URBAN INFILL: EXTENT AND IMPLICATIONS IN THE CITY OF MONASH

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The Melbourne 2030 planning scheme seeks to promote housing development in and around activity centres. However, there has been no progress in achieving this aspiration. This study shows that, for the City of Monash, infill constituted almost all the new housing development between 2000 and 2006. The infill was mapped and shown to be dispersed throughout the city. Very little occurred in the vicinity of activity centres or railway stations.

INTRODUCTION

Under the Melbourne 2030 strategic plan, the Victorian Government sought to curb the spread of suburbs on Melbourne's frontier by enabling urban consolidation. Previously, demand for new housing was met through the subdivision of green-field land on the urban fringe, dispersed infill (such as new dwellings in the back yards of existing dwellings) and major projects, particularly in the inner Melbourne area. Since the legislation of Melbourne 2030 in 2002 there is a new focus. This is development in activity centres within easy access to established public transport.

The Urban Development Program (UDP), a major initiative of the Victorian Government to support the implementation of Melbourne 2030, was established in 2002. It is currently monitoring the development of the green-field subdivisions and major project residential infill developments, but not dispersed infill.[1] Thus there is little official information on the level of dispersed infill. The Melbourne 2030 planning documents have nothing to say about possible infill in established suburbs outside the boundaries of activity centres. One study suggests that some 35 per cent of new dwellings in Melbourne take the form of infill.[2] This paper explores the extent and location of infill between 2000 and 2006 in one of the thirty-one local government areas in the Melbourne Metropolitan Area (MMA): the City of Monash.

Analyses of infill development and its associated impacts to date rely on coarse-scale input data. One study, for instance, aggregated land parcels into 1-kilometre grid cells,[3] and others used Australian Bureau of Statistics (ABS) yearly dwelling approval and dwelling stock records at five year intervals.[4] Greater local detail can be derived from analysis of building approval data,[5] or the analysis of development applications (DAs) and time-series cadastral datasets (described below) held in Building Commission and local government databases, respectively. In addition, some information has been derived from interviews with policy makers,[6] and from visual analysis of cadastral data.[7] The broad area analyses are interesting but of limited use to local government planners (the main guardians of land-use planning practice). Accordingly, the 35 per cent figure cited above is, at best, a rough estimate and offers no detail with regard to geographical patterns of infill. We argue here that the data streams and the technology for handling them have recently become such as to support the detailed analysis so far missing from decision support and analysis.

Even though authorities in Australia have adopted the digital revolution in many ways, including mapping, the automation of digital spatial data integration for infill mapping has so far been more of an aspiration than an achievement. Constraints include, among other things, difficulties in

securing the necessary data flow path prerequisite to the land parcel subdivision pattern mapping of the kind that can reveal which land parcels have been re-developed, and in what way.

This paper presents a methodology for, and the results of, the mapping and analysis of infill patterns, land parcel by land parcel for the City of Monash (Figure 1), a local government area of 81.5 square kilometres, which is located in the eastern suburban region of the MMA.

DWELLING STOCK IN THE CITY OF MONASH IN 2001 AND 2006

Table 1 shows something of the nature of the last inter-censal period change in residential dwelling structure in the City of Monash. It indicates that discrete dwelling ('separate house') totals declined by 1.4 per cent. In contrast, medium development density, (both in 'semi-detached, row or terrace house' and 'flat unit or apartment' dwelling structure types) increased by 42.3 per cent and 35.7 per cent respectively between 2001 and 2006. These figures suggest that infill development has been occurring on a significant scale in the City of Monash.

INFILL MAPPING: THE DATA FLOWS

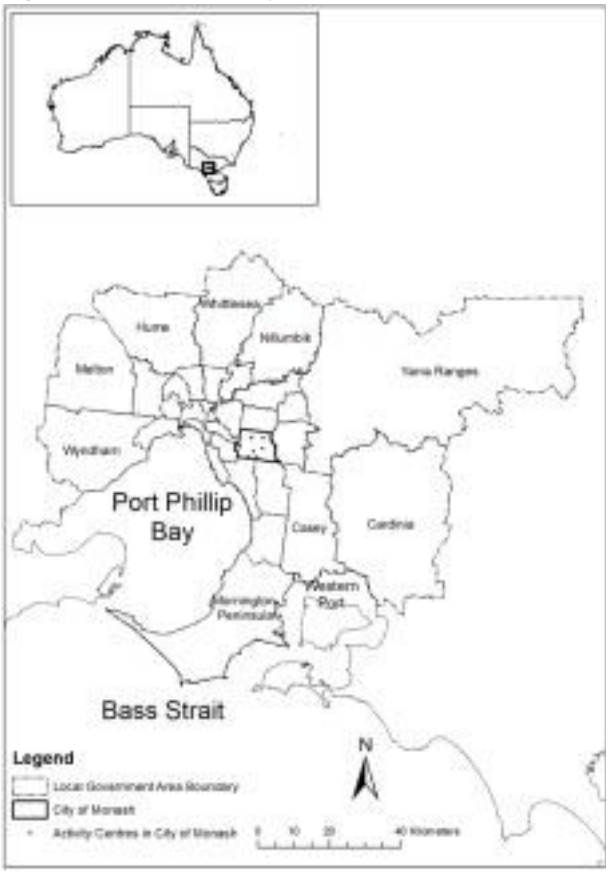
The term 'infill' has been used to refer to:[9]

- two or more new medium-density dwellings constructed on sites that were formerly occupied by detached houses or
- improvements on vacant lots in areas originally established by land parcel subdivision for suburban settlement in detached houses.

Following the ABS, a dwelling can be: a separate house; a semi-detached, row or terrace house, townhouse; a flat, unit or apartment; or other dwelling.[10]

In the following analysis, we present a spatial data handling flow path designed to identify infill as defined above between December 2000 and October 2006 (Figure 2). All datasets (for example cadastre,

Figure 1: Location of study area



Notes: The Melbourne Metropolitan Area (MMA) is shown together with the administrative boundaries of its constituent 31 local government areas, as defined by the municipal amalgamations of 1996. The map shows the City of Monash in the South East of the MMA.

address point, planning scheme and Melbourne 2030 activity centres) used in this study were assembled from Victorian Spatial Data Infrastructure and Department of Planning and Community Development sources. We acknowledge access to City of Monash aerial photo coverages for 1999, 2001, 2005 and 2007.

The cadastre is a register of the precise location, extent, value, use and ownership of land. Together with information about improvements (for example buildings), the

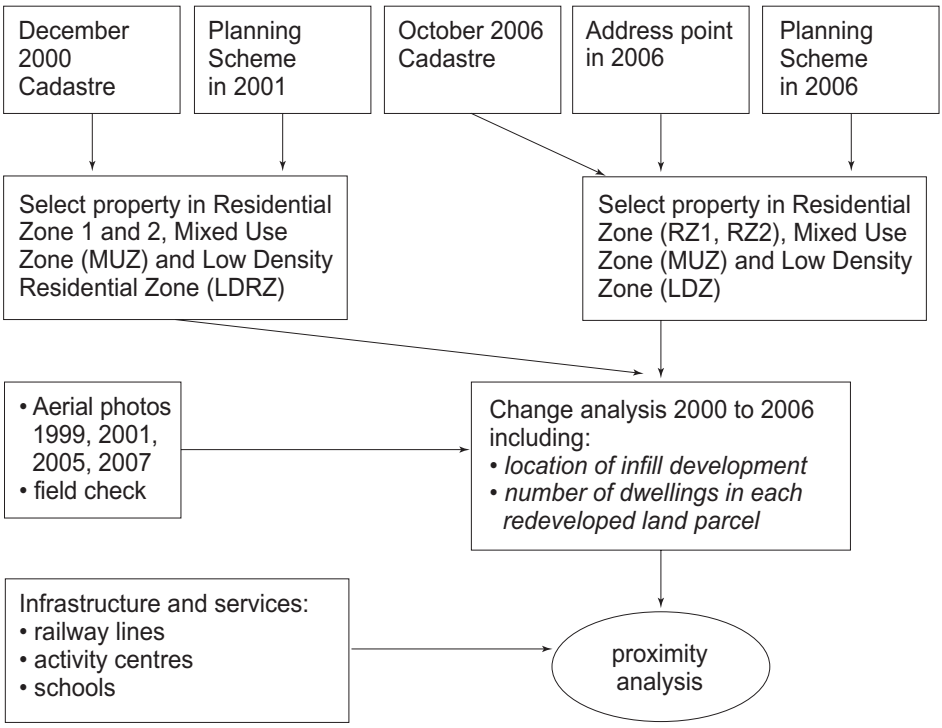
Table 1: Number of dwellings by dwelling structure type in the City of Monash, 2001 and 2006

Dwelling types	2001	2006	Change (total number)	Changes (per cent)
Separate house	47,697	47,043	-654	-1.4
Semi-detached, row or terrace house	4,051	5,766	1715	42.3
Flat unit or apartment	4,569	6,199	1630	35.7
Total	56,317	59,008	2691	4.8

Source: Time Series Profile Monash (C) (LGA 24970), ABS, Catalogue number 2003.0

Notes: During that time the population (by census night count) of Monash city rose from 156,898 to 161,936 (an increase of 3.21 per cent).[8]

Figure 2: Spatial data collection and analysis flow paths



cadastre is used to establish rateable land values, and so will be maintained and updated for, among other reasons, taxation purposes.[11] The Vicmap Address dataset (VADD) is a fully-geocoded digital street-address dataset. The records include the spatial relationship of each address to the relevant land parcel in the cadastre.[12] Urban addresses in metropolitan Melbourne are assigned eight metres back from the property road frontage mid-point.[13] Because in 2006 all dwelling non-spatial attributes (for instance, unit number, house number, or street name) are in VADD, we used both the property dataset and VADD for analysing the 2006 dwelling patterns. Other datasets, such as planning scheme boundaries and landmark datasets (including non-residential properties, such as abattoirs, camping grounds, caravan parks, car parks, cemeteries, parks, recreation areas, showgrounds and sports areas),[14] were also used to differentiate residential property from non-residential property. We validated the infill map derived from the datasets described by checking it against aerial photos and by field checks.

ANALYSIS

Interpreting the pattern of change

Each land parcel in the cadastral dataset is associated with its number and other attributes, such as plan number, lot number, or address number. Database selection query and validation tests using aerial photos were implemented and derived. Thus the residential infill component of urban form change has been mapped in Figure 3 (see inside back cover) using the five categories shown in Table 2. Most of the land parcel dwelling density changes refer to backyard sub-divisions or to land parcels redeveloped by demolition of old housing stock for replacement with from two to seven dwelling units (Table 2). The additional dwellings from infill between 2000 and 2006 accounted for 4.8 per cent

Table 2: Relative significance of density classes for infill developments between 2000 and 2006

Infill development class	Number of infill developments	Proportion (per cent)
2–7 dwellings	1455	98.11
8–19 dwellings	17	1.15
20–39 dwellings	7	0.47
40–77 dwellings	3	0.20
78–178 dwellings	1	0.07

Table 3: Summary of contribution of infill development to dwelling supply, 2000 to 2006

Number of dwellings in 2000	55778[1]
Number of infill development between 2000–2006	1483
Total number of dwellings from infill development	4147
Number of additional dwellings between 2000–2006	2664[2]
Per cent of additional dwellings by infill over the number of dwellings in 2000	4.8

Notes: In this calculation, we assume that every infill development occurred on a developed land parcel. In only a few cases (observed in aerial photos in 1999, 2001 and 2006) were there more than two dwellings developed on land classified in 2000 as vacant land.

[1] The estimated number of dwellings in 2000 using the total number of dwellings in 2001 and 2006 (Table 1)

[2] The number of additional dwellings equals the total number of dwellings from infill development less the number of dwellings subdivided as of 2000

of the total dwelling stock in 2000 (see Table 3).

Infill development and activity centres

Within the City of Monash, Melbourne 2030 designates the following activity centres:[15]

- one principal activity centre: Glen Waverley
- four major activity centres: Oakleigh, Mount Waverley, Brandon Park, Clayton, and
- one specialised activity centre: Monash University.

It is clear from Figure 3 and Table 4 that between 2000 and 2006 infill development did not occur preferentially around these activity centres. Indeed, within the 400m radius activity centre core zones, neither the Oakleigh major activity centre nor the Monash University specialised activity centre accrued any residential infill development during the period under review. The majority of infill development within 400m and 800m buffers surrounding all activity centres is of the least intensifying class. In these instances, one dwelling in 2000 had been replaced by two to seven dwellings by 2006. There is one example of denser infill (where one dwelling that had been there in 2000 had been subdivided into 25 dwelling multi-units by 2006) within 400m of the Glen Waverley principal activity centre. Overall, of the total number of dwellings mapped for 2000 and later replaced with denser infill developments,

Table 4: Infill development within activity centres

Activity Centres	Count	Min	Max	Sum	Percentage of total infill development 2000–06	Percentage of total dwelling addition 2000–06
400 metre buffer						
Glen Waverley	23	2	25	76	1.55	1.99
Clayton	28	2	6	75	1.89	1.76
Oakleigh	0				0.00	0.00
Mount Waverley	13	2	3	28	0.88	0.56
Brandon Park	5	2	3	12	0.34	0.26
Monash University	0				0.00	0.00
Sum					4.65	4.58
800 metre buffer						
Glen Waverley	103	2	25	248	6.95	5.44
Clayton	73	2	6	177	4.92	3.90
Oakleigh	30	2	27	97	2.02	2.52
Mount Waverley	46	2	3	96	3.10	1.88
Brandon Park	10	2	3	23	0.67	0.49
Monash University	39	2	4	100	2.63	2.29
Sum					20.30	16.52

Notes: Summary of infill developments by number of dwellings (count of land parcels sub-divided, minimum, maximum and the sum of newly extant dwellings), percentage of total added dwellings by infill development, and percentage of total infill development within the 400m and 800m buffers around each activity centre.

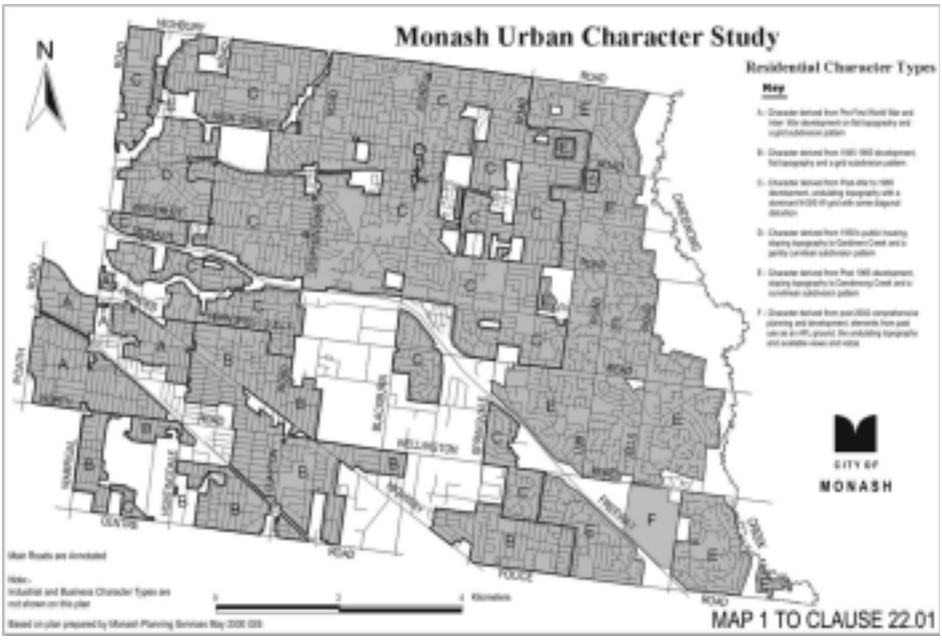
fewer than five per cent of them are found within 400 metres of any activity centre. Of course, some infill development occurred within 800 metres of activity centres. When infill within the 400 and 800 metre distances are added, they accounted for 20 to 30 per cent of all land parcel redevelopments between 2000 and 2006.

INFILL DEVELOPMENT AND THE PATTERN OF SUBURBANISATION

One possibility considered was that infill development has occurred in close proximity to railway routes. If so, such infill development might imply that access to railway stations is a factor in shaping the location of such development. However, Figure 3 and Table 5 show that infill development did not occur preferentially around the railway stations in the City of Monash. Approximately 10 per cent of infill developments occurred within 400 metres of railway stations. These contributed 7.2 per cent of additional dwellings in the period 2000 to 2006. The number of infill developments increases rapidly (from 9.7 per cent to 33.9 per cent) as proximity from railway stations decreases. Furthermore, in areas further from these railway stations (800m distance compared with 400m distance) the average land parcel area increases and so, therefore, does the scope for redevelopment by infill.

Figure 4 describes the different types of residential urban character identified within the City of Monash. Table 6 reveals that most infill developments (705 land parcel redevelopments) occurred in urban character class 'C' followed by class 'B' (403), class 'D' (108) and class 'A' (106). As would be expected, no infill development has taken place for class 'F' (this area was rezoned as residential land

Figure 4: Monash Urban Character



Source: Department of Sustainability and Environment, 2006[16]

after 2001) and very little for the 'second youngest' age-zone: class 'E' (Table 6). Table 6 also shows that the largest land parcel re-developed is in class 'C' (that is the green land parcel to the West of the city in the corner of Highbury Road, Figure 3). However, except for a small number of land parcels in class 'E', the median area of land parcel re-developed between 2000 and 2006 ranges from 690m2 to 760m2.

DISCUSSION

Comparison between the infill development map (Figure 3, inside back cover) and the Monash Urban Character (Figure 4) map show that between 2000 and 2006, infill development occurred in diverse topographic locations. These include:

- the flat areas around Oakleigh major activity centre
- topographically undulating areas around Glen Waverley principal activity centre and
- areas of sloping topography to the West of the Mount Waverley major activity centre.

Thus, it seems that the topographic characteristics of the site do not strongly influence the probability of a land parcel being subdivided.

Instead, Birrell et al. argue that it is property owners, small builders and developers acting as 'opportunistic players in the sense that the location of their investment depends on where properties come up for sale and their judgement of whether the market price for the detached house in question will allow a profitable redevelopment'[17] that explain the main aspects of infill development in Monash city. Observations from redevelopment project studies in California, America, also found that redevelopment proposals are generally more opportunistic than systematic:

> If a development proposal is deemed feasible from a regulatory, market, and financial perspective, it will tend to be pursued, regardless of whether other, potentially better, opportunities are available elsewhere.[18]

The findings of our study are consistent with this interpretation: that is, the land parcels are large and old enough for profitable redevelopment. For instance, Table 5 and Table 6 show that the average land parcel area where infill development occurred between 2000 and 2006 ranged from 700 to 900 square metres. As proximity to railway stations increases, the average land parcel area decreases. This suggests that rather than proximity to railway stations, it is land parcel size that influences the spatial location of infill development. Additionally, Table 6 shows that the majority of infill development occurred in the land parcels that are relatively old (developed from post-war to 1965). These post-war to 1965 land parcels are located in areas of Monash Urban Character type B and C (Figure 4).

Table 5: Proximity analysis of infill development and railway stations

Railway station buffer	Count	Min	Max	Sum	Percentage of total infill developments	Percentage of total additional dwellings	Average land parcel (square metres)
400m	144	2	7	335	9.7	7.2	773.8
800m	503	2	178	1453	33.9	35.7	873.9

CONCLUSION

This paper demonstrates an application of a data integration approach to infill development mapping in the City of Monash between the late 2000 and 2006. The relative significance of infill as a component of the residential area urban form change is identified in more detail than has been the case before. With regard to the City of Monash it was found that, between 2000 and 2006:

- small scale infill was the dominant component of residential urban form change between 2000 and 2006
- activity centres and railway stations are not the magnet for high density development as originally envisaged by the Melbourne 2030 policy
- the driving force for most infill development decisions appears to be 'opportunism', in the sense that any land parcel coming onto the market is soon likely to have one or two extra dwellings built on it, if it is large and/or old enough for profitable redevelopment.

The City of Monash infill pattern resulting is one mapped as a dispersed pattern of dual occupancy and unit development (Figure 3). The resulting redevelopment is thus unlikely to deliver many benefits of the type most sought under the Melbourne 2030 planning scheme. Rather, the existing pattern of transport within established suburbia, which involves a heavy reliance on the private car, will be adopted by those living in the new infill developments.

The datasets used in this study are maintained and updated, and so the results reported here will soon be out of date. Our future work will not only refer to up-dating, but also to the application of the approach adopted here to data about the other 30 local government areas in the Melbourne metropolitan area. Given the low temporal resolution of dwelling stocks data in census datasets (collected at five-year intervals), adoption of the detailed approach explored here would offer better support for local government planning decision support than seems to be available at the moment.

Table 6: Summary of land parcel sizes (mean, minimum and maximum) and urban character class

Urban Character Class (Figure 4)	Mean (square metres)	Min (square metres)	Max (square metres)	Median (square metres)	Number of infill developments
A	865.06	534.31	6597.43	734.88	106
B	776.87	418.47	3986.39	730.55	403
C	926.55	548.93	17103.24	759.73	705
D	722.62	475.55	1563.54	690.62	108
E	1516.59	642.91	4484.71	1121.47	43
F	—	—	—	—	0
Others	—	—	—	—	118

Notes: The 'others' class refers to residential land (defined as such under the 2001 residential zone planning scheme) but it is outside the classes A–F identified in Figure 4.

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