Sprawl and the City

Combining the qualities of suburban and urban living to create better residential infill

Anthony Duckworth-Smith
Wealthy and politically stable medium-sized, low-density cities like Perth in Western Australia consistently rank highly in global city liveability surveys. Apart from the benefits afforded by their security and prosperity these types of metropolitan areas tend to perform well against functional criteria such as accessibility of services and quality of infrastructure. This is despite the challenges of providing extensive networks to service a diffuse pattern of urban settlement. These cities, in terms of averaged measures of liveability, appear to be operating close to an optimal state balancing residential amenity with effective infrastructure and service provision.

Perth is predicted to experience substantial population growth well into the future. If current and historical trends continue, this will mean a continued expansion of a sprawling suburban development pattern across the metropolitan fringe. This would mean a shift away from its advantageous combination of metropolitan scale and form and a transition into a large-sized, low-density city. There is emerging evidence to suggest that if this is the case, it will struggle to sustain the qualities of living that it has been used to, as infrastructure becomes strained and reliance on the automobile makes travel more difficult and expensive.

To counteract this loss of ‘performance’ there is much support at a strategic level in Perth for a more compact city form where a larger proportion of new development is concentrated within existing urban areas. This type of development is referred to as ‘urban infill’ or ‘urban intensification’. Whilst this may make sense at the metropolitan scale the challenge for planners and urban designers is to consider what forms of urban infill will be appropriate in achieving this city-wide model. The compact city demands an alternative, more intense pattern of urban development. Perth is therefore at something of a crossroads in terms of defining its future form and character. Applied research is needed to develop the new products and practices required to achieve this different city form.

At the general level there are three ways in which urban infill can be achieved in a widespread fashion – Node, Corridor and Area (see over).

How can an understanding of the qualities of different residential environments be used to assess and improve urban infill in sprawling cities?

1 Definitions of liveability from global surveys vary widely with some assessments prioritising economic factors and others concentrating on lifestyle. The broadest definition would simply describe the degree to which a place supports different aspects and functions of life such as safety, employment, health, convenience and social and aesthetic needs.


Node

Node infill is characterised by the agglomeration of mixed use urban activity around a central facility or group of facilities, such as a train station or shopping area, and/or entertainment uses. Typically the residential typologies are high-density, medium- to high-rise apartment complexes.

Corridor

Corridor infill development consists of primarily medium- to high-density residential apartments distributed along a carriageway with road based public transport such as buses or light rail. The rear of the development often abuts an existing suburban area.

Area

Area infill is characterised by low- to medium-rise residential development occurring in a piecemeal fashion on existing suburban lots which are typically subdivided into smaller landholdings. Building typologies are usually standalone or grouped dwellings but may also consist of apartments.
The question often debated is which of these types of infill is the most appropriate – and further what are the challenges in making these residential environments broadly attractive and an enduring model for urban development? In order to answer these questions it is necessary to understand the relative qualities of living in different residential environments in these types of cities so that expectations are understood and the shortcomings of proposed models can be identified. In turn this would allow these to be addressed and the best case put forward.

There are many different ways in which the qualities of living in a particular place or what we may term a ‘residential environment’ can be assessed. Broadly these are either from the viewpoint of the expert or from experience. Whilst inhabitants provide valuable information based on lived experience, professionals are able to study more complex factors which require specialised knowledge. For example, health professionals are able to determine the likelihood of poor health outcomes from work. Therefore to be certain living arrangements and architectural aspects affect health, the likely quality of residents’ perceptions regarding the physical aspects of their residential environment such as pollution and noise as well as transport accessibility and availability of key services.

There is much research in the field of environmental psychology into residents’ perceptions of the quality of their built environments – what is termed ‘neighbourhood satisfaction’ or ‘perceptions of residential environment quality (PREQ).’ This field of work attempts to build assessment models based on a wide range of indicators which have been established through analysis and interviewing residents. Results are often comprehensive though technically complex. Many

The structure of the assessment framework developed in this document works down from an urban metabolism framework and up from the study of a number of conceptual and analytical approaches to residential environment quality. The metabolic framework provides an overarching categorisation of urban functions and ensures that the diverse elements of the urban system are represented. In order to focus on the residential environment the functional categories of the urban system have been translated into elements which are specifically related to the everyday act of dwelling. The resulting elements represent the key functional domains of the residential environment nested within the broader urban metabolic framework.

**Metabolic Framework**

<table>
<thead>
<tr>
<th>Dwelling Quality</th>
<th>Amenity Security Quality of Life Resource Intensity Social Protection Household Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protection</strong></td>
<td><strong>Amenity</strong></td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td><strong>Quality of Life</strong></td>
</tr>
<tr>
<td><strong>Transmission</strong></td>
<td><strong>Resource Intensity</strong></td>
</tr>
<tr>
<td><strong>Community</strong></td>
<td><strong>Social</strong></td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td><strong>Household Economy</strong></td>
</tr>
</tbody>
</table>

The elements of the functional framework for dwelling are populated with criteria which are derived from a range of conceptual and analytical frameworks related to residential environment quality. These draw on both expert and layperson viewpoints. A performance objective is described against each criteria and a method of measurement formulated. The following studies provided useful guidelines for developing the assessment criteria and objectives utilised in this study:

- The Grattan Institute study ‘What Matters Most? Housing Preferences Across the Australian Population’ examines the relative value that people place on different criteria describing the qualities of residential environments. In Perth a similar study was undertaken in 2013 – ‘The Housing We’d Choose’. The criteria and their organisation were slightly different but similar enough to enable a comparison of results. The comparative analysis used in this study sought to establish criteria that were clearly confirmed as important for the majority of households from both surveys.

- The World Health Organisation Quality of Life questionnaire (WHOQoL-100 Australian Version) gives useful insights into key spatial factors which are associated with health outcomes. For example, several questions relate to respondents’ perceptions regarding the

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of the indices utilised are not directly related to spatial design decisions, such as residents’ upkeep of properties, and are difficult to quantify. If these are excluded, however, a useful set of indicators for measurement of the qualitative aspects of the residential environment can be developed from this literature. This field tends to confirm the importance of security, unpolluted areas, green space and connectivity to important services.

- The development of indicators to measure the performance of residential environments in terms of resource intensity was guided by relevant categories of measurement frameworks offered by the US Green Building Council’s Leadership in Energy and Environmental Design (LEED) for Neighbourhood Development. This document and others such as ‘Liveable Neighbourhoods’ are also useful when looking at the measurement of amenity aspects of the residential environment. They attempt a quantitative assessment of particular qualities of places, and whilst the frameworks are not applied meticulously in this study they provide useful guidelines relating to which criteria are important to measure at various scales.

- EnviroDevelopment™ is an assessment scheme for new urban developments developed and adopted by the Urban Development Institute of Australia (UDIA) and is aimed at documenting outstanding performance against six key project elements. Residential environment quality for higher density developments such as urban infill addresses such criteria as reduction in urban heat island, incorporation of green roofs and walls, collective gardens, noise control, provision of communal facilities and an engaging and inclusive public realm.

- The UK Design Council’s ‘Building for Life standard’ is the UK industry standard for new housing developments. It provides a number of recommendations with regard to design quality. It covers neighbourhood scale items such as access to facilities and public transport as well as promoting the sharing of streets, well designed public spaces and the availability of private space.

- The NSW State Environmental Planning Policy No.65 (2002) is perhaps the most comprehensive quality guideline for residential development in Australia. Its focus is primarily on design, that is aspects of amenity or quality which can be shaped through spatial design. The design guidelines were compiled by a large number of architects and designers working together over a substantial time period. It represents a comprehensive account of criteria which contributes to the quality of higher-density residential environments from the perspective of design professionals.

These documents represent the key inputs into the development of the assessment framework (criteria, objectives and indicators) contained within this book. There are thirty nine criteria with associated objectives and measurement indicators organised under the five functional elements – Amenity, Quality of Life, Resource Intensity, Social and Household Economics.

How can we make sense of what is a good performance – and be able to use this to inform an assessment of the different infill contexts under consideration? Firstly, we need to compare different residential environments to benchmark the range of possible scores. Ideally this would take place using a multitude of sample sites but that analytical burden is too great. Can we, however, choose two residential environments that are likely to give us an appreciation of the range of values as well as help inform decisions about urban infill?

To answer this consider that in sprawling cities urban infill is characterised as being somewhere in-between the offer of the ‘horizontal’ individual dwelling pattern in a suburb on the metropolitan fringe (Sprawl) and the ‘vertical’ living arrangement of an apartment complex within the CBD (City). The proposition is that this ‘middle ground’ of infill could potentially take advantage of the different qualities presented by both of these locations and provide a broadly attractive and enduring pattern of infill. The benchmarking therefore could select these two opposing residential environments to understand the distinctive qualities of each. With these two extremes of quality defined and understood it should be theoretically possible to understand the position of other kinds of residential environments on this quality spectrum. Therefore a preliminary assessment of the performance of other in-between scenarios such as different kinds of urban infill is enabled.

The measurement of each criteria contained within this book follows this method, describing the range of quality – to understand which, if any, urban context (the Sprawl or the City) shows a clear advantage in relation to...
the objective. Given this understanding a preliminary assessment is then made about the performance of the different infill contexts on offer – the Node, Corridor and Area.

This reveals two things. Firstly, the relative overall performance of each infill context with respect to the good and bad of the selected living environments. Secondly, through the identification of performance deficiencies against individual criteria, the scope of effort and investment required to improve each situation.

Finally, the method strives to recommend a way forward, to identify a preferred approach for urban infill based on an assessment of residential environment quality. The work is able to determine the pattern of urban development which offers the greatest quality and therefore has the greatest potential to provide a broadly attractive and enduring residential environment. In addition, the shortcomings of this pattern are scrutinised and recommendations/tactics made for its improvement – to make the best better and truly formulate the ‘best of both worlds’ which may hold the key to living in the future (un)sprawling city.
The purpose of this research is to try and understand the qualities of living in Perth and to use this information to inform priorities regarding the planning and design of urban infill to achieve attractive and enduring residential environments.

To this end, as the first step, the work proposes to benchmark the measurement framework by sampling two very different residential environments – the typical single dwelling in a modern suburb on the urban fringe (the Sprawl) and a typical apartment in the city centre (the City).

A standalone dwelling in the suburb of Butler is selected. This is a typical new suburb on the urban periphery of Perth in the northwest coastal corridor which has been designed using the New Urbanist principles of the ‘Liveable Neighbourhoods’ operational planning policy.

The apartment selected is in East Perth, in close proximity to Perth CBD. This dwelling is located in a typical contemporary development in an area which supports the largest number of high-rise, high-density residential buildings in the inner urban area of Perth.

These two extremes illustrate a range of performance in terms of their residential environments. One draws on the aspects of the ‘suburban dream’ and the other the convenience and diversity of inner-city living. The two vastly different contexts have been chosen to give the best indication of what constitutes good or acceptable performance against the quality criteria.

In order to make meaningful comparisons between sites there needs to be some guidelines to ensure we are comparing ‘apples with apples’.

Of course the units need to be identical but also there needs to be a common understanding of the scale of the denominator. For example, is the measurement an average across the suburb or does it relate to just the dwelling.

In order to enable the measurement and provide a consistent framework, which can then be used in the subsequent analysis, a number of different measurement scales were developed. The following pages illustrate the measurement scales using the two initial sample sites – the Sprawl and the City.

The following pages illustrate the sampling sites from the sprawling city of Perth used to benchmark the measurement framework.
Sampling Sites

The two suburbs which contain the specific sampling sites, Butler and East Perth are shown in red in relation to the metropolitan area of Perth.
The sprawl sample site is located in one of the outer metropolitan planning sub-regions. This is a large ‘finger’ of suburban lands which has extended along the northern coast of the city. This region has the highest stocks of undeveloped land zoned for (sub)urban expansion (greenfield) as well as the highest rate of land consumption for subdivision over the last ten years (WAPC 2014, p. 62). It is the most sprawling part of the city.

The city sample site is located in Perth city centre which belongs to the central planning sub-region. This territory contains some of the oldest urban settlement patterns in Perth and is chiefly defined by urban expansion up until 1980. Most urban infill has occurred in this region through rezoning of suburban lands, brownfield development and the construction of apartments in urban centres. The city centre location contains the most dense residential environments in the city.
// Base Data

The base data is used to describe the quantitative characteristics of each of the sample sites and is used in subsequent calculations.

<table>
<thead>
<tr>
<th>Measured Qualities</th>
<th>Sprawl</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Area (m²)</td>
<td>577</td>
<td>2991</td>
</tr>
<tr>
<td>Dwellings (No.)</td>
<td>1</td>
<td>111</td>
</tr>
<tr>
<td>Occupancy (pers/hhold)</td>
<td>2.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Vehicles (veh/hhold)</td>
<td>1.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Density (net,dw/ha)</td>
<td>17</td>
<td>371</td>
</tr>
<tr>
<td>Site Cover (%)</td>
<td>66</td>
<td>48</td>
</tr>
<tr>
<td>Communal Area (m²)</td>
<td>0</td>
<td>1017</td>
</tr>
<tr>
<td>Median House Price ($)</td>
<td>435k</td>
<td>588k</td>
</tr>
<tr>
<td>Floor area (m²/dw)</td>
<td>223</td>
<td>76</td>
</tr>
<tr>
<td>Bedrooms (No./dw)</td>
<td>3.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Full-time workers (No./hhold)</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Commute (km)</td>
<td>14.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Driving Age (%)</td>
<td>65</td>
<td>90</td>
</tr>
<tr>
<td>Building Height (Lv)</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Public Transport (% work trips)</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>Active Transport (% work trips)</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Family Size (child/fam)</td>
<td>1.9</td>
<td>1.3</td>
</tr>
</tbody>
</table>
The quality criteria, their objectives, the indicators used to gauge performance against them and their comparative measurements are developed and then used to inform a preliminary assessment of the different infill contexts.
Amenity

List of criteria

A1 Naturalist
A2 Openness
A3 Noisescape
A4 Privacy
A5 Parklife
A6 Pleasure Garden
A7 Stargazer
A8 Walkability
A9 Freedom Machine
Access to nature is pleasing and beneficial to humans, particularly those living in urbanised areas. But how much of the land surface is actually close to a more natural state? The sub-region gives an average representation of land use assignment in the sample urban context.

This indicator measures the proportion of land area devoted to parks, recreation and state forest in each sub-region.

The suburban context is replete with natural territories whilst in the city it is clearly sparser and more difficult to find.
A3 Noisescape

Noise levels are consistently cited as an important factor by residents when considering the overall quality of their residential environment. Conventional housing designs do not typically deal with environmental noise in an effective manner.

**Background night-time noise levels** were calculated using a method of Assigned Noise Levels taking into account land use and transport.

The night-time noise level in the suburb where traffic dissipates and residential uses are predominant is perceived as half that of the city. This allows relaxed outdoor conversation and buildings can be naturally ventilated.

See also

A4 A6 Q5

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Sprawl

<table>
<thead>
<tr>
<th>dB(A)\text{L}_{10,\text{night}}</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
</tr>
</tbody>
</table>

City

<table>
<thead>
<tr>
<th>dB(A)\text{L}_{10,\text{night}}</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
</tr>
</tbody>
</table>

Infill

Node

Corridor

Area

Concentration of traffic density and mixed use

Typically adjacent to high traffic volumes and speeds

Dispersed receivers generally away from major noise sources

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It would seem that the city fabric, planning frameworks and policies do a good job in providing a quantity of parks for residents, no matter where they live.

Parks are a tried and tested amenity of an urbanised area. Public parks in urban areas were formalised in the nineteenth century to provide opportunities for health and wellbeing in the face of accelerated urbanisation. Today their value to people is widely recognised and they are legislated through urban planning policy.

This indicator measures the number of formal parks available to each resident within a walkable catchment.
A6 Pleasure Garden

Gardening is recognised as an activity and pastime which is not only pleasant but one with substantial health and wellbeing benefits as well as supporting community development and fostering personal skills.

This indicator measures the amount of private and communal ground floor open space available for gardening per person.

The suburban life has more than enough room to get your hands in the earth owing to the large areas of private open space.

<table>
<thead>
<tr>
<th>Sprawl</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>107 m²/pers</td>
<td>12 m²/pers</td>
</tr>
</tbody>
</table>

See also

A1, R4, R5, S3

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Q5 Air Quality

Improving the air quality of residential environs was one of the initial reasons for the development of suburbs. It is also a consistent aspect of people’s residential preferences and is linked to various health outcomes. Ironically the desire to live in clean, uncrowded and unpolluted areas has meant a dramatic increase in the use of combustion-powered motor vehicles whose emissions are concentrated in areas of traffic density.

This indicator uses DEC monitoring sites to estimate the percentage of allowable NO₂ concentration averaged over a one-year period.

Air quality is substantially better in the suburbs typically located away from arterial roads and congested areas.

<table>
<thead>
<tr>
<th>Sprawl</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>12%</td>
<td>59%</td>
</tr>
</tbody>
</table>

allowable NO₂  allowable NO₂

Node Corridor Area

Concentration of traffic typically in congested conditions
Dwellings located in close proximity to large traffic volumes
Urban context but typically located away from sources with interception possible

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R1 Embodied Energy

Embodied energy refers to the equivalent amount of energy required to produce and deliver the building materials required and have them assembled to deliver a particular product. In this instance it refers to the dwelling, consisting of just the building.

This indicator converts the amount of energy required per m² of Usable Floor Area (UFA) into the equivalent weight of coal that would be required to be combusted to yield this.

The ‘cottage’ technique of building, which doesn’t require complex engineering or excavation, is significantly less energy intensive than high-rise techniques.
R4 Carbon Storage

Trees are able to sequester carbon dioxide from the atmosphere and therefore potentially offset one of the significant emissions which contribute to global warming and climate change.

This indicator measures the amount of annual carbon emissions from daily household electricity use able to be sequestered from intensive tree planting in private open space and the verge.

The suburban lot has a relatively large area of open space per resident that could potentially accommodate tree planting.

<table>
<thead>
<tr>
<th>Sprawl</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

CO₂-e emissions/ hhold

**Sprawl and the City**

See also

A6 Q5 R1 R2 R7 E1

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The concentrated dwelling of the city clearly requires less road surfacing per person to support it. The area of asphalt (and other types of bituminous road surfacing) at the neighbourhood scale that is required to sustain habitation is an indicator of the amount of local infrastructure (e.g. drainage pits, pipes and wires, road building materials, etc.) required to sustain a pattern of dwelling. It also reveals the amount of hardscape which gives a first order indication of possible local heat absorption and urban heat island impacts.

**This indicator measures the amount of road surfacing required per person.**

**Sprawl**

**City**

<table>
<thead>
<tr>
<th>81</th>
<th>7</th>
</tr>
</thead>
</table>

$m^2$/pers

The concentrated dwelling of the city clearly requires less road surfacing per person to support it.

**Infill**

- **Node**
  - High-density concentrated infill makes efficient use of resources

- **Corridor**
  - Medium- to high-density linear infill moderately efficient

- **Area**
  - Distributed pattern still requires investment in streets
This section puts forward urban planning and design tactics to overcome poor and average results of the best performing infill context to demonstrate the way to achieve high quality urban infill and meet the study objectives.
Appendix A: Methods of Measurement

This appendix provides technical information and references with respect to the methods of measurement for the indicators.