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To cite this article: Cathryn Hamilton & Jon Kellett (2017) Cost comparison of infrastructure on greenfield and infill sites, Urban Policy and Research, 35:3, 248-260, DOI: [10.1080/08111146.2016.1274257](https://doi.org/10.1080/08111146.2016.1274257)

To link to this article: <http://dx.doi.org/10.1080/08111146.2016.1274257>



Published online: 09 Jan 2017.



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Cost comparison of infrastructure on greenfield and infill sites

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ABSTRACT

Planning policy in most Australian capital cities aims to divert development from the fringe into established inner urban areas. A fundamental logic underlying this policy of land recycling is that State and Local governments are challenged financially to provide appropriate standards of infrastructure and services in greenfield locations. This paper explores the range of infrastructure provision issues and seeks to identify the actual costs of provision in different locations. Three case studies in metropolitan Adelaide are used to explore the cost factors for developers and government. The study highlights the complexity of analysing the infrastructure cost of different developments which arises from variable record keeping and accounting practices. Nevertheless, the study is able to draw conclusions about the relative costs of infrastructure provision in different locations and reinforces previous studies that have demonstrated the higher costs of infrastructure on the fringe as opposed to infill. The estimated infrastructure costs for the infill development case study at Bowden are shown to be approximately one third that of both greenfield and renewal areas of the Playford Alive project on the urban fringe.

澳大利亚各州首府的规划政策，大多将开发项目由城市边缘转向成熟的市中心。这种土地再利用政策背后的基本逻辑是，在未开发地区提供充足的基本设施和服务对州政府和地方政府造成较大的财政压力。本文研究基础设施供给的各种问题，以便确定不同地点的成本。我们通过阿德莱德市的三个案例，探讨开发商和政府的成本因素。研究凸显了分析开发项目基础设施成本的复杂性，因为每个项目的档案和记账方法各不相同。不过，研究依然能够对不同地点基础设施供给的相对成本做出结论，并证明此前研究得出的结论，即城市边缘地区基础设施供给成本高于市中心。位于市中心的鲍登开发项目，其基础设施成本仅为城市边缘 Playford Alive 项目（不论是新建区域还是再建设区域）的三分之一。

ARTICLE HISTORY

Received 1 June 2016
Accepted 20 November 2016

KEYWORDS

Costs; fringe; greenfield;
infill; infrastructure;
residential

Introduction

Almost 80% of Australia's 23.6 million people currently live in its major cities (Department of Infrastructure and Regional Development 2015). It is predicted that, by 2050, this figure will rise to more than 90% of the population being resident in Australia's major cities (Infrastructure Australia 2010). For urban residents location matters for a range of reasons, amongst which, access to infrastructure can figure highly. Owner occupation rates in Australia have hovered around 70% over the last four decades (Kupke and Rossini 2011), and the transaction costs of moving house (for example

agents fees and stamp duty) can act as inhibitors to movement, so choice of residential location represents an important decision which bears cost implications in respect of travel time, access to public transport, schools and other facilities as well as costs directly relating to the provision of housing. Proximity to infrastructure and services can influence location decisions not only since it affects property resale values (Reed 2007) but also because it influences the costs for accessing services through normal day to day living (Badcock 1982, Dodson and Sipe 2008, Whitzman 2011, Kellett *et al.* 2012).

Infrastructure provision for residential subdivisions consists of many different factors. For example, fundamental urban services such as reticulated water supply, wastewater and storm water drainage, electricity, gas and telecommunications services have been a mandatory requirement for several decades (Neutze 1995). Up until the mid-1990s government was often responsible for funding or otherwise providing these services. Similarly, there is a general expectation that new housing estates will be provided with paved roads and footpaths and whilst the maintenance of these facilities in most cases passes to local councils on completion, they are initially constructed and paid for by the developer. The privatisation of utilities and the funding model which has moved from funding infrastructure from taxation revenue towards a user pays system, has resulted in developers continuing to provide water supply, wastewater, roads and stormwater infrastructure in new housing developments with the costs normally passed on to house (or land) purchasers (see Neutze 1995, Gurran *et al.* 2009). The requirement to provide infrastructure into communities, however, is acknowledged to extend beyond such necessary provision to include community facilities such as parks and play spaces, libraries, community meeting facilities and other social or soft infrastructure (see Malecki 2002, Casey 2005, Kerkin 2013). Developers have expressed concern about the increasingly complex and diversified nature of infrastructure provision and that government may be expecting them to provide a broader range of infrastructure or contribute toward funding infrastructure deficits (UDIA 2013). Furthermore, looking beyond the immediate site specific community needs of new housing areas, the provision of public transport, the improvement of existing trunk road networks to cope with increased vehicle flows, the increase of school places at both primary and secondary level and the requirements of publically funded health services all add to a growing list of infrastructure requirements which require funding. Recent legislative reforms in South Australia have sought to address this pressing issue with a new process for infrastructure delivery (Government of South Australia 2016).

Most large Australian cities are now pursuing urban consolidation through the use of planning policies such as urban growth boundaries setting limits on growth in greenfield areas and establishing targets for the proportion of new housing development that should be located on recycled inner urban land. Some studies conclude that increasing the number of new dwellings in inner suburban locations reduces the cost of providing services and infrastructure compared to greenfield development, particularly when the transport costs of providing services are included (Trubka *et al.* 2010, Litman 2013). Other literature concludes that increasing the density of population within established areas potentially leads to modifications or additions to infrastructure and services which are not always included in the costs of development (Searle 2004). Whilst the rationale for these policies essentially lies in the domain of urban sustainability in that they represent an attempt to curb urban sprawl, reduce commuter distances and protect agricultural land from urban encroachment, governments appear to be supportive on cost grounds, believing that the reflection of development activity away from the fringe and into the existing urban area represents a cost effective use of existing infrastructure and reduces potential government spending on new facilities on the fringe. At the same time many developers argue the opposite, pointing to higher costs of development on recycled land within the city and arguing strongly for a continuation of development on greenfield sites. In support of this argument they suggest that the lower development costs of infrastructure provision on greenfield fringe land can be passed on to home buyers, thus providing a contribution to affordability. Given that government and developers are responsible for different types of infrastructure provision it is possible that both arguments are correct.

Here we address these issues by posing four questions.

1. Are there real differences in infrastructure cost factors in greenfield (non-serviced) and infill (serviced) residential developments?
2. Can these cost factors be identified?
3. Do the costs of infrastructure provision in both locations differ for government and developers?
4. What are the implications for planning new development?

How infrastructure is provided and paid for is a topic which has stimulated debate and spawned a range of political solutions around the world. For example Community Benefit Agreements in California allow government, developers and communities to negotiate situation specific infrastructure solutions (Camacho 2013) whilst the UK has introduced a Community Infrastructure Levy which seeks to extract funds from most new developments (Henneberry 2016). In Australia a range of approaches are taken to recoup the cost of government provided infrastructure (e.g. section 173 Agreements in Victoria and Community Infrastructure Development Contribution Plans in Western Australia). However it is not the intention in this paper to examine solutions to the infrastructure cost issue but rather to focus on identifying these costs in different locations.

We commence with a review of relevant literature to identify the infrastructure costs for infill and greenfield development for developers and government that have been previously reported in published studies and reports. We then present the analysis of the infrastructure cost factors for three Adelaide case studies, highlighting differences and identifying the allocation of costs to developers or government. The paper discusses the potential impact of these costs and concludes by commenting on the findings in light of current policy directions for directing dwelling construction toward inner city suburbs and transport corridors. An earlier version of this paper was presented at the State of Australian Cities conference (Hamilton and Kellett 2015).

Previous studies

Adams (1994) explains property development in terms of a sequence of stages involving different actors and institutions. Similarly, Coiacetto (2012) explains the costs of the development process in terms of the types of activities involved in the stages of development. These stages may include studies and reports; the preparation of applications; acquiring and holding land; the design of development, buildings and infrastructure; earthworks and preparatory work; infrastructure provision and construction; building construction; landscaping; and various fees such as statutory charges and professional services. Generally, the key actors in the housing development process in Australia are the developer, who prepares the land and arranges for the building of housing, the house purchaser, who chooses dwellings for occupation or for investment and government (both State and Local), which regulates land zoning, subdivision, the character of development, assesses development against standards and guidelines, and ensures the provision of essential infrastructure and services. Hence, both developers and government may provide infrastructure for new housing development incurring costs in this process. Each may pass these costs on to households, either directly within a new development or indirectly, to the broader community. In the following sections, the literature relating to developer cost factors and government cost factors is summarised. Generally the term developer is used to describe a private sector company that aims to make a direct financial profit from the process of development, operating as a trader or investor (Wilkinson and Reed 2008, p. 12). Developers may be public or private, and range from individuals to multi-national companies. The scale of development is a key aspect which determines the type of developer. Small or medium scale housing development is rarely undertaken by large developers (Ruming 2010), whilst large scale developments may be undertaken by private developers or in some instances by government agencies such as Renewal SA in South Australia or Places Victoria.

Developer cost factors

Based on previous studies (ACIL Tasman 2006, Gurran *et al.* 2009, Urbis 2011, Coiacetto 2012) developer cost factors include: land holding and subdivision; professional and legal fees which may

include feasibility studies, engineering, soil tests, design of infrastructure and housing, and associated approvals; the construction of infrastructure and housing; and marketing. ACIL Tasman (2006) noted that external and indirect authority requirements, such as the extension of roads and major road intersection work, sewer/stormwater outfalls and external electricity supply, were generally a small percentage of the total cost of developing land. Government taxes and charges, which included “direct” charges such as stamp duty on purchase of land, levies, public open space contributions and land tax, were also considered to be small components but were noted to have increased as a percentage of the developer cost over the decade (ACIL Tasman 2006). The larger costs relate to land purchase, professional and legal fees, local infrastructure and the construction of housing itself.

Few studies have compared the differences in developer costs for new housing in greenfield and infill areas. A study by SGS (2003) summarises previous studies and notes cost differences between green field fringe and infill development but concludes that under a user pays scenario the higher cost of infrastructure on the fringe may not be a matter of concern for policy makers. More recently the Urbis (2011) study compared costs to developers of new housing in infill and greenfield developments across five mainland cities, Brisbane, Sydney, Melbourne, Perth and Adelaide. For Adelaide, infill development costs were based on 50 apartment dwellings at Hindmarsh 5 km west of the central business district (CBD), while greenfield development costs were based on 100 detached dwellings at Salisbury, approximately 20 km north of the CBD (Urbis 2011). Table 1 summarises the cost factors and costs detailed in the Urbis (2011) study for Adelaide. The mix of costs in each location is complex. There are clear differences between the costs of construction between each location with each infill dwelling costing substantially more than each greenfield dwelling. Land costs and government taxes and charges per dwelling were similar regardless of location. There were higher professional fees charged to developers for the infill development compared to the greenfield development (Urbis 2011). As the specific nature of the professional fees is not disclosed, it is difficult to make comparisons. Between 2009 and 2010 there was a decrease in developer profit and no profit to the developer from infill development in either year.

A review of the detailed costs in the Urbis (2011) study has been used to summarise the infrastructure costs for developers in the Adelaide examples (Urbis 2011). These are presented in Table 2. While infrastructure costs were stated to be very low for the infill site compared to the greenfield development, due to the former having no subdivision construction costs, it is clear from Table 1 that the Adelaide infill development did not deliver a profit to the developer. The Urbis report states that the increased cost of development on the infill site was not matched by an increase in the sale price of dwellings in this location.

The South Australian Government recently released a consultant’s study (InfraPlan 2014) which sought to estimate costs (in 2013 \$) for infrastructure for greenfield and infill development in metropolitan Adelaide. The InfraPlan study applied two approaches to estimating infrastructure costs for greenfield development: one used unpublished data from current greenfield developments on the periphery of Adelaide; while the second approach used infrastructure costs from other Australian cities. InfraPlan (2014) concluded that the average cost of infrastructure for greenfield development for the northern fringe of Adelaide was \$80,500 per lot (range \$72,000 to \$89,300), while cost of infrastructure for Mt Barker in the Adelaide Hills was \$61,900 per lot. Estimating the cost for infrastructure in infill locations was stated to be much more difficult and was estimated from the policy of full cost recovery applying in Sydney (\$15,300 per lot) and from data from Moreland City, Victoria (\$18,300 per lot excluding trunk infrastructure). The InfraPlan (2014) study estimated infrastructure costs for infill development in Adelaide to be \$20,000 per net dwelling (range of \$15,000 to \$25,000). Their report stated that this figure excluded local government sponsored projects within infill development sites and the open space contribution. These costs are summarised in Table 3.

Some qualifications to the estimates of developer infrastructure costs are made by InfraPlan (2014). Firstly, infrastructure components will differ depending on the level and degree of excess capacity which, for both greenfield and infill sites, will determine the need for augmentation of existing infrastructure. Second, they assume that for greenfield projects, major economic and social infrastructure

Table 1. Developer costs per dwelling in 2009 and 2010 in infill versus fringe development in Adelaide using 2010 \$ (Source: Urbis 2011).

Cost component	Adelaide infill		Adelaide greenfield	
	2009	2010	2009	2010
Cost to developer	\$446,000	\$476,000	\$355,000	\$394,000
Sale price	\$440,000	\$460,000	\$395,000	\$415,000
Total cost to purchaser	\$461,561	\$484,452	\$415,289	\$436,436
Land	\$48,000	\$50,000	\$50,000	\$55,000
Govt taxes & charges	\$71,000	\$78,000	\$66,000	\$76,000
Professional fees	\$7000	\$31,000	\$4000	\$13,000
Construction	\$290,561	\$290,452	\$217,289	\$220,436
Development cost & interest	\$51,000	\$51,000	\$38,000	\$51,000
Developers profit	-\$6000	-\$16,000	\$40,000	\$21,000

Table 2. Developer costs for infrastructure per dwelling in 2010 \$ in infill versus fringe development in Adelaide (Source: Urbis 2011).

Category	Inner	Outer
Infrastructure charges	\$6000	\$4000
Subdivision construction (Inc. GST)	0	\$47,574
Total	\$6000	\$51,574

Table 3. Estimates of infrastructure costs in 2013 \$ for infill (inner) development versus greenfield (northern fringe) development in Adelaide (Source: InfraPlan 2014).

Category	Inner	Outer
Infrastructure total	\$20,000	\$80,500
Range	\$15,000–\$25,000	\$72,000–\$89,300

is normally located off-site. Third, local reticulation infrastructure for connecting each allotment is included as it is located within the development site. Finally, InfraPlan (2014, p. 22) states that government has traditionally provided headworks infrastructure for roads, water, sewer, energy and communications, as well as town centres, health care facilities, schools, emergency services, police, public transportation and recreation services. Based on these qualifications, the estimates arrived at by InfraPlan (2014) capture only the costs of infrastructure to developers and not a combined cost to developers and government.

In other relevant research, Murray (2011) noted that the affordability of infill development in metropolitan Melbourne was affected by costs such as undergrounding car parking to maximise amenity of open space. He also stated that consolidating land parcels into a single contiguous assembly of allotments is considered to be desirable for construction efficiencies, however is difficult in reality (Murray 2011). Dalton *et al.* (2007) found that the housing industry and developers generally prefer greenfield sites as they allow simpler and faster site preparation and construction. The costs and developer profit presented in the Urbis (2011) report also explain developer preference for greenfield development over infill development.

Government cost factors

Research on government cost factors has mainly focused on infrastructure and servicing (Newman and Kenworthy 1999, Trubka *et al.* 2010). Newman and Kenworthy (1999, pp. 374–384) developed an economic impact assessment methodology which costed development infrastructure, capturing capital expenditure and servicing costs per household. Their study found that infrastructure and servicing costs for fringe development in metropolitan Perth, Western Australia (WA) totaled \$73,100 per dwelling. For inner suburban development at Fremantle, the costs were calculated to be \$20,000 per dwelling.

Table 4. Costs for infrastructure and servicing per dwelling in 1999 \$* in inner suburban (redevelopment) versus fringe development in Perth (Source: Newman and Kenworthy 1999).

Category	Inner	Outer
Infrastructure and servicing	\$20,000	\$73,100
Transportation	\$89,400	\$176,400
Total	\$109,400	\$249,500

(* in 1999 \$ calculated over 15 years discounted at 10%).

Table 5. Initial capital costs for infrastructure for 1000 dwellings in inner suburban (redevelopment) versus fringe development in Perth (Source: Trubka *et al.* 2010)

Infrastructure category	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
Cost per dwelling	\$50,503	\$136,041

Newman and Kenworthy also calculated transportation costs for fringe development (\$176,400 per dwelling in 1999 dollars) compared to inner suburban development (\$89,400 per dwelling). Table 4 summarises the costs for these factors. Included in operational costs of transportation, however, were the costs for residents and hence this cost was not solely indicative of costs to government.

More recently, Trubka *et al.* (2010) estimated the capital costs for infrastructure for new dwellings in both fringe development and inner suburban development in Perth, Western Australia, drawing on data commissioned by the Western Australian Planning Commission in 2001 (ERM cited in Trubka *et al.* 2010). The initial capital costs found in Trubka *et al.* (2010) are summarised in Table 5. From this study, the cost of infrastructure for fringe development (approximately \$136,000 per dwelling) is significantly higher than that for inner suburban development (\$50,503 per dwelling). Of note are the costs of infrastructure for education and roads which are ten times and six times higher, respectively, for fringe development. Trubka *et al.*'s study assumes that infrastructure for gas, emergency services (fire and ambulance) and police is not required in inner suburban locations. As local government provides community infrastructure and services, in addition to maintaining local roads and footpaths, it is difficult to directly compare the costs for infrastructure and services determined by Newman and Kenworthy (1999) with the study of Trubka *et al.* (2010) as the latter did not include data on the costs of providing municipal services for each development. InfraPlan (2014, p. 66) stated that the costs of infrastructure determined in the Trubka *et al.* studies (2010) were high and unreliable given the age of the original data.

From this review, it is clear that few studies have been undertaken and the data collected is not always directly comparable. Nevertheless, the studies so far reported suggest that the infrastructure cost of infill development appears to be significantly less costly for government than greenfield development on the urban fringe across Australian capital cities. The evidence of cost effectiveness for developers is less clear cut since diverse factors such as development site size, open space contributions and final market value complicate the analysis. The following sections analyse three case studies of recent residential development in metropolitan Adelaide summarising the infrastructure costs for developers and government that could be ascertained from reports and information provided by staff of Renewal SA (state government) and the City of Playford (local government).

Case studies—playford alive and Bowden urban village

The Playford Alive project provides an infill (urban renewal) case and a greenfield case while the Bowden Urban Village project provides a second infill development case.

The Playford Alive project in the City of Playford, 30 km north of the Adelaide CBD commenced in 2008 with an aim to develop 1000 hectares (ha) of land with over 500 ha of new residential development. The existing population of approximately 13,000 is expected to expand to almost 40,000 by 2023. Innovative small lot housing has been developed to fill a stated gap in the market for affordable medium density housing (Renewal SA 2014).

Case 1 playford alive greenfield

The greenfield component aims to deliver 4000 new dwellings in Munno Para through a staged release. In addition to providing the traditional civil works (internal roads and footpaths, water, wastewater and stormwater pipes) in the greenfield area of Munno Para, a recycled water scheme to service up to 19,000 dwellings is also being developed as a partnership between the City of Playford, SA Water and Renewal SA (Renewal SA 2012). Housing in the greenfield area is required to be connected to the recycled water system (Renewal SA 2012).

Case 2 playford alive urban renewal

The urban renewal component, which is project managed by Renewal SA, comprises demolition or upgrade of 1100 publicly owned houses in the suburbs of Davoren Park and Smithfield Plains. Through new construction an additional 700 dwellings will be provided (Renewal SA 2012).

Case 3 Bowden urban village infill

When completed in 2026, Bowden Urban Village will be the first transit oriented development (TOD) in Adelaide. The 16.1 ha site will provide a minimum of 2400 high quality apartments (5 to 6 star Green Star) and terrace dwellings, with an estimated population of 3500. Eighty (80) apartments will be for city workers in rental and purchaser markets (rent then buy) with 32 apartments offered to key city workers such as nurses, police officers and teachers (Renewal SA 2014). In addition to housing, the Bowden project is expected to incorporate up to 20,000 sq. m of commercial space and around 12,000 sq. m of retail space, providing 1200 new jobs (Renewal SA 2014). The site is located on the boundary of the City of Charles Sturt and directly adjacent to the Adelaide Park Lands (Adelaide City Council). The land required remediation prior to development due to contamination from its previous industrial uses.

Developer costs

Information about developer costs for each of the infill and greenfield areas of Playford Alive was obtained from Renewal SA *Annual Reports* (Renewal SA 2012, 2013) and from a discussion with the Project Director (pers. comm., J Blaess 2014). Information about developer costs for the Bowden Urban Village project were provided by the Project Director (pers. comm., C Menz 2014) and from reports (Renewal SA 2014).

An open space contribution is required of all new development in South Australia and may be in the form of land set aside within the development (greenfield sites) or a monetary contribution in lieu of land (renewal sites). The known developer costs are summarised in Table 6. It is clear that the infill TOD developer costs per dwelling are significantly less than the infill development of urban renewal in Playford Alive. The developer was charged less for open space contributions per dwelling in the TOD compared to the Playford Alive Urban Renewal project and expended less on roads. While there

is a higher cost to the developer to provide energy infrastructure in the TOD site compared to the Playford Alive sites, overall the developer expends less on infrastructure in the TOD infill site, which supports the widely held view that infill development should result in reduced need for infrastructure per dwelling.

Government costs

Estimates of local government infrastructure costs and services being provided for each of the case study areas were obtained from budget documents and asset management plans of the City of Playford and City of Charles Sturt and from project update reports (City of Playford 2012, 2013). State government costs were obtained from a review of Renewal SA Annual Reports. The known government capital costs for infrastructure (i.e. not including ongoing operating or servicing costs) are summarised in Table 7. Infrastructure costs are mainly borne by state and local government, while some contributions from federal government were noted. It should be noted that the costs to developers and to government are separate. In Tables 6 and 7 there are some common headings such as roads and open space but these indicate different costs to developers and government in respect of these factors. For example open space costs to developers cover land purchase, whilst for government these relate to landscaping and equipment.

Both of the projects considered in this study have budgets approved by the Parliament of South Australia. The total approved Renewal SA investment in the Playford Alive project is \$315 million (URA 2013). If 5800 new or upgraded dwellings are constructed in Playford Alive area (combined greenfield

Table 6. Developer infrastructure costs per dwelling—3 cases.

Infrastructure category	Case 1: playford greenfield	Case 2: playford urban renewal	Case 3: Bowden infill TOD
Infrastructure design and approvals	\$2580	\$2775	\$749
Roads	\$45,500	\$28,400	\$10,433
Water and sewerage	\$1650	\$7750	\$2887
Telecommunications	n.a.	n.a.	\$105
Electricity	\$3850	\$4000	\$8188
Gas	n.a.	\$250	\$963
Open space (land)		\$6488	\$3330
Total per dwelling	\$53,580	\$49,663	\$26,655

n.a. = not available.

Note: These are costs of provision of the listed infrastructure and do not include maintenance costs.

Table 7. Summary of government capital costs for infrastructure in the case study areas.

Infrastructure category	Case 1: playford greenfield	Case 2: playford urban renewal	Case 3: Bowden infill TOD
Roads	\$4,975,000	\$10,600,000	n.a.
Public transport system upgrade	\$13,000,000		
Fire and ambulance	n.a.	n.a.	n.a.
Police		Police and community working together programme	
Open space	\$5,000,000	\$2,250,000	\$4,900,000
Municipal services	\$17,301,000	\$8,170,000	\$403,000
Education	\$68,400,000 to \$88,400,000	\$44,800,000	\$579,674
Health	\$7,500,000	OPAL programme	
Total	\$116,176,000 to \$136,176,000	\$65,820,000	\$5,882,674
Cost per dwelling	\$29,044 to \$34,044 (4000 dwellings)	\$36,566 (1800 dwellings)	\$2451 (2400 dwellings)

(n.a. = not available).

Note: These are costs of provision of the listed infrastructure and do not include maintenance costs. Where these relate to items listed in Table 6 these costs are additional. The total development cost to government in each case may be higher than the infrastructure total as total development costs may include land purchase, remediation, marketing and other sundry expenditure.

and renewal), the average cost per dwelling is \$54,310. For the Playford Alive project, Renewal SA (state government) and the City of Playford (local government) established a joint employment and skills development programme. In addition, a new retail centre, a GP Superclinic and community centre have also been provided on the boundary between the urban renewal and greenfield areas of the Playford Alive project. The local and state government cost sharing arrangements for improvements to local infrastructure within the urban renewal (infill) area had not been resolved at the time of the study (pers.comm. G Pattinson 2014). Other costs in addition to infrastructure provision are also being borne by state government. As Renewal SA is both the developer and an agency of the South Australian government, its net costs are also a cost to state government.

The total approved Renewal SA investment in the Bowden Urban Village project is \$264.7 million (Renewal SA 2014). If all 2400 dwellings are constructed, the average cost per dwelling is more than \$110,000. In addition, stamp duty concessions up to \$21,330 per dwelling are being given to off-the-plan purchasers of apartments in Bowden with a value up to \$500,000 (Renewal SA 2012). Although indirect, these concessions are real costs to government and should be added to the total development cost above. While not specifically related to infrastructure, it should be noted that the state government paid for the land to be remediated at a cost of more than \$42 million (pers. comm. C Menz 2014). This cost is included in the total \$264.7 million development cost.

For the Bowden infill project, the costs for local government are mainly borne by the City of Charles Sturt. While in its 2012 *Annual Report*, the City of Charles Sturt indicated that extra rates revenue from new dwellings in the Bowden Urban Village would match the extra cost to service the area, budget documents indicate that in the Bowden/Brompton area, extra infrastructure or services are proposed. The Bowden Urban Village project is not the only major residential development being undertaken in the City of Charles Sturt's area of responsibility. The City of Charles Sturt states that from 2011 to 2031, population growth of 13,404 (medium level) is likely, which places additional strain on existing open space assets, and increases requests for new assets (City of Charles Sturt 2013). Urban development that increases density of dwellings has a number of implications noted by the City of Charles Sturt (2013). These include: increased demand for a higher standard and diverse type of reserve and ancillary facilities; additional maintenance costs in small development areas; smaller streets which could impact on service delivery with limited space for field staff trucks & equipment, and a need to review engineering, open space and recreation guidelines. In addition to the developer obligations to address open space within the Bowden Urban Village development itself, the project also includes a \$4.9 m allocation to redevelop 5 ha of the Adelaide Park Lands opposite the Bowden site (Adelaide Park Lands Authority 2014). The Park Lands upgrade design has been endorsed by Adelaide City Council (ACC) and was targeted for completion in 2015 (City of Charles Sturt 2014). The Landscape Master Plan lists 14 projects including: formal and informal recreational facilities, social/cultural facilities and upgrades to access to the Park Lands and North Adelaide Railway Station for both the Bowden residents and North Adelaide residents as well as upgraded lighting. It is stated that the State government currently makes a total annual contribution of \$1.3 million to the maintenance of the Park Lands (Adelaide Park Lands Authority 2014). The preliminary estimate for annual maintenance costs for the upgraded Park Lands area opposite Bowden is approximately \$150,000 (Adelaide Park Lands Authority 2014). There is an expectation from ACC that the State government will increase its annual contribution to cover the increased cost of maintenance. Hence the new infill development at Bowden has resulted in new or upgraded community infrastructure with associated increased costs to local government for servicing.

Combined infrastructure costs

The combined cost of infrastructure for developers and government for these cases is presented in Table 8. There is surprisingly very little difference in total infrastructure cost between the greenfield and renewal areas of Playford Alive, while the total cost of infrastructure for infill at Bowden Urban Village is only one third of that for the Playford Alive project.

Table 8. Combined developer and government infrastructure costs per dwelling.

Infrastructure category	Case 1: playford greenfield	Case 2: playford urban renewal	Case 3: Bowden infill TOD
Developer	\$53,580	\$49,663	\$26,655
Government	\$29,044 to \$34,044	\$36,566	\$2451
Total	\$82,624 to \$87,624	\$86,229	\$29,106

Discussion

From the costs that have been obtained in the current study, a number of points emerge. Firstly, the cost to the developer in providing infrastructure at the Bowden infill site, estimated to be \$26,655 per dwelling, aligns with the InfraPlan (2014) estimate of an average of \$20,000 per dwelling. However it is just over half the cost estimated to service the urban renewal area of Playford Alive (\$49,663 per dwelling). The magnitude of the developer costs for the renewal area of the Playford Alive project are nearer to the cost (\$50,503 per dwelling) estimated by Trubka *et al.* (2010) for infill development although the latter also included government infrastructure costs. The infrastructure fees of \$6000 per dwelling for infill development included in the Urbis (2011) study appear to significantly underestimate the infrastructure costs to developers. The estimated cost to the developer to provide infrastructure to the Playford Alive greenfield site (\$53,580 per dwelling) is similar to the Playford Alive renewal area (\$49,663 per dwelling), which is an interesting finding as the latter is already serviced. The lack of spare capacity in the existing infrastructure to cope with growth from new housing development appears to be a factor leading to increased costs in the renewal area of the Playford Alive project. It is clear that a new school in this area has added to the state government infrastructure costs for the area. The findings of this study appear to support previous statements made by Searle (2004) in respect of the need to evaluate the capacity of existing infrastructure and services to support infill development.

Second, for the Playford Alive project, the government infrastructure costs are similar for both greenfield and renewal areas but are approximately fifteen times that for the Bowden infill site. The combined developer and government infrastructure cost for the infill development at Bowden (\$29,106 per dwelling) is only one third that of the Playford Alive project. The combined cost for Bowden is similar to the cost for infill development estimated by InfraPlan (2014) and the earlier study of Newman and Kenworthy (1999). However, the combined cost for the Playford Alive greenfield area (\$82,624 per dwelling) is significantly less than the cost (\$136,041 per dwelling) estimated by Trubka *et al.* (2010) for fringe development. It is noteworthy that the combined infrastructure costs for both greenfield and renewal areas of the Playford Alive project are similar to the costs estimated by the InfraPlan (2014) report for greenfield areas, although the renewal area is an established suburb and supposedly already serviced.

The infrastructure required in delivering new residential development is site specific and is influenced by the type of housing being delivered. This in turn is driven by the market demographics of household type, age, income and employment. Based on the target market of professional couples and single city workers in the Bowden Urban Village, there is not an anticipated need for a new school in the Bowden area. Further research to monitor the household types taking up residence in Bowden Urban Village needs to be undertaken to ensure that the capacity of current school infrastructure can cope with the actual growth taking place. In established areas, the increased density of planned development implies the need for a review of the capacity of existing infrastructure.

While some absolute costs were able to be determined from the review of budget documents and annual reports of state and local government agencies discussed above, the study demonstrates the difficulty of obtaining detailed information about government infrastructure costs for specific projects. Budget estimates and annual reports to Parliament as well as costs for local government infrastructure projects are often aggregated within broader programs. In addition, as in the case of Playford Alive, the costs for some aspects of infrastructure provision were provided as a total for the entire project, making it difficult to separate out works undertaken in each of the renewal and greenfield projects.

Some data could not be provided or apportioned to either local government or state government so were aggregated and presented as government cost since details of cost-sharing for open space and street infrastructure upgrades were not available. The lack of coordination of infrastructure information and planning across state government has been previously recognised and was one of the triggers for the planning system review which has recently taken place in South Australia (see *UrbanAnalyst* 2011). It is no surprise that one of the recommendations of the Expert Panel on Planning Reform is for a single statutory framework that brings together planning, prioritisation, coordination, funding and delivery of infrastructure under one umbrella that is integrated with zoning and assessment decisions (Government of South Australia 2015).

Regardless of the framework in place, both developers and government need to pass on costs of infrastructure and services. Although this paper has not analysed how these costs are being passed on, it was noted that for the Bowden Urban Village development, the City of Charles Sturt expects all additional costs incurred for infrastructure and services to be covered by rates for the new dwellings. Whilst, with suitable analysis, the required local council rate increase to cover recurrent maintenance may be calculated, the longer term replacement cost of infrastructure as it reaches the end of its life does not appear to be factored in to the government cost estimates discussed above.

The delivery of higher quality public realm in some areas (see the *Urban Design Guidelines* for the Bowden Urban Village (Renewal SA 2014)), and the additional maintenance cost to local government in the new areas may result in increased expectations in surrounding areas. The capacity of local and state governments to deliver higher standards of maintenance in the public realm has been raised in respect of the Adelaide Park Lands upgrade adjacent to the Bowden site. Indeed, the cost of upgrades to the Park Lands comprises the majority of the relatively low government infrastructure cost per dwelling for the Bowden Urban Village project. Decisions about the standards for streetscapes and transport infrastructure are important, particularly as there is increased demand for infrastructure that meets multiple objectives such as high quality urban design and active/healthy living. While the assessment of the capacity of government to meet these multiple objectives and to provide ongoing maintenance was beyond the scope of this study, it should be assessed further as the South Australian government wants infrastructure planning to be integrated with urban planning and to be funded through a standardised framework that spreads the cost burden (Government of South Australia 2015). The state government has listed mechanisms such as long-term value capture or improvement levies and tax increment financing as options to manage affordability. Further work may need to be undertaken to determine the potential impact of these mechanisms on developers, local government and house buyers. Any increase in standards of infrastructure should be assessed for affordability, particularly if they are to be applied across all urban areas rather than to specific new developments. If the latter, the question of whether similar standards will apply to both greenfield and infill is pertinent.

Conclusion

This paper has examined three cases of residential development in metropolitan Adelaide, attempting to identify infrastructure cost factors borne by developers and government. It provides an estimate of costs per dwelling for these cost factors in each case. It is clear from the analysis that the costs for infrastructure for the infill development at Bowden are approximately one third that of the fringe Playford Alive project. The infrastructure cost factors for both the greenfield and renewal areas of the Playford Alive project are surprisingly similar which may reflect a lack of capacity in some infrastructure or the need to upgrade standards of infrastructure in the renewal area. In general the evidence suggests that it is less costly in infrastructure terms for government to develop on infill sites rather than greenfield sites. The evidence from the current analysis and previous studies suggests this is also the case for developers. However, there is some evidence to suggest that developer's construction costs can be higher in infill situations, which may go some way to explaining the resistance on the part of the development industry to current urban growth policy. More research is needed and better quality comparable data required to clarify much of this debate. Policy needs to recognise the variety

of circumstances that exist, especially in respect of the capacity of existing infrastructure and land ownership patterns that can impact on development costs for both government and the development industry. The findings of this study align well with previous studies that have assessed the costs of providing infrastructure for infill and greenfield development. In addition, this study confirms the importance of understanding the capacity of the existing infrastructure to cope with growth and the extent to which infill development renews established areas. As governments plan for increased density of dwellings and population in established areas, they should ensure they understand and direct development toward areas where there is spare existing infrastructure capacity. In addition, government should develop mechanisms to fund infrastructure shortfalls that may limit infill development. Where government proposes mechanisms to spread the cost burden of new infrastructure, the standards for such infrastructure should be agreed beforehand so developers may make informed decisions about where and what they build.

Disclosure statement

No potential conflict of interest was reported by the authors.

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