varies depending on specific rolling stock. Train: 900-1,600 Tram: 70-180 Bus: 75-120
Capacity constraints	Crowding function available (not applied for this modelling). This means, for the modelling undertaken in this report, passengers are not automatically diverted from public transport to cars once the former experiences crowding.

Table 43: Features of the Sydney Strategic Travel Model (STM)

Owned and managed by	New South Wales Government – Transport for NSW
Area covered	Greater Metropolitan Area of Sydney (includes Newcastle and Wollongong Statistical Divisions). However, for this report, modelling was limited to the definition of Sydney in the Greater Sydney Commission Act 2015 No 57.
Software	EMME
Structure of the model	4-step model
Transport modes included (Demand)	Private vehicle (Toll, No Toll) Rail Bus Active
Time periods	Morning peak (7:00–9:00) Inter-peak (9:00–15:00) Evening peak (15:00–18:00) Evening/Night (18:00–7:00)
Road assignment	All time periods
Public transport assignment	AM only
Measure of capacity	A volume/capacity ratio of 1.0 is reached when a vehicle reaches its "total capacity". The definition of total capacity varies by vehicle type and configuration so is shown below in ranges. Total Capacity Train (4 cars): 400-600 Train (8 cars): 1000-1500 Train (12 cars): 1500-1800 Bus: 70
Capacity constraints	No crowding function. This means passengers are not automatically diverted from public transport to cars once the former experiences crowding.

Calculating the environmental performance of the road network

Emissions were calculated based on a flat factoring of VKT. This calculation does not assume that fuel efficiency of the fleet would improve over time, nor does it consider relative congestion levels across scenarios. However, the models do take into account increased fuel efficiency of the fleet over time through vehicle operating costs – these values are used to calculate cost during the assignment phase of the models, so therefore impact mode share and traffic flows.

Appendix D – Green space and social infrastructure modelling

Introduction and key assumptions

The modelling tests the spatial implications of population growth for Melbourne and Sydney's social infrastructure and green space. For the purposes of the report, social infrastructure covers hospitals, schools and tertiary education facilities.

The modelling reflects the current distribution of social infrastructure and green space. In other words, no additional infrastructure is added from the reference case year. In reality, governments will look to upgrade and build new facilities over the next 30 years. As such, the analysis should be viewed as an indication of where demand and accessibility constraints could be located if the city grows under certain land-use scenarios. Care should be taken when comparing the scenarios to the reference case as it is not a realistic comparison of performance.

The modelling takes into account total population within an area. It does not differentiate by age or demographics. This is because different sections of the community require access to hospitals, schools and tertiary education facilities for a range of uses. It is also important to note that the capacity constraints of existing infrastructure were not taken into consideration in the modelling.

Data sources

The green space and social infrastructure modelling presented in this paper was conducted using data from a number of different sources. These sources are detailed below in **Table 44** and **Table 45** for Melbourne and Sydney, respectively.

Table 44: Melbourne – Green space and social infrastructure datasets

Asset	Description	Source
Green space	VICMap Features of Interests – Parks and Reserves	Victorian Department of Environment, Land, Water & Planning
Schools	Public, Private and Catholic Schools Primary and secondary	Victorian Department of Education and Training
TAFEs	TAFE Locations, Victoria	Skills Victoria (Department of Education and Training)
Universities	Universities in Victoria	Universities Australia
Hospitals	Public and private hospitals in all of Victoria Modelling analyses 'major hospitals', classified as those with emergency facilities	Victorian Department of Health and Human Services

Table 45: Sydney – Green space and social infrastructure datasets

Asset	Description	Source
Green space	Sydney Green Grid Links + Sydney Green Grid Open Space / Public	New South Wales Department of Planning and Environment (supplied)
Schools	Public, Private and Catholic Schools Primary and secondary	New South Wales Department of Education / ACARA
TAFEs	TAFE Locations, New South Wales	New South Wales Government – TAFE NSW
Universities	Universities in New South Wales	Universities Australia
Hospitals	Public and private hospitals in all of New South Wales Modelling analyses 'major hospitals', classified as those with emergency facilities	NSW Health

Green space categorisations

Green space modelling was based on state government data and green space definitions. The categorisation of green space differs between Melbourne and Sydney, so the two cities should not be compared.

Table 46 shows the main categories used for the underlying data, and what was included and excluded in this report.

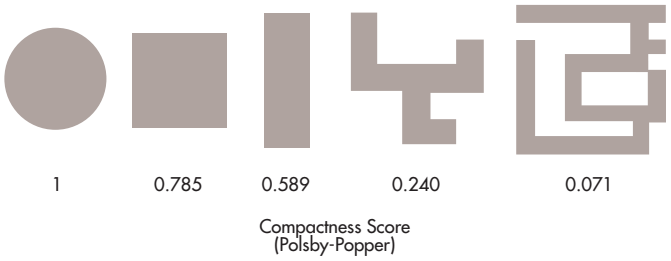
Table 46: Green space categories

	Melbourne	Sydney
Included	Parks Gardens City Squares Reserves within national parks	Parks Gardens Civic
Excluded	Cemeteries National parks/bushland Sports facilities Zoos	Cemeteries National parks/bushland Sports facilities

Note: Victorian data included polygons for 'reserves' (open space) within national parks and separate polygons for whole national parks (bushland). This report includes the former but not the later. For Sydney, the categorisation did not allow for differentiation between open space within a national park and the entire national park, so all were excluded.

Parks were also filtered through a spatial test called the Polsby-Popper Test (see **Figure 55**). This is a mathematical test of compactness to ensure that very thin slices of parkland were excluded from the analysis. If a park was a) not a named park in the dataset, and b) failed the Polysby-Popper test (where a value below 0.12 was rejected), it was excluded from the analysis. This resulted in removing erroneous entries such as median strips and thin linear reserves.

Figure 55: Outline of Polsby-Popper test, sample shapes and results



Modelling

The performance of education and health infrastructure was measured using two indicators: changes in accessibility (measured as percentage of the population within a certain area who can access a facility within a defined travel time budget and mode choice) and changes in demand (measured as population per infrastructure facility).

Accessibility

Access to green space and social infrastructure data was modelled using Arup's Transport Travel Time Analysis tool (T3a). T3a uses network accessibility catchments to measure the real distance and time taken to reach destinations. This network-based approach provides more precise measures for accessibility than traditional radial catchment models which do not interact with the real experience of accessing places – taking into account the street patterns, transport networks or physical barriers on the ground.

The model uses two main types of data:

- network data such as roads, pathways and timetable data from transport operators
- observed travel time data based on real life observations.

The results of these measurements can be used to determine the number of 'opportunities' that can be reached within a given time. These opportunities can include access to jobs, population, schools, hospitals, parks or any other spatially-recorded phenomenon for which data is held.

When using the model for this project, Arup developed a set of bespoke models which used the population and employment distributions, VITM and STM road network congestion results, and public transport network coding assumptions for each scenario for both Melbourne and Sydney.

The origin points were the centroids of travel zones used for both Melbourne and Sydney. This enabled consistency in geography used in the population projections used in each scenario. The T3a algorithms then calculated the travel times between every origin (at the travel zone level) and every destination per set (e.g. local parks, hospitals etc.), for each scenario, by each of the modes specified – walk only, private vehicle, and public transport. The nearest facility in terms of travel time from each zone was then used to calculate the zonal and SA3 level results presented in the paper.

The following criteria were applied on a 'pass' or 'fail' basis for each travel zone, for each city and each scenario for accessibility measures.

Green space:

- any green space within five-minute walk.

Social infrastructure:

- **Schools:** Within five-minute drive, 20-minute public transport trip, or 40-minute walk of at least one school, during the AM peak
- **TAFE:** Within 20-minute drive, or 30-minute public transport trip of at least one TAFE, during the AM peak
- **University:** Within 60-minute public transport trip of a least one major university campus, during the AM peak
- **Hospital:** Within 20-minute drive or 30-minute public transport of at least one major hospital.

Demand

All travel zones which passed the above accessibility criteria were summed into each city's Statistical Area 3 (SA3) zones. This gives the proportion of an SA3's population with access to green space and social facilities, by different categories.

With this data, the following calculations were made in order to understand demand on facilities under each of the population/employment scenarios at a high level:

- Hectares of green space per 1,000 residents (as per NSW and Victorian Government standards)
- Population per school within SA3s
- Population per TAFE within SA3s
- Population per university within SA3s
- Population per hospital within SA3s.

References

[1] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[2] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[3] Infrastructure Australia. (2016). *Australian Infrastructure Plan: Priorities and reforms for our nation's future*, p. 30. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Plan.aspx

[4] SGS Economics & Planning. (2016). *Australian Cities Accounts 2015-16*, p. 5. Retrieved from http://www.sgsep.com.au/publications/gdp-major-capital-city-2015-2016

[5] Australian Trade and Investment Commission. (2017). *Australia's export performance in 2015-16*. Retrieved from https://www.austrade.gov.au/news/economic-analysis/australias-export-performance-in-2015-16 and Department of Industry, Innovation and Science (2016). *Australian industry report 2016*. Retrieved from https://industry.gov.au/Office-of-the-Chief-Economist/Publications/AustralianIndustryReport/index.html

[6] The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, pp. 9-10. Retrieved from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

[7] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[8] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[9] Infrastructure Australia. (2015). *Australian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p. 102. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

[10] The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, pp. 9-10. Retrieved from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

[11] Clark, G. (2013). The Future of Cities: The Role of Strategic Planning. *Future Studies Research Journal*, (5)1, pp. 15-16. Retrieved from https://www.revistafuture.org/FSRJ/article/view/140/213

[12] Australian Bureau of Statistics. (2017). 3101.0 - Australian Demographic Statistics, Jun 2017 – Estimated Resident Population, States and Territories

[13] Australian Bureau of Statistics (2017). 3218.0 – Regional Population Growth, Australia, 2016. Retrieved from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3218.0Main+Features12016?OpenDocument

[14] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[15] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0

[16] Australian Bureau of Statistics. (2017). 3101.0 - Australian Demographic Statistics, Jun 2017 – Estimated Resident Population, States and Territories

[17] Australian Bureau of Statistics. (2013). 3222.0 - Population Projections, Australia, 2012 (base) to 2101. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3222.0; Australian Bureau of Statistics. (2017). 3101.0 - Australian Demographic Statistics, Jun 2017 – Estimated Resident Population, States and Territories

[18] Infrastructure Australia. (2015). *Australian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p. 102. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

[19] The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, pp. 9-10. Retreived from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

[20] Bunker, R. (2012). Reviewing the Path Dependency in Australian Metropolitan Planning. *Urban policy and Research*, 30(4), pp. 443-452. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/08111146.2012.700638

[21] Clark, G. (2013). The Future of Cities: The Role of Strategic Planning. *Future Studies Research Journal*, (5)1, pp. 15-16. Retrieved from https://www.revistafuture.org/FSRJ/article/view/140/213

[22] Transport for NSW. (2016). *Land Use 2016 (LU16) Population and Employment Projections*

[23] Victorian Department of Environment, Land, Water and Planning. (2016). VITM Representation of Plan Melbourne, which aligns with Victoria in Future 2014 data. Population and employment data have since been updated but are not included in the modelling.

[24] Australian Bureau of Statistics (2017). 3218.0 – Regional Population Growth, Australia, 2016. Retrieved from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3218.0Main+Features12016?OpenDocument

[25] Australian Bureau of Statistics. (2017). 2016 Census QuickStats - Greater Melbourne Capital City Statistical Area

[26] GTA Consulting. (2017). *Outer urban public transport access* (unpublished research commissioned by Infrastructure Australia)

[27] Australian Bureau of Statistics. (2017). 6416.0 - Residential Property Price Indexes: Eight Capital Cities, Mar 2017. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/6416.0

[28] Australian Bureau of Statistics. (2017). 6345.0 - Wage Price Index, Australia, Jun 2017

[29] SGS Economics & Planning. (2016). *Australian Cities Accounts 2015-16*, p. 5. Retreived from http://www.sgsep.com.au/publications/gdp-major-capital-city-2015-2016

[30] Victorian Department of Economic Development, Jobs, Transport and Resources. (2017). *Victoria's economy.* Retrieved from https://economicdevelopment.vic.gov.au/victorian-economy-in-focus/victorias-economy

[31] Bureau of Infrastructure, Transport and Regional Economics. (2011). *Research Report 125 - Cities - Population growth, jobs growth and commuting flows in Melbourne*, p. 122. Retrieved from https://bitre.gov.au/publications/2011/report_125.aspx

[32] Australian Bureau of Statistics. (2016) 127.0.55.001 – Australian Statistical Geography Standard (ASGS): Volume 1 – Main Structure and Greater Capital Statistical Areas, July 2016

[33] Australian Bureau of Statistics. (2016). 2016 Census - SA4 By Labour Force Status

[34] Bureau of Infrastructure, Transport and Regional Economics. (2011). *Research Report 125 - Cities - Population growth, jobs growth and commuting flows in Melbourne*, p. 157. Retrieved from https://bitre.gov.au/publications/2011/report_125.aspx

[35] Victorian Department of Economic Development, Jobs, Transport and Resources. (2013). Travel in metropolitan Melbourne – Victorian Integrated Survey of Travel & Activity (VISTA) Survey 2013, p. 2. Retrieved from http://economicdevelopment.vic.gov.au/transport/research-and-data/vista/vista-2013

[36] Infrastructure Australia. (2015). *Australian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p. 32. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

[37] Victorian Department of Economic Development, Jobs, Transport and Resources. (2013). Victorian Integrated Survey of Travel & Activity (VISTA). Retrieved from http://economicdevelopment.vic.gov.au/transport/research-and-data/vista/vista-data-and-publications

[38] Victorian Department of Environment, Land, Water and Planning. (2017). *Plan Melbourne 2017-2050.* Retrieved from http://www.planmelbourne.vic.gov.au/the-plan

[39] Infrastructure Victoria. (2016). *Victoria's draft 30-year infrastructure strategy.* Retrieved from http://www.infrastructurevictoria.com.au/30-year-strategy

[40] Victorian Department of Environment, Land, Water and Planning. (2017). Plan Melbourne 2017-2050. Retrieved from http://www.planmelbourne.vic.gov.au/the-plan; Victorian Department of Environment, Land, Water and Planning. (2016). *Victoria in Future 2016 - Small Area Land Use Projections (SALUP 2016).* Retrieved from

https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future-2016/victoria-in-future-data-tables

41 GTA Consulting. (2017). *Outer urban public transport access* (unpublished research commissioned by Infrastructure Australia)

42 Victorian Department of Environment, Land, Water and Planning. (2016). *Victoria in Future 2016 - Small Area Land Use Projections (SALUP 2016)*. Retrieved from https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future-2016/victoria-in-future-data-tables

43 Victorian Department of Transport and the City of Melbourne. (2009). *Transforming Australian Cities*, p. 10. Retrieved from http://www.transformingaustraliancities.com.au/

44 Infrastructure Australia. (2016). *Australian Infrastructure Plan: Priorities and reforms for our nation's future*, pp. 35-36. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Plan.aspx

45 Victorian Department of Environment, Land, Water and Planning. (2017). *Plan Melbourne 2017-2050*. Retrieved from http://www.planmelbourne.vic.gov.au/the-plan

46 Victorian Department of Environment, Land, Water and Planning. (2017). *Plan Melbourne 2017-2050*. Retrieved from http://www.planmelbourne.vic.gov.au/the-plan

47 Crane, R., & Weber, R. (2015). *The Oxford Handbook of Urban Planning*. Oxford University Press, p. 169

48 The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, p. 10. Retrieved from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

49 Department of the Prime Minister and Cabinet. (2016). *Smart Cities Plan*., p. 11. Retrieved from https://cities.dpmc.gov.au/smart-cities-plan

50 Department of the Prime Minister and Cabinet. (2016). *Smart Cities Plan*. Retrieved from https://cities.dpmc.gov.au/smart-cities-plan; Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

51 Infrastructure Victoria. (2016). *Victoria's draft 30-year infrastructure strategy*, p. 74. Retrieved from http://www.infrastructurevictoria.com.au/30-year-strategy

52 Infrastructure Victoria. (2016). *Victoria's draft 30-year infrastructure strategy*, p. 116. Retrieved from http://www.infrastructurevictoria.com.au/30-year-strategy

53 Victorian Department of Education (2017), *Statistical brochure*. Retrieved from http://www.education.vic.gov.au/about/department/Pages/factsandfigures.aspx

54 Australian Bureau of Statistics. (2017). 3101.0 - Australian Demographic Statistics, Jun 2017 – Estimated Resident Population, States and Territories

55 Australian Bureau of Statistics. (2017). 2016 Census QuickStats - Greater Sydney Capital City Statistical Area. Retrieved from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1GSYD?opendocument; Australian Bureau of Statistics. (2013). 2011 Census Quick Stats - Greater Sydney Capital City Statistical Area. Retrieved from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/1GSYD?opendocument&navpos=220

56 Australian Bureau of Statistics. (2017). 2016 Census QuickStats - Greater Sydney Capital City Statistical Area. Retrieved from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1GSYD?opendocument

57 GTA Consulting. (2017). *Outer urban public transport access* (unpublished research commissioned by Infrastructure Australia)

58 Australian Bureau of Statistics. (2017). 6416.0 - Residential Property Price Indexes: Eight Capital Cities, Mar 2017. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/6416.0

59 Australian Bureau of Statistics, (2017), *Wage Price Index*, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6345.0Jun%202017?OpenDocument

60 SGS Economics & Planning. (2016). *Australian Cities Accounts 2015-16*. Retreived from http://www.sgsep.com.au/publications/gdp-major-capital-city-2015-2016

61 SGS Economics & Planning. (2016). *Australian Cities Accounts 2015-16*. Retreived from http://www.sgsep.com.au/publications/gdp-major-capital-city-2015-2016

62 Australian Bureau of Statistics. (2016). 2016 Census - SA4 By Labour Force Status

63 Australian Bureau of Statistics. (2016). 2016 Census - SA4 By Labour Force Status

64 Australian Bureau of Statistics. (2017). 6524.0.55.002 - Estimates of Personal Income for Small Areas, 2011-2015. Retrieved from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6524.0.55.0022011-2015?OpenDocument

65 Transport for NSW. (2016). Household Travel Survey 2014-15 - How do people travel? Retrieved from https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/hts-viz/hts-viz-how-do

[66] Infrastructure Australia. (2015). *Australian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p. 84. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

[67] Infrastructure Australia. (2015). A*ustralian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p.32. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

[68] Transport for NSW. (2016). Household Travel Survey 2014-15 - How long do people travel by mode? Retrieved from https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/hts-viz/hts-viz-how-long

[69] Transport for NSW. (2016). Household Travel Survey 2014-15 - LGA Profiler. Retrieved from https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/lga-profiler

[70] GTA Consulting. (2017). *Outer urban public transport access* (unpublished research commissioned by Infrastructure Australia)

[71] Transport for NSW. (2017). *Future Transport 2056 Draft Strategy*, p. 6. Retrieved from https://future.transport.nsw.gov.au/react-feedback/future-transport-strategy-2056/

[72] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*, pp. 6-7. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[73] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*, p. 91. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[74] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*, pp. 6-7. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[75] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*, pp. 14-15. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[76] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*, p. 17. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan; Transport for NSW. (2016). Land Use 2016 (LU16) Population and Employment Projections

[77] In 2017 the Greater Sydney Commission merged and renamed the 2016 Districts to create five new Districts: Western City District, Central City District, Eastern City District, North District, and South District; Greater Sydney Commission. (2016). *Towards our Greater Sydney 2056*. Retrieved from https://www.greater.sydney/publications

[78] Infrastructure Australia. (2016). *Australian Infrastructure Plan: Priorities and reforms for our nation's future*, pp. 35-36. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Plan.aspx

[79] Greater Sydney Commission. (2017). *Draft Greater Sydney Region Plan*. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[80] Committee for Sydney. (2017). *Issues Paper 14 - Adding to the Dividend, Ending the Divide #3,* p. 6. Retrieved from http://www.sydney.org.au/wp-content/uploads/2015/10/CfS-Issues-Paper-14-Adding-to-the-Dividend-Ending-the-Divide-3-1.pdf

[81] O'Neill, P. (2016). *Addressing Western Sydney's jobs slide*. The Centre for Western Sydney, p. 3. Retrieved from https://www.westernsydney.edu.au/cws/policy

[82] Crane, R., & Weber, R. (2015). *The Oxford Handbook of Urban Planning.* Oxford University Press, p. 169

[83] The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, p. 10. Retrieved from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

[84] Department of the Prime Minister and Cabinet. (2016). *Smart Cities Plan*., p. 11. Retrieved from https://cities.dpmc.gov.au/smart-cities-plan

[85] Department of the Prime Minister and Cabinet. (2016). *Smart Cities Plan*. Retrieved from https://cities.dpmc.gov.au/smart-cities-plan; Greater Sydney Commission. (2017). Draft Greater Sydney Region Plan. Retrieved from https://www.greater.sydney/draft-greater-sydney-region-plan

[86] Infrastructure NSW. (2014). *State Infrastructure Strategy – Update*, p. 107. Retrieved from http://www.infrastructure.nsw.gov.au/expert-advice/state-infrastructure-strategy-update-2014.aspx

[87] Infrastructure NSW. (2014). *State Infrastructure Strategy – Update*, p. 99. Retrieved from http://www.infrastructure.nsw.gov.au/expert-advice/state-infrastructure-strategy-update-2014.aspx

[88] Audit Office of NSW. (2017). *Planning for school infrastructure*. Retrieved from http://www.audit.nsw.gov.au/news/planning-for-school-infrastructure, p. 6

[89] SGS Economics & Planning. (2016). *Australian Cities Accounts 2015-16*, p. 5. Retreived from http://www.sgsep.com.au/publications/gdp-major-capital-city-2015-2016

[90] Department of the Prime Minister and Cabinet. (2016). *Smart Cities Plan*. Retrieved from https://cities.dpmc.gov.au/smart-cities-plan

[91] Ahrend, R., Farchy, E., Kaplanis, I., & Lembcke, A. (2014). *What Makes Cities More Productive? Evidence*

on the Role of Urban Governance from Five OECD Countries, pp. 5-6

92 Burdett, R., & Rode, P. (2015, November 25). Who runs out cities? How governance structures around the world compare. Retrieved from https://www.theguardian.com/cities/2015/nov/25/who-runs-our-cities-how-governance-structures-around-the-world-compare

93 Mouat, C., & Dodson, J. (2013). Reviewing the Auckland 'super city': towards an ongoing agenda for evaluating super city governance. *Australian Planner*, pp. 138-147

94 Australian Bureau of Statistics. (2017). 2016 Census QuickStats – Brisbane (C) Local Government Area. Retrieved from http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/LGA31000?opendocument

95 Gleeson, B., Dodson, J., & Spiller, M. (2010). *Metropolitan governance for the Australian city: The case for reform*. Griffith University Urban Research Program, Issues Paper 12

96 Next Generation Engagement Project. (2017, September 28). *Next Generation Engagement Project*. Retrieved from https://blogs.unimelb.edu.au/nextgenengagement/

97 Angel, S., & Blei, A. (2016). The productivity of American cities: How densification, relocation, and greater mobility sustain the productive advantage of larger U.S. metropolitan labor markets. *Cities, 51*, 36-51. Retrieved from https://doi.org/10.1016/j.cities.2015.11.030

98 Bureau of Infrastructure, Transport and Regional Economics. (2013). *Research Report 142 - Cities - Population growth, jobs growth and commuting flows - a comparison of Australia's four largest cities*, p. 63. Retrieved from https://bitre.gov.au/publications/2013/files/report_142.pdf

99 Bureau of Infrastructure, Transport and Regional Economics. (2013). *Research Report 142 - Cities - Population growth, jobs growth and commuting flows - a comparison of Australia's four largest cities*, p. xvi. Retrieved from https://bitre.gov.au/publications/2013/files/report_142.pdf

100 BIS Shrapnel. (2015). *Forecasting the distribution of stand-alone employment in Sydney to 2035*, p. 16. Retrieved from https://www.greater.sydney/background-material

101 Infrastructure Australia. (2015). *Australian Infrastructure Audit: Our Infrastructure Challenges – Report Volume 1*, p. 32. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Audit.aspx

102 Bureau of Infrastructure, Transport and Regional Economics. (2014). *Freightline 1 - Australia freight transport overview*, p. 4. Retrieved from https://bitre.gov.au/publications/2014/freightline_01.aspx

103 Bureau of Infrastructure, Transport and Regional Economics. (2014). *Urban public transport: updated trends*. Retrieved from https://bitre.gov.au/publications/2014/is_059.aspx

104 The Grattan Institute. (2013). *Productive Cities: Opportunity in a changing economy*, pp. 28-36. Retrieved from https://grattan.edu.au/report/productive-cities-opportunity-in-a-changing-economy/

105 Commonwealth of Australia. (2002). *Disability Standards for Accessible Public Transport 2002*. Retrieved from https://www.legislation.gov.au/Details/F2011C00213

106 Infrastructure Australia. (2016). *Capturing Value: Advice on making value capture work in Australia*. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/reform_series.aspx

107 The World Bank. (2017, July 7). *CO2 emmissions (metric tons per capita)*. Retrieved from http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

108 Department of the Environment and Energy. (2017). *International activities - Paris Agreement*. Retrieved from http://www.environment.gov.au/climate-change/international/paris-agreement

109 The Climate Council. (2017). *Local Leadership: Tracking local government progress on climate change*, p. 24. Retrieved from https://www.climatecouncil.org.au/cpp-report

110 The Bureau of Meteorology and CSIRO. (2016). *State of the Climate*. Retrieved from http://www.bom.gov.au/state-of-the-climate/

111 Infrastructure Australia. (2016). *Australian Infrastructure Plan: Priorities and reforms for our nation's future*, p. 124. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Plan.aspx

112 Infrastructure Australia. (2016). *Australian Infrastructure Plan: Priorities and reforms for our nation's future*, p. 124. Retrieved from http://infrastructureaustralia.gov.au/policy-publications/publications/Australian-Infrastructure-Plan.aspx

Future Cities

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