ENVIRONMENT DESIGN GUIDE

THE COSTS OF URBAN SPRAWL – INFRASTRUCTURE AND TRANSPORTATION

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This is one of three companion papers taken from a study that assesses the comparative costs of urban redevelopment with the costs of greenfield development. This paper shows that substantial costs could be saved in infrastructure and transport if urban redevelopment became the focus. The second paper GEN 83: The Costs of Urban Sprawl – Predicting Transport Greenhouse Gases from Urban Form Parameters *assesses how these different urban typologies perform with respect to greenhouse gases. The third paper* GEN 85: The Costs of Urban Sprawl – Physical Activity Links to Healthcare Costs and Productivity *discusses the health costs and productivity losses that can be linked to human inactivity in suburban living.*

The savings in transport and infrastructure for 1000 dwellings are in the order of $86 million up-front for infrastructure and $250 million for annualised transportation costs over 50 years.

Keywords:
urban sprawl, redevelopment, greenfield, transport, infrastructure, urban planning

Figure 1: The suburban planning model for many Australian cities puts an emphasis on car travel over more active alternatives such as walking or riding

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1.0 INTRODUCTION

The costs of different urban forms has become of interest globally due to the need to assess the sustainability of cities from their financial, environmental and social perspectives (Newman et al., 2009). Australian cities are under focus as the Prime Minister has announced Federal Government involvement in urban planning in order to cope with expected population increases (BCA, 2009). In the future if there is Federal money in urban infrastructure, transport, healthcare, etc., projects will need to meet certain criteria regarding costs, climate change, and health. The papers in this series are designed to assess these implications by examining two alternative approaches to urban development: redevelopment in walkable, transit-oriented developments and fringe development in conventional low-density car dependent suburbs.

	Urban Redevelopment	Fringe Development
Daily per capita Greenhouse Gas Emissions from transport (Measured in CO_2-e)	0 to 4 Kg	8 up to 10 Kg
Distance to CBD	less than10 km	more than 40 km
Activity Intensity (measured by population and jobs per hectare)	> 35	< 20
Transit Accessibility	more than 80% with >15min service	less than 15% with >15min service

Table 1: Defining criteria of the dichotomous urban forms

1. Activity intensity is a measure of density that includes residential and commercial activity on urbanised spaces. As such, areas occupied by large natural bodies such as lakes, rivers and parklands are omitted from its calculation.
2. Transit accessibility relates to the proportion of land within an urbanised area that is within 400m of a full-service bus or tram, or within 800m of a train station. 'Full-service' is defined as a route operating seven days a week with at least four services per hour on weekdays and Saturdays during the day and two services per hour on Sundays and holidays.

(Source: data collected for this study)

Redevelopment is based around present urban areas that are already well served by public transport but can also include new developments, so long as transit accessibility, walkability, and density are implemented in the planning and design process. Table 1 sets out the two development types according to some of their defining characteristics. More detailed data can be found in the Appendices attached to paper two, based on Sydney and Melbourne local government areas.

The two development types are based on the data collected on Sydney and Melbourne which included a local government area's distance to the CDB, estimated daily per capita greenhouse gas emissions, activity intensity and transit accessibility rating. The Local Government Areas (LGAs) of the CBD, Port Phillip and Yarra for Melbourne and the CBD, South Sydney and Leichhardt in Sydney are examples of inner-city/ core areas that rate well within the above-defined thresholds of the defining criteria. As for the criteria into which fringe developments would fall, LGAs to represent these in Melbourne would include the Yarra Ranges, Cardinia and Mornington Peninsula and others, and Penrith, Camden, Gosford, and the Blue Mountains in Sydney. Table 2 sets out some other transport data that characterise Melbourne's local area differences in order to show how much more walkable and transit oriented the core/inner area is. These are also wealthier areas as Table 2 indicates.

	Core	Inner	Middle	Outer/ Fringe
Car	2.12	2.52	2.86	3.92
Public Transport	0.66	0.46	0.29	0.04
Walk/bike	2.62	1.61	1.08	0.81
Income >$70,000	12%	11%	10%	6%

Table 2: Trips per day per person by area – Melbourne

(Source: Kenworthy and Newman, 2000)

The research has examined the economic costs associated with these two modes of development, first assessing the physical planning costs associated with the different transport and infrastructure requirements, and then two new areas of public policy – greenhouse gas emissions and activity-related health costs. These are the subjects of increasing interest and their economic costs can be compared with the more traditional costs of physical planning.

2.0 INFRASTRUCTURE COSTS

2.1 Background

The economic assessment of infrastructure costs associated with urban sprawl is not a recent concept. Such assessments have been done in Australia as early as the 1970s and numerous assessments have been done since; however, the most recent studies in Australia that could be found by the authors were from 2001 and 2003, and these simply capitalised the costs reported in previous assessments to then current values. The challenge in interpreting the assessments is that infrastructure costs are so heavily dependent on area-specific factors. For instance, road costs among different prospective development areas may vary based on the necessity for major arterial roads, costs for sewerage and water infrastructure could vary immensely depending on terrain and soil conditions, and many infrastructure components will differ depending on the level and degree of excess capacity. It is also difficult to determine who bears the costs of new infrastructure developments because of constantly changing government-induced fees, taxes, policies, and building standards.

Labour Wage Increases	June 1999	June 2007	Index Change	% Increase
Electrical	83.1	114.8	31.7	38.1%
Gas	83.1	114.8	31.7	38.1%
Water	83.1	114.8	31.7	38.1%
Construction	83.8	115.7	31.9	38.1%
Transportation	86.8	110.8	24	27.6%
Government Administration & Defence	84.4	113.4	29	34.4%
Health and Community	85.9	113.5	27.6	32.1%
Property and Business	83.3	111.4	28.1	33.7%
Education	83.8	113.5	29.7	35.4%
Price Increases of Supplies				
Weighted Average of 6 capital cities	119.2	148.3	29.1	24.41%
Consumer Price Index (CPI)	122.3	157.5	35.2	28.78%

Table 3: National labour and construction input price increases from June 1999 to June 2007

(Source: ABS, 2008a, 2008b, 2008c)

Despite the area-specific nature of calculating development costs, the evidence suggests that initial capital costs and operating costs of sprawling developments outweigh the costs associated with inner-city redevelopment. Perhaps the most significant infrastructure category to mark an economic difference in provisioning is road construction. In many cases it can make up 50 per cent of the cost difference between the two iconic development forms (SGS, 2003). The provisioning of water and sewerage infrastructure is another expensive infrastructure requirement. Markedly in these two categories, but in the others to some degree as well, inner-city redevelopment offers significant cost savings by either utilising excess capacity or requiring less of the service because of shorter distances and greater compactness.

2.2 Calculating the Costs of Infrastructure

For determining the infrastructure costs of inner city and fringe developments, the main source of data was drawn from a paper prepared for the Western Australia Planning Commission in 2001. Environmental Resource Management Pty Ltd (ERM) compiled the report, titled Future Perth, with the intent of identifying the economic cost differences between developments in inner, middle and fringe areas (ERM, 2001). It reviewed the information produced by 22 studies across Australia, America, and Canada and sorted the cost findings into three different measures of urban form: inner, middle, and outer. The cities of these 'new world' countries have similar urban structures to that of Australian cities, and thus make useful comparisons.

Cost indexing

The Future Perth report drew on studies that ranged between the years of 1972 to 2000 but adjusted the reported costs to 1999 prices. The same would have been done for the purpose of this study in terms of inflating those reported values by a standard inflation rate to 2007 prices, however, since 2002 the prices of materials and labour in construction have increased disproportionately to the general consumer price index and labour price indices (due largely to the impact of mining operations on the labour market). To account for this, infrastructure costs were inflated according the Australian Bureau of Statistics' (ABS) reported price indices for the years 1999 to 2007. Table 3 shows how some of these categorical costs have changed between those years.

	Inner	Outer
Roads	$5,086,562	$30,378,881
Water and Sewerage	$14,747,616	$22,377,459
Telecommunications	$2,576,106	$3,711,851
Electricity	$4,082,117	$9,696,505
Gas	$0	$3,690,843
Fire and Ambulance	$0	$302,509
Police	$0	$388,416
Municipal Services	Not Reported	Not Reported
Education	$3,895,458	$33,147,274
Health	$20,114,867	$32,347,327
Total	$50,502,726	$136,041,065

Table 4: Initial capital costs for redevelopment versus fringe development infrastructure

(Source: Future Perth, 2001)

When consolidating and inflating the reported residential development costs reported in Future Perth, the appropriate price increase was matched to each category according to the type of industry it fell into and if it was likely to include a labour component, a materials component, or both to allow for the varied degrees of inflation.

Municipal services

Table 4 displays the economic breakdown of inner city and urban fringe initial capital costs in 2007 prices, and represent the higher estimates reported by the studies surveyed by Future Perth. In the case of the inner-city provision of fire, ambulance, and police infrastructure, none of the Future Perth studies reported estimates. This was explained as being a likely result of excess capacity utilisation. Cities typically have staffing ratios that they maintain of police officers to residents, but these costs are covered incrementally and would likely appear as operating costs, not needing new investments in physical infrastructure. Municipal services price estimates were not provided for either of the two urban forms, but this was merely for the reason that none of the surveyed studies researched these costs. They will be higher in the fringe areas, thus the results are conservative.

Operating costs

The Future Perth study also reviewed the operating costs reported by the numerous studies, however, they were incomplete. The majority of studies in the report either did not research operating costs, reported costs only for certain infrastructure items, or only reported them for one type of urban form. Aggregating the costs did not give a comprehensive depiction of infrastructure operating costs associated with inner city and fringe developments and therefore, they have not been included in this assessment; however, the one area for which operational costs are well known is transportation.

Cost For 1000 Dwellings	Inner	Outer
Capital cost of car ownership	$2,990,802	$8,628,654
Fuel costs	$1,203,925	$3,255,349
Other operating car costs	$1,476,392	$4,259,675
Time costs (total)	$6,158,348	$8,210,448
Private transport	$3,116,810	$8,210,448
Public transport	$3,041,538	$0
Walking and cycling	$0	$0
Road costs	$1,216,597	$3,508,806
Parking costs	$2,184,489	$7,709,869
Externalities (total)	$243,731	$703,250
Fatalities	$73,368	$211,693
Injuries	$23,627	$68,172
Property damage	$38,549	$111,228
Air pollution	$90,777	$261,925
Noise pollution	$17,409	$50,232
Transit costs (capital, and operating)	$3,136,540	$470,481
Total	$18,610,824	$36,746,532

Table 5: Transportation Costs for 1000 Inner-City and Fringe Dwellings

Prices shown are calculated for 2007.

* Public transport travel time costs are not allotted a value for fringe developments because like in the outermost suburbs of Sydney and Melbourne, the level of public transport service is low to non-existent. Travel time costs are not allotted to walking and cycling because the act may also be discretionary, or done for enjoyment, and little empirical evidence exists to quantify the disutility of active commuting modes.

(Source: Newman and Kenworthy, 1999)

3.0 TRANSPORTATION COSTS

3.1 Background

Transportation is a derived need, meaning that people typically travel for some purpose other than for the simple reason of travelling; yet Australian cities are reaching an expansiveness necessitating many residents to commit upwards of an hour or two daily for commuting purposes. The private, public, and external costs associated with the proliferation of roadways are substantial and have largely been driven by automobile dependence, a by-product of fringe development (Newman and Kenworthy, 1999).

In many sprawling suburbs, predominantly in the United States, the private costs of transportation have led to home values dropping and in some cases to a point where homes have been boarded up and abandoned (Newman et al, 2009). This should be a signifier that there are limits to urban growth based on car dependence and that housing affordability does come at a transportation cost.

3.2 Associated Costs of Transportation

The transportation costs associated with both inner-city and fringe development were drawn from a study by Newman and Kenworthy (1999) which, together with infrastructure constituted part of an economic assessment of urban form. The estimated costs were calculated as functions of vehicle kilometres travelled and covered all of private, public and external costs. Table 5 displays a summary of the costs in 2007 prices, which constitute the recurring annual costs of a development of 1000 dwellings.

Cars

The capital costs of cars are represented as annual depreciation figures. The increased wear of longer trip distances in outer-city developments is why the

Item with discount rate (7%)	Inner-City Development	Fringe Development
Transport	$136,309,097	$226,100,382
Roads and Parking	$30,976,806	$102,178,732
Externalities	$2,219,884	$6,504,143
Total	$169,505,787	$334,783,257

Table 6: 15-Year Present Value

(Source: Newman and Kenworthy, 1999)

operating and capital costs of cars appear much higher than in inner areas. The higher fuel costs are also a reflection of longer trip distances but are likely to also be underestimated in this account because of more recent spikes in oil prices.

Parking

Parking costs represent a significant expenditure that can frequently be overlooked. The higher cost associated with fringe development is due to more parking spaces being required for fringe than inner-city residents. In Perth, the parking requirement for inner-areas is approximately four spaces per resident, while outer areas require approximately ten (Newman and Kenworthy, 1999). The level of parking provision is representative of the greater diversity of car trips and the greater proportion of trips requiring private transport that is characteristic of fringe areas.

Understanding future value

To account for the annual stream of costs associated with transportation, their present values were calculated over a period of 15 years as well as 50 years. The 15-year annuity (a term that means the annual costs would be recurring over a period of 15 years) was calculated as a reference point to numerous other economic assessments of development expenditures that tend to use a 15-year time period. The 50-year annuity was calculated for the purpose of this economic assessment to synchronise with the other sections. A discount rate (a term that accounts for the diminishing value of money in time and the risk of an investment) of seven per cent was used for all of the transportation-related costs as suggested by the US Department of Transportation (1994). The high rate is used because empirical evidence suggests that immediate benefits are valued higher than future benefits, hence a lower present value of future costs. Discount rates are frequently debated however, Tables 6 and 7 present the values with a 7 per cent rate to stay consistent with a generally agreed upon value.

Item with discount rate (7%)	Inner-City Development	Fringe Development
Transport	$206,542,055	$342,598,098
Roads and Parking	$46,937,535	$154,826,095
Externalities	$3,363,675	$9,705,379
Total	$256,843,265	$507,129,572

Table 7: 50-Year Present Value

(Source: Newman and Kenworthy, 1999)

4.0 CONCLUSION

Infrastructure, especially transport infrastructure, shapes cities. The past 50 years of urban development in Australia has been based around building new car-dependent suburbs on the urban fringe. Around the world this form of city building is now under serious reconsideration. The data in this paper shows why this is the case – it is very costly. For each new block on the urban fringe compared to redevelopment there is an infrastructure subsidy from various levels of government of around $85,000.

Governments are concerned about affordability and justify this infrastructure investment as part of the subsidy that this generation provides for those who need to buy a house. There is also some evidence that State Treasury officials are unaware of the extent of the subsidy as the roll out of new greenfield infrastructure is automatic rather than a decision assessed by Treasury. On the other hand, inner urban redevelopment projects often need some up front costs and are seen as a burden on the state. This is a reflection of the dominant framing of the issue of urban development as a greenfield issue alone (Schon and Rein, 1995).

Greenfield infrastructure subsidies establish suburbs for at least 50 years before they need renewing (Lucy and Phillips, 2006). It is a major decision that should be made based on the full costs involved. This study would suggest that if a city has land that can be redeveloped then there will be highly significant infrastructure cost savings associated with this compared to new development on the urban fringe.

Once established, there are many ongoing operational costs of both urban typologies but the most significant operational costs are associated with transport. Private and public costs are needed to ensure people travel more easily to and from these urban areas. The cost of both on private and public transport operations for greenfield development is around $18,000 per household per year more than that for urban redevelopment. This needs to feed into debates about affordability as over a 50-year period this adds up to a difference of $251 million for 1000 dwellings, or $251,000 per household. A number of US studies are now showing that transport costs on the urban fringe are higher than mortgage costs (CTCNT, 2006; Lipman, 2006).

Thus infrastructure and transport costs are suggesting the need to focus on redevelopment rather than fringe development. As Australian cities have developed planning structures and funding structures that are oriented toward greenfield development, the reversal of this to focus on redevelopment is not straightforward.

The recent increased involvement of the Federal Government in infrastructure and planning is now an opportunity to reshape urban development around more cost-effective urban regeneration initiatives.

The two companion papers assess what this could mean for costs associated with greenhouse gases and inactivity-related health impacts and productivity loss, which further reinforce this conclusion.

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