FINAL REPORT

Costs and benefits of alternative growth scenarios for Sydney

Focusing on existing urban areas

Prepared for
NSW Planning and Infrastructure

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THE CENTRE FOR INTERNATIONAL ECONOMICS
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CANBERRA

Centre for International Economics
Ground Floor, 11 Lancaster Place
Majura Park
Canberra ACT 2609

GPO Box 2203
Canberra ACT Australia 2601

Telephone +61 2 6245 7800
Facsimile +61 2 6245 7888
Email cie@TheCIE.com.au

Website www.TheCIE.com.au

SYDNEY

Centre for International Economics
Suite 1, Level 16, 1 York Street
Sydney NSW 2000

GPO Box 397
Sydney NSW Australia 2001

Telephone +61 2 9250 0800
Facsimile +61 2 9250 0888
Email ciesyd@TheCIE.com.au

Website www.TheCIE.com.au

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Executive summary

Cities around the world and around Australia have very different urban structures. These include differences in the concentration of employment and dwellings (density) and the types and variety of dwellings provided.

Much of the pattern of city structures reflects economic drivers such as transport costs, income levels and industrial composition, as well as natural features such as geography and topography. However, governments have also played a major role in shaping how cities, including Sydney, have developed. This role for government in land use planning reflects the view that the market will not deliver a land use pattern that maximises net public benefits (that is, is efficient) or provide equitable outcomes if left to its own devices. The role of government in land use planning also reflects the complementary role that government plays in delivering public infrastructure and services. For these reasons, governments can seek to facilitate the emergence of more efficient land use outcomes than would otherwise emerge, as well as appropriately planning infrastructure and service provision to meet Sydney's growth.

This project

Sydney's population and employment will grow over coming decades. Based on projections from the Bureau of Transport Statistics, between 2011 and 2031 Sydney's population will increase by over 1 million people and employment will increase by around 500 000 people. Based on expected household formation rates, over 400 000 additional dwellings will be required.

The growth in Sydney could be accommodated in a variety of ways. In this project, the CIE and ARUP consider the benefits and costs from alternative ways of accommodating part of this growth across infill areas and through different dwelling types. In particular, it considers the following scenarios for accommodating growth in population, dwellings and employment.

- Baseline – using projections from the Bureau of Transport Statistics for employment, population and dwelling growth.
- Balanced centres – where growth in dwellings and employment is focused on local centres and strategic centres, with little growth across dispersed infill areas/
- Strategic centres – where growth in dwellings and employment is focused on strategic centres such as Sydney CBD, Parramatta, Chatswood and others;
- Dispersed infill – where growth is focused outside of centres; and
- Inner middle – where growth is focused on parts of Sydney closer to the CBD.

For all scenarios the amount and location of Greenfield development are held constant, so that only infill development patterns are changed. Total population, dwelling and employment changes are also held constant across scenarios. This means that scenarios do not consider the costs and benefits of Sydney's growth as a whole nor the costs and benefits of changes in the Greenfield-infill mix. The purpose of assessing costs and benefits of these scenarios is to test alternative futures for infill development and to tease out factors that may be important in developing policies around land use planning.

The scenarios represent substantially different patterns for *new development*. In particular, there are marked differences in the pattern of development around centres. The scenarios capture less difference in population and employment outcomes between subregions and local government areas and there will, of course, be many directions that Sydney could take that are not directly assessed in this project.

While new development outcomes are very different, it is important to understand that new development is overlayed on historical development patterns and structures. This means that differences in overall population and employment patterns are smaller. In this context comparisons often made between cities are less relevant to considerations around Sydney's growth. For example, Sydney's average density would reach that of Hong Kong only with 1000 years of growth where all growth is concentrated in existing areas at current levels of growth. It would take 75 years of such growth to achieve a density similar to Paris. Hence the changes to Sydney, such as its spatial structure and transport patterns, accompanying Sydney's growth to 2031 are considerably smaller than many might expect in the medium term.

This project assesses each scenario according to its estimated impact, relative to the baseline, on social infrastructure (education and health), physical infrastructure (electricity, water and wastewater), transport and local council infrastructure. In addition, broader social, environmental and productivity impacts are considered. Finally, the value created by land use change is measured for each scenario. This is the value placed on new developments in excess of the cost of the resources used to produce them.

The findings

The benefit-cost analysis shows that some scenarios are likely to provide greater net public benefits than others, although the differences are relatively small in the context of government expenditures on infrastructure and service provision (chart 1). The Balanced Centres scenario has the highest net benefits (benefits less costs) of $1 830 per new dwelling or $193 million in total, relative to baseline. The least beneficial scenarios are characterised by concentrated development in a particular type and location, such as the Strategic Centres scenario, or greater density where benefits are lower, such as the infill dispersed scenario.

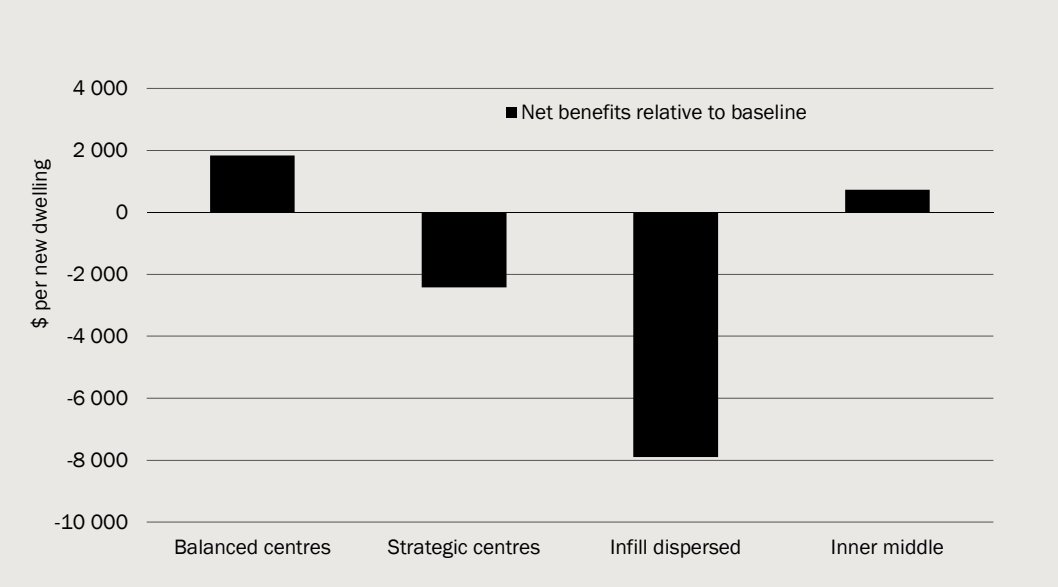
The net benefits relative to baseline per new dwelling by category for each scenario are shown in table 2. A positive number is a net benefit relative to the baseline arising from changes between 2016 and 2031.

For cost factors, such as infrastructure costs and transport congestion costs, alternative infill scenarios lead to relatively small differences. That is, perhaps surprisingly, while

infrastructure and congestion costs associated with growth are likely to be large for all scenarios, the cost differences between scenarios are much smaller. Of the cost drivers, transport congestion and crowding and social impacts from transport are most important, with the Balanced Centres scenario providing benefits in these categories of around $2 000 per new dwelling relative to baseline.

Notably, the transport patterns across alternative scenarios, as modelled by the Bureau of Transport Statistics Strategic Transport Model, are remarkably similar — relatively little change is observed in mode shares and average trip times. This partly reflects that existing employment and dwellings are a large part of the transport task and that for most journeys where the CBD is not the destination people predominantly use cars. This modelling reflects outcomes when infrastructure and services are held constant for each scenario. (If there are particular transport projects that have high net public benefits then it would make sense to focus development in areas serviced by these projects.) Congestion and crowding impacts do vary marginally across scenarios. The largest difference is the Balanced Centre scenario, which generates a benefit of $1700 per new dwelling from reduced transport costs, relative to baseline.

1 Net benefits of each scenario per new dwelling



Data source: The CIE.

Productivity spillovers arising from employment density are also relatively different across scenarios, with the Strategic Centres scenario estimated to provide for productivity spillovers in the order of $2 000 per dwelling relative to baseline, compared to a net cost of almost $2000 per dwelling for the infill dispersed scenario. This reflects a greater concentration of employment in areas where there is already dense employment, such as the CBD.

Significant variation is found in the value of land use change, which measures the latent demand (or potential net value gain) for alternative types of redevelopment across infill areas of Sydney. We find that there is substantial value available from redevelopment across Sydney in the form of:

- demand for rezoning to high density across all areas, with the strongest impacts in larger centres;
- demand for rezoning of industrial land to residential land; and
- demand for smaller block sizes while continuing to maintain low density development — people appear to have quickly diminishing returns for land as measured through block size and hence splitting blocks can provide much greater value.

However, scenarios that focus on a particular type of development in particular locations, such as the Strategic Centres scenario, push far too much of the same type of development into these areas than will be demanded. This means that the value of land use change in total is much lower for this scenario than for the baseline.

2 Net benefits per new dwelling across scenarios by category

	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle
	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv
Transport	0	1 678	84	1 128	- 13
Electricity	0	86	180	531	372
Water and sewerage	0	0	0	0	0
Primary education	0	- 168	127	- 278	- 356
Secondary education	0	181	- 388	282	- 47
Health	0	0	0	0	0
Local council	0	- 262	- 187	- 733	- 708
Environmental	0	199	276	- 35	220
Social	0	806	711	- 127	- 122
Value of land use change	0	45	-5 102	-6 794	249
Productivity spillovers	0	- 734	1 876	-1 873	1 134
Net benefits per dwelling	**0**	**1 830**	**-2 423**	**-7 899**	**729**
	$m, npv	$m, npv	$m, npv	$m, npv	$m, npv
Net benefits total	**0**	**193**	**-255**	**-832**	**77**

Note: Net present values are calculated for 2012 using a 7 per cent real discount rate.
Source: The CIE.

The scenarios modelled involve changes in dwelling/population outcomes and changes in employment outcomes. The benefits and costs of these different changes can largely be separated out. A scenario that used employment patterns from the baseline and dwelling patterns from the Balanced Centres scenario would have higher net benefits than any of the scenarios modelled.

The benefit and cost outcomes arising from different patterns of growth are not deterministic. Growth can be managed well or poorly, with forward (or strategic) planning both within agencies and across government playing an important role in this management. Errors in forward planning are likely to be more consequential in scenarios that concentrate people or employment in the one place. For example, we have found that costs for concentrating development around centres will be far smaller for education if demand can be spread across schools in the local government area, such as through changes in catchment boundaries, rather than managed only within existing catchment constraints.

Implications for the Metropolitan Strategy

The benefit cost analysis suggests a number of implications that are relevant to the types of *land use outcomes* sought by the Metropolitan Strategy.

- No scenario outperforms all others across each cost and benefit item. The best performing scenarios may perform more poorly in some areas. Achieving a more efficient land use outcome is therefore a *balance* between the different types of benefits and costs that arise from land use change.
- Scenarios that allow for different types of development across a broader set of areas tend to perform better. In particular, the balanced centres scenario has a higher net public benefit than other scenarios and the baseline. This scenario would perform even better if employment outcomes looked more like those of the base case.
- Infrastructure cost differences associated with alternative infill development scenarios are relatively small, reflecting small or unquantifiable cost differences between scenarios. Note that transport impacts have been modelled through the amount of additional congestion, so infrastructure costs for transport do not vary across scenarios.
- For transport, congestion cost implications are similar across scenarios for the same infrastructure and public transport service provision. If there are transport services that can be provided with much higher net public benefit in some areas than in others, then development in these areas would be likely to be advantageous. This is likely to be dependent on specific opportunities and corridors to which transport services can be improved at relatively low cost.
- Within infill areas, differences in benefits and costs arising from demand factors, such as demand for new residential development and industry level growth (and hence demand for employment space) drive a greater part of the differences between scenarios.
- There is substantial value from new development that can be unlocked by changes in planning restrictions and costs, across a range of centre types, locations and types of development.

As well as providing direction on outcomes, benefit cost analysis of alternative scenarios can provide guidance on areas of policy focus or process for the Metropolitan Strategy. Given that findings are subject to uncertainty and that market demand and costs are subject to change, it is useful to consider how the NSW Government may facilitate the emergence of land use outcomes with greater public benefit, regardless of what these may turn out to be. For instance, what policies and processes can assist in the emergence of more efficient land use outcomes? How can policies and processes be used to support rather than hinder desired land use outcomes?

There are likely to be many areas where the NSW Government can act to reduce government failures and market failures to enable the emergence of more efficient land use outcomes. These include infrastructure funding arrangements, governance of the planning system and reducing the costs imposed by government on new development. We touch on some of these in chapter 15, although it is outside the scope of this project to consider in detail the policy implications arising from this benefit cost analysis.

One important implication from the benefit cost analysis relates to the role of forward (or strategic) planning. Forward planning in a government service context has a role in matching services to emerging demand, as well as in shifting or managing demand towards socially beneficially outcomes. The findings of this benefit cost analysis suggest that there would be value in placing a greater focus on the role of forward planning of land use in infill areas in matching services to demand. That is, forward planning could be used to ensure that people's choices of where to live and work are appropriately supported by planning and government services. Demand factors may be difficult to predict and are subject to change. Ensuring that these demand pressures are monitored on an ongoing basis may better allow for forward planning to fulfil this facilitation role. Alternatively, policy mechanisms and processes could be designed so that they are able to adapt to changes in market conditions.

1 Background

Current patterns of development in Sydney

The current pattern of development in Sydney can inform the development of a baseline and scenarios. There are some key features of current development patterns.

- Population and dwelling growth has occurred across Sydney. There has been significant growth in the Sydney LGA and in the North West areas in particular (chart 1.1).
- The majority of new dwellings approved in Sydney over the last 10 years have been multi-unit dwellings (chart 1.3)
- Employment growth in Sydney over the past 10 years has likely been heavily focused in the Sydney CBD (chart 1.5), with slightly more than 20 per cent of Sydney's employment growth estimated to have come from the Sydney CBD. There has also been strong employment growth in Ryde (Macquarie Park) and Blacktown.

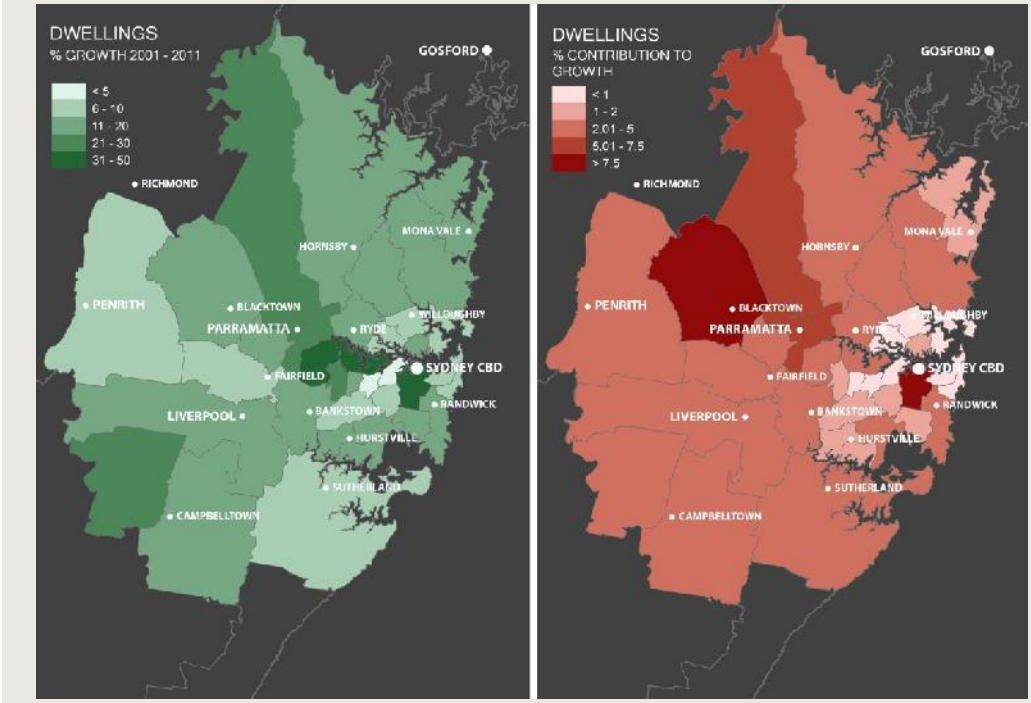
Historical dwelling changes

Dwelling growth has occurred across Sydney, but with particularly strong growth in the Sydney LGA and the outer areas of Sydney, particularly the North West and South West.

MDP projected dwelling change

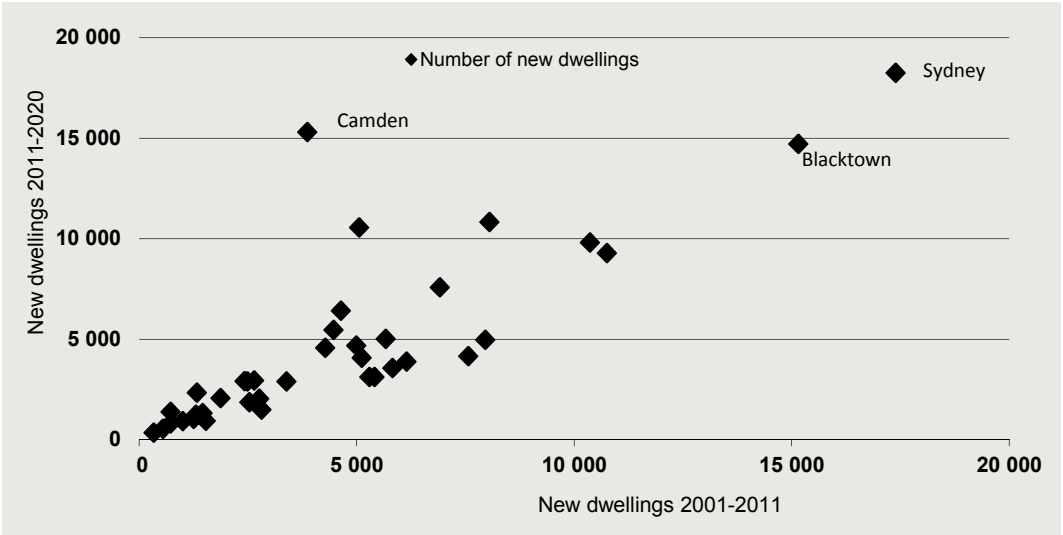
The Metropolitan Development Program provides expectations of future dwelling projections by Local Government Area (LGA). These follow a similar pattern to the past decade with the exception of much stronger increases in new dwellings in the Camden LGA (chart 1.2).

1.1 Dwelling growth across Sydney



Data source: ABS Census 2006, ABS Building Approvals, 2001 – 2011.

1.2 MDP projections versus historical dwelling growth

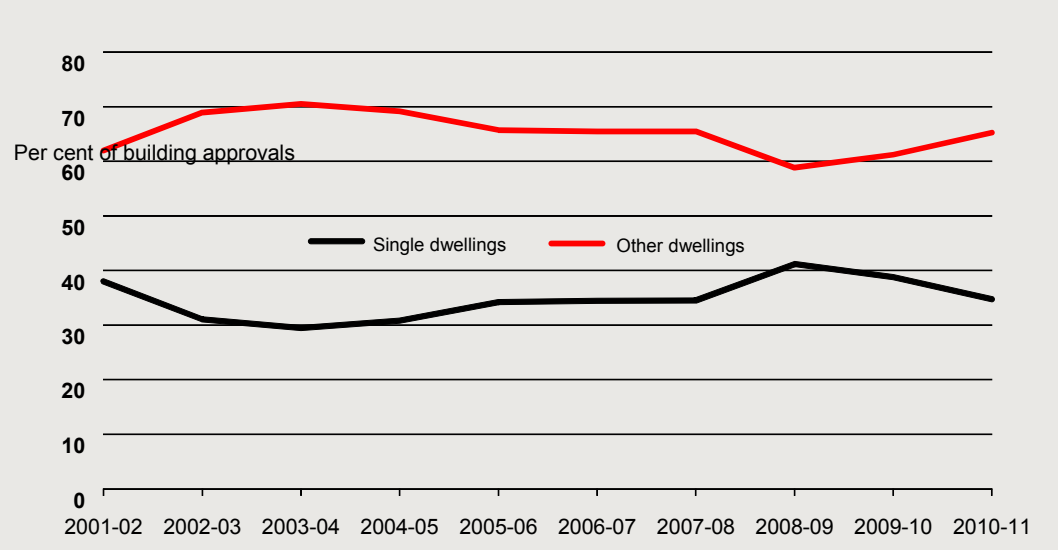


Data source: ABS Census 2006, ABS Building Approvals, 2001 – 2011.

Historical type of dwelling approvals

Dwelling approvals over the past ten years were split approximately one third to new separate houses and two thirds for other dwellings, including semi-detached dwellings, townhouses, units and flats.

1.3 Type of building approvals in Sydney



Data source: ABS Building Approvals by LGA.

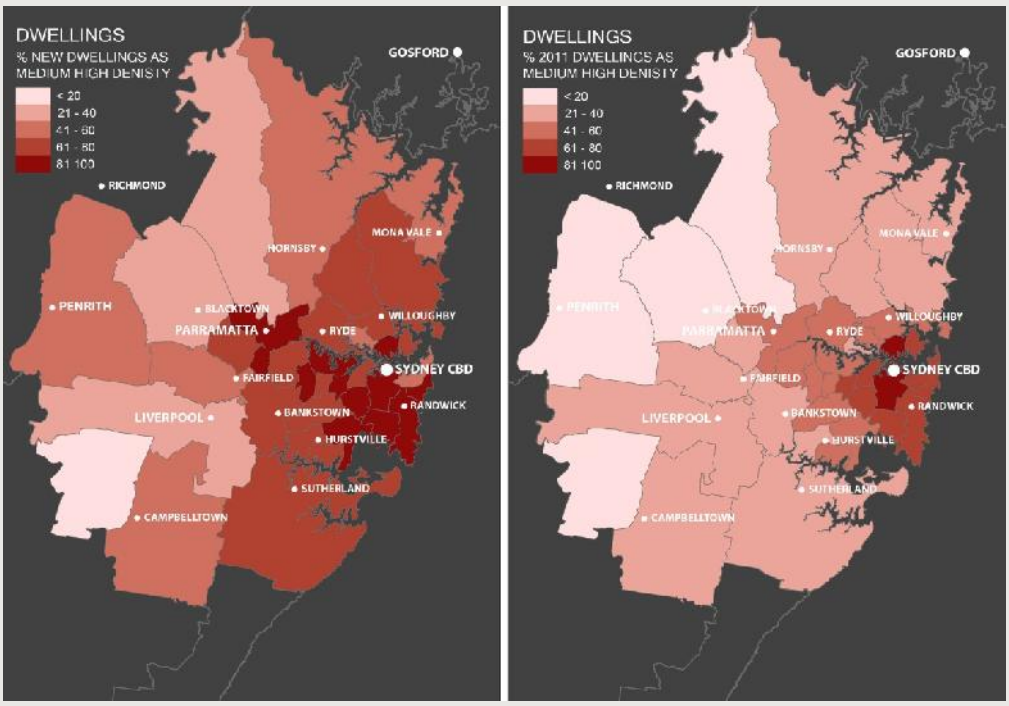
There is a clear outward pattern of a declining share of medium/high density (right hand panel of chart 1.4, as would be expected. There is also a much higher proportion of new dwellings being built as medium/high density across Sydney than the existing dwelling stock, particularly in a channel out from the CBD to Parramatta (left hand panel of chart 1.4).

Historical employment change[1]

Employment growth has been concentrated in the Sydney LGA, with this LGA comprising over 20 per cent of employment growth in Sydney over the past decade. There has been low or negative employment growth in areas surrounding the Sydney LGA. In fringe areas there has been employment growth, likely associated with population change. Ryde also experienced strong employment growth, reflecting growth in Macquarie Park.

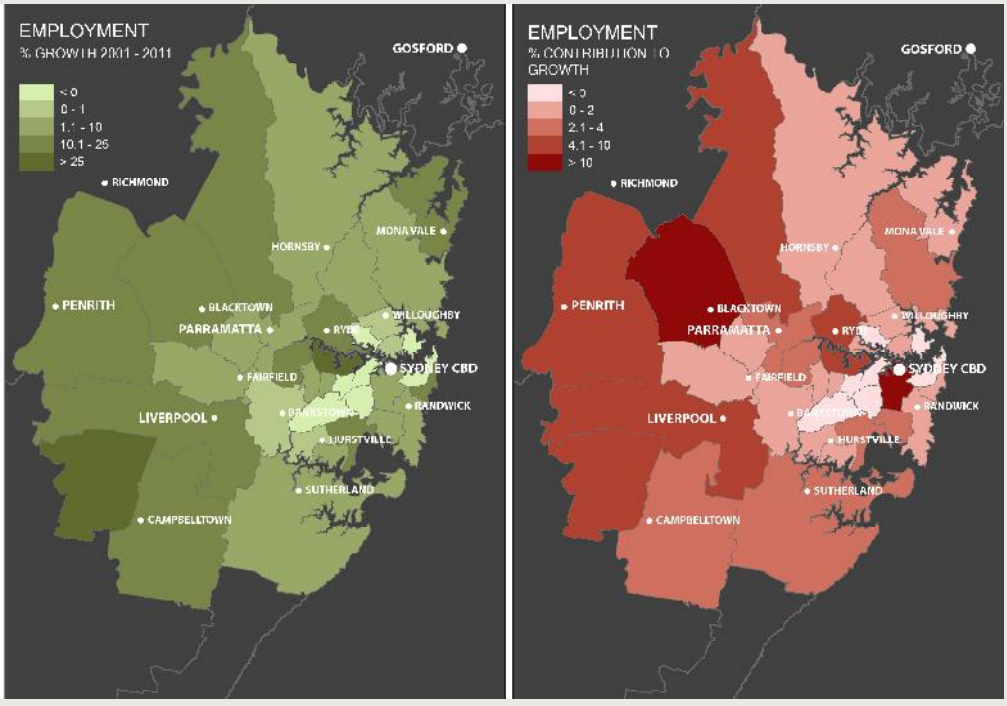
1 Employment figures are available from the 2001 and 2006 Censuses. 2011 figures are available from the Bureau of Transport Statistics, which are projections. We use a 2011-2001 change to be comparable to the changes in dwellings reported above.

1.4 Type of building approvals across Sydney



Note: New dwellings are from 2001 to 2011.
Data source: ABS Census 2006; ABS Building Approvals by LGA.

1.5 Employment change across Sydney 2001-2011



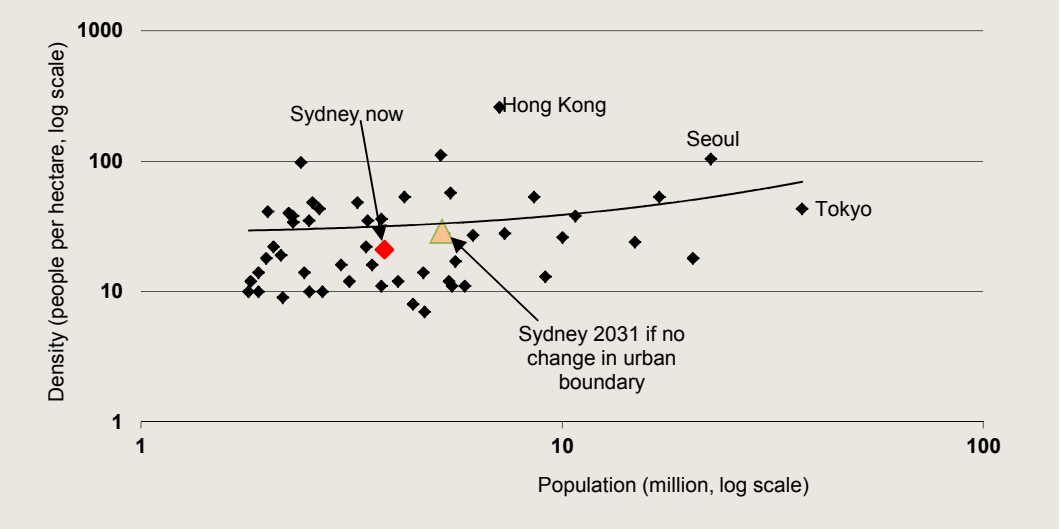
Data source: Bureau of Transport Statistics Journey To Work data Table 10 2006 and Table 26 2001; Bureau of Transport Statistics, NSW Transport and Infrastructure, 2009, Employment Forecasts by Local Government Area (LGA) by Industry.

Density across Sydney and comparison to other cities

There are many alternative patterns for a city structure. Looking across the world, there are cities with density many multiples of the density of Sydney and those with density far lower than Sydney, even for comparable population sizes (chart 1.6, using log scale). The types of densities are also very different with some cities having lower density spread out across a large part of the city and others having much more focused density (charts 1.7, 1.8 and 1.9).

Even if Sydney did not move outwards at all, its population density in 2031 would remain below typical density levels of comparable cities today.

1.6 Population and density across cities in the world (log scale)

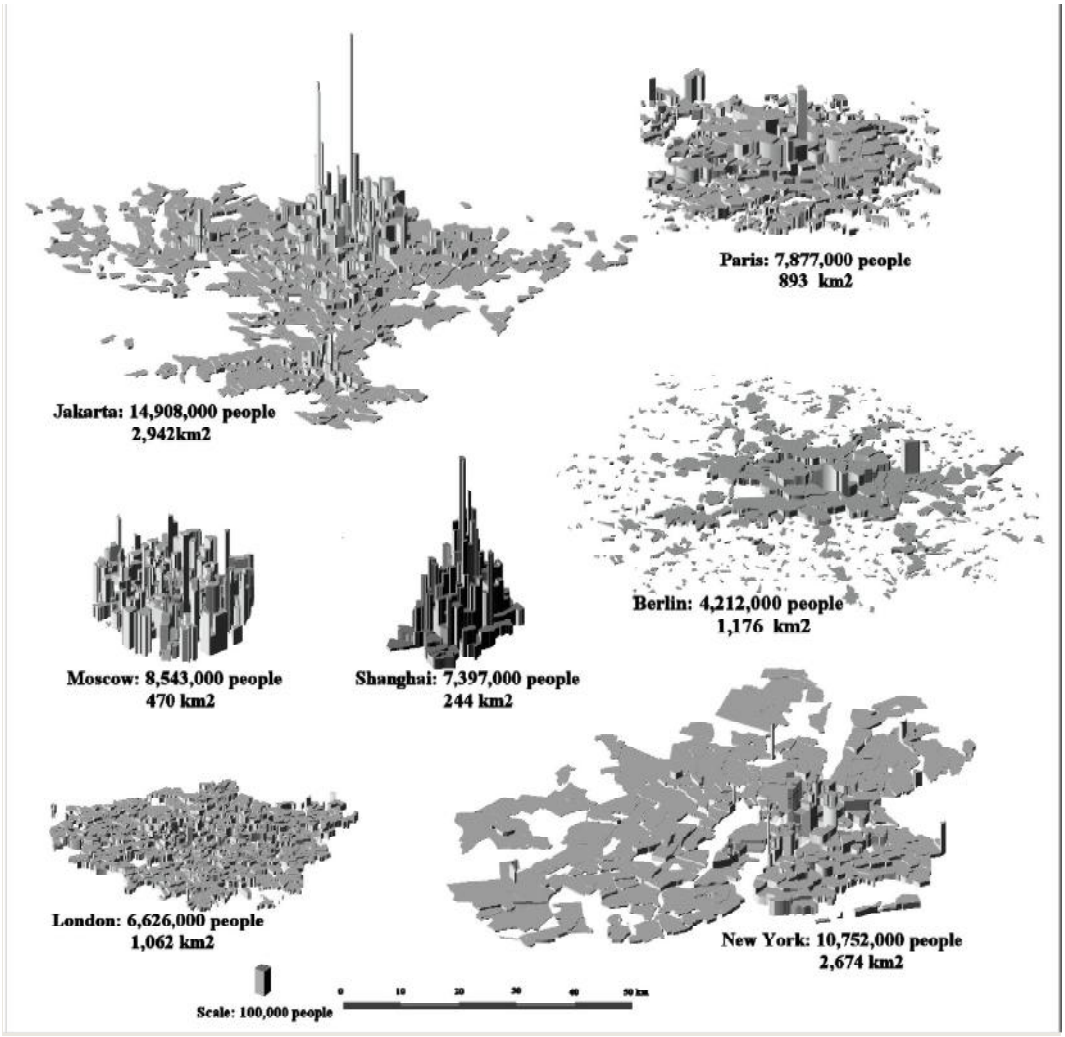


Data source: Demographia web site, www.demographia.com.

These different patterns are partially formed by natural features, the time period over which a city developed (and the transport mainly used at that time) and the industrial composition. For instance, one of the most popular urban models is the Alonso, Muth Mills model, which predicts that higher transport costs lead to a more condensed city.[2] But city structures are also influenced by strategic city planning, and the very different outcomes between cities suggests that this influence may be considerable. It is in this context that we seek to understand the impacts, benefits and costs of moving Sydney in particular planning directions.

2 See for example, Kulish, M., A. Richards and C. Gillitzer 2011, "Urban structure and housing prices: Some evidence from Australian cities", Reserve Bank of Australia Discussion Papers, 2011-3.

1.7 Different types of urban structure

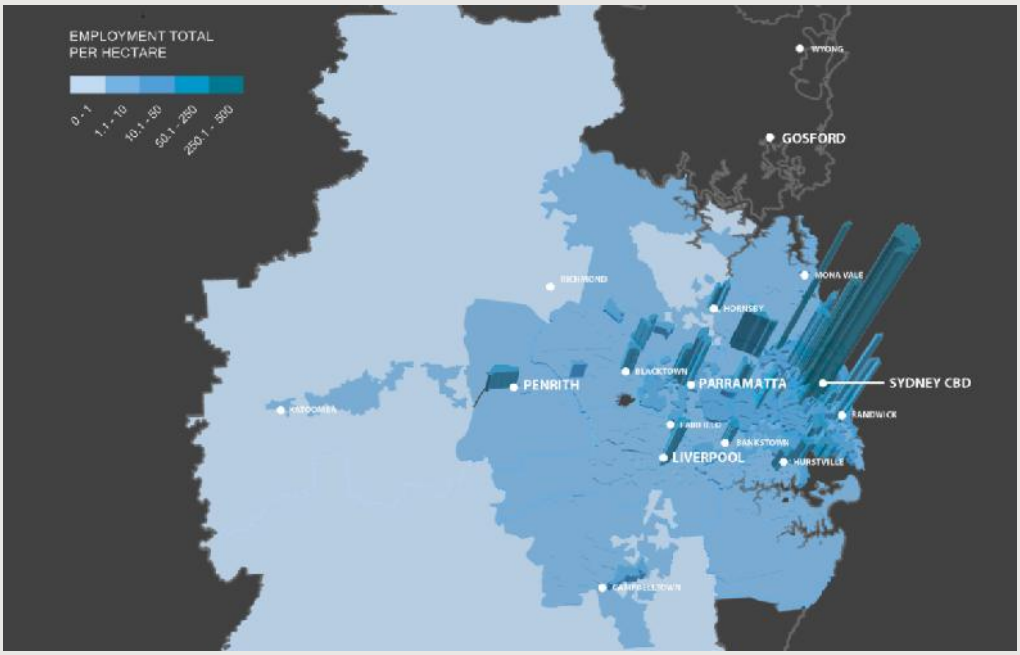


Data source: Bertaud, A. 2010, "Spatial structures, land markets and urban transport", presentation to Paris Atelier AFD, June Transport et formes urbaine.

1.8 Sydney's dwelling structure in 2031 under base case projections

Data source: ARUP based on Bureau of Transport Statistics projections.

1.9 Sydney's employment structure in 2031 under base case projections



Data source: ARUP based on Bureau of Transport Statistics projections.

Objectives of this project

The objective of this project is to inform the review of the Metropolitan Plan 2012. It aims to:

- highlight the trade-offs implicit in alternative spatial growth structures within Sydney's existing areas;
- test the costs and benefits of key strategic planning options such as:
  - a base case capturing market expected outcomes under current policies;
  - a dispersed increase in housing across all areas;
  - the location of housing close to existing centres;
  - the location of housing and employment mainly in strategic centres;
  - the location of housing and employment mainly in strategic and regional centres; and
  - different splits between the location of housing and employment between East and West Sydney.

This project considers only development paths within existing areas. The amount and location of Greenfield development (dwellings and employment) is the same under each scenario. The level of Greenfield development assumed may interact with infill development scenarios, such as through transport congestion. However, these impacts are expected to be minor.

Estimating costs and benefits associated with strategic infill growth paths is a complex and demanding task. There is considerable uncertainty about the outcomes from benefit cost analysis of strategic infill development paths. There is also the likelihood that strategies that are preferred now may not always be preferred if preferences or costs change or as better ways are found to undertake development of different types. Reflecting this, we also discuss how instruments available to the NSW Government can be used to facilitate a more efficient land use pattern.

2 Trade-offs from alternative growth scenarios

The way that Sydney grows has different implications for the value placed on living in Sydney by households, the productivity of businesses and the costs incurred by government. These implications are not always obvious and are often conflicting. For example, a strategy that reduced government costs may not align with a strategy that maximised the value of living in Sydney.

This chapter sets out the types of trade-offs that can occur from different growth patterns.

Why cities exist?

The existence of cities largely reflects 3 factors, which together could be termed benefits of agglomeration.

- By living together we can more cheaply provide common infrastructure, such as electricity, water and wastewater, health and education.
- We enjoy living together (up to a point) including because of the greater privately provided amenities.[3]
- We are more productive working near each other.

The offset to these positive aspects of cities is congestion — of transport, of services and of space in general. For example, Kahn (2010) finds that a 1 per cent increase in population is associated with a 0.13 per cent increase in average commute time in the US.[4]

Hence the problem of city design at a strategic level can be characterised as maximising the advantages that accrue from being in cities while minimising the disadvantages. That is, maximising benefits of agglomeration while minimising costs of congestion.

A fourth area of trade-off noted by Glaeser and Kohlase 2003 is with natural features. They argue that cities have historically developed to take advantage of transport options such as ports and waterways, but that as these transport costs have declined "cities should locate where it is pleasant to live or where governments are friendly."[5] Sydney offers a range of natural features that could be (and have been) a focus for development.

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3 Albouy, D. 2008, "Are big cities bad places to live? Estimating quality of life across Metropolitan areas", National Bureau of Economic Research working papers, No. 14472.

4 Kahn, M. 2010, "New evidence on trends in the cost of urban agglomeration", in Glaeser, E., *Agglomeration Economics,* University of Chicago Press, pp. 339-354.

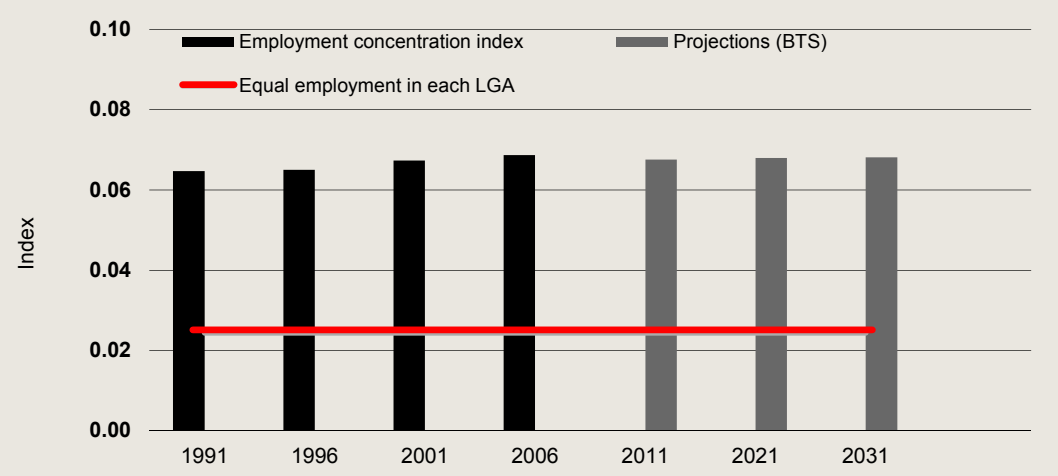
5 Glaeser, E. and J. Kohlhase 2003, "Cities, regions and the decline of transport costs", Harvard Institute of Economic Research discussion papers, No. 2014, p 30.

Housing and employment patterns

As a city grows, there is a tendency for commute times to increase unless employment decentralises. For instance, as noted by Healy (1965), with a continuing monocentric city structure and similar density, a quadrupling of the metropolitan population will lead to a doubling of average commute distances.[6] Changes in employment structures are a key mechanism working against this. The much lower actual relationship between population and commutes shows that in practice there is a significant role played by decentralisation of employment in reducing commute times in big cities.[7]

This same phenomenon is evident in Sydney. While the CBD retains a role as a major employment destination and has been a major part of accommodating additional employment, other centres have also shown strong employment growth. The evidence from the 2011 Census for employment growth is not yet available. Previous evidence from the 2001 and 2006 censuses and Bureau of Transport Statistics projections indicate strong growth in Parramatta, Macquarie Park and Blacktown. In areas closer to the CBD, employment has become increasingly focused on the CBD. Using an overall measure of employment concentration across Sydney's LGAs we see that concentration has remained fairly constant and is projected to continue to remain fairly constant by the Bureau of Transport Statistics. The employment concentration index shows that employment is more concentrated than an even spread across Sydney (the red line) but far below the employment concentration of a fully monocentric city where all employment was in one location, for which the concentration index would be 1.

2.1 Employment concentration in Sydney



Note: Concentration index is calculated as the sum of the squared share of employment in each LGA.

Data source: ABS Census 1991, 1996, 2001, 2006; Bureau of Transport Statistics; CIE analysis.

Spreading jobs away from the CBD has two impacts. Firstly, this reduces commute times, providing a benefit. Secondly, this may reduce productivity spillovers that arise

6 Healy, K. 1965, "Some major aspects of urban transport policy formation", in National Bureau of Economic Research, *Transportation economics,* pp 327-348.

7 Kahn, M. 2010, "New evidence on trends in the cost of urban agglomeration", in Glaeser, E., *Agglomeration Economics,* University of Chicago Press, pp. 339-354.

from employment density, generating a cost.[8] Moving to a polycentric approach can be thought of as trying to get the best of both worlds — achieving density of business activity but in multiple locations.

International evidence suggests that cities that have a high concentration of their employment in one area also have a high concentration of population around a centre.[9] Hence employment patterns and housing patterns do tend to match, presumably as people seek to avoid longer travel times and businesses take advantage of labour supply seeking employment that involves less travel.

In Sydney, people do not necessarily match their housing location with their employment location. As can be seen on any weekday morning or afternoon, people are moving everywhere. There are travel movements from the Eastern suburbs into Macquarie Park, from the Northern Beaches into the Eastern Suburbs, from East to West and West to East. Some movements are obviously stronger than others, but the spread of different movement patterns does mean that attempts to minimise commuting costs might be less effective than otherwise.

The lack of housing and employment matching likely reflects constraints on adjusting to opportunities in Sydney, with migration patterns found to be dominated by local movements (within the same local government area and subregion)[10], and urban movement limited by natural constraints (location of family, friends, schools etc) and government constraints such as stamp duty costs.

Other factors that could change the pattern of housing and employment are working from home and teleworking. There is evidence of an increase in teleworking — working at home on some days — although this is still small. The Bureau of Transport Statistics reports that in 2001, 3.8 per cent of workers indicated that they sometimes worked from home as part of a teleworking policy.[11] By 2009 this figure was 7.5 per cent. Few teleworkers were working from home on most days.

Economies of scale in infrastructure provision

Infrastructure services, such as transport, water and electricity are subject to economies of density. That is, because a substantial part of costs are fixed for servicing a given area, having more people in an area reduces the costs per person (or the cost per unit of output). Examples of these economics of density include:

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8 Households and businesses are constantly making their own decisions about the trade-off between productivity and higher wages, as against longer commutes. However, this trade-off will not necessarily reflect the impacts of decisions on others.

9 Glaeser, E. and M. Kahn 2003, "Sprawl and urban growth", National Bureau of Economic Research working papers, No. 9733.

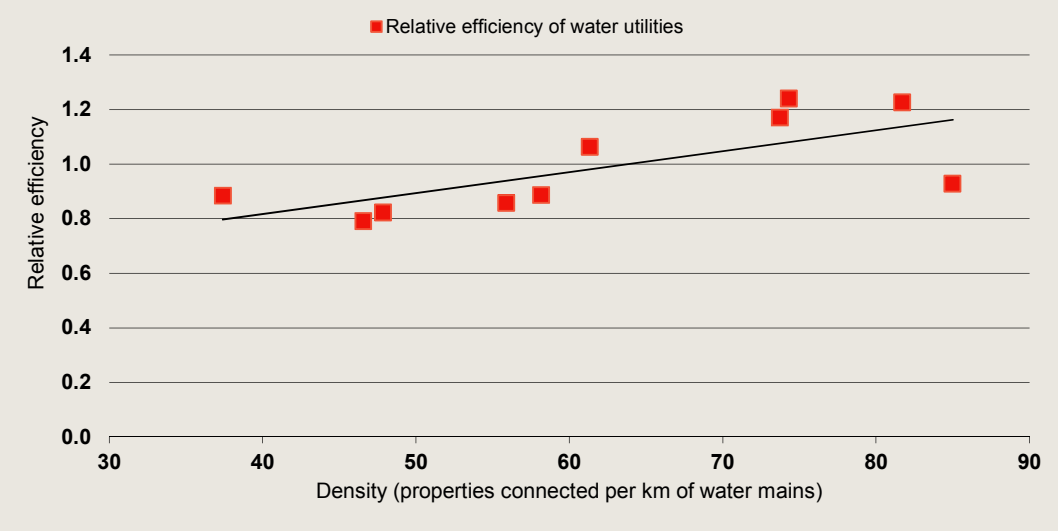
10 NSW Planning 2009, *MDP 2008-09 Migration Report,* Metropolitan Development Program.

11 Bureau of Transport Statistics 2011 (Corpuz, G.), "An empirical assessment of teleworking using the Household Travel Survey data", Australasian Transport Research Forum 2011 Proceedings, September.

- across Australia's major cities, a doubling in density is associated with over a 30 per cent improvement in productivity in providing water (chart 2.2).
- electricity infrastructure costs (capital and operating) are significantly lower for distribution businesses servicing Sydney versus those servicing country NSW;[12] and
- costs per passenger served for public transport are lower in larger. For example, bus costs are less than half per passenger trip for NSW Metropolitan areas (Sydney) versus outer metropolitan (such as Newcastle).[13]

These economies of density are a major reason for the existence of cities.

2.2 Economics of density in urban water



Data sources: Essential Services Commission Victoria, *An analysis of the productivity of the Victorian water industry,* Staff Research Paper No 12/1, Technical Report, Feburary (efficiency indicator used is from stochastic frontier analysis); National Water Commission, National Performance Report 2010-11, Indicator A3.

Economies of density may not continue at all ranges of density. At some point, costs of accessing infrastructure for repairs and cost of land used for infrastructure become high and outweigh other gains. The point at which this happens will differ for different types of infrastructure and may depend on topography and geography. Typically infrastructure services that require a large land component will be the first to realise diseconomies of density. For government services, education is most land intensive and is likely to face diseconomies of density. Transport also uses a significant land component. However, there are options for using land more efficiently in providing transport services, such as moving from cars to buses or multiple people per car. For areas such as health, land costs are a relatively minor part of costs and hence diseconomies of density are unlikely to be important in this sense.

12 Australian Energy Regulator 2009, *State of the Energy Market 2009,* table 6.1 and figure 6.8.

13 IPART, Reports for bus fares for metropolitan and outer metropolitan areas, for the NSW Government owned bus operations.

2.3 Ranking of infrastructure by potential for diseconomies of density

Source: The CIE.

Public services are developing methods of limiting diseconomies of density, through replacing land with capital. For instance:

- open spaces are being improved by making them more intensive, such as through more playgrounds and other equipment;
- multi-storey schools are being built, aiming to ensure that greater demand is accommodated by building up rather than removing open spaces;
- transport infrastructure solutions are being sought underground and elevated above ground, to avoid reliance on land — most of Sydney's recent projects have involved these components including the Cahill Expressway, Eastern Distributor, Syd Einfeld Drive, Cross-City Tunnel, Lane Cove Tunnel, Harbour Tunnel; and
- options are being considered for improved use of existing transport land such as increased use of buses instead of cars, with buses offering the potential to transport many more people per lane than cars. Density also offers the possibility of different types of transport, moving from car to bus to light rail to heavy rail as density increases.

Importance of government service provision

Different scenarios for Sydney may imply a different importance of public (and shared) services as against privately provided and used services. Low density development provides its own open space (to a degree) through backyards and transport is more likely to be by car. Higher density development may necessitate greater use of public open space and public transport.

Hence a development strategy focusing on pockets of higher density could be characterised as having a greater role for public services. The realised benefits of such a strategy may well depend on the effectiveness with which these services are provided. If there is good public service provision then such a strategy would have larger benefits, while if public services are not provided then this type of strategy would have smaller benefits.

Also, the costs and benefits of any growth scenario for Sydney will reflect the way in which this growth is managed. Costs will tend to be higher where publicly provided services are less flexible in response to changing demand or where projections of demand for new development are poor and infrastructure is provided that is unneeded. For example, later in this report we find that scenarios that concentrate growth in particular centres will have far higher costs for education infrastructure relative to baseline if this growth cannot be managed across neighbouring schools. Hence, fixed school catchment areas would tend to increase the costs of managing these types of scenarios.

Choice

Different people want different types of housing, different urban environments and different levels of access to particular types of amenities. Offering choice in goods and services is recognised as having substantial economic value.[14] This reflects that greater choice allows people to select the options that most closely correspond to their preferences. This is no different for housing. Providing the same type of housing across Sydney is unlikely to suit everyone's preferences.

The importance of housing choice has recently been the focus of work by the Grattan Institute.[15] This work highlights the different choices that people make, given the same prices and types of available housing. It also finds that there is a gap between the current housing stock and what people would choose.

Market forces

Developers are the primary agents of change in the provision of housing.[16] They are the group responsible for redeveloping existing areas. Clearly, developers work in a market and require returns to be interested in undertaking development. For any scenario to occur requires that strategies are incentive compatible for developers — that is the policy framework leads to developers choosing to provide the type and amount of housing sought by the scenario. The implications of this for implementation are explored more thoroughly in chapter 14.

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14 For example, the imperfect competition framework now frequently used in spatial economics relies on greater variety providing greater value. See for example, Fujita, M., P. Krugman and A. Venables 2001, *The spatial economy,* MIT: London.

15 Grattan Institute 2011, *Getting the housing we want,* November; Grattan Institute 2011, *The housing we'd choose,* June.

16 The Government also plays a development role in some cases.

3 Scenarios

Objectives in developing scenarios

The development of future growth scenarios for Sydney allows the economic performance of different spatial patterns to be assessed and compared. The scenarios provide the basis for assessing performance of alternate city structure options within existing urban areas, building on the economic analysis undertaken by CIE in 2010 which focused on greenfield/infill housing growth proportions in Sydney.

Each scenario represents a proposed change to land use compared to a base case scenario. The base case reflects the land use scenarios expected to occur under a continuation of current policies and patterns. For the land use changes captured in a scenario to be achieved would require changes in the policy settings embedded in the base case (or new policies). In this way, the assessment of the performance of the scenarios will assist in the identification and optimisation of a policy setting and city structure with maximum net public benefits.

The future growth scenarios have been identified by Department of Planning and Infrastructure but are elaborated in greater detail in this Report. The impact of the scenarios will be assessed using the methodology described in the following chapters.

Development of scenarios is a critical part of benefit cost analysis. Where scenarios are not well defined then there may be limited usefulness to the analysis. There are two aspects to this.

- A scenario should capture a magnitude of change that is feasible in a physical sense and feasible in that it could be generated by changes in policy/implementation settings.
- Scenarios that capture bundles of changes (such as changes in employment and housing distribution and/or housing type) may be better analysed by looking at changes in each part of the bundle separately.

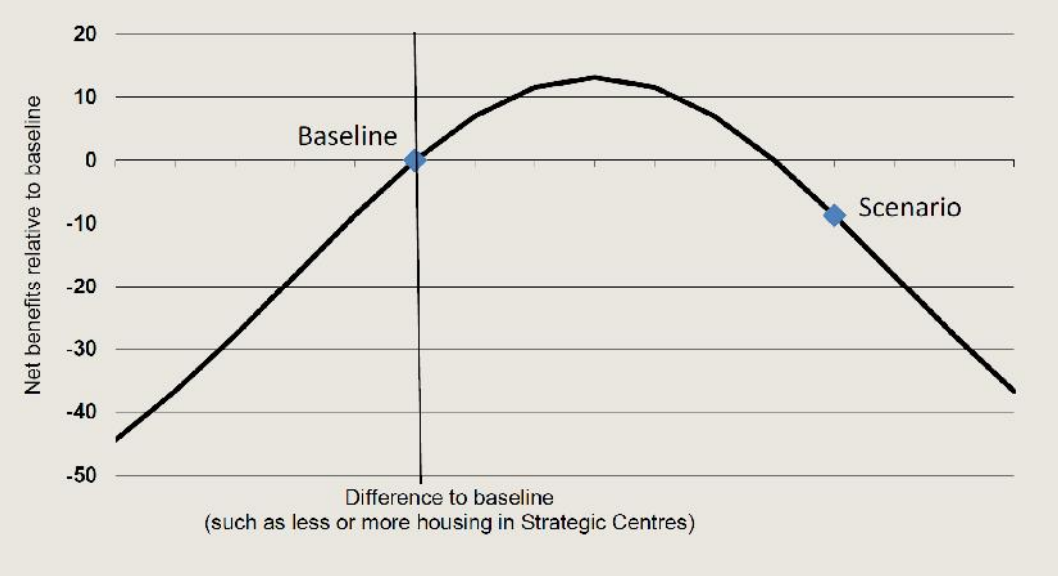
These are discussed in turn.

Magnitude of changes considered

The magnitude of the change captured from the Base Case can have important implications for a finding of a net benefit or cost. For example, suppose a scenario represented a substantial change in the amount of housing occurring in the catchments of Strategic Centres relative to the Base Case. It is possible that this scenario has net public costs relative to a baseline but that there are net public benefits from a smaller amount of additional housing in Strategic Centres (chart 3.1). If the scenario captures too large a change, then this would not be discovered.

This is not only a theoretical proposition. Large changes from a Base Case that captures what the market is expected to deliver under current policy settings are more likely to lead to net public costs. This is because such a scenario might push against where the market is directing resources, potentially implying large private net costs of development.

3.1 Evaluation of alternative scenarios



Source: The CIE.

Bundling of changes in scenarios

A scenario is expected to capture simultaneous changes to housing types, housing distributions and employment distribution. It may provide more practical guidance for planning policies and implementation practices to separately consider key features of the scenarios one-by-one, as well as considering scenarios as a whole. For example:

- For a given dwelling and population distribution across centre types and a given employment focus, are there net benefits from focusing growth towards centres or dispersed outside of centres?
- For a given share of housing being located near centres and a given employment focus, is it better to locate housing in one set of LGAs or another?
- For a given share of housing being located near centres and across LGAs, is it better to focus employment on Western Sydney or the inner and middle suburbs and the CBD?

The main area where bundling might be particularly problematic is bundling of dwelling and employment changes in assessing transport impacts. We model both the base case employment level with the scenario dwelling change, as well as a change in both employment and dwellings according to the scenario.

Sydney Metropolitan Plan Centres Hierarchy

Definition of the different development paths for Sydney is structured around the distribution of growth across Sydney's Strategic Centres, Local Centres and outside of centres, using the centres hierarchy set out in the Metropolitan Plan for Sydney 2036 (reproduced in table 3.2 below).

The Metropolitan Plan for Sydney 2036 outlines the centre hierarchy for the city. The key elements of the centres approach continue to be:[17]

- concentrating activity in accessible centres
- managing out–of–centre development to maximise the economic and social advantages of clustered activity
- making provision for the growth and urban renewal of existing centres
- planning for new centres to emerge in appropriate locations
- focusing State interest and involvement in the success of Global Sydney, the Regional Cities, Major and Specialised Centres
- influencing the distribution and scale of land uses to improve transport choice and boost active transport and public transport use
- locating 80 per cent of new housing within walking catchments of centres
- providing a diversity of settings for a wider range and density of housing, and
- concentrating commercial activity and job destinations in centres to achieve agglomeration, productivity benefits and improve workforce access

3.2 Centre types

Type	Location
Global City — main focus for national and international business, professional services, specialised shops and tourism. It is also a recreation and entertainment destination for the Sydney region with national significance	Sydney, North Sydney
Regional city — Provide for more lifestyle and work opportunities close to the growing parts of Sydney	Parramatta, Liverpool, Penrith
Specialised Centre — Places such as hospitals and business centres that perform vital economic and employment roles across Sydney	Norwest, Macquarie Park, St Leonards, Randwick Education and Health, Port Botany, Sydney Airport, Rhodes, Sydney Olympic Park, Bankstown Airport – Milperra, Westmead, Potential Specialised Centre, Penrith Education and Health, French's Forest
Major centres — major shopping and business centre for the district, usually with council offices, taller office and residential buildings, a larger shopping mall and central community facilities	Blacktown, Castle Hill, Hornsby, Brookvale – Dee Why, Chatswood, Bondi Junction, Kogarah, Hurstville, Burwood, Bankstown Campbelltown - Macarthur Planned Major Centres — Rouse Hill, Green Square, Leppington Potential Major Centres — Mt Druitt, Fairfield, Prairiewood

Source: Sydney Metropolitan Strategy 2036.

17 Metropolitan Plan for Sydney 2036

Factors influencing the distribution of dwelling and employment growth between these centres and areas outside of centres across the scenarios include:

- pro-rated application of forecasted dwelling and employment growth provided by BTS (incorporating the Metropolitan Development Program forecasts);
- subregional housing targets set out in the Metropolitan Plan for Sydney 2036 (Table D1);
- subregional employment targets set out in the Metropolitan Plan for Sydney 2036 (Table E1); and
- Strategic Centre employment targets set out in the Metropolitan Plan for Sydney 2036 (Table E2).

The dwelling and employment targets in the Metropolitan Plan for Sydney 2036 were calculated after considering household and dwelling projections, jobs, demographic and economic trends, land capacity, infrastructure and feasibility.

All the scenarios focus on various patterns of dwelling and employment growth within metropolitan Sydney's existing urban area. Growth in Greenfield areas has been derived from Bureau of Transport Statistics (BTS) forecasts (consistent with the Base Case scenario) and held constant for all scenarios.

The outputs from the scenarios include data relating to dwelling form, dwelling distribution, employment distribution and population distribution. In order to manipulate the distribution of dwellings across the city while keeping dwelling numbers and population growth constant, it has been necessarily to adopt an average occupancy for the city, at 2.3 people per dwelling. Appendix C includes a short technical paper on the issue of occupancy rates, how they vary across Sydney and the relative impact of this variation on population growth under different dwelling distribution patterns.

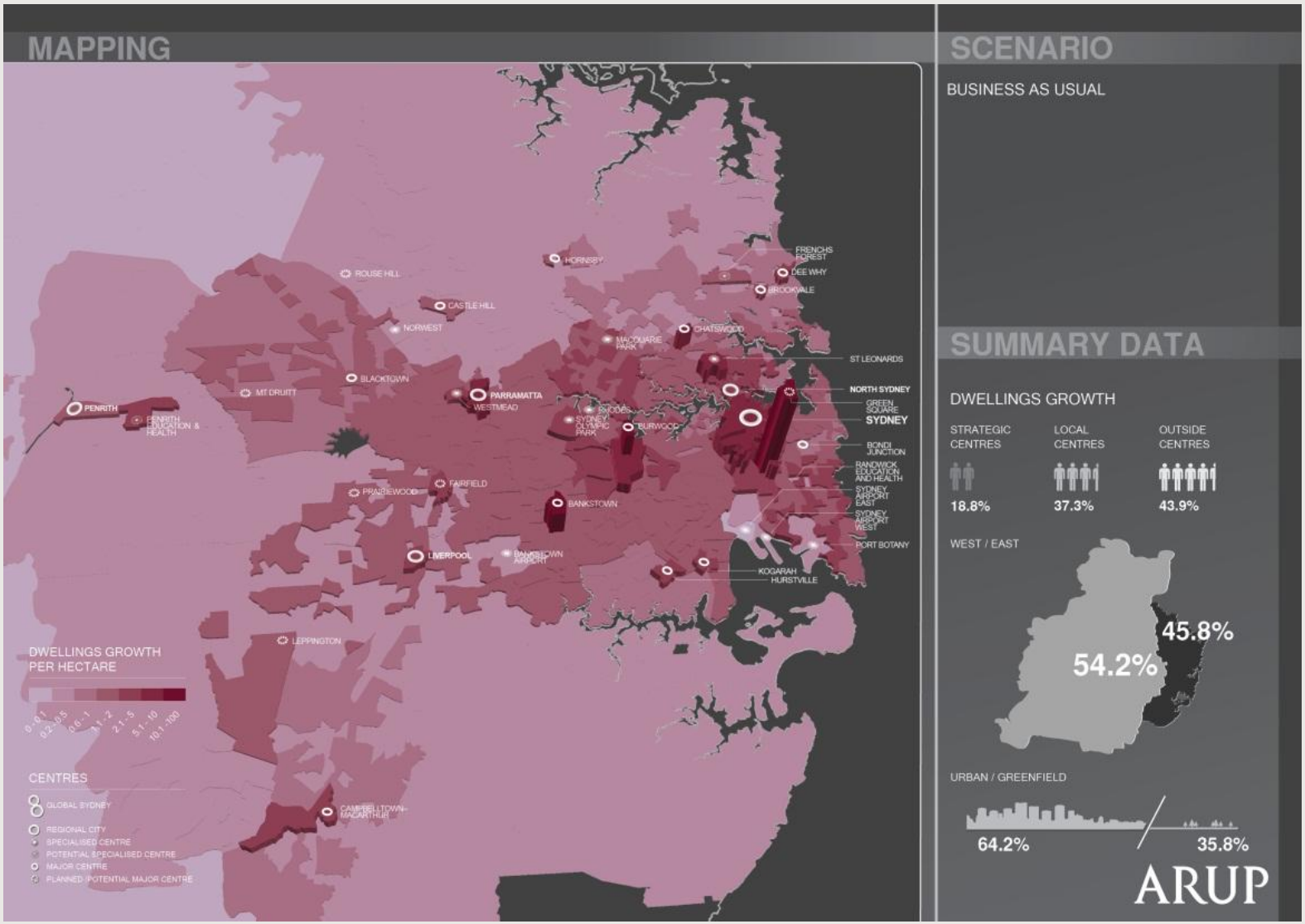
Detailed descriptions of the methodologies for formulating the individual scenarios are described under the individual scenario headings below. Detailed descriptions of the scenarios are also provided in Appendix D.

The base case

The Base Case scenario assumes the extension of existing trends for dwelling and employment and has been derived from Bureau of Transport Statistics (BTS) forecasts. Figures 2 and 3 present a concise summary of the Base Case scenario, reflecting the distribution of homes and jobs growth respectively across Sydney from 2006 to 2031 under this scenario.

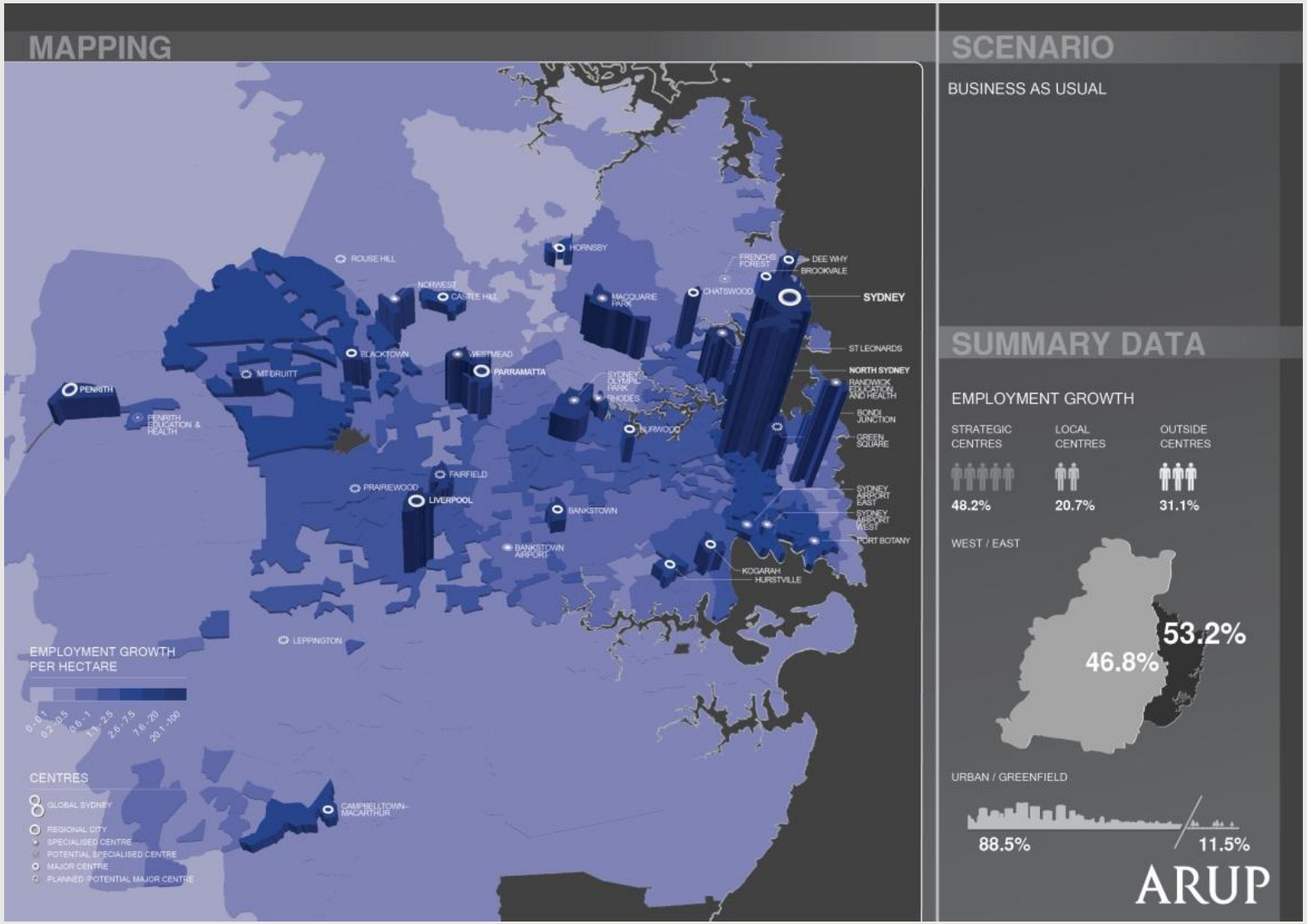
While the Base Case implies a continuation of historical trends, it reflects less focus on employment growth in the CBD, in recognition of the capacity constraints which exist.

3.3 Dwelling growth 2016 to 2031 baseline



Data source: ARUP based on Bureau of Transport Statistics projections..

3.4 Employment growth 2016 to 2031 baseline



Data source: ARUP based on Bureau of Transport Statistics projections.

Alternative scenarios for Sydney's growth

Scenario Development

Four alternative scenarios for Sydney's growth have been developed for this study. The scenarios are based on the distribution of dwelling and employment growth across the Sydney Metropolitan Area. They refer to the centres hierarchy contained within the Metropolitan Plan for Sydney 2036 described above and the distribution of growth between western Sydney (consisting of West Central, North West and South West planning subregions) and eastern Sydney (consisting of Sydney City, East, Inner West, Inner North, North East, North and South planning subregions).

Across all the scenarios, dwellings and jobs growth within Greenfield areas have been held constant, consistent with the Base Case, to enable the study to focus on the relative merits of different patterns of urban infill development within the existing urban area.

The following assumptions have been made in developing scenario:

- centres hierarchy based on Metropolitan Plan for Sydney 2036;
- Sydney (OPD) Population in 2031 will be 5.2 million (including 43.3 per cent greenfield and 56.7 per cent urban infill);
- homes in Sydney in 2031 will be 2 million (including 35.8 per cent greenfield and 64.2 per cent urban infill);
- jobs in Sydney in 2031 will be 2.6 million (including 11.5 per cent greenfield and 88.5 per cent urban infill); and
- dwelling and employment growth between 2006 and 2016 will match the Base Case for all scenarios

The process by which employment and housing is allocated to the centres and outside of centres in each of the scenarios is based on pro-rata distributions of the employment and housing targets for the Strategic Centres and/or the planning subregional targets set out in the Metropolitan Plan for Sydney 2036 and/or pro-rata shares in the Base Case, as appropriate. The feasibility of these distributions being realised, for example taking into account current and future market provision of housing, is not tested.

Tables 3.5 and 3.6 summarise the parameters used to define the scenarios. The methodology for defining these distributions is described in more detail below, supported by graphical representations of each scenario showing both dwelling and employment growth from 2016 to 2031.

3.5 Summary of Scenarios population/dwellings compared to the Base Case

Area	Population/dwellings				
	Base Case	Balanced Centres	Strategic Centres	Infill Dispersed	Inner-Middle
Strategic Centre	18.8%	40.0%	80.0%	0.9%	24.5%
Local Centre	37.3%	40.0%	0.0%	19.1%	34.1%
Centres	56.1%	80.0%	80.0%	20.0%	58.6%
Outside Centres	43.9%	20.0%	20.0%	80.0%	41.4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**
East	45.8%	55.9%	61.9%	61.9%	70.4%
West	54.2%	44.1%	38.1%	38.1%	29.6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Shares are of non-Greenfield development.
Data source: ARUP

3.6 Summary of Scenarios employment compared to the Base Case

Area	Employment				
	Base Case	Balanced Centres	Strategic Centres	Infill Dispersed	Inner-Middle
Strategic Centre	48.2%	50.0%	75.0%	25.0%	53.1%
Local Centre	20.7%	50.0%	25.0%	4.0%	19.5%
Centres	68.9%	100.0%	100.0%	29.0%	72.6%
Outside Centres	31.1%	0.0%	0.0%	71.0%	27.4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**
East	53.2%	54.7%	58.5%	51.5%	70.0%
West	46.8%	45.3%	41.5%	48.5%	30.0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Shares are of non-Greenfield development.
Data source: ARUP

Balanced centres

Charts3.5 and 3.6 present a concise summary of the Balanced Centres scenario, reflecting the distribution of homes and jobs growth respectively across Sydney from 2006 to 2031 under this scenario. Key features of the Balanced Centres Focus pattern of growth are described in more detail below.

Balanced Centres Housing Form

Housing growth in centres under the Balanced Centres scenario includes a mix of housing forms. Global Sydney (including Sydney CBD and North Sydney) consists of all high density multi-unit housing. The Regional Cities and Major Centres consist of 50 per cent high density multi-unit housing and 50 per cent medium density. Housing growth in Local Centres is made up of 10 per cent high density multi-unit houses and 90 per cent medium density. Housing growth outside of centres is medium density.

Balanced Centres Housing Distribution

Housing distribution for the Balanced Centres scenario includes 80 per cent of all new housing in the catchment areas of all centre types and 20 per cent dispersed housing.

The Balanced Centres scenario evenly distributes its dwelling growth between Strategic Centres and Local Centres. Across the Strategic Centres, this growth reflects that major gateways (including Port Botany, Sydney Airport and Bankstown Airport-Milperra) are not expected to experience dwelling growth and the other Specialised Centres (including Frenchs Forest, Macquarie Park, St Leonards, Randwick Health and Education, Rhodes, Sydney Olympic Park, Westmead, Norwest and Penrith Education & Health) are likely to experience only half of the dwelling growth anticipated for the balance of the Strategic Centres.

Local Centres will receive 40 per cent of dwellings under the Balanced Centres scenario. This growth will be distributed evenly across all Local Centres.

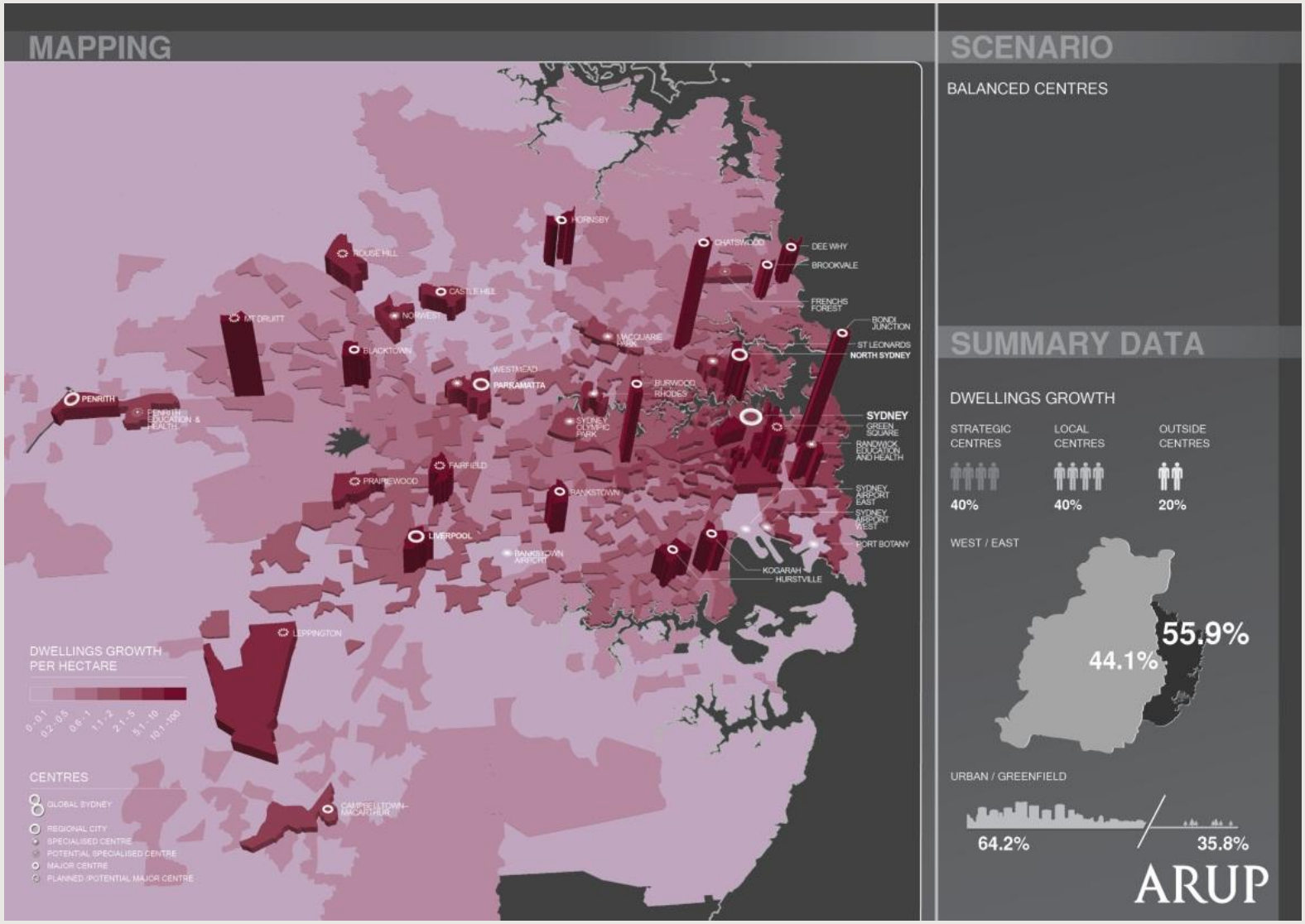
Outside of centres, pro-rata distribution of dwelling growth under the Balanced Centres scenario is based on the targets for subregional growth set out in the Metropolitan Plan for Sydney 2036 (minus centres based dwelling growth) shared evenly across each Local Government Area within each subregion.

Balanced Centres Employment Distribution

Employment distribution for the Balanced Centres Focus scenario is based on 50 per cent of growth in Strategic Centres and 50 per cent in Local Centres with no out of centre employment growth. A minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

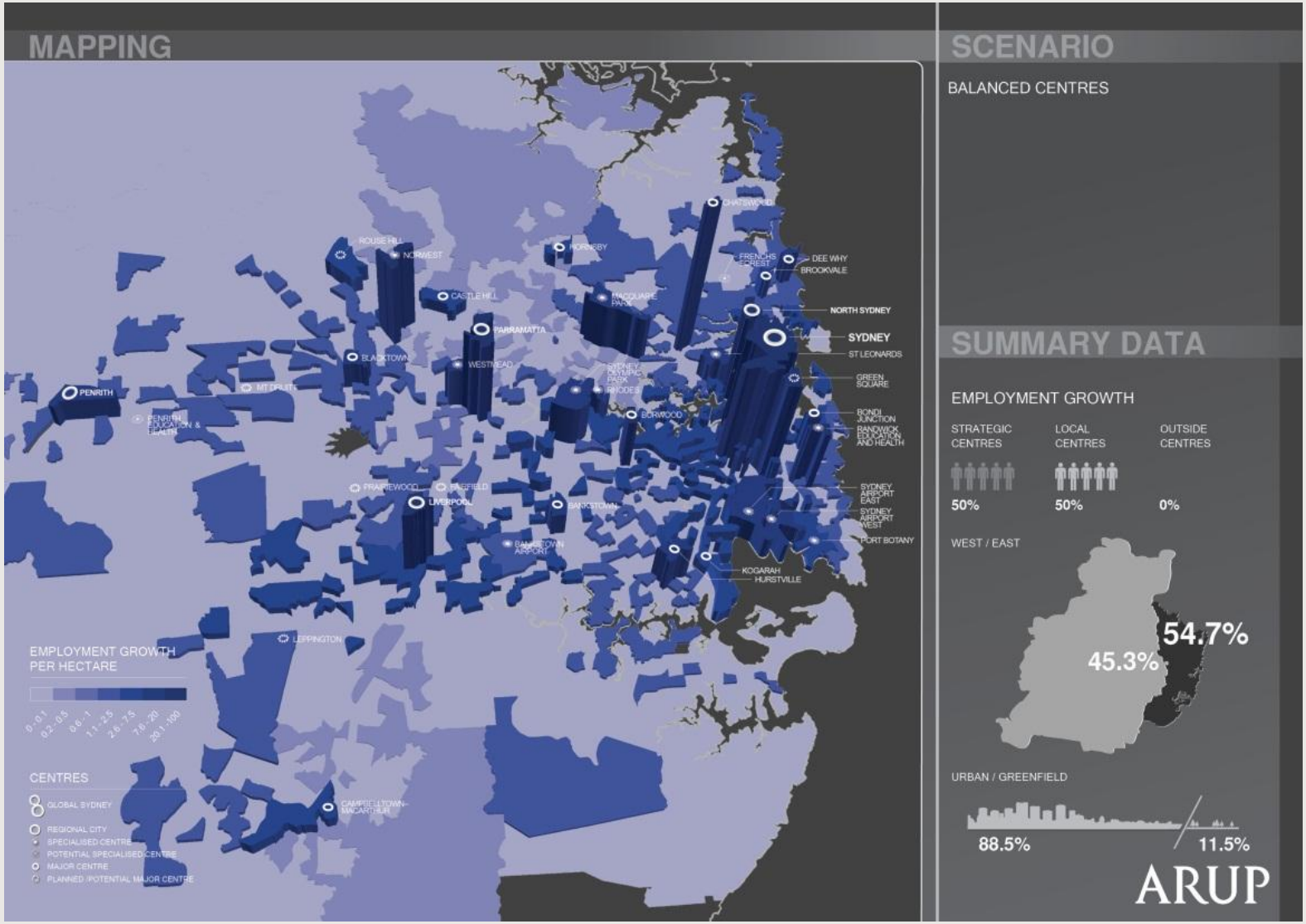
Across the Strategic Centres, pro-rata distribution of employment growth under the Balanced Centres scenario is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036. Employment growth is evenly distributed across the Local Centres under this scenario.

3.7 Dwelling growth 2016 to 2031 balanced centres



Data source: ARUP.

3.8 Employment growth 2016 to 2031 balanced centres



Data source: ARUP.

Strategic centres

Figures 28 and 29 present a concise summary of the Strategic Centres Focus scenario, reflecting the distribution of homes and jobs growth respectively across Sydney from 2006 to 2031 under this scenario.

Strategic Centres Focus Housing Form

Under the Strategic Centres Focus scenario all Strategic Centres housing growth will be high density multi-unit housing. Little housing growth will occur in Local Centres. Housing growth outside of centres will be medium density.

Strategic Centres Focus Housing Distribution

Like the Balanced Centres Focus scenario, housing distribution for the Strategic Centres Focus scenario contains 80 per cent of all new housing in the catchment areas of all centre types and 20 per cent dispersed housing. However, rather than even distribution of dwelling growth across centres of all types, the Strategic Centres Focus scenario focuses all centres dwelling growth within the 35 Strategic Centres with no dwelling growth within the Local Centres.

Under this scenario, pro-rata distribution of dwelling growth to the Strategic Centres and outside of centres is based on targets for subregional growth set out in the Metropolitan Plan for Sydney 2036. Of this pro-rata growth, 80 per cent of growth within each subregion is distributed evenly across the subregion's Strategic Centres, with the remaining 20% allocated to areas outside of centres and shared evenly across each Local Government Area within the subregion.

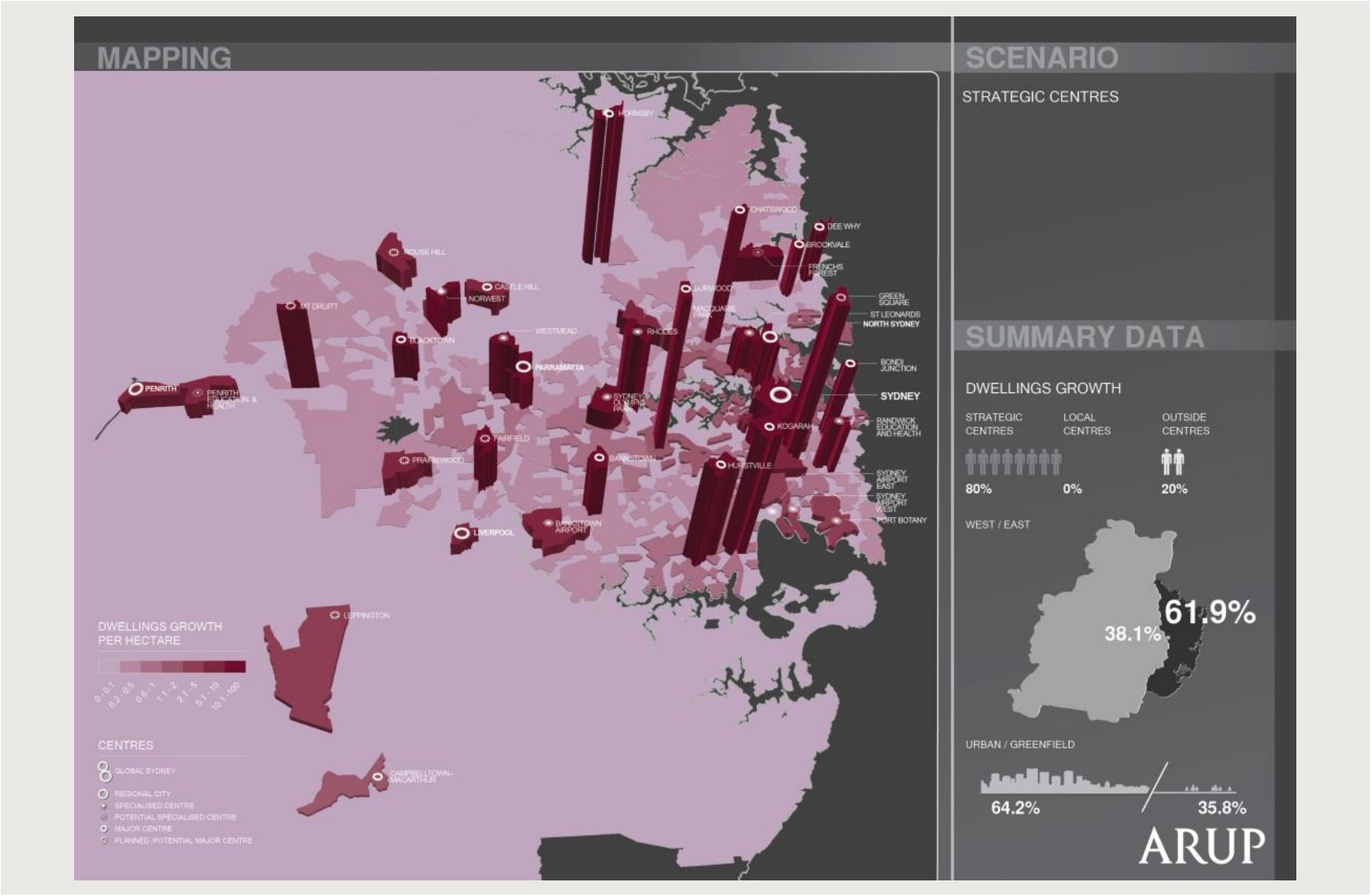
Strategic Centres Focus Employment Distribution

Employment distribution for the Strategic Centres Focus scenario is based on 75 per cent of growth in Strategic Centres and 25 per cent in Local Centres with no out of centre employment growth. Under this scenario, a minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

Across the Strategic Centres under this scenario, pro-rata distribution of employment growth is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036.

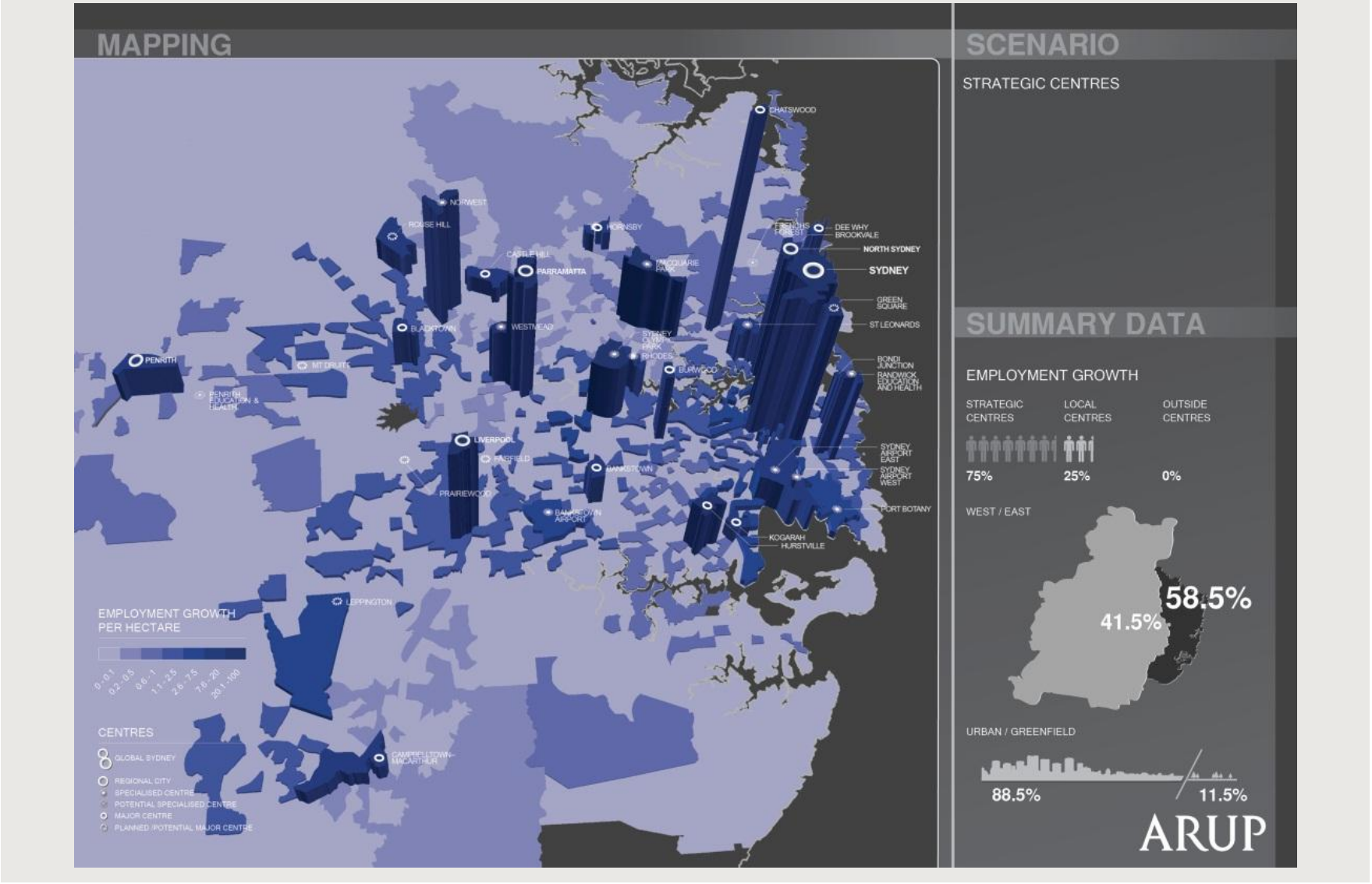
For the Local Centres under the Strategic Centres Focus scenario, pro-rata distribution of employment growth is based on the targets for subregional employment growth set out in the Metropolitan Plan for Sydney 2036, minus centres growth. Due to the high proportion of growth ascribed to Strategic Centres in this scenario, 9 per cent of the 2016 to 2031 growth contribution is redistributed to ensure all Local Government Areas reflect employment growth over this period. This redistributed portion is drawn from the South, Inner West, North and North East sub-regions and shifts to the Sydney City, East and Inner North sub-regions. Employment growth within each subregion is allocated evenly across the Local Centres.

3.9 Dwelling growth 2016 to 2031 strategic centres scenario



Data source: ARUP.

3.10 Employment growth 2016 to 2031 strategic centres scenario



Data source: ARUP.

Infill dispersed

Figures 38 and 39 present a concise summary of the Infill Dispersed scenario, reflecting the distribution of homes and jobs growth respectively across Sydney from 2006 to 2031 under this scenario.

Infill Dispersed Housing Form

Under the Infill Dispersed scenario, housing growth includes a mix of housing forms. Global Sydney (including Sydney CBD and North Sydney) consists of all high density multi-unit housing. The Regional Cities and Major Centres consist of 50 per cent high density multi-unit housing and 50 per cent medium density. Housing growth in Local Centres is made up of 10 per cent high density multi-unit houses and 90 per cent medium density. Housing growth outside of centres is medium density.

Infill Dispersed Housing Distribution

In contrast to the Balanced Centres Focus and Strategic Centres Focus scenarios, the Infill Dispersed Scenario contains 20 per cent of all new housing in the catchment areas of all centre types and 80 per cent dispersed housing.

Pro-rata distribution of dwelling growth under this scenario is based on targets for subregional growth set out in the Metropolitan Plan for Sydney 2036. Of this pro-rata growth, 20 per cent of growth within each subregion is distributed across the subregion's centres evenly, with 80 per cent allocated to areas outside of centres and shared evenly across each Local Government Area within the subregion.

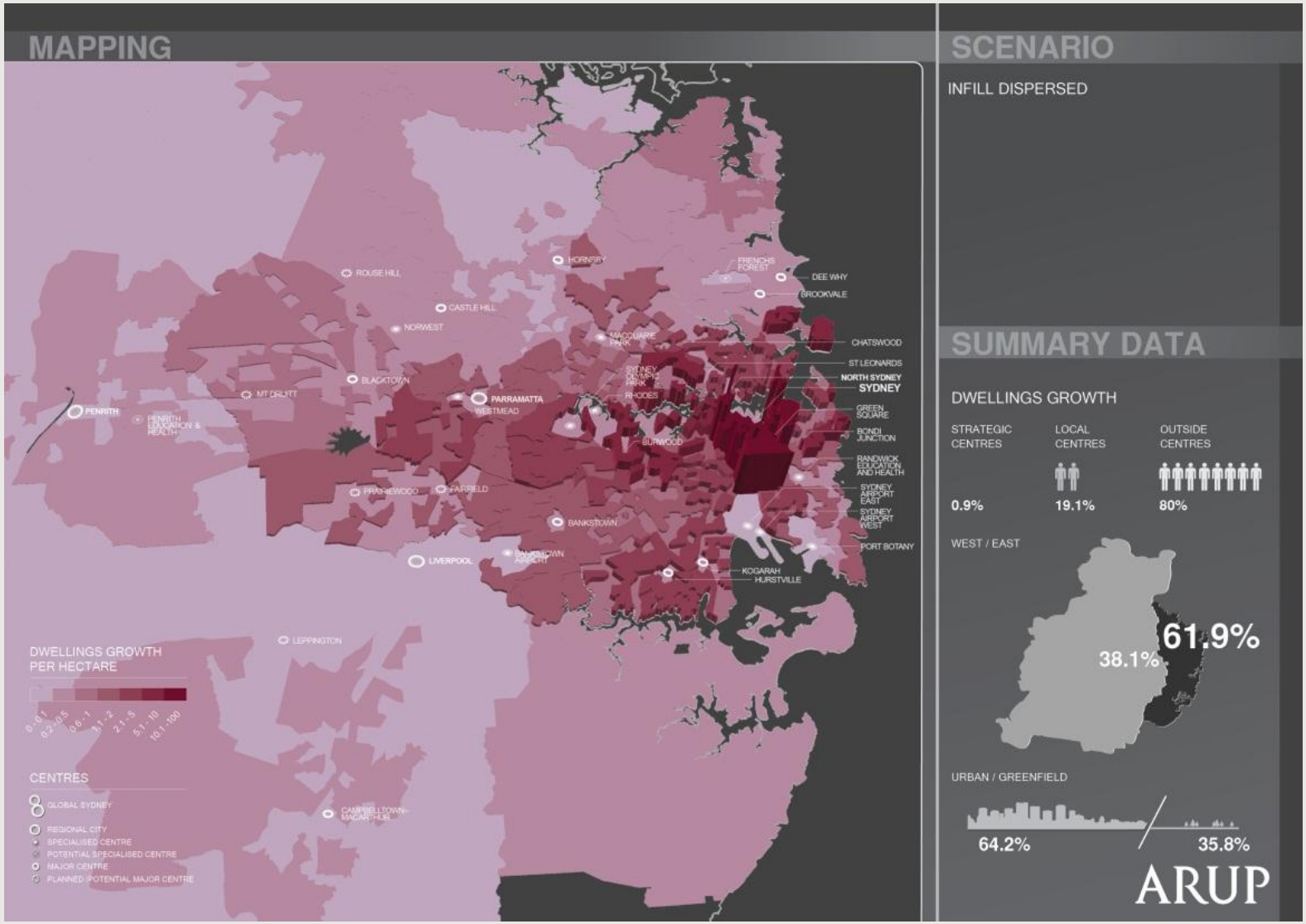
Infill Dispersed Employment Distribution

Employment distribution for the Infill Dispersed scenario is based on deflated employment growth in Strategic Centres with only 25 per cent of growth in Strategic Centres, 4 per cent in Local Centres and 71 per cent out of centres. Under this scenario, a minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

Across the Strategic Centres, pro-rata distribution of employment growth under the Infill Dispersed scenario is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036.

Across the Local Centres under this scenario, employment growth is based on 4 per cent allocated evenly across all Local Centres. Outside of centre growth under the Infill Dispersed scenario is equivalent to pro-rata subregional employment growth (minus growth in centres of all types for the subregion), shared evenly across each Local Government Area within the subregion.

3.11 Dwelling growth 2016 to 2013 infill dispersed scenario



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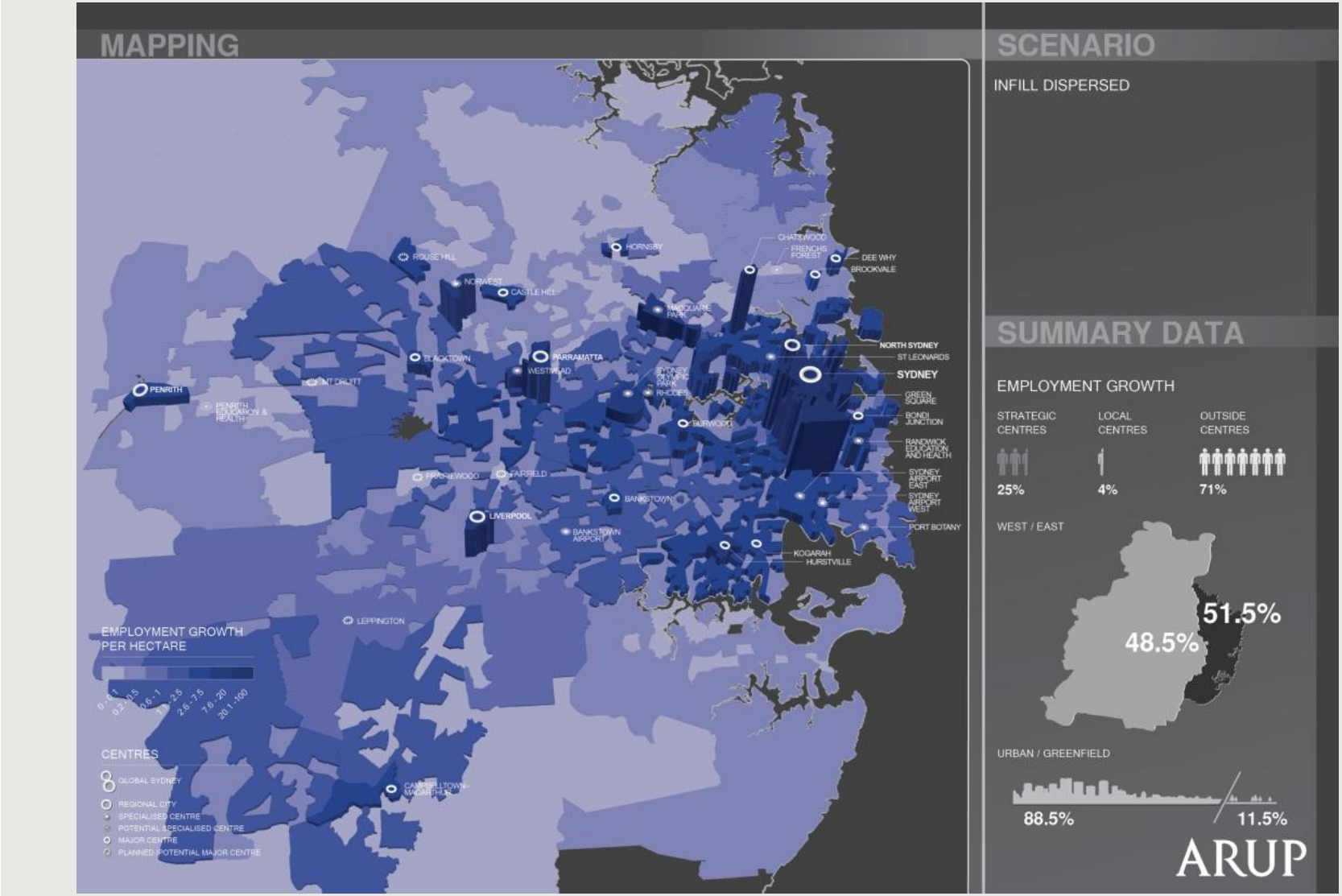
3.12 Employment growth 2016 to 2031 infill dispersed scenario



Data source: ARUP.

Inner middle

Charts 3.13 and 3.14 present a concise summary of the Inner Middle Concentration scenario, reflecting the distribution of homes and jobs growth respectively across Sydney from 2006 to 2031 under this scenario. Key features of the Inner Middle Concentration pattern of growth are described in more detail below.

Inner Middle Concentration Housing Form

Under the Inner Middle Concentration scenario, all new housing in centres will be high density multi-unit housing. Outside of centres new housing will be medium density.

Inner Middle Concentration Housing Distribution

Housing distribution for the Inner Middle Concentration scenario includes a higher proportion of new housing in Sydney's inner and middle subregions. The distribution of dwellings under this scenario is shaped by dwelling distribution during the earlier years of the Base Case scenario (that is for 2006 to 2011) with a factor applied to all subregions and centre types to realise a distribution of 70 per cent dwelling growth in eastern Sydney and 30 per cent in western Sydney.

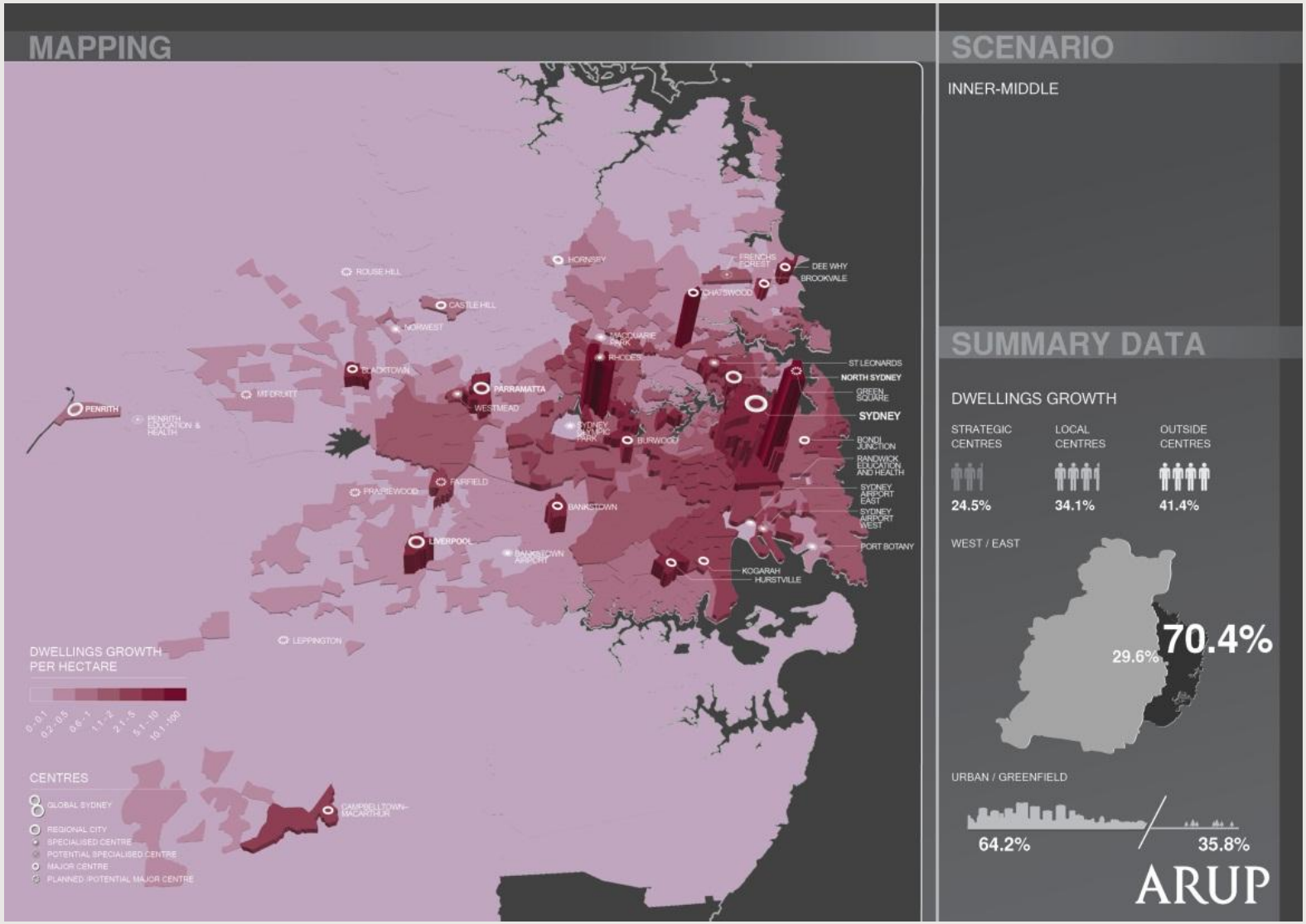
Under the Inner Middle Concentration scenario, approximately 24.5 per cent of dwelling growth will occur in Strategic Centres, 34.1 per cent will occur in Local Centres and 41.4 per cent will occur outside of centres.

Inner Middle Concentration Employment Distribution

Employment distribution for the Inner and Middle Concentration scenario also contains a higher proportion of new employment in the inner and middle subregions. This distribution is based on pro-rated application of the earlier years of the Base Case scenario (that is 2006 to 2011) with a factor applied to all subregions and centres types to realise a distribution of 70 per cent employment growth in eastern Sydney and 30 per cent in western Sydney.

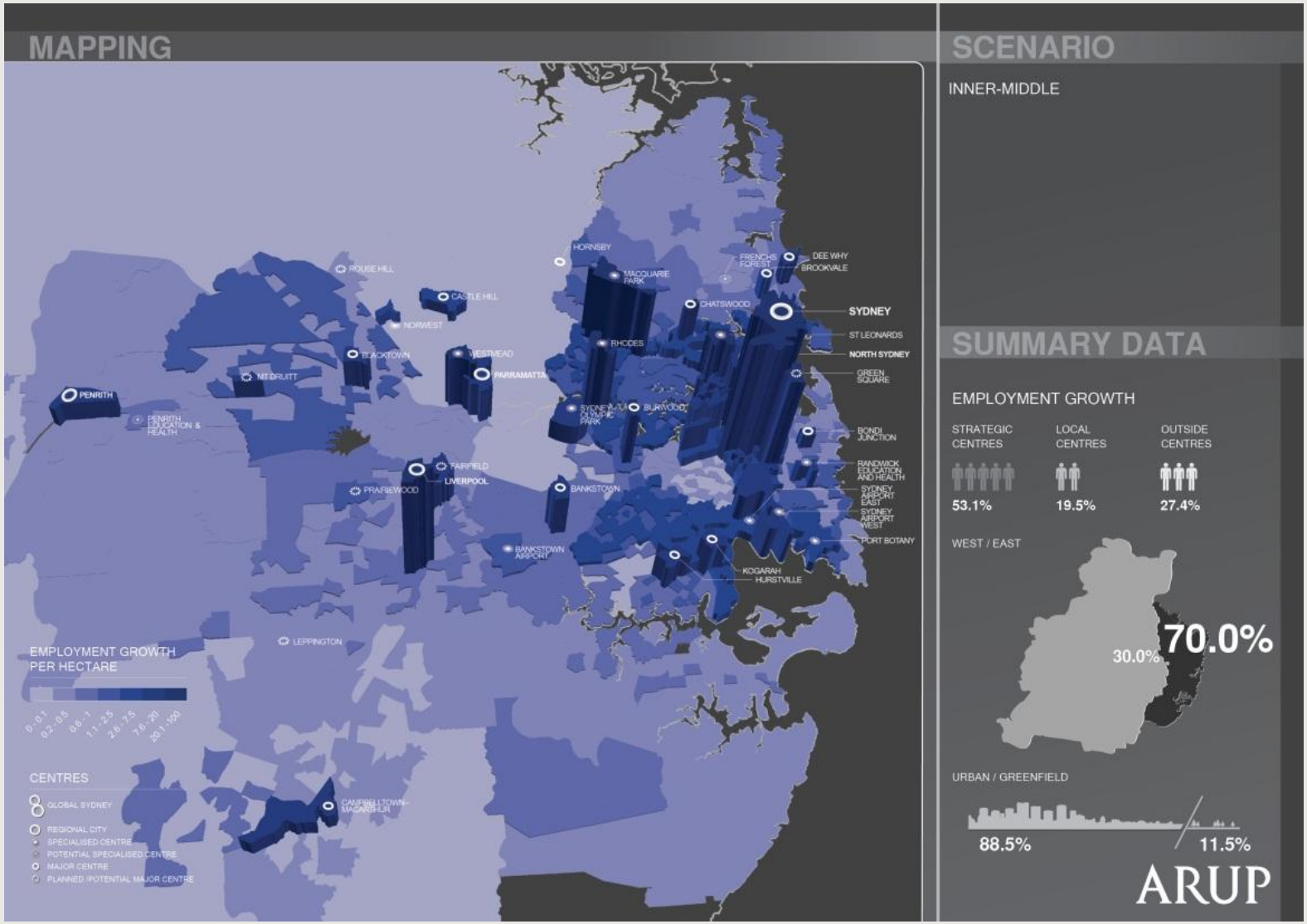
Approximately 53.1 per cent of employment growth under the Inner Middle Concentration scenario will be generated in Strategic Centres, with 19.5 per cent in Local Centres and 27.4 per cent in areas outside of centres.

3.13 Dwelling growth 2016 to 2031 inner middle scenario



Data source: ARUP.

3.14 Employment growth 2016 to 2031 inner middle scenario



Data source: ARUP.

4 Methodology for estimating costs and benefits

This chapter sets out the methodology for the assessment of benefits and costs from alternative growth paths.

Cost-benefit analysis

Cost-benefit analysis allows the systematic comparison of different types and different time profiles of costs and benefits. It:

- places costs and benefits on a common (normally monetary) basis so that they can be compared on an apples-for-apples basis; and
- compares different time profiles of costs and benefits by using assumptions about the value of costs and benefits in future years, through a discount rate, and through projecting costs and benefits forward for a period of normally 30-50 years.

It is a powerful tool for ensuring that the full benefits and costs of alternative options can be considered together.

Cost-benefit analysis of alternative growth scenarios

The assessment of costs and benefits of alternative growth scenarios can be divided into two parts.

- Benefits and costs for private businesses and households engaging in a decision to develop a particular area of land or purchase a piece of developed land.
- Benefits and costs external to those engaged in the decision.

The first type of benefit reflects a private value of developing a particular piece of land. We call this the 'value of land use change'. It reflects the difference between the value a household places on a developed dwelling less the costs of developing the dwelling. This value can be large because of premiums built up from planning restrictions such as zoning or other development controls.

The second type of benefit/cost captures a vast array of what are largely costs, known as third-party costs or external costs. These include costs associated with infrastructure to support a new development (physical infrastructure, health and education infrastructure and transport infrastructure), changes in amenity (particularly transport amenity) and environmental and social implications. External benefits may also arise from productivity or positive amenity spillovers related to new development.

Measuring costs and benefits

In measuring costs and benefits from alternative scenarios for Sydney's growth key issues are the types of costs and benefits included, the spatial scale at which costs and benefits are driven and the assumptions made about future service standards.

Types of costs and benefits included and excluded

The set of costs and benefits included in this study are shown in table 4.1.

For cost benefit analysis, the focus is on the difference between costs and benefits of a scenario and that for the baseline. Areas that are excluded reflect that information is not available and that these costs or benefits are expected to be similar across scenarios.

4.1 Benefits and cost included and excluded

Included	Excluded
Value of land use change	Operating costs associated with government services, except for transport
Transport costs	Fire services, ambulance
Physical infrastructure costs, such as electricity water and wastewater	
Social infrastructure costs, such as health and education	
Local council costs, related to local transport and open space	
Social impacts	
Environmental impacts	
Productivity spillovers	

Source: The CIE.

The methodology used for each type of cost and benefit is set out in the relevant chapter.

Note that some studies have included a different range of costs and benefits, such as energy costs or fuel costs.[18] These are private costs that are wrapped up in the value of land use change. Unless all private costs and benefits can be specified individually, measuring particular private cost and benefit is likely to lead to biased benefit-cost analysis. For instance, it would be inappropriate to consider fuel costs or energy costs without also considering land costs. In general it is not possible to specify and measure each individual private cost and benefit item as these often reflect the preferences and circumstances of individual households and businesses.

Spatial scale of costs and benefits

Development could happen in a myriad of ways across Sydney. There may be costs or benefits from redesigning the development of a particular site, such as changing the way

[18] Trubka, Newman and Bilsborough 2008, *Assessing the costs of alternative development paths in Australian Cities,* Curtin University Sustainability Institute, for Parsons Brinkerhoff.

it interfaces with the street, or changing the parking requirements. Issues on this small scale cannot be addressed in a benefit-cost analysis across the whole of Sydney. At this scale, benefits and costs depend on how each development is done.

Across Sydney, benefit-cost analysis can assist through providing strategic guidance on how benefits and costs vary at a higher level. For example, whether particular patterns impose smaller or greater infrastructure costs, or whether particular development patterns would have different implications for transport congestion. The relevant area to drive these types of costs and benefits will differ. For instance, local transport congestion will depend on the amount of development in a suburb, while congestion on arterials will depend on the development along the catchment corridor. For hospitals, which service large populations covering several local government areas, infrastructure spending will be impacted if the number of people in the hospital catchment changes. For electricity networks, a substation is a critical part of network costs and typically serves a suburb.

Because costs are driven at different levels there is a need to undertake modelling at different spatial scales. The smallest scale that we use is a travel zone. There are 2142 travel zones in the Sydney region covered by this cost-benefit analysis, in 41 local government areas. The median travel zone contained 719 dwellings in 2011.

It is not necessary to model all costs at a travel zone area. For instance, an electricity substation services multiple travel zones and hence the relevant measure of demand on each substation is the sum of demand from these travel zones. Where costs or benefits are determined by a larger area we have aggregated travel zones accordingly.

The scales used in this cost-benefit analysis are set out in table 4.2.

4.2 Spatial scale for modelling

Category	Spatial scale
Value of land use change	Travel zone
Transport	Travel zone
Electricity costs	Local government area
Education	Local government area for high schools and each school for primary schools
Water and wastewater costs	Local government area
Local council costs	Local government area
Environmental impacts	Travel zone and local government area
Social impacts	Travel zone and local government area
Productivity spillovers	Local government area
Health infrastructure	Sub-region
Value of land use change	Travel zone

Data Source: The CIE

Service standards

Many of the costs incurred in new development are government costs related to providing services for new development. For example, the costs of upgrading parks to

cope with higher density. In undertaking cost-benefit analysis a presumed level of service standards is required for these government services. If service standards are presumed to fall with new development, then the social costs of reduced service standards needs to be estimated. If service standards are presumed to remain the same, then the financial cost of ensuring this is input into the benefit cost analysis. The costs of maintaining service standards should not be double counted with a decline in service standards.

Our approach is to assume that service standards are maintained at current levels. We then estimate the cost needed to ensure that this is the case. The exception to this approach is transport. For transport, we first measure the costs if service standards were allowed to fall and then consider separately the ability of spending to ameliorate a reduction in service standards. We do this because of the complexities of maintaining constant travel times across all parts of Sydney, as discussed in greater detail in chapter 6.

There is no attempt to measure costs that arise because of time lags between the provision of services and the demand for services. These could be high if there are failures in strategic planning through demand projections.

Standard parameters

Benefit cost analysis requires a set of assumptions about the link between benefits incurred in different years, the dollar value reported and the period over which benefits and costs are measured. For this analysis, key assumptions are as follows.

- A discount rate of 7 per cent (real) per year is used to discount future benefits to today. The results are tested with a discount rate of 4 per cent and a discount rate of 10 per cent.
- All costs are converted to 2012 dollars.
- Costs and benefits are measured for housing and employment changes that occur from 2016 to 2031. We expect that dwelling outcomes will be the same across all scenarios up until 2016. Benefits and costs are typically measured as capitalised values, which means that they reflect future expected costs and benefits over the life of the dwellings.

PART B

Assessment of costs and benefits

5 Value of land use change

A major factor in the design of a city is the value that residents and potential residents place on different types of housing and different locations within a city. A good development path will ensure that housing is developed of a type and in locations that have the highest value.

Assessing the additional value that can be created by developing Sydney in different ways is difficult. The activity happening in the market offers one perspective. This currently suggests that demand is high for medium and higher density housing, relative to the amount of this housing in Sydney's housing stock. However, the activity in the market is influenced by many factors that mean that it may not reflect the best development of Sydney.

In this chapter we set out what is captured in measuring the value of developing Sydney in different ways and how this can best be measured. Technical Appendix A offers greater detail about the methodologies employed and the findings of the analysis.

Defining the value of land use change

The value of land use change captures the private benefits from redeveloping a particular parcel of land. In principle this measures the difference between the value placed on a new development (i.e. demand) less the opportunity costs of the resources used in making the development.

For example, suppose three existing houses whose market value was $500 000 each could be purchased, demolished and redeveloped into 10 apartments at a cost of $2 million. Then the opportunity cost of resources is $3.5 million. If the apartments could be sold for $400 000 each, giving total revenue of $4 million, then the value of land use change would be $0.5 million.

The value of land use change would, in a free market, be close to zero as developers took advantages of opportunities. The market for development is highly constrained and for this reason there are large and different values of location across Sydney.

Measuring the value of land use change

The value of land use change is very difficult to measure in a systematic way across Sydney. Alternative approaches are discussed in Appendix B. For this study, we use statistical analysis of the impact of zoning on land values as a proxy for the value of land use change. That is, how much does the zoning of a piece of land change its value given the other characteristics of the land, such as its access to transport and other services and local government area.

The future value of land use change could be different to that today, reflecting factors such as changes construction costs, changing amenities and transport availability. In many instances, these changes are separately assessed, such as for transport costs. Hence the measure of value of land use change is based on a value that maintains current standards of government services and other amenities.

The value of developing across Sydney

We measure the value of development in a number of ways.

- Measuring the value of rezoning from low density to either medium or high density. Medium density is classified as a lot occupied by 3 or more dwellings, all with access to the ground floor and that are not apartments. This definition essentially captures town house type development. High density is classified as apartments. Low density is other development, including semi-detached and detached housing.
- Measuring the value from rezoning of industrial areas to medium to high density.
- Measuring the value of smaller block sizes within low density development. While in many instances transition to smaller block sizes (such as subdivision) may be difficult, there will be many properties where this is feasible.

We find evidence of substantial value of land use change in all these categories. This likely reflects that land use restrictions (zoning) have not kept pace with changes in people's preferences and changes in the economic structure of Sydney. Each of these 3 types of value of land use change are discussed in turn.

The value of moving to medium/high density

There is evidence that the largest benefits from value of land use change from moving from low density to medium or high density in infill areas are likely to accrue from development of higher density housing in strategic centres (chart 5.1). For instance, we find that land value increases from rezoning of low density land to high density in strategic centres would increase land values by 25 per cent on average. In some instances the value of land use change would be much higher, as our estimates are averages. Examples of areas likely to benefit most from rezoning include places like Millers Point, where relatively low density housing occurs in immediate proximity to Sydney CBD[19].

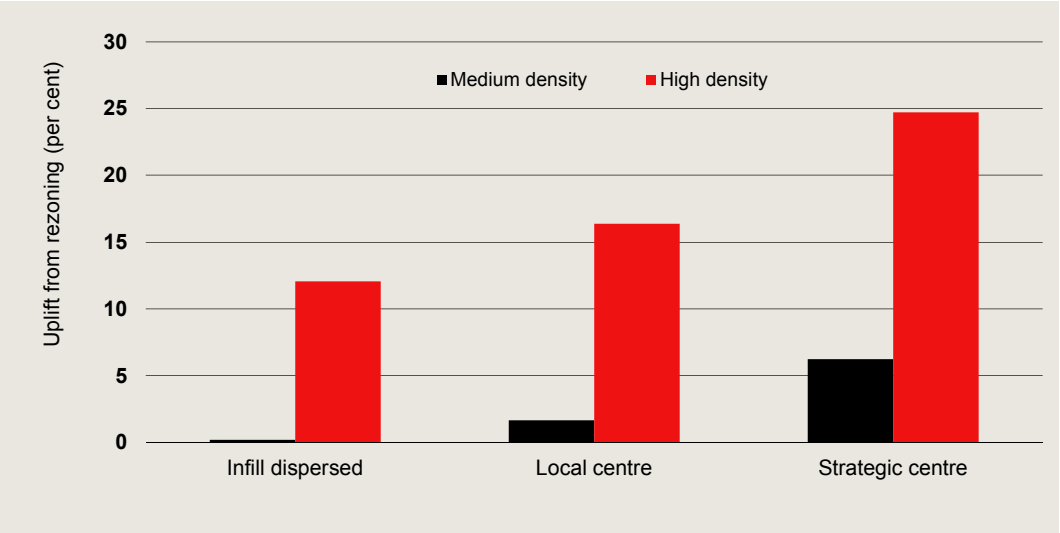
For areas classified as dispersed infill the value of land use change is estimated to be negligible for rezoning to medium density and around half of the value for strategic centres for rezoning to high density on average. Hence these areas are currently less attractive as places for movement from low to medium density.

The reasons why centres are more attractive for new development could be that people value the access to public transport provided by centres or the other services provided by

19 Millers point is subject to floor space ratio restrictions of 2:1, height restrictions of 9 metres and Heritage provisions. City of Sydney website, http://www.cityofsydney.nsw.gov.au/development/planningcontrolsconditions/planninginstruments.asp, accessed 11 July 2012.

centres, and that the planning system has not responded to this demand through changes in zoning.

5.1 Value of land use change across types of centres



Data source: The CIE.

Our estimates of the value of land use change from moving from low to medium/high density vary depending on the statistical model used. Results for additional models are shown in Appendix A.

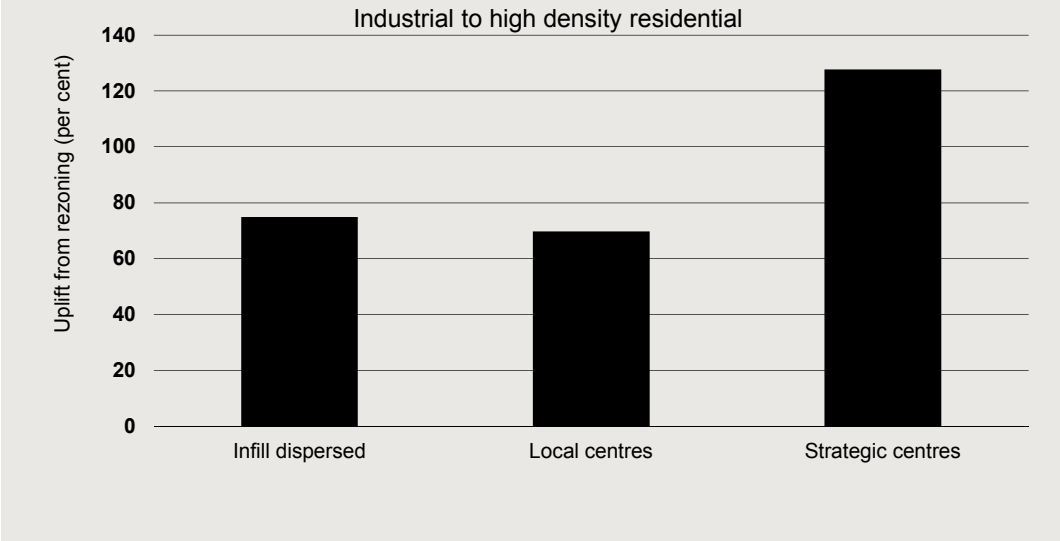
A variety of other specifications were also tested, including allowing for different impacts across local government areas or different impacts depending on distance from the CBD. The specification with zoning linked to the type of centre generated the most consistent results and best utilises the data given inconsistencies in council definitions.

The analysis conducted above cannot address the many additional development controls that exist around dwellings within a particular zoning type. For example, 'high rise' could constitute anything from a small apartment block to a 50 storey tower. The data on additional controls such as floor space ratios and building heights covers too few council areas to allow for full analysis of development scenarios across Sydney, although it may be useful for smaller areas of analysis.

The value of rezoning of industrial land

Another area where value of land use change is highest is the redevelopment of industrial areas into residential (and higher density) residential areas. Industrial land is priced well below similarly situated residential land (chart 5.2). This is reflected in the uptake of ex-industrial sites by developers, as discussed further below.

5.2 Value of redeveloping industrial areas



Data source: The CIE

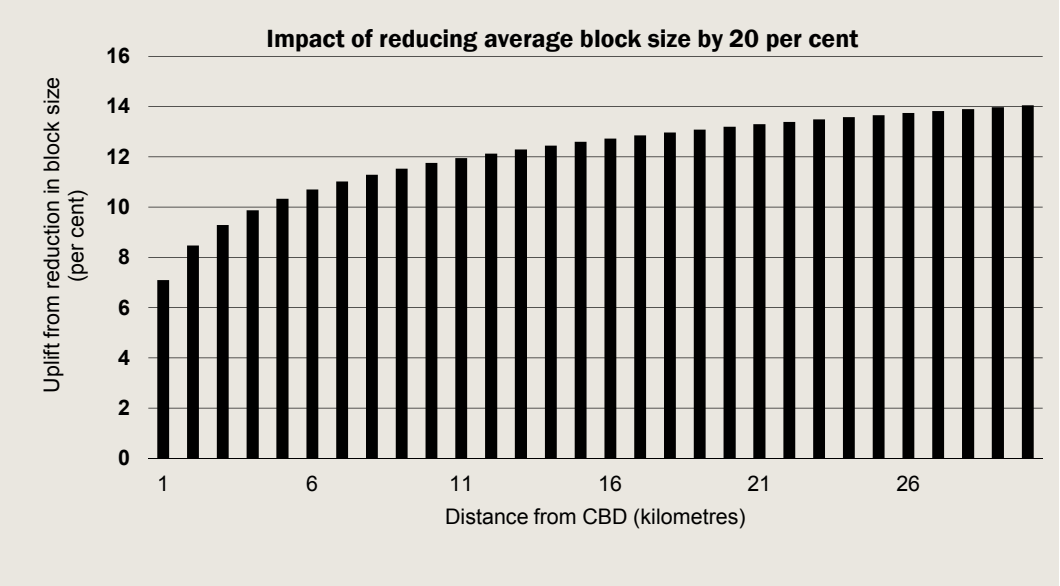
The value of smaller block sizes

Land value evidence suggests that block sizes for low density housing are currently above the level favoured by households in many areas. Within properties classified as low density, smaller block sizes are worth far more on a per square metre basis than larger blocks after controlling for other factors. This indicates a sharply diminishing return to land — once a household has sufficient land for their house the estimated value of additional land is low.

The increase in value obtained from reducing block size increases as we move further from the CBD (chart 5.3). This is likely because areas closer to the CBD already have relatively small block sizes. (For instance, a doubling of distance from the CBD is associated with a 25 per cent increase in block size.)

It is not always practical to be able to make smaller block sizes from existing blocks, depending on the location (and age) of the house, the ability to allow access to multiple smaller blocks and the topology of the block. However, where it is practical then allowing smaller block sizes to occur more readily may be an important mechanism to unlock value of land use change. (Note that where a dwelling is knocked down, it may be a higher value option to redevelop at higher density rather than splitting the block size.) This type of development is not explicitly considered in any scenario, but probably aligns best with dispersed infill.

5.3 Value of smaller block sizes



Data source: The CIE.

Has there been a change in preferences for density?

There may be a disconnect between the value obtained from the redevelopment of a dwelling and the impacts on neighbouring areas. In large part, these impacts are factored in by measuring the costs of ensuring service standards remain constant for key amenities. This would not capture any measure of dislike of density from for example an aesthetic point of view, such as density changing the character of the area.

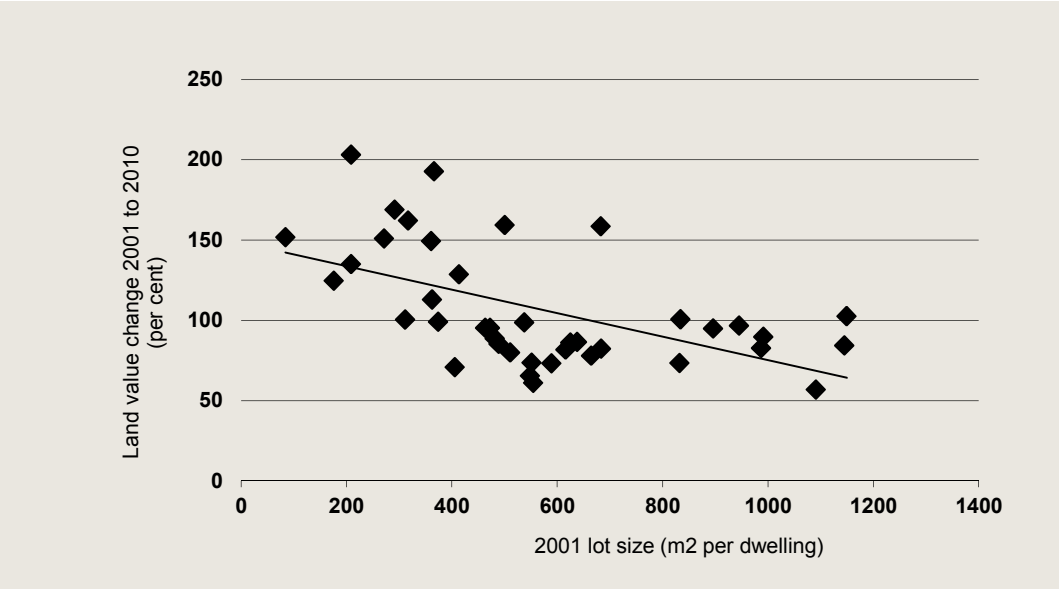
Using the land value database we can see a systematic pattern of greater increases in land values for those areas with smaller lots and higher density in 2001.[20] For instance, the land value for areas towards the lower end of the lot size spectrum increased on average by close to 150 per cent. For areas with larger lots and lower densities, the increase in land value over this period was on average closer to 60 per cent.

Potentially, this correlation might reflect changes in the value placed on living near the CBD, because of changes in congestion and/or the value of time, and the higher density living typically found closer to the CBD. However, after allowing for distance to the CBD, the impact of lot size remains the same. In fact, the original lot size for a local government area in 2001 was a better predictor of land value change from 2001 to 2011 than distance to the CBD, suggesting that there has been a shift towards valuing more dense locations more highly. This may be a one-off shift or part of a continuing trend.

20 Analysis has used both land area per capita and average lot size. We report average lot size results although findings are similar using land area per capital once outliers are excluded — land area per capita is problematic for some local government areas such as the Blue Mountains that cover vast land areas.

These changes suggest that living in a dense area has become more preferable than it was in 2001.[21]

5.4 Average lot size and land value change 2001 to 2011



Data source: CIE analysis based on Census 2001, 2006 and land and zoning database.

Alignment with market activity

Dwelling approvals have been evenly split between Eastern Sydney and Western Sydney over the past ten years. Within Eastern Sydney, around 20 per cent of dwelling approvals have occurred in Sydney local government area. In Western Sydney, part of the development has been infill and part Greenfield.

There is no information on how historical development has aligned with centres, within LGAs. However, the substantial amount of development around the Sydney City LGA suggests that centres have been an important part of development.

The high value from redeveloping previous industrial sites is also evident in market activity. Areas such as Green Square and Rhodes have achieved considerable development. Developers have also purchased sites previously used for other uses at places such as the former Summer Hill mill, Carlton United Brewers and Harold Park for residential or mixed use development. Barangaroo, an ex-industrial site, is being developed for commercial and residential use.

How large is the market for different types of housing?

The premium for rezoning represents the amount for a small amount of additional housing of a particular type. If there are large changes in development path then it is

21 We are investigating analysis considering the expected value of land in an area against actual value and whether this gap is systematically related to density. This analysis is not currently completed.

necessary to form some views on how much demand there is for different types of density and the available supply of areas for such development. It would be expected that:

- value of land use change would rise with population growth, if there were no changes in zoning, as demand would grow for additional housing;
- value of land use change will fall as more of the same type of development occurs and hence the supply of that type of development increases; and
- value of land use change will fall as areas that are more easily developable are used. This includes redevelopment of industrial sites, redevelopment of sites with older (depreciated) properties.[22]

To estimate the changes in the value of land use change, we make adjustments for the above factors, as discussed below.

The value of land use change and population growth

Housing demand would be expected to be broadly related to population growth. That is, in the absence of new development, real prices for housing would rise by something close to the rate of population growth. (In practice, price growth may be somewhat slower if people choose to locate outside of Sydney because of affordability.) There may also be differences between housing demand and population growth because of changes in demographics.

Because our scenarios allow for both new dwellings and population growth, these supply and demand impacts should, on average, balance out to mean that the value of land use change on average is similar across time.

The value of land use change and supply of dwellings

While we allow supply and demand factors to balance out on average above, if development is focused on a particular type of housing, then demand for this type of housing may be more quickly saturated. This reflects a declining demand curve. For instance, if all new development was high rise 1 bedroom apartments, then developers would be likely to quickly find that there was a limited market for these new dwellings.

One measure of the decline of the demand curve was recently estimated by the Grattan Institute, through a survey of a small number of Sydney and Melbourne residents as to their housing preferences. This choice survey allowed the calculation of changes in demand, as well as highlighting housing preferences. The estimation of choices for this survey included the region, the size of the dwelling (small, medium and large) and the type of the dwelling (detached, semi-detached, apartments up to 3-storeys and apartments 4 storeys and above).

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22 Where there is renovation of existing properties, partly reflecting the inability to change development type because of land use restrictions, then this may preclude redevelopment for many years. A developer has to pay for the land and the building, with the building having higher value post-renovation. In general it would be expected that a continued supply of sites with older buildings will come onto the market as buildings naturally age and hence a diminished supply of possible development opportunities is mainly relevant for industrial land..

The measure of the relationship between price and quantity is the elasticity of demand. This measures the percentage change in quantity of demand relative to the percentage change in price. If this is close to 0, then this indicates that the value attached to a type of housing declines relatively steeply with changes in supply. If this is further from 0, such as -1, then this indicates that there is additional demand for the type of housing stock at close to current prices.

For the Grattan Institute study, the overall elasticity of demand was -0.33, meaning that a 10 per cent increase in the price of a particular type of housing reduced demand by about 3.3 per cent. Alternatively, a 3.3 per cent increase in the stock of a particular type of housing would, in the absence of other changes, reduce the price (and hence value) of housing by 10 per cent.[23]

There were slightly different impacts across regions and types of housing. In particular, the study found:

- the value of additional smaller dwellings would decline less quickly than the value for medium to large dwellings for additional stock;
- the value of detached dwellings declined more quickly with a change in supply than for other types of dwellings; and
- the value of dwellings in fringe areas would decline less quickly than the value for other areas for additional stock.

However, these impacts would typically be relatively small (~0.02) compared to the base elasticity of -0.33.

We do not allow substitution across as broad a range as the Grattan Institute study, as their work considers substitution between housing size, housing type and location. For this reason we reduce the elasticity to -1 for our analysis. This has the effect of penalising scenarios that concentrate development in particular types or locations of housing. This is subtracted from the general value of land use change that this type of housing currently attracts.

The value of land use change and supply of sites

A continual supply of sites is generally available for redevelopment as buildings get older. However, for major redevelopment opportunities, site supply may be more lumpy and less certain. For instance, major site supply has occurred through changing industrial land into residential land, as industrial areas within the city have shrunk and industrial sites have moved to fringe areas or offshore.

There is a substantial supply of land zoned as industrial across Sydney. We estimate that if 5 per cent of this land was used for residential development then this would provide about 17 per cent of the new dwelling stock in our scenarios.

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23 This suggests that housing affordability concerns could be quickly alleviated by increasing the supply of housing.

The value of land use change from alternative scenarios

The analysis above suggests that there is substantial latent value in reducing the restrictions on development across Sydney. The highest value could be realised by:

- rezoning areas close to strategic centres as high density;
- allowing low density development to occur through smaller block sizes and particularly making it easier for small subdivisions likely undertaken by small building companies across Sydney; and
- allowing industrial areas to become residential, where these areas are poorly used as industrial land and land contamination issues are small.

None of the scenarios explicitly align with the second point — the value to be realised by many small dwelling additions on existing land through block division. However, this aligns most closely with an infill dispersed scenario.

The assumptions used to derive final numbers for the purposes of this benefit cost analysis areas follows.

- Five per cent of industrially zoned land in Sydney would be utilised for residential development. This equates to providing sufficient land for about 20 per cent of new development if used as medium/high density residential development.
- The premiums attached to rezoning are as set out in the analysis above.
- The average premium gained from development declines as more of a particular type of development occurs. We have used an elasticity of 1, implying if the dwelling stock increases by 10 per cent then average value of land use change decreases by 10 per cent. We have adopted a lower figure than the Grattan Institute because substitution occurs only between type of dwelling and location rather than type of dwelling, size of dwelling and location.
- Existing land stocks across centre types and zoning types are estimated based on metres squared from our land database. The number of dwellings for each centre is estimated through applying a land value of 150 m2 per dwelling for medium density and 100 m2 per dwelling for high density, to roughly calibrate with Census data.

Summary

The estimated value of land use change from each scenario is shown in table 5.5. The scenarios that perform best are those that spread development more evenly across Sydney and across development types, such as the baseline, balanced centres and inner-middle scenario. Scenarios that perform poorly are those that concentrate development in a particular area and with a particular type of dwelling. Key points are that:

- There is a large rezoning premium available from higher density development of strategic centres. Scenarios that allow some of this latent demand to eventuate have benefits. However, the strategic centres scenario is likely to provide more development in these areas than necessary to meet demand. For instance, strategic centres currently accommodate around 10 per cent of Sydney's dwellings, a substantial part of which is not high rise or medium density. The strategic centres scenario would provide much more high rise developments in these centres than is provided by the current dwelling stock.

- The infill dispersed scenario provides medium density housing in dispersed areas. The rezoning for this type of development is estimated to be relatively low. As discussed earlier, a strategy that appears to provide higher benefits would be to allow for smaller block sizes within a low density zoning. This may better align with a dispersed infill scenario.

5.5 Value of land use change

Item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Value of land use change relative to baseline	0.0	4.7	-537.7	-716.0	26.3

Data source: The CIE

6 Transport costs

Implications for transport is a major concern of residents of Sydney in response to new development and increased density. This chapter sets out the current outcomes of the Sydney transport network and the estimated cost changes as a result of alternative scenarios for infill development.

The analysis uses the Strategic Transport Model and Bureau of Transport Statistics analysis of changes in transport outcomes as a result of land use change.

Current outcomes of Sydney's transport system

The majority of trips in Sydney's transport system are undertaken by car. For example, Xu and Milthorpe (2010)[24] find that:

- car trips made up over 70 per cent of journeys to work in 2006. This share has been steadily increasing since the 1981, and the ratio of car passengers to car drivers has also fallen over this time indicating falling occupancy rates per car;
- public transport mode share has fallen from 25 per cent in 1981 to 22 per cent in 2006. This reflects that even though the number of public transport trips has increased, it has increased less quickly than other trips;
- public transport is the dominant mode for trips into Sydney CBD but has a much less important role elsewhere. Public transport made up 75 per cent of trips into Sydney CBD in 2006, 32 per cent of trips into other regional centres were by public transport. Only 10 per cent of trips to other areas were by public transport; and
- the majority of public transport trips are into the CBD, with this journey type making up 47 per cent of all public transport work trips. This is likely to reflect the concentration of public transport services into the CBD, rather than to other locations, as well as the much higher costs for driving into the CBD (such as parking).

Roads are congested at times across Sydney and are more congested during morning and afternoons on weekdays. The number of trips has increased faster on weekends than on weekdays[25], leading to greater congestion on weekends. The AustRoads performance indicators suggest that average speeds on major roads in NSW urban areas, of which most are in NSW, have not changed much since 1999 (chart 6.1). Roads and Traffic Authority data (now Roads and Maritime Services) indicates a similar finding in Sydney

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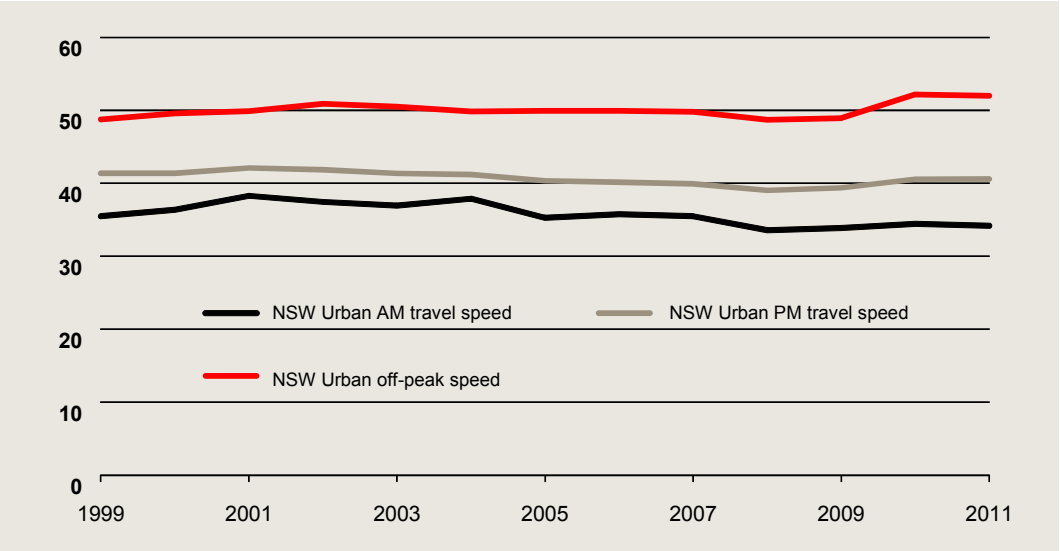
24 Xu, B. and F. Milthorpe 2010, "Analysis of Journey To Work Travel Patterns in Sydney", Australasian Transport Research Forum 2010 Proceedings.

25 The number of weekend trips has increased more than twice as fast as the number of weekday trips between 2001/02 and 2010/11. The number of weekday trips has increased by 7.4 per cent over this period, compared to 16.9 per cent for weekend trips. NSW Bureau of Transport Statistics, *2010/11 Household Travel Survey Summary Data*, 2010/11.

and across Sydney's major roads.[26] These may not be representative of the road system as a whole as performance indicators are focused on major routes that have had substantial investment.

6.1 Road speeds for NSW urban areas



Data source: AustRoads Performance Indicators.

Sydney's rail system is heavily used during peak periods and for accessing the CBD. Measures of load (number of passengers as a share of the number of seats) indicate loads are typically over 100 per cent and often far higher (table 6.2). There may be some capacity to run more trains down existing train lines, although constraints in the CBD rail system mean that this is limited, in the absence of additional infrastructure investment.

6.2 CityRail capacity and utilisation (morning peak into CBD)

Line	Measured at	Passengers No.	Average load Per cent	Maximum load Per cent
Illawarra	Sydenham(2)	16 970	130	160
Airport & East Hills	Green Square/ Redfern	13 075	120	150
Bankstown	Erskineville/ Campsie	8 050	150	180
North Shore(3)	St Leonards	16 780	110	150
Eastern Suburbs	Kings Cross	9 120	70	120
Northern	Redfern	5 365	150	160
Western	Redfern	18 465	130	170
South	Redfern	9 235	110	150
Inner West	Macdonaldtown	4 185	120	150
Newcastle & Central Coast	Strathfield	3 880	110	130
Blue Mountains	Parramatta	3 120	90	100
South Coast	Hurstville	2 550	100	130
Total(4)		**110 795**	**123**	**180**

Data Source: CityRail website, accessed 18 July 2012, http://www.cityrail.info/about/our_performance/service_capacity.jsp.

26 Roads and Traffic Authority 2011, *Annual speed and traffic volume data in Sydney*, http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/annual_speed_and_traffic_volume_data_2009-2010.pdf.

Figures on bus crowding (people versus capacity) are not systematically collected. Buses are likely to be crowded during peaks but otherwise have relatively low utilisation. Buses have substantial capacity to respond to additional demand given the relative ease with which additional buses can be brought into service. In some areas, such as buses coming across the Sydney Harbour Bridge there is also congestion of buses on the road network.

Average commute distances and times

The median trip length for journey to work trips in Sydney was 10.8 kilometres in 2006 and has generally been on a rising trend.[27]

For this analysis the year in which scenarios depart from each other is 2016. Using 2016 model predictions from the Bureau of Transport Statistics Strategic Transport Model (STM) we have calculated, for the AM peak, average trip times to and from different types of origins and destinations and for different modes, as well as mode shares.[28] Times include in-vehicle time, waiting time and access and egress times. The transport patterns across these different journey types are relatively similar in most respects. The major differences are that:

- journeys from strategic centres are slightly shorter than other journeys. Interestingly, journeys from strategic centres have a similar public transport share as journeys from elsewhere. Journeys from the East of Sydney are also slightly shorter than journeys from the West; and
- journeys to strategic centres by car are longer than for other types of destinations. The rail share is much higher for journeys to strategic centres reflecting the previously noted public transport dominance of the CBD.

6.3 Average trip times 2016

Item	Average from each type of origin				
	Local centres	Strategic centres	Infill	East	West
Car time (minutes)	22.3	18.7	22.9	21.5	23.0
Bus time (minutes)	77.0	61.5	79.9	71.2	83.5
Rail time (minutes)	110.2	88.8	111.6	93.8	124.6
Car share (per cent)	84.7	86.0	84.7	84.6	85.1
Bus share (per cent)	7.3	6.5	7.1	7.4	7.0
Rail share (per cent)	8.0	7.5	8.2	8.0	7.9
Item	**Average to each type of destination**				
	Local centres	Strategic centres	Infill	East	West
Car time (minutes)	19.9	28.5	21.8	24.0	19.9

27 Xu, B. and F. Milthorpe 2010, "Analysis of Journey To Work Travel Patterns in Sydney", Australasian Transport Research Forum 2010 Proceedings. Xu and Milthorpe 2010 note that trip distances have generally increased over the past 20 years and the decline in 2006 may represent an anomaly related to changing of zone boundaries.

28 Note that this analysis excludes areas outside the 41 local government areas that form part of this study.

Bus time (minutes)	75.3	72.3	79.6	73.2	75.3
Rail time (minutes)	122.2	110.4	123.4	113.2	122.2
Car share (per cent)	90.0	70.7	89.2	80.3	90.0
Bus share (per cent)	6.4	8.4	6.8	7.1	6.4
Rail share (per cent)	3.5	20.9	4.0	12.6	3.5

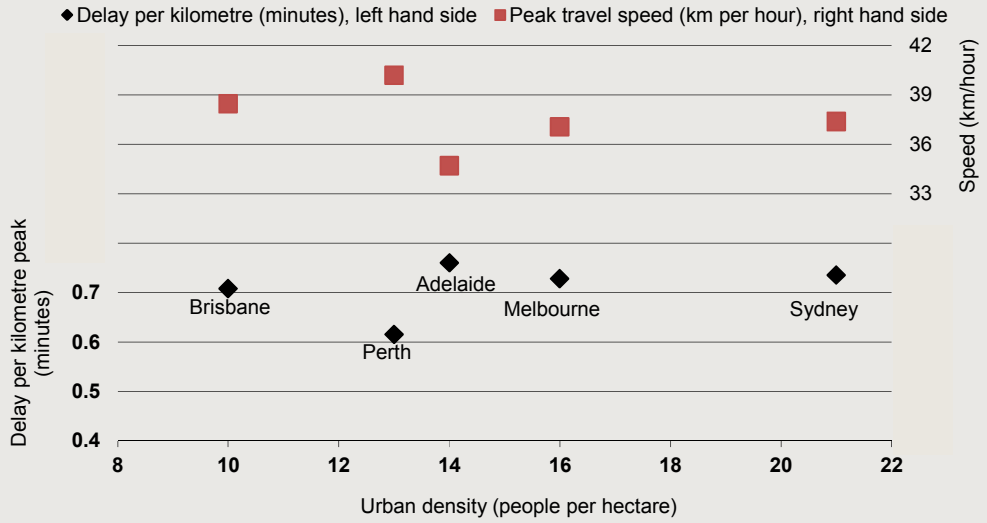
Data Source: CIE analysis based on STM 2016 model run.

6.4 Density and congestion in Australian cities

It is a common belief that there is a strong relationship between the traffic congestion that they face and urban density. While this is likely true to some degree, the lack of deterioration of road speeds in Sydney through time suggests that this has and can be managed. Potentially, this also reflects that many behavioural changes can occur to reduce transport demand if road conditions worsen, such as changes in employment patterns.

Looking across Australian cities, there is a weak positive relationship between urban density measures and congestion measures for major urban roads. The extent to which these differences reflect differences in the set of roads measured is not known.

Urban density and congestion in Australian cities



Data Source: CIE analysis based on STM 2016 model run.

Impacts of increased infill development on Sydney's transport

Additional population (and employment) accommodated in Sydney could lead to:

- higher transport infrastructure costs to maintain the same service standards (such as the same travel time for journeys as currently experienced);
- lower service standards (but no additional infrastructure costs) because of greater congestion on roads and public transport services; and
- some combination of the above.

For this report, we allow for a general increase in transport provision, so as to ensure that there is no dramatic congestion.[29] We do not seek to target infrastructure at any particular scenarios[30] and hence measure the change in transport outcomes as this is the only difference between scenarios. We then consider whether it would be expected that transport solutions would be more or less amenable to a particular scenario.

The transport system outcomes that we consider are:

- additional car and bus congestion to existing residents. This is measured as the additional time required to undertake the same trip that they choose to make in 2016; and
- changes in the crowding of public transport services (bus and rail) and the loss of amenity implied by having to stand rather than be seated.

We also consider the implications of alternative scenarios for active transport, with external health benefits and for social inclusion in chapter 12.

Changes in transport outcomes

The changes in transport outcomes from our quite different housing and employment scenarios are starkly similar. That is, the transport outcomes are very little changed between scenarios, although there is a general worsening in outcomes relative to 2016. This applies across indicators such as mode share, average trip times, average trip distances and congestion costs.

The similarity between outcomes from different scenarios makes sense in the context of current travel pattern.

- The change in the location of new development is dramatic between scenarios. However, the shape of Sydney changes much less quickly, as the new population is equivalent to a 17 per cent increase in Sydney and much less in infill areas, which are the only development varied across scenarios. This is telling in itself, as it indicates the long times required to alter city structures — comparisons of Sydney to Hong Kong are not meaningful in that it would take about 1000 years of concentrated development for Sydney to become similar to Hong Kong at the current rate of population increase. It would take 75 years of concentrated development at current rates for Sydney's density to be similar to that of Paris.
- Mode share would be expected to change mainly in response to a substantial increase or decrease in employment located in the CBD, in the absence of new bus or rail routes. While this does vary across scenarios, the larger movements relate to other strategic centres for which most travel is by car. Service provision (and infrastructure)

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29 The BTS modelling undertaken includes a range of transport augmentation projects. This includes the South West Rail Link, North West Rail Link, Epping to Parramatta Rail Link, Western Express, M2/M5 and Greater Western Highway widening, M5 East duplication, M4 extension and widening, M2 to F3 tunnel, Integrated Bus Networks and Northern Beaches busway. These are used for modelling purposes only and should not be viewed as government policy.

30 Developing specific bus routes, train timetables and road programs to align with each scenario is beyond the scope of this project and would take many months of work with the Bureau of Transport Statistics and transport planners.

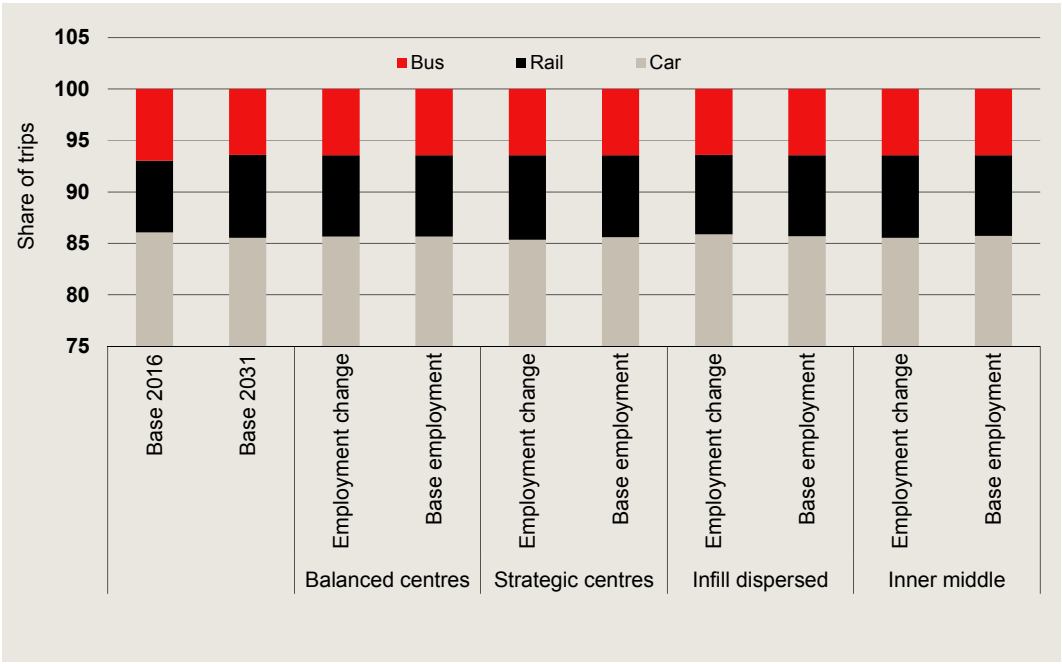
is also held constant across scenarios, which limits the changes in mode share to those that occur from changing demand rather than those related to changing supply of transport services.

- The length of trip (in kilometres) to get to work has been shown to be almost identical for employment located close to and further from the CBD.[31] Hence changes in the location of employment would not be expected to alter trip length substantially.
- The trip times estimated for 2016 are relatively similar for journeys from most types of infill areas. This suggests that behavioural patterns generally adapt to give relatively similar transport outcomes. For instance, people living further from the CBD are less likely to work in the CBD, hence reducing average trip times.

The mode shares and changes in travel time and crowding between scenarios are shown in the charts below. Key points are that:

- mode shares are very similar across scenarios (chart 6.5);
- average trip distances and times are very similar across scenarios (chart 6.6);
- additional congestion varies slightly across scenarios and most scenarios lead to less congestion than the base case (chart 6.7); and
- crowding of bus and rail services varies slightly across scenarios with most scenarios leading to less crowding of rail services (charts 6.8 and 6.9).

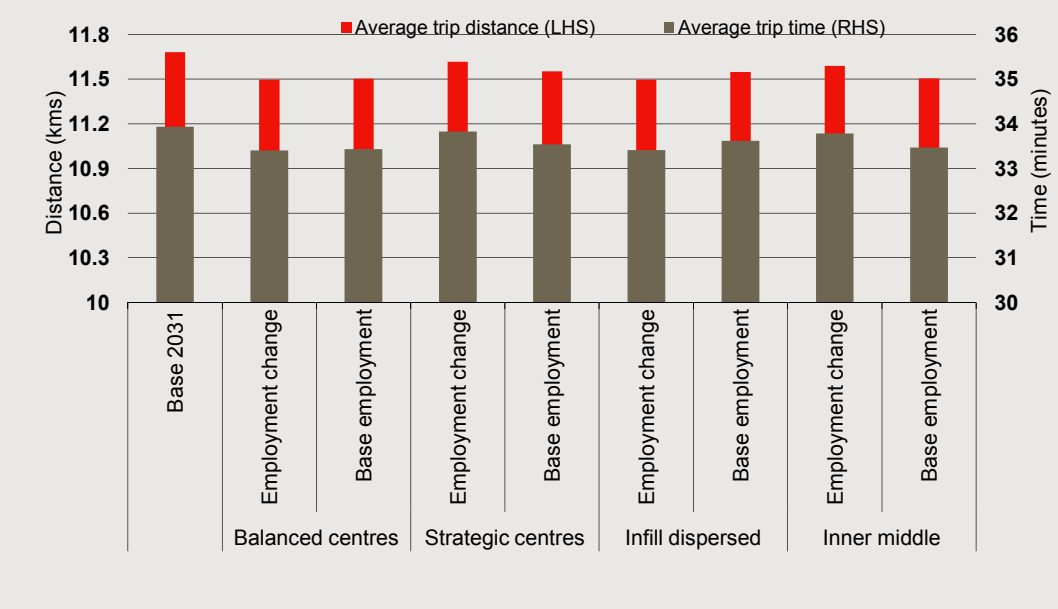
6.5 Mode shares 2031 (shortened y axis)



Data source: CIE analysis of outputs from the STM transport modelling.

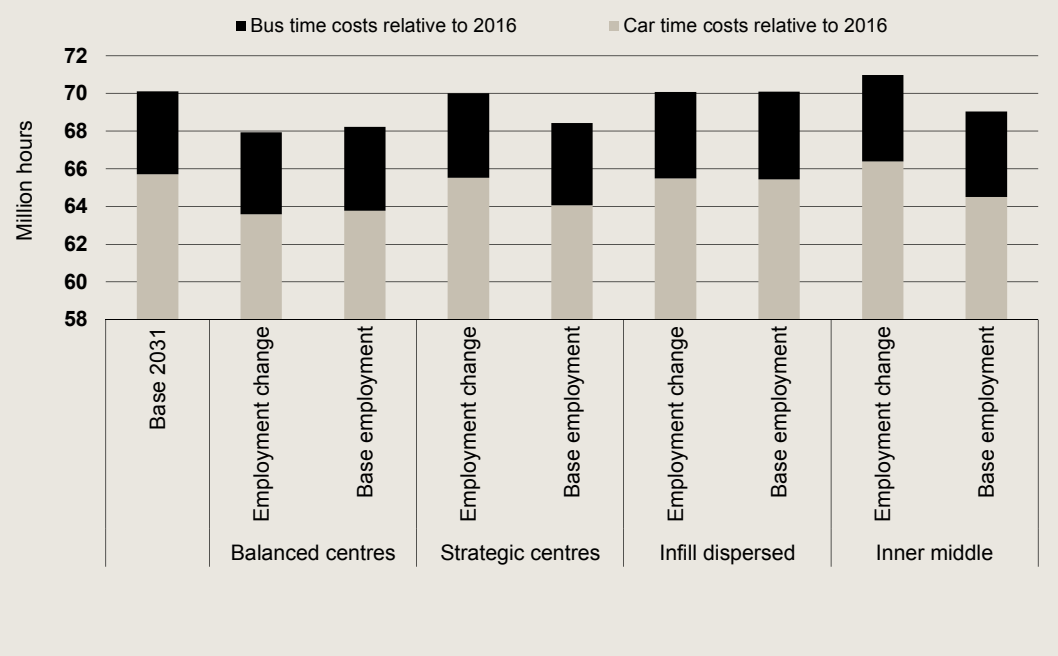
31 Xu, B. and F. Milthorpe 2010, "Analysis of Journey To Work Travel Patterns in Sydney", Australasian Transport Research Forum 2010 Proceedings, Figure 8.

6.6 Average trip times and distances



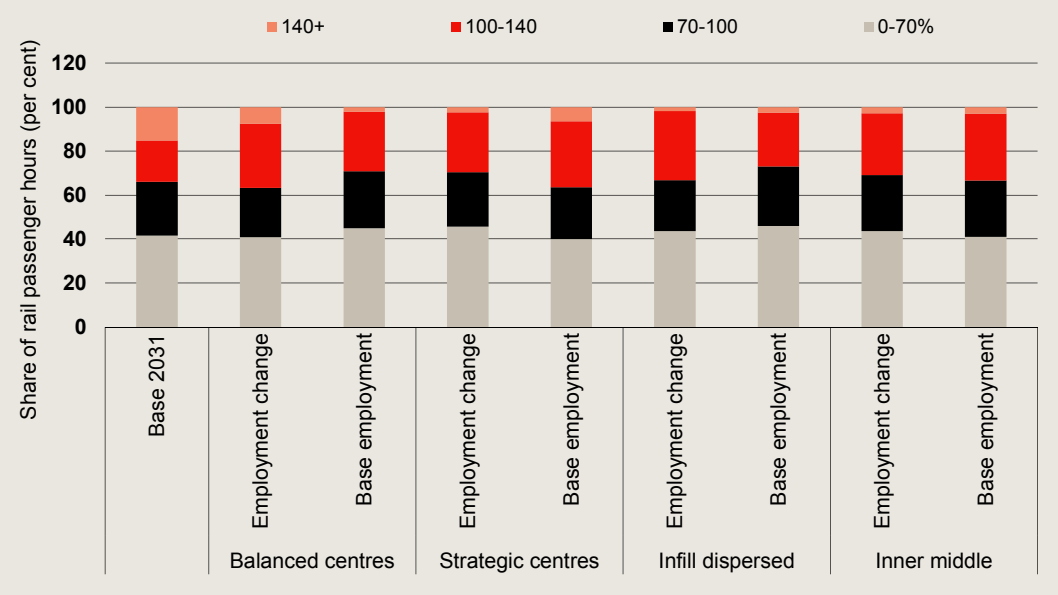
Data source: CIE analysis of outputs from the STM transport modelling

6.7 Additional car and bus hours for 2016 journey pattern



Data source: CIE analysis of outputs from the STM transport modelling.

6.8 Rail crowding 2031



Data source: CIE analysis of outputs from the STM transport modelling

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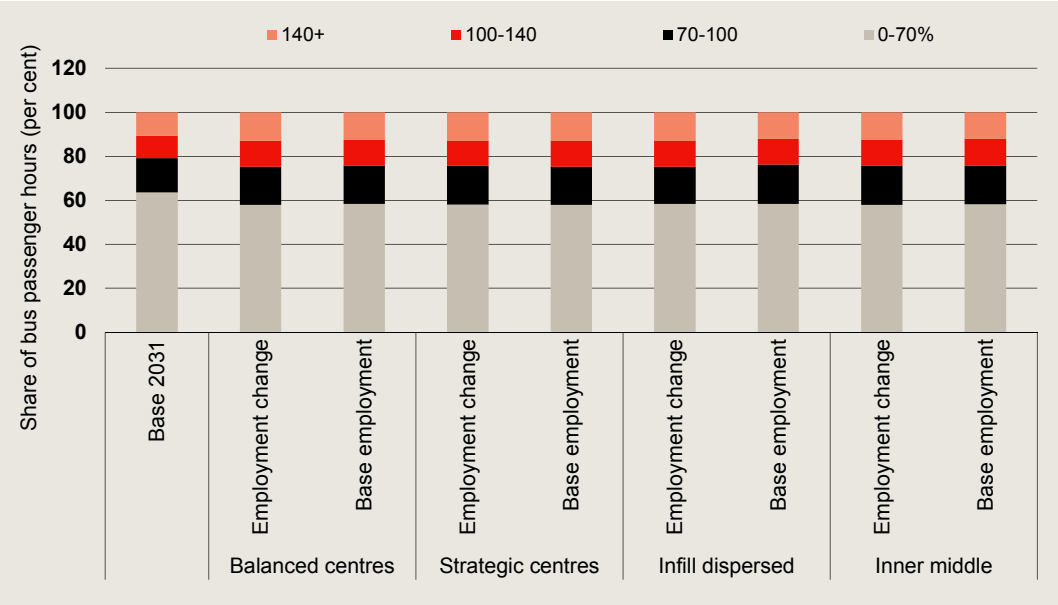
6.9 Bus crowding 2031



Data source: CIE analysis of outputs from the STM transport modelling.

Valuing changes in transport outcomes

The changes in transport outcomes are valued using standard parameters for the cost of time and cost of crowding. These are set out in table 6.10.

6.10 Parameters used to value transport changes

Parameter	Value
Value of time (2012) [a]	$12 per hour
Increase in value of time [a]	0.5 per cent per year
Annualisation of 3.5 hour AM peak	900
Value of time of uncrowded (<70 per cent) public transport relative to base value of time [b]	1.0
Value of time of semi-crowded (70-100 per cent) public transport relative to base value of time [b]	1.2
Standing value of time relative to base [b]	1.8
Period over which transport changes are assessed	2016 to 2046

[a] Australian Transport Council, National Guidelines for Transport System Management in Australia, Volume 4, Appendix A.2 — value of $10 per hour in 2006 escalated to 2012; [b] Australian Transport Council, National Guidelines for Transport System Management in Australia, Volume 4,Appendix A.3.
Data Source: CIE analysis based on STM 2016 model run.

The transport cost changes result in relatively minor differences relative to the baseline scenario in 2031. The Balanced Centres and Infill Dispersed scenarios result in slightly lower transport costs than the base case. The Strategic Centres and Inner-Middle scenarios have very similar transport costs to the base case.

We have also estimated the transport cost differences if housing patterns changed as per the scenario but employment patterns remained as in the base case. In this case all scenarios result in slight lower transport costs than baseline.

Note that we do find large changes in transport costs relative to 2016. For example, costs associated with longer car and bus time are estimated at between $800 million and $900 million in 2031 for all scenarios.

6.11 Transport costs relative to baseline 2031

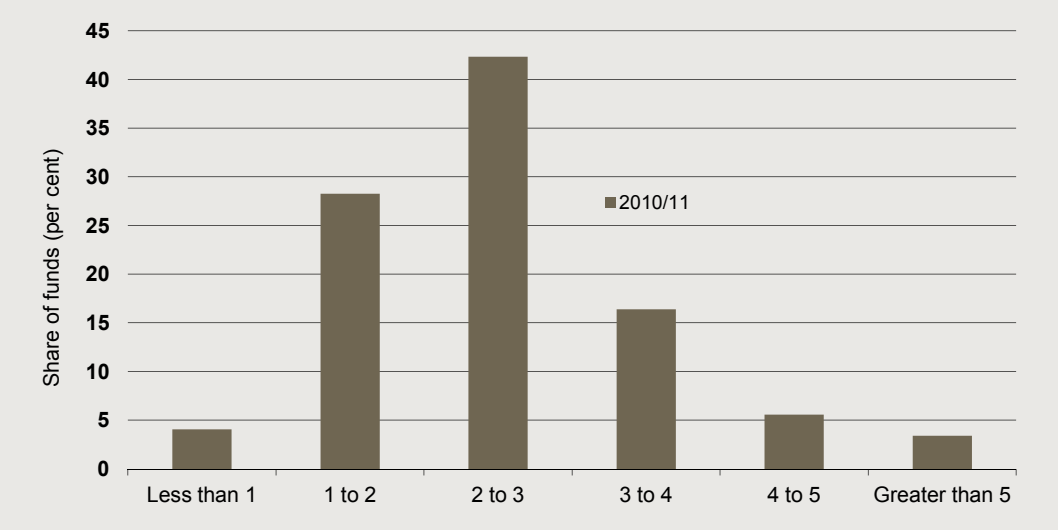
	Crowding costs - rail $m 2031	Crowding costs - bus $m 2031	Car time $m 2031	Bus time $m 2031	Total $m 2031	NPV 2012-2046 $m 2012
Baseline	0.0	0.0	0.0	0.0	0.0	0.0
Balanced centres	-23.3	-3.4	-25.6	-0.7	-52.9	-176.8
Strategic centres	-0.2	-1.0	-2.4	1.0	-2.7	-8.9
Infill dispersed	-30.3	-4.8	-2.8	2.2	-35.6	-118.9
Inner-middle	-6.8	-3.3	8.3	2.1	0.4	1.4
With employment maintained as in baseline scenario						
Baseline	0.0	0.0	0.0	0.0	0.0	0.0
Balanced centres	-24.4	-2.2	-23.2	0.4	-49.3	-164.7
Strategic centres	-14.9	-2.3	-19.9	-0.5	-37.5	-125.2
Infill dispersed	-19.5	-1.7	-3.3	3.1	-21.5	-71.9
Inner-middle	-27.0	-2.1	-14.5	1.6	-42.1	-140.4

Note: Changes in time or crowding levels are applied to the trips of existing residents in 2016.
Data Source: CIE analysis based on STM model runs.

Service provision and alternative scenarios

The cost results presented above have not sought to tailor infrastructure or public transport services to the particular scenarios, given the complexities in doing this and the limited time available. It may be possible for scenarios to perform better than currently measured with improved transport services or infrastructure. For instance, benefit cost ratios for NSW construction expenditure (estimated at time of decision to undertake expenditure) are generally in the order of 1-3 (chart 6.12).

6.12 Share of funds with different benefit-cost ratios NSW



Note: Based on benefit cost ratios at time of decision to undertake expenditure.

Data source: AustRoads Performance Indicators.

There are no clear lessons from the transport literature about when transport is cheaper (and better) and often this is case specific depending on the topography of a city and its transport corridors and the opportunity cost of land (and availability of land not already developed for additional transport corridor). There are lessons relating to particular modes and when particular modes might be appropriate, which we expanded on below.

Most transport studies support a positive relationship between urban density and the efficiency and provision of a public transport system, and hence a link between urban density and public transport mode share. As Rickwood and Glazebrook note, this relationship may be more complex than appreciated, with higher densities increasing public transport mode share because of improved access to services and through reduced car ownership.[32]

Some authors have questioned the idea that "density is destiny" in terms of public transport use.[33] Density is not destiny but instead has its impact largely in that density is linked to greater accessibility to public transport services, and the provision of public

32 Rickwood, P. and G. Glazebrook 2009, "Urban structure and commuting in Australian cities", *Urban policy and research,* Vol. 00, No. 0, 1-18.

33 Mees, P. 2010, "Density and transport mode choice in Australian, Canadian and US cities.

transport to areas of greater density makes economic sense as these services will likely attain greater patronage and hence be more efficient.[34]

Rickwood and Glazebrook also document the strong relationship between closeness to the CBD and public transport use independent of accessibility.[35] This arises because people living nearer to the CBD are more likely to work in the CBD and there is a strong focus of Sydney's public transport system on providing services to and from the CBD. Whether or not this focus is an efficient response to demand or otherwise is unclear.

The relationship between public transport provision and density can best be considered through the different fixed costs of transport systems as against their marginal costs.

- Cars have a fixed cost from the road infrastructure and then marginal costs for users related to their own vehicles, time, fuel etc.
- Buses require the same road infrastructure but then buses themselves are much more lumpy, with the costs of a system with 1 passenger per bus the same as one with close to full buses. Hence the marginal costs of additional users is, up to a point quite low. The overall costs (of purchasing buses and fuel) for transporting a full bus is lower than for each passenger using separate cars, and buses can make more efficient use of road infrastructure. However, time costs are higher for buses.
- Rail has the highest upfront costs in rail infrastructure and rollingstock and then low marginal costs for both additional services and additional passengers on existing services.

Light rail is somewhere between buses and heavy rail, particularly where there is dual use of road infrastructure.

The costs per trip implied from the above are shown in chart 6.13. The implication being that cars will be the least cost travel solution where there are fewer trips along the route, bus-light rail will be the least cost solution at some intermediate solution and heavy rail the least cost solution at higher densities. Alternatively, bus and rail systems will tend to perform better at higher densities.[36]

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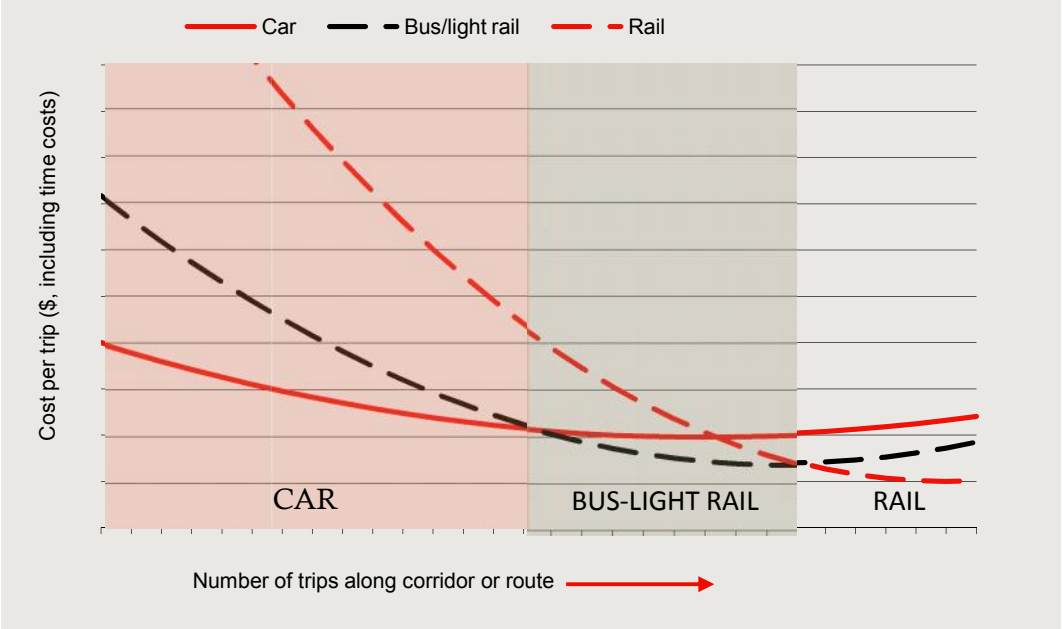
34 Cervero, R. and E. Guerra 2011, "Urban densities and transit: a multi-dimensional perspective", University of California Berkely Center for Future Urban Transport working papers, No. 2011-6, September.

35 Rickwood, P. and G. Glazebrook 2009, "Urban structure and commuting in Australian cities", *Urban policy and research,* Vol. 00, No. 0, 1-18.

36 For example, for rail Graham, D., A. Couto, W. Adeney and S Glaister (2003, "Economies of scale and density in urban rail transport: effects on productivity", *Transportation Research,* Part E, 39, pp. 443-458) document the economies of density in rail transit.

6.13 Costs per trip for different mode types



Source: The CIE.

The thresholds relevant for each type of transport option to be the least cost solution may differ between corridors depending on whether land is available, whether tunnels have to be built and many other factors. Cervero and Guerra document some relevant findings for US rail transit systems. [37]

- Net costs (costs net of fares) per passenger mile varied from US$0.22 to almost US$5.00. Hence there is substantial variation in the efficiency of US rail transit systems.
- Mass transit needs mass. Many recent US investments in heavy rail and light rail were found to have lacked enough density to support the investment. Heavy rail systems were estimated to need about 45 people per gross acre and light rail 30 people per gross acre around stations to achieve a high cost cost-effectiveness rating.

In terms of the scenarios for this benefit-cost analysis, these sorts of findings suggest that concentrating people more in particular places, rather than wide spreading is likely to be more conducive to additional public transport services that are cost-effective. This could be particularly true if service frequency could be increased along existing routes. This is possible but there are potential constraints on this particularly for rail that may require costly investment s to address.

Furthermore, while we would expect that additional public transport services could be cost effectively provided in scenarios such as the balanced centres and strategic centres, it is not clear whether this is preferable in terms of total benefits and costs. This reflects that we do not have a good comparison of the net benefits available from additional future road versus public transport investment. There may also be localised congestion issues

37 Cervero, R. and E. Guerra 2011, "Urban densities and transit: a multi-dimensional perspective", University of California Berkely Center for Future Urban Transport working papers, No. 2011-6, September.

from concentration of people and jobs in specific places that would be particularly costly if car use continued to be the dominant mode for most journeys across Sydney.

We do not seek to adjust the cost estimates from an unchanged set of infrastructure and services across scenarios, as there does not appear to be strong evidence suggesting any scenario would be able to be serviced by transport options more or less cheaply than others.

Summary

The aggregate transport impacts across scenarios are set out in table 6.14 (a positive is a benefit relative to baseline). The key points are:

- the difference in transport impacts across scenarios are relatively small;
- the balanced centres scenario (with employment change) provides a gain of over $170 million in transport impacts relative to baseline, in present value terms; and
- the strategic centres and inner-middle scenarios provide greater transport benefit relative to baseline when employment patterns remain the same as the baseline, rather than when employment is also changed. This suggests that simple alignment of employment and housing patterns may not be the easy answer to transport issues that might be expected.

6.14 Transport impacts across scenario

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Without employment change	0.0	164.7	125.2	71.9	140.4
With employment change	0.0	176.8	8.9	118.9	-1.4

Data Source: The CIE

7 Electricity and water infrastructure

Physical infrastructure includes roads, rail and other transport (discussed earlier), water and sewerage, electricity, gas and telecommunications. Future population growth will require providing additional physical infrastructure in order to ensure that existing service standards are maintained. Changes in the future spatial location of population can also impact on the future costs of providing physical infrastructure.

The cost of electricity and water/sewerage infrastructure arising out of alternative future growth scenarios will reflect the extent of spare infrastructure capacity in existing areas and the costs of upgrading in different areas once capacity constraints are met. In this chapter we focus on electricity and water/sewerage infrastructure costs that are expected to be influenced by the spatial location of the future population.

Electricity networks

As an essential service, all dwellings constructed in NSW are connected to the electricity network. The costs of connection and augmentation are divided across developers and the electricity businesses. Developers will pay costs directly attributable to them, while broader augmentation costs will often be borne by the entire customer base, incorporated through distribution and transmission regulated prices.

Network performance investment has three drivers – demand/capacity, replacement and reliability. The scenarios for Sydney's growth are expected to have a major impact on demand/capacity and this is therefore, the main focus of our analysis.

Electricity use

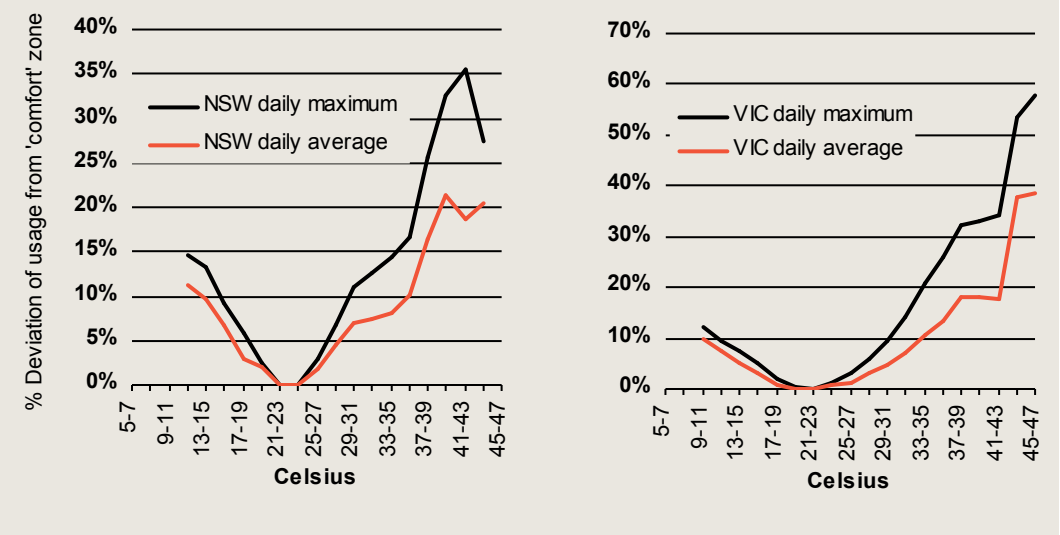
Electricity use is expected to rise in Sydney mainly because of population growth. Electricity use may also rise from higher per capita consumption, although per capita consumption has flattened in recent years. In terms of the electricity network, the major driver of the need for capacity expansion is peak load electricity requirements — that is, the maximum amount of electricity required at any one time.

Temperature is a key driver of peak loads

A key driver of peak load is temperature. Chart 7.1 presents the results of statistical analysis undertaken estimates the relationship between temperature and usage (both peak and average). In the charts below, usage is described relative to the 'comfort zone', the temperature point at which usage is lowest. For example, in NSW an increase in temperature from the 'comfort zone' (of 21-23 degrees Celsius) to around 36 degrees Celsius results in an increase in average usage by about 10 per cent. Peak usage increases by about 15 per cent for the same change in temperature range. The impact of temperature on peak and average usage differs between the states. In Victoria, for

example, there is a lower percentage increase in both peak and average electricity use (relative to the 'comfort zone') — ie temperature gradients are less steep.

7.1 Relationship between usage and temperature, peak and average usage

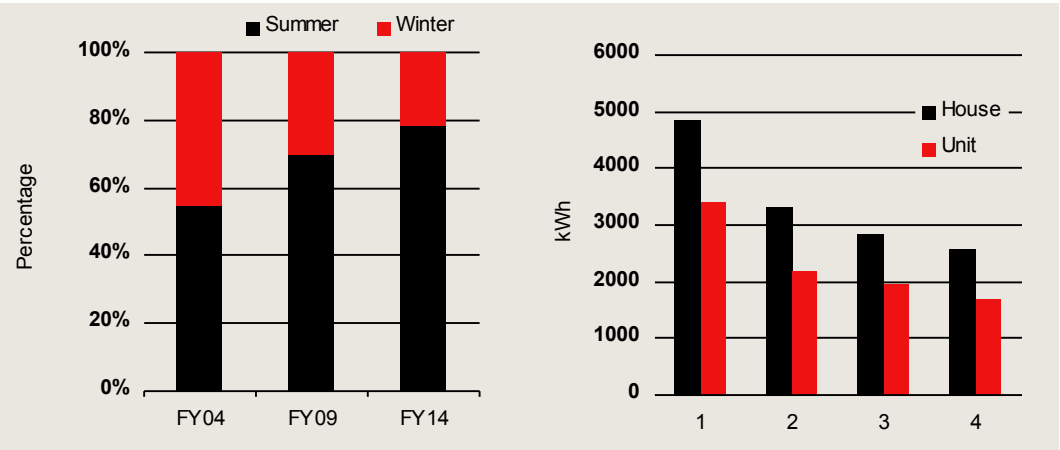


Data source: The CIE.

Peak loads are shifting to summer peaks

In most jurisdictions throughout Australia, the peak load (in aggregate) has shifted from winter to summer peaks.[38] In Sydney peak energy demand has shifted towards summer across many areas, rather than the original winter peak demand from heating requirements (chart 7.2), reflecting the increased use of air conditioners. This trend is expected to continue into the future.

7.2 Characteristics of electricity use



Note: Proportion of summer and winter is proportion of substations for which peak occurs in winter and in summer.
Data sources: Energy Australia Regulatory Proposal (2008); IPART household survey (2006), p. 11.

38 The one exception is Tasmania where demand still falls in winter periods. See CIE analysis presented in AEMC (2011), *Power of Choice - Rationale and drivers for DSP in the electricity market – demand and supply of electricity*, December, p29.

While the trend, (in aggregate) across the whole of Sydney has shifted toward a summer peak, there are many suburbs in Sydney where peak load occurs in winter. For example, of the 100 suburbs in Sydney serviced by Ausgrid, peak electricity use occurred in the winter months in 41 of these (predominantly coastal) suburbs in 2011 - by 2017 is expected to fall to 36 suburbs.[39]

Further, if current trends are maintained, peak demand is forecast to increase from 14,595 MW in 2010-11 to 20,380 MW in 2029-30, with average annual growth of 1.98%.[40]

Alternative growth scenarios are expected to impact on peak demand

The alternative scenarios are expected to impact on the total demand for electricity and peak demand for electricity through a number of channels:

- development further from the coast will have a greater impact on peak electricity load requirements as these areas are hotter and likely to have a high uptake of air conditioning; and
- lower density development will likely generate higher electricity use if current patterns of per capita electricity use continue.

Both these factors suggest that electricity use will be higher for a development scenario with more people located in areas further away from the coast and/or in lower density development.

The transportation network also has significant electricity demand and this is likely to differ between the different scenarios. The rail network and road tunnels such as the potential M4 tunnel have significant electricity requirements. For the purposes of this benefit cost analysis this is not varied across scenarios.

Many of the costs associated with these electricity demand patterns are met privately and factored into people's decisions about where to live. As such, they are included in our estimation of value of land use change benefits and should not be double counted here. For example, house prices in an area typically reflect (amongst other things) the climate of the area. However, it is possible that people are not fully factoring in future changes in temperature that may arise from climate change. These changes could reduce people's willingness to live in areas further away from the coast or increase their costs of doing so.

Costs of electricity infrastructure

The costs that are not factored into people's decisions are additional infrastructure costs related to new development that are borne by all electricity users. The costs required to upgrade network infrastructure to meet future demand in electricity due to population growth is dependent on a range of factors such as:

- the extent of spare capacity in the existing network and when full capacity will be reached; and

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39 Ausgrid (2012), *Electricity System Development Review*, *2011/12.*

40 See CIE analysis presented in AEMC (2011), *Power of Choice - Rationale and drivers for DSP in the electricity market – demand and supply of electricity*, December, p22.

- the costs of upgrading the network in the particular area.

The two main electricity distribution network service providers (DNSP) in metropolitan Sydney are Ausgrid and Endeavour Energy (Endeavour). Ausgrid's network covers the majority of the inner city, eastern and northern areas of the Sydney metropolitan region and Endeavour's network covers the western and southern areas, including both the North West and South West growth centres.

Excess capacity

Electricity distribution systems are highly complex and include a range of assets, many of which are interconnected through a grid system. There are a number of factors that influence the extent of excess capacity in different parts of the network. A key factor is capacity at individual subtranmission and zone substations located in different suburbs throughout Sydney.

However, distribution feeders that form part of the electricity grid and link to substations may also impose constraints on the system. That is, even though there may be spare capacity at a substation, there may be constraints at the feeder level, which limit the ability to meet demand in a particular location.

Another factor that can influence the capacity constraints in particular locations is the flexibility of the infrastructure to shift loads between substations. That is, the substations form part of a grid system and the system is typically managed as a grid, rather than individual discrete units. In practice, this means that where full capacity has been met in substation, this can be managed through sharing load between other infrastructure in the grid, rather than an upgrading the substation.

Ausgrid and Endeavour have both provided information on current and forecast peak usage and substation capacity at each of its substations in the Sydney Metropolitan Area. We have used this as the basis our estimate of excess capacity – recognising the caveats noted above that can be overcome through detailed site specific modelling by the DNSPs at each of the locations.

Table 7.3 presents the estimated 'secure capacity' at all substations located within an LGA and estimated peak demand at 2016.[41] It includes network augmentation already committed in particular areas.

7.3 Estimated substation spare capacity, 2016

LGA	Peak season	Current Capacity	Peak Load Forecast	Spare capacity
		(MVA)	(MVA)	(MVA)
Baulkham Hills	Summer	559	384	175
Blacktown	Summer	834	608	226
Camden	Summer	134	120	14
Campbelltown	Summer	307	235	72
Fairfield	Summer	406	281	125

41 The secure capacity of a substation is the capacity with one major piece of apparatus out of service. This is often referred to as its "Firm" or N-1 rating.

LGA	Peak season	Current Capacity	Peak Load Forecast	Spare capacity
Hawkesbury	Summer	179	127	52
Holroyd	Summer	127	94	33
Liverpool	Summer	357	275	82
Penrith	Summer	554	434	120
Wollondilly	Summer	4	4	0
Ashfield	Winter	85	71	14
Auburn	Summer	180	150	30
Bankstown	Summer	610	535	75
Botany Bay	Summer	616	547	69
Burwood	Winter	63	37	26
Canada Bay	Summer	365	251	114
Strathfield	Summer	162	111	51
Canterbury	Winter	325	268	57
Hornsby	Winter	648	477	171
Hunters Hill	Summer	56	72	0
Hurtsville	Summer	432	303	129
Kogarah	Summer	24	27	0
Kuringai	Winter	109	87	23
Lane Cove	Summer	529	315	213
Leichardt	Winter	63	40	22
Manly	Winter	50	42	8
Marrickville	Winter	135	113	22
Mosman	Winter	113	65	48
North Sydney	Summer	114	105	9
Pittwater	Winter	99	73	25
Randwick	Winter	223	140	83
Rockdale	Summer	183	147	36
Ryde	Summer	356	359	0
Sutherland	Winter	739	502	237
Sydney	Summer	1,990	1,612	378
Warringah	Winter	762	551	211
Waverley	Winter	47	28	19
Willoughby	Summer	172	128	44
Wollahra	Winter	163	119	44
Parramatta	Summer	389	503	0
Blue Mountains	Winter	523	298	225

Note: For Ashfield, supply is assumed to be provided by Auburn substation. For Strathfield, supply is assumed to be provided by Canada Bay substation

Data source: CIE analysis based on network provided data.

Based on these estimates there is likely to be spare capacity in many LGAs at 2016. This reflects the significant investments recently undertaken and committed over the next few years by the DNSPs. In 2010/11, for example, Ausgrid completed projects valued over $350m to augment the subtransmission network and reliability projects. This is part of Ausgrid's $8.5bn capital investment program for the period 2009-14 that was recently

approved by the Australian Energy Regulator (AER).[42] Network augmentation to meet peak demand and maintain network reliability over the next decade and beyond have been key drivers of this investment program.

The main factor in costs is when spare capacity is reached. This is measured through when population growth leads to peak use matching 100 per cent of capacity, based on current per capita peak requirements. When capacity is reached we include the cost of a substation upgrade.

Cost of upgrading network infrastructure

Once full capacity is reached we assume that additional augmentation to the distribution network would be required. We assume that this would involve upgrading the existing substations in the year after full capacity has been reached.[43] We assume that a substation upgrade is only required only once over the 15 year time horizon.

There is limited specific information that we have been able to obtain regarding the costs of infrastructure provision to meet population growth in each area. Given this we have relied on cost of recent substation upgrades in two separate cases.

- $33.3m for the establishment of a zone substation at Edmonston Park;[44]
- $30 million for replacement of the Top Ryde substation[45]; and
- $50m for the Parramatta Zone Substation replacement.[46]

These often are for both growth and upgrade and it is difficult to separate out impacts. We convert estimates into per new person cost estimates and find a cost per new person of around $2700. We apply this cost to any new people in an area in excess of current capacity.

Number of substation upgrades

Across the scenarios, the different patterns result in different need for upgrades of substations in each local government area. In the baseline, 16 local government areas are estimated to require substation upgrades as a result of population growth. In the balanced centres and inner middle, upgrades are only required in 11 local government areas. In the strategic centres scenario and infill dispersed, upgrades are required in 13 local government areas.

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42 Ausgrid 2011, Network Performance Report 2010/11, p6.

43 In practice there may be opportunity to shift loads between the substations and to adopt demand management measures that could help defer substation upgrades. Detailed modelling would be required to assess this on a case-by-case basis.

44 Endeavour Energy (2012) PR110 Establishment of Edmonston Park Zone Substation, Network consultation paper, July, p30

45 http://www.ausgrid.com.au/Common/About-us/Newsroom/Media-Releases/2009/March/Top-Ryde-substation.aspx?page=1&year=2009&month=3&id=5dc6b7ee-56b3-4a69-bb6a-46352d18564f

46 http://www.endeavourenergy.com.au/wps/wcm/connect/ee/nsw/nsw+homepage/ournetworknav/current+major+projects/greater+western+sydney/power+for+parramatta+to+grow

Water and wastewater services

As an essential service, all dwellings constructed in Sydney are connected to the water and wastewater networks. The costs of connection and augmentation are typically divided between the developers and Sydney Water. Developers will pay costs directly attributable to them, while broader augmentation costs are borne by the entire customer base, incorporated through regulated prices.[47]

The scenarios developed reflect differences in the location of future population growth within infill areas.

Sydney Water has indicated there are likely to be differences in existing capacity within specific areas and between different infill areas. For example, in some areas closer to centres water and sewerage mains may already have significant excess capacity while mains located away from centres were originally sized to a much lower capacity. Sydney Water has indicated that there are likely to be such differences within LGAs but at this stage it is not in a position to provide detailed information across all LGAs (although information can be provided on a case-by-case basis). Detailed information of capacity across the whole network is likely to be available by the end of 2012. Detailed information regarding cost differentials within infill areas are also not available at this stage and have, therefore, have not been included in the modelling.

Summary

Table 7.4 provides the net present value of the electricity and water infrastructure impacts across the different scenarios. A positive number is a benefit relative to the baseline. All scenarios result in lower electricity costs than the baseline, up to as much as an estimated $56 million for the infill dispersed scenario. There are no known differences in water and wastewater infrastructure costs between alternative infill scenarios.

7.4 Electricity and water impacts across scenarios

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Electricity	0.0	9.0	19.0	56.0	39.2
Water and wastewater	0.0	0.0	0.0	0.0	0.0

Data Source: The CIE

47 In the past a 'developer charge' applied for new developments in Sydney. Currently a developer charge only applies for costs associated with the recycled water network.

8 Health costs

While future population distribution is a key factor influencing health infrastructure costs, it is only one aspect of the complexity of health services demand and delivery. Population ageing and changes in population health and treatment pathways will drive continuous growth in demand for health infrastructure and services in Sydney over the next several decades. This is driving innovation in service delivery models as suppliers of health services find new ways of meeting demand growth in cost effective ways.

The population distribution scenarios examined in this review impose different magnitudes of population change in each local area, which may trigger new health infrastructure costs depending on local capacity constraints and demand management options. The alternative scenarios have been assessed according to demand and supply factors relevant for health infrastructure. No explicit data is available to enable this to be quantified. Rather, proxy variables have been considered and used to assign scores to four cost-related criteria for each scenario.

Using these scores, only moderate differences across the scenarios in terms of the possible impact on health infrastructure costs relative to the base case. This highlights the complexity of health infrastructure investment decisions, which are not only driven by population changes. That said, it did show that the strategic centres scenario appears to impose least costs as it spreads population growth marginally more evenly across local government areas, and doesn't 'overweight' growth in areas already showing signs of capacity constraints.

Complex drivers of health infrastructure costs

A variety of interrelated demand and supply factors influence health infrastructure expenditure and delivery decisions.

While the magnitude of future population changes will place pressure on necessary health infrastructure costs, other relevant demand-side factors affected by population distribution include the demographic and socioeconomic profile of the resident population and the degree of existing unmet or underserviced demand across the broad and interconnected spectrum of health services.

For instance, different population cohorts require different types of health services. Younger communities are more likely to require a higher proportion of child and family services and primary health care, compared to more aged communities that may require more subacute, residential aged care and community based services.

Demand for types of health services can also reflect differing levels of access to appropriate preventative and early intervention health services. For instance demand for acute health services can often reflect local population access to effective primary and allied health services.

This complexity means that different local populations are likely to require access to different combinations of general practice services, primary and community health care, aged care, private health services, dental care, medical imaging and pathology services, day procedure services, allied health and other services.

Although not impacted by the dispersion of population, the increasing prevalence of chronic and non-communicable diseases, consumer preferences for new care delivery models and the availability of new forms of health intervention technologies will also exert demand pressure and may ultimately prompt new health infrastructure costs.

Several supply side responses have the potential to offset this demand pressure, including new models of care to manage demand more efficiently, the rollout of specialist health services, and the opportunity to co-locate complementary providers of health services.

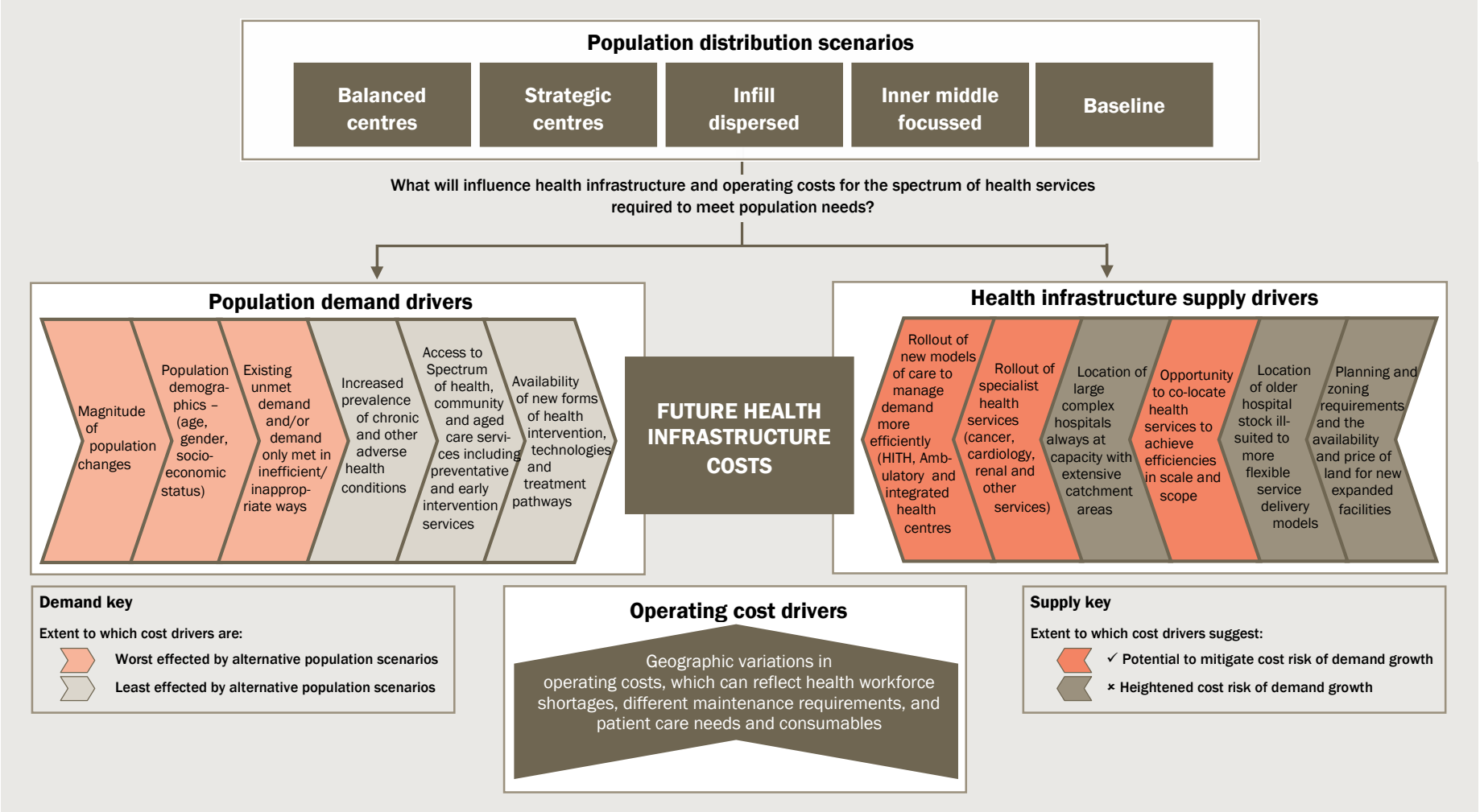
However, there are limits to the flexibility and adaptability of supply to additional demand, which varies from one geographic area to the next. For instance large inner city hospitals that already have large catchment areas and older hospitals that may be ill-suited to capacity enhancing measures may not be able to flex enough to meet new demand without changes to the servicing of existing demand. The (lack of) land availability, planning and zoning restrictions, and price of land for expanded health infrastructure stocks, can also present a challenge to geographic areas trying to cater for higher than forecast population (and health services) demand.[48]

Chart 8.1 shows the various demand and supply side factors resulting from or associated with each of the population distribution scenarios, which will influence future health infrastructure costs for the wide spectrum of health services including hospitals, primary and allied health care facilities, medical imaging and pathology practices and infrastructure for other health services.

Clearly there are many forces in play, which results in an important degree of regional variation. For instance, Sydney's inner ring contains several well established hospitals which offer high complexity services and have a large drawing area as a result. This service model may in some cases limit the extent to which the distribution of growth at the local level will impact on the need for additional capacity at existing health sites and/or the need for new facilities. In other cases it will exacerbate existing pressure depending on the options available to the hospital and other health services in the area to otherwise manage demand.

[48] While it is acknowledged that land costs can impact on health infrastructure costs in different geographic areas, land costs comprise a very small proportion of total construction costs for new health services, which in the case of hospitals is around 3 per cent of construction costs.

8.1 Demand and supply factors affect future demand and infrastructure costs



Data source: The CIE

Assessing the scenarios — Potential impact on health infrastructure decisions

Given that the scenarios impose differing magnitudes of population changes across Sydney to 2031, they can potentially impact on future infrastructure costs depending on the:

- total number of additional residents in each LGA over the 15 years to 2031;
- proportional change in residents compared to existing 2016 population in an LGA;
- existing unmet or underserviced demand for health services in each LGA — shown by measures such as available public beds per 100 000 of population, available private beds per 100 000 of population, and emergency department waiting times for triage category 2 relative to the NSW average;[49] and
- access to effective hospital demand management programs in each LGA, shown by measures such as the rate of hospitalisations for ambulatory sensitive conditions per 100 000 population for a particular LGA relative to the NSW average.

Analysing the scenarios in terms of their impact on these measures will provide high level and broad indicative estimates on health infrastructure cost pressures. However, it should be noted that this is not comparable to the more detailed and comprehensive planning tools used by the NSW Ministry of Health to assess health infrastructure capacity and population needs, which could not be accessed within the timeframe and scope of this review.50

The above indicators were used to conduct a qualitative analysis of the population distribution scenarios according to their likely impacts on health infrastructure provision costs.

Each of the indicators above were given a 'score' based on an assessment of how the additional population pressure they imposed on an LGA would be likely to affect particular areas given the current level of unmet demand and the demand management programs in place.

The methodology used to measure each criteria and the key outcomes for each scenario is illustrated in chart 1.5. Broadly, the analysis allocates a score to each scenario in terms of its assessed performance against key indicators that assess the relative pressure placed on health infrastructure costs.

It is important to stress that these results are indicative only, and the results do not reflect the unique circumstances within each LGA that may influence the ability of existing or future health infrastructure to meet population requirements.

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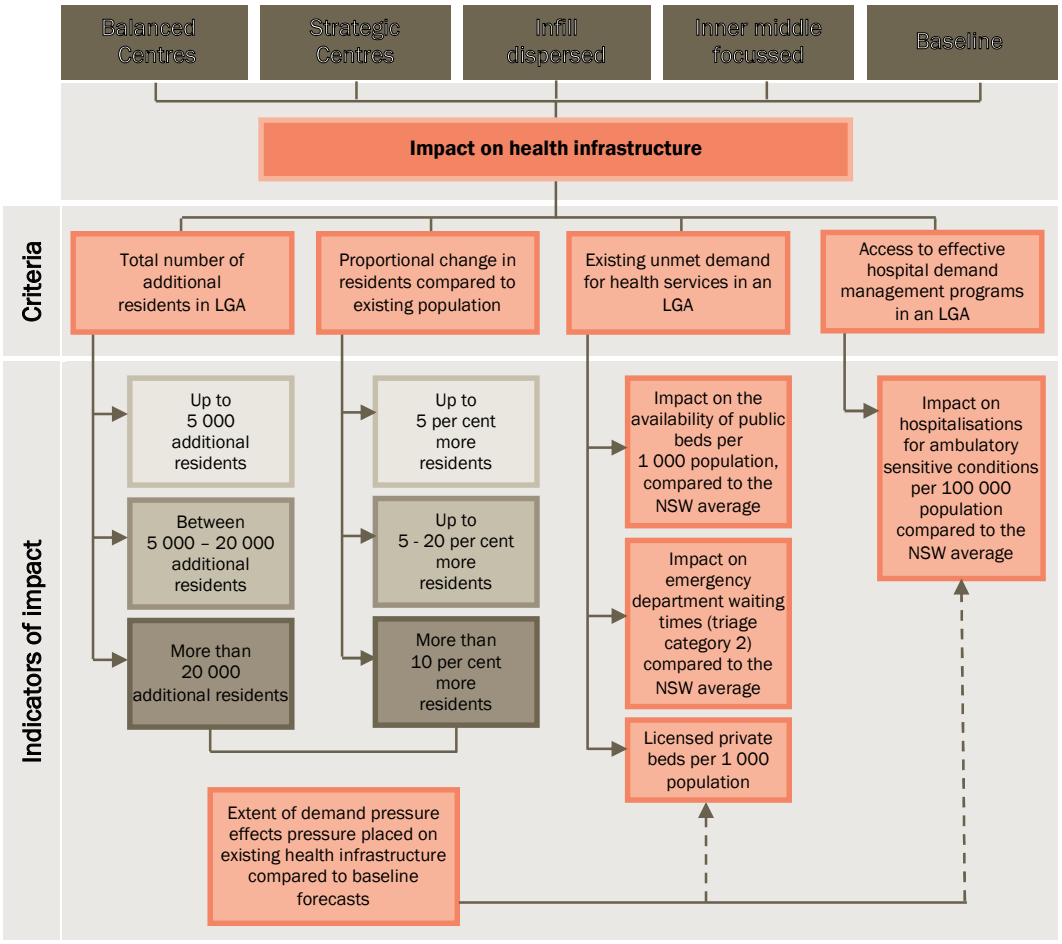
49 These are not the only indicators of potential unmet demand and have been selected because of the availability of publicly available information by the relevant Local Health Districts. Other relevant indicators would include admission rates and length of stay among others.

50 Some of the more sophisticated planning tools used by the NSW Ministry of Health to assess the state of health infrastructure capacity and assess unmet demand include FlowInfo, aIM (acute inpatient modelling), SiAM (subacute inpatient activity modelling), Operating Room Modelling, MHCCP (Mental Health – Clinical Care and Prevention Model).

The results suggest that for the Sydney region as a whole there is no substantial difference across the scenarios in terms of pressure placed on health infrastructure costs.

That said, the highest rating (least likely to impose additional health infrastructure costs) was for the strategic centres scenario and the lowest was for infill dispersed (where additional health infrastructure costs are most at risk).

8.2 Qualitative analysis on health cost impacts of population scenario



Scenario	Baseline forecasts	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
Rating	4/5	2/5	1/5	5/5	3/5
outcomes	Larger demand swings expected in LGA's showing signs of existing demand pressure	✓ Existing services meeting demand relatively well	✓ Most balanced sharing/spread across LGAs ✓ Existing services meeting demand relatively well	× Larger demand swings expected in LGA's showing signs of existing demand pressure	✓ Existing services meeting demand relatively well

Data source: The CIE

Relatively consistent results across scenarios for the aggregated Sydney region do tend to mask differences in the profile of infrastructure demand and cost pressures at the local level. Table 8.5 shows the results of the qualitative analysis for each Local Health

District. Cells highlighted in red indicate where relative cost pressures are likely to be greatest under each scenario.

This shows that Western and South Western Sydney are the regions most exposed in terms of potential future infrastructure pressures, including areas such as Auburn, Blacktown, Holroyd Parramatta, Penrith, Wollondilly, Liverpool, Fairfield, Camden and Campbelltown, and Bankstown.

8.3 Results differentiated by subregion

	Baseline forecasts	Balanced centres	Strategic centres	Infill dispersed	Inner middle focussed
Sydney	Low Risk	Low Risk	Low Risk	Low Risk	Medium risk
South Western Sydney	High Risk	Medium risk	Medium risk	Medium risk	Medium risk
South Eastern Sydney	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Western Sydney	High Risk	High Risk	High Risk	High Risk	High Risk
Nepean Blue Mountains	High Risk	Medium risk	Medium risk	High Risk	Medium risk
Northern Sydney	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

Data source: The CIE

High Risk | Medium risk | Low Risk

These results should be interpreted with some caution.

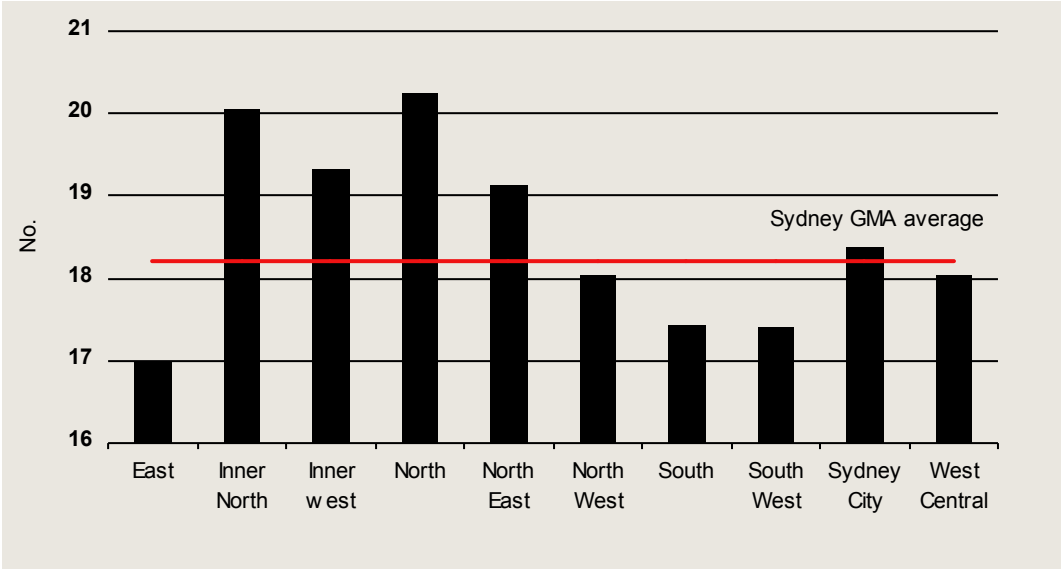
Given the diversity and complexity of health service delivery across Sydney and the myriad of drivers of health infrastructure investment decisions, this review has assumed that demand for health services across the Sydney GMA can be managed with *relatively consistent* cost profiles across the scenarios. We have therefore excluded estimates of the relative costs of health infrastructure provision from the quantitative analysis elsewhere contained in this report.

9 Education costs

Education infrastructure

In 2012, more than 415 000 students were taught in 886 Sydney school sites — including infants and primary schools, community schools, high schools and special needs schools.[51] Within these schools there were 20 822 permanent and 2 014 demountable teaching spaces which accommodated an average of 18.2 students per teaching space (chart 9.1). The total land area of existing schools in the Sydney metropolitan region was approximately 3225 hectares.

9.1 Enrolments per teaching space by subregion, 2012



Data source: NSW Department of Education and Training data and the CIE.

Capacity in Sydney's education infrastructure

By 2016, it is expected that aggregate education infrastructure in the Sydney region will be over capacity. These capacity constraints are concentrated in primary schools in the near term. A permanent accommodation capacity deficit of over 23 000 enrolments is

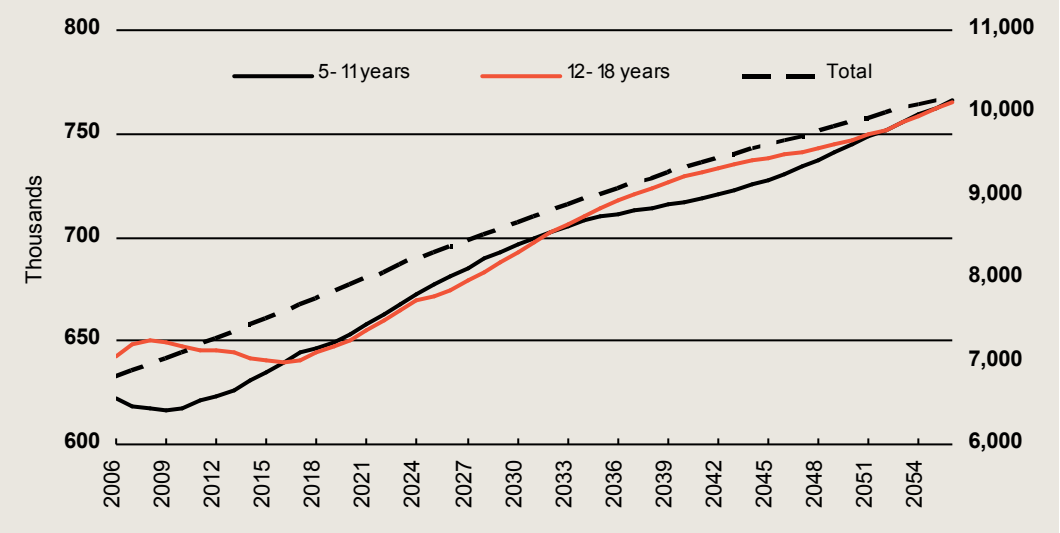
51 TAFE institutes have been excluded from the study given that the need for them to be localised to a particular geographical area is not great. Instead, many TAFE facilities tend to specialise in business areas and draw students from across the metropolitan area.

Schools for specific purposes have also been excluded from the analysis. Although an important element of education facility planning across the Sydney metropolitan area, the specific entry requirements and unique design characteristics of these schools makes comparison unsuitable. However, it is recognised that population growth will necessitate additional such schools.

expected in primary schools in 2016, while high schools are expected to have the facilities to accommodate a further 18 500 students. Given that there is currently an average of 23 students per teaching space in metropolitan infant and primary schools, keeping students per classroom constant would necessitate an additional 1029 primary school teaching spaces to accommodate the additional demand.

However, demographic factors are expected to lead to significant additional demand for secondary school facilities at a later stage. While the population aged between 5 and 11 years has began to increase significantly, the population aged between 12 and 18 years is expected to rise only from 2017 (chart 9.2). Expected higher demand for government high school facilities may be mitigated to some extent by the higher proportion of students who choose to leave the secondary school system and the presence of non-government sector providers, which typically capture a higher proportion of the secondary school market (compared to the primary school market).

9.2 NSW population projections

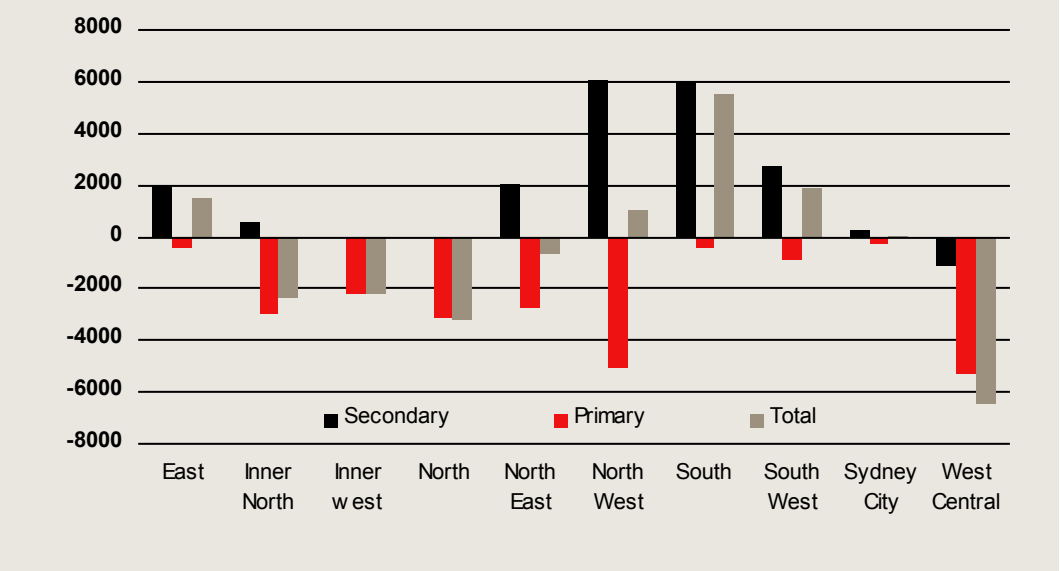


Data source: ABS 2008, *Population Projections, Australia, 2006 to 2101*, Cat. No. 3222.0, April.

However, such factors have been incorporated into planning models by DET and, as such, the demand shortfall may still be significant. Adding to this pressure, private sector providers may continue to only capture their current level of demand at the secondary level. Recent legislation that has raised the school leaving age to 17 years old may also exacerbate the demand shortfall.

Education capacity levels also differ among Sydney's geographical regions. In 2016, it is expected that there will be excess capacity in aggregate schools located in the East, North West, South and South West subregions. However, the expected aggregate capacity deficit is almost 15 000 enrolments, of which the West Central and North subregions are expected to account for around 43 per cent and 21 per cent of the shortfall respectively. We note that expected enrolment capacity differs significantly within subregions when clustered by primary and secondary school type. While all subregions are expected to have a capacity shortfall in primary schools in 2016, only the Central West is expected to have a secondary school shortage (chart 9.3).

9.3 Expected enrolment capacity by subregion, 2016

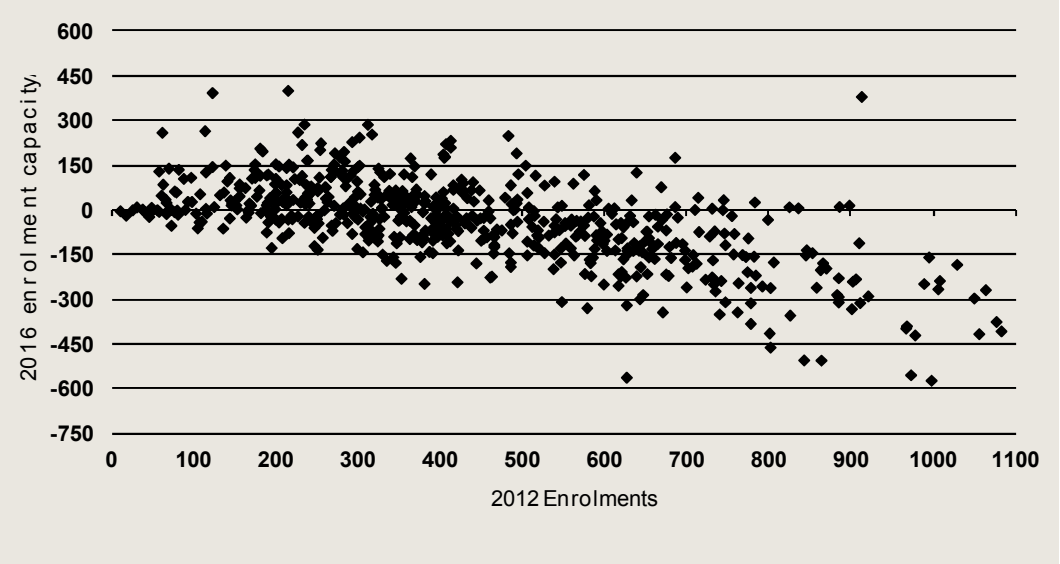


Data source: NSW Department of Education and Training data and the CIE.

We note however that these geographic subregions mask important differences across and within local government areas in future education service demand and capacity. Charts 9.4 and 9.5 show expected capacity and enrolments in 2016 for all primary schools and secondary schools respectively in the Sydney region. While 58 per cent of primary schools are expected to have a capacity deficit in 2016, this is true for only 28.5 per cent of Sydney's secondary schools. However, while the largest capacity shortfall is around 570 enrolments for primary schools, this figure rises to 890 in the case of secondary schools.

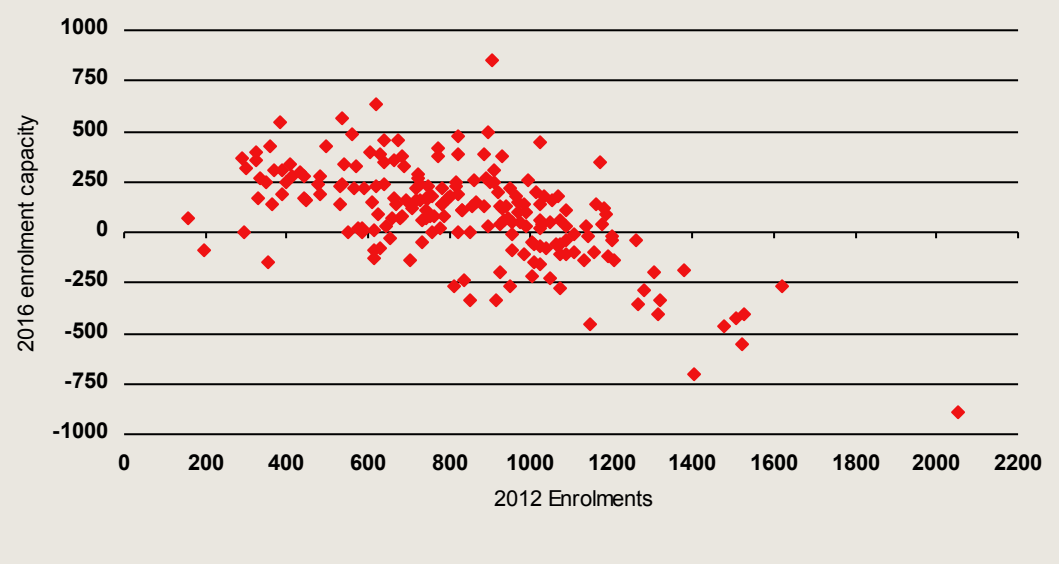
It is considered that capacity issues have arisen because of increasing fertility rates and a greater propensity for families to locate in higher density urban areas, which were not anticipated in strategic planning. School capacity has been further limited by policy prescriptions that aim to lower average class sizes and improve building standards, which increasingly demand additional space per student. For instance, practical activities areas, withdrawal spaces and additional storage are now standard requirements of modern primary school teaching spaces.

9.4 Expected enrolment capacity by primary school, 2016



Data source: NSW Department of Education and Training data and the CIE.

9.5 Expected enrolment capacity by secondary school, 2016



Data source: NSW Department of Education and Training data and the CIE.

School infrastructure provision also has limited location flexibility. NSW Department of Education and Training standards require that, as far as possible, a primary school should be within 1.6 kilometres road distance of the bulk of its likely drawing area to minimise the demand for bus transport.[52] However, the necessary land requirements for extending school facilities are relatively large,[53] and there are only limited cases where NSW DET has been able to expand an existing school through land acquisition. Such land purchases are subject to administrative procedures that limit the Department's ability to purchase appropriate lots of land in a permitting timeframe as they become

52 Department of Education and Training, *Requirements for New School Sites*.

53 The school facilities standard land area per student equated to around 70 metres squared.

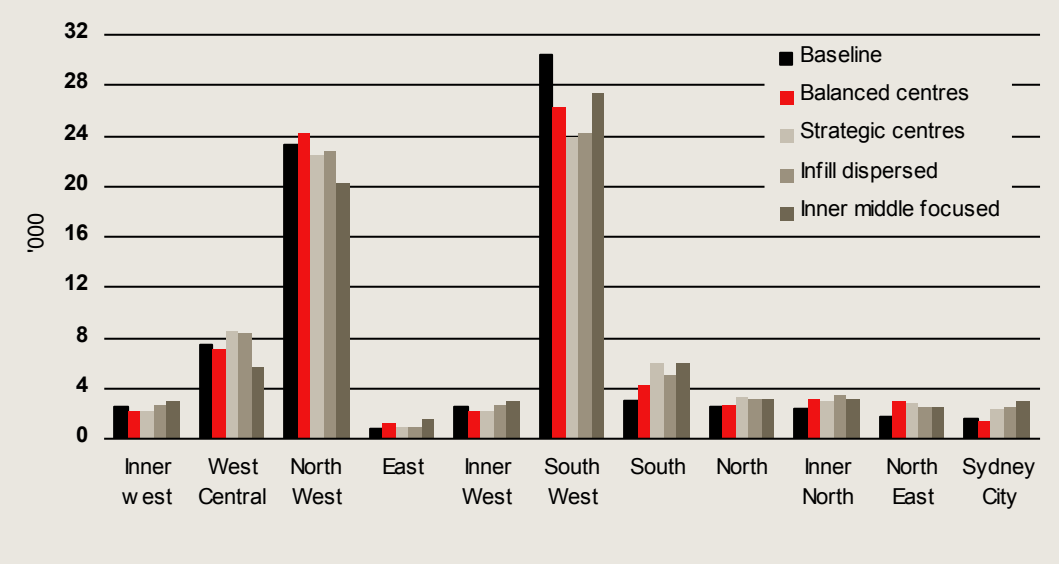
available. Further, a large stock of heritage listed buildings on existing school sites makes extension of current facilities more difficult.

Increasing enrolment density within the confines of existing school grounds, or creating 'medium density schools', is therefore an option currently being tested and pursued by the NSW Department of Education.

Additional enrolments by population distribution scenario

Under each population distribution scenario an additional 45 469 primary school enrolments and 31 319 secondary school enrolments are expected in the Sydney region in 2031.[54] On average across the scenarios, the North West and South West sub-regions are expected to account for 63 per cent of the additional enrolments. The enrolment distribution profile across the various sub-regions is relatively consistent across the scenarios (chart 9.6).

9.6 Additional school enrolments by scenario, primary and secondary 2031



Data source: NSW Department of Education and Training data and the CIE.

Costs of additional education infrastructure provision

The NSW Department of Education and Training has estimated approximate per capita building and development costs for upgraded school facilities as per table 9.7. Average costs per student place associated with an urban school redevelopment where the school

54 Projected enrolments are based on the proportion of both primary school and secondary school enrolments in 2012 in each school to the total population serviced by that school. This ratio (0.06 and 0.04 per cent for primary and secondary school enrolments respectively) is assumed to remain constant.

size is deemed to be inadequate are proportionally much larger than the cost of upgrading facilities were no land acquisition is necessary.[55]

9.7 Cost of providing upgraded school developments

	Primary schools (per student place)	High schools (per student place)
Core upgrade: school size is generally adequate[a]	$21 000	$31 000
Core upgrade: school size is generally inadequate[b]	$34 000	$50 000

[a] Upgrade by a combination of refurbishment and additions. [b] Upgrade by demolition of existing and multi-story rebuild on existing site.
Source: NSW Department of Education and Training (2012).

Aggregate relative costs were calculated on projected enrolments out to 2031 associated with each population growth scenario in excess of estimated capacity in 2016, the average land cost per student relevant in each travel zone, and building and development costs dependant on whether the average school size is deemed to be adequate or not.

Note that no costs of changes in the quality of school provision (such as crowding) were calculated given that education service standards were held constant for this exercise. That is, the cost of maintaining the average land available per student as enrolment populations increase is incorporated into the cost results.

Cost summary

We model the cost of providing additional education infrastructure through managing demand at a local government area level and managing demand at a school level. The first allows for greater flexibility by NSW Education to adjust school boundaries/drawing areas, while the second allows for less ability to adjust.

The cost of providing education infrastructure is likely to be large under all scenario (over $1.5 billion in present value). However, differences in the urban growth path have small impacts on these relative social infrastructure costs, with scenarios differing by less than $50 million over the period to 2031 where demand can be managed at a local government area level (table 9.8). (The numbers in table 9.8 are shown as benefits relative to baseline, hence a positive is a benefit.)

If demand is managed at a smaller spatial scale, the scenarios perform less well against the baseline. For example, the strategic centres scenario would cost an extra $366 million in present value today. This reflects that there would be much higher demand on a small set of schools under such a concentrated scenario and other schools in the same local government area but outside of centres would retain capacity.

55 School size was deemed adequate if the average land available per student was greater than the benchmark average school size (three hectares per primary school and six hectares per high school) divided by the benchmark number of students per primary and high school (provided by DET).

9.8 Relative education infrastructure impacts across scenarios

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Local government area					
Primary education	0	-18	13	-29	-38
Secondary education	0	19	-41	30	-5
Total	0	1	-27	0	-42
School level					
Primary education	0	-108	-161	-171	-154
Secondary education	0	-64	-205	-72	-84
Total	0	-172	-366	-244	-238

Data Source: The CIE

10 Local council costs

Local councils are responsible for administering their local government area. This includes the provision of services and amenity to residents such as land use planning, cultural development, local roads and waste management and community facilities such as child care and public libraries. In particular, when development occurs within a local council's jurisdiction, the council manages the provision of local infrastructure to meet the increased demand for facilities and services.

To fund the provision of infrastructure required to maintain facilities and services, development contributions are levied on new development sites. The Environmental Planning and Assessment Act 1979 (EP&A Act) sets out how the NSW's development contributions system works.

Funds can be raised to provide infrastructure including roads, public transport, streetscape, traffic management, storm water management systems, volunteer emergency service facilities, civic and urban improvements, open space and public domain, and cultural and community faculties.

Developer contribution charges levied by the local council provide an indication of the cost to maintain service levels with additional demand from development within the area. The link between developer contributions and the cost to council is not obvious primarily because developer contributions can be levied via one of two different methods.

This chapter reports developer contributions per person per local council. In some instances these charges may not reflect future costs. We make adjustments to developer contributions to provide an assessment of the local council infrastructure costs associated with new development.

Developer contributions framework

Local councils identify infrastructure needs and cost in Development Contributions Plans (DCPs). Under the EP&A Act, development contributions can be levied under either Section 94 or Section 94A of the EP&A Act.

- **Section 94**—a maximum of $20 000 per residential lot or per dwelling in established/infill development areas can be levied as a local development contribution.
- **Section 94A**—fixed development consent levels, consent authority may impose, as a condition of development consent, a requirement that the applicant pay a levy of the percentage of the proposed cost of carrying out the development, given it is authorised by a contributions plan. The maximum levy rates for different ranges of proposed cost of carrying out the development as specified under section 94E of the EP&A Act are given in table 10.1.

Development contributions cannot be levied under a Section 94 in addition to Section 94A for a given site.

Funds raised through development contributions under section 94 and section 94A are specified for the provision, extension or augmentation of the public amenities or public services as specified in the Development Contributions Plan.

10.1 Maximum Section 94A levy rates

Section	Percentage rate
All development types valued at $100 000 or less	0.0%
All development types valued at $100 001 and up to $200 000	0.5%
All development types valued in excess of $200 000	1.0%

Source: Environmental Planning and Assessment Regulation 2000, Division 1B — Development consent contributions, Section 25K: Section 94A levy-maximum percentage.

Size of developer contributions

Information on development contributions was collected from Section 94 and Section 94A Development Contributions Plans across the 41 Sydney Metropolitan local government areas.[56] Development contributions frequently levied funds for provision of community facilities, open space and recreation, public domain, accessibility and traffic and plan administration.

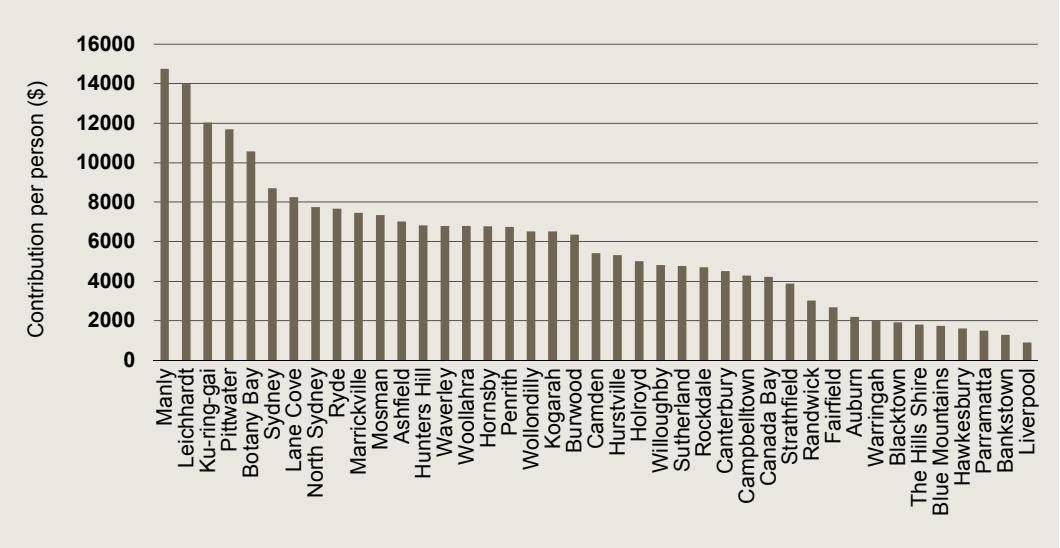
The average development contribution per person across the 41 LGAs was $5 797.[57] The lowest and highest contribution rate per person was $912 in established areas of Liverpool and $14 741 in Manly, respectively (chart 10.2). [58]

56 Excluding greenfield development areas

57 All estimates of contribution rates are in 2012 dollars

58 Estimates of contributions per person were provided in the majority of Section 94 contribution plans. Contributions per person from Section 94A plans were estimated by total works divided by number of new dwellings and the assumed occupancy rate per dwelling for each respective LGAs. Contribution rates per person were not available for Campbelltown, Waverley and Woollahra LGAs. Estimates for these three local councils are an average of developer contributions charged by local councils within the same subregion.

10.2 Development contributions – per person 2012 dollars



Data source: The CIE.

Of the average contribution charge, 60 per cent was collected for provision of open space and recreation, 18 per cent for community facilities and 11 per cent for civic urban improvements (table 10.3). The remaining was collected for provision of roads and public transport, traffic management and accessibility, environmental improvements, and to fund the cost of plan administration and management.

10.3 Contribution per person across major facility and service funding categories

	Contribution charges per person (2012$)			
Facility/service	**Average**	**Per cent**	**Min**	**Max**
Open space & recreation	3 485	60	0	12 116
Community facilities (incl. public domain & local facilities)	1 044	18	0	3 299
Civic urban improvements (incl. streetscape, landscape & flood and drainage management)	614	11	0	6 069
Transport (roads, public transport, accessibility, traffic)	467	8	0	4 428
Plan administration & management	67	1	0	311
Other (e.g. environmental improvements)	132	2	0	4 066
Total	**5 809**		**912**	**14 741**

Source: The CIE.

Do costs align with developer contributions?

The developer contributions levied by local councils within the Sydney metropolitan vary substantially (chart 10.2). The variation may reflect:

- the different requirements of each council and the cost of maintaining current service levels given existing infrastructure and layout;
- inconsistencies in the estimation and application of developer contributions by local councils resulting in contributions which are not cost reflective; or
- a mixture of both.

To some degree the cause of these variations can be investigated by examining local councils' financial statements.

Local councils' financial statements are reported alongside annual reports for each financial year. Included in the financial statement is *Note 17: Statement of Developer Contributions* which summarises the Council's recovered contributions and the expenditure of funds levied under Sections 94 and 94A. All contributions levied under Sections 94 and 94A must be utilised for the specific purpose they were levied as outlined in the relevant Contributions Development Plan. Interest earned on unspent funds must be attributed to remaining funds.

Information on developer contribution funds for each local council was collected from financial statements for 2010-11.[59] In particular information was gathered on the:

- opening balance;
- contributions received during the previous financial year;
- expenditure during the year; and
- contributions held as a restricted asset.

The contributions held as a restricted asset in 2010-11 varied considerably across local councils. In 2010-11 Mosman held $0 as a restricted asset, whilst Ku-ring-gai held the largest amount, $71 million, as a restricted asset (chart 10.4).

In 2010-11 there was a total of $626 million held as a restricted asset across 38 local councils for which data was available.[60] This is a substantial amount of money held within local councils to be spent on provision of facilities and services as necessary to accommodate development growth. It suggests that some local councils may be collecting developer contributions in excess of the funds which are actually spent, or that there are significant barriers to using these funds.

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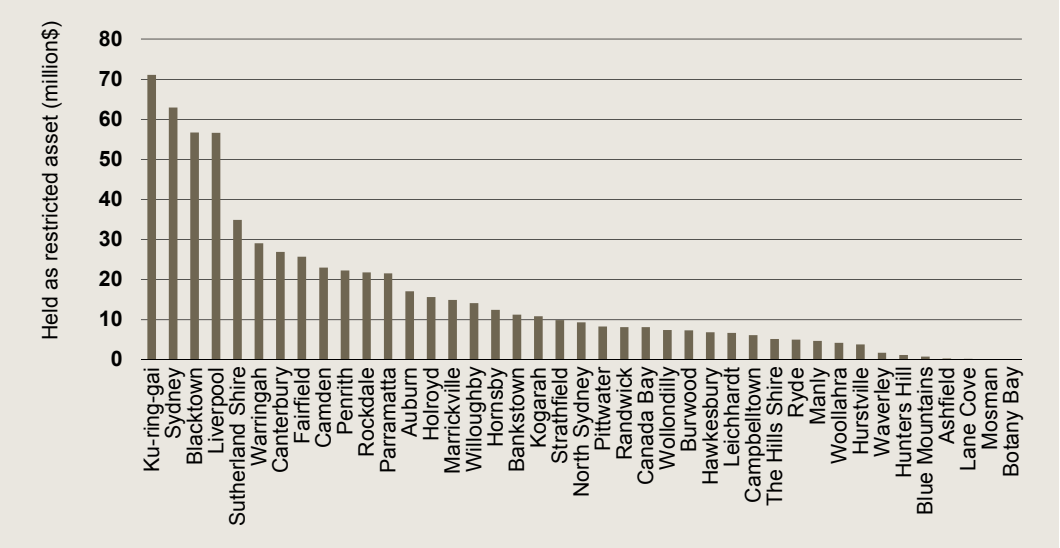
59 Botany Bay council does not publicly provide its financial statements so data on developer contributions could not be collected. Financial statements for 2010-11 for Canterbury and Lane Cove were not available but data for 2009-10 financial years were collected.

60 Data not available for Botany Bay, Canterbury and Lane Cove in 2010-11.

10.4 Contributions held as restricted asset by local councils in 2010-11 [a]



[a] Contribution held as asset in 2010-11 for Mosman council was $0. Financial statements for Botany Bay council not publicly available. 2010-11 financial statements were not publicly available for Canterbury and Lane Cove councils, data sourced from 2009-10 financial statements.

Data source: The CIE.

The relationship between the contributions held as a restricted asset per capita of growth by each local council and their recent developer contribution charges may indicate where developer contributions are not cost reflective. For example, a large amount held in asset per person coupled with a relatively high developer contribution may indicate charges are not cost reflective and are currently set above actual costs.

Chart 10.5 shows there is no systematic relationship between the amount held as a restricted asset per capita of growth and the current contribution levied per person. However there are a few councils which levy a relatively high developer contribution in addition to currently holding a relatively high amount in asset per capita of growth.

A cost reflective developer contribution charge was estimated for each local council by deducting the amount held as asset per capita of growth from the contribution charge currently levied. In many cases the amount held as a restricted asset by a given council decreased, in this case the amount held as asset per capita of growth would be negative but has been assumed to be zero.

10.5 Relationship between per capita size of asset to contribution per person

Note: "Amount held/growth person" is equivalent to the change in the amount held as a restricted asset from 2006 to 2011, divided by the number of new people in the area between the same time period 2006 to 2011.

Data source: The CIE.

This potential excess in developer charges was subtracted from total costs to estimate the cost per new person across the 41 local councils resulting from new development.

The growth in the amount held as a restricted asset was divided by the growth in population between 2006-2011. This provided an estimate of the asset held per person of growth in this period and an indication of whether there was an excess charged. As of 2010-11, ten local councils had an excess of greater than $1 000 per person held as a restricted asset (table 10.6).

10.6 Councils with holdings greater than $1 000 per person

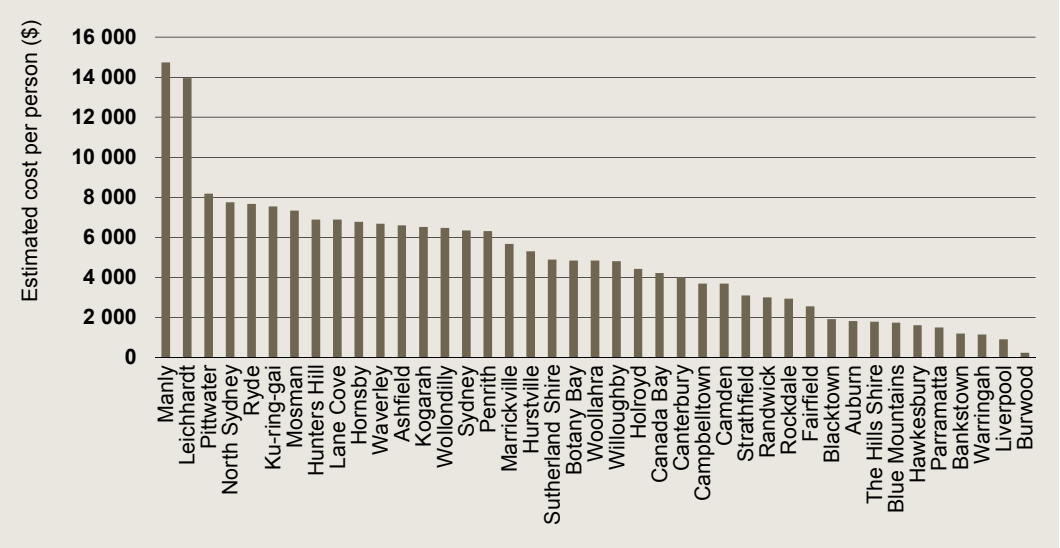
Excess held as restricted asset per person	Local council
$1 001 - $2 000	Marrickville, Rockdale
$2 001 - $4 000	Campbelltown, Pittwater, Sydney, Woollahra
$4 000 - $6 000	Camden, Ku-ring-gai
$6 000 - $8 000	Burwood, Sutherland Shire

Note: Some areas of these local councils are within greenfield areas.

Source: The CIE.

The estimated cost per person is substantially large in Manly and Leichhardt local government areas, estimated as over $14 000 per person respectively (chart 10.7). The estimated cost in Pittwater, North Sydney, Ryde, Ku-ring-gai and Mosman ranged between $7 000 to $8 200 per person. At the other end of the spectrum the local government areas with the lowest estimated cost were Burwood and Liverpool with an estimated cost less than $1 000 per person.

10.7 Estimated costs per person – 2012 dollars per person



Note: Estimated cost per person for LGAs with missing data are based on an average of costs in the respective subregions.

Data source: The CIE.

There are limitations using the amount of contributions held by a local council to estimate costs. The amount of contributions held by a local council in a given financial year provides a rough indication of any excess between the contributions levied and the amount of contributions actually spent. However it does not provide a complete picture because the amount remaining in restricted asset may be determined by the timeframe of the contributions plan. It may be that the contributions plan requires a significant outlay of funds in subsequent years which may substantially draw down the restricted asset. It is also not accurate to compare the amount held in asset across local councils because contributions relate to developer contributions plans (DCPs), which vary considerably across local councils. For this reason we use the change from 2006 to 2011. Also, if council underestimate costs this is not picked up in the analysis.

Cost of development by scenario

All scenarios impose higher local council costs than the base case (table 10.8). This reflects the systematic shifting of development towards local government areas as per the Metropolitan Strategy. The poorest performing scenarios are the infill dispersed and inner middle scenarios, imposing an extra $70-$80 million cost for local council infrastructure in present value terms from new development from 2016 to 2031.

There may also be differential impacts on infrastructure costs within a local government area. However, no information is available with which to assess any such impacts.

10.8 Relative local council impacts across scenario

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Local councils	0.0	-27.7	-19.7	-77.2	-74.6

Data Source: The CIE

11 Environmental impacts

The extent and type of environmental impacts will vary under different growth scenarios for Sydney. Higher density in strategic centres will tend to reduce vehicle kilometres travelled (VKTs) relative to lower density housing located at a distance from business areas. Dwelling density may influence the quantity of greenhouse gases produced by households.

Coverage of environmental impacts

There are many different environmental impacts arising from different urban growth paths. It is important to distinguish the environmental impacts that are influenced by the choice of urban growth patterns as opposed to environmental impacts which will be incurred regardless as the region accommodates a growing population. For this study we focus our attention on how the following environmental impacts change under different urban growth scenarios:

- **Greenhouse gas emissions**—urban growth scenarios can influence the amount of greenhouse gases that are emitted due to transport and in-dwelling use and construction.
- **Air pollution from transport**—the location of dwellings relative to workplace influences the vehicle kilometres travelled and subsequent air pollution. Urban growth scenarios which reduce VKTs reduce air pollution. Air pollution can be both a local phenomenon, (with pollution higher right next to roads) and a Sydney-wide problem with air pollution concentrating in particular areas due to topography.
- **Biodiversity**—can be negatively or positively impacted by urban growth scenarios. Scenarios which increase prevalence of native species relative to the baseline will improve biodiversity whilst scenarios which remove native species and habitat will degrade biodiversity. The degree of impact primarily depends on the existing state of biodiversity and its connectivity to other zones of biodiversity.

There are other areas that we have not quantified and valued in this study, such as impacts on waste or water quality and quantity. We expect these impacts to be relatively similar across all scenarios, as all scenarios impose the same population change.

Greenhouse gas emissions

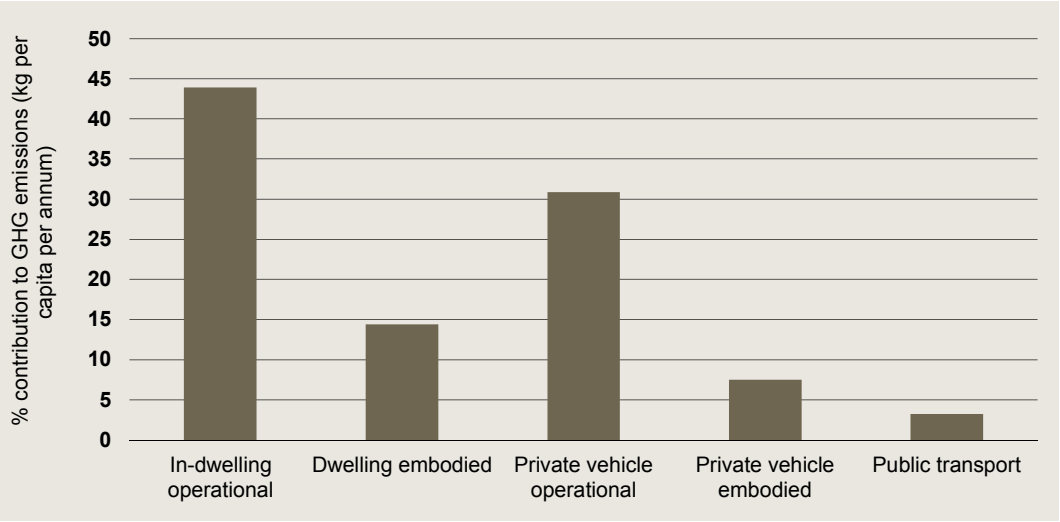
The key generators of greenhouse gas emissions which differ by type of urban growth scenario are transport and in-dwelling use. The level of transport is influenced by the distance between people's homes and workplace and the provision of services within the local area. Greenhouse gases generated through in-dwelling use will vary by the type of dwelling people choose to build in different areas and the climatic conditions associated with different areas.

The amount of greenhouse gas emissions will also depend on the types of energy used in the future, both in-house (such as gas, electricity and solar) and for the power stations and the energy mix (gas, electricity and solar) used by appliances. Policies that make electricity sources and transport fuels less greenhouse gas intensive, such as the current Clean Energy Future scheme, will reduce the difference in production of greenhouse gases between alternative land use scenarios.

A recent study by Peter Rickwood has examined the impact of urban planning on both aggregated dwelling-related and transport-related household energy use.[61] This study included greenhouse gas emissions from transport and from dwellings. Dwelling related energy use and emissions factors in the energy used in creating the dwelling (embodied energy) as well as the energy used by people living in the dwelling.

Under Rickwood's baseline scenario the largest contributors of household GHG emissions are in-dwelling energy use followed by petrol consumption. Contributions from dwelling embodied and private vehicle embodied energy are less significant. The contribution from public transport is relatively small (chart 11.1).

11.1 Proportional contribution to per capita GHG emissions by category



[a] Baseline scenario with projected breakdown (by category) of GHG emissions in 2031

Data source: Rickwood, P. 2009. *The impact of physical planning policy on household energy use and greenhouse emissions*, submitted for PhD to University of Technology Sydney, October.

This study considered alternative scenarios for land use and associated energy use and greenhouse gas emissions. We draw heavily on their analysis for our modelling by adjusting the information from the wide range of scenarios used in the Rickwood study to fit the scenarios adopted in our study.

The scenarios considered by Rickwood (2009) do not align exactly with those that we consider. The scenarios can be considered as varying a number of factors:

- The share of development occurring on Sydney's fringe
- The share of development in existing areas located near centres

61 Rickwood, P. 2009. *The impact of physical planning policy on household energy use and greenhouse emissions*, submitted for PhD to University of Technology Sydney, October.

- The nature of development near centres – East Asian style high rise or European style medium rise

A key finding from Rickwood, was that overall shifting infill development between centres and existing suburbs makes little difference to greenhouse gas emissions.[62]

Four of Rickwood's scenarios are centre focused—scenarios 7, 8, 9 and 10 with variations between medium and high density dwellings. Scenarios 7 and 8 model medium and high density, respectively, with a focus on centres and scenarios 9 and 10 also model medium and high density, respectively, with a strong focus on centres. The change in energy use per capita from moving from medium density to high density dwellings. Below are key findings from comparing these scenarios.

- **Focus on centres (scenarios 7 and 8)**— Shifting dwellings from medium density to high density increases GHG emissions (per capita/year) from in-dwelling energy use and dwelling embodied energy by 3 per cent and 4 per cent respectively. Conversely, GHG emissions from private vehicle use and private vehicle embodied energy both decrease by 1 per cent. GHG emissions from public transport increases by 1 per cent.
- **Strong focus on centres (scenarios 9 and 10)**—the relative change in GHG emissions between medium and high density increases in scenarios with a strong focus on centres. GHG emissions from in-dwelling and dwelling embodied uses increase by 5 per cent and 8 per cent respectively, whilst GHG emissions from private vehicle use and embodied in private vehicles decreases by 3 per cent and 1 per cent respectively. GHG emissions from public transport increase by 2 per cent. The overall change in GHG emissions from a shift from medium to high density in scenarios with a strong focus on centres is a 3 per cent increase in GHG emissions.

From the scenarios in Rickwood, we can deduce the change in GHG emissions (kg/capita/year) for each scenario in the analysis relative to the baseline scenario (table 11.2).

62 Rickwood, P. 2009. *The impact of physical planning policy on household energy use and greenhouse emissions*, submitted for PhD to University of Technology Sydney, October. Page 280.

11.2 Estimated GHG emissions per capita

	Proportion of growth			GHG emissions per capita (kg)	Relative change to baseline (kg/capita)
	Fringe	Suburbs	Centres		
Baseline	35.8	28	36	5 927	0
Balanced centres	35.8	13	51	5 894	-33
Strategic centres	35.8	13	51	5 894	-33
Infill dispersed	35.8	51	13	5 978	51
Inner middle	35.8	27	38	5 924	-3

Note: The CIE based on results in Rickwood, P. 2009. *The impact of physical planning policy on household energy use and greenhouse emissions*, submitted for PhD to University of Technology Sydney, October.
Data Source: The CIE

To value the changes in GHG emissions reductions from land use, we use the carbon price set out in Australian Government Clean Energy Future Scheme. The carbon price will begin as a fixed price at $23 per tonne from July 2012 and remain fixed for the first three years, rising by 2.5 per cent each year in real terms. From 2015 the carbon price will be a flexible price set by the market under an emissions trading scheme.[63] Applying a $23 per tonne in this analysis over the time period until 2031 may overstate the cost of GHG emissions because many commentators project the carbon price to fall post 2015.

It should be noted that the carbon price in the Treasury modelling reflects the economywide marginal cost of abatement. There may also be additional costs of adapting to the effects of climate change which could vary across regions. Different parts of Sydney, for example, may face adaptation costs such as increased health related costs attributable to heat stress, increased risks of bushfires and additional infrastructure costs. These costs have not been included in our analysis.

Air Pollution

Air pollution imposes substantial health impacts on the community.[64] Population groups particularly susceptible include the young, elderly and those with pre-existing health conditions.

In order to help protect the health of the Australian population, the National Environment Protection Council (in 1998) set ambient air quality standards and goals for six criteria pollutants in the National Environment Protection Measure for Ambient Air Quality (AAQ NEPM). The six pollutants in the AAQ NEPM are ozone, particles, carbon monoxide, nitrogen dioxide, sulphur dioxide and lead. The AAQ NEPM standards are currently under review.

Of particular concern for human health are emissions of particulate matter with aerodynamic diameter 10 (PM_{10}) and aerodynamic diameter of 2.5 ($PM_{2.5}$). Both can cause mortality or morbidity from either short term or long term exposure. Key health

63 Australian Government, 2012. *An overview of the Clean Energy Legislative Package*. http://www.cleanenergyfuture.gov.au/clean-energy-future/an-overview-of-the-clean-energy-legislative-package/

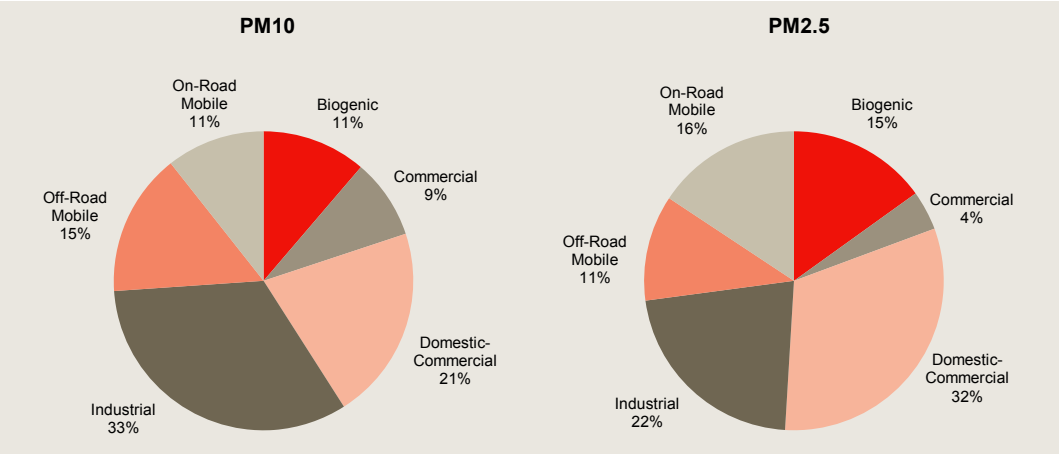
64 NSW Department of Environment and Conservation (DEC), 2005. *Air Pollution Economics: Health Costs of Air Pollution in the Greater Sydney Metropolitan Region.* Department of Environment and Conservation NSW.

conditions linked to exposure include cardiovascular and respiratory disease, bronchitis, asthma attacks, reduced lung function and restricted activity days.

Recent epidemiology research suggests there is no safe level of exposure to some criteria pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}).[65] In order to minimise the health impacts a national exposure reduction framework is being investigated as part of the current review of the NEPM. Key areas of exposure to be investigated in the framework include areas adjacent to main roads which are exposed to the emissions from motor vehicles, buses and freight vehicles.

The NSW Air Emissions Inventory provides a detailed listing of pollutants discharged into the atmosphere by each source type during a given time period and at a specific location.[66] Air pollution can come from a number of sources, of which transport is a particular focus of this study as industry composition is assumed to be the same for each scenario. In the Sydney region, the on-road mobile sector (incl. passenger motor vehicles and freight vehicles) contribute 11 per cent and 16 per cent of PM_{10} and $PM_{2.5}$, respectively (chart 11.3).

11.3 Emissions of particulate matter (PM2.5 and PM10) – Sydney region



Data source: DECCW, 2007. *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales: emissions to area report analysis for criteria pollutants.* Technical Report No. 10.

Urban growth patterns can influence key transport factors such as vehicle kilometres travelled and the mode of transport. Both of these factors influence the amount of air pollution generated by motor vehicle transport. We have estimated the change in vehicle kilometres travelled (VKTs) for each main transport mode under each scenario. We applied a unit cost of air pollution per VKT available in the literature to estimate the cost of air pollution for each scenario. The Bureau of Transport and Regional Economics uses an estimate that each kilometre of urban car travel incurs 2.5 cents (in 2007 dollars) in air pollution costs.[67] Similarly, RailCorp (2007) estimate the cost of air pollution as 2.6 cents

65 World Health Organization (WHO), 2006. *Air Quality Guidelines: Global Update 200. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide.* World Health Organization.

66 DECCW, 2007. *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales emissions to area report analysis for criteria pollutants. Technical Report no. 10.* http://www.environment.nsw.gov.au/air/airinventory.htm

67 Bureau of Transport and Regional Economics 2007, *Estimating urban traffic and congestion cost trends for Australian cities.* Working Paper no. 71, p.79.

per car kilometre travelled (in 2006-07 dollars). The cost of noise pollution is estimated as 0.9 cents per car kilometre travelled (in 2006-07 dollars). [68]

Other modes of transport also produce air pollution, although much smaller amounts than cars. For instance, air pollution costs attributable to buses are estimated at 32.8 cents per vehicle kilometres (in 2006-07 dollars) and air pollution costs for rail are estimated at 0.9 cents (in 2006-07 dollars) per rail car kilometre. [69] The cost of noise pollution attributable to these two transport modes are 2.1 cents per bus vehicle kilometre and 3.7 cents per rail car kilometre (in 2006-07 dollars).[70]

Our modelling does not capture all possible impacts of land use scenarios on air pollution costs. Some areas of Sydney are more susceptible to air pollution than other for reasons related to topography and the weather. This means that smog can concentrate in particular areas. If more people were to live in these areas then air pollution costs would be higher than accounted for in this report. The national exposure reduction framework currently being developed will be better able to identify variation in exposure to air pollution across airsheds.

Biodiversity

Biodiversity includes all plants, animals, fungi, bacteria and other micro-organisms in the natural environment. It encompasses three components: genetic diversity, species diversity and ecosystem diversity, which comprise composition (species and genes), structure (vegetation and landscape structure) and function (ecosystem processes including nutrient and energy cycling).[71]

Society places value on biodiversity both for its intrinsic value and also the ecosystem services it provides. Healthy ecosystems are critical to the wellbeing of current and future generations.[72]

The impacts on biodiversity from urban development differ by the type of development, the existing biodiversity located on the site and the connectivity of the site to other areas of biodiversity. Some urban development may improve biodiversity on a site by replacing or increasing the number of native species whilst other forms of development might remove or degrade native species. For example, the clearing of habitat to increase dwelling numbers in a low density residential area would negatively impact on biodiversity, particularly if threatened species, habitat or communities are cleared.

Urban development can also impact on aquatic biodiversity. For example, urbanisation of outer city areas can impact on aquatic biodiversity through increased levels of polluted

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68 RailCorp 2007, *The value of CityRail to the NSW Community,* November, pp. 20-21.

69 RailCorp 2007, *The value of CityRail to the NSW Community,* November, pp. 20-21.

70 RailCorp 2007, *The value of CityRail to the NSW Community,* November, pp. 20-21.

71 DECCW, 2010. *Draft NSW Biodiversity Strategy 2010-2015.* http://www.environment.nsw.gov.au/resources/biodiversity/strategy/10821DraftBioStrat.pdf

72 DECCW, 2010. *Draft NSW Biodiversity Strategy 2010-2015.* http://www.environment.nsw.gov.au/resources/biodiversity/strategy/10821DraftBioStrat.pdf

run-off from surfaces hardened for new roads and housing or loss or fragmentation of riparian vegetation cleared for development.

The impact on biodiversity from different urban development forms can not be quantified in this study because of a lack of detailed information on the spatial location of the population and the specific biodiversity characteristics within each LGA.

The focus of this study is assessing different scenarios of infill development, as opposed to development within greenfield areas which we reviewed in our previous study.[73] It is anticipated the biodiversity impacts are relatively small in scenarios of infill development because development has already taken place on the site. However, impacts may occur if development degrades biodiversity connectivity between existing biodiversity sites. Sites of high value biodiversity have already been identified and isolated within the Sydney Metropolitan area. These include national parks, nature reserves, state conservation areas, regional parks and bushlands reserves located across SMA. The constraints on land availability implied by these areas are maintained across all scenarios.

The development approval process includes measures to mitigate impacts on biodiversity arising from development. These measures aim to 'improve or maintain' biodiversity without inhibiting development. Examples include biodiversity certification and Biobanking. BioBanking is a market-based scheme that enables biodiversity credits to be created and sold to offset the impact on biodiversity values that are likely to occur as a result of urban development.

Summary

The environmental benefits of scenarios relative to baseline are shown in table 11.4. The balanced centres, strategic centres and inner middle scenarios generate environmental benefits of $20-$20 million in present value terms from 2016 to 2046. The infill dispersed scenario is slightly worse than the baseline.

11.4 Environmental impacts across scenarios

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
GHG emissions	0.0	1.8	1.8	-2.8	0.2
Air pollution	0.0	14.2	20.3	-0.6	17.1
Noise pollution	0.0	4.9	7.0	-0.2	5.9
Total	0.0	20.9	29.1	-3.7	23.1

Data Source: The CIE

73 The CIE, 2010. *The benefits and costs of alternative growth paths for Sydney: economic, social and environmental impacts.*

12 Social impacts

The way a city is designed might have substantial social impacts related to the health and wellbeing of people living in the city, or the social capital of a city or area. Potentially, strategic city structure may also change the likelihood or prevalence of pockets of disadvantage within a city.

Teasing out causal social impacts from city spatial structure is difficult. In many instances, strategic level impacts will be outweighed by local level design issues, provision of government services and selection processes that operate within cities through house prices. Nevertheless, there is a substantial literature that seeks to link changes in population density and travel patterns with a range of both positive and negative social and health impacts, which is discussed below.

Density and wellbeing

Increased density has been associated with both higher[74] and lower[75] levels of well-being as measured by various self-reported indicators. This can be explained by the complex and often conflicting relationships between population density, personal well-being and the risk of social exclusion. On the one hand, particular features of the built urban environment under increased population will tend to facilitate increased social mobility.[76] For instance, proximity to shops because of mixed use zoning in dense urban environments makes it easier for people to move around without the use of a car. This leads to a lower risk of social exclusion because residents in a dense urban environment become less physically isolated from each other. Moreover, the convenient transportation opportunities associated with living closer to areas of employment, which is where areas of high population density tend to be may also reduce the time spent commuting; higher commuting times have been found to be associated with reduced social connections and therefore a potentially higher risk of social exclusion, with one rule of thumb being that every 10 minutes of commuting results in 10 per cent fewer social connections.[77]

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74 See Halloran, T. 2012, 'Better together? Population density and well being in the United States' which is based on US data.

75 See for instance Cummins, R. 2005, 'The Personal Wellbeing of Australians Living within Federal Electoral Divisions' which found that the highest reported levels of well being were in federal electoral divisions with low levels of population density with the exception of Higgins, which suggests that wealth moderates the effects of population density on subjective wellbeing. The Divisions with the highest levels of personal wellbeing tend to lie outside the metropolitan regions of capital cities.

76 For more on the relationship between urban design and mobility facilitating social connection, see Kelly, J. 2012, 'Social cities', Grattan Institute.

77 Putnam, R. 1995, *Bowling Alone: The Collapse and Revival of American Community*. Car commuting in particular has been found to one reason for a decline in social capital – Leigh, A. 2010, *Disconnected*, University of New South Wales Press. Holt-Lunstad, J., Smith, T. B. and

Essentially when a residential area is so poorly organised that it is difficult for residents to get around, this can reduce the number of social connections and therefore reduce well being.

On the other hand, most (but not all) of the studies we have reviewed which have explored the relationship between reported personal well being and population density have found that measures of well being are higher in areas of lower population density[78]. This has been attributed to a reduced feeling of connection to the community in areas of higher population density. However the negative relationship may also reflect the process of self-selection of typical residents in high population density versus low population density areas. For instance, recent immigrants, singles and younger to middle aged people[79] may be more likely to settle in high population density areas because these tend to be areas with the greatest employment opportunities, and the lower reported levels of well being may reflect the particular life circumstances of these groups (e.g. lower accumulated assets, the stresses of settling into a new society or moving into the job market). By contrast, areas of lower population density may be more likely to be populated by retirees who have already accumulated assets and thus enjoy higher life satisfaction.[80]

Thus the evidence on the relationship between population density and subjective well being is mixed. On the one hand, density may increase well being because the physical environment built around high density area is facilitative of greater mobility and therefore increased social connections. On the other hand, there seems to be substantial evidence at least from the Australian well being data, that high density may lead to a reduced feeling of connection to the community, though it may be difficult to disentangle this relationship from the demographic characteristics of people who settle in different areas.

The complex relationship between increased population density and well being also has implications for broader health outcomes. Some health outcomes may reflect the features of the built environment in high density areas as much as the intrinsic factor of crowding

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Layton, J. B. 2010, 'Social Relationships and Mortality Risk: A Meta-analytic Review', PLoS Med. looked at morbidity data for more than 300,000 people over an average time span of 7.5 years and found a 50 per cent increase in odds of survival as a function of social relationships. Klinenberg, E. 2002, *Heat Wave: A social autopsy of disaster in Chicago*, University of Chicago Press found that fewer people died in neighbourhoods where people knew and trusted their neighbours, than in a nearby area with weak social connections.

78 See the various studies involving the Personal Wellbeing Index by Cummins 2005, 'The Personal Wellbeing of Australians Living within Federal Electoral Divisions' and Cummins, R. 2008, 'The Wellbeing of Australians – Differences between statistical sub-divisions, towns and cities'.

79 On well being based on immigration status, Cummins 2005, 'The Personal Wellbeing of Australians Living within Federal Electoral Divisions' found that ethnic diversity is far higher within electoral divisions reporting low levels of personal well being. On married couples versus singles and young versus old, the same study found that the electoral divisions with the lowest reported levels of well being contain 11.6% fewer people who are married and almost double the population of people who have never married and that respondents in the electoral divisions with the highest levels of well being contained people who are significantly older.

80 Cummins et al 2011 notes that there is a U shaped relationship between age and reported sense of well being. In addition, those who are retired report above normal levels of personal well being.

itself and some may reflect an element of self-selection among the populations that choose to live in high density areas and those that choose to live in low density areas. In particular living in areas of increased population density appears to be related to better cardiovascular health. This may be related to the increased opportunities for mobility promoted by the built environment in high density areas which means there are more opportunities for walking and cycling to work or to the shops.[81]. This is because high density appears to be a necessary condition for mixed land use and accessible destinations and transit, with a density of 35 persons per hectare expected to increase access to public transport and support local shops and services.[82]

Studies have also found a link between increased population density and increased incidence of mental and behaviourial problems.[83] There is a possible confounding factor in this particular relationship because further study reveals that it is not high population density as such which contributes to the increased rates of mental and behaviourial problems but particular housing environments found in high population density areas. For instance, it has been found that residents of high rise housing have more mental and behaviourial problems than people living in low-rise or single-detached housing.[84] This may reflect the poor environment (in terms of noise reduction from overcrowding, etc) and ***enforced interactions*** that characterises low income/high density housing and these effects may be moderated or negated in wealthier housing areas.

The many studies on the health impacts of density are allow for no general causal conclusions.[85]

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81 Transportation Research Board. 'Does the built environment influence physical activity? Examining the evidence.' Washington, DC: Transportation Research Board, 2005; Ewing R, Schmid T, Killingsworth R, Zlot A, Raudenbush S. 'Relationship between urban sprawl and physical activity, obesity and morbidity.' Am J Health Promot 2003; 18(1):47-57; Robertson-Wilson J, Giles-Corti B. 'Walkabilility, neighbourhood design, and obesity.' In: Townsend T, Alvanides S, Lake A, editors. Obesogenic environments: complexities, perceptions and objective measures UK: Wiley-Blackwell, 2010.

82 Newman, P. and J. Kentworthy 2006, 'Urban design to reduce automobile dependence', Opolis 2(1): 35-52.

83 Evans GW, Wells NM, Moch A. 'Housing and mental health: a review of the evidence and a methodological and conceptual critique.' J Soc Issues 2003; 59(3):475-500; Freeman H. Mental health and high-rise housing. In: Burridge R, Ormandy D, editors. Unhealthy housing: research, remedies and reform Hoboken: Spon Press, 1993; Evans GW, Lercher P, Kofler WW. Crowding and children's mental health: the role of house type. J Environ Psychol 2002; 22(3):221-231.

84 Evans GW, Wells NM, Moch A. 'Housing and mental health: a review of the evidence and a methodological and conceptual critique.' J Soc Issues 2003; 59(3):475-500.

85 Youde Gou 2011, 'Urbanisation and disease patterns in Shanghai'. For more evidence on the relationship with cancer see Mahoney MC, Labrie DS, Nasca PC, Wolfgang PE, Burnett WS. Population density and cancer mortality differentials in New York state, 1978 1982. Int J Epidemiol 1990; 19(3):483-490; Yang C-Y, Hsieh Y-L. The relationship between population density and cancer mortality in Taiwan. Jpn J Cancer Res 1998; 89(4):355-360 Van Hooijdonk, C. et al 2008, 'Higher mortality in urban neighbourhoods in the Netherlands: who is at risk?', J. Ep. Com. Health 62(6): 499-505; Factor R. and I. Waldon 1973, 'Contemporary population densities and human health', Nature 243(5407): 381-384; Martikainen, P. et al 2003, 'Effects of the characteristics of neighbourhoods and the characteristics of people on cause specific mortality: A register based follow up study of 252,000 men', J. Ep. Comm. Health 57(3): 2101-217; Leaderer BP, Belanger K, Triche E, Holford T, Gold DR, Kim Y, et al. Dust mite,

Social impacts from alternative scenarios for infill development

All the scenarios that we consider allow for an increase in density, with differences being between high density and medium density development, for which there is less work than for low density to high density. The social implications of land use change are complicated and, as noted by the Grattan Institute, are not likely to be deterministic — within any scenario there is the possibility for better or worse social outcomes.[86]

In many areas of social impact, the methodologies to allow for inclusion of social impacts into benefit cost analysis are relatively undeveloped or do not fit well within a benefit-cost framework. Given this, we limit the quantitative analysis to the following areas related to transport and mobility.

- There have been a range of studies which have quantified the benefits of walking and cycling in terms of a dollar value per kilometre walked or cycled. In the context of a public health system, health benefits naturally fit within the ambit of benefit-cost analysis as an externality. We use figures of $1.68 per km (in 2010 dollars) and the benefit of cycling at $1.12 per km from work undertaken in Queensland.[87] The distance cycled and distance walked are obtained for each scenario from the transport modelling undertaken by the Bureau of Transport Statistics.
- Social exclusion may result from reduced access to services and transport. One study suggests that each additional trip could be valued up to as much as $19.30 per trip.[88] However, this estimate is likely to be on the high side due to people with a tendency for social exclusion to undertake fewer trips and for reduced accessibility (and hence reduced trips) to exacerbate social exclusion. This study notes findings from generalised cost studies would be around a quarter of this, and we apply this ratio to their estimate. We also adjust the estimate for an average income household. This gives a final value of $4.10 per additional trip. This is applied to trip numbers from the transport modelling undertaken by the Bureau of Transport Statistics.

In estimating social exclusion/inclusion changes between scenarios the transport services provided are the same for each scenario. It is likely that social exclusion is more closely

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cockroach, cat, and dog allergen concentrations in homes of asthmatic children in the Northeastern United States: impact of socioeconomic factors and population density. Environ Health Perspect 2002; 110(4):419; Duhme H, Weiland SK, Keil U, Kraemer B, Schmid M, Stender M, et al. The association between self-reported symptoms of asthma and allergic rhinitis and self-reported traffic density on street of residence in adolescents. Epidemiology 1996; 7(6):578-582; Burrows, B. et al 1989, 'Association of asthma with serum IgE levels and skin test reactivity to allergens', New England Journal of Medicine 320(5): 271-277; Peat, JK et al 1996, 'House dust mite allergens A major risk factor for childhood asthma in Australia', Am. J Respir Crit Care Med 153(1): 141; Baker S, Whitfield R, O'Neill B. 'Geographic variations in mortality from motor vehicle crashes'. New Engl J Med 1987; 316(22):1384-1387; Clark DE. Effect of population density on mortality after motor vehicle collisions. Accident Anal Prev 2003 35(6):965-971.

86 Grattan Institute 2012, *Social Cities,* March.

87 SKM and PWC 2011, *Benefits of the inclusion of active transport in infrastructure projects,* prepared for Queensland Transport and Main Roads.

88 Stanley, J. et al 2010, 'Social exclusion and the value of mobility', Institute of Transport and Logistics Studies.

related to those without access to car, such as those unable to drive or those unable to afford a car. Hence public transport services are likely to be important in alleviating social exclusion. While not valued in this report, scenarios focused on centres would be expected to be more conducive to additional viable public transport services. This suggests that the social inclusion aspects of these scenarios may be undervalued in our analysis.

The transport changes in 2031 for each scenario are shown in table 12.1.

12.1 Transport changes for social valuation 2031

	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle
Distance walked (million kms)	976	988	988	979	983
Value of distance walked ($m)	1 639.0	1 659.9	1 659.4	1 645.4	1 650.7
Difference to baseline ($m)	0.0	20.9	20.4	6.4	11.7
Distance cycled (million kms)	105	105	105	106	105
Value of distance cycled ($m)	117.4	117.7	117.5	118.6	118.1
Difference to baseline ($m)	0.0	0.3	0.0	1.1	0.7
Number of trips	2 679	2 681	2 680	2 676	2 675
Value of trips to baseline ($m)	0.0	5.8	3.4	-11.8	-16.4

Note: We use scenarios that change dwelling and employment at the same time.

Source: The CIE.

Summary

The overall impacts from 2016 to 2046 across scenarios are shown in table 12.2. The balanced centres and strategic centres scenarios perform better because than the baseline because they encourage more active transport and more trips. This would be expected to provide health benefits (partly in the form of avoided or delayed public health expenditures) and to reduce costs arising from social isolation through access to transport making mobility easier.

12.2 Social impacts across scenarios

Cost item	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle focused
	$m	$m	$m	$m	$m
Active transport	0.0	66.8	64.1	23.6	38.9
Trip value	0.0	18.1	10.8	-37.0	-51.7
Total	**0.0**	**84.9**	**74.9**	**-13.4**	**-12.8**

Data Source: The CIE.

13 Productivity spillovers

A major reason for the existence (and success) of cities is their ability to increase the productivity with which goods and services are produced. The major way in which this happens is through businesses being closer to one another, allowing knowledge to move between businesses and improving the interlinkages in the supply chain.

Because of their impact on productivity, as well as the type of economic activity that occurs, cities and particularly business districts offer higher wages than other areas.

This chapter sets out the relationship between the spatial structure of a city and the productivity spillovers that it generates and then uses this to estimate the productivity impact of each scenario for Sydney's growth. Technical material on the approaches used is contained in Appendix B.

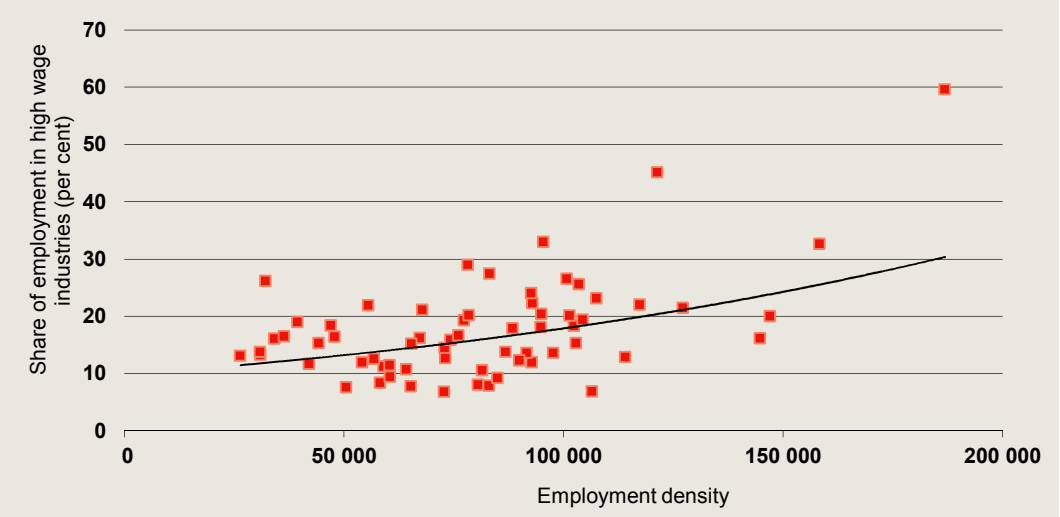
Why do employment areas offer higher wages than elsewhere?

Significant employment areas, such as Sydney CBD, the Global Economic Corridor and Parramatta offer higher wages than other areas for 3 reasons. Firstly, these areas house industries that have higher value, such as financial services and business services (chart 13.1). However, even within the same industry, denser areas offer higher wages (chart 13.2).

Secondly, the people employed in denser areas might work in head offices and be on average better educated. Putting this another way, people employed in denser areas have a higher average amount of 'human capital' because of the functions that they perform. For instance, chart 13.3 shows the share of people with tertiary qualifications against the density of the area. Chart 13.4 shows the relationship between employment density and wages for each local government area and industry, showing a strong positive relationship between measures of education and qualifications and wages.

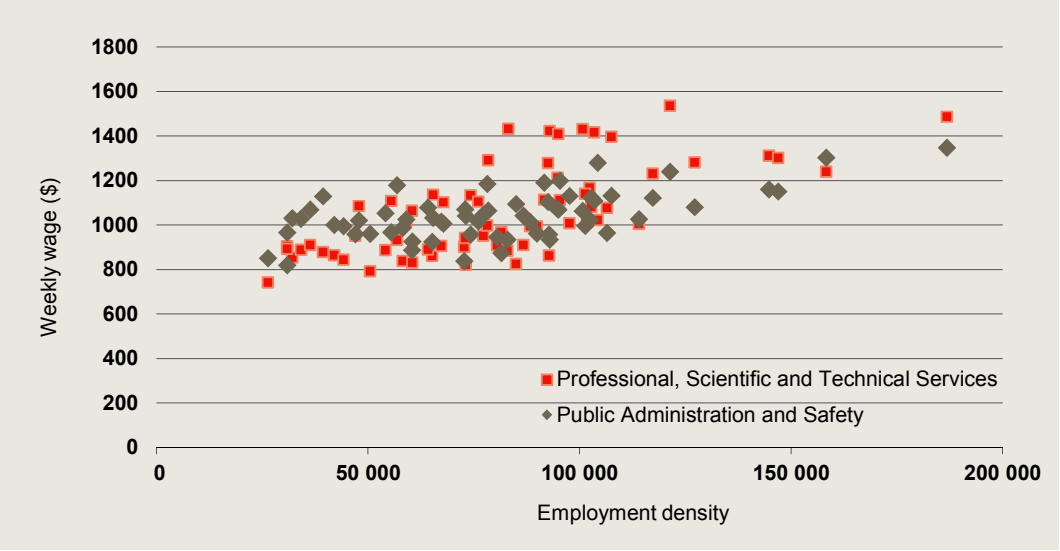
Thirdly, businesses benefit from being in dense areas because they can learn from each other, access the same labour market and interact more cheaply than if they are dispersed. It is this effect that links the spatial structure of Sydney to productivity impacts and is the focus of this chapter.

13.1 Employment density and employment in 'high wage' industries



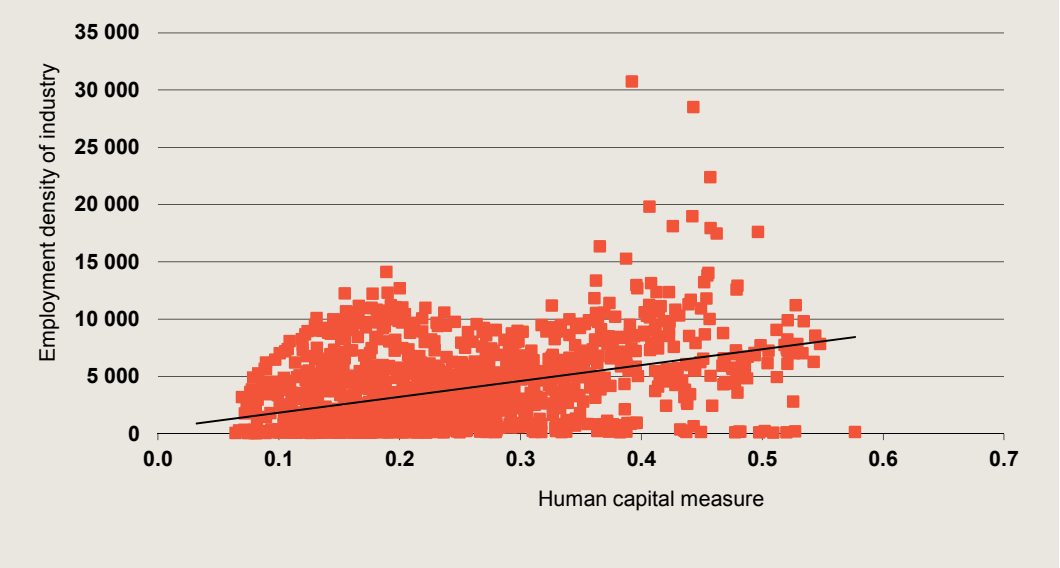
Data source: CIE analysis; ABS Census 2006.

13.2 Wages for specific industries across Sydney



Data source: CIE analysis; ABS Census 2006.

13.3 Education levels and employment density



Data source: CIE analysis; ABS Census 2006.

13.4 Education level s and wages by industry and location

Data source: CIE analysis; ABS Census 2006.

Size of productivity spillovers

The amount by which a businesses' productivity increases with closeness to other businesses is not easy to measure accurately. This is because the impact of density alone needs to be separately isolated from other factors, such as human capital and industry. It is also because there are no measures of business productivity than can be easily drawn on. Our analysis has used wages as a proxy for business productivity. This may understate the impact of density on productivity if higher productivity is not fully captured by wage earners, and is also reflected in higher returns to landowners and higher profits of businesses.

In estimating the impact of density on productivity we use variation in wages across Sydney but not through time. It would be a useful piece of work to examine whether these impacts are of a similar magnitude when considering whether the changes in productivity across Sydney have been driven by changes in density. This has not been undertaken in this study due to time constraints.

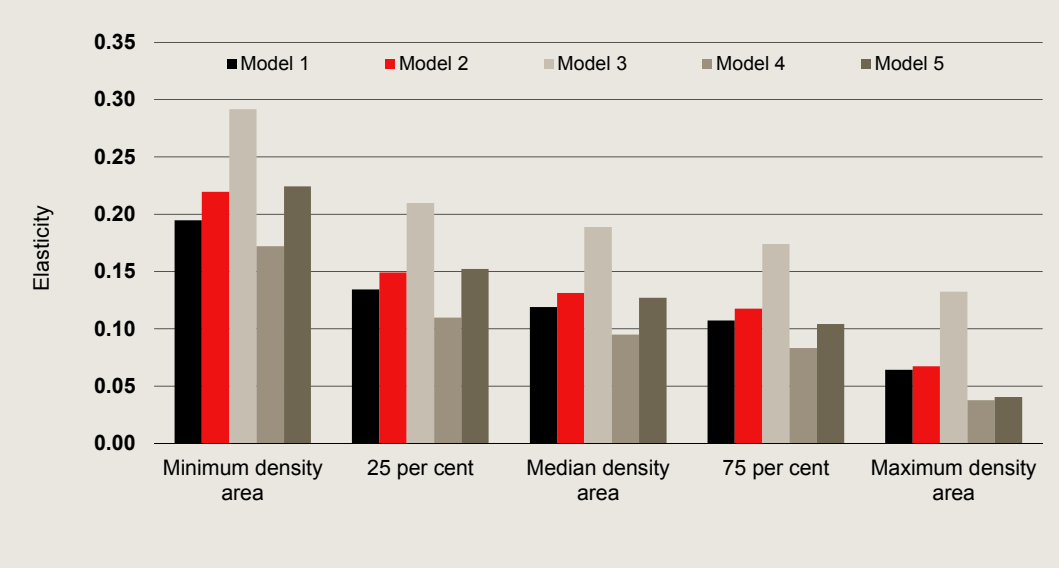
We find that there is a strong and positive relationship between productivity and the density of businesses located in an area that are from the same industry. There is no impact of density of economic activity in general. This means, for example, that a financial services firm benefits from being close to other financial services firms but that a manufacturing firm would not benefit from being close to financial services firms.

13.5 Elasticities of wages with respect to key variables

Variable	Model 1	Range for models
Human capital	0.45**	0.36 to 0.55**
Human capital^2	0.06**	0.03 to 0.08**
Employment density of industry	0.36**	0.32 to 1.31**
Employment density of industry^2	-0.01*	-0.01 to -0.05*
Labour market density	-0.16**	-0.17 to -0.25**

Note: * is significant at the 5 per cent level, ** is significant at the 1 per cent level.
Data Source: The CIE.

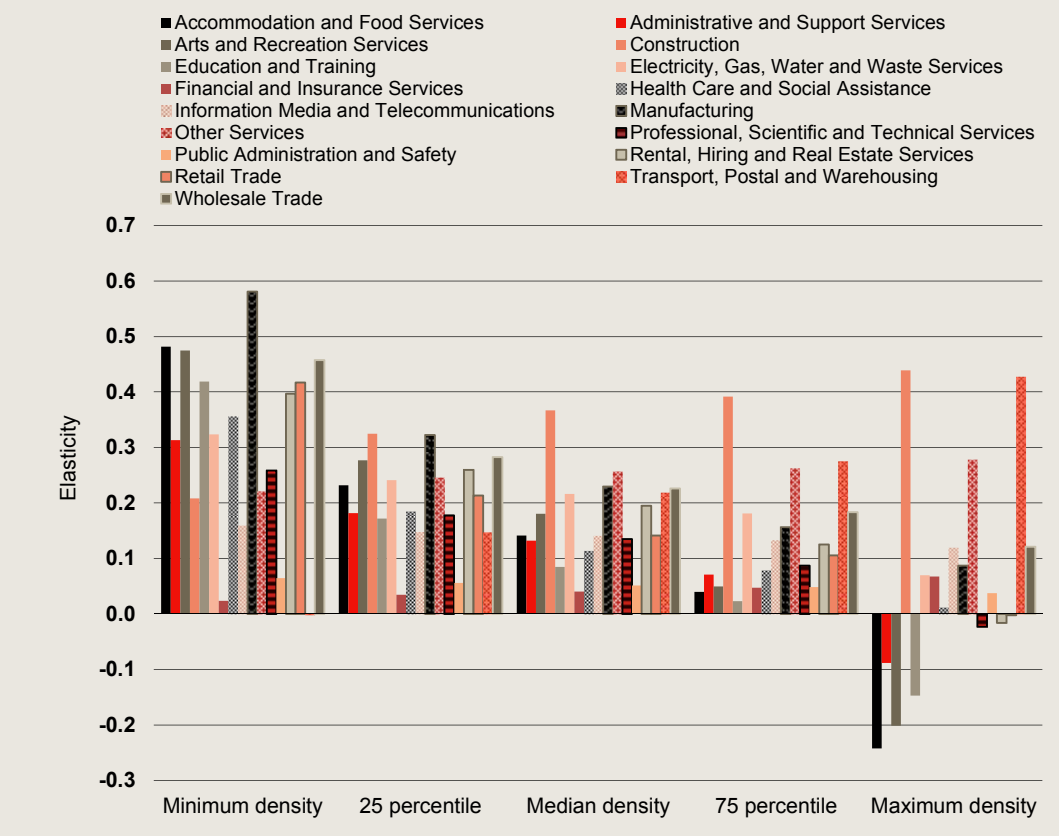
13.6 Average impact of industry density on wages



Data source: CIE analysis. See Appendix B for details.

There are sectoral impacts of industry density, although these are not always statistically robust. The estimated sectoral impacts are shown in chart 13.7

13.7 Sectorial impacts of industry density on wages

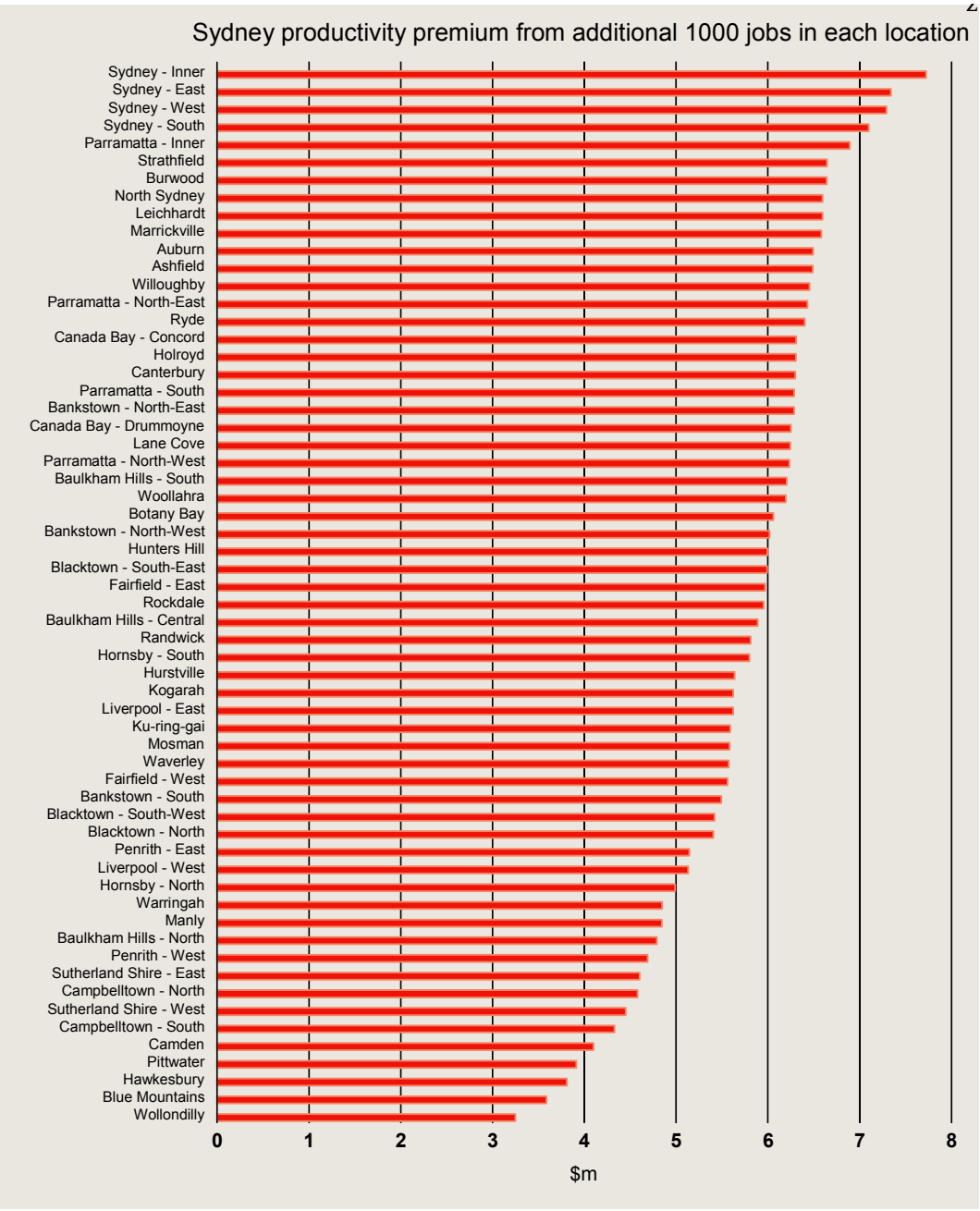


Data source: CIE analysis. See Appendix B for details.

We can apply the estimated productivity changes to an additional 1000 jobs in a statistical local area, with these jobs distributed across industries in the ratio of expected job growth across Sydney from 2016 to 2031. This shows the productivity impact of locating jobs in particular locations, although findings are of course dependent on the actual industry sectors that grow.

Employment growth in inner Sydney has larger impacts on productivity than employment growth elsewhere, given the applied sectoral splits. Parramatta CBD is a close second. The strength of productivity impact from jobs in the area with the least productivity spillover (Wollondilly) is about half that of Sydney CBD. The implied spillovers per new job are significant. For example, for the CBD, in total an additional 1000 jobs is estimated to lead to a productive ty return of $7.7 million per year, equivalent to $7700 per new job in spillovers. These impacts are the result of very small productivity changes for a large amount of existing economic activity. For instance, the marginal increase in job density may lead to a wage increase of only 2 cents per hour for those sectors and areas *most* impacted.

13.8 Current employment density and implied productivity change



Data source: CIE analysis. See Appendix B for details.

Productivity spillovers from alternative growth scenarios

The aggregate impacts across scenarios have been calculated by:

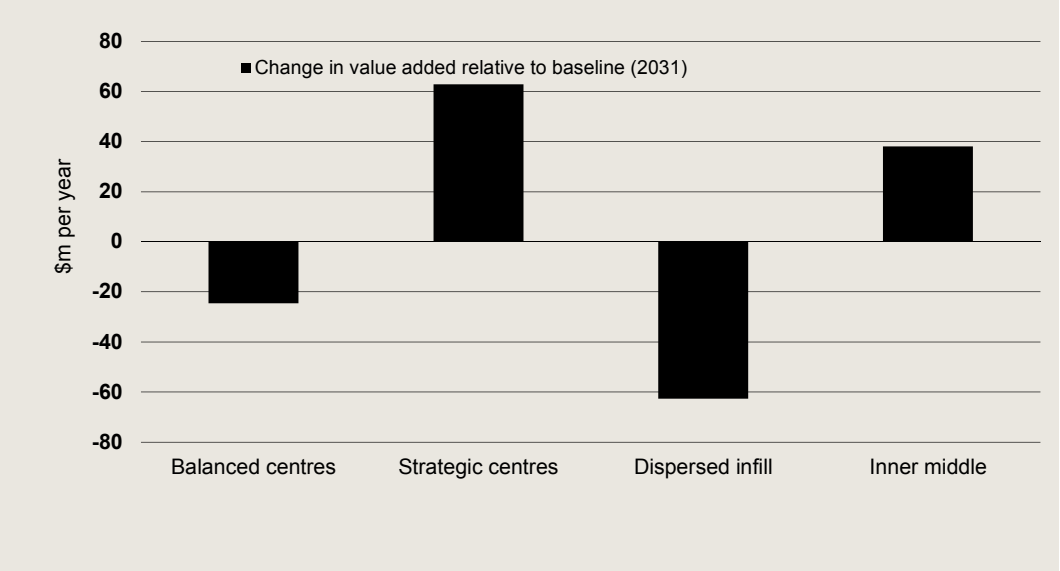
- maintaining the same industry employment shares across Sydney across scenarios;
- estimating industry shares in each statistical local area through using an iterative proportional fitting algorithm based on Bureau of Transport Statistics baseline industry projections;
- applying these industry and SLA level projections to current travel times between SLAs to calculate employment densities. Note that we do not change travel times

between SLAs as the travel time outcomes will depend on how services and infrastructure adapt to each scenario;

- applying the estimated elasticity of productivity to industry employment density to give a productivity change; and
- applying this change to 2016 employment in each industry and aggregating across all industries and SLAs.

The outcomes suggest that the strategic centres and inner middle scenarios employment changes have greater productivity spillovers than baseline and other scenarios.

13.9 Productivity spillovers from alternative scenarios 2031



Data source: The CIE.

In present value terms, this means that alternative scenarios would have productivity spillovers as shown in table 13.10.

13.10 Productivity spillover benefits relative to baseline

Scenario	Impact in 2031	Net present value of cumulative impacts
	$m	$m
Balanced centres	-24.6	-77.3
Strategic centres	62.9	197.7
Infill dispersed	-62.8	-197.4
Inner middle	38.0	119.5

Data Source: The CIE.

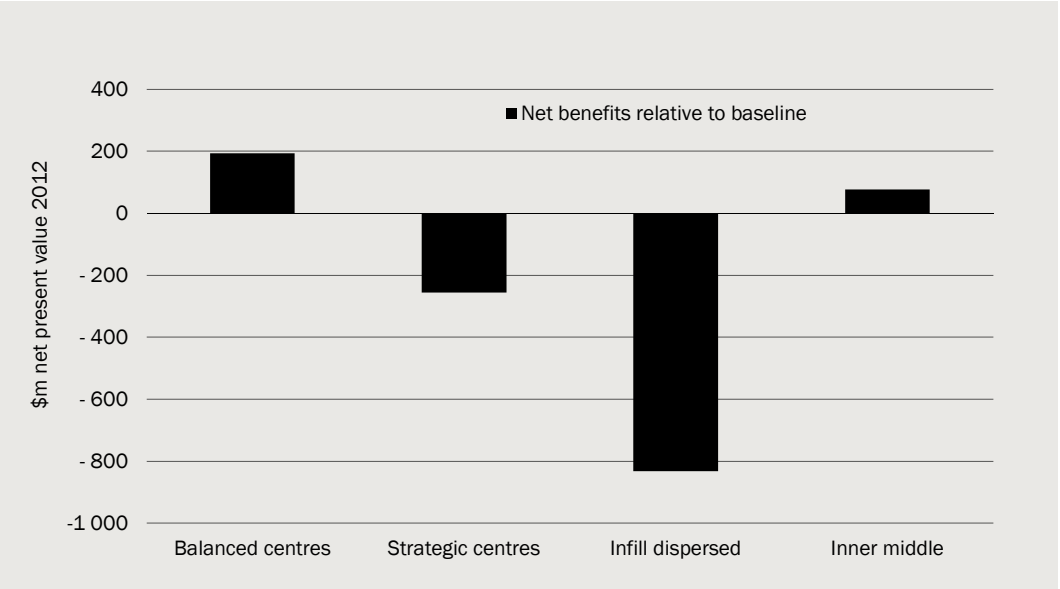
As discussed in Appendix B, there remains considerable uncertainty about productivity spillovers. While we consider that we have advanced this research in this paper, issues related to the causality of relationships have yet to receive significant attention in the Australian context. One useful step would be to see whether changes in employment density match changes in wages through time, rather than looking at employment density and wages across areas.

14 Total findings between scenarios

Net benefits across scenarios

The benefit cost analysis across all categories finds that the balanced centres and inner middle scenarios have net benefits relative to baseline, while the strategic centres and infill dispersed have net costs (chart 14.1). In the scheme of new development and the uncertainty around estimates, the differences between the balanced centres, inner middle, baseline and strategic centres are not substantial.

14.1 Net benefits across scenarios



Data source: The CIE.

Balanced centres outperforms the baseline across most categories, except for productivity spillovers. This suggests that its dwelling pattern may be preferable while its employment pattern is not.

Strategic centres has mixed outcomes compared to the baseline. Its main negative is that there is unlikely to be much demand for as much high density development in strategic centres as implied by this scenario. Infill dispersed also has mixed outcomes to the baseline and performs poorly on the value of land use change.

The inner middle scenario is the only scenario to have worse transport outcomes than the baseline.

14.2 Net benefits across scenarios by category

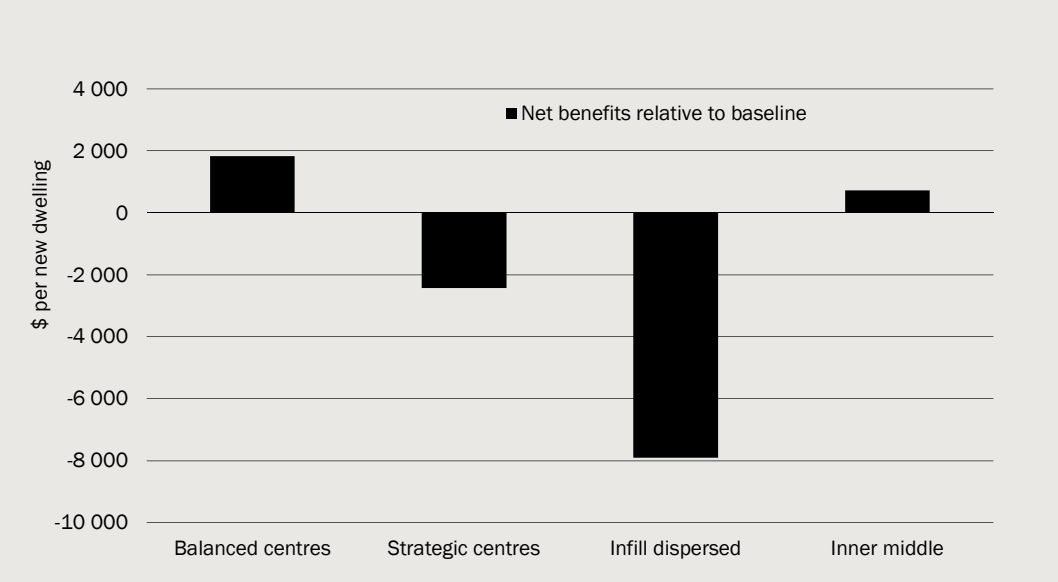
	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle
	$m, npv	$m, npv	$m, npv	$m, npv	$m, npv
Transport	0.0	176.8	8.9	118.9	-1.4
Electricity	0.0	9.0	19.0	56.0	39.2
Water and sewerage	0.0	0.0	0.0	0.0	0.0
Primary education	0.0	-17.8	13.4	-29.3	-37.5
Secondary education	0.0	19.1	-40.9	29.7	-5.0
Health	0.0	0.0	0.0	0.0	0.0
Local council	0.0	-27.7	-19.7	-77.2	-74.6
Environmental	0.0	20.9	29.1	-3.7	23.1
Social	0.0	84.9	74.9	-13.4	-12.8
Value of land use change	0.0	4.7	-537.7	-716.0	26.3
Productivity spillovers	0.0	-77.3	197.7	-197.4	119.5
Total benefits	**0.0**	**192.8**	**-255.3**	**-832.4**	**76.9**

Source: The CIE.

Per dwelling estimates

The equivalent per dwelling estimates of net benefits to baseline are shown in chart 14.3 and table 14.4. The differences range from +$2000 per dwelling to baseline to -$8000 per dwelling. In the context of new development these costs are relatively small, particularly when only cost factors are considered.

14.3 Net benefits across scenarios per new dwelling



Data source: The CIE.

14.4 Net benefits per new dwelling across scenarios by category

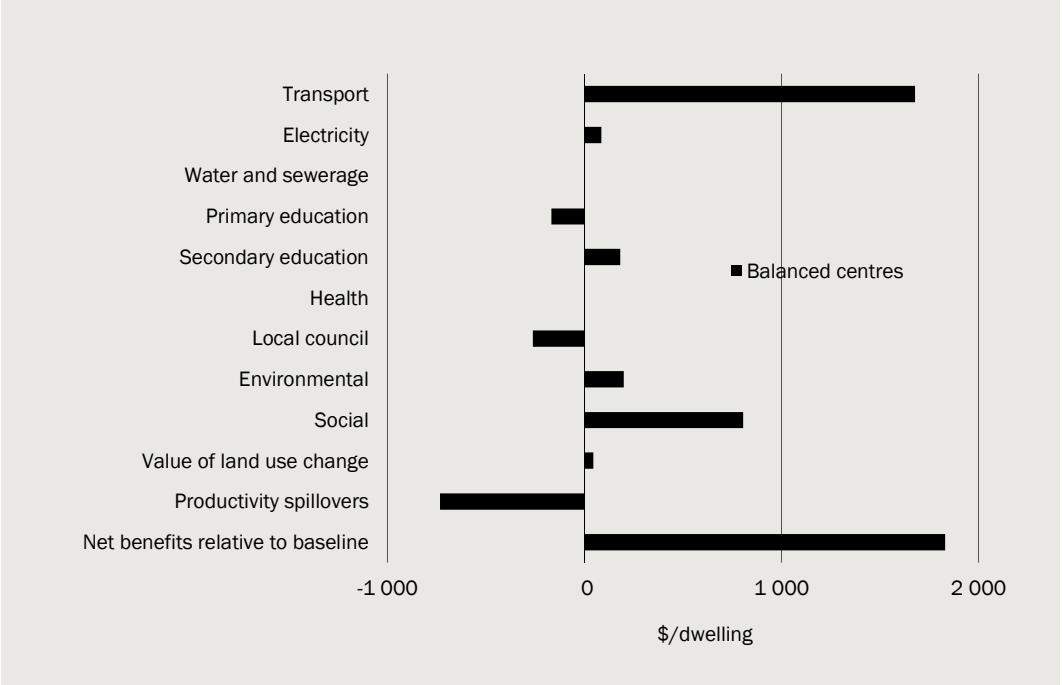
	Baseline $/new dwelling, npv	Balanced centres $/new dwelling, npv	Strategic centres $/new dwelling, npv	Infill dispersed $/new dwelling, npv	Inner middle $/new dwelling, npv
Transport	0	1 678	84	1 128	- 13
Electricity	0	86	180	531	372
Water and sewerage	0	0	0	0	0
Primary education	0	- 168	127	- 278	- 356
Secondary education	0	181	- 388	282	- 47
Health	0	0	0	0	0
Local council	0	- 262	- 187	- 733	- 708
Environmental	0	199	276	- 35	220
Social	0	806	711	- 127	- 122
Value of land use change	0	45	-5 102	-6 794	249
Productivity spillovers	0	- 734	1 876	-1 873	1 134
Total benefits	0	1 830	-2 423	-7 899	729

Source: The CIE.

Outcomes for each scenario

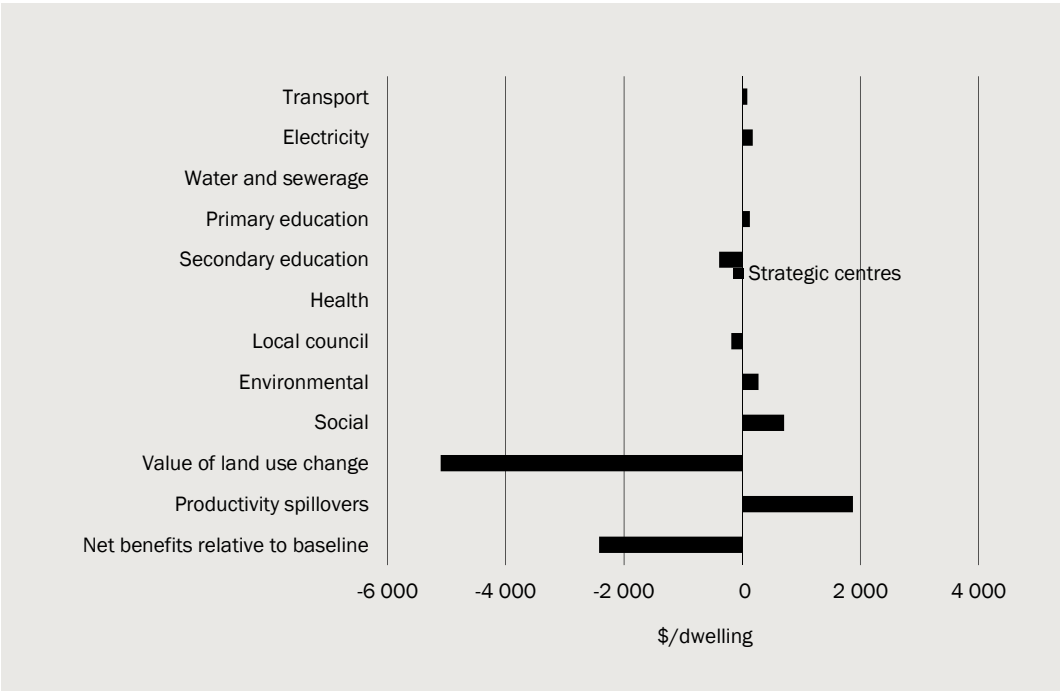
The pattern of outcomes for each scenario are shown in charts 14.5 to 14.8.

14.5 Balanced centres scenario



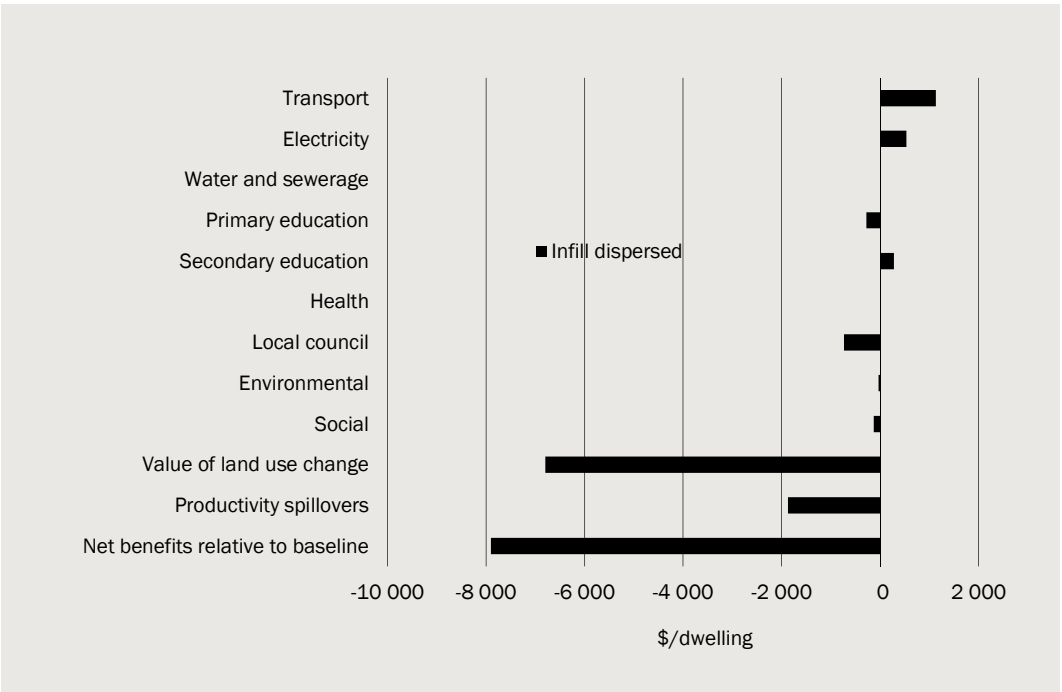
Data source: The CIE.

14.6 Strategic centres scenario



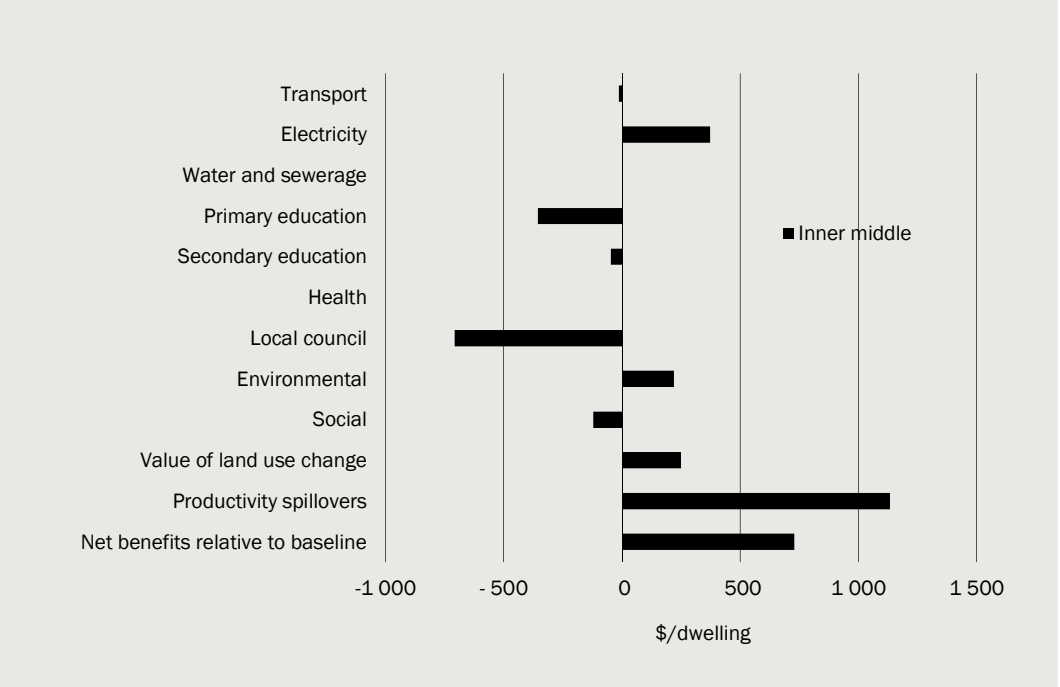
Data source: The CIE.

14.7 Infill dispersed scenario



Data source: The CIE.

14.8 Inner middle scenario



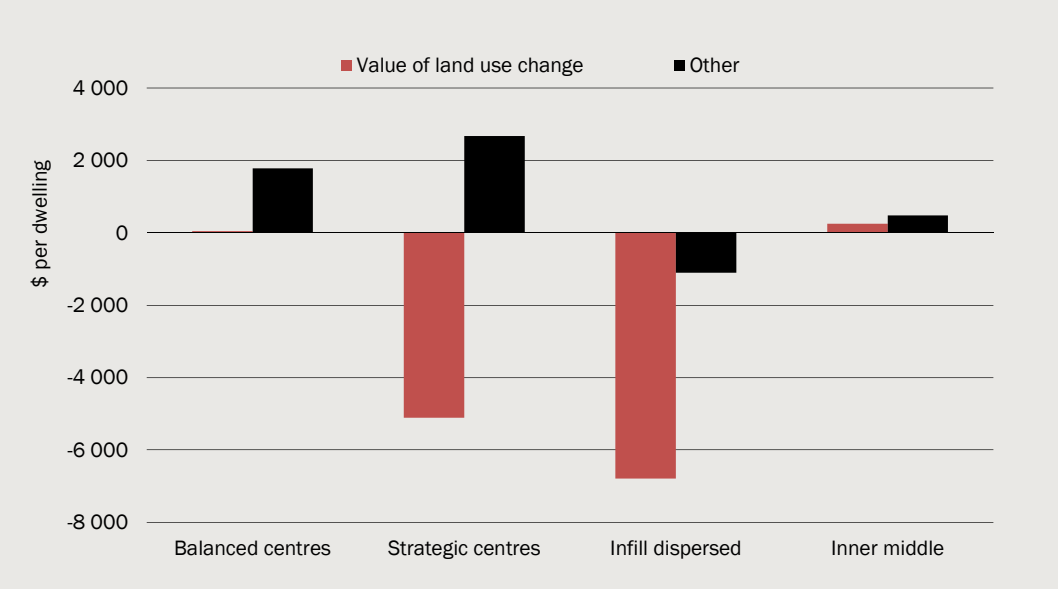
Data source: The CIE.

Demand and externality outcomes

Whether the variation in outcomes occurs as a result of estimated variation in demand factors (value of land use change) or supply factors (where external costs or benefits are imposed by new development) could be an important driver of policy. Demand factors do not need to be incentivised within the market, but rather barriers to their achievement removed. External cost and benefit factors do need to be pushed into market decisions if they are to be accounted for.

The estimates in this benefit cost analysis suggest that there may be more variation in the value of land use change as a demand factor than in externality or supply factors (chart 14.9).

14.9 Demand and externality drivers across scenarios



Data source: The CIE.

Different employment and dwelling mixes

The project has assessed 4 discrete scenarios and one baseline capturing differences in employment and housing outcomes for Sydney's infill areas. In some respects, employment could be viewed as independent of housing, particularly for the types of jobs located in the Sydney CBD and Global Economic Arc.

Changing the location of employment has the largest impacts on the estimated productivity spillovers and on transport. Scenarios that focus more employment in areas where there is currently dense employment have greater spillovers. This may or may not come at the expense of worsening transport outcomes.

We have modelled the transport outcomes for each dwelling scenario under baseline employment projections and under employment projections specific to that scenario. No modelling has been undertaken of alternative employment scenarios outside of this. Nevertheless, this does provide an indication that a scenario that mixed and matched employment and dwelling outcomes could perform better than any of the scenarios above. In particular, a scenario with a Balanced Centres dwelling distribution and a baseline employment distribution would have net benefits relative to baseline of $2400 per baseline, slightly higher than the Balanced Centres dwelling and employment distribution (table 14.10).

14.10 Net benefits per new dwelling across scenarios by category

	Baseline	Balanced centres	Strategic centres	Infill dispersed	Inner middle
	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv	$/new dwelling, npv
Net benefits with scenario employment	0	1 830	-2 423	-7 899	729
Net benefits with baseline employment	0	2 411	-3 247	-6 440	944

Source: The CIE.

Sensitivity of results

The benefit cost findings are underpinned by a range of assumptions. These include general assumptions such as the discount rate and specific assumptions relevant for valuing each benefit and cost item.

The results of the analysis are not generally impacted by general assumptions. The assumptions that are most important to the results are as follows.

- Assumptions about the value of land use change from particular types and locations of development and the degree to which this declines with more of the same type and location of development.
- Assumptions about the location of development within a development category, such as strategic centres — the net benefits from development in different centres of the same type may well be different.
- Assumptions about the type of development underpinning each scenario —the infill dispersed scenario would perform substantially better if it encouraged subdivision of large residential blocks into smaller blocks rather than medium density development.
- Assumptions that underpin the transport model used for analysis of changes in transport congestion and the potential for differential benefit-cost ratios from transport projects in some areas over others.
- Assumptions underpinning infrastructure network estimates or lack of information in some areas in terms of the prospect of different costs related to different infill scenarios (health and water).

We have sought to provide estimates in these areas that are as accurate as possible given the information available. Given uncertainty in estimates, we conclude that the cost differences across scenarios are likely to be relatively small and differences arising out of value of land use change are likely larger. However, demand may vary because of changes in the preferences for different types of housing and the costs of providing different types of housing, which can shift the value of land use change over time. This suggests that ongoing consideration of demand to ensure that planning and government services can meet the spatial location of demand is an important aspect of strategic land use planning.

It is also important to note that we have modelled a specific set of scenarios. There may be other scenarios that have higher net benefits than any of the scenarios modelled.

15 Realising the growth scenarios

Why does government intervene in land use planning outcomes?

The economic rationale for government intervention in land use and development, at least as it relates to efficiency (and not equity) of outcomes, reflects a number of factors.

- Market failures are likely to exist in land use and development with developments imposing costs and benefits beyond those making decisions. This includes the potential to impose costs on others particularly in congestion of services or aesthetic impacts.
- The government is itself a major provider of infrastructure and services linked to land use and development outcomes. For example, the NSW Government is the owner of the Sydney water provider, Sydney Water, the electricity distribution businesses, AusGrid and Endeavour Energy and provides road and public transport services both directly and in partnership with private businesses. Local councils also provide services linked to land use and development outcomes. Because alternative forms of land use change government costs (and these are not always priced correctly), this implies that government intervention *may* lead to more efficient land use outcomes.
- The government may be best placed to coordinate action, where coordinated actions can provide better outcomes than uncoordinated actions. For instance, a coordination which corales industrial businesses together may reduce negative noise spillovers. There also appears to be broad support for the view that a community has some rights in the land use and development outcomes of their area, outside of their direct ownership and control of their own land and property and that the government is in a good position to coordinate the exercise of these rights.

Reflecting these rationales, government has a major role in land use planning, i.e. the direction and facilitation of changes in land uses.

Government role in land use outcomes

The market is unlikely to deliver an efficient land use outcome under current policy settings or left to its own devices, reflecting the market failures above and failures in existing government policies. Changes in land use outcomes that emerge across Sydney will be a result of Government policies as well as market drivers (for example, employment patterns across sectors, technological advancements). The challenge for policy makers is to *facilitate* (through the policy architecture and decision tools) the emergence of land use outcomes that make the broader community better off.

In broad terms, policy could allow a more efficient land use pattern to emerge through:

- accounting for market failures in land use change decisions, and
- eliminating government failures that exist as part of the present policy settings.

There are many decisions that are made by Australian, state and local governments that influence land use outcomes. These decisions can directly change:

- the cost of particular types of development, through
  - charges (infrastructure levies, planning agreements, taxes on building)
  - regulatory requirements (such as environmental standards)
  - planning processes (that can impact on the time lapses for approvals and hence have cost implications)
  - the certainty provided for developers and the community
- the value of particular types of development; through
  - provision of economic and social infrastructure by government
  - development controls
- the quantity, scale and timing of development; through
  - the governance and institutions of the planning system
  - zoning decisions/local environment plans that can affect allowed types of development
  - project decisions, such as approval/rejection of development applications.

Government also has a direct influence through the development corporation Landcom and other entities such as the Office for Strategic Lands and the Sydney Metropolitan Development Authority.

The mix of market and policy drivers will lead to particular land use outcomes. This study focuses on what sorts of land use outcomes provide greater public benefit, and hence can help to guide the policy decisions to facilitate such outcomes. But it is the policy changes themselves that will help to ensure efficient and equitable land use outcomes emerge. We discuss the potential policy options in the context of the findings above, but also, how potential policy options may internalise market failures or appropriately incentivise development. This is particularly important given our finding that the value of development and redevelopment is likely to vary more spatially than the cost of development (within infill areas). The value of development is likely to be more amenable to the exploration process that characterises market activity than to direct estimation of the kinds necessarily employed for this benefit-cost analysis.

Government and market barriers to efficient land use change

Currently, government processes (both local council and NSW) are likely to be creating barriers to efficient development and the achievement of a 'better' land use scenario. Under current policies, there is considerable uncertainty that the scale of development from *any scenario* modelled in this report would be achieved. The scale of development modelled is significantly faster than that occurring over the past few years.

Potential barriers that could be viewed as government failures include:

- elevated uncertainty and costs as a result of the current planning processes and the incentives embedded in the system that restrict and redirect development;

- government pricing (local council and NSW) of infrastructure that may not align with the incremental costs associated with development;
- timing of infrastructure and service provision that falls within the ambit of government and developing planning processes that ensure that government costs are linked to commercially viable development activity;
- fragmentation and/or timing of release of development lots to a scale/timeframe which inhibits development, and
- taxation policies related to housing markets.

In addition, market failures could also be important as related to irreversibility of land use change. For instance, developments have long lives and are not easily changed – patterns of development might occur that do not take account of future costs of change, such as locking in lower densities around future transport nodes. Similarly, land amalgamation is a major area where the market appears to provide a very high cost solution.

This report does not deal systematically with these issues and how they can be addressed. Instead, we touch on some of the major governance/institutional design issues and infrastructure pricing issues as examples of how these areas might be linked to facilitating the emergence of more efficient land use outcomes.

Governance and design of planning processes

Major elements in the governance and design of planning processes include:

- the approach to plan making and the certainty associated with strategic planning; and
- governance and coordination of infrastructure.

These issues and overseas case studies are discussed below.

Approach to plan making

The Sydney Metropolitan Plan is the principal spatial planning strategy for Sydney. While long term in outlook, its status is uncertain (lacking strong statutory support) and it is subject to revisions. Plan making is a trade-off between certainty and adapting to changing circumstances. Embarking on a rigorous plan making process is also fundamental to instilling public and stakeholder confidence in the soundness of the plan. In some jurisdictions, plan making is given greater certainty than in Sydney.

An example is the South East Queensland Regional Plan (SEQRP). The purpose of the SEQRP is to manage regional growth and change in the most sustainable way to protect and enhance quality of life in the region (SEQRP, 2009). The SEQRP is a statutory instrument established under the Sustainable Planning Act 2009. The plan must be addressed both in the preparation of any plans, policies or codes and must also be addressed when preparing development applications or Masterplans.

The plan identifies an "Urban Footprint" of land that is seen to meet urban development requirements of the region. In addition to the Urban Footprint, Identified Growth Areas are identified in the plan as locations (subject to further investigation) that may

accommodate future growth in the region. The statutory nature of the SEQRP provides certainty around implementation of its growth management strategy.

Another examples is the London Plan which is subject to an Examination in Public prior to adoption. The Examination process is conducted by an independent Planning Inspectorate which applies a 'test of soundness' to the plan and thereby the plan-making process. The London Plan must past this 'test of soundness' before it can be adopted and implemented (see box 15.1).

15.1 Examination in public for London spatial development strategy

The EiP process was introduced in 1972 to replace public local inquiries as a means of reviewing the structure plan proposals of county councils. The review of the process was due in no small part to problems experienced at the inquiry into the Greater London Development Plan in the late 1960s resulting from the length of the inquiry and the way in which it had become 'bogged down' in detail.

The EiP represented a new procedure that could focus properly on strategic issues. To achieve this the right of objectors to be 'heard' by an inspector, which is the basis of an inquiry, was removed. In the late 1990s the format of the EiP was also applied when 'Public Examinations' were introduced to discuss and test issues arising in Regional Planning Guidance (RPG) prepared by Regional Planning Bodies.

As structure plans did not apply to Greater London and the RPG for London was approved before the introduction of Public Examinations, London experienced its first EiP in 2003. The Greater London Authority Act 1999 ('the Act') requires that, before publishing or altering his Spatial Development Strategy (the London Plan), the Mayor of London must, unless the Secretary of State directs otherwise, cause an EiP to be held.

Governance and coordination of infrastructure

Delivering the volume and type of housing and in the right areas, as envisaged by the alternative growth scenarios, is a significant challenge. Coordination of enabling infrastructure and related delivery agencies may be required as well as measures to reduce risk to private developers, if scenarios are to be achieved.

In NSW, there are numerous examples of where Government land development agencies have been established to coordinate development. In NSW, Landcom was established as the Government property developer delivering the state's plans for urban development across the greater metropolitan region, operating under the Landcom Corporations Act 2001. Like Landcom, the Sydney Metropolitan Development Authority is governed by the NSW State Government. The Authority is constituted under the Growth Centres (Development Corporations) Act 1974. The SMDA provides a vehicle for the promotion of housing and employment in areas within the greater Sydney Metropolitan Area. The Redfern-Waterloo and Granville areas are example focus areas of the SDMA.

Landcom and SMDA were recently merged into one new organisation called Urbangrowth NSW. Urbangrowth NSW will continue the Government's 10,000 housing

lots program; coordinate and deliver lead-in infrastructure and service provision to development areas; plan and fast-track urban renewal projects to unlock further private sector investment , ultimately leading to more housing choice and affordability.

Outside of Sydney, there are also many examples of delivery authories. Some of these illustrate opportunities for greater co-ordination as a means of improving the effeectiveness of the government's role in the development process. For example, in Perth, the Metropolitan Redevelopment Authority (MRA) is established under the Metropolitan Redevelopment Authority Act 2011. The MRA controls development projects in the Perth area and is now responsible for the former redevelopment schemes of East Perth, Subiaco, Midland, Armadale and the Elizabeth Quay project.

The act in which the MRA operates gives the MRA planning and development powers including land resumption, rehabilitation, land acquisition, disposal and promotion and coordination of urban renewal projects. Community and Local Government consultation is undertaken through a Committee for each of the redevelopment areas (East Perth, Subiaco, Midland, Armadale and the Elizabeth Quay project).

Methods for capturing the value of infrastructure improvements and associated urban uplift is now a common theme in discussions around long term strategies for delivering improved infrastructure (especially transport) integrated with better quality urban forms which contribute to community wellbeing and quality of life.[89]

Beyond the coordiantion role undertaken by these agencies, a number of models also exist for engagement with the private sector to deliver housing and other development.

Infrastructure Australia have a requirement to create Public-Private Partnerships (PPP) around urban rail projects they have funded, with the aim of attracting equity funding to deliver urban development in transit precincts. This model pursues close links between transit operators, land developers, financiers and government.

The UK Government's Homes and Communities Agency are employing a series of enabling measures to deliver housing and regeneration projects which include new models of public and private sector partnership (box 15.2).

89 McIntosh, J., P. Newman, T. Crane and M. Mouritz 2011, *Alternative Funding Mechanisms for Public transport in Perth: The potential role of value capture.* A discussion paper for the Committee for Sydney, November.

15.2 UK Government Homes and Communities Agency

To help deliver HCA's program of activity, a number of investment models are used. The aim of these models is to employ new and innovative ways of working to more quickly to deliver homes, regeneration and growth, and to make more efficient use of public resources and assets.

- **Joint Ventures** - The HCA is a partner in a number of ground breaking joint ventures which deliver regeneration and growth in England. These include Priority Sites, English Cities Fund, and Network Space. English Cities Fund (ECf) was created by the government to identify and break through the barriers to institutional investment and pave the way for higher levels of private investment in the re-shaping of English towns and cities.
- **Local Housing Companies** - Local Housing Companies (LHCs) are public-private joint ventures that put local councils at the heart of house building and help house builders to share the risks of development. They use council-owned land together with private sector investment and expertise to deliver new homes.
- **Private Rental Sector Initiative** - Large scale institutional investment in private rental housing could provide a source of new funding for the housing sector and greater choice for consumers. The Private Rental Sector Initiative was launched in mid-2009 with the first deal for new rented homes agreed with Berkeley Group in 2010. A number of institutional investors are continuing to look toward the creation of residential investment funds.
- **Housing PFI** - The private finance initiative is a procurement approach where central government provides financial support for long-term partnerships between the public and private sectors.
- **New models** - The HCA is also developing additional new models which will enable the Agency and its partners to deliver in the future. Current work includes development of Local Asset Backed Vehicles, infrastructure funding solutions, and energy supply tools.

In addition to delivery authorities, governance and coordination of infrastructure can be improved through more effective integration of land use and infrastructure planning. The Metropolitan Plan for Sydney incorporates infrastructure proposals, but is not the key infrastructure plan for Sydney. The NSW Long Term Transport Master Plan and the NSW State Infrastructure Strategy both perform this role in part. In some jurisdictions, land use and infrastructure planning is delivered in a more coordinated way than in Sydney.

An example is the South East Queensland Regional Plan (SEQRP) which is supported by the South East Queensland Infrastructure Plan and Program (SEQIPP) that outlines the Queensland Government's infrastructure priorities. It establishes priorities for regionally significant infrastructure within a 20-year planning timeframe. The SEQIPP ensures state agencies align their infrastructure and service priorities with the SEQ Regional Plan. It also provides coordination of infrastructure and services provided by state agencies, government-owned corporations, local government and the private sector. The SEQRP

is also underpinned by Regional Transport Plan for South East Queensland, the primary transport plan for the region.

A further example is the London Plan which, in accordance with the *Greater London Authority Act*, is required to be prepared by the Greater London Authority and is supported by a range of other strategies including the London Transport Strategy. The London Plan sets the framework for the development and use of land in London, linking in improvements to infrastructure (especially transport) and setting out proposals for imprlementation, coordination and resourcing.

Pricing and taxation

There are a large range of taxes and charges applied to new housing. There are also subsidies or exemptions from broad based taxes. For the NSW Government, key instruments include infrastructure contributions (state and section 94) and stamp duty. The NSW Government is also able to control a range of hidden taxes in the housing sector, such as those related to inefficient standards.

The design of taxation and pricing instruments could be used to ensure that more efficient land use outcomes are incentivised. This would allow the market to determine the value of development (demand side) and the government to determine the external cost of new development, embedded in charges.

Any consideration of charging would also have to account for the share and structure of funding of infrastructure and implications for housing affordability (in its broad sense rather than for a specific group).

Land amalgamation

A major challenge for the private sector in achieving commercial viability of development, particularly in existing urban areas, is assembly of disparate parcels of land to ensure adequate size and scale for viable development.

A range of land assembly incentives focused on the private sector could occur through a combination of such measures as:

- zoning policies which encourage site amalgamation (e.g. bonus development incentives, increasing plot rations), also known as progressive zoning in the USA;
- facilitating site amalgamation via a convenor or facilitator for an area (this is sometimes led by government agencies in lieu of private sector integration);
- faster development approvals for amalgamated, good quality development projects;
- financing incentives, where developer financing arrangements could be more amenable to amalgamated sites.

Key points

The government facilitates land use change through the policies it chooses. These policies should be designed to align to efficient land use outcomes or to incentivise efficient land use outcomes.

PART C

Technical appendices

A Estimating uplifts from rezoning across Sydney

Cost benefit analysis of alternative urban development scenarios is required to account for a full range of benefits and costs, where these can be measured. One important component of urban planning is the benefits realised from development in different locations, which we term the value of land use change. This note sets out the principles behind these benefits and methods of measuring them, drawing on our previous work for NSW Planning.

Principles for assessing the value of land use change

The value of land use change captures the private benefits from redeveloping a particular parcel of land. In principle this measures the difference between the value placed on a new development (i.e. demand) less the opportunity costs of the resources used in making the development. Value and costs are then typically proxied by market prices, giving the following.

- For a Greenfield development, the value of land use change is the sale price of the final development less the cost of land less development and construction costs less transaction costs. For instance, if a developer could buy a hectare of land for $500 000, divide it into 10 lots (of 1000 m2 each) and develop it for $60 000 per lot in development costs and $300 000 per lot for housing construction costs then the total costs would be $4.1 million. If the final dwellings could then be sold for $500 000 per house or $5 million in total then there would be a net benefit from the value of land use change of $0.9 million.
- For an urban infill development, the calculations are similar, with the value of land use change equalling the difference between the sale price of the final product and the costs of buying existing dwellings, demolition and redevelopment. Transaction costs are likely to be a large part of costs with developers facing significant costs to combine smaller parcels of land for example.

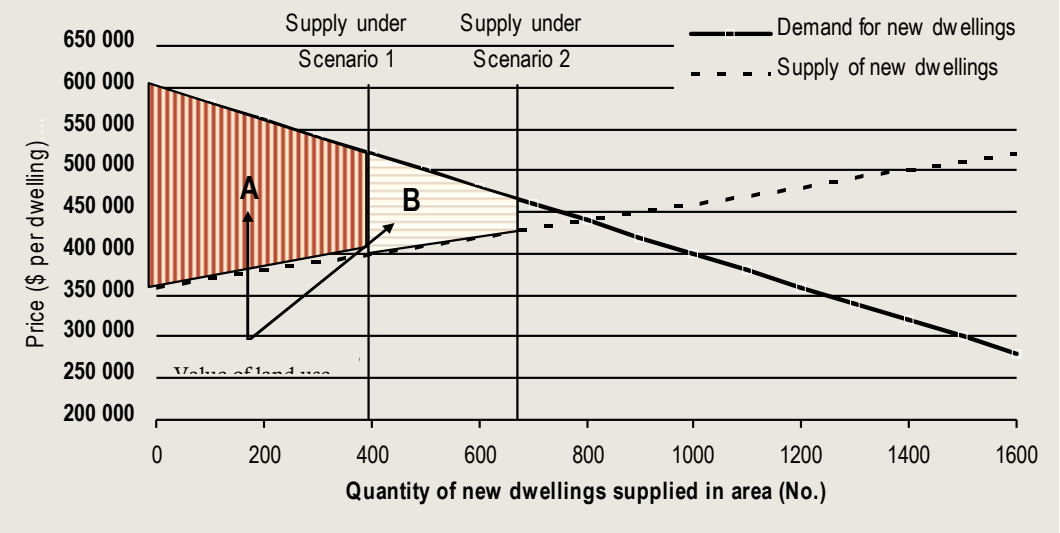
The value of land use change can be shown graphically through demand and supply curves (chart A.1), where:

- the opportunity cost is measured by the supply curve — it slopes upwards, reflecting the fact that as sites that are least costly to develop are used up additional dwelling development becomes successively more costly and a higher 'supply price' is required to make such development worthwhile. This includes the opportunity cost of land in its current use and any on-site development costs;

- the demand or consumer value for dwellings is the downward sloping line — it slopes downward because of variation in willingness and ability to pay for additional dwellings marketed in given area. Different people place different value on a dwelling in that area, reflecting a range of factors such as ability to pay, lifestyle preferences and friends and family. Successively lower values associated with increased quantities of dwellings signify that, to draw in additional purchasers with lower and lower willingness to pay, lower and lower prices may be required;[90] and
- the gap between the supply and demand curve reflects the constraints imposed by planning, councils and government charges and frictions relating to expectations of landholders. For these reasons consumer value will often be substantially higher than the supply price.

The number of new dwellings in an area will differ according to the scenario for how growth is accommodated across Sydney. The value of land use change captures the difference between value and cost for the number of new dwellings in the scenario. In chart A.1, an example is shown for a local government area in which there is more development under scenario 2 than scenario 1. As total new development is the same, there will be local government areas where there is more development in scenario 1 than scenario 2. In this case, the value of land use change from scenario 1 is equal to the shaded area A, while the value of land use change from scenario 2 are equal to A plus B. If further dwellings continued to be accommodated in that area then the value of land use change of additional dwellings would eventually become negative.

A.1 Value of land use change



Source: The CIE.

The value of land use change may change depending on the type of housing expected to be built within an area. For example, willingness to pay for new high rise apartments

90 Note that demand and supply relationships are much more complicated in reality as dwellings are all different. The illustration reflects demand and supply of dwellings that are the same.

may fall more quickly than for medium density (town houses, semi-detached and smaller units blocks) is there are limits to demand for particular types of dwellings.[91]

Measuring the value of land use change

Direct measures of the value of land use change

The principles above suggest a direct method of measuring the value of land use change. That is, estimate final prices, construction costs and development costs. The advantage of this method is that it directly aligns to the benefits that are being measured. For particular rezoning decisions, it is likely to be the preferred method.

For analysis across Sydney, this method has a number of disadvantages.

- The quality of final product differs systematically across Sydney, such as dwellings having different quality fit-outs, which is reflected in market values for housing. Higher quality is also associated with higher construction costs. If market prices are used for housing but the variation in construction costs cannot be accounted for then results will tend to be biased towards implying higher benefits in locations where there is higher quality housing.
- A development decision can imply a number of possibilities. In Greenfield areas, development could imply different lot sizes with different cost and revenue implications. For urban infill development, choices would have to be made in the analysis about the highest value redevelopment, including the type (town houses, medium density apartments, high density apartments) and the mix of dwelling sizes (1 bedroom, 2 bedroom etc).
- There is the potential to understate transactions costs, which are resource costs, in development. For instance, for a BCA it would be necessary to measure the costs of being able to put together multiple parcels of land into a parcel large enough for development scale.

This method may give good estimates for the purposes of BCA where these disadvantages can be overcome and may be the preferred method for analysis of a particular new development. We have sought to use this approach before and were particularly hampered by the first disadvantage. For this reason we would not seek to use this method for this study.

Land value measures of the value of land use change

An alternative approach that recognises that housing costs and quality varies is to consider only land value. The characteristics captured in land value are set out in box A.2.

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91 For instance the Grattan Institute found that 41 per cent would choose detached, 25 per cent semi-detached, 15 per cent up to 3 storeys and 20 per cent above 4 storeys in Sydney.

More specifically, if the total value of the new dwelling is TVD_N and the total value of the existing dwelling (or site if unoccupied) is TVD_O then the value of land use change benefit (VB) is the difference between the two less the costs of achieving the development (TC), as follows.

$$VB = TVD_N - TVD_O - TC$$

The total value of the dwelling can be decomposed into the value of the dwelling (VD) and the value of the site (VS). The cost of development can be broken into the cost of developing the site ($Cost_L$) and the other costs, such as demolition and construction of dwellings. The total benefit is then as follows.

$$VB = (VD_N + VS_N) - (VD_O + VS_O) - (Cost_{Land} + Cost_{Other})$$

This can be rearranged as:

$$VB = (VS_N - VS_O - Cost_{Land}) + (VD_N - VD_O - Cost_{Other})$$

If the additional value of new dwellings is equal to their costs ($(VD_N - VD_O - Cost_{Other}) = 0$), which is a reasonable assumption in a competitive building market, then the value of land use change collapses to the difference in site values less the costs of developing the site.

Because we are looking forward we cannot observe the value of a redeveloped site (VS_N). Instead, we proxy this by an assessment of the value of similar sites that have been developed or are zoned for higher density development, as discussed further below. This could include redevelopment of industrial land to residential or development of existing residential land to higher density residential.

A.2 What is captured in land values

The land value reflects the value that households place on land in a particular location and given constraints on the use of that land. This value in turn reflects the characteristics of the location, such as amenities and recreation, employment opportunities, housing type, crime and climate, individual preferences for these characteristics and idiosyncratic factors such as income and wealth and location of family, friends and work. It also reflects the costs of construction — if the costs of constructing higher density dwellings rise then the value of land zoned for this type of development will tend to fall.

Not everyone's value matters for the possible value of land use change. Rather it is the value of the households whose choices of location would change under the different scenarios. These are the marginal households — those whose values are close to the current market value of sites in that location. This means that current market values can be used as a basis for estimating the value of land use change. Indeed, there is a long history of using house and land prices in this way, known as hedonic pricing.[92] Hedonic pricing seeks to identify the unique influence of particular characteristics on land or dwelling value. In this instance we are interested in the influence of zoning.

Methods of measuring land value changes

Data on land values

This study uses unimproved site value data as the best method of approximating the value of sites. Unimproved site values are collected by the Land Valuer General for taxation and rating purposes. This measure is based on the 'unimproved' value of the land at that point in time, reflecting the location, amenities, zoning and other characteristics of the land, estimated using the market value of parcels of land sold nearby and sales of houses and units. 'Unimproved value' captures some improvements to the land including clearing of timber and vegetation, removal of stone, improvement of soil and excavation, filling, grading and leveling.[93] While not perfect, this data is the best available measure of the value of land in different local government areas and for differently zoned properties. As such it can serve as a proxy of the value of land under

92 Rosen, S. 1974, 'Hedonic prices and implicit markets: product differentiation in pure competition', *The Journal of Political Economy,* Vol. 82, no. 1, pp. 344–55; Gibbons, S. and Machin, S. 2008, 'Valuing school quality, better transport and lower crime: evidence from house prices', *Oxford Review of Economic Policy,* Vol. 24, no. 1, pp. 99–119; Davidoff, I. and Leigh, A. 2008, 'How much do public schools really cost? Estimating the relationship between house prices and school quality', *The Economic Record*, Vol. 84, No. 265, June, pp. 193–206; Smith, V. K. and J. Huang 1995, 'Can markets value air quality? A meta-analysis of hedonic property value models', *Journal of Political Economy,* Vol. 103, no. 1, pp. 209–27.

93 NSW Parliament, Valuation of Land Act 1916, section 4.

alternative uses and hence the potential benefits from developing the land for alternative use.

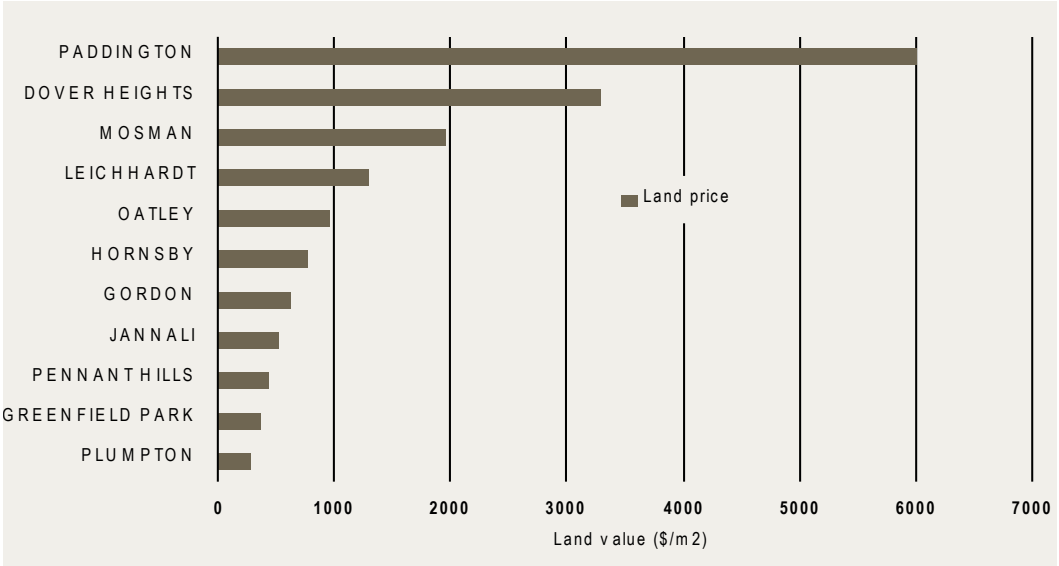
Note that this measure may underestimate the value of land use change to the extent that existing site valuations incorporate an uplift for the possibility of future development/rezoning.

The Land and Property Management Authority dataset includes the:

- property address;
- local government area;
- property size (in square metres or hectares — all are converted into square metres);
- property values from 2001 to 2010;
- whether the property is a strata property or not. Note that each strata property (i.e. a block of units) is a single record;
- the zoning of the property — this differs across LGAs. For most LGAs properties are zoned broadly, such as residential, industrial, commercial, open space and non-urban. For a small number of LGAs, zoning information is more detailed such as low density residential, medium density residential and high density residential; and
- the latitude and longitude of the property location.

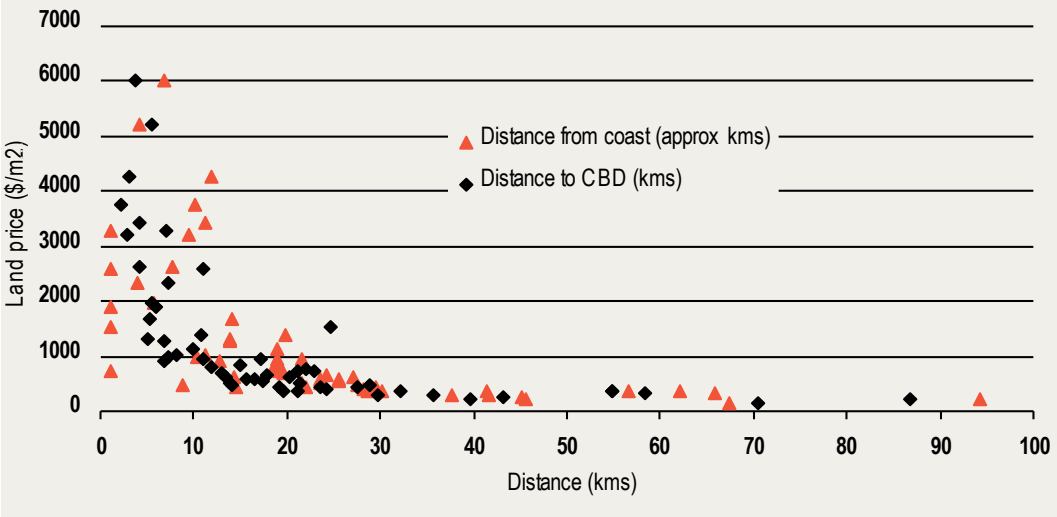
As an example, charts A.3 and A.4 show that there are major differences in land value and some of the major factors behind these differences.

A.3 Land prices in selected Sydney suburbs



Data source: NSW Land Valuer General, Table 1: Representative Land Values for the Sydney Metropolitan Area.

A.4 Land prices and distance from CBD and coast



Data sources: NSW Land Valuer General, Table 1: Representative Land Values for the Sydney Metropolitan Area; CIE calculations.

The approach to measuring the land value uplift and hence the value of land use change can be based on two approaches:

- a matched sampling approach, where each dwelling zoned for low density is compared to a similar dwelling zoned for higher density, and then averages taken across a set of dwellings; or
- a hedonic pricing approach, where the characteristics of the land, including zoning, are used to explain the variation in prices.

We propose to use the second approach as providing a more systematic treatment of the impacts of zoning.

Hedonic pricing seeks to capture the main drivers of differences in land values, including those that we are interested in. It explains the land value by characteristics such as distance from a railway station/CBD/amenities/open space, size of property and type of zoning. While all these estimates are of use for urban planning, we will focus on the impact of zoning. Other variables are necessary to ensure that the estimate of the impact of zoning is not picking up alternative effects (such as higher zoning corresponding to being near transport).

Value of land use change over the estimation period

The methods above estimate the value of land use change for a small amount of additional development, given current market conditions. This may be different through the period of the BCA because of:

- changing costs of development for different types of dwellings;
- changing preferences and demography;
- changing location and type of employment; and
- the saturation of types of housing and the use of the lowest cost sites.

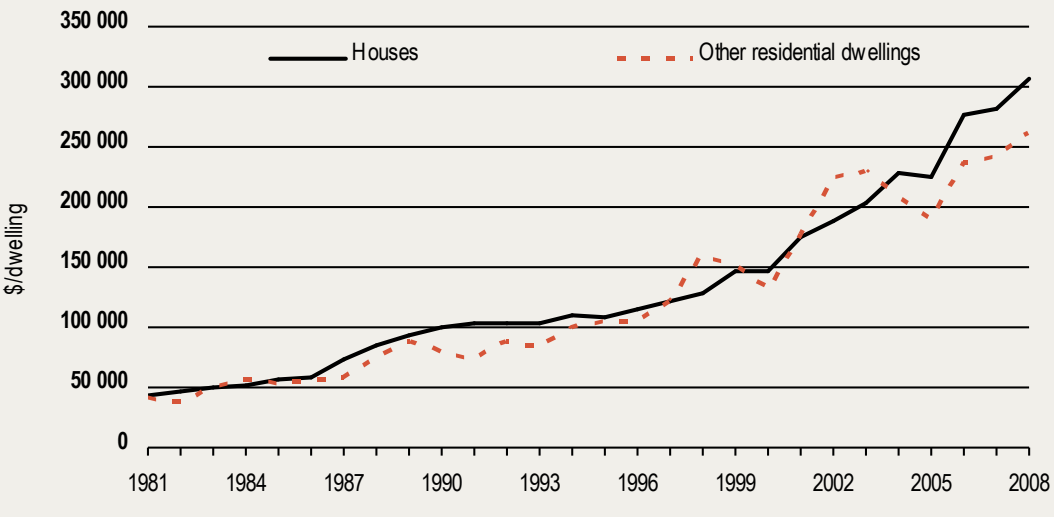
These factors are discussed below. The last is the only factor that we expect to be able to quantify, with other factors being discussed and their implications tested.

Costs of development

Costs of development incorporate the costs of negotiating with existing landholders and council, landscaping, building and construction, provision of infrastructure connections to relevant networks, holding costs and a return for the risk taken by developers. These costs can vary across locations. They also vary considerably depending on the nature of the building, with higher density dwellings costing more than twice as much per square metre of floor space provided.[94] For example, residential building costs are similar for houses and units despite units typically being much smaller (chart A.5).

If there are significant variations in the costs of building different types of development this would be expected to change the gains from development. For example, if cheaper ways are found to build medium density developments (without changing quality) then this would make these developments more attractive commercial propositions and increase benefits.

A.5 Cost of residential building in NSW



Data source: ABS, Cat. no. 8752.0, *Building Activity September 2009*, Canberra.

Preferences and demography

There is a commonplace view from developers and others that there is a movement in preferences away from the suburban block towards the amenities often available in denser development. Whether or not this proves to be long-lived or whether it is a response to prices and availability is unclear.

94 Figures provided by the Urban Development Institute of Australia (development toolkit) in 2010 indicated that high rise residential development (6 storeys and over) would typically cost more than $2500 per square metre, medium rise (3-6 storeys) would cost $1200–2500 per square metre and low rise (up to 3 storeys) would cost $800-$1500 per square metre. These figures are for 2009.

Demographic change would also be expected to influence the demand for different development types. For example, some people downscale as they get older. This demand driver would also influence future value of land use changes and housing types.

Employment

Living near high paid employment is a valuable attribute. The current value of land use change reflects the current and expected pattern of employment across Sydney and the ease with which people can move around Sydney.

Large changes in employment patterns, for example a continued expansion of Sydney as a global services hub would change the demand for land and the benefits of alternative growth paths.

Market saturation and use of major sites

There are both supply and demand side factors that would lead to the expectation that the value of land use change will depend on the amount of development in the area. On the supply side, more development in an area necessitates using sites that are more costly to develop. On the demand side, more development necessitates using sites that are have less value for whatever reason and in targeting households that have weaker preferences for that location. Together these factors suggest that the value of land use change for each new dwelling, or the gap between supply and demand curves in chart A.1, will be lower for greater levels of development.

There are a number of factors that could offset a declining value of land use change. To some extent, additional development in an area could bring amenities that have value and have not been accounted for elsewhere in this report. More importantly, across Sydney, population growth would lead to greater demand for housing, higher house prices and therefore greater value of redevelopment.

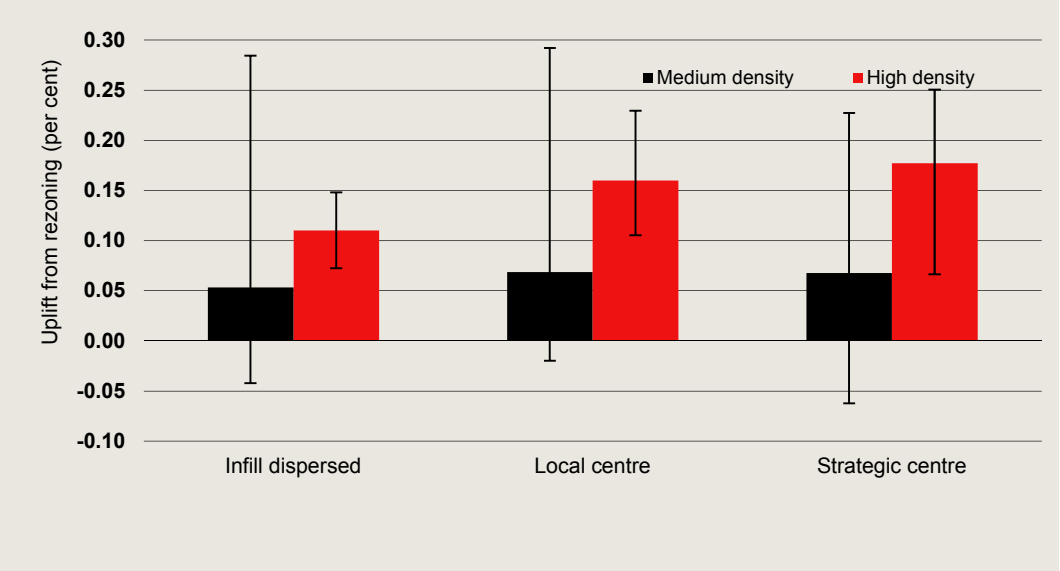
The extent to which these factors change the value of land use change is difficult to estimate. Sources that will be considered include:

- the Grattan Institute study *The Housing We'd Choose,* which allows estimation of some demand elasticities by type of housing;
- assessing of major sites from NSW Planning and share of development coming from major sites; and
- historical rates of inflation for construction costs and land prices.

Alternative models of the value of land use change

In chart A.6 we show the dispersion across various models. These indicate particular uncertainty about the uplift from medium density, although the highest values occur when we do not allow for controls for the local government area and instead use distance from the CBD, which likely means that uplift is proxying for access to the CBD rather than the change in density per se.

A.6 Value of land use change from different models



Note: Columns are the average of 5 models tested. The error bars show the minimum of the models and the maximum of the models.
Data source: The CIE.

The results for model variables and controls are shown in table A.7 and A.8. Interestingly, the value of being close to amenities such as rail stations does not hold universally. We find (in results not reported) that values differ across areas, with access to rail stations having a high value in some areas but not in others. Presumably, this reflects factors such as the frequency of service, speed and the destination of the line. (There is a universal negative to being located very close to a railway station for residential development, which is a common finding of hedonic pricing studies of railways.)

A.7 Statistical results for zoning from each model

Statistic	Model 1 Elasticity	Model 2 Elasticity	Model 3 Elasticity	Model 4 Elasticity	Model 5 Elasticity
Medium density	0.002	0.002	0.018	-0.042	0.284
	(0.34)	(0.22)	(0.00)	(0.00)	(0.00)
High density	0.120	0.123	0.087	0.073	0.148
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Medium density in local centres	0.015	0.015	0.019	0.022	0.008
	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)
High density in local centres	0.043	0.043	0.048	0.033	0.082
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Medium density in major centres	0.060	0.059	0.032	-0.020	-0.057
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
High density in major centres	0.127	0.127	0.097	0.064	-0.081
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Medium density by distance to the CBD			-0.001		
			(0.00)		
High density by distance to the CBD			0.001		
			(0.00)		

Total elasticities					
Medium infill dispersed	0.002	0.002	0.018	-0.042	0.284
Medium local centre	0.017	0.018	0.038	-0.020	0.292
Medium major centre	0.062	0.062	0.050	-0.062	0.227
High infill dispersed	0.120	0.123	0.087	0.073	0.148
High local centre	0.164	0.166	0.134	0.105	0.229
High major centre	0.247	0.250	0.184	0.136	0.067
Other statistics					
Number of observations	965 008	965 019	965 008	965 008	965 008
Adjusted r-squared	0.81553	0.81632	0.8232	0.89687	0.6058

Note: P-values are in brackets. A p-value of 0.05 means that the coefficient estimate is different to zero with a 95 per cent confidence.
Source: The CIE.

A.8 Statistical results for controls from each model

Statistic	Model 1	Model 2	Model 3	Model 4	Model 5
Distance to open space (kms, log)	0.008		0.006	-0.003	0.019
	(0.00)		(0.00)	(0.00)	(0.00)
Distance to bus (kms, log)	0.011		0.011	0.008	0.012
	(0.00)		(0.00)	(0.00)	(0.00)
Distance to high school (kms, log)	0.006		0.021	0.006	0.081
	(0.00)		(0.00)	(0.00)	(0.00)
Distance to primary school (kms, log)	0.030		0.033	0.010	0.038
	(0.00)		(0.00)	(0.00)	(0.00)
Within 100m of railway station	-0.052	-0.048	-0.061	-0.034	0.057
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Within 500m of railway station	0.006	0.006	0.001	0.013	0.040
	(0.00)	(0.00)	(0.28)	(0.00)	(0.00)
Within 1000m of railway station	-0.002	-0.001	-0.010	0.001	-0.035
	(0.01)	(0.23)	(0.00)	(0.41)	(0.00)
Within 100m of bus stop		0.357			
		(0.00)			
Within 200m of bus stop		0.382			
		(0.00)			
Within 500m of bus stop		0.388			
		(0.00)			
Within 1000m of bus stop		0.297			
		(0.00)			
Within 100m of open space		-0.022			
		(0.00)			
Within 200m of open space		-0.017			
		(0.00)			
Within 500m of open space		-0.010			
		(0.00)			
Within 100m of high school		-0.132			
		(0.00)			
Within 500m of high school		-0.023			
		(0.00)			
Within 100m of high school		-0.028			
		(0.00)			
Within 100m of primary school		-0.072			
		(0.00)			
Within 200m of primary school		-0.057			
		(0.00)			
Within 500m of primary school		-0.054			
		(0.00)			
Within 1000m of primary school		-0.033			
		(0.00)			
Kilometres to the CBD			-0.018		-0.037
			(0.00)		(0.00)

Note: P-values are in brackets. A p-value of 0.05 means that the coefficient estimate is different to zero with a 95 per cent confidence.
Source: The CIE.

B Productivity spillovers from agglomeration

Summary

Agglomeration is easily seen in the clustering of economic activity within NSW and within Sydney. It reflects underlying forces that mean that businesses and households receive advantages from locating near one another rather than spreading out.

This position paper defines agglomeration and reviews evidence as to its measurement and its impacts, particularly on productivity. An approach is then put forward to incorporating this into the assessment of costs and benefits of alternative growth paths for Sydney.

The main findings are as follows.

- Current estimates of the impact of employment density on productivity in Sydney and elsewhere in Australia are unsuitable for use in cost benefit analysis. International evidence has shown that the approaches used in Australian studies are likely to overstate estimates by a considerable margin.
- Preliminary analysis conducted by the CIE finds that the approaches used in Australia will also overstate the estimated relationship between density and productivity in Sydney.
- For the purposes of this project, it will be important to gain an understanding of the extent to which agglomeration benefits differ for particular regions in a systematic way. For example, whether agglomeration benefits will be highest for the Global Economic Corridor, Strategic Centres or similar across Sydney. This is not thoroughly tested in existing studies.
- Improvements can be made to current methods within the timeframes of this project. We propose to estimate of the impact of density on productivity adjusting for issues identified in the overseas literature to the extent possible and allowing for non-linear impacts.
- We include a line item for agglomeration benefits (productivity spillovers) for each scenario.

Background

NSW Planning and Infrastructure is seeking to better understand the agglomeration benefits that may arise from alternative scenarios for Sydney's growth. This position paper:

- defines the different linkages that can be viewed as agglomeration;
- sets out methods for measuring agglomeration;
- considers the implications of agglomeration for urban planning in the context of our assessment of the costs and benefits of different spatial patterns for Sydney's growth; and
- puts forward an approach for incorporating agglomeration benefits of alternative scenarios into our analysis.

Types of agglomeration economies

Aggregation is generally viewed as the way the businesses and households aggregate or cluster. Agglomeration is the amount of aggregation, which then has agglomeration *impacts* or *benefits*.

Agglomeration is easily seen in the way that economic activity is structured. Regions are characterised by vast areas will little economic activity and small areas (cities and towns) in which most activity takes place. Within cities, the spatial structure is equally lumpy, ranging from high density central business districts to low density housing and industrial parks.

There are a number of underlying forces that drive economic activity to cluster in the way that we can see, reflecting agglomeration benefits. Various attempts have been made to characterise these beginning with Marshall (1890) who labelled these forces as labour market pooling, input sharing, and knowledge spillovers.[95] That is, businesses (and employees) benefit when they have access to a larger labour market, when they can share fixed costs associated with inputs (or avoid transport costs for inputs) and when they can learn from each other. More recent work has sought to classify agglomeration forces using the underlying mechanisms. This has led to a characterisation of sharing, matching and learning.[96] The types of impacts that could be considered under these categories are set out in the table below.

All these agglomeration forces reflect *positive externalities* from individual decisions of businesses and households to locate near each other.

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95 Marshall, Alfred (1890) Principles of Economics, London: MacMillan.

96 Duranton, G. and D. Puga 2003, "Micro-foundations of urban agglomeration economies", NBER Working Papers, No. 9931.

B.1 Types of agglomeration impacts

Sharing indivisible goods and facilities	Learning	Matching
▪ Reduced input costs for businesses (such as electricity, transport services, business services) by sharing fixed costs ▪ Shared security/law and order ▪ Shared consumer facilities, (eg shopping centres , sporting facilities) ▪ Increased variety of goods for consumers ▪ Increased variety of inputs for businesses ▪ Increased specialisation ▪ Sharing of risk	▪ Improved opportunities for learning and skill transmission (schools, universities, training) ▪ Increasing returns to the accumulation of knowledge and localised knowledge transfer (businesses copying ideas, products)	▪ Improved matching of employees with businesses ▪ Improving matching of businesses with suppliers/clients ▪ Mitigating hold-up problems, such as relying on a sole business as buyer and consequent investment constraint

Source: The above discussion draws heavily on Duranton, G. and D. Puga 2003, "Micro-foundations of urban agglomeration economies", NBER Working Papers, No. 9931.

For a further discussion of the conceptual underpinnings to agglomeration see Duranton and Puga 2004 or Graham et al 2010.[97]

When is agglomeration high or low?

Agglomeration is high when businesses are 'near' to each other (business-to-business) or near to workers (business-to-labour) or consumers (business-to-consumers). The different types of agglomeration imply different definitions of 'near' and different measures of density. The definition of 'near' may also change with changing technologies.

- Business-to business agglomeration will be higher when businesses can more easily move people or good between businesses. Business travel is mainly during business hours and typically using different modes than for commute travel.
- Business-to-labour market agglomeration should be high when businesses can more easily access a larger pool of potential labour, or conversely when employees can more easily access a larger pool of businesses. The type of cost for this aspect of agglomeration is commute travel, which is typically undertaken at peak hour and using both car and public transport.
- Business-to-consumer agglomeration is high when a business can access a large number of consumers. This might be measured through a combination of the above measures, as greater access to consumers will occur when a business is 'near' to households and 'near' to other businesses providing goods or services to households.

In considering these measures, the level of agglomeration of a given region can increase because either *transport costs between or within the region fall* or because of *increases in*

97 Duranton, G. and D. Puga 2003, "Micro-foundations of urban agglomeration economies", NBER Working Papers, No. 9931; Graham, D., S. Gibbons and R. Martin 2010, "The spatial decay of agglomeration economies: estimates for use ion transport appraisal, Imperial College London.

economic activity or population. In practice, there may be trade-offs between these two changes due to congestion.

Measuring agglomeration

Measures of agglomeration can be constructed to capture the impacts discussed above. Most studies of agglomeration construct a measure only for the first — business-to-business linkages. For example, Graham 2006 constructs a measure of effective job density (EJD) for region i as:

$$EJD_i = \sum_j E_j . f(c_{ij})$$

Where E is employment in each region j and $f(c_{ij})$ is a function of the cost of transport between i and j.

A region has a high measure of effective job density when it has high accessibility to other businesses. This measure is typically constructed using access to all other businesses, regardless of their sector. Some types of flows, such as knowledge flows, might be though to be of most relevance for businesses within the same industry. Other impacts, such as supply of intermediate goods would be greatest between particular different industries — for example cement manufacturing as an input into construction.

Similar measures could also be constructed for access to the labour market, with employment replaced by labour force.

Measuring the impact of agglomeration

There is a significant literature seeking to measure the impacts of agglomeration using constructed measures of employment or labour market density. Essentially, these studies are seeking to estimate a relationship as follows:

$$A_i = f(EJD_i, X_i)$$

Where A is a measure of or proxy for productivity in region i, and f is a function of effective job density (EJD) in region i or another measure of density and other control factors (X) for region i.

In seeking to measure such relationships, there are several significant issues.

- Causality between agglomeration measures and productivity
  - direction of causality between density measures and impacts (such as productivity) is not always clear.98 As noted by Glaeser (2010), "The basic problem with estimating agglomeration effects on productivity is that Population density is not itself exogenous. People move to places that are more productive."99

98 Graham, D., S. Gibbons and R. Martin 2010, "The spatial decay of agglomeration economies: estimates for use ion transport appraisal, Imperial College London, p 2.

99 Glaeser, E. 2010, *Agglomeration Economics,* Chicago University Press, p. 13

  - causality may also be an issue in using transport costs to weight densities.100 This is because transport might have been designed to provide access to the most productive place, implying reverse causality between productivity and accessibility.

- Developing production functions or alternative approaches that account for other factors that are likely to be correlated with agglomeration measures.
  - It is often difficult to capture the quality of the labour ('human capital') used by firms or within regions. Returns to human capital are an important driver of productivity and are likely to be correlated to measures of density.
  - The public capital relevant for a business or region is not typically measured. If public capital has been allocated towards particular regions then a productivity differential may measure the return from public capital rather than an additional productivity impact from agglomeration. For example, if public expenditure is focused on providing access to the CBD then businesses in the CBD may benefit from this through a productivity advantage over other less well connected businesses.

These issues can be significant. For example, Combes et al 2010 find that once these types of effects are accounted for, the elasticity of productivity with respect to density falls by more than half.[101] Graham 2010 finds similar reduction in estimates once these factors are taken into account.[102] Our preliminary analysis, discussed later, suggests that including human capital reduces estimates for Sydney to around one tenth of their value in the absence of this variable.

There are a number of studies that measure agglomeration in Australia and overseas that give more or less recognition to these issues.

- Graham 2006, 2007 and 2010 uses firm level productivity regressed against effective job density.[103]
  - No allowance is made for public capital or human capital in the 2006 and 2007 papers
  - The 2010 paper makes allowance for endogeneity, firm-specific effects and, in one case, human capital. It finds much smaller estimates than previous papers that did

100 Graham, D., S. Gibbons and R. Martin 2010, "The spatial decay of agglomeration economies: estimates for use ion transport appraisal, Imperial College London, p 12.

101 Combes, P., G. Duranton, L. Gobillon and S. Roux (2010), "Estimating agglomeration economies with history, geology and worker effects", in Glaeser, E. 2010, *Agglomeration Economics,* Chicago University Press, pp 15-66.

102 Graham, D., S. Gibbons and R. Martin 2010, "The spatial decay of agglomeration economies: estimates for use in transport appraisal, Imperial College London, p 12.

103 Graham, D. 2006, "Investigating the link between productivity and agglomeration for UK industries", Imperial College London; Graham, D. 2007, "Agglomeration economies and transport investment", *International Transport Forum Discussion Papers,* No. 2007-11; Graham, D., S. Gibbons and R. Martin 2010, "The spatial decay of agglomeration economies: estimates for use ion transport appraisal, Imperial College London, p 12.

not have these corrections. One specification allows for human capital, in which case productivity spillovers greatly reduce or disappear. The study is unable to determine whether spillovers have been captured by workers in their wages or whether this is evidence that spillovers do not exist.

  - The 2006 paper also tests for diminishing returns to agglomeration and finds strong evidence of this. That is, agglomeration economies diminish at some levels of density.

- SGS Economics and Planning 2010 and 2012 constructs measures of effective job density for Melbourne and regresses these against sectoral and regional measures of labour productivity.104 Separately, SGS regresses human capital measures (lifetime income) against effective job density.
  - No account is made for public capital, private capital or human capital differences across regions in estimating productivity impacts
  - The construction of labour productivity measures is unclear and may be biasing results as two methods are used and results are negative for one method and positive for the second
- Hensher et al 2012 constructs measures of effective job density (using distance between locations) for Sydney and regresses these against sectoral and regional wage measures.105
  - No account is made for public capital, private capital or human capital differences across regions
  - The main purpose of these estimates is to link to further work using a spatial computable general equilibrium model and hence they state that the agglomeration work is preliminary.
  - A test for non-linearity was undertaken, suggesting the opposite of Graham 2006. That is, an increase in density for areas that are already dense would have a greater impact on productivity than for areas with low density.

As discussed above, papers that have advanced beyond univariate regressions of density against productivity suggest that, in the absence of appropriate techniques, agglomeration elasticities may be overstated by as much as 100 per cent. No study that we are aware of has made these adjustments in Australia to date.

Agglomeration benefits have also been measured using other measures than productivity. For example, Audretsch and Feldman (1996) find that industries in which knowledge is more important cluster more, providing support for the view that knowledge spillovers is

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104 SGS Economics and Planning 2010 (?) , *Agglomeration and Labour Productivity in Australian Cities;* SGS Economics and Planning 2012, "Productivity and Agglomeration Benefits in Australian Capital Cities", COAG Reform Council working draft.

105 Hensher, D., T. Truong, C. Mulley and R. Ellison (2012), "Assessing the wider economy impacts of transport infrastructure investment with an illustrative application to the north-west rail link project in Sydney, Australia*", Institute of Transport and Logistics Studies working papers*, 2012

an important part of agglomeration.[106] Jaffe et al (1993) consider the geographic localisation of knowledge spillovers through patent citations.[107] They find that citations of patents are more likely to be in the same geographic area (narrowly defined) after allowing for the geographic concentration of technology in the area. While Keller (2002) estimates that knowledge spillovers halve at a geographic distance of 1200 kilometres using industry level data.[108]

Implications of agglomeration for the costs and benefits of alternative growth paths

It is widely recognised that agglomeration economies discussed in the previous chapter are important drivers of both economic activity and liveability. However, for policymaking, questions will more likely revolve around whether agglomeration is different in one area versus another and how agglomeration can be facilitated. As noted by Edward Glaeser, the preeminent researcher in this area:

> In general, the existence of agglomeration economies does not itself give guidance about optimal regional policy… The existence of agglomeration economies does not itself suggest moving people from less-dense to denser areas, because as long as people remain in the less-dense areas, their productivity will fall with the move.
>
> Questions of regional policy often require more than just a general sense that agglomeration economies exist. Instead policymakers would presumably be interested in whether agglomeration economies are stronger in some areas than others… Despite the century or so of research on agglomeration economies, we are still far from having reliable estimates of such non-linearities. (Glaeser, E. 2010, *Agglomeration Economics*, p. 13)

This chapter assesses the possible implications of agglomeration for alternative growth paths for Sydney.

Aggregate productivity implications from different employment density patterns[109]

For the purposes of an assessment of the costs and benefits of alternative growth paths we are interested in aggregate productivity impacts across Sydney arising from each path. Different patterns of employment and housing will have different impacts on productivity in particular areas. There may also be net differences in aggregate productivity impacts.

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106 Audretsch, D. and M. Feldman (1996), "R&D Spillovers and the Geography of Innovation and Production", *The American Economic Review*, Vol. 86, No. 3., pp. 630-640

107 Jaffe, A., M. Trajtenberg and R. Henderson (1993), "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations", *The Quarterly Journal of Economics*, Vol. 108, No. 3., pp. 577-598.

108 Keller, W. (2002), "Geographic Localization of International Technology Diffusion", *The American Economic Review*, Vol. 92, No. 1., pp. 120-142.

109 Note that there are differences to the appraisal of changes in land use versus transport investments. This is because transport changes the measure of effective job density through bringing regions closer together as well as changing the location of employment.

Consider first the evidence collated by Hensher et al 2012.[110] This links productivity to effective job density through a log-linear equation. That is:

$$\ln(A_i) = \beta_0 + \beta_1 . \ln(EJD_i)$$

Where A_i is a proxy for productivity in region i (based on wage data) and EJD_i is effective job density for region i, with EJD measured using distances between locations. The regions used align to 14 regions for Sydney.

The focus is then on the estimate of β_1, which is the elasticity of productivity with respect to density. Using industry pooled data, Hensher et al (2012) estimates β_1 at 0.02 — the average allowing for different industry effects is higher at around 0.07. That is a 1 per cent increase in employment density for an area (such as a local government area) generates a 0.02 per cent increase in productivity. What implications does this sort of finding have for aggregate productivity impacts from alternative growth paths for Sydney that all have an equal amount of additional employment? Box B.2 sets out a simplified model, which highlights some of the factors at play.

B.2 Example of employment changes

Take a simplified example where there are two employment regions with the same initial productivity and that do not have access to each other, the CBD and a Fringe Business Park. Currently, the CBD has an employment density of 1 person employed per square metre of land while the Fringe Business Park has a density of 1 person employed per 10 square metres of land. Both are over the same area of 10 000 square metres meaning that 10 000 people are currently employed in the CBD and 1000 people employed in the Fringe Business Park.

Employment is going to increase by 1000 people in Sydney. This could occur with employment accommodated in the CBD, the Fringe Business Park or a mixture of the two. Consider the two extremes.

- All 1000 people are accommodated in the CBD leading to a 10 per cent increase in employment density there. This leads to a 0.2 per cent increase in productivity for the existing 10 000 employed people. Across the Sydney labour force there is a 0.2*10 000/11 000 increase in productivity (0.18 per cent).
- All 1000 people are accommodated in the Fringe Business Park leading to a 100 per cent increase in employment density. This leads to a 2 per cent increase in labour productivity for the existing 1 000 employees. Across the Sydney labour force there is a 2.0*1 000/11 000 increase in productivity (0.18 per cent).

Hence the effect on aggregate productivity from the region with additional employment itself is indifferent to where employment is located in this simplified example.[111]

110 Hensher, D. et al (2012), "Assessing the wider economy impacts of transport infrastructure investment with an illustrative application to the north-west rail link project in Sydney, Australia", *Institute of Transport and Logistics Studies working papers*, 2012.

Importantly, it turns out that once greater complexity is added and linkages between regions, there are net productivity impacts of different employment patterns.

The implications for aggregate productivity can be broken into two parts.[112]

- Different base levels of productivity in different areas — if a given per cent change in productivity is achieved in areas with higher initial productivity then this has higher benefits. This suggests that, using the specification above, increasing density in currently dense areas where productivity is typically higher would have greater benefits.
- Interactions between regions when there are multiple connected regions. Once linkages are allowed between regions then there is a trade-off between the impact region A has on other regions and the impact other regions have on region A. These work in opposite directions, with an influence over other regions generating productivity impacts for these regions from an increase in employment in region A but the influence of other regions reducing the productivity impact in region A. The tradeoffs are also different for small and large regions. In theory, this can lead to increases in employment having the largest productivity impacts when they are in existing areas of high employment density or areas that are unconnected to major employment centres. For 'middle' areas, increases in employment have much lower productivity impacts as the percentage change in density is small due to the influence of other bigger employment centres on existing measures of density in these areas. In practice, no Sydney area would be sufficiently isolated as to experience these counterintuitive impacts and the impact of additional employment on productivity increases as density increases.

Agglomeration and congestion

Measuring agglomeration impacts using historical evidence means that in practice a number of different impacts are being rolled into the estimate. For instance, the measured productivity impacts already allow for the higher congestion that might have occurred because of greater employment or housing density, providing that this congestion is reflected in reduced productivity (or its proxy). The estimates of productivity are also partially the result of the pattern of investment made by governments to support different outcomes.

For this assessment of the costs and benefits of alternative growth paths, we would ideally like to separate out these different components to isolate a 'pure' agglomeration

111 Note that the same arguments apply using different estimates for specific sectors.

112 The log function versus percentage changes — the log function deviates from (and is below) percentage changes as changes get large. As employment changes in a more dense area will tend to be smaller in per cent terms this leads to larger impacts from concentrating employment in regions that already have employment. This impacts is most likely to reflect the specification of effective job density and its relationship with productivity rather than any real finding.

impact. This could then be traded off against separately measured transport and other public infrastructure costs.

Does the market deliver too little or too much agglomeration?

There is presumable some level of agglomeration at which benefits from additional agglomeration are outweighed by costs of congestion. This could be viewed as the socially efficient amount of agglomeration. It is not necessarily clear that the market would generate a level of agglomeration less than this social optimal, despite there being positive externalities from agglomeration.

There have been a number of attempts to understand these issues both in an efficiency sense, which is the focus of cost benefit analysis, and from an equity sense.[113]

An understanding of whether the market over-delivers or under delivers agglomeration relative to the social optimal has generally been studied in the context of policies between regions, where regions might represent countries or states, rather than the narrower regional definitions necessary for analysis within a single urban area such as Sydney. At this level, these papers highlight that the market may under-deliver-agglomeration or over-deliver agglomeration depending on the transport costs between regions. For instance,

> We show that the market equilibrium is characterised by over-agglomeration for high trade costs and under-agglomeration for low trade costs. For very high and very low levels of trade costs and for an intermediate range of trade costs, the market equilibrium yields the socially optimal degree of agglomeration. Rather, from the perspective of allocative efficiency, it turns out that more agglomeration would be socially optimal when trade integration has developed far enough. (Pflüger, M. & J. Südekum 2004. "Integration, agglomeration and welfare," Institute for the Study of Labour Discussion Paper Series, No. 1326, p. 21-22).

Authors of these papers suggest that findings and conclusions for urban policy be treated cautiously at this stage.

Approach used in this paper

This section sets out our approach to including agglomeration benefits in the analysis of alternative growth paths.

Approach to estimation

There are serious questions about the validity of previous estimates of the relationship between density measures and productivity in Australia for use in this paper. We propose to re-estimate relationships for the purposes of placing the estimate of the benefits on a more robust basis. This includes:

- improving the measure of effective job density to align with business-to-business travel modes and times;

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113 Baldwin, R., R. Forslid, P. Martin, G. Ottaviano and F. Robert-Nicoud 2003, *Economic geography and public policy*, Princeton University Press: Oxford, Chapter 11.

- allowing for additional explanators of productivity differences, in particular differences in the qualifications of people employed in different regions. We focus on this variable as quality of labour has been found to be a major bias in estimates overseas;
- allowing for density measures for business-to-business and business-to-labour market;
- allowing for employment density within an industry and in total; and
- allowing for non-linear specification of the relationship between density and productivity.

This builds off previous formulations but allow us to adjust for some of the major issues identified in the literature. The estimation approach is based on the following:

$$\ln(W'_{ij}) = \beta_{0j} + \beta_{1j}.\ln(EJD_i) + \beta_{2j}.\ln(EJD_i)^2 + \beta_{3j}.\ln(Q_i) + \beta_{4j}.\ln(ELD_i) + \varepsilon_{ij}$$

Where W'_i is average wage in region i and industry j based on Census 2006 data for the place of work and is used as a proxy for productivity, EJD_i is effective job density for region i, Q_i is an index of qualifications for people employed in region i and ELD_i is a measure of the effective labour force density in region i. All data will be sourced from the 2006 Census and the Bureau of Transport Statistics for generalised costs between regions.

We have also tested whether using explanatory variables constructed for each industry changes the estimates. That is, is it closeness to economic activity that drives productivity or closeness to activity within the same sector? We find it is the latter and that the former has no discernible impact on productivity.

This approach will provide improved estimates but there will remain residual issues. Of most importance is that the estimates will be made on the basis of differences between regions. Agglomeration is a dynamic process revolving around changes through time. Improved estimation of agglomeration could hence involve understanding whether labour productivity grew most quickly in regions where there was increased employment density — i.e. looking at changes over time.[114] The timeframes of the project do not allow for examination of agglomeration as a dynamic process using multiple Census years.

Other agglomeration and wider economic benefits

The discussion in this paper has focused on agglomeration benefits arising through productivity. SGS Economics and Planning 2012 also discussed agglomeration benefits arising through increased human capital. Knowledge transfer is an important part of agglomeration benefits and could be viewed as an increase in human capital. Productivity equations will capture multiple channels for the impact of density on economic activity. It is our view that the knowledge transfer effect will be captured already in estimates of the elasticity of productivity with respect to density and should not separately be allowed for.

114 In considering this type of evidence, understanding causality between employment growth and productivity growth will be important.

There are other externalities that may be equally or more important than agglomeration. For instance, in transport appraisals, wider economic benefits also includes impacts from imperfect competition and changes in labour supply leading to increases in tax revenue. Only the second of these is relevant for alternative growth paths.

Alternative growth paths imply different amounts of travel time for households. If people substitute towards greater work, at least in part, when they have lower travel time, then this additional work may generate additional tax revenues. Note that the value to the employee is taken into account in their decisions. But taxes drive a wedge between the value of time spent working to the entire community versus the value of that time to the worker.

These have not been factored into the above analysis.

C Occupancy rates and dwelling demand

Context

In order to generate comparable scenarios for the Cost Benefit Assessment, dwelling numbers and population have been kept constant across all scenarios. This approach has involved application of an average occupancy of 2.3 people per dwelling for Sydney's urban infill areas to avoid variations in population arising from different dwelling distributions across the city where variable occupancies to be adopted.

However, in reality occupancy rates vary considerably across Sydney as Figures 1 and 2 below highlight. Figure 1 shows that dwelling occupancy is lowest in the CBD of Sydney at around 1.9-2.2 people per dwelling. Occupancy increase with distance from the CBD until Campbelltown, Blacktown and Hornsby where it peaks around 3-3.2 people per dwelling and then declines again around Penrith (2.8-2.9 people per dwelling) and the Blue Mountains (2.5-2.7 people per dwelling). Figure 2 shows similar trends but has a greater level of detail and indicates lower occupancy rates along transport corridors and in areas of high amenity.

Scenario Occupancy Sensitivity Testing

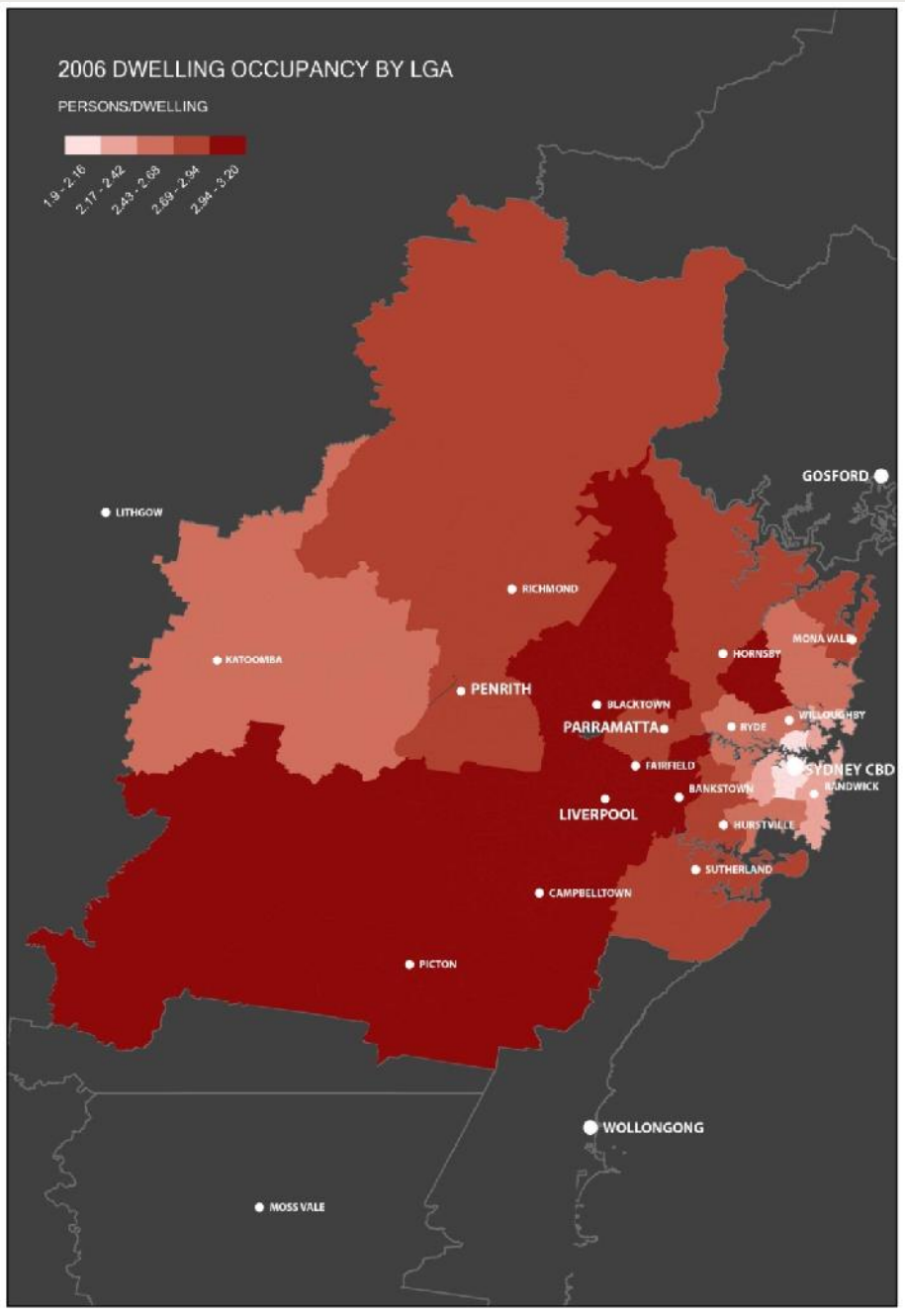
Recognising the significant variation in occupancy rates across Sydney, a sensitivity test has been undertaken for each of the scenarios to test the impact of applying a variable occupancy rate. The approach has been to apply the Base Case scenario occupancy for each individual Travel Zone to the dwelling growth distributions under each scenario to calculate the changes in population which might be expected.

Table C.1 summarises the results of this analysis. This suggests a variation of between 1 to 4 per cent in the population accommodated under the various scenarios with the Inner Middle Concentration scenario showing the greatest deviation from Base Case. Given this limited variation it is not considered significant to the outcomes of the Cost Benefit Assessment as a whole. However, the total quantums of variation suggest that some value may be attainable from a better understanding of measures for increasing dwelling occupancy, and thereby reducing overall demand for new dwellings.

C.1 Occupied Private Dwelling Populations for each scenario based on Base Case variable occupancy rates

	Occupied Private Dwelling Population	Variation from Base Case	Percent variation from the Base Case
Base Case	771 941	-	-
Balanced Centres	760 256	-11 685	2%
Strategic Centres Focus	761 364	-10 577	1%
Infill Dispersed	745 351	-26 590	3%
Inner Middle Concentration	738 049	-33 981	4%

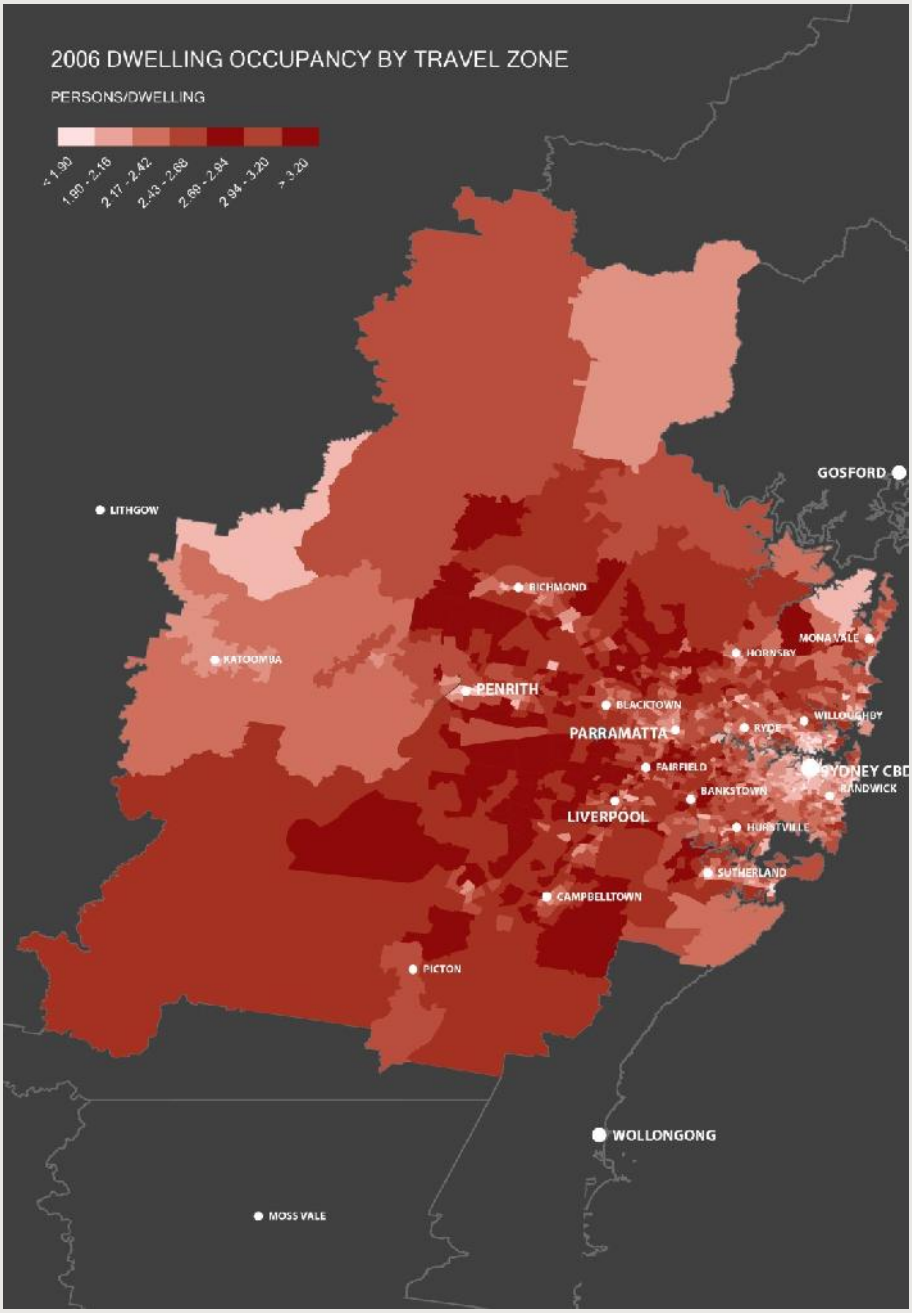
C.2 2006 Dwelling Occupancy by LGA



Data source: ARUP.

The dwelling occupancy by LGA shows a gradual increase in occupancy moving out from the CBD of Sydney. Central Sydney showing the lowest average occupancy rates of between 1.9-2.2, and the Inner West, Eastern suburbs and lower North Shore showing 2.3-2.4. Large areas of Sydney around Campbelltown and Bankstown and Blacktown have occupancy rates in the 3-3.2 range while areas around Penrith, Hornsby and Sutherland have occupancy rates in the 2.8-2.9 range.

C.3 2006 Dwelling Occupancy by Travel Zone



Data source: ARUP

Assessing dwelling occupancy by Travel Zone shows similar trends of lower occupancy in the CBD and in key centres and increased occupancy in Western Sydney. The increased detail allows a more detailed assessment indicates lower occupancy rates along transport corridors and in areas of high amenity around the harbour and coast and within centres.

Conclusions

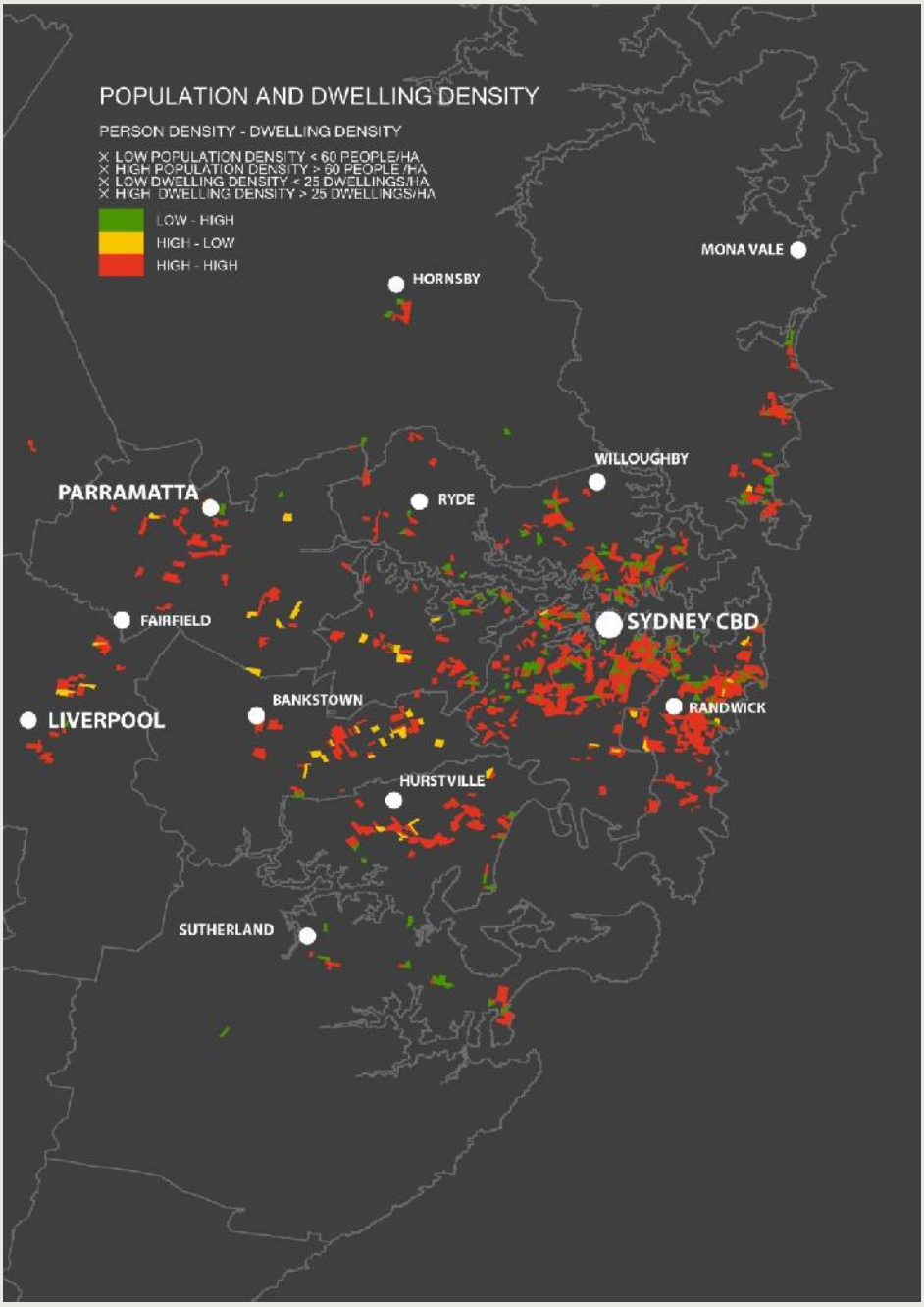
A preliminary review of literature suggests occupancy rates could be influenced by a variety of factors including:

- Housing stock (ie Do higher density dwellings have lower occupancy rates?)
- Proximity to transport (ie Do dwellings close to public transport have higher occupancy rates?)
- Household age (ie Do areas with ageing households have lower occupancy rates than the dwelling size and location would otherwise expect?)
- Cultural background (ie Do recent immigrants households have higher occupancy rates?)
- Household income (ie Do wealthier people have lower occupancy rates?)
- Amenity (i.e. Do locations with higher amenity attract higher occupancy rates?)

Additional review and analysis of occupancy rates across Sydney may be useful in order to provide an increased understanding of factors driving occupancy rates and thereby household demand drivers in Sydney.

Chart C.4 provides an example of the kind of analysis which may be undertaken by comparing population and dwelling densities. This highlights locations which have high population and dwelling densities including Darlinghurst, parts of Balmain and Glebe. It also identifies areas which have high dwelling densities but low population densities including areas around Woollahra and areas which have high population densities but low dwelling densities such as areas around Canterbury and Strathfield.

C.4 2006 Person and Dwelling Density



Data source: ARUP

D Scenarios in detail

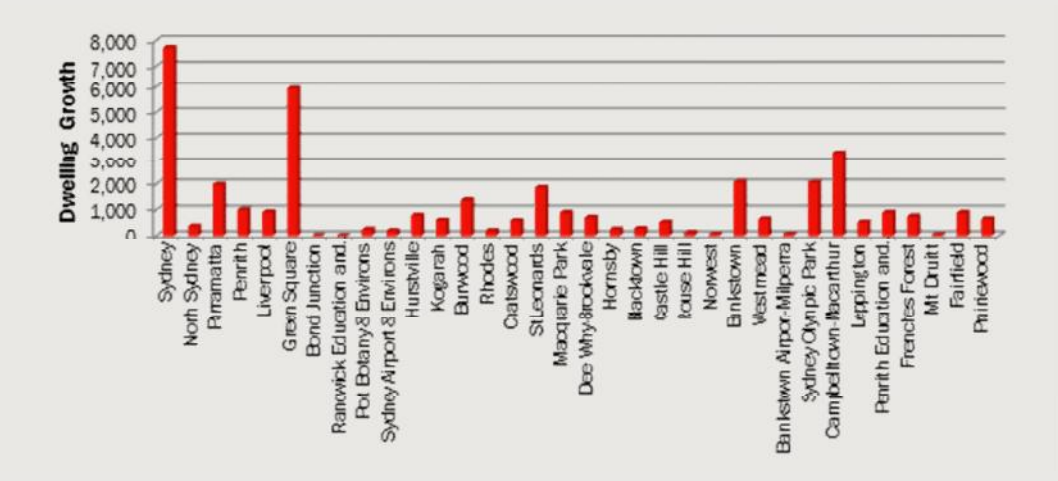
Base case

Base Case Dwelling Distribution

Under the Base Case scenario, approximately 18.6 per cent of dwelling growth (39,508 dwellings) will occur in Strategic Centres, with Sydney (7,744 dwellings), Green Square (5,971 dwellings) and Campbelltown-Macarthur (3,417 dwellings) receiving the highest proportions of Strategic Centre growth as highlighted in Chart D.1.

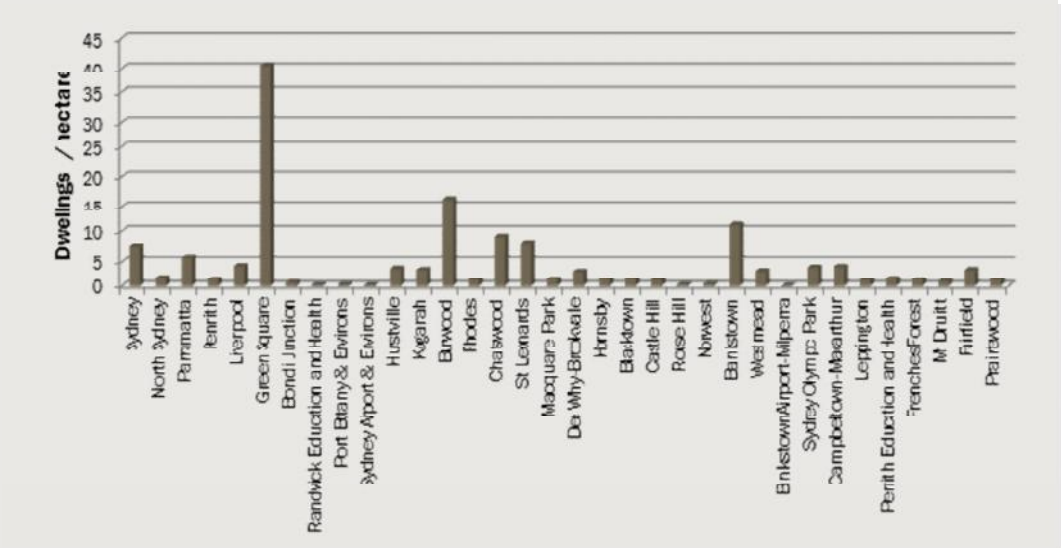
A closer look at the density of dwelling growth across Strategic Centres (see Chart D.2) highlights that Green Square will be subject to particularly intense dwelling development under this scenario at 40.54 dwellings per hectare. The next highest density of dwelling growth is considerably lower at 16.25 dwellings per hectare in Burwood. The majority of Strategic Centres will experience dwelling growth densities of less than 10 dwellings per hectare under the Base Case.

D.1 Strategic Centres Dwelling Growth



Data source: ARUP

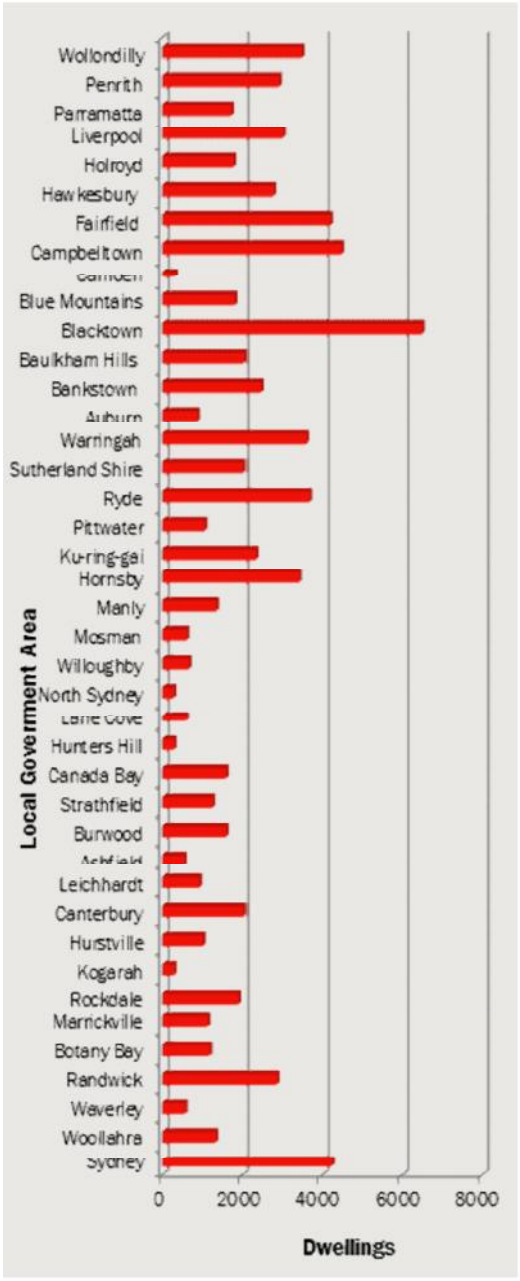
D.2 Strategic Centres Dwelling Growth Density



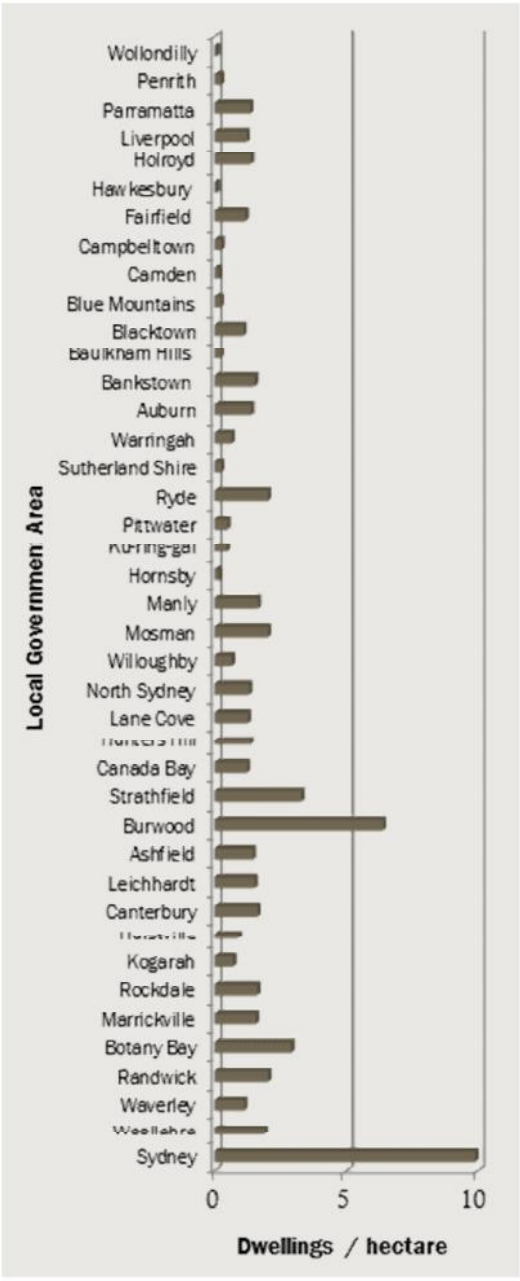
Data source: ARUP

Approximately 37.3 per cent of dwelling growth (80,360 dwellings) will occur in Local Centres across the city under the Base Case, with Blacktown, Campbelltown and Fairfield receiving the largest proportions of Local Centre growth. As to be expected, the intensity of dwelling growth across Local Centres will be lower than for Strategic Centres. Sydney City's Local Centres will have the most intense dwelling growth at around 10 dwellings per hectare, with Burwood the next most intense at around 6 dwellings per hectare. Chart D.3 and D.4 present the total dwelling growth and dwelling growth density for Local Centres across Sydney under the Base Case.

D.3 Local Centres dwelling growth - by LGA



D.4 Local Centres dwelling growth density - by LGA

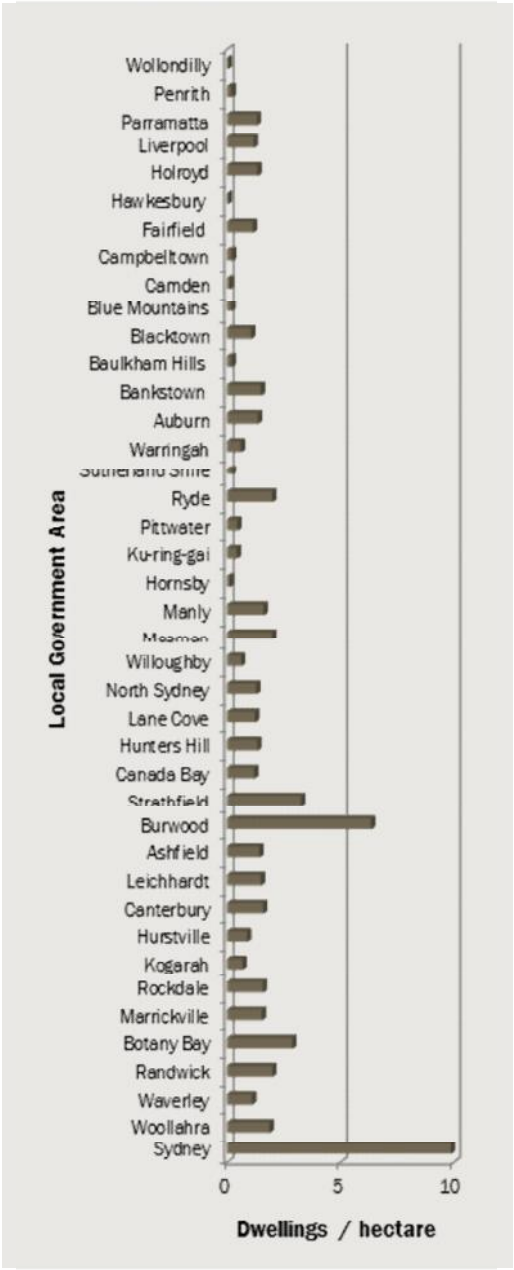


Data Source: ARUP

Areas outside of centres will produce 43.9 per cent (92,745 dwellings) of dwellings under the Base Case scenario, with relatively high levels of out of centre growth expected in Sydney's outer suburbs including Campbelltown, Bankstown, and Sutherland. The intensity of dwelling growth outside of centres will reach a maximum of 6 dwellings per hectare in Burwood with the next highest densities, in North Sydney and Sydney City, considerably lower at around 2.5 dwellings per hectare.

D.5 Outside of Centre Dwelling Growth – by LGA

D.6 Outside of Centre Dwelling Growth Density – by LGA



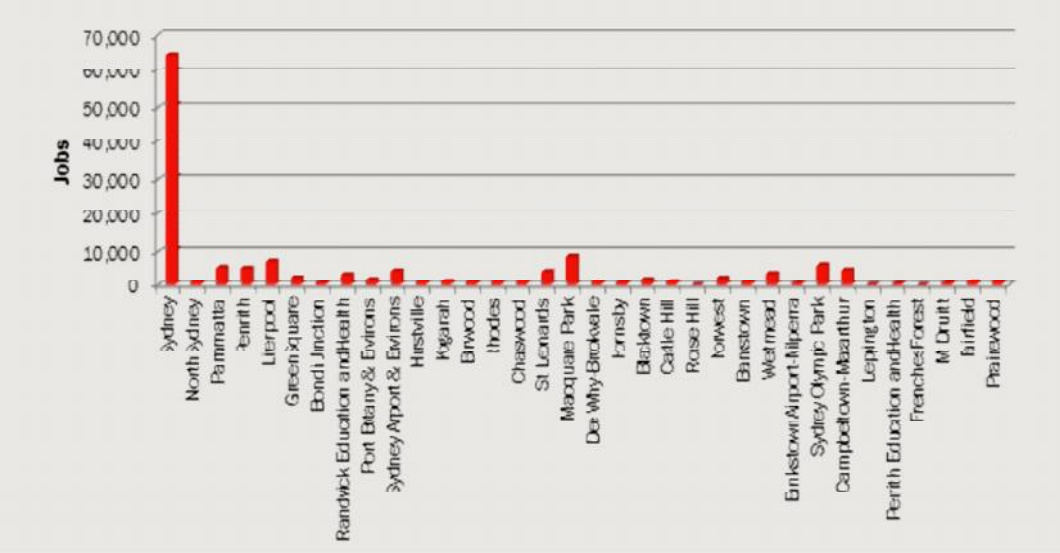
Data source: ARUP

Base Case Employment Distribution

Approximately 48.2 per cent of employment growth (159,188 jobs) under the Base Case scenario will be generated in Strategic Centres, with Sydney CBD (64,842 jobs) generating a significant proportion of Strategic Centre employment growth, making up 40 per cent. The next most significant employment centres, Macquarie Park (8,872 jobs) and Liverpool (7,656 jobs), will generate closer to 5 per cent of Strategic Centre employment growth each under the Base Case (see Chart D.7).

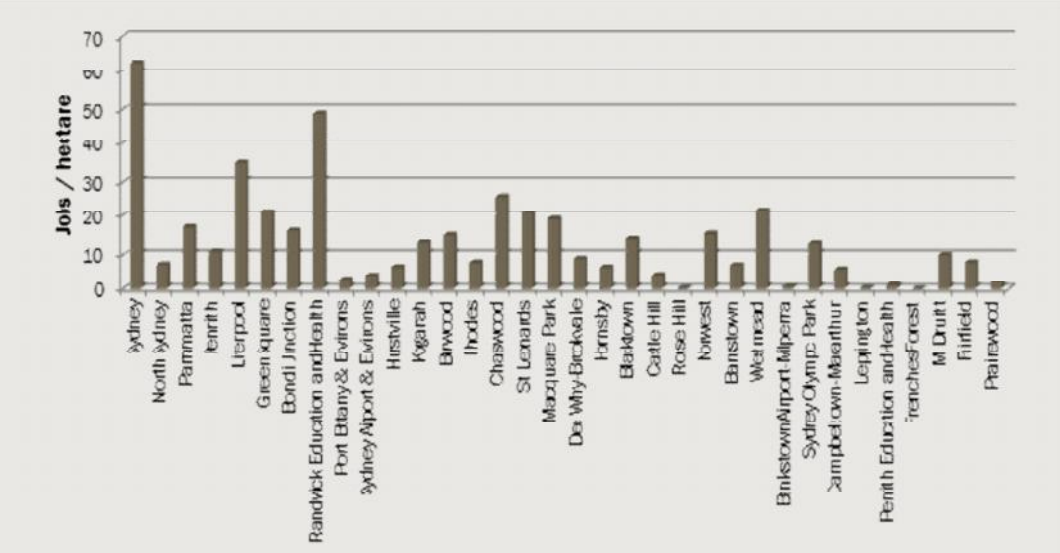
Sydney CBD will maintain the highest density of employment growth of all the Strategic Centres under the Base Case at 63 jobs per hectare, although Randwick Health and Education and Liverpool will also have reasonably high employment growth densities at 49 jobs per hectare and 35 jobs per hectare respectively. As shown in Figure 11, the balance of the Strategic Centres will have under 30 jobs per hectare employment growth.

D.7 Strategic Centres Employment Growth



Data source: ARUP

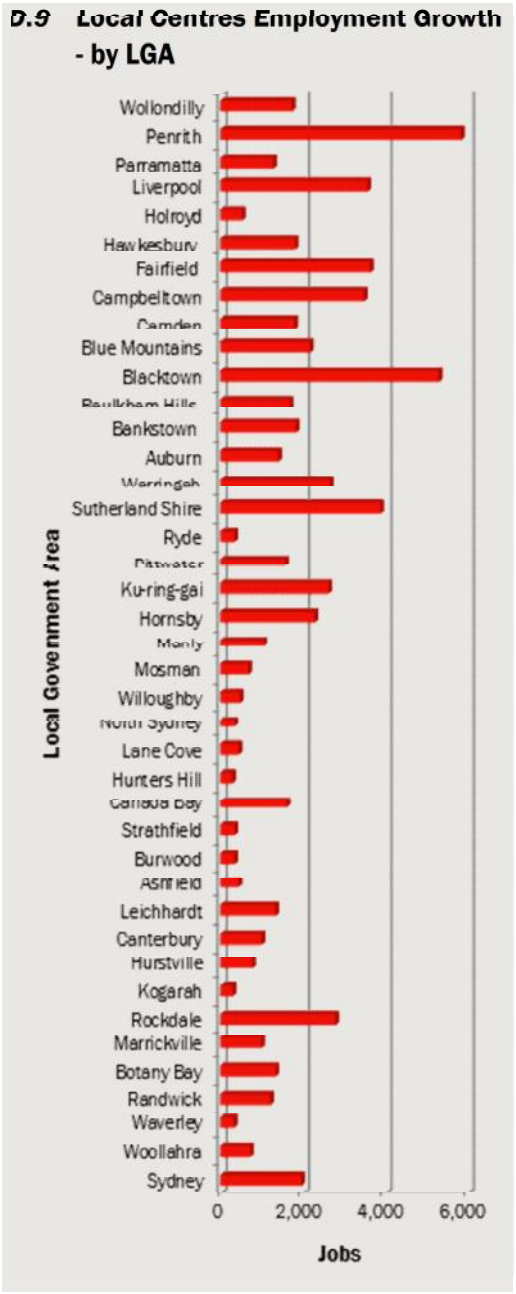
D.8 Strategic Centres Employment Growth Density

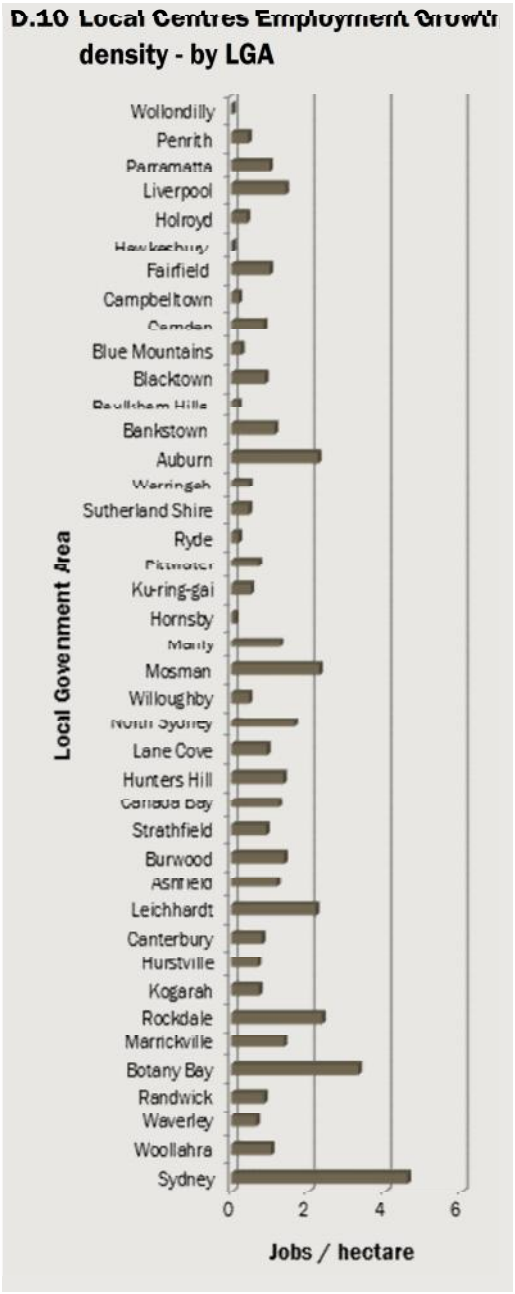


Data source: ARUP

Employment growth in Local Centres under the Base Case will be equivalent to 20.7 per cent of all employment growth (68,254 jobs). Penrith (5,838 jobs), Blacktown (5,303 jobs) and Sutherland (3,888 jobs) will experience the most significant growth in Local Centre employment. However, the density of employment growth in Local Centres will

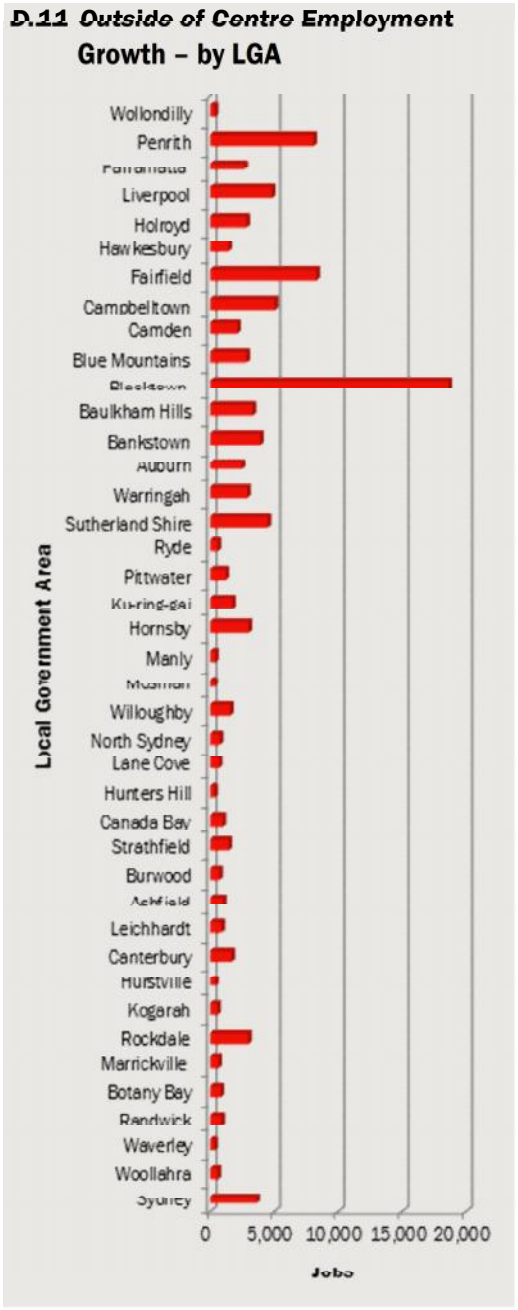
be greatest in Sydney City (4.59 jobs per hectare), Botany Bay (3.31 jobs per hectare) and Rockdale (2.37 jobs per hectare). Chart D.9 and D.10 show the distribution of employment growth in Local Centres across Sydney's Local Government Areas in terms of employment growth numbers and employment growth density respectively, for the Base Case.

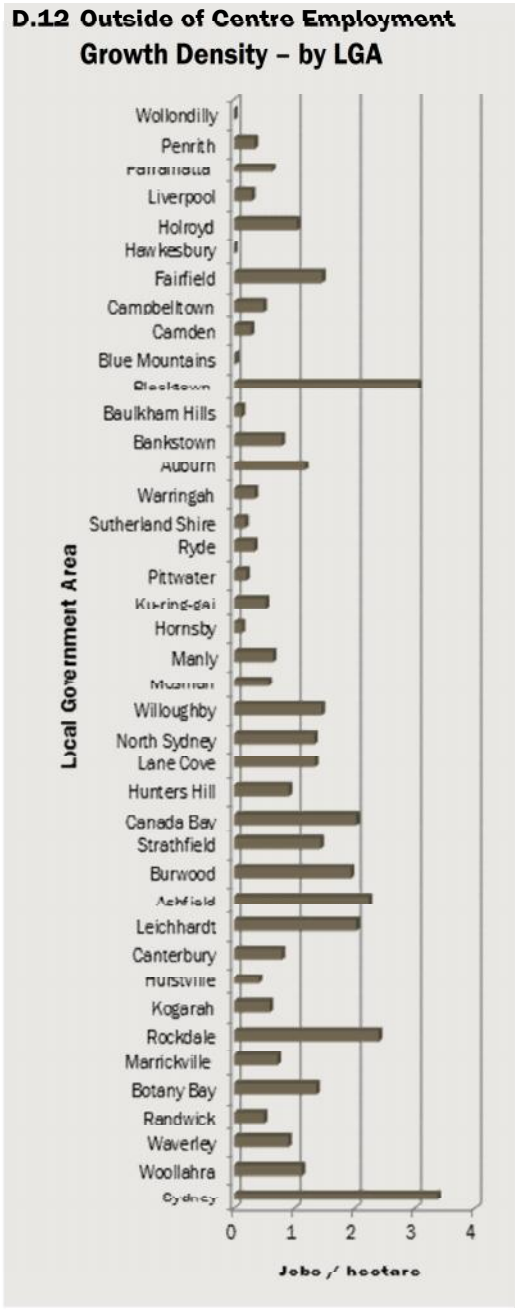




Data source: ARUP

Areas outside of centres will produce 31.1 per cent (80,960 jobs) of employment growth under the Base Case. Out of centre employment growth will generally be greater in Sydney's outer suburbs, with exceptionally high levels occurring in Blacktown (18,630 jobs). Fairfield (8,300 jobs) and Penrith (8,100 jobs) will also generate considerable out of centre employment growth. In contrast, the intensity of out of centre employment growth will be greatest in Sydney's inner and middle suburbs, particularly Sydney City (with 3.38 jobs per hectare), although Blacktown will also provide a relatively high density of employment growth at 3.05 jobs per hectare.





Data source: ARUP

Balanced centres

Balanced Centres Housing Form

Housing growth in centres under the Balanced Centres scenario includes a mix of housing forms. Global Sydney (including Sydney CBD and North Sydney) consists of all high density multi-unit housing. The Regional Cities and Major Centres consist of 50 per cent high density multi-unit housing and 50 per cent medium density. Housing growth in Local Centres is made up of 10 per cent high density multi-unit houses and 90 per cent medium density. Housing growth outside of centres is medium density.

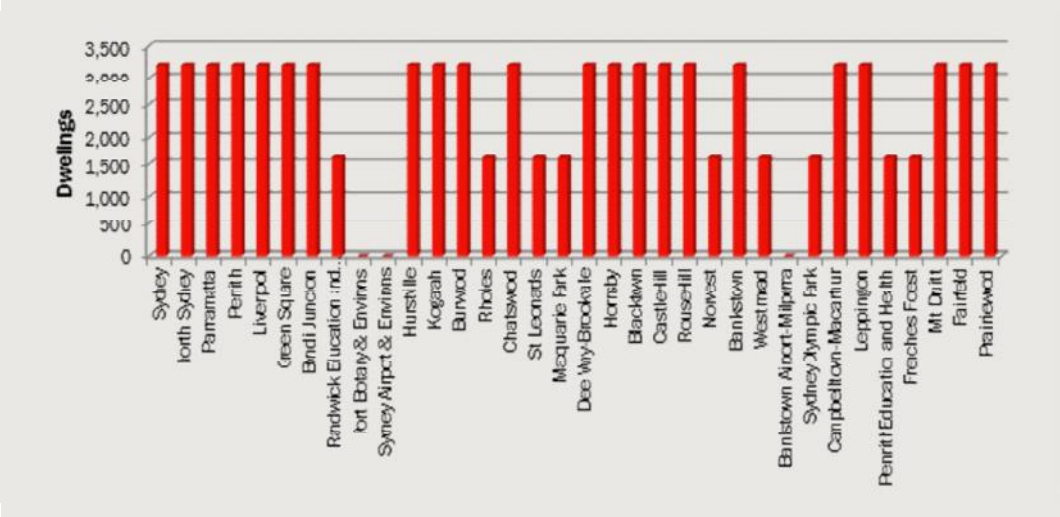
Balanced Centres Housing Distribution

Housing distribution for the Balanced Centres scenario contains 80 per cent of all new housing in the catchment areas of all centre types and 20 per cent dispersed housing.

The Balanced Centres scenario evenly distributes its dwelling growth between Strategic Centres (40 per cent or 85,045 dwellings) and Local Centres (40 per cent). Across the Strategic Centres, this growth reflects that major gateways (including Port Botany, Sydney Airport and Bankstown Airport-Milperra) are not expected to experience dwelling growth and the other Specialised Centres (including Frenchs Forest, Macquarie Park, St Leonards, Randwick Health and Education, Rhodes, Sydney Olympic Park, Westmead, Norwest and Penrith Education & Health) are likely to experience only half of the dwelling growth (at 1,605 dwellings) anticipated for the balance of the Strategic Centres (at 3,209 dwellings). Chart D.13 shows the distribution of dwelling growth across the Strategic Centres for the Balanced Centres scenario.

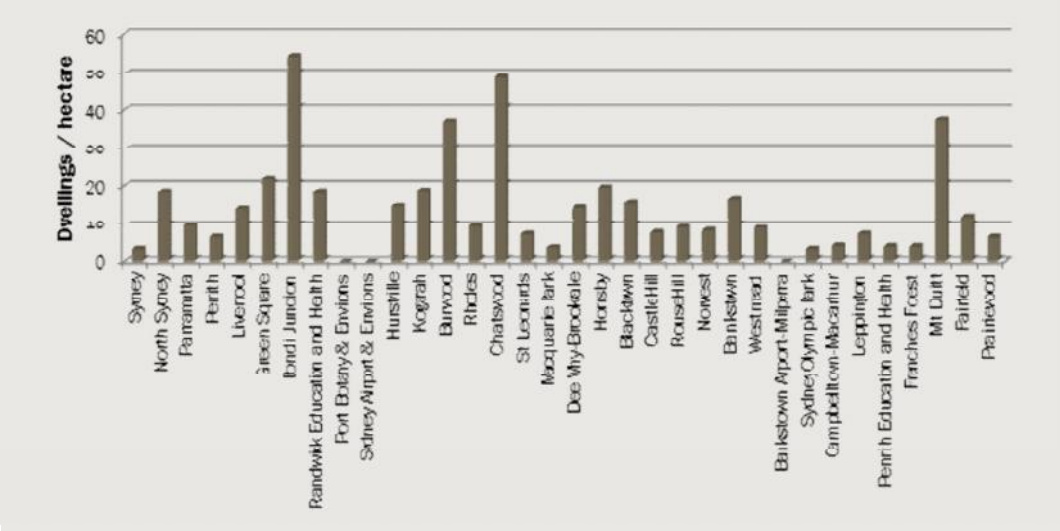
While the quantum of growth is distributed equitably across the Strategic Centres, in terms of growth density, Bondi Junction (54.59 dwellings per hectare), Mt Druitt (37.68 dwellings per hectare), Chatswood (48.25 dwellings per hectare) and Burwood (37.2 dwellings per hectare) are expected to have the highest densities of dwelling growth under the Balanced Centres scenario (see Chart D.14).

D.13 Strategic Centres Dwelling Growth



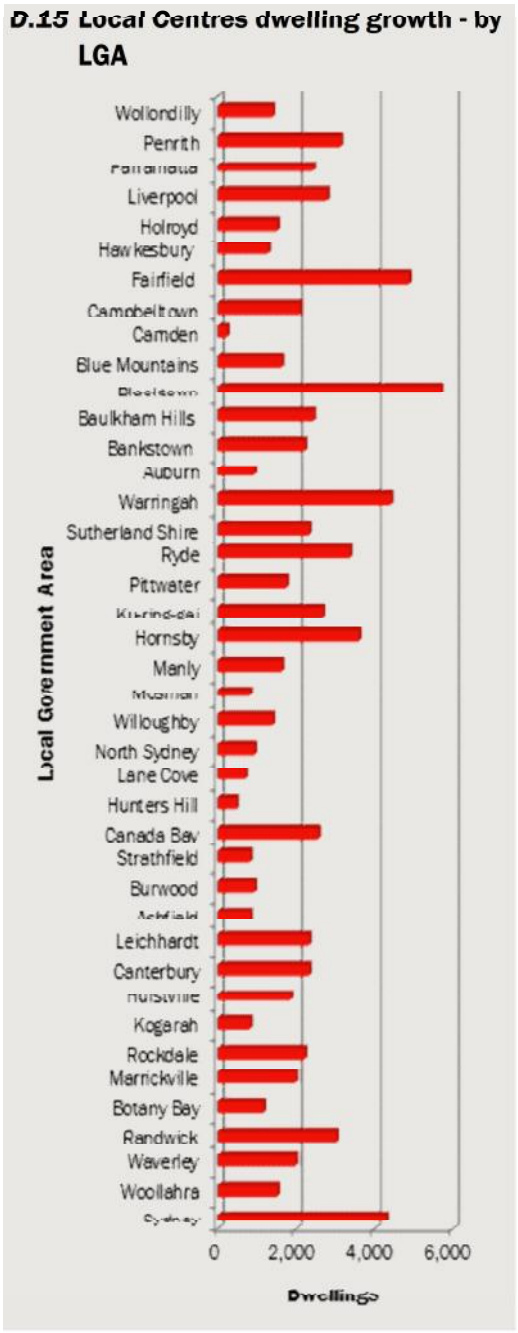
Data source: ARUP

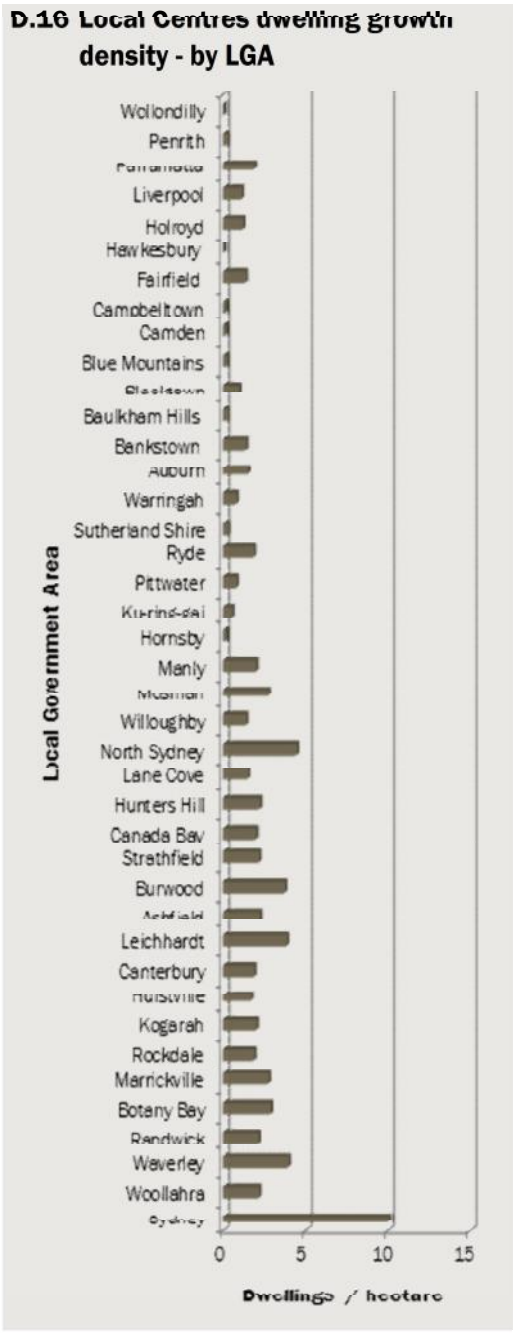
D.14 Strategic Centres Dwelling Growth Density



Data source: ARUP

Local Centres will receive 40 per cent or 85,045 of dwellings under the Balanced Centres scenario. This growth will be distributed evenly across all Local Centres. As the number of Local Centres in each LGA across Sydney varies, this even distribution will result in particularly high dwelling production levels across Local Centres in Blacktown (5,677 dwellings), Fairfield (4,866 dwellings), Sydney City (4,287 dwellings) and Warringah (4,403 dwellings). Under the Balanced Centres scenario the density of Local Centre dwelling production will generally be consistently below 5 dwellings per hectare, apart from in Sydney City where it will be twice this number at over 10 dwellings per hectare.





Data source: ARUP

Outside of centres, pro-rata distribution of dwelling growth under the Balanced Centres scenario is based on the targets for subregional growth set out in the Metropolitan Plan for Sydney 2036 (minus centres based dwelling growth) shared evenly across each Local Government Area within each subregion. Areas outside of centres will produce 20 per cent of dwellings (or 42,523 dwellings). Sydney City (5,783 dwellings) will produce a significant number of this out of centre growth for the Balanced Centres scenario, otherwise the bulk of out of centre growth will occur in western Sydney, particularly the West Central LGAs which will contribute 1,819 dwellings each. Dwelling growth outside of centres under this scenario will be most dense in Sydney City (5.39 dwellings

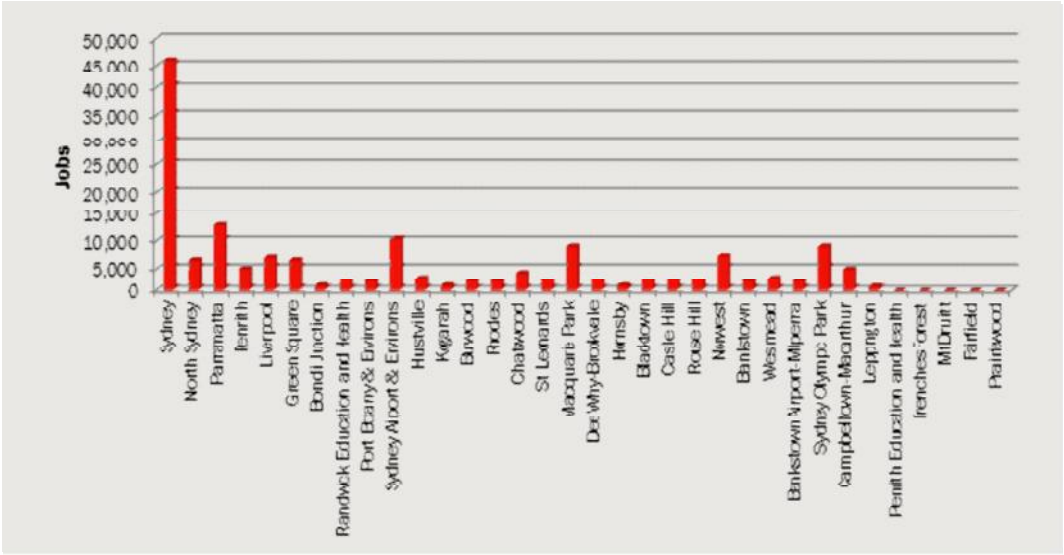
per hectare) and will generally be higher in the inner and middle suburbs and lower in outer Sydney.

Balanced Centres Employment Distribution

Employment distribution for the Balanced Centres Focus scenario is based on 50 per cent of growth in Strategic Centres and 50 per cent in Local Centres (that is 165,076 jobs each) with no out of centre employment growth. A minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

Across the Strategic Centres, pro-rata distribution of employment growth under the Balanced Centres scenario is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036 (see Chart D.17). As such, Sydney CBD (46,131 jobs) will generate a significant proportion of employment growth under this scenario with Parramatta (12,974 jobs), Sydney Airport and Environs (10,572 jobs), Macquarie Park (9,130 jobs), Olympic Park (9,130 jobs) and Norwest (7,460 jobs) also making key contributions to Strategic Centre employment growth. In terms of employment density (see Chart D.18), Chatswood (65.02 jobs per hectare) and Green Square (45.67 jobs per hectare) and Sydney CBD (45.08 jobs per hectare) will have the highest intensities of employment generation. Port Botany and Environs (2.61 jobs per hectare), Bankstown Airport – Milperra (2.16 jobs per hectare) and Leppington (1.72 jobs per hectare) will have some of the lowest densities of employment growth under this scenario.[115]

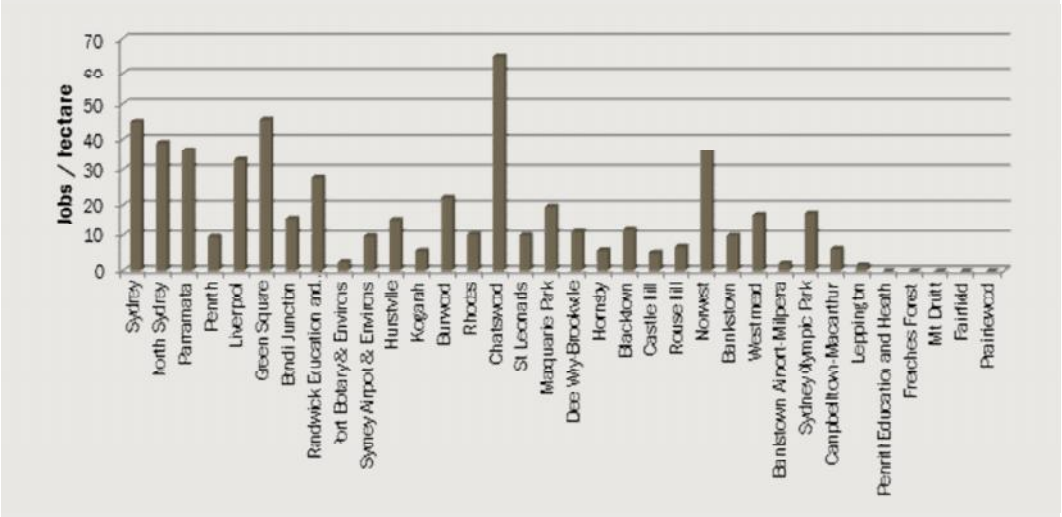
D.17 Strategic Centres Employment Growth



Data source: ARUP

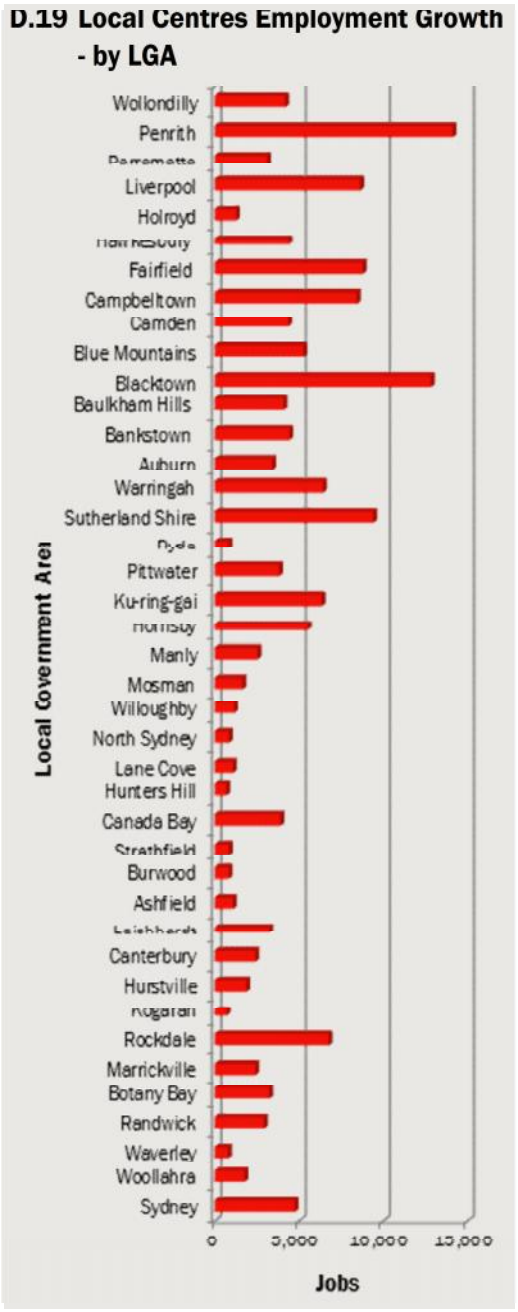
115 Apart from the Potential Strategic Centres of Penrith Education and Health, Frenches Forest, Mt Druitt, Fairfield and Prairiewood which do not have employment growth targets identified in the Metropolitan Plan for Sydney 2036

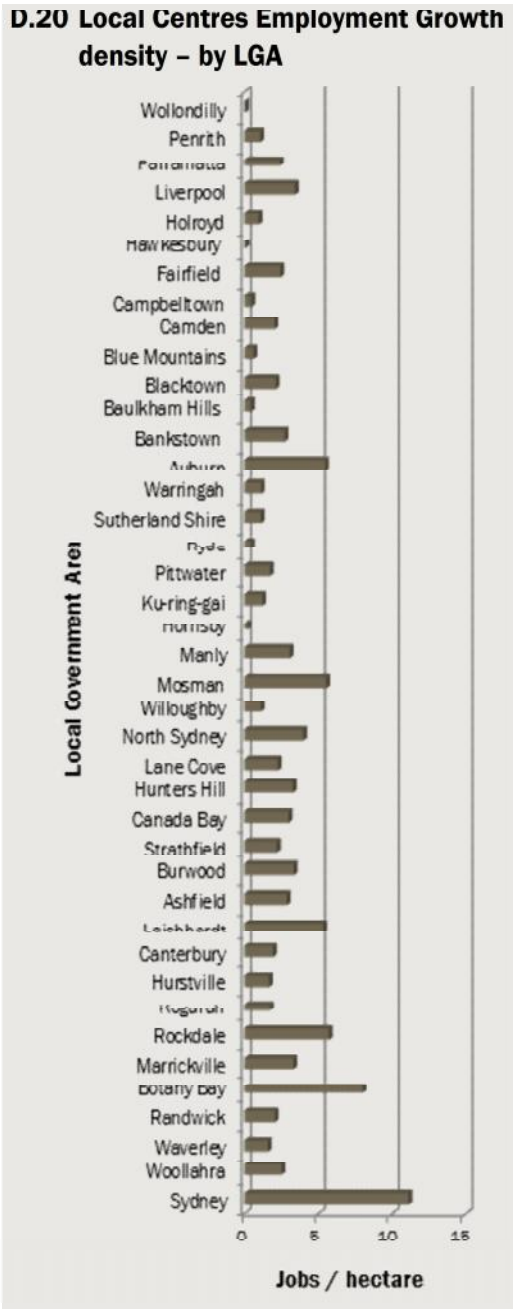
D.18 Strategic Centres Employment Growth Density



Data source: ARUP

Across the Local Centres, employment growth is distributed evenly under the Balanced Centres scenario. Penrith (14,120 jobs), Blacktown (12,827 jobs), Sutherland (9,404 jobs) and Rockdale (6,765 jobs) will experience the most significant growth in Local Centre employment. However, the density of employment growth in Local Centres under this scenario will be greatest in Sydney City (11.11 jobs per hectare), Botany Bay (8.01 jobs per hectare) and Rockdale (5.72 jobs per hectare). Employment growth densities in each of these centres will be consistently higher than under the Base Case scenario. Chart D.19 and D.20 show the distribution of employment growth in Local Centres across Sydney's Local Government Areas in terms of employment growth numbers and employment growth density respectively, for the Balanced Centres scenario. No out of centre employment growth will occur under this scenario.





Data source: ARUP

Strategic centres

Strategic Centres Focus Housing Form

Under the Strategic Centres Focus scenario all Strategic Centres housing growth will be high density multi-unit housing. Little housing growth will occur in Local Centres. Housing growth outside of centres will be medium density.

Strategic Centres Focus Housing Distribution

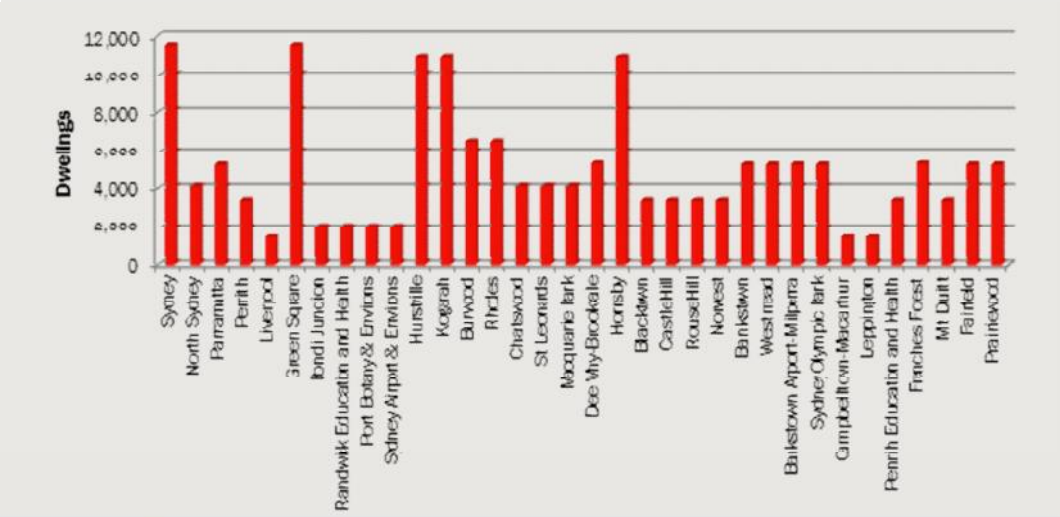
Like the Balanced Centres Focus scenario, housing distribution for the Strategic Centres Focus scenario contains 80 per cent of all new housing in the catchment areas of all centre types and 20 per cent dispersed housing.

However, rather than even distribution of dwelling growth across centres of all types, the Strategic Centres Focus scenario focuses all centres dwelling growth within the 35 Strategic Centres with no dwelling growth within the Local Centres.

Under this scenario, pro-rata distribution of dwelling growth to the Strategic Centres and outside of centres is based on targets for subregional growth set out in the Metropolitan Plan for Sydney 2036. Of this pro-rata growth, 80 per cent of growth within each subregion is distributed evenly across the subregion's Strategic Centres, with the remaining 20% allocated to areas outside of centres and shared evenly across each Local Government Area within the subregion.

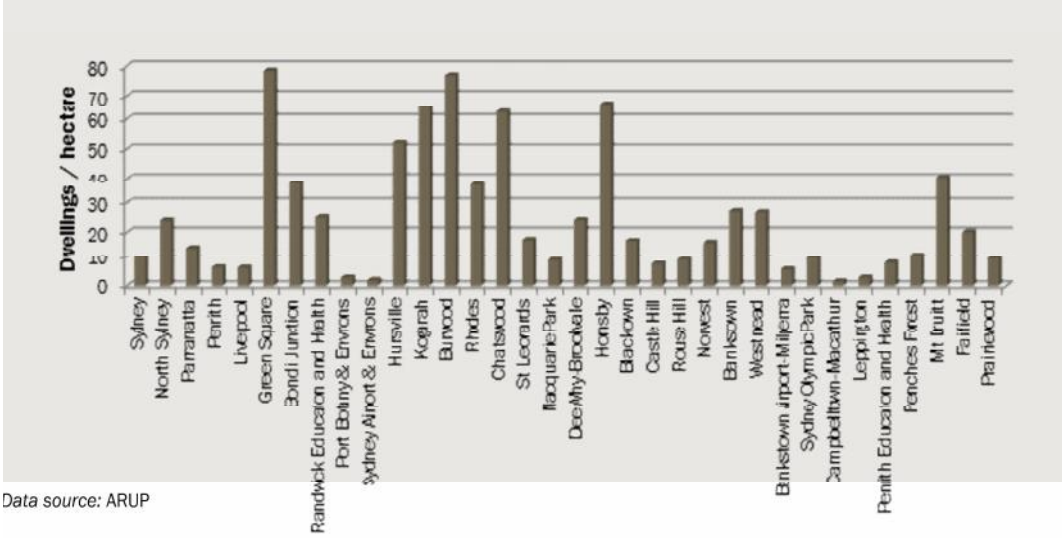
This pattern is reflected in Chart D.21 which highlights Sydney City (11,567 dwellings), Green Square (11,567 dwellings), Hurstville (10,998 dwellings), Kogarah (10,998 dwellings) and Hornsby (10,998 dwellings) as the Strategic Centres with highest dwelling growth under the Strategic Centres Focus scenario. In contrast, Strategic Centres in the south west of Sydney (such as Liverpool and Leppington) will produce the least dwellings (1,384 dwellings each). In terms of the density of dwelling growth, Chart D.22 shows a more variable pattern with Green Square (78.53 dwellings per hectare), Burwood (76.93 dwellings per hectare) and Hornsby (67.28 dwellings per hectare) being the most intense localities under the Strategic Centres Focus scenario, while Campbelltown-Macarthur (1.7 dwellings per hectare), Leppington (2.95 dwellings per hectare) and the major gateways will produce dwellings at much lower densities. No dwelling growth will occur outside of centres under this scenario.

D.21 Strategic Centres Dwelling Growth



Data source: ARUP

D.22 Strategic Centres Dwelling Growth Density



Data source: ARUP

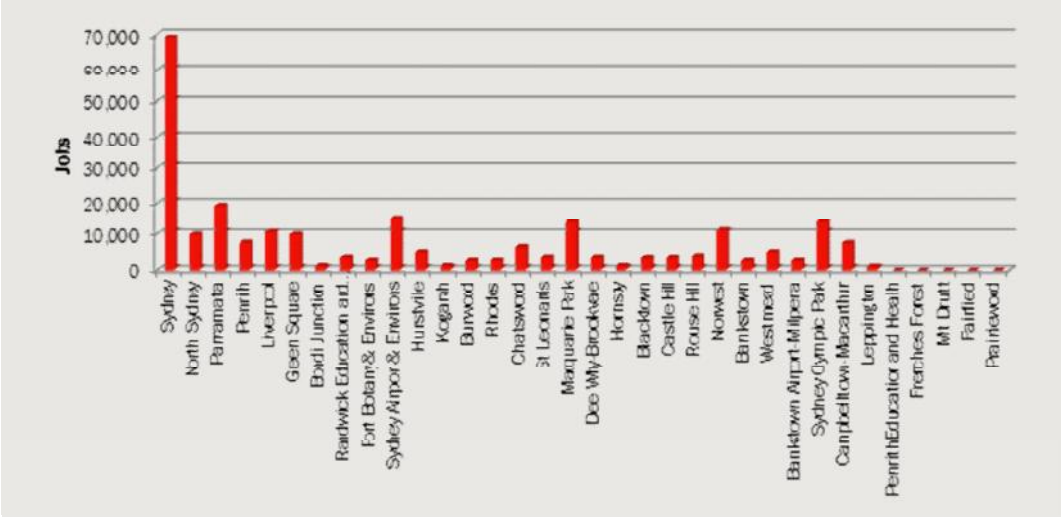
Strategic Centres Focus Employment Distribution

Employment distribution for the Strategic Centres Focus scenario is based on 75 per cent of growth in Strategic Centres (247,614 jobs) and 25 per cent in Local Centres (82,538 jobs) with no out of centre employment growth. Under this scenario, a minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

Across the Strategic Centres under this scenario, pro-rata distribution of employment growth is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036. Accordingly, Sydney CBD (69,197 jobs) will generate the majority of employment with Parramatta (19,462 jobs), Sydney Airport and Environs (15,858 jobs), Macquarie Park (13,695 jobs), Sydney Olympic Park (13,695 jobs) and Norwest (11,191 jobs) making important but substantially smaller contributions

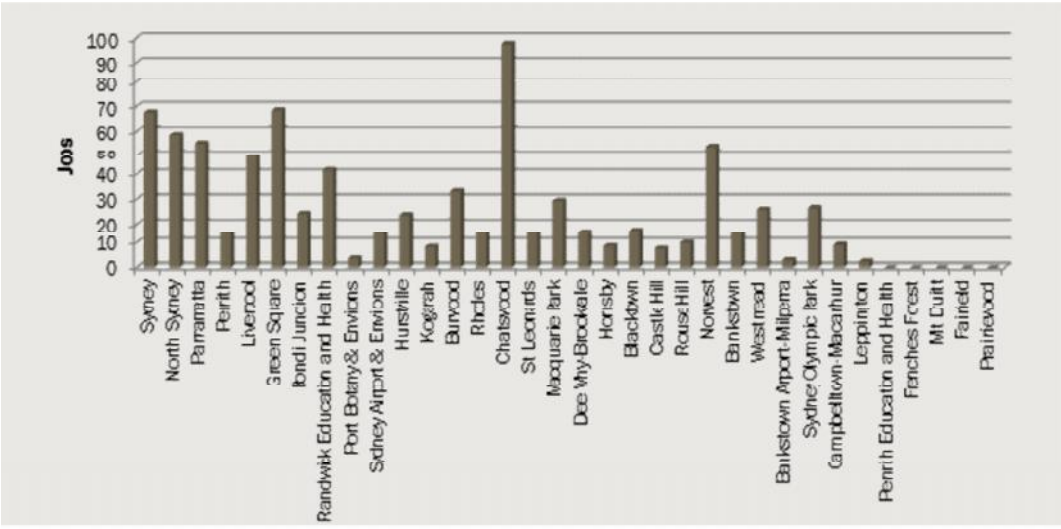
(see Chart D.23). In contrast, Chatswood (97.53) will have the highest density of employment growth under the Strategic Centres Focus scenario, followed by Green Square (68.51 jobs per hectare), Sydney CBD (67.61 jobs per hectare) and Norwest (53.89 jobs per hectare). Port Botany and Environs (3.92 jobs per hectare), Bankstown Airport – Milperra (3.24 jobs per hectare) and Leppington (2.58 jobs per hectare) will have some of the lowest densities of employment growth under this scenario (see Chart D.24).

D.23 Strategic Centres Employment Growth



Data source: ARUP

D.24 Strategic Centres Employment Growth Density



Data source: ARUP

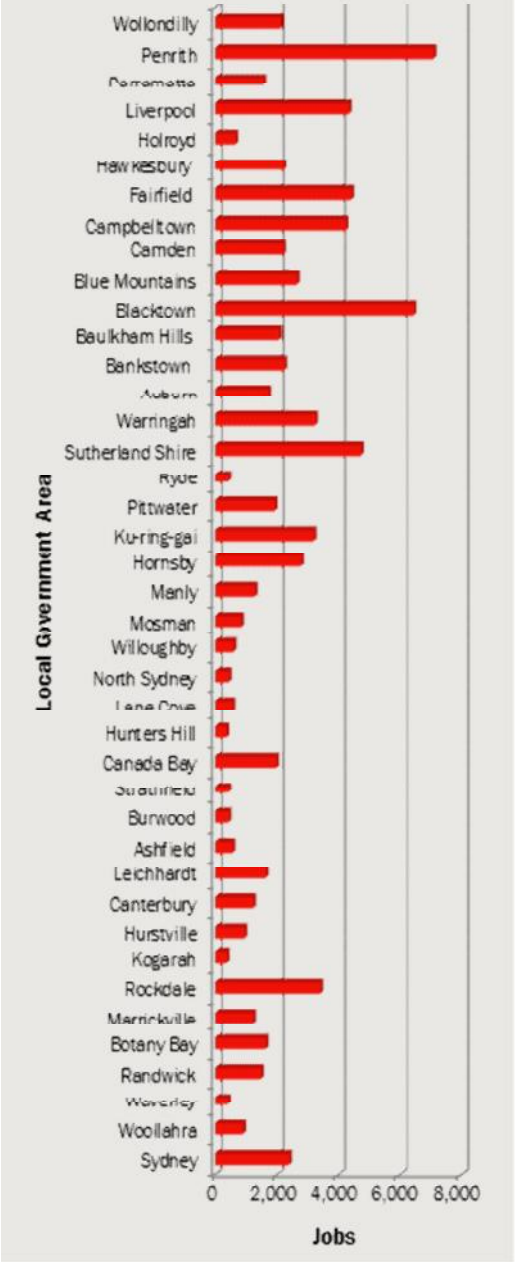
For the Local Centres under the Strategic Centres Focus scenario, pro-rata distribution of employment growth is based on the targets for subregional employment growth set out in the Metropolitan Plan for Sydney 2036, minus centres growth. Due to the high proportion of growth ascribed to Strategic Centres in this scenario 9 per cent of the 2016 to 2031 growth contribution is redistributed to ensure all Local Government Areas reflect

employment growth over this period. This redistributed portion is drawn from the South, Inner West, North and North East sub-regions and shifts to the Sydney City, East and Inner North sub-regions. Employment growth within each subregion is allocated evenly across the Local Centres.

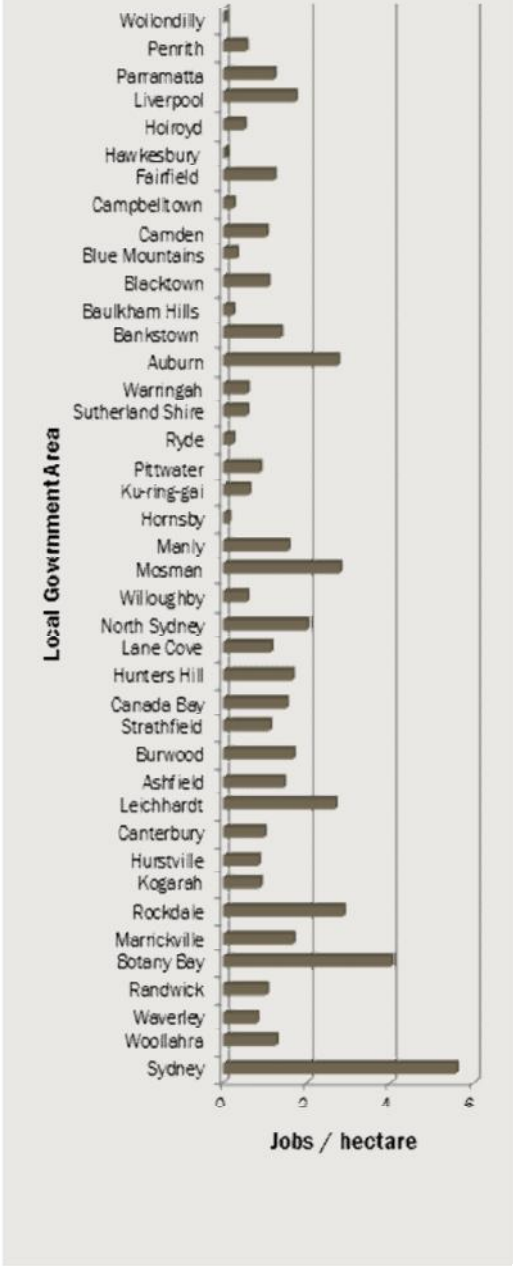
Under the Strategic Centres Focus scenario, a significant proportion of Local Centre growth will occur in Sydney's outer suburbs, particularly Penrith (7,060 jobs), Blacktown (6,413 jobs) and Sutherland (4,702 jobs) LGA's. However, the density of employment growth in these LGA's will be relatively low. Under this scenario employment growth densities in Local Centres will be greatest in Sydney City (5.56 jobs per hectare) and Botany Bay (4 jobs per hectare) with Auburn, Mosman, Leichhardt and Rockdale also reaching similarly high densities of employment growth (at around 2.6 jobs per hectare). Employment densities in Local Centres elsewhere will generally be below 2 jobs per hectare.

No out of centre employment growth will occur under the Strategic Centres Focus scenario.

D.25 Local Centres Employment Growth - by LGA



D.26 Local Centres Employment Growth density – by LGA



Data source: ARUP

Infill dispersed

Infill Dispersed Housing Form

Under the Infill Dispersed scenario, housing growth includes a mix of housing forms. Global Sydney (including Sydney CBD and North Sydney) consists of all high density multi-unit housing. The Regional Cities and Major Centres consist of 50 per cent high density multi-unit housing and 50 per cent medium density. Housing growth in Local Centres is made up of 10 per cent high density multi-unit houses and 90 per cent medium density. Housing growth outside of centres is medium density.

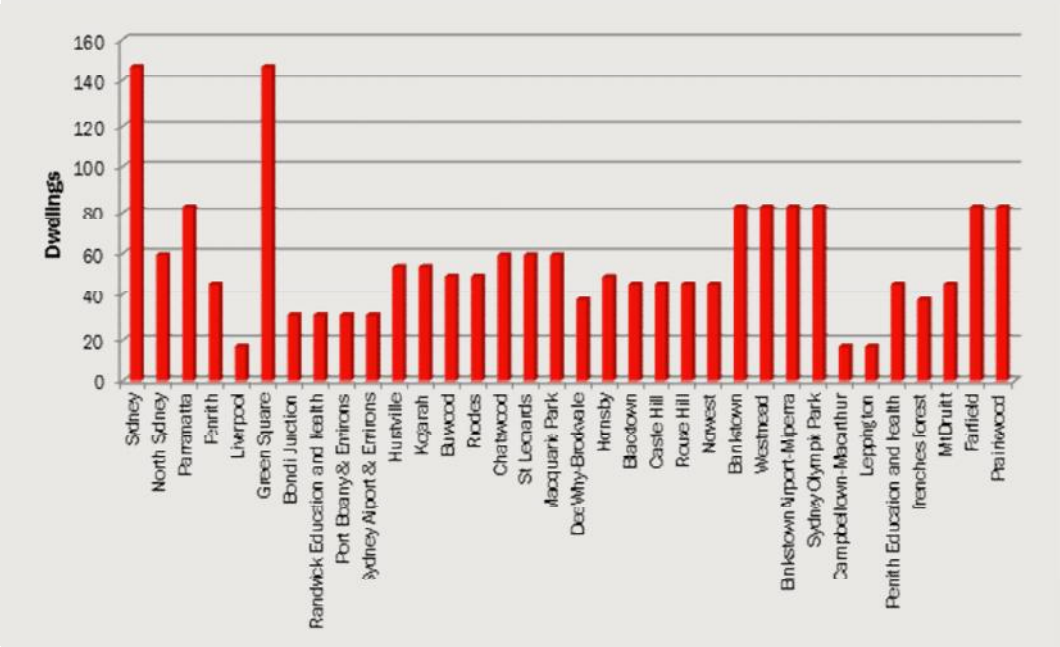
Infill Dispersed Housing Distribution

In contrast to the Balanced Centres Focus and Strategic Centres Focus scenarios, the Infill Dispersed Scenario contains 20 per cent of all new housing (42,523 dwellings) in the catchment areas of all centre types and 80 per cent dispersed housing (170,090 dwellings).

Pro-rata distribution of dwelling growth under this scenario is based on targets for subregional growth set out in the Metropolitan Plan for Sydney 2036. Of this pro-rata growth, 20 per cent of growth within each subregion is distributed across the subregion's centres evenly, with 80 per cent allocated to areas outside of centres and shared evenly across each Local Government Area within the subregion.

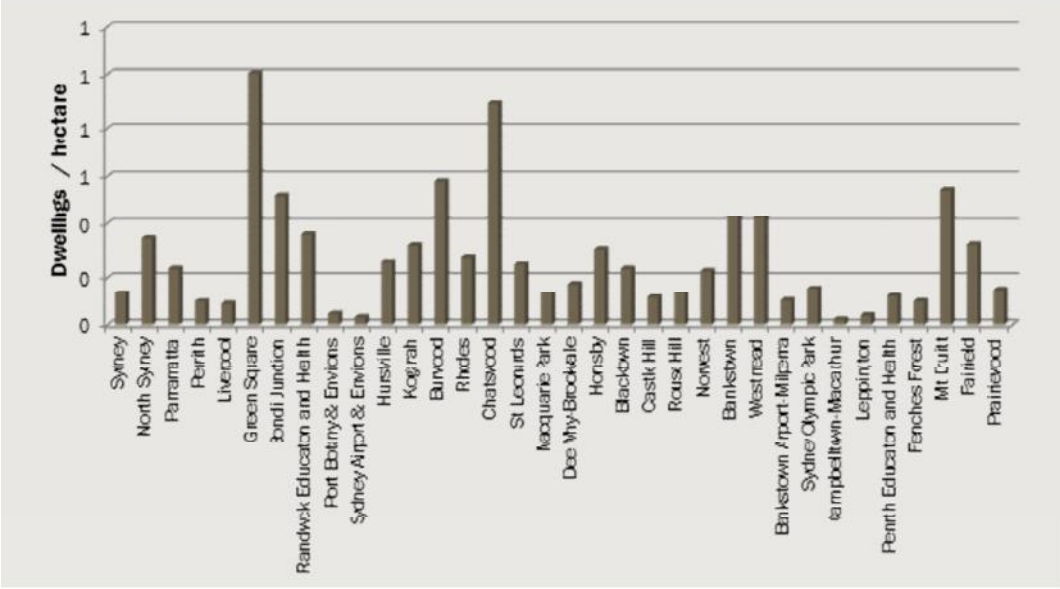
This scenario reflects relatively minor levels of dwelling growth in the Strategic Centres (0.9 per cent or 1,956 dwellings), with Sydney CBD and Green Square accommodating the highest proportions of growth with 148 dwellings each (see Chart D.27). The south western Sydney Strategic Centres, Campbelltown-Macarthur, Leppington and Liverpool, will receive the least dwelling growth under this scenario with 18 dwellings each. At these rates of growth all Strategic Centres will have dwelling growth densities below one dwelling per hectare as illustrated in Chart D.28.

D.27 Strategic Centres Dwelling Growth



Data source: ARUP

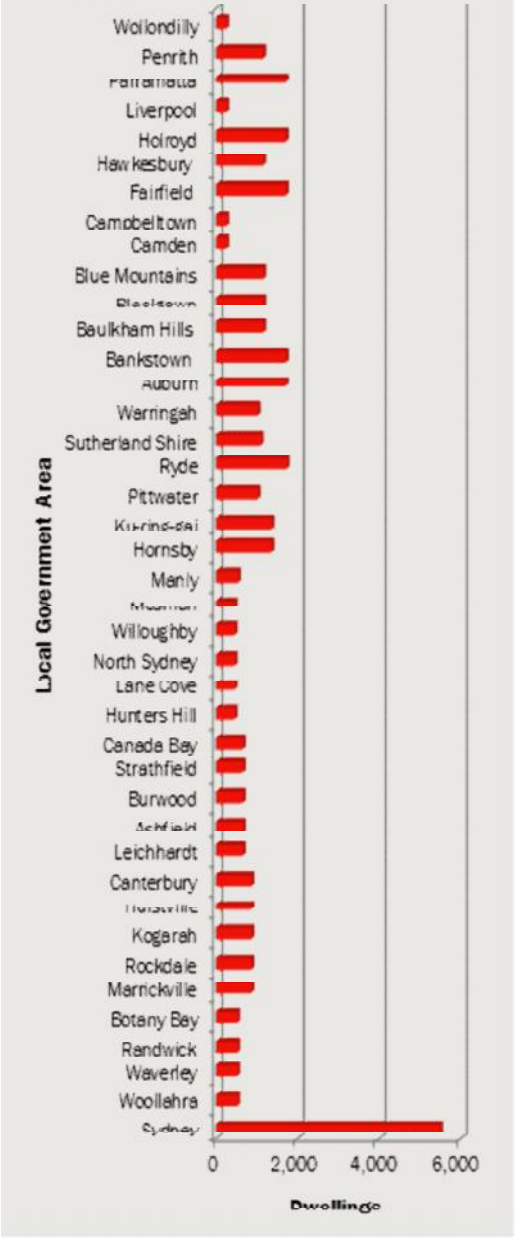
D.28 Strategic Centres Dwelling Growth Density



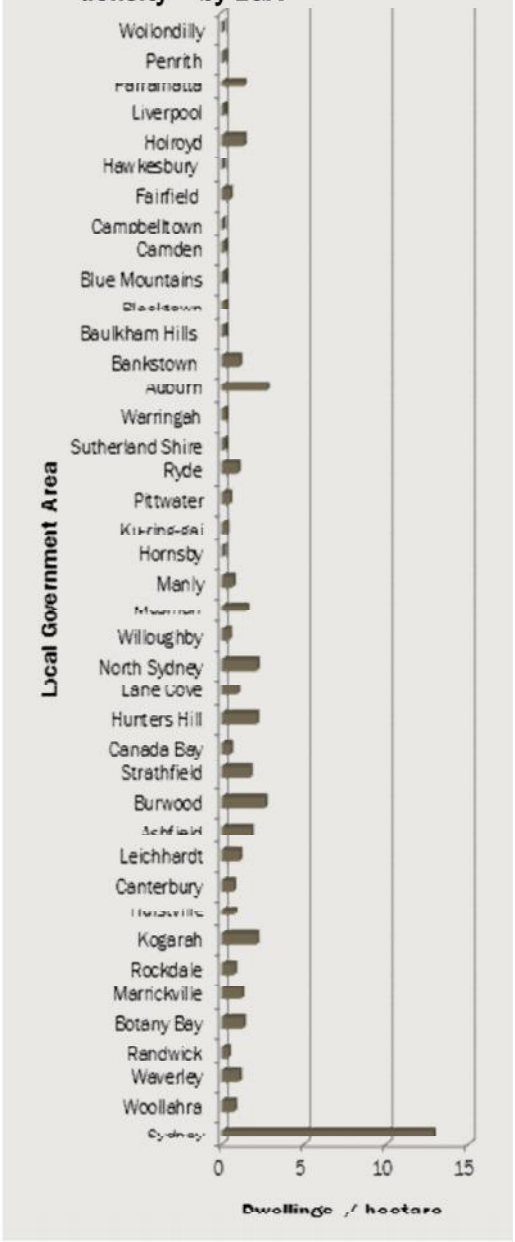
Data source: ARUP

Under the Infill Dispersed scenario, a relatively large proportion of dwelling growth will occur in Local Centres (19.1 per cent or 40,567 dwellings). Sydney City (5,487 dwellings) will produce by far the greatest number of dwellings in Local Centres with the balance fairly evenly spread across other LGAs, though generally higher in the outer suburbs apart from Sydney's south west. Density of dwelling growth will also be greatest in Sydney City (12.83 dwellings per hectare) with all other LGAs producing growth densities of less than three dwellings per hectare in Local Centres (see Chart D.30).

D.29 Local Centres dwelling growth - by LGA



D.30 Local Centres dwelling growth density – by LGA



Data source: ARUP

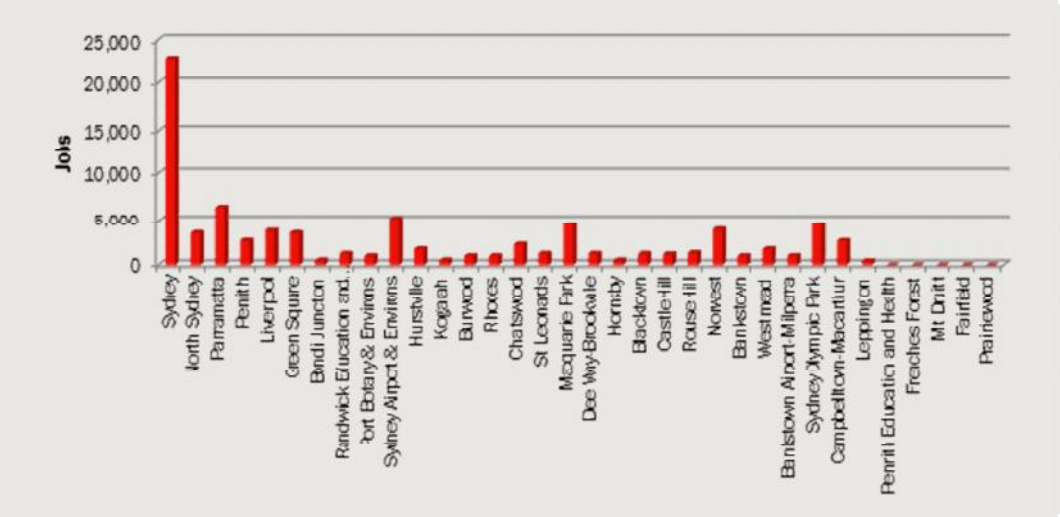
Infill Dispersed Employment Distribution

Employment distribution for the Infill Dispersed scenario is based on deflated employment growth in Strategic Centres with only 25 per cent of growth in Strategic Centres (82,538 jobs), 4 per cent in Local Centres (13,206 jobs) and 71 per cent out of centres (234,408 jobs). Under this scenario, a minimum of 50 per cent of employment growth is distributed across Western Sydney (this includes employment growth in greenfield areas).

Across the Strategic Centres, pro-rata distribution of employment growth under the Infill Dispersed scenario is based on the targets for Strategic Centre employment growth set out in the Metropolitan Plan for Sydney 2036. Under this scenario, Sydney CBD will generate a total of 23,066 jobs (a little over a third of the Base Case), with Parramatta the only other Strategic Centre to generate 5,000 jobs or more (see Chart D.31).

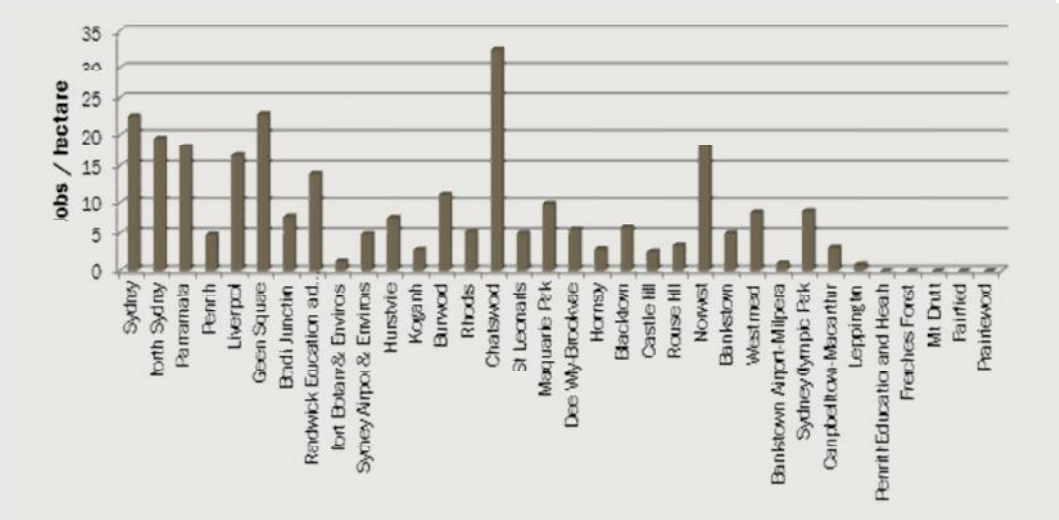
Chatswood (32.51) will have the highest density of employment growth under this scenario, followed by Green Square (22.84 jobs per hectare), Sydney CBD (22.54 jobs per hectare) and Norwest (17.96 jobs per hectare). Port Botany and Environs (1.31 jobs per hectare), Bankstown Airport – Milperra (1.08 jobs per hectare) and Leppington (0.86 jobs per hectare) will have some of the lowest densities of employment growth (see Chart D.32).

D.31 Strategic Centres Employment Growth



Data source: ARUP

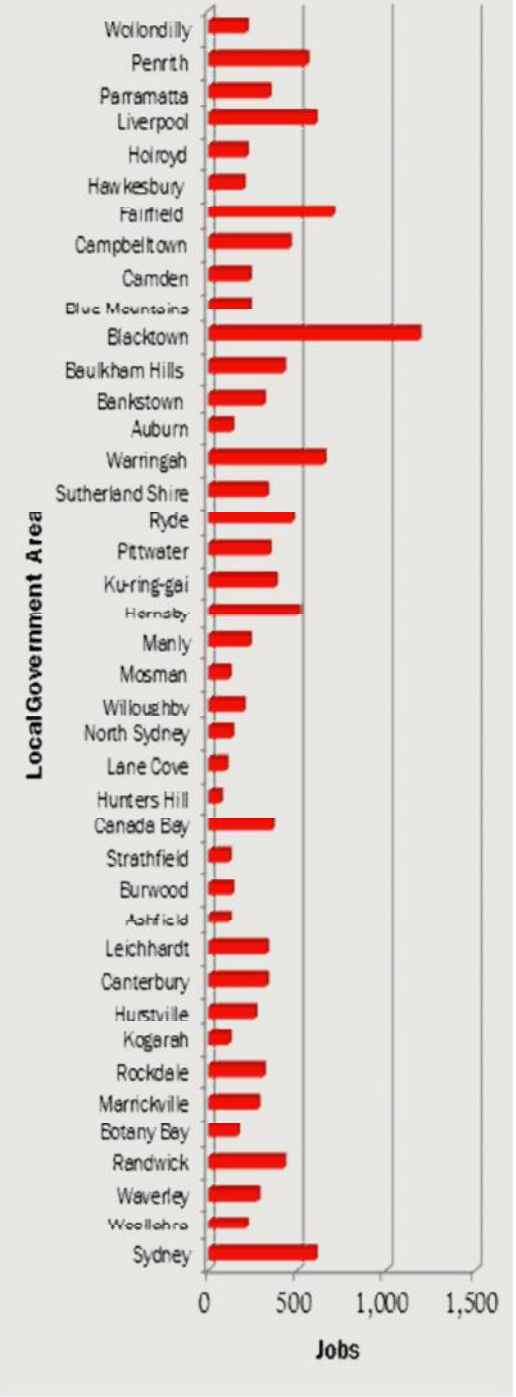
D.32 Strategic Centres Employment Growth Density



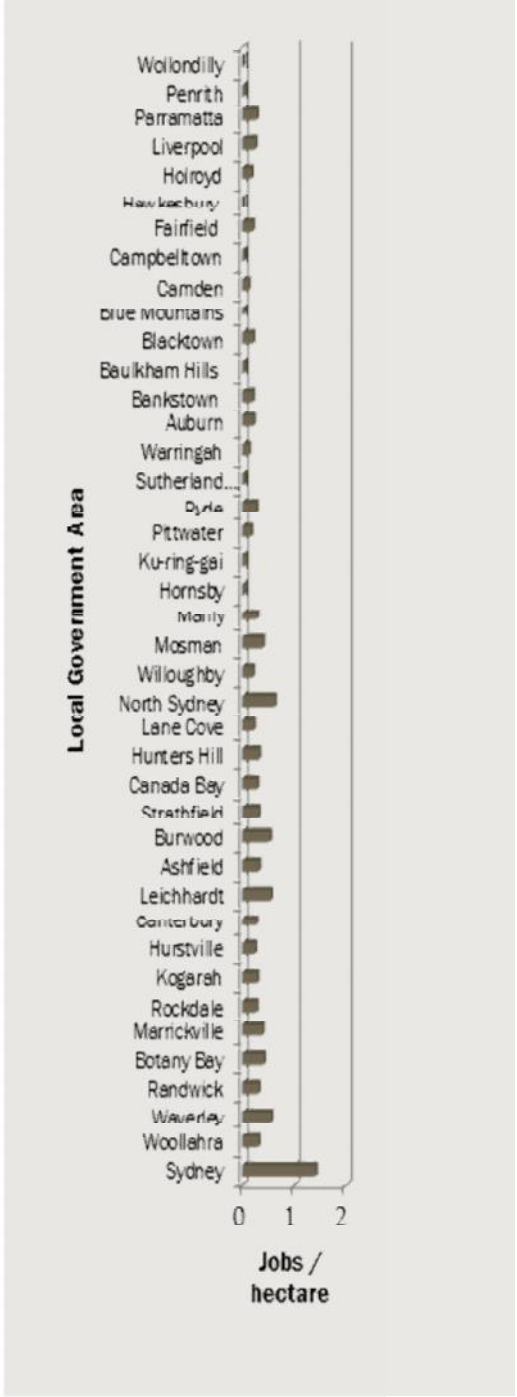
Data source: ARUP

Across the Local Centres under this scenario, employment growth is based on 4 per cent allocated evenly across all Local Centres. This total growth for Local Centres is allocated to the sub-regions based on the proportion of local centres in that region. This step is then repeated at the Local Government Area level; sub-regional growth is pro-rated to each Local Government Area based on the number of Local Centres within the Local Government Area. Blacktown (1,181 jobs), Fairfield (696 jobs) and Warringah (647 jobs) LGAs will have the highest rates of Local Centre employment growth under the Infill Dispersed scenario while Hunters Hill (65 jobs), Lane Cove (97 jobs) and Strathfield (113 jobs) will have some of the least. Local Centre employment growth density will be less than one job per hectare for all LGAs apart from Sydney City at 1.4 jobs per hectare (see Chart D.34).

D.33 Local Centres Employment Growth - by LGA



D.34 Local Centres Employment Growth density – by LGA

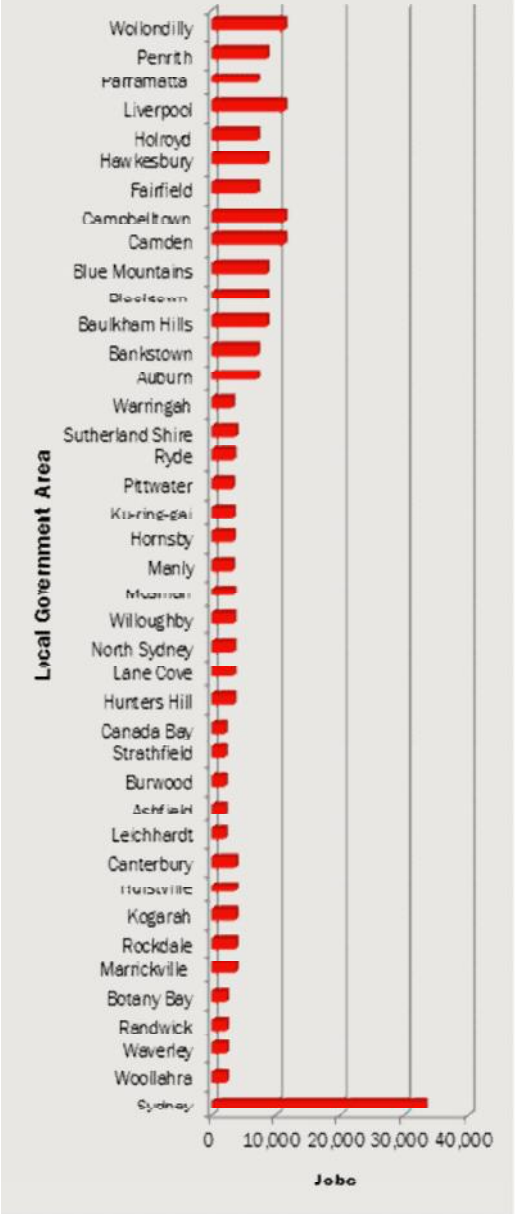


Data source: ARUP

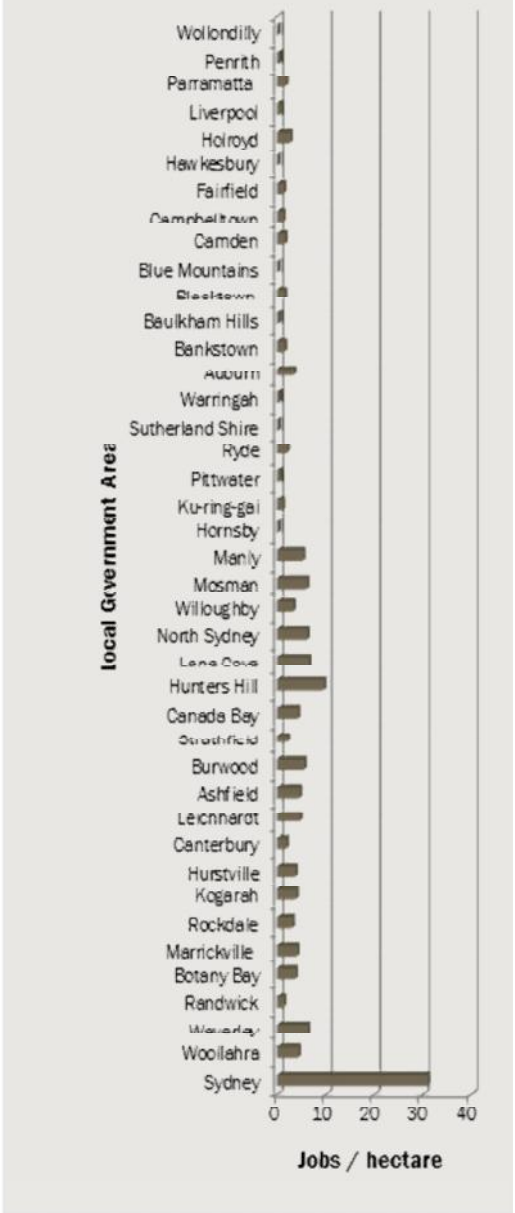
Outside of centre growth under the Infill Dispersed scenario is equivalent to pro-rata subregional employment growth (minus growth in centres of all types for the subregion), shared evenly across each Local Government Area within the subregion. Sydney City (33,184) will generate the highest number of out of centre jobs under this scenario. Otherwise, the majority of out of centre jobs will be generated in the outer LGAs. Sydney

City (30.91 jobs per hectare) will also generate the highest density of employment growth under this scenario. Though substantially lower than this, Sydney's other inner and middle LGAs will generate higher employment growth densities (from 3 to 10 jobs per hectare with a small number of exceptions) than the outer LGAs (less than two jobs per hectare).

D.35 Outside of Centre Employment Growth – by LGA



D.36 Outside of Centre Employment Growth Density – by LGA



Data source: ARUP

Inner middle

Inner Middle Concentration Housing Form

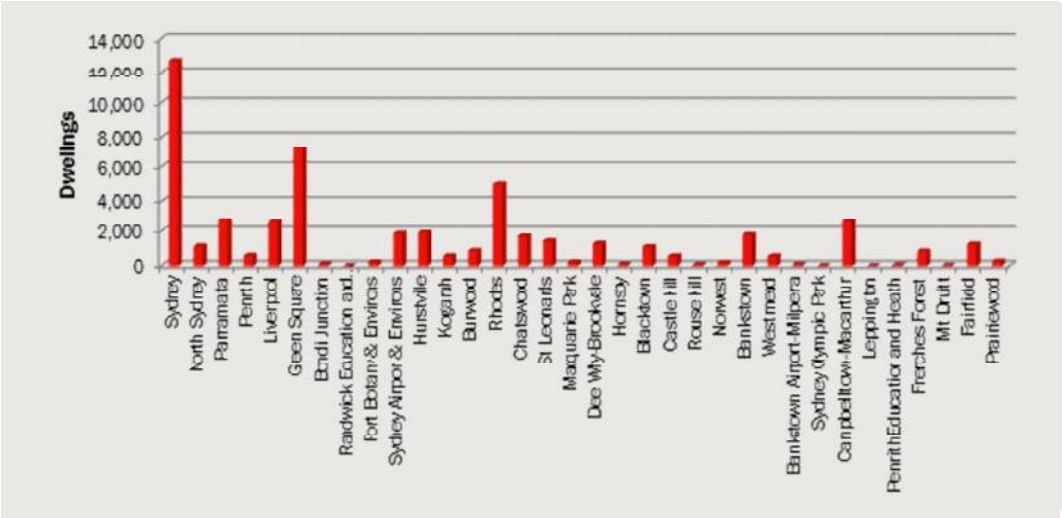
Under the Inner Middle Concentration scenario, all new housing in centres will be high density multi-unit housing. Outside of centres new housing will be medium density.

Inner Middle Concentration Housing Distribution

Housing distribution for the Inner Middle Concentration scenario contains a higher proportion of new housing in the inner and middle subregions. The distribution of dwellings under this scenario is shaped by dwelling distribution during the earlier years of the Base Case scenario (that is for 2006 to 2011) with a factor applied to all subregions and centre types to realise a distribution of 70 per cent dwelling growth in eastern Sydney and 30 per cent in western Sydney.

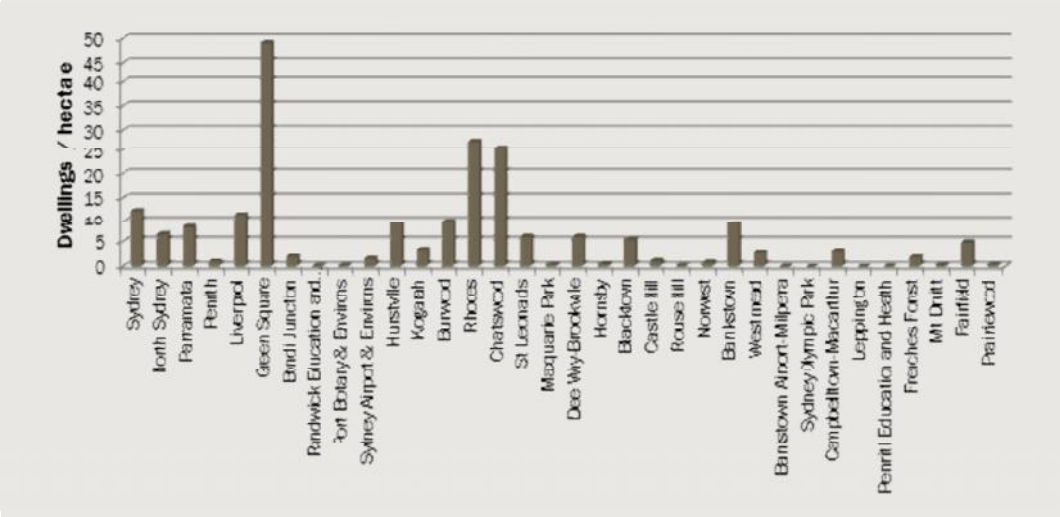
Under the Inner Middle Concentration scenario, approximately 24.5 per cent of dwelling growth (52,124 dwellings) will occur in Strategic Centres, with Sydney (12,716 dwellings), Green Square (7,240 dwellings) and Rhodes (5,027 dwellings) receiving the highest proportions of Strategic Centre growth as highlighted in Chart D.37. A closer look at the density of dwelling growth across Strategic Centres (see Chart D.38) highlights that Green Square (49.15 dwellings per hectare), Rhodes (27.67 dwellings per hectare) and Chatswood (26.18 dwellings per hectare) will be subject to particularly intense dwelling development under this scenario with all other Strategic Centres maintaining dwelling growth densities approaching 10 dwellings per hectare or less.

D.37 Strategic Centres Dwelling Growth



Data source: ARUP

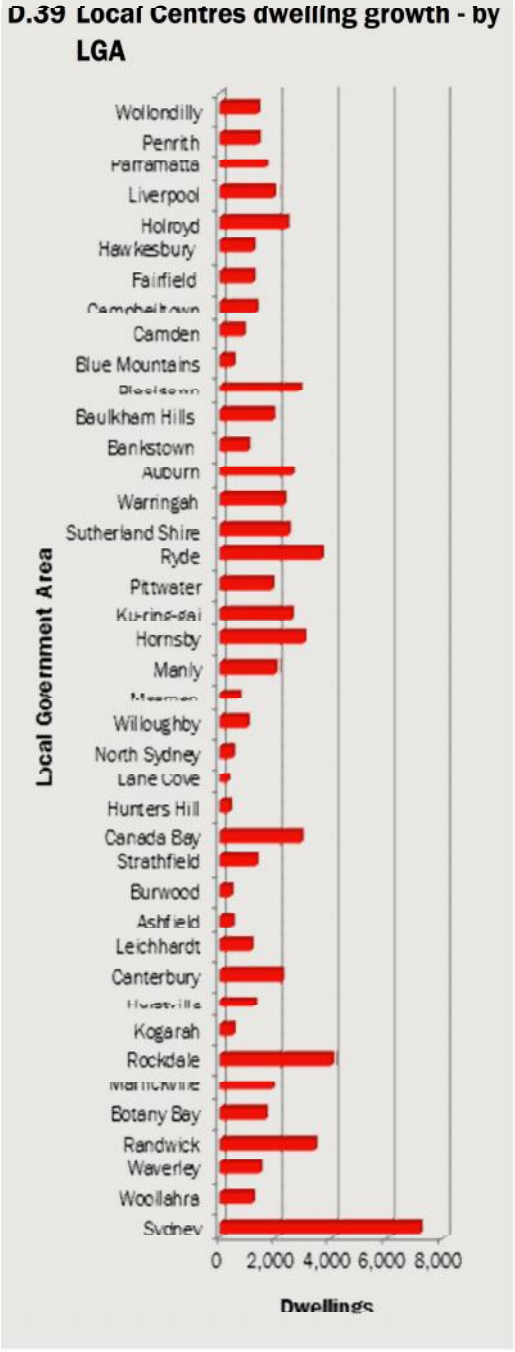
D.38 Strategic Centres Dwelling Growth Density



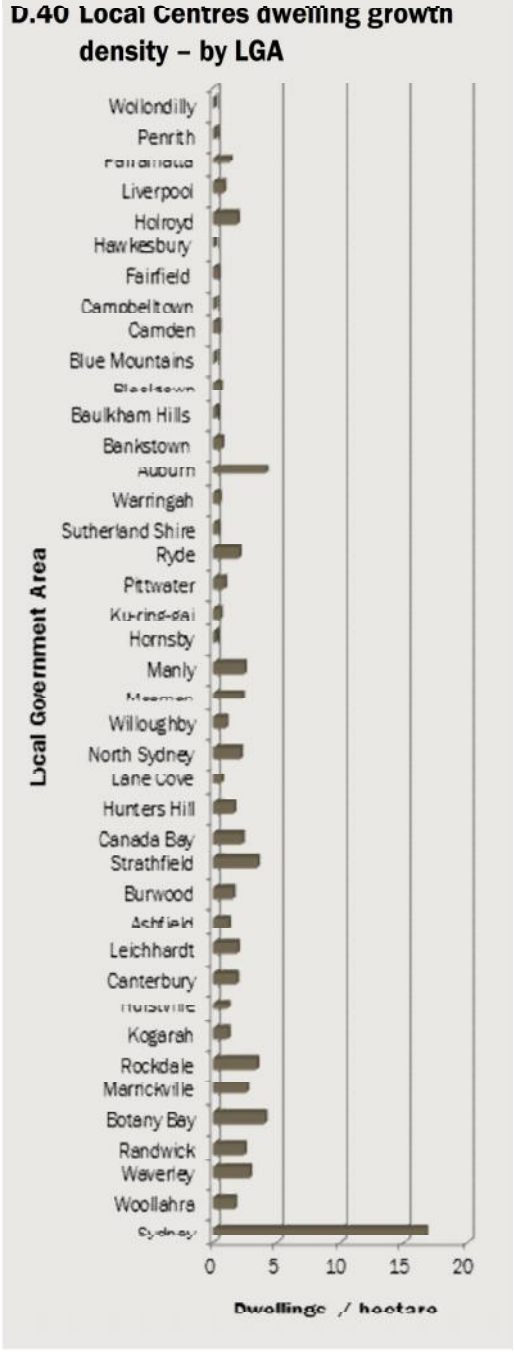
Data source: ARUP

Approximately 34.1 per cent of dwelling growth (72,443,360 dwellings) will occur in Local Centres across the city under the Inner Middle Concentration scenario, with Sydney City (7,128 dwellings), Rockdale (3,968 dwellings) and Ryde (3,613 dwellings) producing the highest numbers of dwellings in Local Centres. As to be expected, the intensity of dwelling growth across Local Centres will be lower than for Strategic Centres. Under this scenario, Sydney City's Local Centres will have the most intense dwelling growth at around 16.66 dwellings per hectare, with all other LGAs producing less than five dwellings per hectare. Chart D.39 and D.40 present the total dwelling growth and dwelling growth density for Local Centres across Sydney under the Inner Middle Concentration scenario.

D.39 Local Centres dwelling growth - by LGA



D.40 Local Centres dwelling growth density – by LGA



Data source: ARUP

Under the Inner and Middle Concentration scenario, areas outside of centres will produce 41.4 per cent of dwellings (88,046 dwellings), with relatively high levels of out of centre growth expected in Sydney City (6,509 dwellings), Sutherland (5,742 dwellings), Auburn (5,216 dwellings), Hornsby (4,604 dwellings), Ryde (4,573 dwellings) and Holroyd (4,172 dwellings). Unique amongst the scenarios, the Inner Middle Concentration will see the highest density of dwelling growth outside of centres occurring in inner and middle LGAs, in particular Canada Bay will have the most intense growth with 6.21 dwellings per hectare rather than Sydney City (6.06 dwellings per hectare). Other LGAs with high dwelling growth densities under this scenario include Ashfield (4.62 dwellings per hectare) and North Sydney (3.62 dwellings per hectare). Waverly, Rockdale, Ryde and Auburn also have over two dwellings per hectare growth while the balance of LGAs have less than one dwelling per hectare under this scenario.

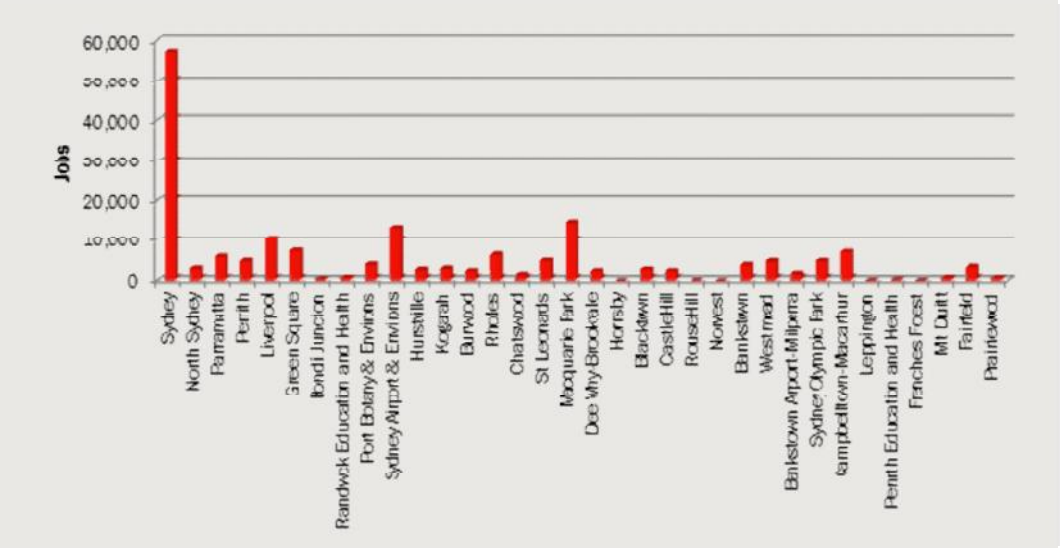
Inner Middle Concentration Employment Distribution

Employment distribution for the Inner and Middle Concentration scenario also contains a higher proportion of new employment in the inner and middle subregions. This distribution is based on pro-rated application of the earlier years of the Base Case scenario (that is 2006 to 2011) with a factor applied to all subregions and centres types to realise a distribution of 70 per cent employment growth in eastern Sydney and 30 per cent in western Sydney.

Approximately 53.1 per cent of employment growth (175,298 jobs) under the Inner Middle Concentration scenario will be generated in Strategic Centres, with Sydney CBD (57,205 jobs) generating a significant proportion of Strategic Centre employment growth at 32 per cent.[116] Macquarie Park (14,782 jobs) and Sydney Airport and Environs (13,561 jobs) are the next largest centres for employment growth under this scenario, accommodating considerably smaller quantities of growth. The density of employment growth is somewhat more evenly spread across the Strategic Centres with Sydney CBD (55.90 jobs per hectare), Liverpool (49.59 jobs per hectare) and Green Square (47.88 jobs per hectare) having the highest employment growth densities as highlighted in Chart D.42.

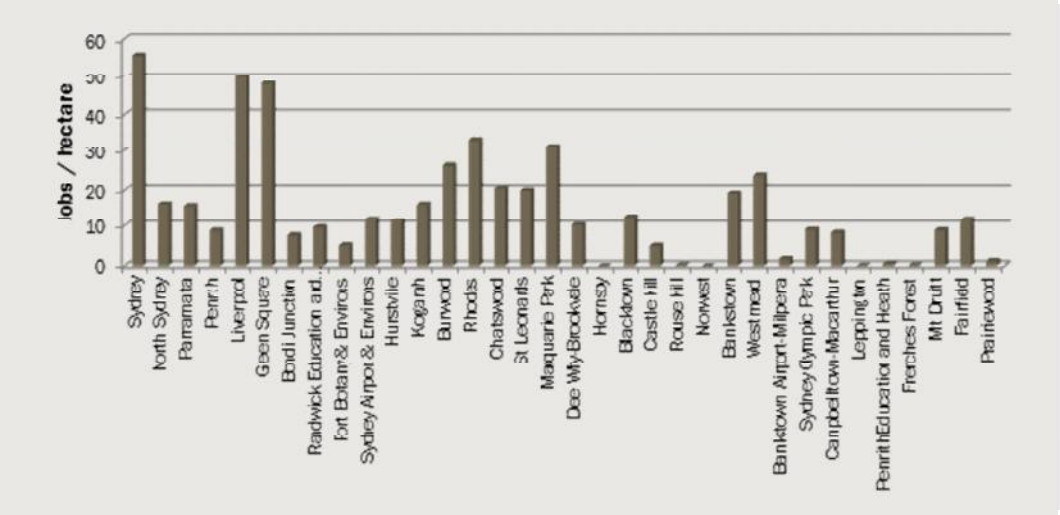
116 Although this is less than the Base Case scenario under which Sydney CBD generates 64,842 jobs, 40 per cent of Strategic Centre employment growth

D.41 Strategic Centres Employment Growth



Data source: ARUP

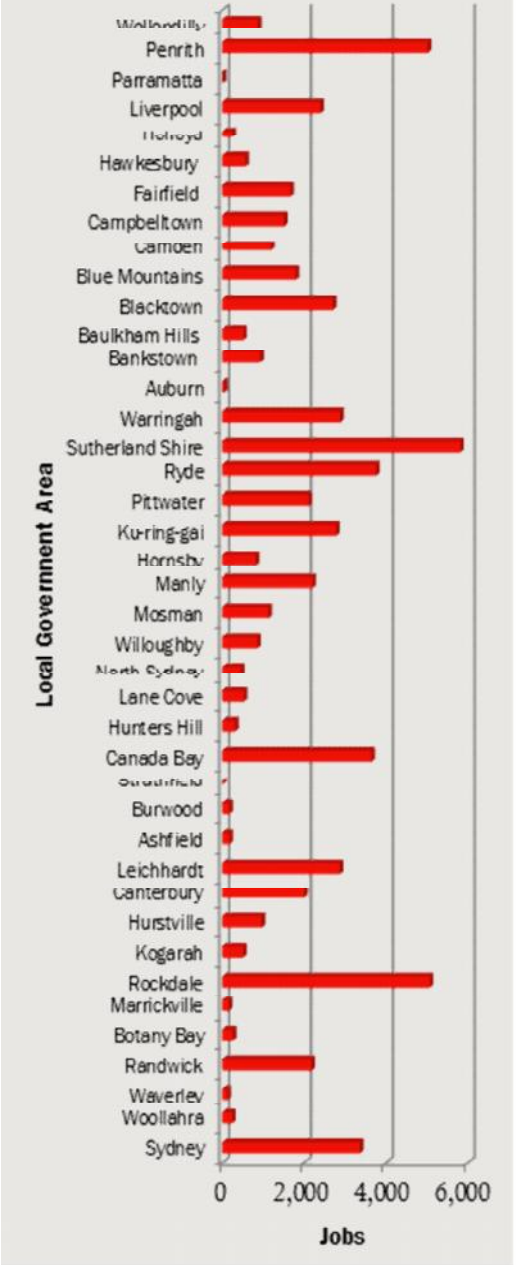
D.42 Strategic Centres Employment Growth Density



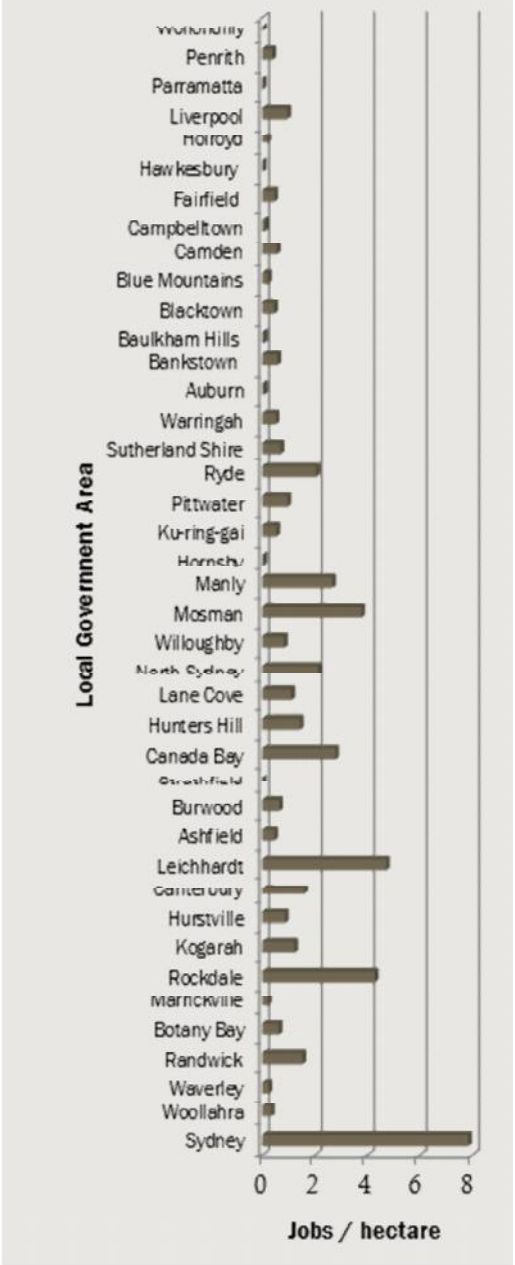
Data source: ARUP

Employment growth in Local Centres under the Inner Middle Concentration scenario will be equivalent to 19.5 per cent of all employment growth (64,449 jobs). Sutherland (5,802 jobs), Rockdale (5,058 jobs) and Penrith (5,006 jobs) will experience the most significant growth in Local Centre employment under this scenario, although a number of other LGAs will also have strong Local Centre employment growth (see Chart D.43). The density of employment growth in Local Centres under the Inner Middle Concentration scenario will be greatest in Sydney City (7.84 jobs per hectare) and generally higher across the inner and middle suburbs and lower in Sydney's outer LGAs where it will be typically less than two jobs per hectare (see Chart D.44).

D.43 Local Centres Employment Growth - by LGA



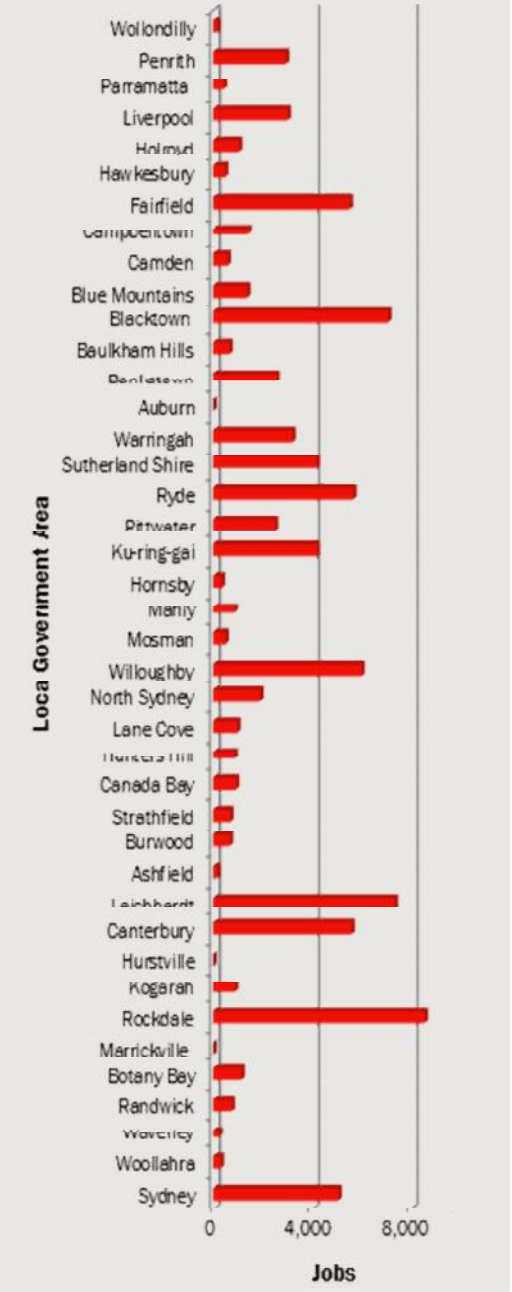
D.44 Local Centres Employment Growth density – by LGA



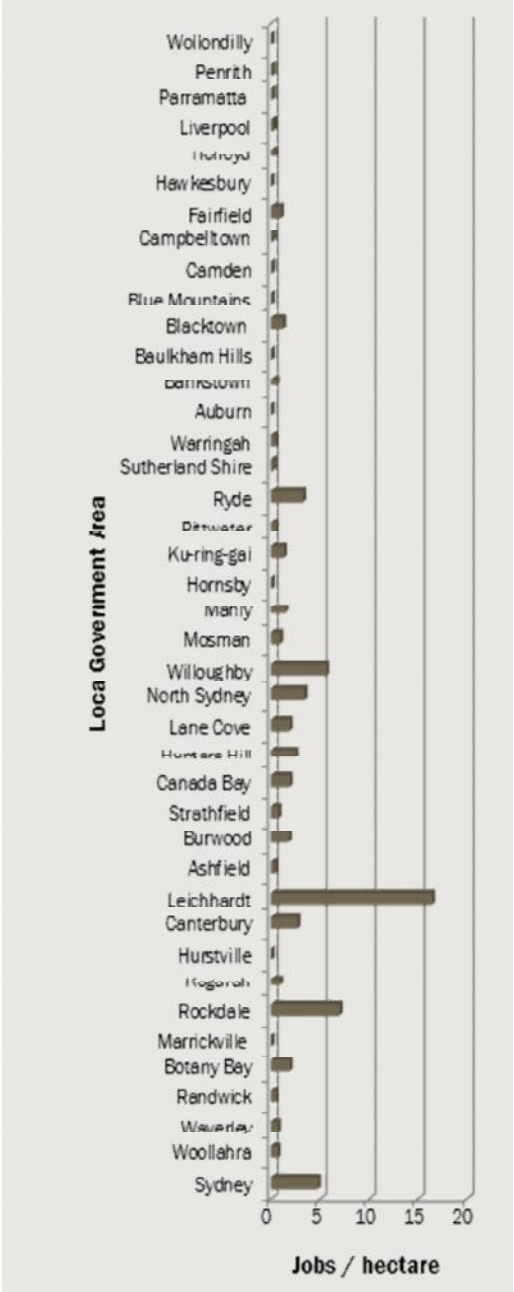
Data source: ARUP

Under this scenario, areas outside of centres will produce 27.4 per cent (90,404 jobs) of employment growth. Rockdale (8,548 jobs), Leichhardt (7,338 jobs) and Blacktown (7,064 jobs) will generate the highest rates of out of centre employment growth, although a number of other LGAs will also generate relatively high levels (see Chart D.45). Leichhardt (16.39 jobs per hectare) will generate by far the highest density of out of centre employment under the Inner and Middle Concentration scenario, with Rockdale and Willoughby the only other LGAs generating more than five jobs per hectare of employment growth (see Chart D.46).

D.15 Outside of Centre Employment Growth – by LGA



D.16 Outside of Centre Employment Growth Density – by LGA



Data source: ARUP

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