AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

# CITIES FOR THE FUTURE:

## BASELINE REPORT AND KEY ISSUES

'Altering the shape of cities, land use and transport facilities that support cities could assist in reducing the need for transport and reduce greenhouse gas emissions.'

**FEBRUARY 2010**

This report was made possible with the generous funding of the following organisations.

This report was supported by the Built Environment Industry Innovation Council and co-funded by the Australian Government Department of Innovation, Industry, Science and Research.

This report is based on findings from independent research conducted by the Allen Consulting Group, Veitch Lister Consulting (VLC) and the Urban Research Program (URP) at Griffith University.

## President's Foreword

The Australian Sustainable Built Environment Council (ASBEC) is the peak body of key organisations committed to a sustainable built environment in Australia.

ASBEC members are industry and professional associations, non-government organisations and government observers who are involved in the planning, design, delivery and operation of our built environment, and are concerned with the sector's social and environmental impacts.

ASBEC's Cities for the Future Task Group comprises representatives from the Green Building Council Australia, Australian Institute of Architects, Australian Conservation Foundation, Property Council of Australia, the Planning Institute of Australia and the Association of Consulting Engineers Australia. This report has been made possible with funding from task group members, the Built Environment Industry Innovation Council (co-funded by the Australian Government Department of Innovation, Industry, Science and Research), the ACT Planning and Land Authority and the Victorian Employers' Chamber of Commerce and Industry.

This report is the first part of a four stage project which aims to explore and measure the links between greenhouse gas emissions from urban transport and land use within our cities. Importantly, the project aims to set out in practical terms what impact that changes to land use and transportation will have on greenhouse gas emissions, economic outcomes and liveability in Australian cities.

Under a "business-as-usual" approach our urban centres will become more transport intensive and less transport efficient. Congestion will worsen, travel times become longer and transport related greenhouse gas emissions increase.

This research report will be the baseline information which, following the conduct of expert workshops, will be refined to develop alternative scenarios for selected cities and recast our vision in order to deliver sustainable, liveable places for our diverse and growing population.

It is anticipated that the outcomes of this project will ultimately identify the costs and benefits of various urban scenarios and potential optimal urban forms to inform public policy and government decision making.

If your organisation is interested in supporting the further stages of this innovative work, please contact the task group chair, Ms Romilly Madew, Green Building Council Australia, ph 02 8239 6200 or romilly.madew@gbca.org.au or the Executive Officer of ASBEC, Ms Julieanne McIntyre, ph 02 8252 6707 or julieanne@asbec.asn.au.

Tom Roper

President, ASBEC

AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

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# Executive Summary

The cities and urban form of tomorrow present both challenges and opportunities.

The United Nations forecasts that today's urban population of 3.2 billion will rise to nearly 5 billion by 2030. By then, three out of five people will live in cities and the world will no longer be a global village but a global city.

In 2009, Prime Minister Kevin Rudd said: "Capital city strategic plans are needed to lift economic productivity, respond to climate change and ensure the nation is geared up for 35 million people by 2049."[1] The focus on developing cities to cope with a much larger population has been reinforced by the release of the Intergenerational Report 2010.

With this in mind, and with the release of the Council of Australian Governments' criteria for strategic planning systems for our major cities (see box inset), we must recast our vision of urban development, recognising that urban form - or more broadly, the morphology of cities - is linked to problems of rapidly rising greenhouse gas (GHG) emissions.

Altering the shape of cities, land use and infrastructure could assist in reducing the need for transport and its resulting GHG emissions.

## THIS REPORT

This ASBEC paper is stage one of a broader study about cities, transport and urban land use. The aim of stage one is to:

- **Review key issues:** provide context to the key issues in the relationship between transport, land use and sustainability, particularly through a review of the current literature;
- **Develop tools:** develop a set of tools to assist in learning about transport GHG emissions that can be used to estimate emissions from this source, in particular in urban areas and for urban Australia at large;
- **Provide benchmark estimates:** use the new set of tools to provide benchmark estimates of future GHG emissions in key cities and provide guidance about likely GHG emissions in the rest of urban Australia;
- **Assess liveability:** develop other tools to assess how changes in cities are expected to impact upon liveability in those cities; and
- **Promote further research:** provide a platform for the conduct of further stages of the study.

**COAG's criteria for the strategic planning systems in our major cities will focus on:**

1. Providing for planned, sequenced and evidence-based land release that meets the housing needs of a growing population and keeps homes affordable.
2. Balancing in-fill and greenfield development.
3. Implementing credible plans to reduce GHG emissions – through initiatives such as energy efficiency measures, changes to town planning, practical improvements in public transport infrastructure and reform of building codes and regulations.
4. Adapting to the risks of climate change such as coastal inundation and more extreme weather events.
5. Emphasising world-class design and associated architectural integrity.
6. Providing for building and upgrading nationally significant infrastructure, such as transport corridors, intermodal connections and communications and utilities networks.
7. Providing for governments to take into account independent, expert advice on the objectives and implementation of their planning system.
8. Providing an effective framework for private sector investment and innovation in the urban infrastructure given that with the fiscal constraints on governments, the nation will need to harness private capital.

## LITERATURE REVIEW FINDINGS

Much has been written about cities, transport and urban land use, some of which has been captured in this report. Studies identify a number of issues and outline the need for change:

- **Car dependency:** traffic congestion produces demand for more and bigger roads and removal of impediments to traffic flow (such as pedestrians, cyclists and public transit such as trams). These measures make automobile use more advantageous at the expense of other modes of transport, so greater traffic volumes result. In addition, the urban design of cities adjusts to the needs of automobiles, driving low-density and unsustainable development in Australia's cities.

[1] Address to the Business Council of Australia, 27 October 2009

- **Reducing the need for mobility:** car-dependent cities separate where people live and where they work, which is contributing to rapid growth in transport GHG emissions. Reducing the need for mobility means transforming the city's transport infrastructure and land use arrangements in ways that bring people closer to their desired destinations and that make non-motorised travel and public transport modes practical and more attractive.
- **Compact cities:** the creation of the modern 'Compact City' demands the rejection of single-function development and the dominance of the car. This school of thought places considerable emphasis on raising urban density, especially in residential areas.
- **Altering the morphology of cities:** some urban planners argue that increasing urban density is only one part of the solution, with employment density, access to lower-emitting transport modes and alternative urban forms, such as 'corridor cities', providing answers.
- **Urban lifestyle issues:** some researchers note the need to take a broader view of sustainability, urban lifestyles and liveability. While households in inner city areas consume less transport energy, they also consume more of other services that raise GHG emissions than households in suburban and rural areas.

The most recent contributions to the literature about cities and land use adds more weight to the view that the sustainability of Australian cities can be improved by relocating development, raising residential and employment density and providing suitable supporting infrastructure.

In particular, the most recent studies provide more evidence about GHG emission impacts from transport, as well as economic outcomes. This evidence has advanced the development of analytical frameworks and tools that could be used to estimate the impact of future GHG emissions or abatement potential expected from altered approaches to land use and transport.

Clearly, the shape of our cities and the distribution of land uses can influence transport and therefore GHG emissions. However, in raising sustainability and reducing GHG emissions, we are likely to realise other tangible benefits, such as healthier communities, more accessible services, appropriate response to demographic change, more efficient use of land and infrastructure. These factors must also be considered when we assess costs and benefits.

## NEW TOOLS TO ASSESS CITIES AND THEIR FUTURE

Undertaking this report and other reports highlighted a gap in the development of tools in Australia to understand urban form with respect to Australian cities. ASBEC identified that a set of tools is needed that:

- **Measures the impact of alternative urban forms:** preferably this should have greater granularity than a simple distinction between high density and lower density development;
- **Takes into account the different forms of Australian cities:** preferably the framework would be specifically calibrated for most, if not all, cities, including capital cities, other cities and regional areas;
- **Provides indications or predictions over a range of factors and outputs:** this should include the social cost of alternatives, GHG emissions, economic factors and factors that shape the broad concept of liveability of cities;
- **Enables assessment of tradeoffs between key factors:** would, for example, a decrease in GHG savings be offset by reduced social disruption?; and
- **Enables cost benefit analysis:** impacts need to be monetised to enable comparison between alternative urban forms and possible other measures to raise sustainability.

Therefore, a new set of tools was developed in this study to meet these needs. Drawing together and modifying a range of existing tools enabled comprehensive analysis of the key issues regarding land use and transport in Australia's major cities. For the purpose of this study, the cities of Greater Melbourne and South East Queensland were examined.

These tools aim to draw together:

- **Transport and land use change:** using simulation models that track how people travel within cities, taking into account their transport mode options, including car, public transport, cycling and walking, as well as where they live, where they work and other destinations. These models look at a city in terms of a transport network and communities, and reflect how each person's decisions impact upon them and the community throughout the city and wider region studied.

- **Assessment of broader liveability:** this draws together the wide variety of factors needed to assess if changes in a city alters liveability from a triple bottom line perspective. That is, does the change raise environmental outcomes, alter community or change economic wellbeing? This is constructed as a composite index enabling users to look at the parts as well as the sum of the parts.

The development of the tools reveals a very concerning picture about future transport GHG emissions in major urban areas in Australia. The picture is obtained from baseline projections about land use and mobility in specific cities in the future. The baseline analysed involves urban scenarios that are consistent with current long term plans for metropolitan areas and regions. In these scenarios, cities are projected to accommodate many needs including providing living space for growing populations, expected rates of expansion in economic activity and employment, and governments are expected to continue with their current sets of land use plans and the provision of transport infrastructure, among many other changes.

After development of the tools and using them in the analysis, we are able to compare cities today with how they are expected to perform into the long-term future (the 2030s and 2040s).

## KEY FINDINGS

The key findings (especially from the use of the transport elements of the new tools - the VLC's Zenith Travel Forecasting Model) included:

- **Urban centres will become more transport-intensive and less transport efficient:** VLC's Zenith Model foreshadows that the urban centres studied will become more transport-intensive and less transport efficient. The total amount of passenger travel and time spent travelling in cities is forecast to grow more than proportionally to population and employment.
- **Transport is forecast to be slower:** Average trip speed (kilometres per hour) is projected to decrease in both regions by around 10 to 13 per cent between 2006 and 2041. The slowing of average trip speed is an indicator of increased congestion of the transport system.
- **Transport outcomes are likely to deteriorate:** people in both cities are projected to spend more time travelling per day and to travel longer distances. People in South East Queensland and Greater Melbourne will see their travel time increase by approximately 26 and 23 per cent, respectively, by 2041. This is an indicator that transport systems are becoming less efficient.
- **Transport GHG emissions are projected to rise in the studied urban centres:** GHG emissions in South East Queensland are projected to have the largest increase, rising by 75 per cent between 2006 and 2041.
- **Transport GHG emissions from within urban Australia are projected to rise substantially under the baseline scenario:** Without additional policy interventions these GHG emissions are projected to rise from an estimated 41 megatonnes per annum in 2006 to 60 megatonnes in 2041. This 46 per cent projected increase draws on the baseline scenarios of both major urban areas where already significant planning and land use interventions are underway to promote compact cities.
- **The need for mobility costs time and harms the environment:** Overall, the analysis shows that the need for mobility and its costs in terms of time and harmful impacts upon the environment are projected to increase in both areas studied in the baseline analysis. These adverse changes are expected to outpace the growth in underlying population and represent a challenge for future transport networks.

## NEXT STEPS

How can altered urban morphology, land use and transport infrastructure provision change the pessimistic outlook for Australian cities? Stage Two of this study will focus on preliminary tool development, which involves a workshop to bring together key experts and stakeholders in Australia to discuss the initial findings and how the future for key cities in Australia can be transformed.

The Stage Two workshop will develop alternative frameworks for land use, transport, environmental outcomes and community planning, with the output a set of instructions about key planning decisions, including decisions regarding public infrastructure.

The consulting team will use the new analytical tools to assess the difference that an altered city plan could make to transport and economic outcomes, GHG emissions and liveability. Outlining a clear vision for alternative, sustainable cities will demonstrate why change is required, what it can achieve and why action is better than inaction.

# Glossary

| | |
|---|---|
| ABARE | Australian Bureau of Agricultural and Resource Economics |
| ABS | Australian Bureau of Statistics |
| AC | Activity Centres |
| ACs & GA+ | Activity Centres Growth Areas Plus |
| ACF | Australian Conservation Foundation |
| ACG | Allen Consulting Group |
| ASBEC | Australian Sustainable Built Environment Council |
| BCA | Benefit Cost Analysis |
| BEMP | Built Environment Meets Parliament |
| BITRE | Bureau of Infrastructure, Transport and Regional Economics |
| BTRE | Bureau of Transport & Regional Economics |
| CBD | Central Business District |
| CCTG | ASBEC Climate Change Task Group |
| $CO_2$-e | Carbon dioxide equivalent |
| CPRS | Carbon Pollution Reduction Scheme |
| DCC | Department of Climate Change |
| DPCD | Department of Planning and Community Development, Victoria |
| GDP | Gross Domestic Product |
| GHG | Greenhouse gas |
| ICE | Internal Combustion Engine |
| MITM | Melbourne Integrated Transport Model |
| MULUTT | Modular Urban Land Use and Transport Tool |
| NOX | Nitrogen oxide |
| NPV | Net present value |
| SLA | Statistical Local Area |
| SOX | Sulphur oxide (including dioxide) |
| TOD | Transit-Oriented Development |
| TZ | Travel Zone |
| UGB | Urban Growth Boundary |
| UK | United Kingdom |
| UNEP | United Nations Environment Programme |
| URP | Urban Research Program |
| US | The United States of America |
| VAMPIRE | Vulnerability Assessment for Mortgage, Petroleum and Inflation Risks and Expenditure |
| VKT | Vehicle Kilometres Travelled |
| VLC | Veitch Lister Consulting |

**Units**

| | | | |
|---|---|---|---|
| $m | million dollars | km | kilometres |
| btkm | billion tonne kilometres | min | minutes |
| ha | hectare | mm | millimetres |
| hr | hour | Mt | Mega tonnes or one million tonnes |
| kg | kilograms | pa | per annum |

# 1 THIS DISCUSSION PAPER AND BASELINE REPORT

## THIS STUDY

The Australian Sustainable Built Environment Council (ASBEC) commissioned this major study to explore and measure the linkages between GHG emissions from urban transport and land use within Australia's cities.

ASBEC's terms of reference establish that the study will:

- analyse the complex interaction between factors that shape urban land use, transport services and GHG emissions;
- identify insights that are supported by evidence and additional key contentions that require further analysis;
- map expected transport GHG emissions into the future from major urban centres based on current land use plans and infrastructure provision;
- identify leading practice and related transport and land use change and the consequent potential for reduced GHG emissions if these changes were adopted through key scenarios;
- assess the relevant implications of change, and especially identify the potential to reduce GHG emissions at lower cost than current mainstream approaches, such as abatement expected to be achieved through the Australian Government's proposed Carbon Pollution Reduction Scheme (CPRS) or other measures; and
- draw on a wide range of indicators of social and economic wellbeing to develop a comparable measure of a city's liveability.

The Allen Consulting Group (ACG), Veitch Lister Consulting (VLC), and the Urban Research Program (URP) at Griffith University have established a consortium to undertake the study.

This study builds on many recent research reports released by ASBEC and its constituent members exploring the potential of the built environment to raise sustainability (see box in next page). All of these studies are founded on the view that sustainability is driven by and dependent upon raising performance in the economic, social and environmental dimensions of the built environment. Genuine sustainability in the built environment can only be achieved if each component of sustainability is advanced.

## RECENT ASBEC STUDIES INTO THE SUSTAINABILITY OF THE BUILT ENVIRONMENT

ASBEC and its constituent members have produced a number of reports containing substantive analysis about the role of the built environment in shaping more sustainable outcomes. Three recent studies and their key contributions are noted below.

### Capitalising on the building sector's potential to lessen the costs of a broad based GHG emissions cut (2007)

This study commissioned by the ASBEC Climate Change Task Group (CCTG) extended the earlier work of the Australian Business Roundtable on Climate Change to include a more detailed analysis of the significant energy efficiency potential of the building sector. The key findings of this research are that:

- The building sector is responsible for a significant proportion of Australia's total GHG emissions, and energy use in buildings is rapidly growing. Electricity demand in residential and commercial buildings can be halved by 2030, and reduced by more than 70 per cent by 2050 through energy efficiency;
- Energy efficiency could deliver savings of 30-35 per cent across the whole building sector by 2050. Energy savings in the building sector (which accounts for 60 per cent of GDP and 23 per cent of GHG emissions) could reduce the costs of greenhouse gas abatement across the whole economy by $30 per tonne, or 14 per cent, by 2050. By 2050, GDP could be improved by around $38 billion per year if building sector energy efficiency is adopted, compared to previous economy-wide estimates of the 60 per cent deep cuts scenario; and
- Australia has the ability to achieve at least 60 per cent deep cuts in GHG emissions by 2050 supported by the capacity to transform buildings to deliver energy savings.

### The Second Plank – Building a Low Carbon Economy with Energy Efficient Buildings (2008)

The CCTG commissioned this analysis to stimulate discussion about the complementary role that energy efficiency can play in supporting the Australian Government's Carbon Pollution Reduction Scheme (CPRS).

The report showed that the building sector in Australia has the potential to reduce GHG emissions well beyond reductions that were likely to be stimulated by the CPRS measures, particularly if carbon is priced in the market at around $20 per tonne as foreshadowed in the Australian Government's Carbon Pollution Reduction Scheme Green Paper.

The report identified a range of measures that could be used to enhance the complementary role that the building sector could play. The highest priority measures identified in the report have the effect of providing building owners with an incentive to reduce their structural energy demand and therefore their GHG emissions. Real change involves stimulating energy efficiency in existing as well as new buildings, and in both commercial and residential sectors.

The report notes that savings from energy efficiency measures in the built environment are dependent upon there being an economy-wide measure to contain GHG emissions. Establishment of a carbon price is identified as being of particular importance. Without this, energy efficiency measures may suffer from the rebound effect, with little net change in emissions. Equally, energy efficiency savings in the building sector could play a critical role in the implementation of the CPRS, especially in the early years and into the medium term by ensuring that there is a capacity for the community and the economy to adjust to the lower carbon future.

**RECENT ASBEC STUDIES INTO THE SUSTAINABILITY OF THE BUILT ENVIRONMENT (Cont'd)**

### Principles for planning sustainable communities (2009)

This document was assembled for the Built Environment Meets Parliament (BEMP) partners: the Association of Consulting Engineers Australia, Australian Institute of Architects, Green Building Council of Australia, Planning Institute of Australia, and the Property Council of Australia, all of which are members of ASBEC.

The principles for planning sustainable communities provided a model strategic planning framework that seeks to identify the critical factors or issues that should be addressed by all strategic plans for Australia's major cities.

The model is more than a checklist - the model framework:

- outlines principles that can guide the drafting of urban strategies;
- requires clear and coherent goals that will drive strategic plans;
- proposes metrics that provide a basis for measuring performance against promises; and
- proposes government institutions that will better co-ordinate the implementation of urban planning strategies.

If the model framework is well designed, then all current and future government urban strategies should measure up to the framework, or return to the drawing board.

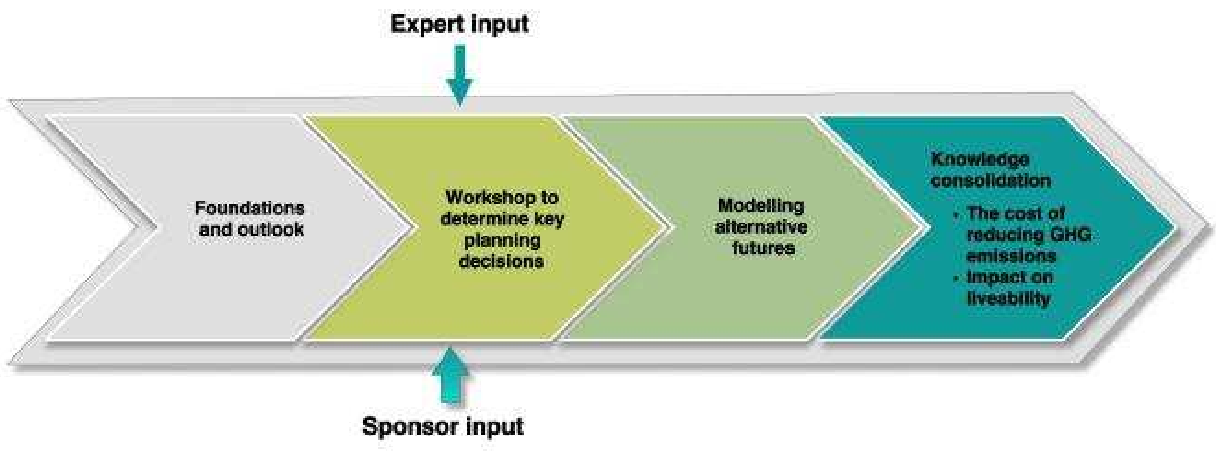
Source: http://www.asbec.asn.au/research and http://bangthetable.com/bemp

## STUDY STAGES

The study will be completed through the following broad stages:

- **Stage 1:** foundations and outlook;
- **Stage 2:** future cities workshop;
- **Stage 3:** alternative futures; and
- **Stage 4:** knowledge consolidation.

Completion of this report forms stage one of the study.



The staged approach has been employed to enable decisions being made about the urban centres to be studied in detail, and for the nature of land use and transport scenarios and other factors to be determined in the future as the study progresses.

The next stage of the study is the preliminary tool development, which involves bringing together experts to decide upon the urban form that they believe provides the greatest promise to reduce transport GHG emissions while preserving or improving liveability. The discussion will relate to specific cities depending upon the composition of the sponsor group and their interests. The workshop will develop alternative frameworks for land use, transport, environmental outcomes and community planning, with the output a set of instructions about key planning decisions, including decisions regarding public infrastructure. In the subsequent study stages, the consulting team will apply this guidance to build sophisticated models about the urban areas being studied. These models will combine information about what is known about cities, especially where people live, where they work and play, and how they move around the city. The models will reflect detailed insights we have about factors such as income, age, gender, family structure and others that shape choices about mobility, costs and outcomes such as transport GHG emissions.

Information from the transport simulation results will also be useful to assess the socio-economic dimensions of changes in land use. An index of liveability will be constructed to compare and contrast different cities and land use policies over time and between different future scenarios. The index will draw on the methodologies already tried and tested by members of the study team and make use of the additional data available from the economic and transport models developed for this study. This will allow the study team to demonstrate the difference that changes make to community wellbeing, allow calculation of a benefit cost ratio and assessment of the cost (or saving) of each tonne of GHG emissions, among other indicators.

The choice of which specific urban centres to include in the detailed future scenarios will be made as the study progresses. In any case, the study will extrapolate key findings to provide an estimate of impacts upon urban areas in Australia at large.

## CONTACT DETAILS

This paper is essentially a discussion paper. The authors welcome the opportunity to discuss any element of this report.

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# 2 CITIES, URBAN FORM AND SUSTAINABILITY

## CITIES IN CONTEXT

Three-quarters of Australians live in urban centres with populations greater than 100,000 and populations in major capital cities continue to grow strongly (ABS 2006). Australia is becoming increasingly urbanised. The population of Australia's capital cities is projected to grow by an average of 47 per cent by 2031, while for the rest of Australia the average growth rate to 2031 is 37 per cent (ABS 2008).

Cities today are the great engines of economic growth. With their aggregation of people, services, businesses, educational institutions and supporting infrastructure, cities are the focal points for economic development and activity. In contrast to perceptions that Australia's economy 'rides on the sheep's back', or is dependent upon what can be extracted from a mine, some three-quarters of value added in Australia is produced in the major urban regions of Australia (ACG 2003).

The built environment — those facilities that deliver amenity and liveability to Australia's resident and visitor populations — which is concentrated in cities, has been assessed as contributing 40 per cent of the nation's total asset base; by way of contrast, Australia's natural environment (land, minerals, oil and gas, timber) constitutes one third (ABS 2003).

Cities are also the gateways to the movement of goods and services in international trade and finance in investment, serving all regions. The services they provide raise the competitiveness and viability of activities throughout Australia. Cities host sporting and cultural functions that bond Australians and define many aspects of what is best about living in Australia.

Cities and major urban areas pose many key challenges to sustainability. Human settlements in general and cities in particular are a source of pressure on the rest of the (natural) environment. Settlement based activities draw down resources such as energy, water and materials; they convert land into production and consumption landscapes; and they generate waste and GHG emissions to air, land and water.

Cities are hungry consumers of ecological services. While cities theoretically could offer advantages to the biosphere by requiring less space per person, using resources efficiently, and allowing for collective action, we have yet to avail ourselves of this opportunity (White 2002). Our poorly functioning urban systems are implicated in numerous environmental challenges including global climate change, air and water quality, and overproduction of waste.

While cities are a driver of environmental challenges, it is also clear that they are also vulnerable to adversity caused by these challenges, including global warming and related hazards. Key climate change threats to human settlements and cities are noted in the box that follows.

## CLIMATE CHANGE THREATS IN CITIES AND HUMAN SETTLEMENTS

Many reports about the impact of global climate change on Australia indicate that many Australian ecosystems, regions and industries are vulnerable to climate change in the coming decades. It is likely that cities, where human settlement is concentrated, face many particular threats.

Key human settlement vulnerabilities are discussed below.

- **Climatic variability**: lower rainfall and more frequent and intense droughts will threaten the security of water supplies, accentuate competition between users, stretch allocations for environmental flows, and result in lower water yields for many catchments linked to urban centres with implications for their future economic viability (e.g. Goulburn). Implications for agriculture (dry land as well as irrigated farmland) and long-term viability of associated service towns are key issues for assessment.
- **Higher costs:** higher food prices relative to other areas of household expenditure are becoming evident reflecting challenges producers face in adjusting to climate change. Water quality is also likely to be affected through reduced runoff, increased temperature and higher salinity. Actions to avoid the risk of potable water shortages in urban catchments have resulted in investments in more reliable, but expensive sources, such as desalination and water recycling, and these costs will be passed through to urban communities over time.
- **Bushfires and related hazards:** increased risk of bushfire to human settlements would also align with the lower rainfall/higher temperature scenario.
- **Water and food security:** the United Nations Development Programme (UNDP) warns that the progress in human development achieved over the last decade may be slowed down or even reversed by climate change, as new threats emerge to water and food security, agricultural production and access, and nutrition and public health. The impacts of climate change could, by 2080, push another 600 million people into malnutrition and increase the number of people facing water scarcity by 1.8 billion. In addition, food security is also threatened by the expansion of unfettered development into the decreasing stocks of viable peri-urban areas on the edges of our cities, where some of the best market garden land exists.
- **The heat island effect:** higher than average temperature effects in cities.
- **Inundation:** sea level rise of between 180mm and 1900mm by 2100 would significantly impact Australia's coastal settlement directly as beaches erode and shorelines move inland as well as via storm surges linked to extreme cyclonic events.[2]
- **Urban infrastructure damage:** the infrastructure assets that sustain cities can become liabilities under an increased number of cyclones and storm surges and episodes of heavy rainfall and flooding in certain regions, accentuated by an absence of planning and design guidelines for jurisdictions historically not associated with such extreme events.
- **Health:** climate changes are also expected to enhance the spread of some disease vectors, such as Dengue fever and Ross River virus, expanding into more heavily populated human settlements where the problems may be hard to control.

Source: Newton 2006, ACG 2005

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[2] Estimates of sea level rise in the literature vary considerably. For instance, sea level rise projections presented to the March 2009 Climate Change Science Congress in Copenhagen ranged from 0.75 to 1.9 metres by 2100 relative to 1990, with 1.1–1.2 metres the mid-range of the projection (DCC, 2009). In contrast, the IPCC Fourth Assessment Report states that global average mean sea level is projected to increase by 180-590mm by 2100 (CSIRO, 2010). For further information about sea level rise projections refer to Newton 2006, DCC 2009, CSIRO 2010a, CSIRO 2010b and Climate Change in Australia 2010.

## GREENHOUSE, ENERGY AND TRANSPORT CHALLENGES

The consumption of energy in our cities is directly responsible for the surge in GHG emissions, which in turn is resulting in hazardous climate change.

Primary energy consumption throughout Australia is forecast to increase at a rapid rate. The Australian Government's energy forecasting body, the Australian Bureau of Agricultural and Resource Economics (ABARE), has projected an average rate of increase of 2.2 per cent per year, which is significantly above the expected rate of population increase (ABARE 2005).

Recent studies conducted for ASBEC (2008) show that the built environment is a significant source of demand for energy consumption and a major driver in the rapid rate of growth in energy demand. Analysts note with alarm that a rapid growth rate in energy demand is expected despite a forecast reduction in energy used per unit of gross domestic product, which reflects an expectation of a decline in energy intensity that is due to increasing energy efficiencies (Productivity Commission 2005), new energy technologies (ABARE 2005), and a shift in the structure of the economy towards less energy-intensive sectors (Newton 2006).

Energy consumption is a major driver of GHG emissions in Australia because of the nation's reliance on fossil fuels. This is particularly true in the case of transport. In 2007, transport contributed 78.8 megatonnes per carbon dioxide equivalent ($CO_2$-e Mt) emissions, or around 15 per cent of Australia's national inventory of emissions. Road transport alone is responsible for 87 per cent of the total transport GHG emissions.

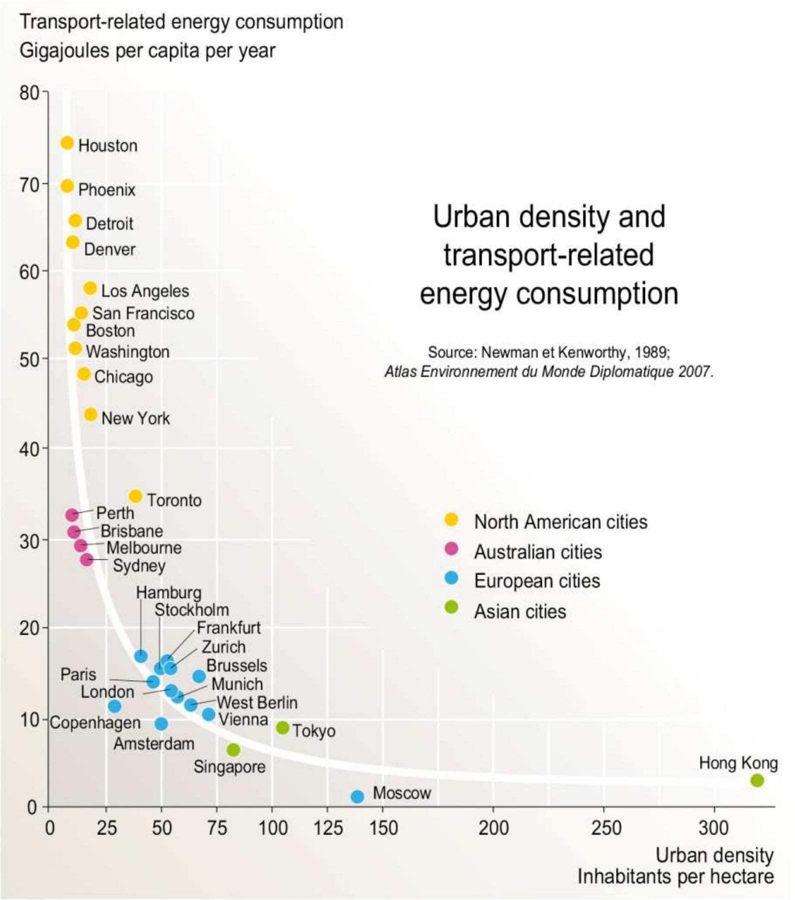
Transport emissions are one of the strongest sources of emissions growth in Australia. Emissions from this sector were 26.9 per cent higher in 2007 than in 1990. The Department of Climate Change indicates that preliminary estimates for 2008 indicate that transport emissions have increased by 2.2 per cent since 2007 (DCC 2009).

The significance of transport in GHG emissions (and other environmental harms) reflects fundamental changes in technologies, cities and society. A sustained increase in personal mobility has been one of the key transitions in modern Australia (Newton 2006). A further key change has been the phenomenon of auto-oriented suburbanisation in the great boom following the Second World War. Suburbanisation has involved the rapid expansion of the size of cities through a process of rolling out development on the fringe of cities.

Key factors associated with suburbanisation include the rapid expansion in private car ownership, the shift in many jobs to the city fringe (especially manufacturing jobs which were the mainstay of economic growth in the post war boom), and the provision of investments in public infrastructure, especially roads and freeways, facilitating the spread of suburbs.

Australian researchers Newman and Kenworthy (1989) were among the first to observe that car (or automobile) use, and therefore GHG emissions and other environmental problems, are related to urban morphology. In a groundbreaking study of 32 cities from around the world, they found a strong inverse relationship between population density and the amount of energy being used. In simple terms, the greater the density of a place, the less transport energy is being used in that place.

### Urban Density and Transport Related Energy Consumption




Source: UNEP/GRID-Arendal Maps and Graphics Library, 2009, UNEP/GRID-Arendal, http://maps.grida.no/go/graphic/urban-density-and-transport-related-energy-consumption1 (accessed on 1 Sep 2009).

Cities with high density, such as Hong Kong, have a far lower transport energy demand per capita than low density cities such as Houston by a factor of 18. Cities in the United States typically sprawl and on average have a high energy demand, while European cities have higher density levels and lower demand for energy. Canadian and Australian cities are in between the United States and Europe. Cities in Asia have the highest density and lowest energy demand.

A conclusion drawn by Newman and Kenworthy from analysis of cities is that urban sprawl — typical of US cities and increasingly Australian cities — is characteristic of automobile dependence and indeed drives automobile dependence. Reflecting automobile dependence, private passenger vehicle travel represents three-quarters of total road travel in Australia which in turn contributes a significant part of transport GHG emissions.

It is notable that the factors shaping cities continue to change. Many of these changes suggest a further compounding of problems and challenges to sustainability in cities. Key factors are noted in the box that follows.

**Changes in Transport and Mobility Needs In Cities**

Transport needs in Australia's cities are not fixed. Key aspects of change and some implications are noted below.

- **Expected growth:** projections of car traffic for Australia's capital cities to 2020 suggests volumes one-third higher than that in 2002, and 40 per cent higher when growth in light commercial vehicle traffic is included. These growth rates are 25 per cent higher than for non-metropolitan Australia (BTRE 2000).
- **Disbursed mobility needs:** there is now a greater dispersion of trip origins and destinations within cities. The central business district (CBD) ceased to be the dominant employment destination in cities many years ago, with the suburbanisation of jobs into areas not well-served by public transport. Measurement reveals a situation at odds with current perceptions. In Sydney for example, 13 per cent of jobs have been estimated to be in the CBD. The reality of more balanced and self-contained residential communities, with a measure of overlap of housing markets and labour characteristic of the early post-war metropolitan era, has diminished at the suburb level, but warrants attention at the 'city of cities' scale.
- **Mobility imbalances:** vehicle kilometres travelled per person per trip increases with distance from the CBD in the large cities, reflecting poorer access to public transport, employment and services.
- **Evolving mix:** while passenger vehicle transit makes up the majority of road travel in Australia today and it is expected to continue to grow, the fastest rate of growth in the share of road travel is in the category of light commercial vehicles (seven per cent per annum), which service intra-urban freight needs. Growth in the volume of freight that is transported by road, both urban and ex-urban, has also continued at rates more closely aligned to rates of economic growth than population growth. It is estimated that the freight task will double over the next decade, increasing in volume from 375 billion tonne kilometres (btkm) in 1999–2000 to 648 btkm in 2020, at an average annual growth rate of 2.8 per cent.
- **Congestion:** traffic congestion is likely to increase in Australia's biggest cities. The bulk of city traffic is now dominated by non-work activities, such as social and recreational, ferrying children, shopping and personal business. Congestion is experienced by drivers throughout the city, not just those commuting to work and home.
- **Car parking:** car parking has a fundamental impact on transport and land use patterns. Litman (2006) highlighted the role that parking has to play in the vicious cycle of automobile dependency, with generous parking supply leading to car-oriented land use patterns, increased per capita motor vehicles and car-oriented transport policies and planning practices in turn reducing choice and raising social stigma attached to alternative modes of transport, which eventually reinforces the need for generous parking.
- **Higher future costs:** when these projections on traffic volumes are linked to data on existing road capacity, the costs of congestion and associated costs to the national economy if nothing is done have been projected to be as high as $30 billion per year (BTRE 2000).

Source: Newton 2006.

## APPROACHES TO COMBATING CITY TRANSPORT GHG EMISSIONS

Approaches to reduce the effects of GHG emissions from urban transportation can rest on changes in technology or demand factors. Looking at technology first, options frequently considered include altering vehicles, altering fuels, or altering roads or transit ways.

While the technology inherent in some modes of transport, especially cars, is improving continuously, which is part of the reason for the community's continued enthusiasm for the car, technological solutions to GHG emissions face many challenges. They can often be too expensive to be practical, simply shift the GHG production to elsewhere in the supply chain (such as electric cars, for example, which reduce vehicle GHG emissions but raise stationary energy GHG emissions), are often not viable on a public scale or they are susceptible to the 'rebound effect' (where increased energy efficiency leads to increased use and therefore little or no net change in emissions) (Trubka et al 2008).

Demand based solutions to the problem of urban transport GHG emissions seek to reduce the use of GHG intensive mobility. One way of achieving this is to apply a price to activities that result in GHG emissions in order to discourage pollution and encourage the pursuit of less expensive alternatives. A core role of the CPRS is to apply such a price signal to GHG emissions throughout the economy.

There is some doubt about how effective applying a reasonable price upon transport fuel and transport GHG emissions will be in reducing those emissions. The Garnaut Climate Change Review (2008) calculated that an emissions price of $20 per tonne would increase the cost of petrol by around 5 cents a litre and the cost of travel in a medium-sized car by less than 1 per cent. This amount is unlikely to stimulate a significant change in travel behaviour for most households. Under these circumstances the carbon price penalty would simply be a tax raising revenue rather than driving a shift towards greater sustainability.

The threat of peak oil may have a larger impact on transport GHG emissions than policy interventions. Oil prices have risen steeply over the last few years. World oil prices more than tripled from an average of US$30 per barrel in the 1990s to an average of over US$90 in 2008, reaching a peak of nearly US$150 in July 2008 (Garnaut 2008). Price increases of this magnitude did result in changes to transport demand and encouraged a shift towards alternative transport modes (such as trains in urban areas) and fuels. Oil prices are particularly volatile and the global financial crisis has unwound much of the increase of 2008. Most long term forecasts factor in progressive scarcity and price increases.

Fuel price pressures and the uncertain additional GHG reduction benefits are likely to be factors behind the Australian Government's decision in the Carbon Pollution Reduction Scheme White Paper (2008) to protect motorists from higher fuel costs due to the CPRS for the first three years of its operation.

A further approach to altering demand could be to reduce the need for mobility in cities. This could advance transport GHG abatement as well as reduce exposure to the threat of peak oil. This may be achieved through transport and land use integration – transforming the city's transport infrastructure and land use arrangements in ways that bring people closer to their desired destinations and that make non-motorised travel and public transport modes practical and more attractive. Examples of planning movements that promote transport and land use integration include compact cities, New Urbanism, Smart Growth and Transit-Oriented Development (TOD), while policies such as targeting employment to activity centres also fit within this frame.

## URBAN CONSOLIDATION AND THE COMPACT CITY

Newman and Kenworthy have been joined by many other analysts, commentators, environmental groups, planners, civic leaders and far-sighted business interests who see overcoming car dependence as a key requirement of future sustainable cities (Newman 2006). The key change is to raise the density of urban areas to reduce the need to travel and subsequent fuel use, decrease GHG emissions and moderate social harms associated with car dependency.

There is no single agreed definition of the compact city and some authors note that few of the supporters of the concept describe it in ways which are explicit (Jenks, Burton and Williams, 1996). The compact city model of urban development, also frequently termed the ‘urban consolidation model’, emerged in the 1960s. Key elements of the model relate to notions of high-density settlements, less dependence on cars, social fairness, self-sufficiency of daily life and independency of governance. This model is in part a reaction against the unbounded urban sprawl evident in the UK, the USA and Australia. The compact city school of thought is often linked to an appreciation of European cities and advocacy for urban revitalisation, especially in the United States. The approach has gained momentum as the debate regarding urban planning began to be dominated by sustainability issues (Alford and Whiteman 2009).

Further analysis has revealed a broader range of factors beyond residential density that are also influential in shaping transport choices that people make, including car use. Key aspects include the following:

- employment density and activity intensity (Chandra 2006);
- existence and spacing of employment and service centres (Mindali et al 2004);
- local land use mix (Cervero and Kockelman 1997);
- neighbourhood design and street layout (Handy et al 2006);
- local accessibility to transport infrastructure/modal options (that is, the distance and ease of access to public transport, especially pedestrian access);
- the quality and extent of public transport — independently of urban form (Mees 2000);
- the affordability of housing across suburb locations;
- the affordability of public transport fares;
- levels of car ownership, as well as the affordability of fuel and other motoring-related expenses (Troy 1996);
- the availability of parking;
- the trade-off between lower cost housing on the outskirts of cities and the higher costs of transport necessary to live in those areas (Lipman, 2006, Dodson and Sipe 2006); and
- the household structure including age and gender (Morris and Richardson 1997).

These factors often lead to suggestions that are closely aligned with the compact city vision, but do not automatically result in a plan that drives overall consolidation or other changes in urban morphology. These factors have, however, been taken up as design principles in the New Urbanist, Smart Growth and TOD literature (Dittmar and Ohland 2004; Garde 2006).

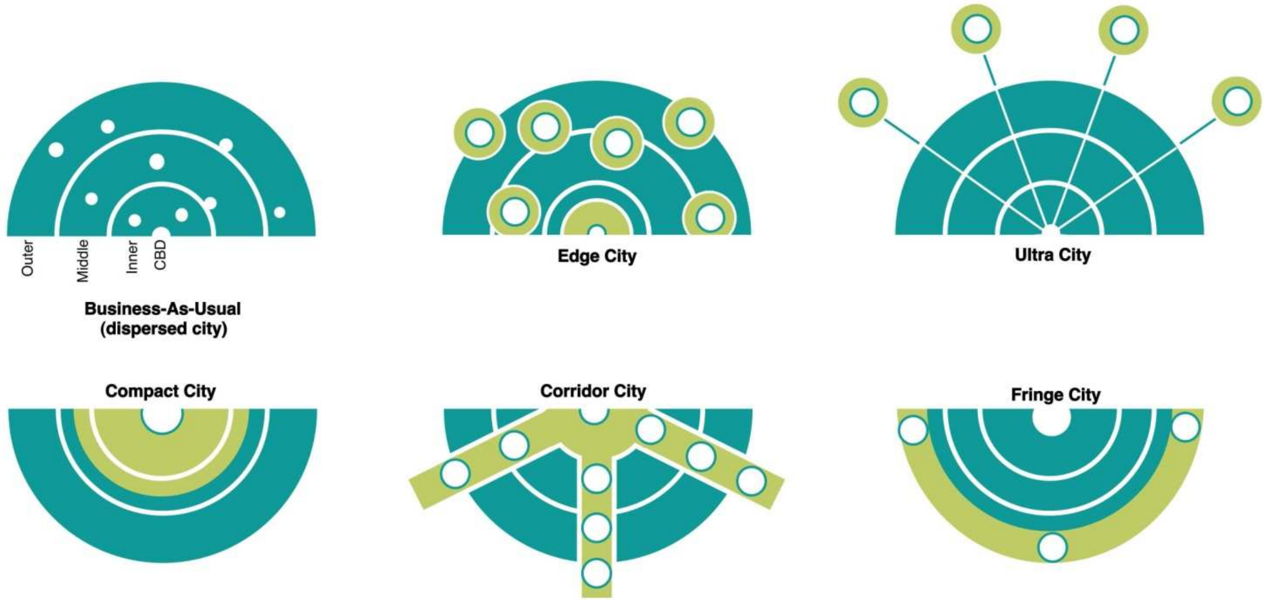
Establishing an urban form that would perform better than existing plans is still an open question. Analysts (Alford and Whiteman 2009) recently identified a number of different compaction models listed below.

- **City Centre development model:** where a greater residential mix is encouraged in or near a high-density Central Business District (CBD) which otherwise serves as the dominant commercial, service and employment centre for a larger urban environment, and is supported in this by radial transport networks. In this model, a growth in high-rise apartment-living may bring even higher residential densities to inner city areas than already exist, increasing the proportion of the metropolitan population who live in these inner areas.
- **Rail Corridor development model:** where consolidation is focused along radial rail corridors within a metropolitan area. This model involves the creation of ‘urban villages’ around suburban railway stations, where local services, shopping and employment opportunities would be concentrated. As, according to Newman and Kenworthy (1999), “rail transit systems, compared to all other motorised transportation, appear to have the best energy efficiency and the greatest ability to attract people out of cars”, commuters would be encouraged to eschew their cars and travel

through or from these 'villages' to the larger urban centre by rail. Variations on the corridor approach might extend to include urban development around a tramway (or light rail) network. In these examples, the urban village adopts a more linear form around nodes in the tram network, as opposed to around railway stations. In this model there are long linear shopping streets with higher density residential uses occurring in the surrounding streets.

- **Activity Centre development model:** the building of more 'liveable', higher-density and better serviced communities within a larger, more polycentric urban environment. The key to this model is the mixed-use development (that is, combining commercial, service, employment and residential purposes, etc.), which would allow people to concentrate their various activities within a particular location, thus reducing the number of separate trips required to access these activities. Higher 'nodal' densities, and enhanced inter-modality (for example, rail-bus-tram exchanges) would also be expected in this model to lead to greater public transport patronage, and less use of motor vehicles for those commuting to the centres.

### Urban Morphology Alternatives




## ALTERNATIVE APPROACHES TO THE COMPACT CITY

Criticisms of the pursuit of residential density as a policy prescription to cure a range of social, environmental and economic ills ranges over a number of dimensions (Mindali, Raveh and Salomon 2004). Some major themes are summarised as follows.

- **Spurious correlation and other issues:** some analysts view that the observation of a relationship between two factors, density and energy use, is not a sufficient evidentiary basis on which to build far reaching policy positions. The failure to use a multivariate analysis and not taking variables likely to influence household decisions (such as household income for example) into account can affect the research results (Gomez-Ibanez 1991, Cervero et al 1997). Other analysts show that different statistical models applied to the same data can yield different results and that more sophisticated techniques, including more factors, erode the strength of simple relationship between density and automobile use (but do not eliminate it) (Handy, Cao and Mokhtarian, 2005).
- **Culture and other factors:** the observed relationship between density and private transport use seems to reflect a great deal about different cultures in the clustering of cities in particular portions of the curve. Changing urban form may be difficult without changing culture. Within each cluster of cultures or countries there is variance that is not explained by the relationship, suggesting that other factors are also important.
- **Compacting cities will be unpopular and politically infeasible:** too many households may prefer not to live in high density (Breheny 1992). Others note that communities consistently exhibit a strong preference for a suburban lifestyle (Gordon and Richardson 1997 and Troy 1996).

- **Density is ineffective or too slow:** planning for higher density and making larger investment in transportation infrastructure will not make a significant difference in overall travel patterns and the changes that may be experienced are not sufficient to justify the often substantial public investment involved (Gordon and Richardson 1997) or more recently, these measures will take too long to make a material contribution to combating the threat of dangerous climate change (Mees 2008).
- **Businesses concerns:** higher density can raise costs for many businesses, as well as the rewards from circumventing planning restrictions that provides an incentive and means for effective lobbying and rent seeking (Gordon and Richardson 1997).
- **Low density has advantages that appear to be overlooked:**attributes include scale economies, lower cost of housing, modernity and desirable attributes of greater personal space (Gordon 1990). This suggests that shifting to greater density may involve costs. When confronted with plans to raise density in many communities in Australia a common complaint is that governments will not provide the infrastructure necessary to support increased demands or will deliver it too late.
- **Limits to consolidation:** rather than having spare, underutilised infrastructure that can be absorbed with infill developments, infrastructure facilities in many cities in Australia already experience congestion. Road, rail, water and sewerage infrastructure in inner Sydney and other places may be reaching their designed capacity and the end of their economic lives (Searle 2003).

Some urban theorists advocate what has been termed the ‘dispersed city’ model of urban development (Alford and Whiteman, 2009) which prescribes spatially larger, more decentralised cities. Urban development approaches that could be associated with the ‘dispersed city’ approach are outlined below.

- **Highly decentralised, low-density suburbanisation:** such development is often within ‘enclosed’ but car-friendly neighbourhoods characterised by detached housing (often on larger allotments), and where suburbs are interconnected via extended arterial road or freeway networks. In this model of development different types of activity tend not to be co-located, while local commerce will be aggregated within large shopping malls that are most easily accessible by car. Transport modes other than the car are likely to play only a very marginal role overall.
- **Managed Growth Area Development:** where urban growth at or beyond the metropolitan fringe is channelled through designated development corridors, generally along major highways and other regional-based transport infrastructure, these corridors being separated and contained by ‘green wedges’ (that is, protected rural land).
- **Edge Cities/Satellite Towns:** where either (i) largely self-contained sub-centres (that is, that have some characteristics of a CBD), develop on the metropolitan fringe, generating their own market catchments in competition, to some degree, with the larger, dominant CBD; or (ii) where metropolitan residential catchments otherwise expand to include separate neighbouring towns (a phenomenon known as ‘counter-urbanisation’).

It is notable that the latter two of these approaches involve application of compact city approaches.

## PLANNING IN PRACTICE

In practice, urban consolidation is a key attribute or objective of almost all medium to long term metropolitan plans for capital cities and most other cities in Australia. It has been the dominant change in urban form since the 1970s (Troy 2004). It is enshrined across all major current metropolitan plans (Gray, Gleeson and Burke 2008). Metropolitan plans now lay out a vision for consolidation with greater clustering around activity centres connected by transport networks.

While generally deferring to urban consolidation, current plans are far from uniform and there is debate about the degrees of centralisation and consolidation that is ideal in the compact city. It is also notable that most plans involve a mixture of development models, including such concepts as TODs and 'decentralised activity centres'. In most cases new development is concentrated on raising density, but it is notable that most plans for major metropolitan areas also involve 'greenfields' development on the fringe of the existing city.

### More Compact Cities in Recent Urban Plans

Many Australian state governments have developed land use policies which attempt to alter urban form to gain greater urban efficiency.

- The Victorian Government strategy, Melbourne 2030, seeks to concentrate almost 70 per cent of planned new dwellings by 2030 within existing urban boundaries, increasing the proportion of dwellings in about 100 mixed use activity centres from 24 to 41 per cent of new development, raise the proportion of public transport trips from 9 to 20 per cent and control outer urban growth through a legislated urban growth boundary.
- The Queensland Government's South East Queensland Regional Plan seeks to accommodate 40–50 per cent of the planned 575,000 new dwellings by 2026 through infill or in a hierarchy of nominated activity centres and to limit outer urban development to nominated corridors.
- The Western Australian Network city strategy aims to locate 60 per cent of the planned 370,000 new dwellings by 2031 within existing urban areas in nominated activity centres and brownfield sites linked by public transport, and 40 per cent in higher density new outer urban areas.

These strategic plans flag government commitment to more compact cities through higher density, mixed use, transit-oriented development in activity centres, improved public transport and limits on outer urban growth. Some analysts view that all of these plans share implementation problems. In particular, governments exhibit a reluctance to require compliance with clear compact city policies. City plans also provide some scope for extension of the urban footprint of the fringe of existing cities. Governments have also extended urban growth boundaries.

Integrating land use and transport planning is essential for a successful compact city policy, but public transport remains under-funded in most Australian cities. Without adequate public transport provision the expected efficiency gains from increased density may be put at risk, as well as community acceptance of higher density.

Source: Buxton 2006

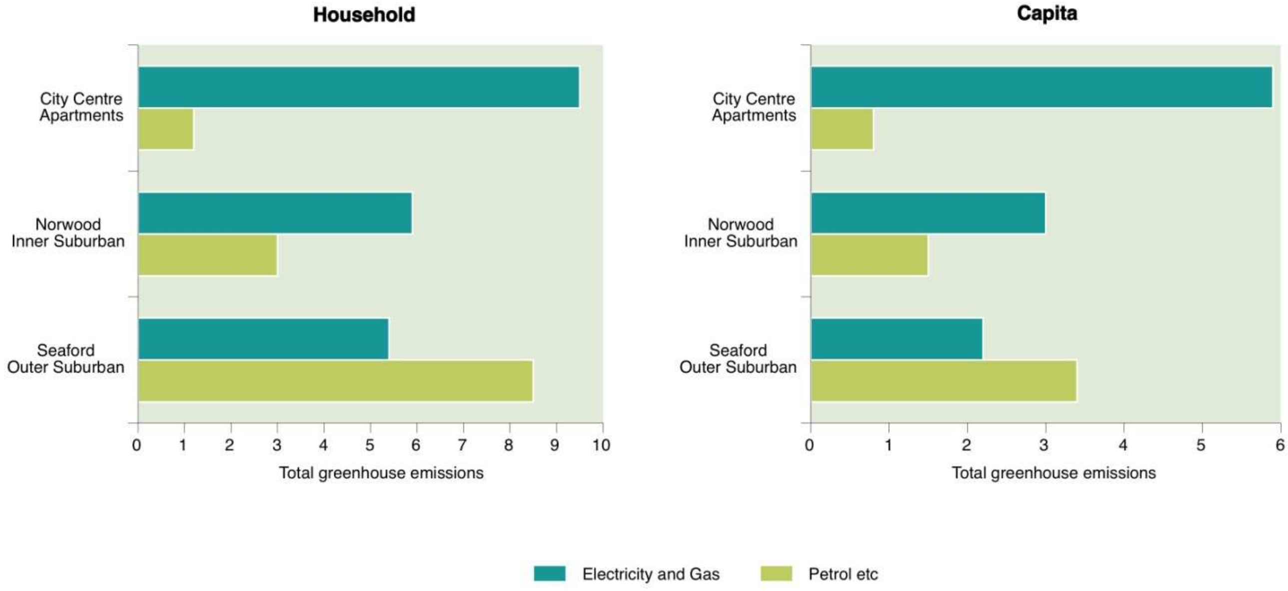
While urban consolidation is a major theme of stated plans, some planners lament that governments have not acted to fully integrate residential development, employment location and transport systems across capital cities (Buxton 2006). Some analysts are concerned that current actions work to create two city types: service rich, higher income inner and middle suburbs; and service poor, lower income outer urban areas. Governments do seek to transfer a proportion of outer urban development into established areas. However, state governments still extend capital city boundaries, and sprawling suburbs will inevitably lead to increased car use, particularly for cross-town trips. Until recently, billions of dollars in public resources has been spent on freeway construction in both Sydney and Melbourne, while public transport infrastructure, particularly services to connect new outer suburbs, have been largely ignored or delayed (Newman 2006).

## TAKING A BROADER VIEW

Urban consolidation may face a significant challenge, with research suggesting households in urban and inner city environments emit more greenhouse gases than those in rural environments. The Australian Conservation Foundation's online Consumption Atlas (the Atlas) (ACF, 2007) shows the spatial differentiation in the GHG emissions attributable to the consumption patterns of average households across Australia. A key strength of the Atlas is that it includes calculation of direct as well as indirect emissions. The Atlas reveals higher GHG emissions are attributable to urban household consumption than in rural areas, and higher GHG emissions again in inner city areas. These observations present a challenge to the notion that urban consolidation could be automatically expected to raise sustainability and reduce GHG emissions (Grey et al 2008).

A study of travel and housing GHG emissions over three areas of Adelaide reinforces the need to take a broad view. The comparison is of households living in city centre apartments, inner suburban dwellings and outer suburban dwellings. Key results are reflected in the chart below.

### Household Electricity and Transport GHG Emissions in three Areas of Adelaide




Source: Perkins et al 2007.

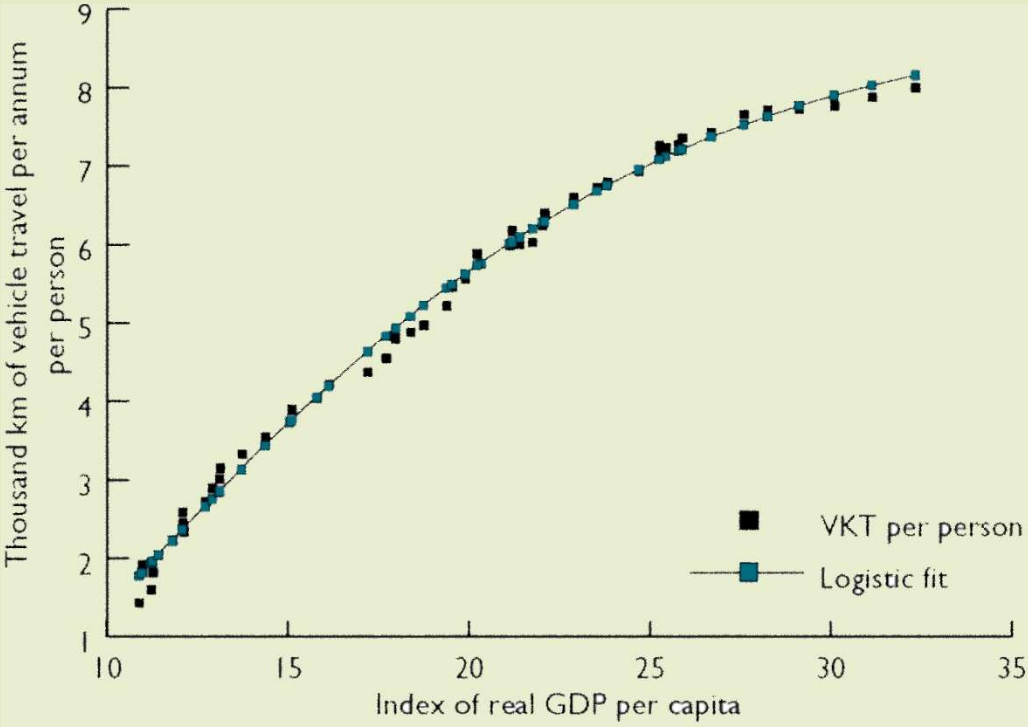
The evidence available from this specific study in Adelaide (but replicated in other sources) indicates that while households in inner city areas may be responsible for relatively few transport GHG emissions, they are responsible for significantly more GHG emissions in stationary energy demand. In per capita terms, the study found that people in city centre apartments were responsible for more GHG emissions than the others, and that the lowest emitters were in the outer suburbs (Perkins et al 2007).

There is also evidence of additional fundamental factors at play in shaping the demand for mobility in cities. It would be expected that if incomes rise, people will have the means to buy more of a good or service. Theory does seem to fit reality in the case of travel demand. Rising incomes over time are associated with greater travel. It will be important to take into account the underlying demand pressures when thinking about managing transport needs in cities.

**Income and Transport Demand**

Car travel in Australia appears to be related to economic activity levels. The trend in per capita car travel (kilometres per person) in Australia has in general been following a logistic (saturating) curve against real per capita income measured in terms of real Gross Domestic Product (GDP) per person.

The figure below shows the observed (or actual) amount of travel and the predicted amount of travel (the logistic fit data). The observed and fitted data are very close over most of the period. The close relationship between income and the amount of vehicle traffic is apparent looking at specific cities, regions and Australia at large.




Clearly, as incomes per person increase, personal car travel per person also increases, but at a slowing rate over time. Essentially, more car travel is attractive as incomes rise, but there reaches a point where further increases in per capita income elicit no further demand for car travel per capita. However, traffic then continues to respond in a one-to-one relationship to population growth which is also a significant component of aggregate economic activity.

Source: Garget and Gafney

It seems likely that a range of factors are at play in shaping consumption and emissions profiles. Factors such as income, age, family size and expenditure patterns can be expected to play a role, as well as the possibility that differentials in housing form (the availability of a garden and other aspects of amenity) could be significant in a way akin to density in regard to transport decisions. Without considering the broader picture, however, planners in pursuit of transport GHG reductions may lock some households into more energy-intensive housing or lifestyles that actually raise overall consumption and demand that subsequently raises urban GHG emissions.

## KEY POINTS

This chapter has sought to provide a review of the factors that are thought to shape urban land use, transport services and GHG emissions.

A major theme is that car dependency has resulted in low density, unsustainable development in Australia's cities. A key issue is that our cities contribute to rapid growth in transport GHG emissions.

Reducing the need for mobility in cities offers the greatest opportunity for reducing transport GHG emissions.

The 'compact city' school of thought places considerable emphasis upon raising urban density in terms of raising residential density.

Others view that there is more at play than density alone. Altering the morphology of cities, not merely altering density, is the key. Key issues include employment density, access to lower greenhouse gas emitting transport modes and the layout of transport infrastructure.

A large number of alternative morphologies are available. Each would rely upon a different mix of land use change and transport infrastructure support. At this stage it is not clear which, if any, is more sustainable and which would be affordable and actually be liveable.

Some researchers note the need to take a broader view about sustainability and urban lifestyles and liveability. While households in inner city areas use less transport energy, they also consume more of other services that raise GHG emissions than households in other areas. It is important to take such factors into account when considering urban sustainability.

# 3 RECENT REPORTS, EVIDENCE AND INSIGHTS

## NEW MILESTONES

A number of recently released studies have contributed evidence and insights into the relationship between transport, urban form and sustainability. This chapter seeks to identify some key insights about what these studies have identified.

## THE ECONOMIC IMPACTS OF ALTERNATIVE DEVELOPMENT PATHS

The recently published study, Assessing the Costs of Alternative Development Paths in Australian Cities, provides a tool to assess the economic costs in urban development decisions in Australia by comparing inner-city redevelopment and conventional fringe development (Trubka et al, 2008). The two development types are based on four or five inner local government areas in Melbourne and Sydney, as well as a similar number of fringe local government areas. The table below summarises key characteristics.

### Representative Characteristics of Two Opposing Urban Forms

| | *Urban redevelopments* | *Fringe developments* |
|---|---|---|
| Daily per capita GHG emissions (kg $CO_2$-e) | 0-4 | 8-10 and up |
| Distance to CBD (km) | <10 | >40 |
| Activity intensity | >35 | <20 |
| Transit accessibility (% with >15 min service) | >80 | <20 |

Source: Trubka et al 2008.

The tool provides an estimate of the embodied cost of the two development types broken down into the categories of infrastructure provision, transportation costs, GHG emissions and health costs. The costing methodology looks at the development and operating costs over a 50-year period for 1000 dwellings in each development type. These costs are reported in terms of their value today. Estimated costs are noted in the table that follows.

AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

### Estimated Development Costs For 1000 Dwellings

| | Inner $m | Outer $m |
|---|---|---|
| *Infrastructure* | | |
| Roads | 5 | 30 |
| Water and sewerage | 15 | 22 |
| Telecommunications | 3 | 4 |
| Electricity | 4 | 10 |
| Gas | | 4 |
| Fire and ambulance | | .. |
| Police | | .. |
| Education | 4 | 33 |
| Health | 20 | 32 |
| *Transport (50 year NPV)* | | |
| Transport and travel time | 206 | 343 |
| Roads and pricing | 47 | 155 |
| Externalities | 2 | 10 |
| *Greenhouse gas (50 year NPV)* | 17 | 37 |
| *Health (from activity, 50 year NPV))* | | |
| Direct | | 2 |
| Indirect | | 2 |
| **Total** | **323** | **684** |

Source: Trubka et al 2008.

The analysis suggests very substantial cost differences between fringe and inner redevelopment. In total, the inner redevelopment is estimated to save some $361 million per 1000 dwellings. Up-front infrastructure cost savings account for $86 million of this, and the rest is dominated by ongoing operating cost savings in transportation (that are reflected in Net Present Value terms).

It is notable that the greenhouse gas cost differential between the two building types is relatively modest. The greenhouse gas savings from the higher density redevelopment has an estimated value today in NPV terms of $19 million per 1000 dwellings over fringe development. That is, greenhouse savings are thought to account for about 5 per cent of the total cost saving. Of course, the greenhouse gas savings are linked to the transport (operating cost) savings.

A simple model is developed from these assessments. This is as follows:

$$y = 5.6x + 306$$

Where:

y is the cost of development in millions of dollars

x is the distance to the CBD

It is proposed that this can be used to predict urban development costs associated with development in Australian cities. It is suggested that assumptions about the character of a development proposal be made when dealing with developments that are otherwise at odds with the formula. Thus a TOD on a rail line, but a long distance from the CBD, should be treated more like a middle suburb. Other developments that are near the CBD, but are not served by transit and are not very dense and mixed would be more like a middle suburb (Trubka et al 2008).

## TRANSFORMING AUSTRALIAN CITIES – THE CORRIDOR CITY

A recent study, 'Transforming Australian Cities' sets out a new vision for Corridor Cities: "In Australian cities, the aim should be to maximise development along new and future road based trunk public transport corridors" (Adams et al 2009: 12). By 2029, key linear transport corridors would, under this vision, be developed into medium rise, high density corridors that connect all activity centres and provide easy access to high quality public transport from the adjacent 'productive suburbs'. Development of these corridors would take development pressure off the existing suburbs, which can then develop as the new 'green lungs' of metropolitan areas.

The 'Transforming Australian Cities' study sets out a strategy and approach to planning that is expected to be generally applicable to all Australian cities. To demonstrate its workability it has analysed application of the approach to Melbourne. The key steps are set out in the box below.

The study results indicate a substantial development capacity. In Melbourne this would harvest 34,477 potential sites that meet the criteria with an area of 6,693 ha. The current population of these sites is estimated to be 200,790 people. The study authors see two possible development density scenarios: a low-density scenario (180 people per hectare) and a high-density scenario (400 people per hectare). Under these scenarios, Melbourne's urban corridors could accommodate a potential population increase of 1 million to 2.5 million. This would transform metropolitan Melbourne enabling it to meet the projected population of 5 million by 2029.

The 'Transforming Australian Cities' study sees that the major benefit of the proposed approach is that Australian cities could immediately start to move to improve their long term liveability, economic productivity and environmental sustainability, through the positive forces of the private market system, and achieve this by only changing about 3 per cent of the existing footprint of the city.

**Steps To Focus Development Along Urban Corridors**

The major analytical approach involves the following steps.

**Step 1:** Identify cadastral parcels

**Step 2:** Remove special building zones

**Step 3:** Select parcels along tram and priority bus routes

**Step 4:** Remove areas in parks

**Step 5:** Remove public use and industrial zones

**Step 6:** Remove sites without rear laneway access

**Step 7:** Remove recently developed sites and sites in planning (DPCD)

**Step 8:** Remove heritage register buildings

**Step 9:**Remove sites with frontage less than 6m

**Step 10:** Remove 50% of sites within the heritage overlay

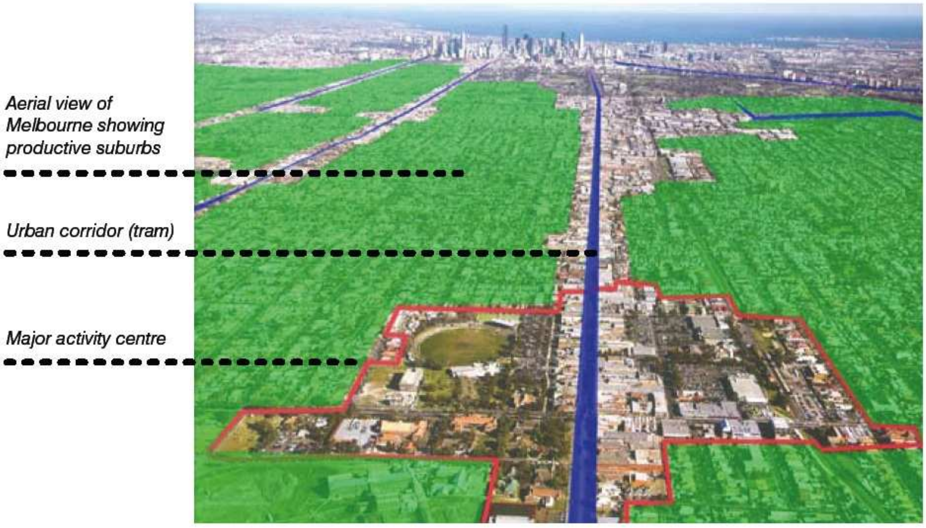
**Step 11:** Determine sites available for development

Source: Adams et al 2009.

This analysis and results are based on pragmatic considerations about the scope to change community values in Australia.

> *Australians have a love affair with the suburban block with its detached single dwelling and extensive greenery. This deep seated empathy is not going to change in the short term nor are these areas going to be rebuilt by 2029. Attempting to retro-fit significantly increased density development in areas not well serviced by public transport is unlikely to be a viable proposition. Instead we need to enhance the quality of these areas while introducing greater sustainability*. (Adams et al 2009:27)

### A Corridor City: An Aerial View




Source: Adams et al 2009.

‘Transforming Australian Cities’ views that the other benefits of the proposed approach includes the following:

- The increased densities in the corridors will support a wider array of services and experiences for residents and visitors.
- The economics of providing high quality public transport services along denser corridors would improve.
- High quality, calmed public transport streets with continuous active frontages would provide a safe and vibrant pedestrian environment.
- Environmental excellence in energy, water and waste management would minimise the need for upgrading existing or new infrastructure.
- An increased pool of affordable housing would become available, provided through the market.
- The application of good urban design principles, such as high quality public realm, clear definition between public and private space, active street frontages, and sun and weather protection, would improve the quality of urban space.
- Production of mixed use development would result in greater accessibility to local work, services and recreational opportunities.
- New ‘high streets’ connecting activity centres provide an urban experience close to suburbia.

## MACRO-URBAN ALTERNATIVES

Alford and Whiteman's 2009 study 'Macro-Urban Form, Transport Energy Use and Greenhouse Gas Emissions: An Investigation for Melbourne' broadens analysis about the impact of alternative approaches to urban morphology.

Rather than espouse the perceived benefits of a preferred approach, the study measures what difference alternative transport and land use arrangements would bring. Alford and Whiteman have tested ten urban scenarios. Each scenario represents a particular vision of Melbourne in 2031, according to how, in the future, population growth may be distributed, and transport infrastructure deployed. The scenarios are listed below, with their chief descriptors in Alford and Whiteman's terms.

1. **Current Trend/Base Case:** Continued urban development according to current patterns, with no change to existing policy or implementation programs. This is the outcome using the current (2008) planning and transport frameworks to 2031.

2. **Non-Intervention:** Current policy and implementation programs are reversed and development occurs without high-level planning intervention or Urban Growth Boundary (UGB).

3. **Activity Centres (AC) Growth Areas Plus:** Strong Infrastructure investment, and high-level planning interventions as espoused in Melbourne 2030, including development of urban fringe growth areas.

4. **Activity Centres (AC) only:** Strong Infrastructure investment and high-level planning interventions focused on Principal and Major Activity Centres (as identified in Melbourne 2030) only.

5. **Super CBD:** Half of future population growth and all future employment growth to be concentrated in an enlarged CBD.

6. **Super CBD + Parking Prohibition Variant:** As above, but with no new off-street parking permitted in this larger CBD area.

7. **Inner City:** Future growth to be directed to the inner-city, 'transport-rich' areas of Melbourne, including the CBD.

8. **Polycentric City (Outer Centres):** Urban growth directed toward major outer suburban centres, while primacy of CBD maintained.

9. **Polycentric City (Middle Centres):** Urban growth directed toward major middle ring suburban centres, while primacy of CBD maintained.

10. **Linear Development:** Large-scale residential and employment development to be confined to within 400 metres of a railway station or tram-stop, with expansion in public transport capacity.

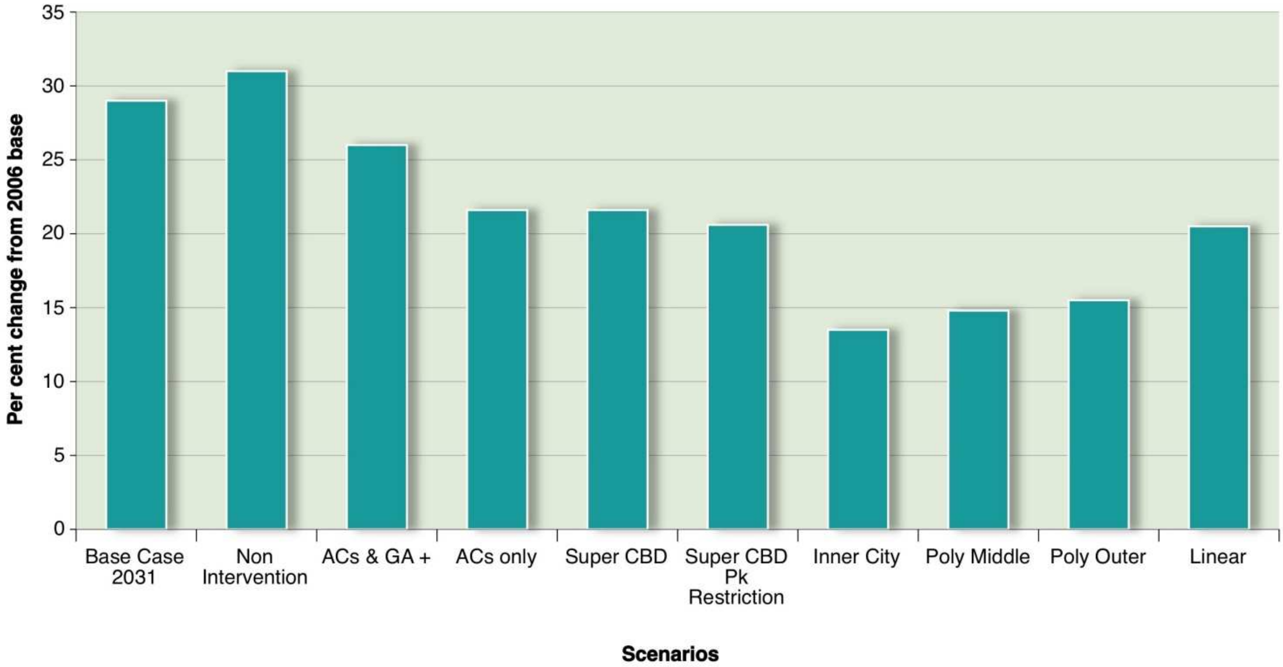
These scenarios span many ideas advanced by planners and advocates for more sustainable cities. It should be noted that all scenarios involve more than a single change. For example, the inner city scenario involves raising residential and employment density in target regions, plus investment in tram and rail systems and bike paths necessary to support the transport needs of the metropolitan area at large.

Another feature of the analysis is the use of a detailed transport model, in this case the Melbourne Integrated Transport Model (MITM) developed by the Victorian Department of Transport. This looks at transport and land use decisions on a metropolitan scale, in this case, the city of Melbourne (covering the region included in the area defined by the ABS as the Melbourne Statistical Division). While the MITM model provides metropolitan level results, it arrives at these through the analysis of travel and land use decisions taken at the level of residential communities. This is in contrast to some studies, (such as the study by Trubka, Newman and Bilsborough (2008), which use information at the local government area which is then aggregated to form estimates for the city at large. The MITM approach has the strength of looking deeper within communities and taking advantage of knowledge about additional factors such as the interconnections between communities provided by roads, rail and other facilities.

A key finding of the modelling is that changes to transport and land use at the metropolitan scale (and supporting policy changes) can be expected to have a measurable and significant impact upon city-wide transport GHG emissions. Projected transport GHG emissions in all of the intervention scenarios (3 through to 10) are lower than the base case.

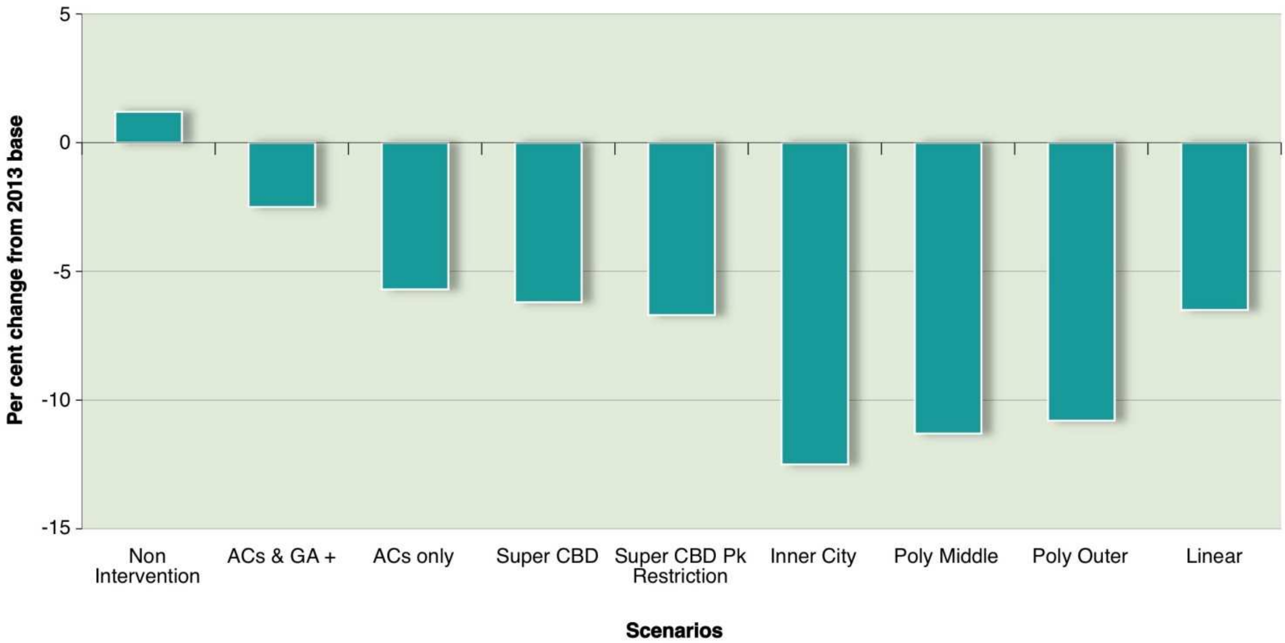
The Inner City scenario (scenario 7) produces the lowest GHG emissions, followed closely by Polycentric City Middle Centres and the Polycentric City Outer Centres scenario. The change in GHG emissions by scenario compared to the base case scenario is illustrated in the following figure.

### Changes in Total GHG Emissions for Base Cases 2006-2031




Source: Alford and Whiteman 2009.

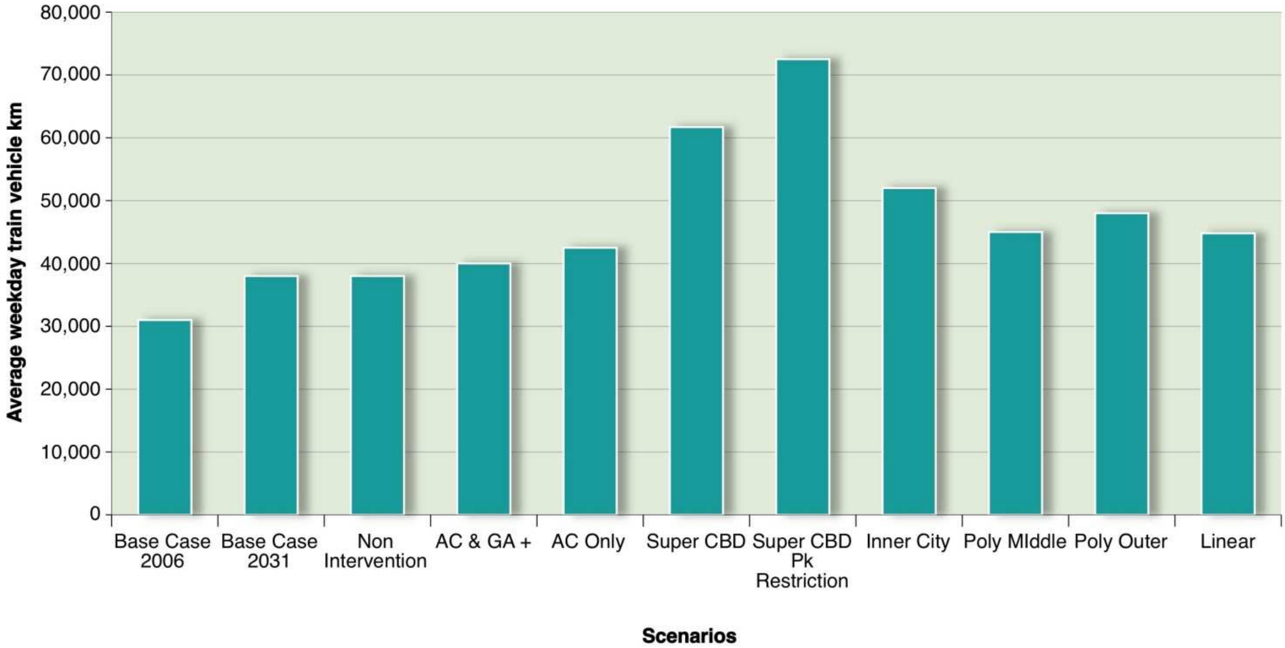
### Changes in GHG Emissions Compared to 2031 Base Case, Melbourne Statistical Division




Source: Alford and Whiteman 2009.

The results suggest that GHG emission outcomes are driven by a range of factors in addition to density. Alford and Whiteman suggest that the Inner City scenario has a better GHG profile than the Super CBD scenarios (scenarios 5 and 6) despite all three raising density in the area closer to the CBD, because the Inner City scenario involves getting the best out of the tram network — that is, with denser walking catchments and a 'fit for purpose' tram network. Indeed, the simulation results indicate that the Inner City scenario involves the highest proportion of trips taken by tram and the lowest amount of distance travelled in private vehicles (measured as vehicle kilometres travelled - VKTs). The Super CBD scenarios essentially involve more car travel by people who live on the outer parts of the city and this offsets much of the savings from higher inner city density.

### Public Transport Mode Share



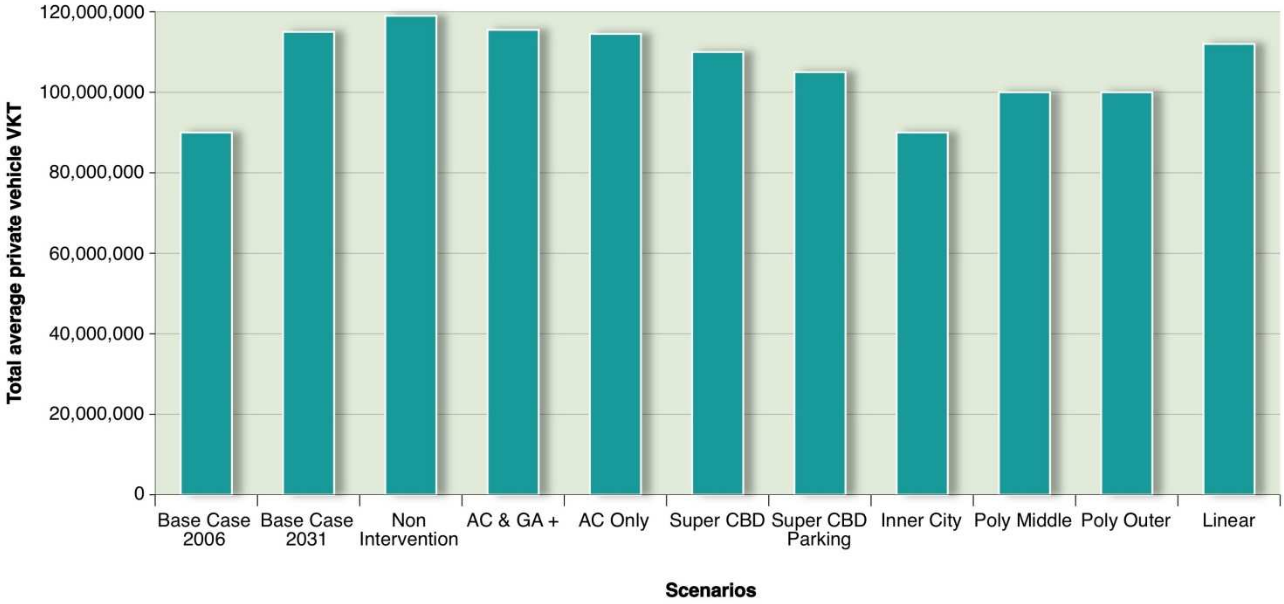

Source: Alford and Whiteman 2009.

The transport GFG emission reductions in the Polycentric City scenarios are only marginally lower than the Inner City scenario, but they are also significantly ahead of the Super CBD scenarios that concentrate upon maximising density (in terms of residential population and employment). The Polycentric City scenarios perform better than the Super City scenarios in terms of GHG emissions largely because they involve less distance travelled on average through the city. The Polycentric scenarios also exhibit a higher proportion of bus travel than the Super CBD scenarios and, given that buses are less carbon intensive per passenger kilometre than trains, this contributes to a lower overall GHG emission footprint in these scenarios. While reducing overall distance travelled, the Polycentric scenarios still rely on mechanised mobility and slightly more journeys are expected to be undertaken by car in these scenarios than in the Inner City scenario, explaining why these still produce slightly more emissions than the Inner City scenario.

The Linear Development scenario shows that transport GHG emissions reductions may be achieved by locating high density residential and development activities in transit corridors (given suitable improvements in supporting transit infrastructure). The model results suggest, however, that this approach still involves relatively high private trips and VKTs, reflecting residual needs for cross-town travel and thus reducing the GHG abatement potential of the approach.

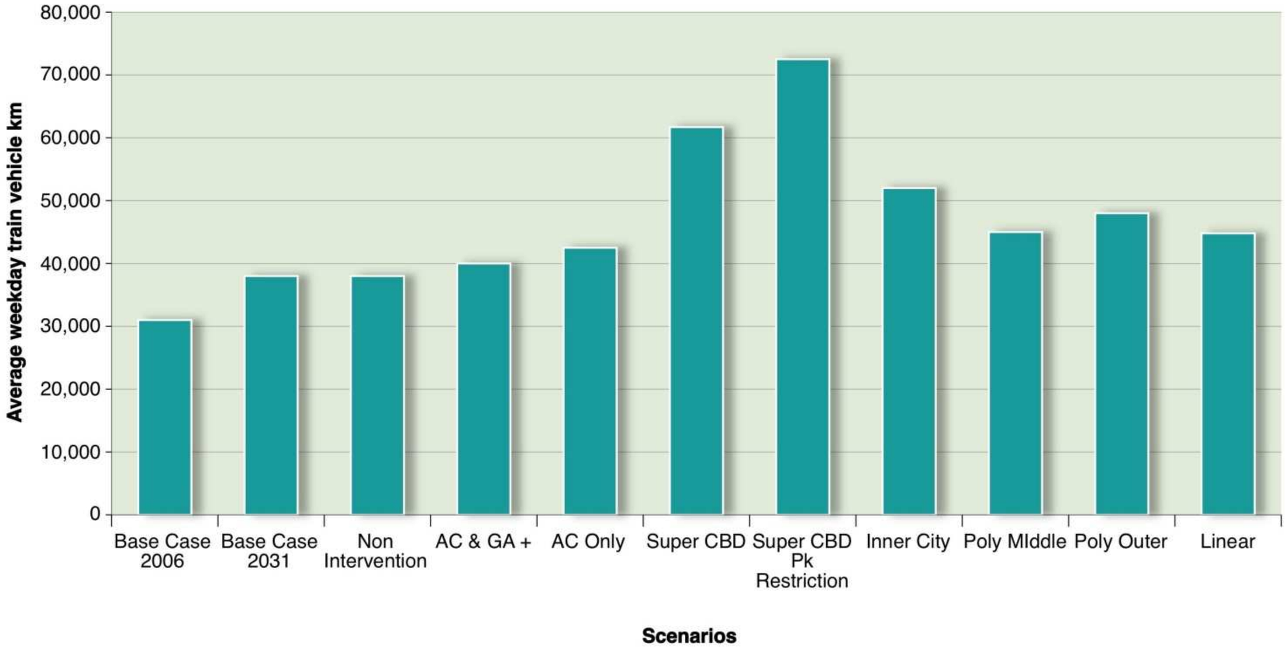
Raising density and activity in the Activity Centre scenarios were found to reduce transport GHG emissions compared to existing plans, but this reduction is lower than other scenarios. The analysis suggests that increasing residential densities in outer growth areas will have little impact on transport GHG emissions unless VKTs are also lowered; that is, more needs to be done to facilitate less driving and shorter car journeys.

### Total Average Weekday Private Vehicle (VKT)




Source: Alford and Whiteman 2009.

### Average Weekday Train Vehicle Kilometres Travelled




Source: Alford and Whiteman 2009.

Alford and Whiteman provide information that helps to place the GHG emission abatement potential from altered urban form in context. The largest reduction in projected GHG emissions is expected to achieve a reduction in base case GHG emissions of around 12 per cent by 2031. Given realisation of base case emissions of around 30 $CO_2$-e Mt pa by 2031, this suggests that altering urban form could improve Melbourne's transport GHG emissions by around 1.4 Mt per annum. That is around 2 per cent of Australia's current transport GHG emissions. It is also notable that transport GHG emissions in Melbourne are projected to rise from current day GHG emissions (2006 in the study), even under existing planning approaches which were heralded as being an advance in sustainability, and will still be larger under even the most active measures to alter urban form.

Detailed measurement of urban transport and land use options is still in its infancy. Alford and Whiteman flag areas where they view a more complete analysis could be provided. They suggest that this could include:

- updating model data to use the 2006 Census results;
- inclusion of separate data for freight, agriculture and commercial travel, as well as including the mode share for zero emission transport options such as walking and cycling; and
- including other cities and regions.

## KEY POINTS

The most recent contributions add more weight to the view that we can raise sustainability in Australian cities by altering urban form over time through relocation of development, increased residential and employment density and suitable supporting infrastructure. In particular, these recent studies provide more evidence about GHG emission impacts from transport, as well as economic outcomes.

The more recent studies introduce new tools to assist the evaluation of alternative urban forms and their impacts. While providing valuable insights, these tools still appear to be in their formative stages.

What is needed is a tool or set of tools that:

- measure the impact of alternative urban forms — preferably this should have greater granularity than a simple distinction between high density and lower density development;
- takes into account the different forms of Australian cities — preferably it would be specifically calibrated for most if not all, including capital cities, other cities and regional areas;
- provide indications or predictions over a range of factors/outputs — this should include the social cost of alternatives, GHG emissions, economic factors as well as factors that shape the broad concept of liveability;
- enables assessment of tradeoffs between key factors — would, for example, an decrease in GHG savings be offset by reduced social disruption?; and
- enables cost benefit analysis — impacts need to be monetised to enable comparison between alternative urban forms and other possible measures to raise sustainability.

# 4 NEW TOOLS TO ASSESS CITIES AND THEIR FUTURE

## MULTIPLE TOOLS FOR A MULTI-PRONGED CHALLENGE

Changing urban form is expected to alter a number of dimensions shaping the performance of cities. This poses a multi-pronged challenge, which can be addressed by using a range of assessment tools. Two broad tools will be used.

- Transport and land use change
- Assessment of broader liveability

The application and development of the tools are reviewed briefly in the sections that follow.

## TRANSPORT AND LAND USE CHANGE

### Zenith Transport Simulation Models

The key innovation in the study relates to the use of the Zenith Travel Forecasting Model framework. The Zenith transport simulation model is a mature analytical technology. Key strengths of the approach are that it:

- simulates the travel demands and patterns of an entire region (or market) — Zenith models are available for all of the mainland capital cities and many major cities in Australia;
- includes many types of transport, including non-motored modes (walking and cycling), public transport, private car as well as commercial vehicle travel;
- specifies the transport network within the modelled area in considerable detail. All freeway, arterial, sub-arterial and collector roads are included in the simulation network, as well as every train line, train station, tram route, bus route and tram/bus stop. The large area covered by the Zenith model results in a transport network comprised of some 60,000 links (that is, sections of road or railway line, ferry links etc);
- uses a 'fine-grained' resolution breaking cities up into many smaller areas or travel zones in order to reflect travel demand and patterns accurately — in the case of the Zenith model for Melbourne some 2,519 travel zones are used;
- captures much about the 'main drivers' shaping decisions to travel. The main drivers include the land use structure of the region (that is the distribution and intensity of various land uses) and the configuration and characteristics of the transport system (that is, travel speed, capacity, frequency of public transport services etc). The model is also influenced to some degree by factors that shape transport pricing such as parking charges, petrol price, tolls and public transport fares; and
- is validated regularly comparing the model results to real world transport outcomes and changed as necessary.

### Limitations with Traditional Transport Simulation Models

There are a number of factors that would pose significant constraints upon the usefulness of using traditional transport simulation models when seeking to evaluate the impact of changing urban form and implications for sustainability for all major cities in Australia over the long term. Key factors are listed below.

- **Fixed land use:** land use is defined as a fixed factor in many transport simulation models. In systems terms, land use is exogenous and is external to the model. Land use is taken into account by decisions taken by the operator and is generally defined as being fixed and unchanging.
- **Fixed transport infrastructure:** transport facilities such as roads, rail, and bus routes are also constructed as being part of the fabric of the model and are not changed within the model (say as a response to increasing demand for travel in a particular area), or only particular changes can be made by the operator with some difficulty.
- **Single city centric:** many models tend to be built for a particular city and assumptions and factors in that model tend to become somewhat idiosyncratic over time. Using a collection of such models would make robust, consistent and transparent analysis of all major cities in Australia unlikely.

- **GHG emissions are an externality:** presently neither travellers nor transport service providers pay for greenhouse gas emissions and thus do not enter as a factor when considering transport options. Since emissions do not generally shape travel behaviour, they are not normally modelled in most frameworks. (Countering this situation is a key factor in support of putting a price on carbon.)

## Key Innovations in the Zenith Models

Significant changes have been made to the Zenith models in order for them to be useful in this study. The key points are as follows.

- **Land use change scenarios:** the expected future distribution of population (including socio-economic profiles) and employment (by type) has been specified for each of the 2,000 to 3,000 travel zones in models for key regions. These changes are taken into account by essentially constructing a new model for each time period studied. The changes rely on data that is generally found in census updates, so changes are reflected in 5-year increments over the period from 2006 until 2041. The land use changes are based on land use planning information available in the most recent plans prepared by government planning authorities. Changes are also made in each Zenith model to account for the development of additional special travel generators such as new or changed ports, hospitals and airports.
- **Transport infrastructure change scenarios:** Zenith models for selected regions have been upgraded in order to account for planned provision of additional transport facilities such as roads, rail facilities and bus routes, as they are likely to reflect information in government regional infrastructure plans.
- **Many city frameworks:** the land use and transport infrastructure change scenarios have been prepared for a suite of Zenith models relating to Greater Melbourne and South East Queensland. The use of a common framework avoids modelling quirks distorting results, while also providing for a wide range of cities.
- **GHG emission accounting:** the Zenith models have been modified to track activities that contribute to transport GHG emissions and to report projected emissions over time for each region modelled. This analysis includes all greenhouse gases and reports the information in terms of tonnes of $CO_2$-e.

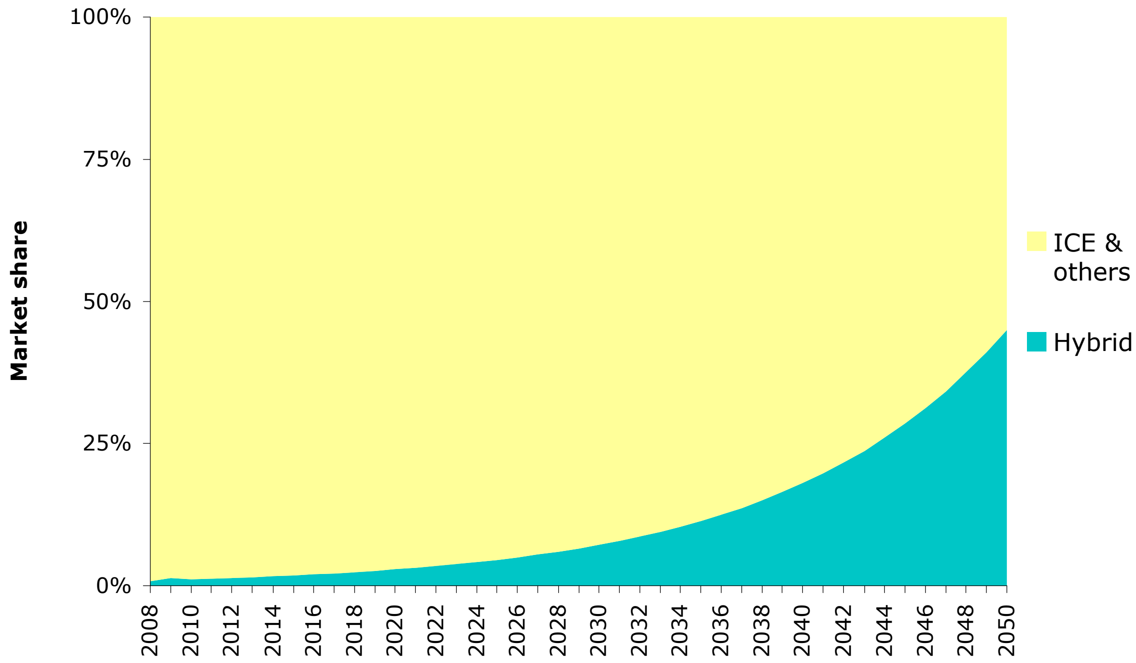
Significant model development has been required in order to account for land transport GHG emission estimates in the Zenith models. As a starting point, the models normally account for the amount of travel undertaken, and fuel/energy used.  Key issues relate to other factors that can be expected to change over time including:

- the vehicle fleet mix;
- fuel efficiency; and
- emissions intensity.

Vehicle fleet mix can be expected to change reflecting the entry of hybrid, plug in hybrids and electric vehicles challenging the dominant market position of vehicles powered by an internal combustion engine (ICE). Most evidence available today is about hybrid vehicles. Hybrid cars use an ICE engine as well as electrical generators and motors. They are very fuel efficient using around 50 per less fuel in normal use than ICE powered cars and a similar amount less in GHG emissions, with performance differing by make. The first mass produced hybrid was the Toyota Prius that first went on sale in Japan in 1997, and was subsequently introduced worldwide in 2001. Sales of hybrid cars have grown very rapidly in Australia from a small base. Reflecting factors such as higher fuel prices and greater awareness about GHG emissions, it can be expected that sales of hybrid cars will continue to grow.

One benchmark for the market inroads of hybrid vehicles is the entry of efficient diesel vehicles, especially those with turbocharged engines. These are reported to have sustained a growth rate of around 6 per cent over many years in Europe and are seeing similar growth rates in Australia in recent years. To produce an estimate of the possible impact of the expanded entry of hybrids, the forecast used in this study is to assume that they sustain a growth rate in sales of around twice that of turbocharged diesels – that is 12 per cent. On this basis, hybrids would account for around 50 per cent of new vehicle sales by 2050 (see the chart below).

**Baseline New Vehicle Market Share, 2008-2050**




Note: ICE = Internal Combustion Engines.

Source: ACG and VLC estimates.

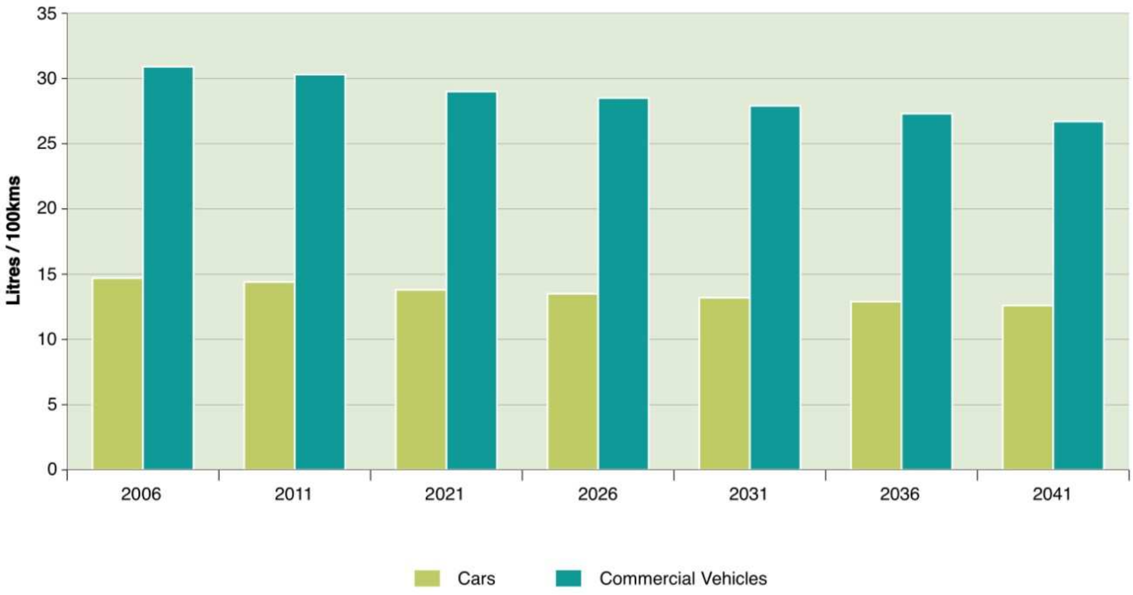
The rate at which vehicles convert fuel into distance is a key parameter in estimating GHG emissions (and the economics of differing transport modes). Over many years, improvements in the efficiency of engines in vehicles sold in Australia appear to have been largely channelled into many aspects of performance, particularly vehicle acceleration, rather than into fuel economy. ABS statistics show that measured fuel efficiency (the amount of fuel consumed by the vehicle fleet divided by the distance travelled) has been static over time. This may reflect factors such as increased traffic congestion, which would offset technical efficiencies.

Currently producers in Australia have flagged their intent to provide cars which are more fuel efficient and have set targets to achieve a reduction in the average fuel intensity of vehicles sold. Given such measures and expectations of higher fuel prices over time and greater awareness of fuel consumption and GHG emissions, it is reasonable to expect an improvement over time. An improvement in fuel efficiency of the vehicle fleet is factored into the baseline estimates. This is separate to the changes that are expected to occur with the entry of a higher proportion of hybrid and electric vehicles. The changes foreshadowed in the baseline estimates are portrayed in the chart on the next page.

The GHG intensity of the fuels used is another factor to consider when assessing transport GHG emissions. This can be expected to reflect changes in fuel, such as the addition of ethanol. It is also notable that ICE vehicles produce a cocktail mix of various pollutants that contribute to global warming (and other problems).

Possible changes in the GHG emissions intensity of different categories of vehicles over time are provided in the chart that follows.

### Baseline Fuel Efficiency, 2006-2041




Source: ACG and VLC estimates based on data from CSIRO (2008).

## Data Outputs

The Zenith models start with simulations that relate to the performance of current urban transport systems and projections into the future. Summary network performance indicators at a city-wide, regional or sub-regional level will be available for:

- average trip distance (by transport mode — car/public transport/riding);
- average trip time (by transport mode);
- market share (by transport mode);
- overall network volume/capacity ratio;
- average network speed;
- total travel distance (by transport mode);
- total travel time (by transport mode);
- value of time spent (by transport mode);
- total vehicle operating costs;
- total fuel expenditure;
- total operating cost (by mode);
- accident costs; and
- transport GHG emissions (in total and by mode).

Currently, there are Zenith models for most capital cities in Australia and many other larger cities and urban areas. The inclusion of the cities to be examined further in the next stages of this study depends upon the choices made by the study sponsors.

Information obtained from this analysis will be used in subsequent elements.

### Baseline emissions intensity, grams per litre

| | 2006 | 2011 | 2021 | 2031 | 2041 | 2050 |
|---|---|---|---|---|---|---|
| ***NOx*** | | | | | | |
| Car | 11.0 | 10.9 | 10.7 | 10.6 | 10.4 | 10.3 |
| Commercial vehicle | 15.3 | 15.3 | 15.2 | 15.1 | 15.1 | 15.0 |
| Public transport | 11.0 | 10.9 | 10.7 | 10.6 | 10.4 | 10.3 |
| ***NMVOC*** | | | | | | |
| Car | 6.3 | 6.0 | 5.2 | 4.4 | 3.8 | 3.1 |
| Commercial vehicle | 9.6 | 9.5 | 9.4 | 9.4 | 9.3 | 9.2 |
| Public transport | 6.3 | 6.0 | 5.2 | 4.4 | 3.8 | 3.1 |
| ***SOx*** | | | | | | |
| Car | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Commercial vehicle | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| Public transport | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| $CO_2$ | | | | | | |
| Car | 2,200.9 | 2,191.0 | 2,171.4 | 2,152.3 | 2,135.6 | 2,118.8 |
| Commercial vehicle | 2,368.5 | 2,359.5 | 2,341.5 | 2,324.0 | 2,308.7 | 2,293.3 |
| Public transport | 2,200.9 | 2,191.0 | 2,171.4 | 2,152.3 | 2,135.6 | 2,118.8 |
| $CH_4$ | | | | | | |
| Car | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 |
| Commercial vehicle | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Public transport | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 |
| $N_2O$ | | | | | | |
| Car | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Commercial vehicle | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Public transport | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| ***CO*** | | | | | | |
| Car | 88.0 | 83.6 | 74.9 | 66.3 | 58.9 | 51.4 |
| Commercial vehicle | 92.5 | 91.8 | 90.5 | 89.2 | 88.1 | 87.0 |
| Public transport | 88.0 | 83.6 | 74.9 | 66.3 | 58.9 | 51.4 |
| ***Total*** | | | | | | |
| Car | 2,307.6 | 2,292.9 | 2,263.5 | 2,234.9 | 2,210.0 | 2,184.9 |
| Commercial vehicle | 2,488.3 | 2,478.5 | 2,459.0 | 2,440.0 | 2,423.4 | 2,406.8 |
| Public transport | 2,307.6 | 2,292.9 | 2,263.5 | 2,234.9 | 2,210.0 | 2,184.9 |

Source: VLC Zenith Travel Forecasting Model.

## ASSESSMENT OF LIVEABILITY

It is not sufficient to only assess GHG implications of changed land use in cities. Raising sustainability genuinely involves addressing the triple bottom line. Key dimensions are entwined within the general rubric of the liveability of a city. It is likely that changes in land use and transport infrastructure provision would alter a wide range of factors that together contribute towards the overall liveability of a city.

Useful results have been obtained in other studies using a composite index (see box below).

**Liveability Indices, Urban Form and Transport**

Liveability indexes provide a means of assessing urban areas. These have been produced by various agencies and public sector bodies including indexes compiled by the Cairns City Council and Victorian Government.

At an international level, liveability indices are often used to compare major cities or nations as a whole. The major international liveability indices are listed below.

- The United Nations' Human Development Index
- The Economist Intelligence Unit's Liveability Ranking and Quality-of-Life Index
- The Mercer Human Resource Consulting's Worldwide Quality of Living Survey
- The Vanderford-Riley Well Being Schedule
- International Living's Quality of Life ranking.

Griffith University's Urban Research Program (URP) is at the forefront of measuring and quantifying indicators of liveability in Australia. Recent indices concerning specific aspects of liveability which have been adopted by various state government agencies and others, and are listed below.

- **VAMPIRE:** Vulnerability Assessment for Mortgage, Petroleum and Inflation Risks and Expenditure. VAMPIRE indexes measure the extent of household exposure to the impacts of higher fuel prices and mortgage interest rates, and identify the relative degrees of socio-economic stress in suburbs in Brisbane, Sydney, Melbourne, Adelaide and Perth. VAMPIRE has been constructed using detailed 2006 Census data at the Collection District level (typically about one residential block) regarding car dependence, income and home ownership status.
- **MULUTT:** Modular Urban Land Use and Transport Tool. This tool includes capacity for destination-based accessibility analysis in a Geographic Information System, applied to datasets obtained from a number of sources (such as the 2006 ABS Census), and using information relating to the land use destinations, the road/pedestrian network, and the public transport network. This work is now modelling accessibility for low socio-economic status groups in Australian cities.

Source: Dodson and Sipe 2007 and Pitot et al 2005.

The main innovation for this study is to focus on liveability in particular places and then to aggregate findings for those places to gain an indication of liveability for the city at large. The tool should be able to see how liveability changes over time and with alternative land use and infrastructure arrangements.

While existing tools such as MULUTT have particular strengths, especially in terms of providing results at a very high level of spatial disaggregation (that is, looking a neighbourhoods in detail), it is not feasible to compile the necessary datasets to provide a similar framework for all of the cities that could be included in this study with the time and resources that are available.

An index score will be compiled drawing on results for travel zones over the indicators contained in the table that follows.

### Liveability Indicators

| Liveability factor | Indicator | Description |
|---|---|---|
| *Economics* | | |
| Jobs | Employment density | May be calculated in terms of jobs per hectare or jobs per 1000 residents in each Travel Zone (TZ). |
| Changes in cost | Travel cost | Average cost of transport in each TZ derived from the model travel matrices. Essentially a function of trips, trip distance, transport mode factors in the model. This indicator measures variable costs such as fuel use rather than fixed costs such as the decision to purchase a car. |
| Changes in travel time | Trip time | Average travel time per person in each TZ derived from the model travel matrices. |
| *Social* | | |
| Public transport | Public transport supply | A count of the number of public transport services available in each TZ across an average working day. The services are allocated to TZs according to the proportion of the TZ falling within a catchment area for individual public transport services (that is, one kilometre from where train services may be accessed and 400 metres wherever bus and tram services may be accessed. In other words, each individual service is counted at each point where it can be accessed by passengers, either at a train station or a bus or tram stops within a given area. These services are weighted according to the passenger load capabilities defined in the model (Alford and Whiteman 2009). |
| Education | Accessibility to education | Reflects the total number of enrolments in pre-schools, primary-schools and secondary schools that, on average, can be reached within 60 minutes by public transport and car in each area. |
| Retail | Accessibility to retail | The total number of jobs in retail that, on average, can be reached within 60 minutes by public transport and car in each area. This indicator is a proxy measure of the accessibility to shops in the region. |
| Leisure | Recreation opportunities | Similar to the above for retail except the focus is upon travel for recreation. |
| Community | Accessibility to community services | Similar to the above for retail except the focus is upon travel for community services (calculated as a residual by subtracting out all other travel destinations). |
| Disruption | Change in residential population | Calculated in terms of change in resident population from one scenario to another for each TZ. |
| Residential density | Residential density | Can be calculated in terms of persons per hectare or simply to use the number of people per TZ. |
| *Environment* | | |
| Energy consumption | Transport energy consumed | Total per TZ calculated based on location of origin of trips. |
| Greenhouse | Greenhouse gas emissions | Total per TZ calculated based on location of origin of trips. |

Note: TZ equals Travel Zone which is the representation of land used in transport models, normally calculated in terms of ABS census collector districts.

Source: Alford and Whiteman 2009, the ACG.

The index that will be developed will report an overall liveability score for each city. The study will measure how the indicator changes over time and with changed land use and other assumptions.

While liveability is inherently subjective and there are significant limitations attached to modelling, this is not necessarily a liability. A liveability model is useful because it simplifies, enabling the construction of a framework that can reflect the important aspects that shape how liveable people are likely to view the city they live in, or could live in.

## KEY POINTS

A new set of tools has been developed in this part of the broader study to assess how changes in urban form may contribute to sustainability and liveability.

The development of the Zenith models to allow for changes in transport and land use based on current metropolitan and regional plans is a major innovation.

A framework has also been developed to use model information to assess changes in the broader liveability of cities examined.

# 5 TRANSPORT BASELINE PROJECTIONS

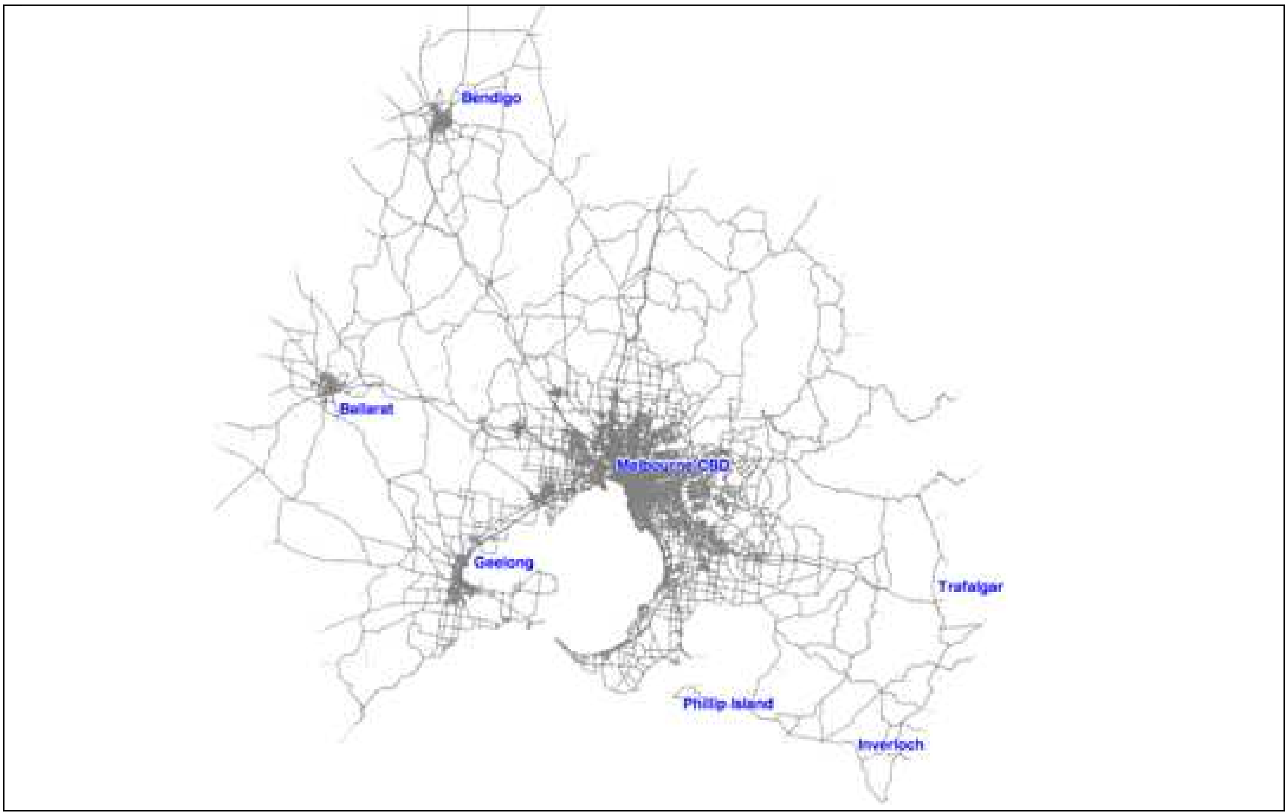
## APPROACH

A key step to assess the impact that alternative urban forms would have on economic, social and environmental indicators is to provide measurements about current and expected outcomes in major urban centres. Baseline projections for two major urban centres (Greater Melbourne and South East Queensland) have been estimated using the Zenith Travel Forecasting Model. The results of these projections for each centre are provided in the sections below.

## GREATER MELBOURNE

The Greater Melbourne region, which includes Melbourne CBD, Geelong, Bendigo and Ballarat, houses approximately 20 per cent of Australia's population (see map below).[3]

### Greater Melbourne Region




Source: VLC Zenith Travel Forecasting Model.

[3] Further details about the Statistical Local Government areas contained within the Greater Melbourne region are presented in Appendix A.

## Planning and Land Use Context

The Zenith model framework for the Greater Melbourne area is forward looking and takes into account much of the expected transport, demographic, economic and land use decisions factored into key government plans. That is, the baseline does not merely extend the present transport systems into the future. A major part of the task in preparing the baseline projections is to forecast and allow for factors such as:

- growing populations;
- the location of population growth;
- economic growth – reflected particularly in the number of jobs, their nature and location;
- changes in the road network;
- changes in public transport facilities (including the provision of infrastructure the capacity of services and their frequency); and
- changes in other modes of transport (including cycling and walking).

As shown in the table below, in 2006, the Greater Melbourne area had a resident population of around 4.2 million and employed approximately 2 million people. According to forecasts factored into the Zenith model, by 2041, around 6.8 million people are expected to call Greater Melbourne home, a change of 61 per cent from 2006.

### Estimated Population and Employment in Greater Melbourne

| | 2006 | 2021 | 2026 | 2031 | 2036 | 2041 |
|---|---|---|---|---|---|---|
| Population (million) | 4.2 | 5.3 | 5.7 | 6.1 | 6.4 | 6.8 |
| Employment (million) | 2.0 | 2.5 | 2.7 | 2.8 | 3.0 | 3.2 |

Source: VLC Zenith Travel Forecasting Model.

Managing this rapidly growing population presents the region with challenges, especially in transport. More people living and working in Greater Melbourne means more cars on the roads, more people using public transport, more commuters needing to get to work each morning and more goods moving through the region. This in turn means that the load required for transport will grow significantly as the major drivers for transport demand in the region (population and employment) experience considerable growth.

The future of the largest urban area within Greater Melbourne — the Melbourne metropolitan region — is expected to be shaped by the Melbourne 2030 Plan. Key aspects of the Melbourne 2030 Plan drawing on the Victoria Government's own description of the Plan are set out in the box that follows. The baseline projections are broadly consistent with the achievement of the Melbourne 2030 Plan.

## Planning Melbourne

### Melbourne 2030

Released in 2002, Melbourne 2030 provides a long-term plan for Melbourne and the surrounding region. A focus of the Melbourne 2030 Plan is to accommodate development – housing and employment – in selected parts of established areas to encourage more effective use of infrastructure for human services, public transport and water, power and communications. It directs growth to activity centres and the five designated growth areas (see the figure after this box), and identifies 12 green wedges. It also introduced the Urban Growth Boundary as a tool to manage the outward growth of metropolitan Melbourne.

### Better transport links

*Public transport*

At the time Melbourne 2030 was released, only 9 per cent of motorised trips within the metropolitan area were made on public transport. The Growing Victoria Together target is 20 per cent by 2020, to return public transport usage to the levels of the 1970s.

Major upgrades in public transport capability are planned, including expanded coverage and improvements in speed, reliability, ease of use, amenity and safety. A principal public transport network will be established by building on existing train and tram services, and creating new cross-town bus services, between principal and major activity centres in metropolitan Melbourne. Local public transport services will be improved, particularly bus services, and a key focus will be improved services in middle and outer metropolitan areas. Attention will also be paid to impending capacity constraints in the inner area.

Integrated land-use and transport strategies will complement the upgrades so that additional development can be accommodated in areas that are highly accessible to the public transport system and to the principal public transport network.

*Road use*

Melbourne 2030 will continue to support investment in the road system to meet freight and personal mobility needs. Car use will still be important and often essential, but past and current rates of growth in private vehicle use are not sustainable.

Priority for future road investments will be given to:

- completing the Scoresby Integrated Transport Corridor and links to regional Victoria;
- reducing the backlog in providing arterial roads in outer suburbs;
- making safety improvements;
- resolving conflicts between cars, cyclists and pedestrians;
- making on-road public transport operate more efficiently; and
- making road freight operate more efficiently and with lower external impacts.

Melbourne 2030 recognises that road system management, rather than major road building, is a key issue for the future. The government foreshadows its intent to make the most of substantial investment in the road system and recognise the needs of all categories of road users.

(continued over)

**Planning Melbourne (Continued)**

*Walking and cycling*

Active modes of travel such as walking and cycling have the potential to reduce the growth in all forms of motorised travel and to improve public health. Melbourne 2030 recognises the importance of providing safe, attractive and continuous pedestrian and cycling routes and facilities, on and off-road, as an integral part of new and existing urban development. The Principal Bicycle Network will be completed.

*Freight*

By 2010, the Victorian Government intends that rail will carry 30 per cent of all freight to and from Victoria's ports – double the rate at the time the Plan was released. However, even with rail playing a larger role, road freight is expected to increase in volume. Melbourne 2030 will protect and invest in the long-term potential of the ports. It will also recognise the need to improve road links serving the ports and key industry areas (including the Scoresby Corridor) within Melbourne, completing road links of freeway standard to regional cities and progressively upgrading other key road and rail links from regional Victoria to the ports. Land with good road and rail access will be protected for longer-term industrial development needs.

**Melbourne @ 5 million**

An update of Melbourne 2030, *Melbourne @ 5 million* was released in December 2008. This was shaped by data from the ABS that showed that Melbourne's population was growing faster than previously thought and current projects would mean that Melbourne would reach 5 million people much sooner than expected. In particular an additional 600,000 dwellings would need to be accommodated in the next 20 years.

The key elements of Melbourne @ 5 million are summarised below.

A more compact city through:

- designation of six new central activities districts with CBD-like functions;
- employment corridors to improve accessibility to jobs and services and reduce congestion on the transport network;
- established areas to accommodate 53 per cent of new dwellings.

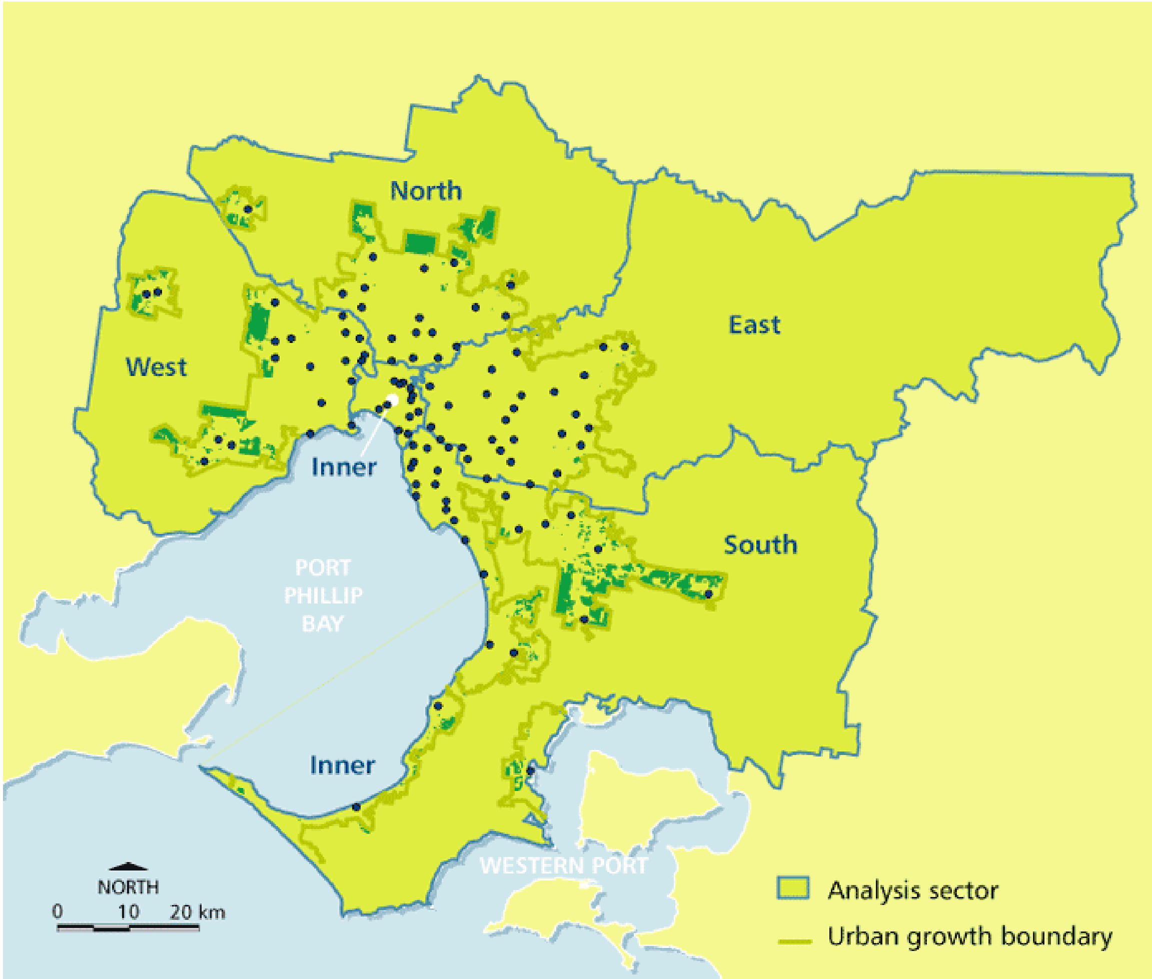
Better management of growth through:

- growth areas to accommodate 47 per cent of new dwellings;
- investigation areas in the north and west, with a small proportion in the south east, for potential extensions to the growth areas;
- more efficient use of greenfield land with a target of 15 dwellings per hectare;
- amendment to the operation of the growth areas infrastructure contribution and the removal of the requirement for the contribution from land included in the Urban Growth Boundary prior to 2005; and
- consideration of the unique green wedge values in the investigation of changes to the Urban Growth Boundary.

Melbourne @ 5 million provides complementary policy initiatives to the directions of Melbourne 2030 and the two documents should be considered together.

Source: http://www.dse.vic.gov.au/melbourne2030online/content/strategic_framework/03a_compact.html.

## Melbourne 2030 New Residential Development Location Plan




**WEST**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 55 | 46 | 60,000 |
| • | 15 | 31 | 40,000 |
| Dispersed | 30 | 23 | 30,000 |
| Totals | 100 | 100 | 130,000 |

Brimbank, Hobsons Bay, Maribyrnong, Melton, Moonee Valley, Wyndham

**NORTH**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 50 | 45 | 50,000 |
| • | 20 | 32 | 35,000 |
| Dispersed | 30 | 23 | 25,000 |
| Totals | 100 | 100 | 110,000 |

Banyule, Darebin, Hume, Moreland, Nillumbik, Whittlesea

**EAST**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 15 | 5 | 5,000 |
| • | 20 | 50 | 55,000 |
| Dispersed | 65 | 45 | 50,000 |
| Totals | 100 | 100 | 110,000 |

Boroondara, Manningham, Knox, Maroondah, Monash, Whitehorse, Yarra Ranges, Stonnington (part)

**SOUTH**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 60 | 44 | 80,000 |
| • | 10 | 25 | 45,000 |
| Dispersed | 30 | 31 | 55,000 |
| Totals | 100 | 100 | 180,000 |

Bayside, Cardinia, Casey, Frankston, Glen Eira, Greater Dandenong, Kingston, Mornington Peninsula

**INNER**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 0 | 0 | 0 |
| • | 70 | 89 | 80,000 |
| Dispersed | 30 | 11 | 10,000 |
| Totals | 100 | 100 | 90,000 |

Melbourne, Port Phillip, Stonnington (part), Yarra

**METROPOLITAN TOTAL**

| | Average annual dwelling starts 1996–97 2000–01 % | Proposed household distribution 2001–30 % | No. |
|---|---|---|---|
| Greenfield | 38 | 31 | 195,000 |
| • | 24 | 41 | 255,000 |
| Dispersed | 38 | 28 | 170,000 |
| Totals | 100 | 100 | 620,000 |

- Greenfield development
- • Strategic redevelopment sites (Principal and Major Activity Centres only depicted)
- Dispersed urban and non-urban development

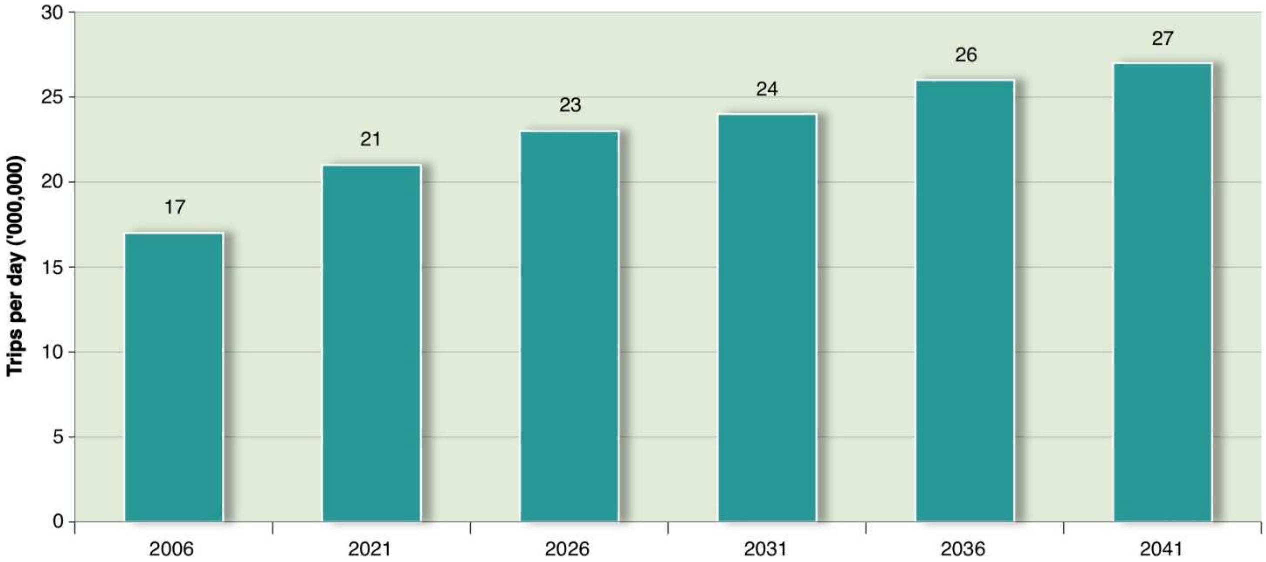
NOTE. Non-urban development is generally located in and around small townships. It currently accounts for 3 per cent of development and is proposed to account for 1.5 per cent of all additional households by 2030. This equates to 9,500 households.

Source: http://www.dse.vic.gov.au/melbourne2030online/content/popups/fig_17.html

## Greater Melbourne Baseline Analysis Results

VLC's Zenith model shows that transport demand in Greater Melbourne is projected to grow significantly. In a typical day in 2006, residents in Greater Melbourne are reported to have made around 17 million trips, with almost 13 million of these trips made by car. On a daily basis, around 79 per cent of people travelled by car, 6 per cent by public transport and 15 per cent by walking or cycling. By 2041, the number of trips is expected to reach around 27 million trips per day (see chart below).

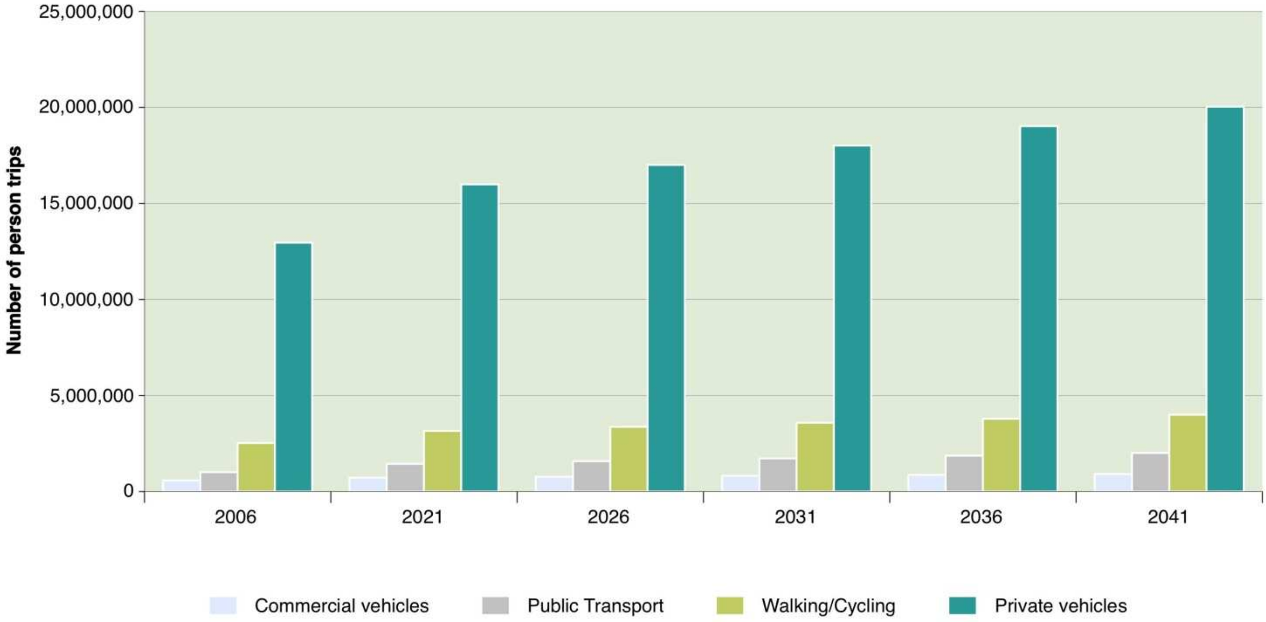
### Trips Per Day, Greater Melbourne (2006-2041)




Source: VLC Zenith Travel Forecasting Model.

While the number of trips per person in Greater Melbourne is projected to remain relatively constant, the total number of trips is expected to increase significantly due to population growth, which will be evenly spread across all transport modes. Indeed, as show in the chart that follows, from 2006 to 2041 the number of passenger trips in public transport will almost double, while the person trips by car are projected to increase by 55 per cent.

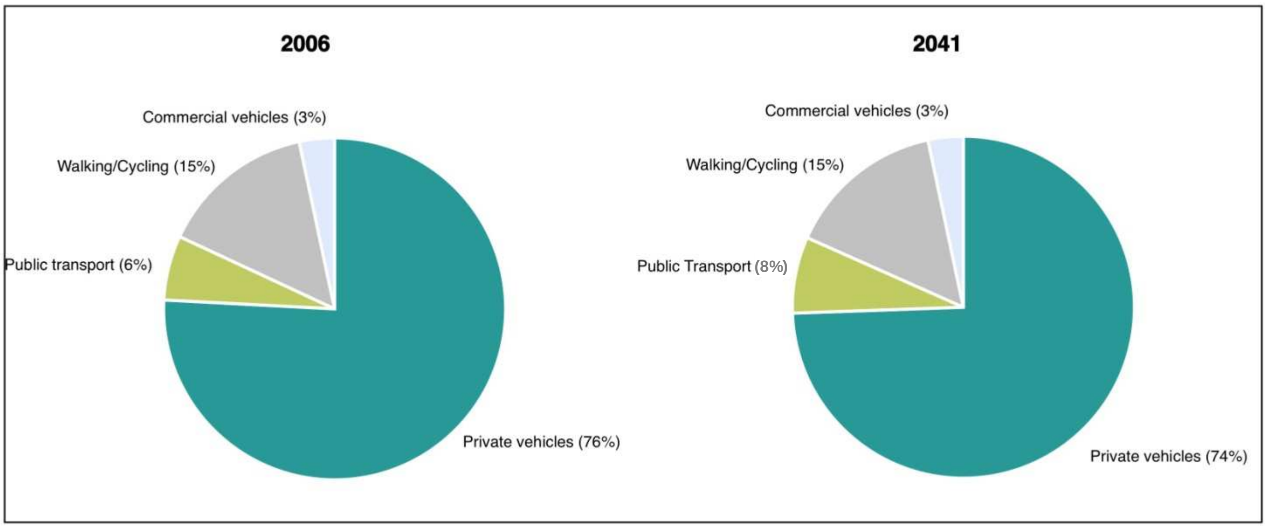
#### Number of Person Trips by Transport Mode from 2006 to 2041, Greater Melbourne




Source: VLC Zenith Travel Forecasting Model.

Despite the large increase in the number of trips taken using public transport and despite an increase in the numbers who choose to walk or cycle, it is interesting to note that the mix of transport modes is forecast to remain largely unchanged (see chart below). That is, under the baseline scenario, people are not expected to fundamentally change the way they travel. Private motor vehicles are expected to account for around three-quarters of trips made.

#### Share of Transport Mode in 2006 and 2041, Greater Melbourne




Source: VLC Zenith Travel Forecasting Model.

The analysis shows that transport outcomes for people are likely to deteriorate in time under the baseline scenario. Indeed, while the number of trips per person is projected to remain constant at 3.4 trips per day, people in Greater Melbourne will spend more time travelling per day and will travel longer distances. Compared to 2006 levels, time spent travelling is expected to increase by 23 per cent in 2041. This will mean that an average resident of this urban centre will travel around 13 minutes more every day in 2041 than in 2006. Further, on average, people living in the region are projected to travel around 5 kilometres more per day (see table that follows).

### Estimated Travel Time and Distance, Greater Melbourne

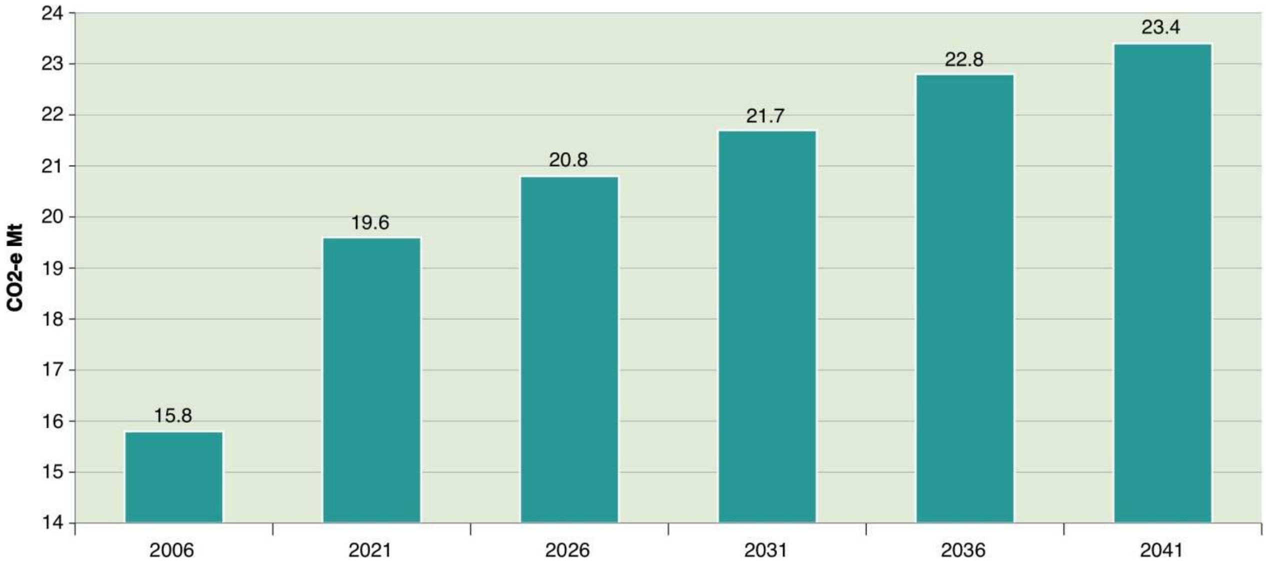
| | 2006 | 2021 | 2026 | 2031 | 2036 | 2041 |
|---|---|---|---|---|---|---|
| Time spent travelling (minutes per person per day) | 55 | 62 | 64 | 65 | 67 | 68 |
| Kilometres travelled (per person per day) | 43.0 | 45.6 | 46.3 | 46.9 | 47.4 | 47.9 |

Source: VLC Zenith Travel Forecasting Model.

Transport within Greater Melbourne is also forecast to be slower. Indeed, average trip speed (kilometres per hour) is projected to steadily decrease over the forecast period from a weighted average for private and commercial vehicles of 49 kilometres per hour in 2006, to approximately 44 kilometres per hour in 2041 (equivalent to a decrease in speed of approximately 11 per cent). The slower average speed in the region is an indicator of increased congestion of the transport system in this urban centre.

Given the projected increase in the amount of travel in Greater Melbourne and reduction in transport efficiency it should be unsurprising to see higher transport GHG emissions. Baseline emission estimates in the chart below show that GHG emissions are projected to rise from 15.8 Mt per annum of $CO_2$-e, to around 23.5 Mt per annum in 2041. This represents an increase of approximately 48 per cent from 2006 to 2041, with a compound annual growth rate of 1.1 per cent.

### Transport GHG emissions (total $CO_2$-e Mt pa), Greater Melbourne, 2006-2041




Source: VLC. NB: the graph reflects the 'trend' scenario, which relates to certain assumptions of policy, technology and behaviour which are considered most appropriate for a baseline forecast.

The increase in GHG emissions reported above are projections based largely on 'business-as-usual' assumptions about the future. A key aspect about the future that is not included in a 'business-as-usual' scenario is the advent of major policy interventions to combat GHG emissions, such as the CPRS. If the CPRS was applied to transport fuels, it is likely that it would change the cost of transport and stimulate further changes in the use of transport and subsequent transport GHG emissions.[4]

### Greater Melbourne Baseline Summary

The baseline projections suggest that without significant change or policy intervention Greater Melbourne will become more transport intensive and less transport efficient. Indeed, while in 2006 people living in the region travelled a total of 182 million of kilometres per day,[5] this figure is expected to increase by almost 80 per cent in 2041 (see table below). Further, people will not only travel more in the future, but they will travel more inefficiently as the time spent travelling in the region grows more than proportionally to population and employment (total time spent travelling in the region is projected to increase by 99 per cent from 2006 to 2041. This is in contrast to an increase in population and employment of 61 and 63 per cent, respectively).

This also adds up to less sustainable transport outcomes. In addition to the higher social and economic costs of transport in Greater Melbourne, it is expected that environmental outcomes will deteriorate significantly. Transport GHG emissions will increase broadly in line with population and economic growth. This increase is projected to occur even after taking into account the increasing efficiency of vehicles (including the use of more hybrid vehicles), higher oil prices, and the significant efforts of wide ranging planning interventions intended to raise sustainability by making Melbourne a more compact city and improving transport infrastructure, especially public transport services.

## Greater Melbourne Baseline Projection, Key Indicators

| | Units | 2006 | 2041 | % Change |
|---|---|---|---|---|
| *Reference indicators* | | | | |
| Population | Million | 4.2 | 6.8 | 61% |
| Employment | Million | 2.0 | 3.2 | 63% |
| *Transport indicators* | | | | |
| Passenger kilometres per day | '000 000 kms | 181.7 | 325.9 | 79% |
| Time spent travelling per day (total in the region) | Million hours | 3.9 | 7.7 | 99% |
| Average trip speed | | | | |
| Private vehicles | Kms per hr | 48.0 | 42.9 | -11% |
| Commercial vehicles | Kms per hr | 57.3 | 50.2 | -12% |
| Transport GHG emissions (total $CO_2$-e, pa) | Megatonnes | 15.8 | 23.4 | 48% |
| *Transport indicators – per person* | | | | |
| Time spent travelling (per person per day) | Minutes | 54.9 | 67.8 | 23% |
| Kilometres travelled (per person per day) | Kms | 43.0 | 47.9 | 11% |

Source: VLC, VLC Zenith Travel Forecasting Model.

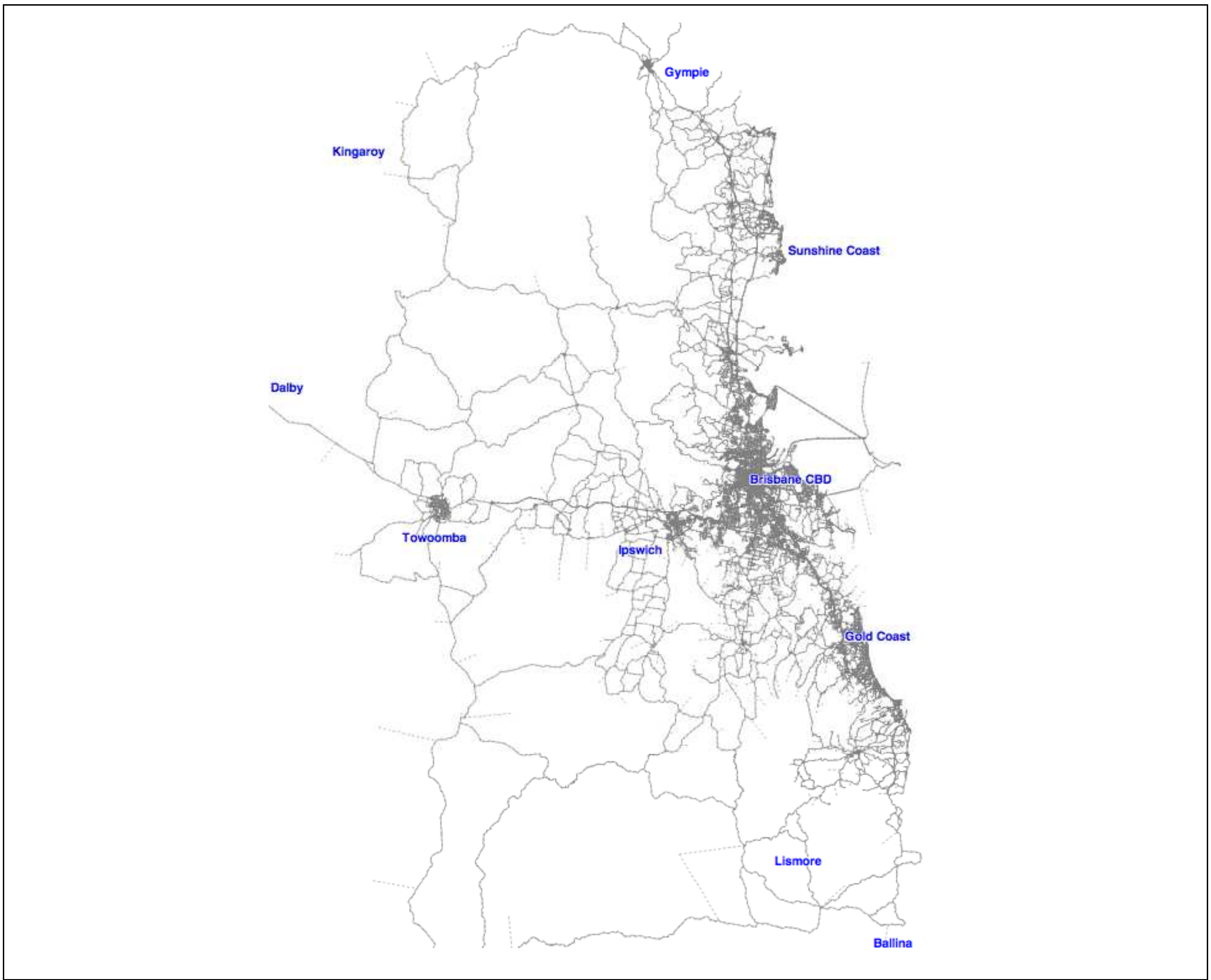
[4] This estimate of BAU transport emissions is provided as a 'baseline' to assist in the consideration of the difference that changed land use and transport infrastructure provision could make to urban transport emissions. It reports an estimate of what may happen without further policy change. Other policy changes may well have a profound effect on urban transport GHG emissions.

[5] This figure includes public transport in suburban and regional trains, tram and bus and transport in private and commercial vehicles.

## SOUTH EAST QUEENSLAND

The South East Queensland (SEQ) region includes Brisbane CBD, Gold Coast, Sunshine Coast, Ipswich, Toowoomba, Gympie, Kingaroy, Dalby, Lismore and Ballina (see map below). [6]

### South East Queensland Region




Source: VLC Zenith Travel Forecasting Model.

### The planning and transport context

The baseline projections for the SEQ region reflect the profound changes that are expected to occur in one of Australia's most dynamic regions. The analysis reflects many forecasts of continued rapid growth in economic activity and the resident population. The Queensland Government seeks to manage and direct growth and this activity is manifest in the South East Queensland Regional Plan and other planning instruments. These influences are taken into account in the Zenith model when preparing baseline projections. Details about the SEQ Regional Plan are set out in the box that follows.

[6] Further details about the Statistical Local Government areas contained within the South East Queensland region are presented in Appendix A.

### South East Queensland Regional Plan 2009–2031

The South East Queensland Regional Plan 2009–2031 is the Queensland Government's plan to manage growth and protect the region's lifestyle and environment. It was released in July 2009 and revised the previous 2005-2026 plan. The plan responds to issues such as continued high population growth, traffic congestion, koala protection, climate change and employment generation. The Plan balances population growth with the need to protect the lifestyle that residents of South East Queensland value and enjoy.

Under the Plan, the population of SEQ is expected to increase from 2.8 million in 2006 to 4.4 million in 2031. The Plan accommodates or contains growth within the planned urban footprint. A guiding principle is to promote liveability and transport efficiency and reduce car dependence and private vehicle travel, locate urban development in the urban footprint either within or near existing communities to utilise their infrastructure and services, or within existing activity centres and at key locations along planned public transportation infrastructure.

Taking into account land required for residential, employment and other purposes, as well as physical constraints, the SEQ Regional Plan provides sufficient land to accommodate an additional 754,000 dwellings expected to be required to 2031. The historically low density settlement in the region provides significant opportunities for infill development. In addition, large areas of remnant broadhectare lands are suitable for further development. Through the effective use of infill, remnant broadhectare and broadhectare lands, the urban footprint can accommodate projected growth to 2031.

To promote more compact development within the urban footprint, the SEQ Regional Plan:

- sets targets by local government area to contribute to an increase in the proportion of additional dwellings constructed through new development or redevelopment in existing urban areas to 50 per cent by 2031 (see table in the next page);
- requires new residential developments in development areas to achieve a minimum net dwelling yield of 15 dwellings per hectare (with the potential for higher densities as appropriate through the planning process). This will help to provide a mix of dwelling types to match the community's changing needs, household sizes and structures; and
- requires higher density residential development to be focused within and around regional activity centres, and public transport nodes and corridors. This will improve access to existing and planned facilities and services, restricts further land allocation for rural residential development and promotes a more sustainable use of existing rural residential areas.

**South East Queensland Regional Plan 2009–2031 (continued)**
**Dwellings by Local Government Area**

| | **2006 existing** (dwellings) | **Total additional** (dwellings) | **Infill and redevelopment** (minimum) (dwellings) | **Balance areas** (dwellings) | **Infill and redevelopment share** (%) |
|---|---|---|---|---|---|
| Brisbane | 397,007 | 156,000 | 138,000 | 18,000 | 88 |
| Gold Coast | 202,588 | 143,000 | 97,000 | 46,000 | 68 |
| Ipswich | 52,357 | 118,000 | 18,000 | 100,000 | 15 |
| Lockyer Valley | 11,554 | 11,500 | 0 | 11,500 | 0 |
| Logan | 90,179 | 70,000 | 28,000 | 42,000 | 40 |
| Moreton Bay | 123,900 | 84,000 | 35,000 | 49,000 | 42 |
| Redland | 49,779 | 21,000 | 15,000 | 6,000 | 71 |
| Scenic Rim | 13,652 | 15,000 | 2,000 | 13,000 | 13 |
| Somerset | 7,818 | 6,500 | 0 | 6,500 | 0 |
| Sunshine Coast | 130,016 | 98,000 | 37,000 | 61,000 | 38 |
| Toowoomba SSD | 45,538 | 31,000 | 4,000 | 27,000 | 13 |
| Total | 1,124,388 | 754,000 | 374,000 | 380,000 | 50 |

Source: SEQ Regional Plan 2009–2031

The South East Queensland Infrastructure Plan and Program (SEQIPP) outlines the priorities to support the SEQ Regional Plan. It establishes priorities for regionally significant infrastructure within a 20-year planning timeframe. The 2009 edition of the plan identifies $124 billion in estimated infrastructure investment (inclusive of federal government contributions and other revenue sources). Transport investment absorbs the largest part of the planned investment.

## SEQIPP Planned Investment

| | $ million |
|---|---|
| Transport (including investigations) | 94,624 |
| Industry development | 136 |
| Water | 4,559 |
| Energy | 3,312 |
| Health | 5,804 |
| Education and training | 2,901 |
| Community services | 3,570 |
| Sport and recreation | 184 |
| Completed projects (2004-05 to 2008-09) | 9,128 |
| Total | 124,218 |

Source: http://www.dip.qld.gov.au/index.php?option=com_content&task=view&id=247&Itemid=337.

Four years into the SEQIPP, 87 projects are complete, another 173 projects are underway and $16.4 billion has been invested.

The SEQ region is expected to experience the higher population and employment growth of the two regions studied in this report. Indeed, as reported in the table below, VLC projections have found that the resident population of the SEQ region will increase by approximately 81 per cent by 2041 (compared to 2006 levels). This means that by 2041, 5.5 million people will live in this region.[7]

Employment in South East Queensland will grow more than proportionately to the population in the region. Indeed, the estimates in the Zenith Travel Forecasting Model reflect government workforce projecting, and show that employment will more than double as the region will employ 1.5 million more people in 2041 than in 2006.

**Estimated Population and Employment in South East Queensland**

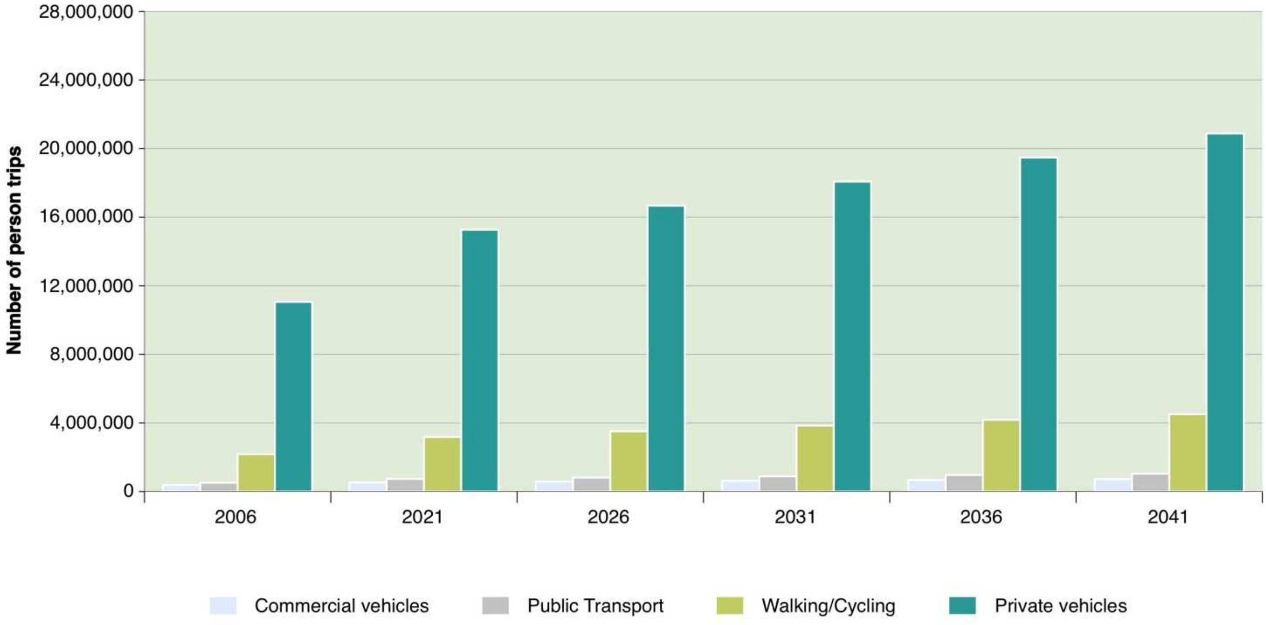
| | 2006 | 2021 | 2026 | 2031 | 2036 | 2041 |
|---|---|---|---|---|---|---|
| Population (million) | 3.0 | 4.1 | 4.4 | 4.8 | 5.1 | 5.5 |
| Employment (million) | 1.4 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 |

Source: VLC Zenith Travel Forecasting Model.

## SEQ Baseline Projections

Estimates from the Zenith model show that the amount of trips in the region will almost double by 2041, increasing from 14 million in 2006 to around 27 million in 2041. The total number of trips is expected to increase significantly in all transport modes. As shown in the chart below, from 2006 to 2041, the number of passenger trips in public transport will increase by 103 per cent, while the person trips by private car are projected to increase by 89 per cent.

**Number of Person Trips by Transport Mode from 2006 to 2041, South East Queensland**




Source: VLC Zenith Travel Forecasting Model

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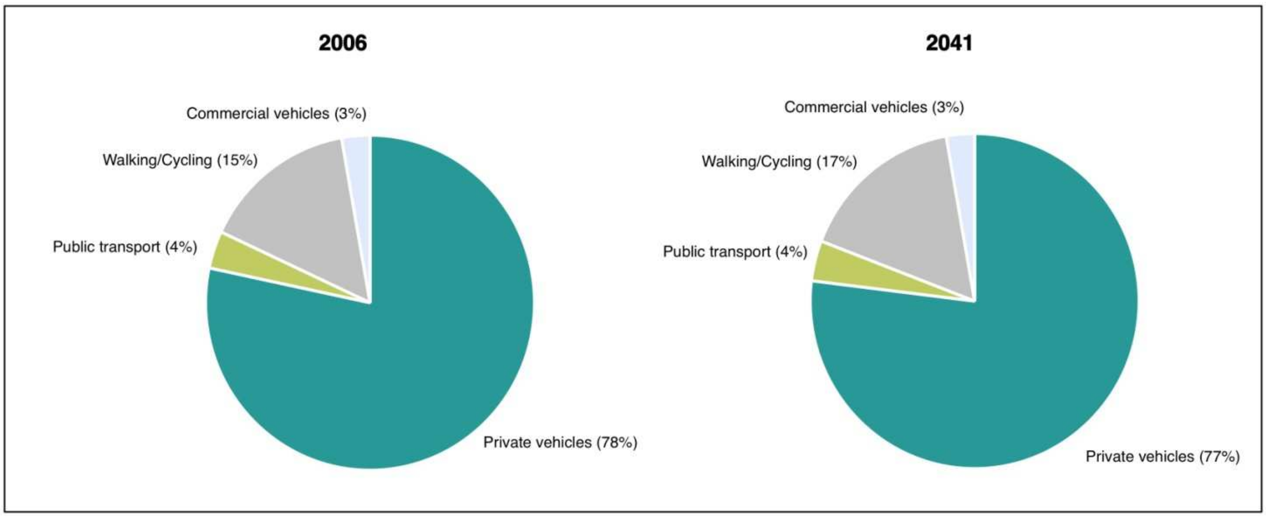
[7] Queensland Government official projections currently project a population for SEQ of 4.4 million in 2031 (Queensland's Future Populations 2008) in the medium series projection. The projection used in the Zenith Model for SEQ rises to 4.8 million in 2031. The variation reflects additional information used in the Zenith Model projections and lags in being able to revise a detailed spatial model where it is necessary to form a view about where people can be expected to live, what kind of job they can expect and where it is, as well as where various social services such as schools and retail will be located to service the population.

Despite this increase, it is interesting to note that the mix of transport modes is forecast to remain almost constant during the projection period (see chart that follows). That is, under the baseline scenario, people are not expected to fundamentally change the way they travel.

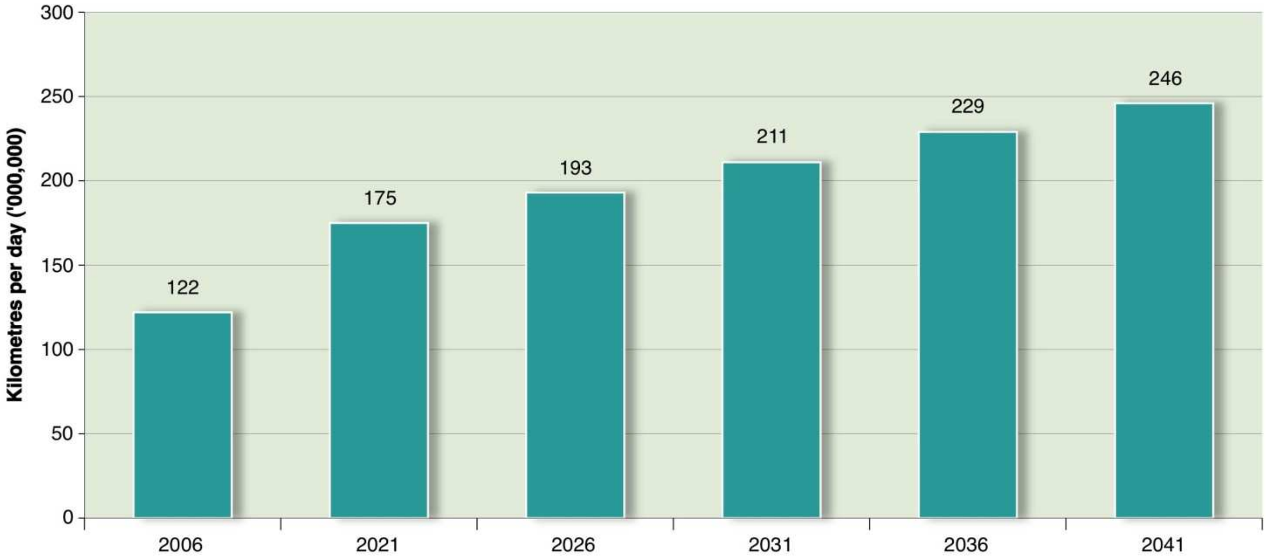
**Share of Transport Mode in 2006 and 2041, South East Queensland**




Source: VLC Zenith Travel Forecasting Model.

The South East Queensland region is forecast to become more transport intensive. As show in the chart below, the total passenger kilometres travelled in this region will more than double by 2041 (in comparison to a 79 per cent increase in Greater Melbourne over the same period). People living in the region are projected to require more transport to get to work, school, university, or to go to the shops, visit friends and family or any or undertake many of the other journeys needed in life.

**Total Passenger Kilometres Travelled, South East Queensland (2006-2041)**




Source: VLC Zenith Travel Forecasting Model.

A further indicator of increasing transport intensity in SEQ is that the amount of distance that people are on average expected to travel each day will increase in the baseline projection.

Transport outcomes for people living in the region are projected to deteriorate in the future. Indeed, in contrast to Greater Melbourne where the trips per person are expected to remain constant (albeit longer and slower), the number of trips in South East Queensland is forecast to increase from 3.9 per capita per day in 2006 to 4.1 in 2041 (equivalent to a 5 per cent increase). Additionally, these trips will take longer and people will travel longer distances. As shown in the table below, compared to 2006 levels, an average South East Queenslander will spend 14 minutes more per day in transportation and will travel almost 5 kilometres more.

### Estimated Travel Time and Distance, South East Queensland

| | 2006 | 2021 | 2026 | 2031 | 2036 | 2041 |
|---|---|---|---|---|---|---|
| Time spent travelling (minutes per person per day) | 51 | 59 | 61 | 63 | 64 | 65 |
| Kilometres travelled (per person per day) | 40.4 | 43.0 | 43.6 | 44.1 | 44.6 | 45.0 |

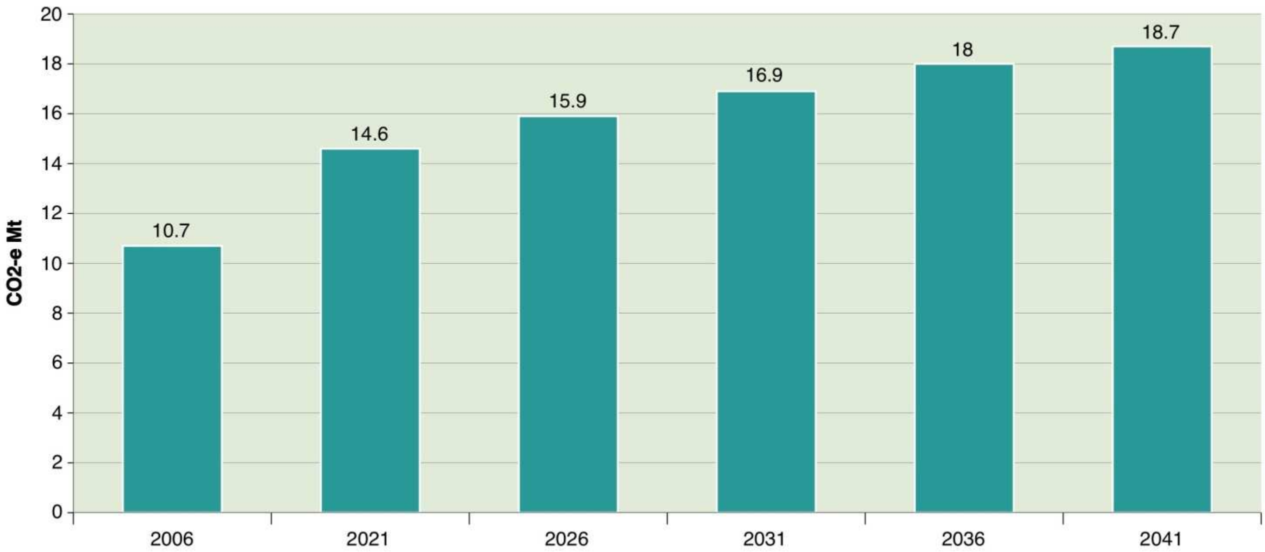
Source: VLC Zenith Travel Forecasting Model.

The transport and land use systems system in SEQ will be significantly less efficient by 2041. In 2041, South East Queenslanders will spend 3.3 million hours more travelling than they spent in 2006. This 130 per cent increase in travelling time is greater than population and employment growth (81 and 107 per cent, respectively).

Transport in this region will be significantly slower in the future than in 2006. The Zenith Model projects that average speed for private vehicles will be reduced by around 13 per cent (from 48 kilometres per hour in 2006 to 41 kilometres per hour in 2041), while kilometres per hour for commercial vehicles will be lower by approximately 10 per cent (taking the average speed of these vehicles from 56 kilometres per hour in 2006 to 51 in 2041). This is an indication of increased congestion of the transport system in this region.

More travel, longer distances and greater congestion will contribute towards significant growth in transport GHG emissions in the region. Indeed, as shown in the chart below, it is estimated that GHG emissions for the South East Queensland region will increase from approximately 11 Mt per annum in 2006, to around 19 Mt per annum in 2041 (an increase of 75 per cent). In contrast, GHG emissions in Greater Melbourne are forecast to grow by approximately 48 per cent during the same period.

### Transport GHG emissions (total $CO_2$-e Mt pa), South East Queensland, 2006-2041




Source: VLC. NB: the graph reflects the 'trend' scenario, which relates to certain assumptions of policy, technology and behaviour which are considered most appropriate for a baseline forecast.

## South East Queensland Baseline Summary

Notwithstanding extensive and detailed long term planning that is currently pursuing 'smart' or contained growth within the urban footprint, together with extensive infrastructure investment, especially in the transport area, the South East Queensland region is expected to become more transport intensive and less transport efficient. The Zenith model baseline projection suggests that the impressive growth that is expected to occur in the SEQ region will be accommodated through substantial reliance on transport. There will be more people and jobs than many other regions in Australia, but the distance that is expected to remain between where people live, where their jobs are and where services are provided has to be filled by transport, especially the private car.

The sustainability of the transport outcomes for SEQ is an open question. At a personal level, people on average will spend 65 minutes per day travelling by 2041, compared to 51 minutes in 2006. This is relatively high and would push the region onto an equal footing with cities that are widely viewed as having long commuting times. A key indication of a deterioration in sustainability is the projection of a 75 per cent increase on current transport GHG emissions by 2041, with an estimate of around 19 million tonnes emitted in that year.

Key indicators of change in SEQ over the baseline projection period are provided in the table below.

### South East Queensland Key Indicators

| | Units | 2006 | 2041 | Change |
|---|---|---|---|---|
| *Reference indicators* | | | | |
| Population | Million | 3.0 | 5.5 | 81% |
| Employment | Million | 1.4 | 2.9 | 107% |
| *Transport indicators* | | | | |
| Passenger kilometres per day | '000 000 kms | 122.4 | 246.3 | 101% |
| Time spent travelling per day (total in the region) | Million hours | 2.6 | 5.9 | 129% |
| Average trip speed | | | | |
| Private vehicles | Kms per hr | 47.5 | 41.3 | -13% |
| Commercial vehicles | Kms per hr | 55.9 | 50.6 | -10% |
| Transport GHG emissions (total $CO_2$-e, pa) | Megatonnes | 10.7 | 18.7 | 75% |
| *Transport indicators – per person* | | | | |
| Time spent travelling (per person per day) | Minutes | 51.4 | 65.0 | 26% |
| Kilometres travelled (per person per day) | Kms | 40.4 | 45.0 | 11% |

Source: VLC, VLC Zenith Travel Forecasting Model.

## URBAN AUSTRALIA

A goal of the analysis is to gain an initial insight into the likely land transport GHG emissions from the total metropolitan area of Australia. At this stage of the study the approach is to interpolate the 'bottom-up' analysis findings from two specific urban areas to the rest of urban Australia.

The approach taken is to apply the bottom-up findings to other major urban areas and then to add the estimates to form an urban Australia estimate. Estimated GHG emissions per capita are calculated from the baseline estimates and the weighted average result is applied to population forecasts for other urban areas of Australia. This approach:

- is likely to be reasonable for long run estimates of car transport GHG emissions — the BTRE notes that after about 2020 it is likely that main influence upon car use will be population growth;
- possibly understates GHG emissions from freight and commercial vehicles which are expected to be driven largely by changes in activity (ie GDP) which grows faster that population growth; and
- will not capture all urban transport GHG emissions as there are some geographical areas for which there are no official sources of long-term demographic projections available.

Clearly, given the above factors, the findings of the approach should be viewed as being illustrative. It is expected that in further stages of the study that more urban areas will be studied directly, therefore enabling a more reliable urban Australia estimate.

Estimates of the population in Australia's major urban areas are provided in the table below. From this it seems that the urban population is expected to grow from 15.4 million in 2006 to 24.2 million in 2041. It is particularly interesting that urban Australians already account for 74 per cent of the total population by this estimate, and that this share is expected to continue to grow to 77 per cent by 2041. Australia is projected to continue to become more urbanised.

### Estimated Urban Population (millions)

| | 2006 | 2041 | % Change |
|---|---|---|---|
| Sydney (SD) (a) | 4.10 | 5.70 | 39% |
| Greater Melbourne (a) | 4.20 | 6.80 | 62% |
| SEQ (a) | 3.00 | 5.50 | 83% |
| Adelaide (b) | 1.15 | 1.53 | 34% |
| Perth (b) | 1.52 | 2.82 | 86% |
| Greater Hobart | 0.21 | 0.27 | 29% |
| Darwin | 0.11 | 0.20 | 77% |
| ACT | 0.33 | 0.47 | 39% |
| Newcastle (SSD) (c) | 0.51 | 0.61 | 19% |
| Wollongong (SSD) (c) | 0.28 | 0.34 | 22% |
| Metro | 15.41 | 24.24 | 57% |
| Australia (b) | 20.70 | 31.60 | 53% |
| Urban Share | 0.74 | 0.77 | 3% |

a) VLC Zenith Travel Forecasting Model

b) ABS 2008

c) Macintosh and Parr, 2004, with ACG estimates for 2041 based on state wide average growth rate.

Land transport GHG emissions from within urban Australia are projected to rise substantially under the baseline scenario. Without additional policy interventions these GHG emissions are projected to rise from an estimated 41 $CO_2$-e Mt pa in 2006 to 60 $CO_2$-e Mt in 2041. This projected 46 per cent increase draws on the baseline scenarios of major urban areas where already significant planning and land use interventions are underway to promote compact cities.

**Estimated Urban Land Transport GHG Emissions (total $CO_2$-e Mt pa)**

| | 2006 | 2041 | % Change |
|---|---|---|---|
| Sydney (SD) (a) | 13.80 | 16.90 | 22% |
| Greater Melbourne (a) | 15.80 | 23.40 | 48% |
| SEQ (a) | 10.70 | 18.70 | 75% |
| Adelaide (b) | 4.09 | 5.02 | 23% |
| Perth (b) | 5.42 | 9.25 | 71% |
| Greater Hobart | 0.73 | 0.87 | 19% |
| Darwin | 0.41 | 0.66 | 63% |
| ACT | 1.19 | 1.53 | 28% |
| Newcastle (SSD) (c) | 1.83 | 2.00 | 9% |
| Wollongong (SSD) (c) | 1.00 | 1.12 | 12% |
| Metro Australia | 54.96 | 79.45 | 45% |

Source: ACG estimates. NB: the graph reflects the 'trend' scenario, which relates to certain assumptions of policy, technology and behaviour which are considered most appropriate for a baseline forecast.

## BASELINE PROJECTIONS KEY POINTS

VLC's Zenith model used a bottom-up approach to estimate the baseline outlook for two major urban centres in Australia (Greater Melbourne and South East Queensland). This analysis compares cities today with how they are expected to perform into the future (2041) across a number of dimensions, including transport and GHG emissions. The key points of the baseline projections are as follows.

- Key findings for the two regions studied are as follows:
  - **South East Queensland:** is projected to experience the higher growth in population, employment and transport demand of the two regions studied in this report. The total number of passenger kilometres travelled per day in this region will more than double by 2041 (compared to 2006 levels), reaching 246 million kilometres per day in 2041. People living in this region are expected to spent 26 per cent more time travelling per day by 2041 (compared to 2006), and travel on average around 5 kilometres more per day. These outcomes will see transport GHG emissions of the region increase by 75 per cent by 2041.
  - **Greater Melbourne:** the total time spent travelling in the region will grow more than proportionally to population and employment, with total time spent travelling projected to increase by 99 per cent from 2006 to 2041. This is in contrast to an increase in the population and employment of 61 and 63 per cent, respectively. In line with higher transport demand and longer travelled distances, environmental outcomes in Greater Melbourne are expected to deteriorate significantly. Transport GHG emissions are projected to increase by 48 per cent from 2006 to 2041.
- **Urban centres will become transport intensive and less transport efficient:** VLC's Zenith model foreshadows that the urban centres studied will become more transport intensive and less transport efficient. Indeed, the total amount of passenger travel and time spent travelling in cities is forecast to grow more than proportionally to population and employment.
- **Transport is forecast to be slower within the studied cities:** Indeed, average trip speed (kilometres per hour) is projected to decrease in both regions by around 10 to 13 per cent between 2006 and 2041. The slowing of average trip speed is an indicator of increased congestion of the transport system.
- **Transport outcomes are likely to deteriorate:** The analysis shows that transport outcomes for people are also likely to deteriorate in time under the baseline scenario. Indeed, people in both cities are projected to spend more time travelling per day and to travel longer distances. South East Queensland and Greater Melbourne will see travel time per capita increase from 2006 by approximately 26 and 23 per cent respectively, to 2041. This is an indicator that transport systems are becoming less efficient.
- **Transport GHG emissions are projected to rise in the studied urban centres:** Emissions in South East Queensland are projected to have the largest increase, rising by 75 per cent between 2006 and 2041.

- **Land transport GHG emissions from within urban Australia are projected to rise substantially under the baseline scenario:** Without additional policy interventions, these emissions are projected to rise from an estimated 41 $CO_2$-e Mt pa in 2006 to 60 $CO_2$-e Mt in 2041. This 46 per cent projected increase draws on the baseline scenarios of major urban areas where already significant planning and land use interventions are underway to promote compact cities.
- **The need for mobility costs time and harms the environment:** Overall, the analysis shows that the need for mobility and its costs in terms of time and harmful impacts on the environment are projected to increase in both areas studied in the baseline analysis. These adverse changes are expected to outpace the growth in underlying population and represent a challenge for future transport networks.

# 6 DEVELOPING ALTERNATIVE FUTURES FOR CITIES

The previous chapters set the foundations of the study and illustrated the modelling methodology through the example of transport GHG emissions for Greater Melbourne and South East Queensland. The next stage of the study would be to design an alternative urban form that is more sustainable ecologically, socially and economically.

## BUILDING AN ALTERNATIVE URBAN FORM

Assessing alternative urban form in cities in Australia starts with the baseline projections for the expected performance of a city. From there, future stages of the study would consider changes in tangible attributes including:

- **Residential land use:** essentially allocating where people live in the city and changing the density of the city;
- **Economic land use:** changing where people are expected to work in terms of the location of manufacturing, commercial, wholesale, retail and other 'industrial' facilities; and
- **Supporting transport facilities:** altering the availability of major facilities such as public transport facilities, bus routes and roads.

The challenge, however, is in determining the preferred alternative form. The approach taken in this study is to seek the input of a range of key stakeholders involved with the design and governance of communities, conduct of commerce, protectors of the environment and community solidarity.

## SETTING STRATEGIC GUIDANCE

The study will obtain strategic planning guidance through workshops established to collectively define an alternative planning approach for selected cities. The workshops will not actually undertake the modelling for alternative urban forms. Instead, they will establish a framework providing strategic guidance that will be used by the technical study team. The key elements of guidance expected to be obtained are outlined in the sections below.

### A Vision for the City

Establishing the vision for the alternative city is crucial. What is needed is a short overall statement about what is wanted.

### Land Use Guidance

- Allocation rules about the spatial allocation of residential growth.
- Allocation of economic land (taking into account major economic activities such as manufacturing, retail, professional and business services, government administration and other 'industrial' activities).
- Approaches to mixed use area.
- Approaches to conservation/heritage/recreation.
- Approaches to food production and water security.

### Transport Guidance

- Expected passenger journey/destination density.
- Scope for public investment in roads, rail, bus, tram and other facilities.
- Accessibility targets for key public transport facilities.
- Service level and service quality expectations for public transport.
- Support for cycling and pedestrian access.

### Social and Community Approach

- Arrangements to promote housing affordability.
- Conservation land use.

### Environment

- Conservation land use.
- Green space access.

### Fiscal Approach

- Identify likely public costs.
- Assessment of likely public spending constraints.
- Identification of specific sources of public funds.
- Impacts upon private sector.

## ASSESSMENT IN THE NEXT STUDY STAGES

The next stages of the study involve applying the planning guidance obtained from experts and stakeholders and then constructing a virtual manifestation of this urban form. Expected urban outcomes will be measured.

The study will report results for each city specifically examined.

The study will also provide an estimate about what could be achieved throughout urban Australia if broadly similar changes were implemented everywhere. This will be achieved by adding the impacts of the cities specifically studied and extrapolating possible impacts to other cities based on factors such as expected population size.

A dimension of key concern in the study is the potential for changes in urban form to reduce GHG emissions. This would be reported for selected cities and for urban Australia at large. In addition, the study will estimate the economic effectiveness of urban form as a means of combating GHG emissions. This would be in traditional cost benefit terms, and also in simple dollars of public spending per tonne of GHG emissions that could be avoided.

Of course, sustainability is not merely about GHG emissions or economics. A range of factors need to be assessed. Many important factors will be reflected in the composite sustainability indicator that will be used in the study.

## CONCLUSION

Literature review findings, together with the Zenith Travel Forecasting Model projections, point to major infrastructure and environmental challenges in Australia's cities of the future. By 2041, growth in population, employment and transport demands will lead to significant increases in traffic congestion, time spent travelling and GHG emissions from transport vehicles.

As urban centres become more transport intensive, they will also become less transport efficient – and this will have a dramatic impact on the quality of life of Australia's urban citizens.

What's more, without additional policy interventions greenhouse gas emissions from land transport within urban Australia are projected to rise from an estimated 41 megatonnes per annum in 2006 to 60 megatonnes in 2041.

Overall, the analysis shows that both the need for mobility and its impacts upon the environment and quality of life are projected to increase in both areas studied in the baseline analysis. These adverse affects are expected to outpace the growth in underlying population and represent a challenge for future transport networks.

The research points to the need for decisive action to change the way people live, work and play in their cities – not to mention the morphology of the cities themselves.

The challenge is to recast our vision for Australia's cities and deliver sustainable, liveable places that service a diverse and growing population. While the model is still being debated, the principles of the sustainable city of the future are clear: well planned, built and operated places that are sensitive to their environment, meet the diverse needs of existing and future residents, and contribute to a high quality of life for all the people who live there.

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# 7 APPENDIX A: STATISTICAL LOCAL AREAS USED IN REGIONAL ANALYSIS

## GREATER MELBOURNE

| Statistical Local Area | SLA MAINCODE |
|---|---|
| Melbourne (C) - Inner | 205054601 |
| Melbourne (C) - S'bank-D'lands | 205054605 |
| Melbourne (C) - Remainder | 205054608 |
| Port Phillip (C) - St Kilda | 205055901 |
| Port Phillip (C) - West | 205055902 |
| Stonnington (C) - Prahran | 205056351 |
| Yarra (C) - North | 205057351 |
| Yarra (C) - Richmond | 205057352 |
| Brimbank (C) - Keilor | 205101181 |
| Brimbank (C) - Sunshine | 205101182 |
| Hobsons Bay (C) - Altona | 205103111 |
| Hobsons Bay (C) - Williamstown | 205103112 |
| Maribyrnong (C) | 205104330 |
| Moonee Valley (C) - Essendon | 205105063 |
| Moonee Valley (C) - West | 205105065 |
| Melton (S) - East | 205204651 |
| Melton (S) Bal | 205204654 |
| Wyndham (C) - North | 205207261 |
| Wyndham (C) - South | 205207264 |
| Wyndham (C) - West | 205207267 |
| Moreland (C) - Brunswick | 205255251 |
| Moreland (C) - Coburg | 205255252 |
| Moreland (C) - North | 205255253 |
| Banyule (C) - Heidelberg | 205300661 |
| Banyule (C) - North | 205300662 |
| Darebin (C) - Northcote | 205301891 |
| Darebin (C) - Preston | 205301892 |
| Hume (C) - Broadmeadows | 205353271 |
| Hume (C) - Craigieburn | 205353274 |
| Hume (C) - Sunbury | 205353275 |
| Nillumbik (S) - South | 205405713 |
| Nillumbik (S) - South-West | 205405715 |
| Nillumbik (S) Bal | 205405718 |
| Whittlesea (C) - North | 205407071 |
| Whittlesea (C) - South-East | 205407075 |
| Whittlesea (C) - South-West | 205407076 |
| Boroondara (C) - Camberwell N. | 205451111 |
| Boroondara (C) - Camberwell S. | 205451112 |
| Boroondara (C) - Hawthorn | 205451113 |
| Boroondara (C) - Kew | 205451114 |
| Manningham (C) - East | 205504211 |
| Manningham (C) - West | 205504214 |
| Monash (C) - South-West | 205504971 |
| Monash (C) - Waverley East | 205504974 |

| | |
|---|---|
| Monash (C) - Waverley West | 205504975 |
| Whitehorse (C) - Box Hill | 205506981 |
| Whitehorse (C) - Nunawading E. | 205506984 |
| Whitehorse (C) - Nunawading W. | 205506985 |
| Knox (C) - North-East | 205553672 |
| Knox (C) - North-West | 205553673 |
| Knox (C) - South | 205553674 |
| Maroondah (C) - Croydon | 205554411 |
| Maroondah (C) - Ringwood | 205554412 |
| Yarra Ranges (S) - Central | 205607451 |
| Yarra Ranges (S) - Dandenongs | 205607452 |
| Yarra Ranges (S) - Lilydale | 205607453 |
| Yarra Ranges (S) - North | 205607454 |
| Yarra Ranges (S) - Seville | 205607456 |
| Bayside (C) - Brighton | 205650911 |
| Bayside (C) - South | 205650912 |
| Glen Eira (C) - Caulfield | 205652311 |
| Glen Eira (C) - South | 205652314 |
| Kingston (C) - North | 205653431 |
| Kingston (C) - South | 205653434 |
| Stonnington (C) - Malvern | 205656352 |
| Gr. Dandenong (C) - Dandenong | 205752671 |
| Gr. Dandenong (C) Bal | 205752674 |
| Cardinia (S) - North | 205801452 |
| Cardinia (S) - Pakenham | 205801453 |
| Cardinia (S) - South | 205801454 |
| Casey (C) - Berwick | 205801612 |
| Casey (C) - Cranbourne | 205801613 |
| Casey (C) - Hallam | 205801616 |
| Casey (C) - South | 205801618 |
| Frankston (C) - East | 205852171 |
| Frankston (C) - West | 205852174 |
| Mornington P'sula (S) - East | 205905341 |
| Mornington P'sula (S) - South | 205905344 |
| Mornington P'sula (S) - West | 205905345 |
| Bellarine - Inner | 210052751 |
| Corio - Inner | 210052752 |
| Geelong | 210052753 |
| Geelong West | 210052754 |
| Newtown | 210052755 |
| South Barwon - Inner | 210052756 |
| Greater Geelong (C) - Pt B | 210102757 |
| Queenscliffe (B) | 210106080 |
| Surf Coast (S) - East | 210106493 |
| Surf Coast (S) - West | 210106495 |
| Golden Plains (S) - North-West | 210152491 |
| Golden Plains (S) - South-East | 210152492 |
| Greater Geelong (C) - Pt C | 210152758 |
| Ballarat (C) - Central | 220050571 |
| Ballarat (C) - Inner North | 220050572 |
| Ballarat (C) - North | 220050573 |

| | |
|---|---|
| Ballarat (C) - South | 220050574 |
| Hepburn (S) - East | 220102911 |
| Hepburn (S) - West | 220102912 |
| Moorabool (S) - Bacchus Marsh | 220105151 |
| Moorabool (S) - Ballan | 220105154 |
| Moorabool (S) - West | 220105155 |
| Gr. Bendigo (C) - Central | 235052621 |
| Gr. Bendigo (C) - Eaglehawk | 235052622 |
| Gr. Bendigo (C) - Inner East | 235052623 |
| Gr. Bendigo (C) - Inner North | 235052624 |
| Gr. Bendigo (C) - Inner West | 235052625 |
| Gr. Bendigo (C) - S'saye | 235052626 |
| Gr. Bendigo (C) - Pt B | 235102628 |
| Mount Alexander (S) - C'maine | 235105431 |
| Mount Alexander (S) Bal | 235105434 |
| Macedon Ranges (S) - Kyneton | 235204131 |
| Macedon Ranges (S) - Romsey | 235204134 |
| Macedon Ranges (S) Bal | 235204135 |
| Mitchell (S) - North | 240204851 |
| Mitchell (S) - South | 240204854 |
| Murrindindi (S) - East | 240205621 |
| Murrindindi (S) - West | 240205622 |
| Lake Mountain Alpine Resort | 240208149 |
| Baw Baw (S) - Pt B East | 255100834 |
| Baw Baw (S) - Pt B West | 255100835 |
| Yarra Ranges (S) - Pt B | 255107458 |
| Mount Baw Baw Alpine Resort | 255108209 |
| Bass Coast (S) - Phillip Is. | 255200741 |
| Bass Coast (S) Bal | 255200744 |
| South Gippsland (S) - Central | 255206171 |
| South Gippsland (S) - West | 255206175 |
| French Island | 255208529 |

## SOUTH EAST QUEENSLAND

| Statistical Local Area | SLA MAINCODE |
|---|---|
| City - Inner | 305011143 |
| City - Remainder | 305011146 |
| Dutton Park | 305011187 |
| Fortitude Valley | 305011227 |
| Herston | 305011274 |
| Highgate Hill | 305011277 |
| Kangaroo Point | 305011304 |
| Kelvin Grove | 305011315 |
| Milton | 305011378 |
| New Farm | 305011421 |
| Newstead | 305011427 |
| Paddington | 305011454 |
| Red Hill | 305011481 |
| South Brisbane | 305011525 |
| Spring Hill | 305011528 |
| West End | 305011607 |
| Woolloongabba | 305011631 |
| Albion | 305031004 |
| Alderley | 305031007 |
| Ascot | 305031026 |
| Ashgrove | 305031031 |
| Bardon | 305031048 |
| Chelmer | 305031132 |
| Clayfield | 305031151 |
| Corinda | 305031162 |
| Enoggera | 305031206 |
| Graceville | 305031241 |
| Grange | 305031244 |
| Hamilton | 305031255 |
| Hendra | 305031271 |
| Indooroopilly | 305031293 |
| Kedron | 305031312 |
| Lutwyche | 305031345 |
| Newmarket | 305031424 |
| Nundah | 305031446 |
| St Lucia | 305031506 |
| Sherwood | 305031522 |
| Stafford | 305031533 |
| Stafford Heights | 305031536 |
| Taringa | 305031558 |
| Toowong | 305031574 |
| Wilston | 305031618 |
| Windsor | 305031623 |
| Wooloowin | 305031634 |
| Anstead | 305071018 |
| Aspley | 305071034 |
| Bald Hills | 305071037 |
| Banyo | 305071045 |

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|---|---|
| Bellbowrie | 305071053 |
| Boondall | 305071064 |
| Bracken Ridge | 305071072 |
| Bridgeman Downs | 305071075 |
| Brighton | 305071078 |
| Brookfield (incl. Brisbane Forest Park) | 305071084 |
| Carseldine | 305071121 |
| Chapel Hill | 305071127 |
| Chermside | 305071135 |
| Chermside West | 305071138 |
| Darra-Sumner | 305071167 |
| Deagon | 305071173 |
| Doolandella-Forest Lake | 305071176 |
| Durack | 305071184 |
| Ellen Grove | 305071203 |
| Everton Park | 305071211 |
| Ferny Grove | 305071217 |
| Fig Tree Pocket | 305071222 |
| Geebung | 305071236 |
| Inala | 305071288 |
| Jamboree Heights | 305071296 |
| Jindalee | 305071301 |
| Karana Downs-Lake Manchester | 305071306 |
| Kenmore | 305071318 |
| Kenmore Hills | 305071323 |
| Keperra | 305071326 |
| McDowall | 305071353 |
| Middle Park | 305071375 |
| Mitchelton | 305071383 |
| Moggill | 305071386 |
| Mount Ommaney | 305071408 |
| Northgate | 305071435 |
| Nudgee | 305071442 |
| Oxley | 305071451 |
| Pinjarra Hills | 305071465 |
| Pinkenba-Eagle Farm | 305071467 |
| Pullenvale | 305071473 |
| Richlands | 305071484 |
| Riverhills | 305071487 |
| Sandgate | 305071514 |
| Seventeen Mile Rocks | 305071517 |
| Taigum-Fitzgibbon | 305071556 |
| The Gap | 305071567 |
| Upper Kedron | 305071585 |
| Virginia | 305071593 |
| Wacol | 305071596 |
| Wavell Heights | 305071604 |
| Westlake | 305071612 |
| Zillmere | 305071653 |
| Annerley | 305091015 |

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|---|---|
| Balmoral | 305091042 |
| Bulimba | 305091086 |
| Camp Hill | 305091097 |
| Cannon Hill | 305091102 |
| Carindale | 305091108 |
| Carina | 305091113 |
| Carina Heights | 305091116 |
| Coorparoo | 305091157 |
| East Brisbane | 305091195 |
| Fairfield | 305091214 |
| Greenslopes | 305091247 |
| Hawthorne | 305091258 |
| Holland Park | 305091282 |
| Holland Park West | 305091285 |
| Moorooka | 305091391 |
| Morningside | 305091397 |
| Norman Park | 305091432 |
| Tarragindi | 305091563 |
| Yeerongpilly | 305091645 |
| Yeronga | 305091648 |
| Acacia Ridge | 305111001 |
| Algester | 305111012 |
| Archerfield | 305111023 |
| Belmont-Mackenzie | 305111057 |
| Burbank | 305111091 |
| Calamvale | 305111094 |
| Chandler-Capalaba West | 305111123 |
| Coopers Plains | 305111154 |
| Eight Mile Plains | 305111198 |
| Gumdale-Ransome | 305111251 |
| Hemmant-Lytton | 305111265 |
| Kuraby | 305111331 |
| Lota | 305111337 |
| MacGregor | 305111356 |
| Manly | 305111364 |
| Manly West | 305111367 |
| Mansfield | 305111372 |
| Moreton Island | 305111394 |
| Mount Gravatt | 305111402 |
| Mount Gravatt East | 305111405 |
| Murarrie | 305111413 |
| Nathan | 305111416 |
| Pallara-Heathwood-Larapinta | 305111456 |
| Parkinson-Drewvale | 305111463 |
| Robertson | 305111492 |
| Rochedale | 305111495 |
| Rocklea | 305111498 |
| Runcorn | 305111503 |
| Salisbury | 305111511 |
| Stretton-Karawatha | 305111541 |
| Sunnybank | 305111547 |

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| Sunnybank Hills | 305111552 |
| Tingalpa | 305111571 |
| Upper Mount Gravatt | 305111588 |
| Wakerley | 305111601 |
| Willawong | 305111615 |
| Wishart | 305111626 |
| Wynnum | 305111637 |
| Wynnum West | 305111642 |
| Beaudesert (S) - Pt A | 305150552 |
| Bribie Island | 305202002 |
| Burpengary-Narangba | 305202005 |
| Caboolture (S) - Central | 305202008 |
| Caboolture (S) - East | 305202013 |
| Caboolture (S) - Hinterland | 305202014 |
| Caboolture (S) - Midwest | 305202015 |
| Deception Bay | 305202016 |
| Morayfield | 305202018 |
| Ipswich (C) - Central | 305253962 |
| Ipswich (C) - East | 305253965 |
| Ipswich (C) - North | 305253966 |
| Ipswich (C) - South-West | 305253974 |
| Ipswich (C) - West | 305253976 |
| Browns Plains | 305304601 |
| Carbrook-Cornubia | 305304603 |
| Daisy Hill-Priestdale | 305304605 |
| Greenbank-Boronia Heights | 305304608 |
| Kingston | 305304612 |
| Loganholme | 305304615 |
| Loganlea | 305304618 |
| Marsden | 305304623 |
| Rochedale South | 305304631 |
| Shailer Park | 305304634 |
| Slacks Creek | 305304637 |
| Springwood | 305304642 |
| Tanah Merah | 305304645 |
| Underwood | 305304651 |
| Waterford West | 305304654 |
| Woodridge | 305304656 |
| Logan (C) Bal | 305304663 |
| Albany Creek | 305405951 |
| Bray Park | 305405957 |
| Central Pine West | 305405958 |
| Dakabin-Kallangur-M. Downs | 305405961 |
| Griffin-Mango Hill | 305405963 |
| Hills District | 305405971 |
| Lawnton | 305405973 |
| Petrie | 305405974 |
| Strathpine-Brendale | 305405978 |
| Pine Rivers (S) Bal | 305405988 |
| Clontarf | 305456201 |
| Margate-Woody Point | 305456204 |

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| Redcliffe-Scarborough | 305456206 |
| Rothwell-Kippa-Ring | 305456208 |
| Alexandra Hills | 305506251 |
| Birkdale | 305506254 |
| Capalaba | 305506257 |
| Cleveland | 305506262 |
| Ormiston | 305506264 |
| Redland Bay | 305506265 |
| Sheldon-Mt Cotton | 305506267 |
| Thorneside | 305506268 |
| Thornlands | 305506271 |
| Victoria Point | 305506273 |
| Wellington Point | 305506276 |
| Redland (S) Bal | 305506283 |
| Beenleigh | 307053461 |
| Bethania-Waterford | 307053463 |
| Eagleby | 307053466 |
| Edens Landing-Holmview | 307053471 |
| Jacobs Well-Alberton | 307053473 |
| Mt Warren Park | 307053476 |
| Ormeau-Yatala | 307053481 |
| Wolffdene-Bahrs Scrub | 307053493 |
| Biggera Waters-Labrador | 307103508 |
| Bilinga-Tugun | 307103511 |
| Broadbeach-Mermaid Beach | 307103514 |
| Broadbeach Waters | 307103515 |
| Bundall | 307103517 |
| Burleigh Heads | 307103521 |
| Burleigh Waters | 307103523 |
| Coolangatta | 307103527 |
| Currumbin | 307103533 |
| Main Beach-South Stradbroke | 307103555 |
| Mermaid Wtrs-Clear Is. Wtrs | 307103562 |
| Miami | 307103563 |
| Palm Beach | 307103573 |
| Paradise Point-Runaway Bay | 307103576 |
| Southport | 307103585 |
| Surfers Paradise | 307103587 |
| Ashmore-Benowa | 307153502 |
| Carrara-Merrimac | 307153525 |
| Coombabah | 307153531 |
| Currumbin Valley-Tallebudgera | 307153534 |
| Currumbin Waters | 307153535 |
| Elanora | 307153537 |
| Helensvale | 307153543 |
| Hope Island | 307153547 |
| Kingsholme-Upper Coomera | 307153551 |
| Molendinar | 307153564 |
| Mudgeeraba-Reedy Creek | 307153566 |
| Nerang | 307153567 |
| Oxenford-Maudsland | 307153568 |

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| Pacific Pines-Gaven | 307153572 |
| Parkwood-Arundel | 307153578 |
| Pimpama-Coomera | 307153581 |
| Robina | 307153582 |
| Varsity Lakes | 307153592 |
| Worongary-Tallai | 307153593 |
| Beaudesert (S) - Pt B | 307200553 |
| Guanaba-Springbrook | 307203538 |
| Caloundra (C) - Caloundra N. | 309052132 |
| Caloundra (C) - Caloundra S. | 309052133 |
| Caloundra (C) - Kawana | 309052135 |
| Maroochy (S) - Buderim | 309054902 |
| Maroochy (S) - Coastal North | 309054905 |
| Maroochy (S) - Maroochydore | 309054907 |
| Maroochy (S) - Mooloolaba | 309054911 |
| Maroochy (S) - Nambour | 309054914 |
| Maroochy (S) - Paynter-Petrie Creek | 309054917 |
| Noosa (S) - Noosa-Noosaville | 309055752 |
| Noosa (S) - Sunshine-Peregian | 309055755 |
| Noosa (S) - Tewantin | 309055756 |
| Caloundra (C) - Hinterland | 309102136 |
| Caloundra (C) - Rail Corridor | 309102138 |
| Maroochy (S) Bal | 309104918 |
| Noosa (S) Bal | 309105758 |
| Esk (S) | 312053050 |
| Kilcoy (S) | 312054250 |
| Beaudesert (S) - Pt C | 312100555 |
| Boonah (S) | 312100800 |
| Gatton (S) | 312103250 |
| Laidley (S) | 312104450 |
| Cherbourg (S) | 315102330 |
| Cooloola (S) (excl. Gympie) | 315102532 |
| Cooloola (S) - Gympie only | 315102535 |
| Kilkivan (S) | 315104300 |
| Kingaroy (S) | 315104350 |
| Maryborough (C) | 315104950 |
| Murgon (S) | 315105500 |
| Nanango (S) | 315105650 |
| Tiaro (S) | 315106850 |
| Wondai (S) | 315107450 |
| Cambooya (S) - Pt A | 320012151 |
| Crow's Nest (S) - Pt A | 320012551 |
| Jondaryan (S) - Pt A | 320014201 |
| Rosalie (S) - Pt A | 320016451 |
| Toowoomba (C) - Central | 320016901 |
| Toowoomba (C) - North-East | 320016903 |
| Toowoomba (C) - North-West | 320016905 |
| Toowoomba (C) - South-East | 320016906 |
| Toowoomba (C) - West | 320016908 |
| Cambooya (S) - Pt B | 320052154 |

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| Clifton (S) | 320052400 |
| Crow's Nest (S) - Pt B | 320052554 |
| Dalby (T) | 320052650 |
| Jondaryan (S) - Pt B | 320054204 |
| Pittsworth (S) | 320056050 |
| Rosalie (S) - Pt B | 320056454 |
| Stanthorpe (S) | 320056600 |
| Warwick (S) - Central | 320057262 |
| Warwick (S) - East | 320057263 |
| Warwick (S) - North | 320057265 |
| Warwick (S) - West | 320057266 |
| Bowen Hills | 305011067 |
| Tweed (A) - Tweed-Heads | 120057554 |
| Tweed (A) - Tweed Coast | 120057556 |
| Lismore (C) - Pt A | 120074851 |
| Byron (A) | 120101350 |
| Kyogle (A) | 120104550 |
| Lismore (C) - Pt B | 120104854 |
| Tweed (A) - Pt B | 120107558 |
| Tenterfield (A) | 130157400 |