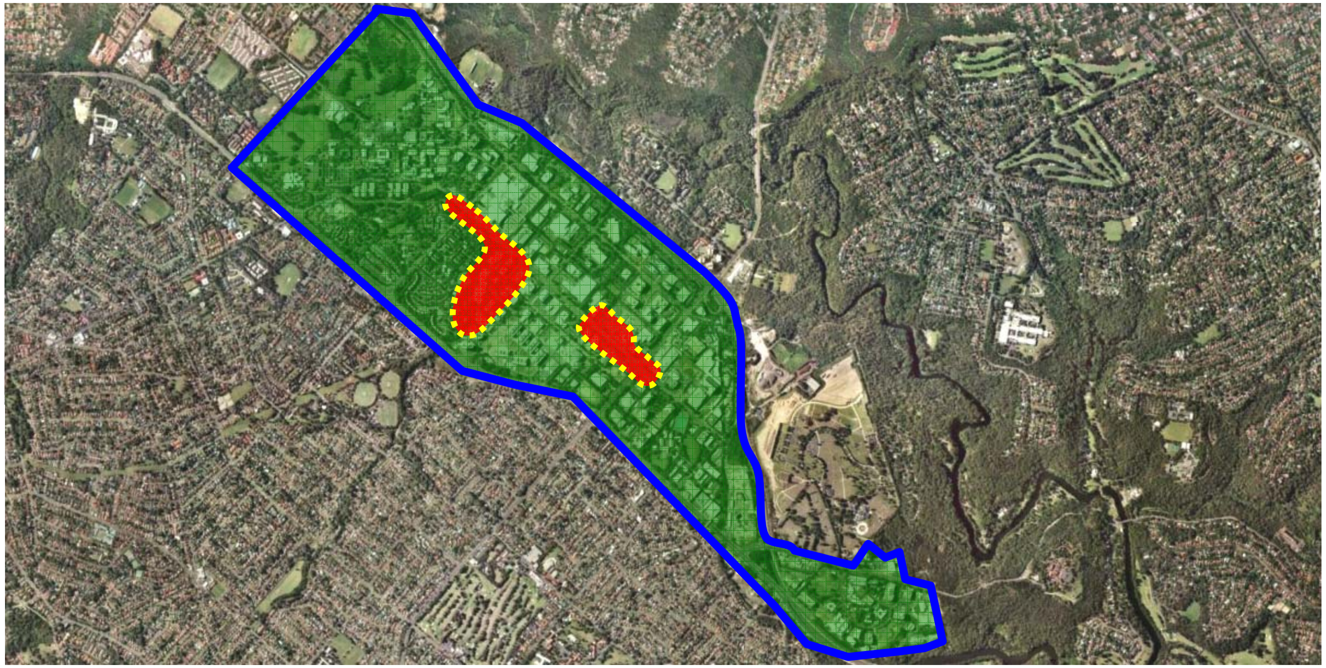
Macquarie Park
City of Ryde Council



Baseline Movement Economy Report

Final Report

1 December 2009

Space Syntax

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Report reference

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1.1 Executive Summary Key findings

A priority of the international agenda on sustainable cities is that high levels of pedestrian movement are a proven requirement for economically successful and socially cohesive urban centres. High performing pedestrian movement infrastructures are equally important to make urban centres safe and secure.

The City of Ryde Council (CoR) and the State Government wish to plan strategically for Macquarie Park's growth by increasing its economic and social performance. Council appointed Space Syntax to provide a baseline Movement Economy Report to advise on the functional performance of its urban layout, pedestrian movement infrastructure and land use potential.

A central question for enhancing economic and social sustainability in Macquarie Park is whether the proposed distribution of land uses is spatially integrated with the pedestrian and vehicle movement infrastructures to produce a **local movement economy** (description page 14).

Space Syntax's strategic design shows how the effects of a viable pedestrian infrastructure, passing trade and natural surveillance, would improve development certainty, property value and social cohesion. The goal is to strategically design movement infrastructures so that "attractor" buildings work productively with efficient urban layouts to generate local movement economies.

KEY FINDINGS

Significantly improved urban layout to generate increased pedestrian activity and two potential urban villages

Macquarie Park's Development Control Plan (DCP) 2008 Structure Plan can be refined to achieve an efficient and productive pedestrian movement infrastructure. Space Syntax analysis of its proposed Pedestrian Structure Plan shows that a refined pedestrian infrastructure would help improve Macquarie Park's economic and social sustainability across the whole site, as well as helping develop two potential urban villages. Pedestrian use of public transport for the three new railway stations would also be expanded. The Plan would enable more people to participate in the local economy of Macquarie Park.

The first potential village would be located along the northern part of Shrimpton's Creek to the Macquarie Shopping Centre, extending west to Byfield Street, and also extending along Waterloo Road to Herring Road. The second potential village would be located around the DCP park on the northern side of Waterloo Road, between proposed Roads 8 and 9 in DCP Structure Plan (figure 1.8) and extend along Waterloo Road to Land Cove Road. Waterloo Road would become a major pedestrian route between the two potential villages.

The potential urban villages identified in the Pedestrian Structure Plan are composed of strategic routes that would be realised only when suitable land uses are located directly on these routes to match good levels of pedestrian and vehicle movement.

Movement-seeking land uses, such as retail and commercial would migrate to the strategic movement-rich streets, producing multiplier effects, which attract more land uses to an area and help grow the villages' critical economic mass. The process is called the movement economy. It is a dynamic relationship between the high spatial accessibility of urban layouts, good levels of pedestrian and vehicular movement, and the appropriate distribution of land uses.

For economic activity to improve, at the detailed level the proposed streets and pedestrian ways across Macquarie Park require increased densities, reduced setbacks and continuous, active frontages with direct public entrances facing the proposed routes.

Spatial Accessibility

An important part of this Report is the Spatial Accessibility analysis of Macquarie Park's DCP adopted by Council in June 2008. This Report's Vehicle Accessibility analysis shows that the proposed DCP's street layout improves vehicle route choice potential across the network, as indicated in the Macquarie Park Traffic Study - key conclusion point 4.

Space Syntax's Pedestrian Accessibility analysis shows that the DCP's pedestrian route choice potential is also partially improved. Strategic design scenarios investigated in this Report, forecast that pedestrian route choice potential can be greatly improved to achieve efficient pedestrian accessibility across the site.

The objective is to strategically structure the public realm so that a sustainable distribution of pedestrian activity can be achieved while avoiding the problems of under-used streets and other public spaces.

Spatial accessibility analysis indicates that, depending on the forthcoming masterplans of the Macquarie Centre and Macquarie University, pedestrian movement along Herring Road would increase. The analysis also shows that there would be increased movement potential along Waterloo Road, from Herring to Khartoum Roads, and in the area around Byfield Street, south of Waterloo Road (figures 1.4 - 1.7).

A more difficult location to increase accessibility and pedestrian activity is around the heavily trafficked area along Lane Cove Road and further east, between Waterloo and Wicks Road.

Urban Layout (figures 9.9 – 9.14)

Depending on the configuration of streets in an urban area, pedestrians have either easy or complicated access to facilities. Ease of movement increases pedestrian activity in streets, as well as enhancing public safety.

Finely grained blocks connected by strategic routes make pedestrian movement more easily navigable. Size and block shape determine trip length and travel time for all journeys from any origin to any destination in a network.

The analysis shows that the DCP 2008 would change the existing sparse urban layout of very large block sizes. Existing blocks of up to 240,000m^2 would be reduced to an average of 18,000m^2 sized blocks, with five 8,000 m^2 blocks around the proposed DCP park on Waterloo Road. The shortest perimeter walking journeys for the above block sizes would be 24.5 minutes, 6.7 minutes and 4.5 minutes respectively.

The proposed routes in the Pedestrian Structure Plan reduce the average block size to increase easily navigable pedestrian movement . This is achieved by establishing managed pedestrian rights-of-way across large blocks and past existing buildings. For increased retail and commercial performance, Space Syntax recommends block sizes should average between 5000m^2 and 10,000m^2 with no more than 5000m^2 blocks in the two potential urban villages.

Route choice for pedestrian movement is significantly improved when block sizes are less than 5,000m^2 . The shortest perimeter walking time is 3.5 minutes. Smaller block sizes enable people to select a number of different routes to access urban facilities, making it possible to link a “chain” of destinations and facilitate multi-purpose journeys. Successful urban centres typically have a network of activated streets rather than a single street.

Pedestrian Observation Study (figures 4.1 to 4.12)

The analysis shows that when pedestrian movement is measured in hourly averages per day Macquarie Park has very low pedestrian movement compared with successful urban centres.

Movement levels are concentrated along Herring Road from Epping Road past the Waterloo Road intersection nearly as far as Talavera Road, and also between Macquarie Shopping Centre and Macquarie University.

On a weekday and at the weekend, the highest movement levels occur either side of the pedestrian crossing on Herring Road between the university and the shopping centre. On a weekday similar movement levels extend west to the shopping centre’s entrance on Waterloo Road of the. Similar movement levels were recorded on Lyon Park Road between Giffnock Avenue and Epping Road. Waterloo, Talavera and Lane Cove Roads have very low weekday and weekend pedestrian activity. Lane Cove and Waterloo Roads’ intersection has very low weekday and weekend pedestrian movement levels, as does the Delhi Road site, although weekday peaks on Julius Street are equivalent to levels on some parts of Herring Road.

Land Uses (figures 9.1 – 9.2)

The majority of land uses in Macquarie Park are commercial offices. The survey shows that retail land uses are mainly confined to the shopping centre. The shopping centre and the university act as important attractors for pedestrian and vehicle movement.

A growing number of cafes are dispersed across Macquarie Park. Most cafes are note easily accessible for street passers-by. Instead they are reliant on populations in individual buildings for their trade. There is a small concentration of retail land uses on Land Cove Road which are associated with hotel accommodation across the road. Residential land uses are divided into two precincts – one near Shrimpton’s Creek and the other north of Talavera Road.

Space Syntax recommends that:
(i)a greater diversity of land uses be distributed through the potential urban villages, and

(ii)CoR investigates the possibility of increased densities in some residential areas (eg along Herring Road) and for mixed use developments in areas adjacent to railway stations (eg North Ryde) to improve economic and social sustainability.

Vehicle infrastructure (figures 7.1 – 7.12)

Space Syntax modelling of movement infrastructures investigates road network configurations to provide an immediate view about how traffic circulation would be distributed across an entire system for all routes. It shows the degree of route choice potential from lanes through streets to motorways. The modelling forecasts how changes to any selected route or group of routes would affect the whole network.

Macquarie Park currently performs as a car dependent site. Spatial accessibility analysis shows high vehicle route choice for the arterial network and low pedestrian route choice, because the very large blocks produce very long walking distances to facilities. Strategic design scenarios in this Report demonstrate how to better integrate the vehicle and pedestrian infrastructures to help build a local movement economy.

The Macquarie Park Traffic Study (2008) recommends that road capacity in Macquarie Park needs to increase to accommodate the projected population growth to 2031, and suggests that important intersection improvements at Lane Cove and Waterloo Roads should accommodate a balance between vehicle congestion and pedestrian access demands. The study also suggests improvements at other intersections, especially along Herring Road, to achieve a balance between vehicle and pedestrian activity.

Space Syntax’s vehicle infrastructure modelling shows that increased route choice potential throughout Macquarie Park would reduce trip times and traffic congestion.

1.3 Executive Summary Key findings

Urban Structure:
Street Frontages and Building Entrances for Natural Surveillance and Urban Safety (figures 9.3 – 9.6)
The survey shows that in Macquarie Park most of the site has either long, continuous blank walls or semi-transparent frontages (partially glazed walls or with setbacks). There are very few transparent frontages (walls with doors and windows) and they are segregated from each other in localised areas where specialised retail land uses are sited.

The presence of transparent frontages (walls with doors and windows) around public spaces is an important element of a well functioning built environment. Facades with entrances opening directly onto the public realm encourage pedestrian activity and contribute to the natural surveillance of streets. Where frontages have direct physical access to the public realm, there are more "eyes on the street", and this improves urban safety

For most buildings, entrances are either unrestricted (public entry is not limited and available to all) or controlled (public entry is limited, say for security reasons). Where large numbers of unrestricted entrances face adjacent streets, they contribute to the natural surveillance of the street and pedestrian activity in the public realm.

The survey shows that most of Macquarie Park has controlled entrances to its buildings and they are very sparsely distributed. Space Syntax suggests that more unrestricted entrances, especially around the potential urban villages, will improve urban safety through the presence of greater pedestrian activity.

Strategic Design
(pedestrian figures 10.1 – 10.33)
(vehicle figures 11.1 – 11.25)
(public transport figures 12.1 – 12.6)
(block size figures 13.1 – 13.13)
Space Syntax produced numerous strategic design scenarios for improving Macquarie Park's pedestrian movement infrastructure. Each scenario investigated different configurations of the urban layout to understand the possibilities of the Park. The pedestrian observation study and block size analysis informed the development of the strategic design scenarios.

Two options were selected in consultation with CoR. A maximal option considered many new strategic routes across the site, and recommended option was determined by through-site limitations. The recommended option, the Pedestrian Structure Plan, is shown in figures1.4 - 1.7.

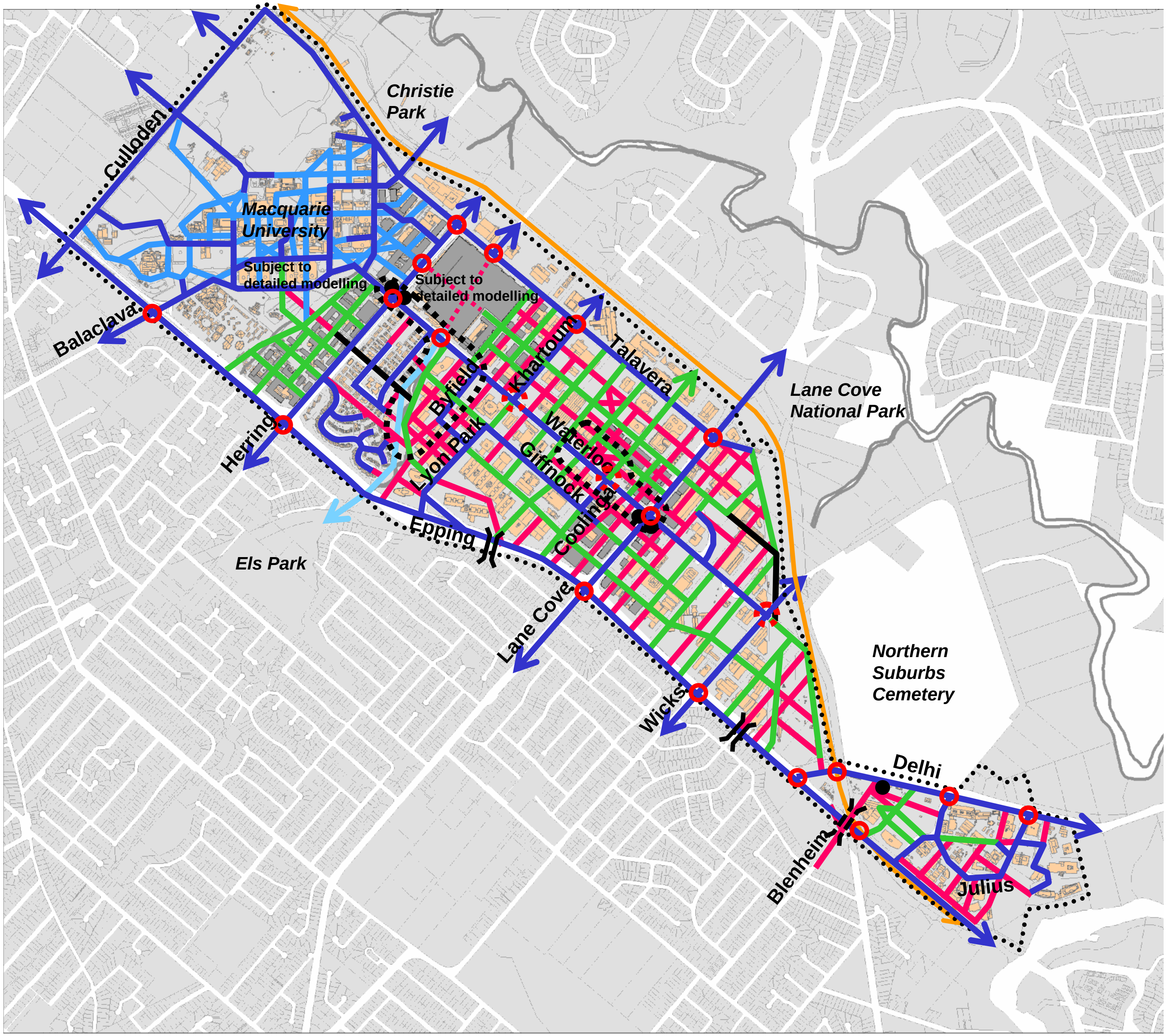
The chief benefit of the evidence-based investigation of Macquarie Park is that it has produced a reliable, objective database to inform CoR's planning, urban design and transport management, and:

(i) translate goals into measurable urban design standards and monitor their performance over time,

(ii) provide evidence of economic and social performance to inform negotiations between Council, infrastructure groups and development stakeholders.

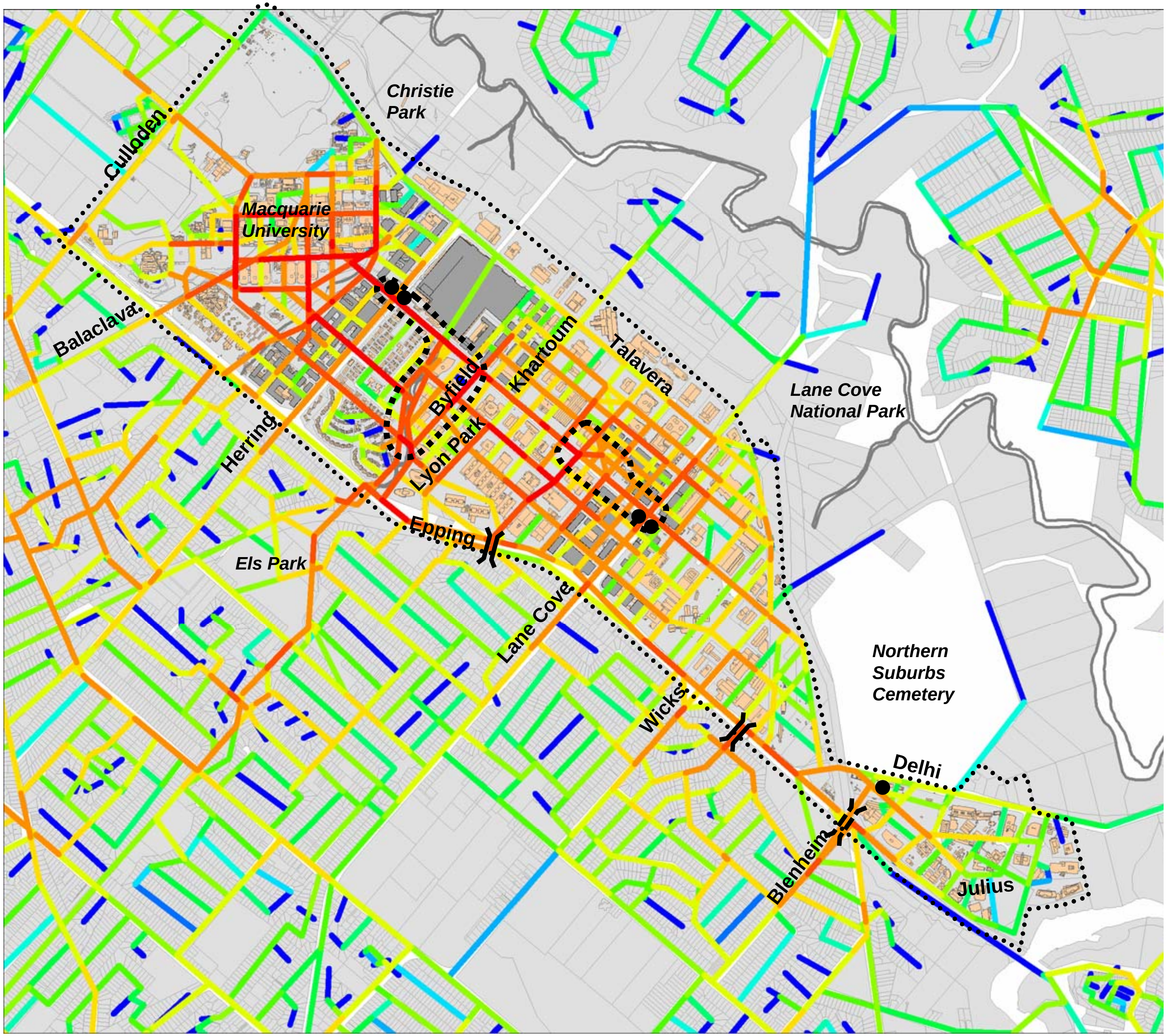
NEXT STEPS
Detailed high-resolution investigations and strategic design would be produced for the Station Precincts, including the Macquarie Park Shopping Centre and Macquarie University.

1.4 Executive Summary Proposed Pedestrian Structure Plan



- Space Syntax proposed pedestrian ways
- Space Syntax proposed streets subject to traffic modelling
- DCP 2008 proposed streets
- Existing streets
- Existing university pedestrian ways
- Existing creek pathway
- M2 Motorway
- DCP 2008 site boundary
- Existing signalised crossings
- Proposed signalised crossings
- Existing pedestrian bridge
- Possible pedestrian bridge
- Railway Station entrances
- Potential urban village for retail and commercial land uses

1.5 Executive Summary Spatial Accessibility analysis of proposed Pedestrian Structure Plan



Choice R800

Spatial Accessibility analysis of the proposed Pedestrian Structure Plan shows that two potential urban villages are achievable. The first village is located along the northern part of Shrimpton's Creek to the Macquarie Centre around Byfield Street, and extending along Waterloo Road to Herring Road. The second village is around the park (proposed in the DCP) on the northern side of Waterloo Road, between Roads 8 and 9 (proposed in the DCP) and extending along Waterloo Road to Land Cove Road.

The site's future is determined by the DCP 2008 and the 2030 Metropolitan Strategy. The Strategy's designation of Macquarie Park as a 'Knowledge Corridor" would be enhanced by the advent of two potential urban villages.

Existing pedestrian bridge

Possible pedestrian bridge

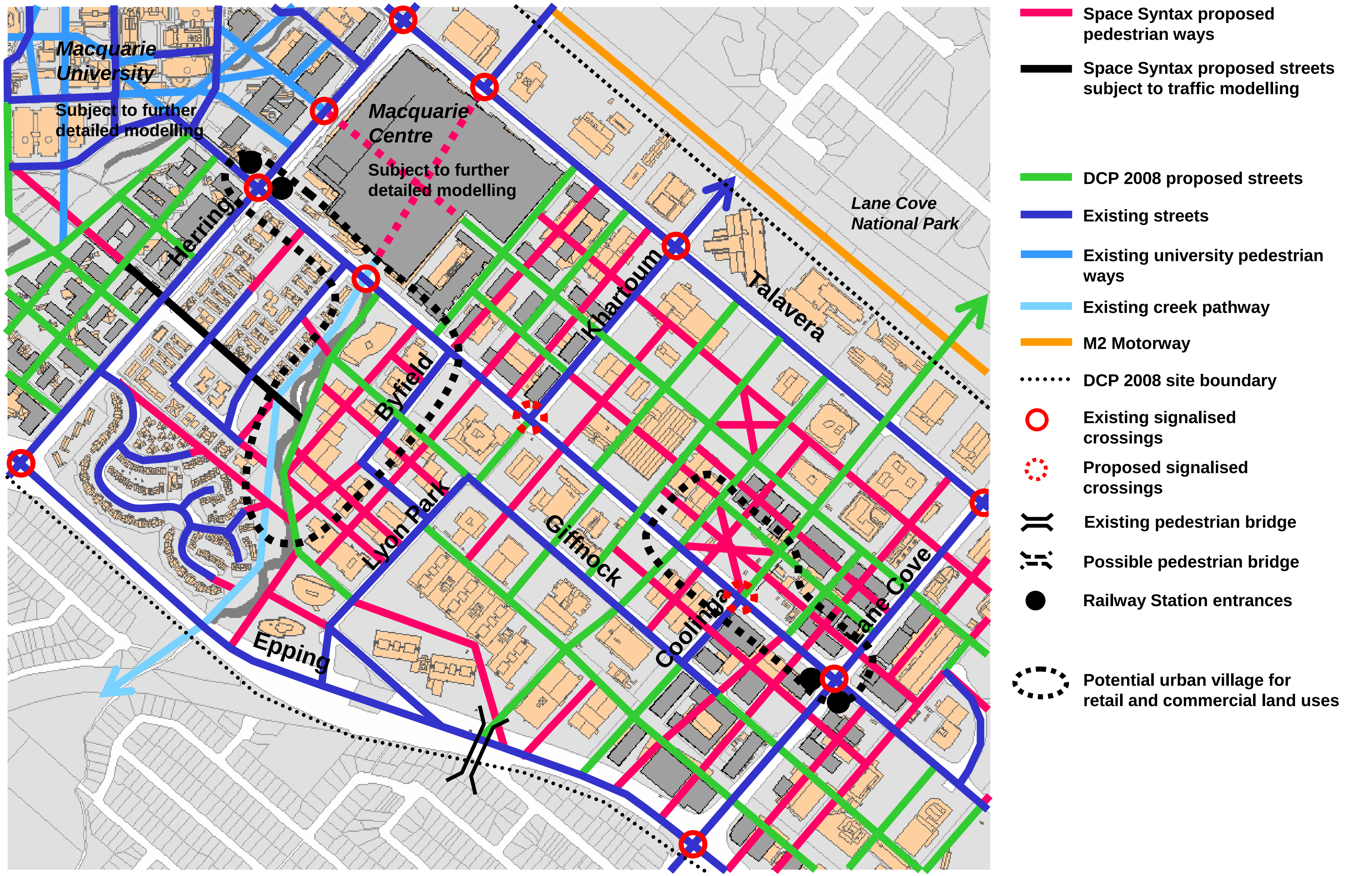
Railway Station entrances

Potential urban village for retail and commercial land uses

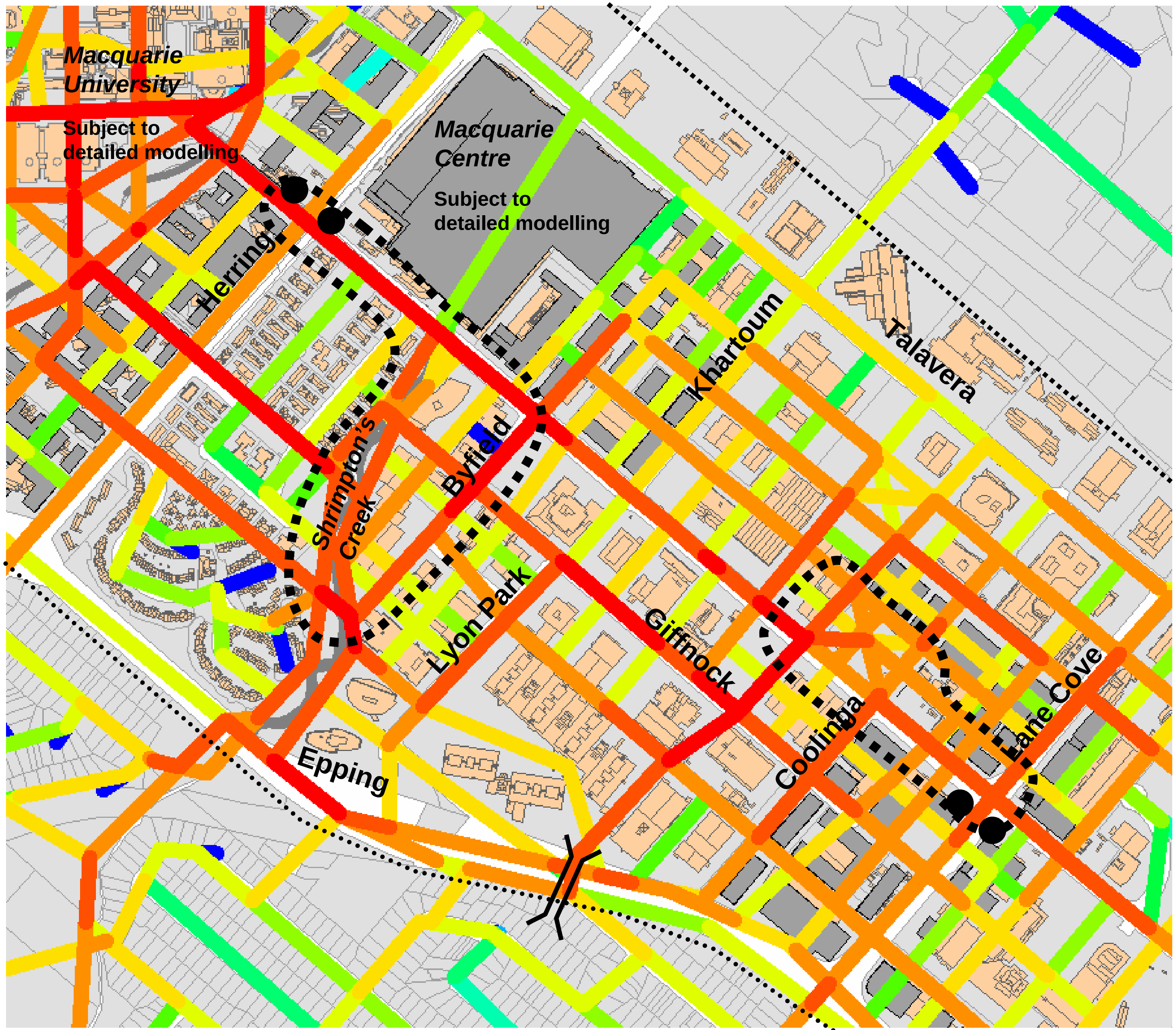
Pedestrian movement potential

High

Low


Macquarie University
Subject to further detailed modelling
Macquarie Centre
Subject to further detailed modelling
Herring
Lane Cove National Park
Talavera
Khartoum
Byfield
Lyon Park
Giffnock
Epping
Coolinga
Lane Cove
Space Syntax proposed pedestrian ways
Space Syntax proposed streets subject to traffic modelling
DCP 2008 proposed streets
Existing streets
Existing university pedestrian ways
Existing creek pathway
M2 Motorway
DCP 2008 site boundary
Existing signalised crossings
Proposed signalised crossings
Existing pedestrian bridge
Possible pedestrian bridge
Railway Station entrances
Potential urban village for retail and commercial land uses

1.7 Executive Summary Spatial Accessibility analysis of proposed Pedestrian Structure Plan



Spatial Accessibility analysis of the proposed Pedestrian Structure Plan shows that two potential urban villages are achievable. The first village is located along the northern part of Shrimpton's Creek to the Macquarie Centre around Byfield Street, and extending along Waterloo Road to Herring Road. The second village is around the park (proposed in the DCP) on the northern side of Waterloo Road, between Roads 8 and 9 (proposed in the DCP) and extending along Waterloo Road to Land Cove Road.

DCP 2008 site boundary

Existing pedestrian bridge

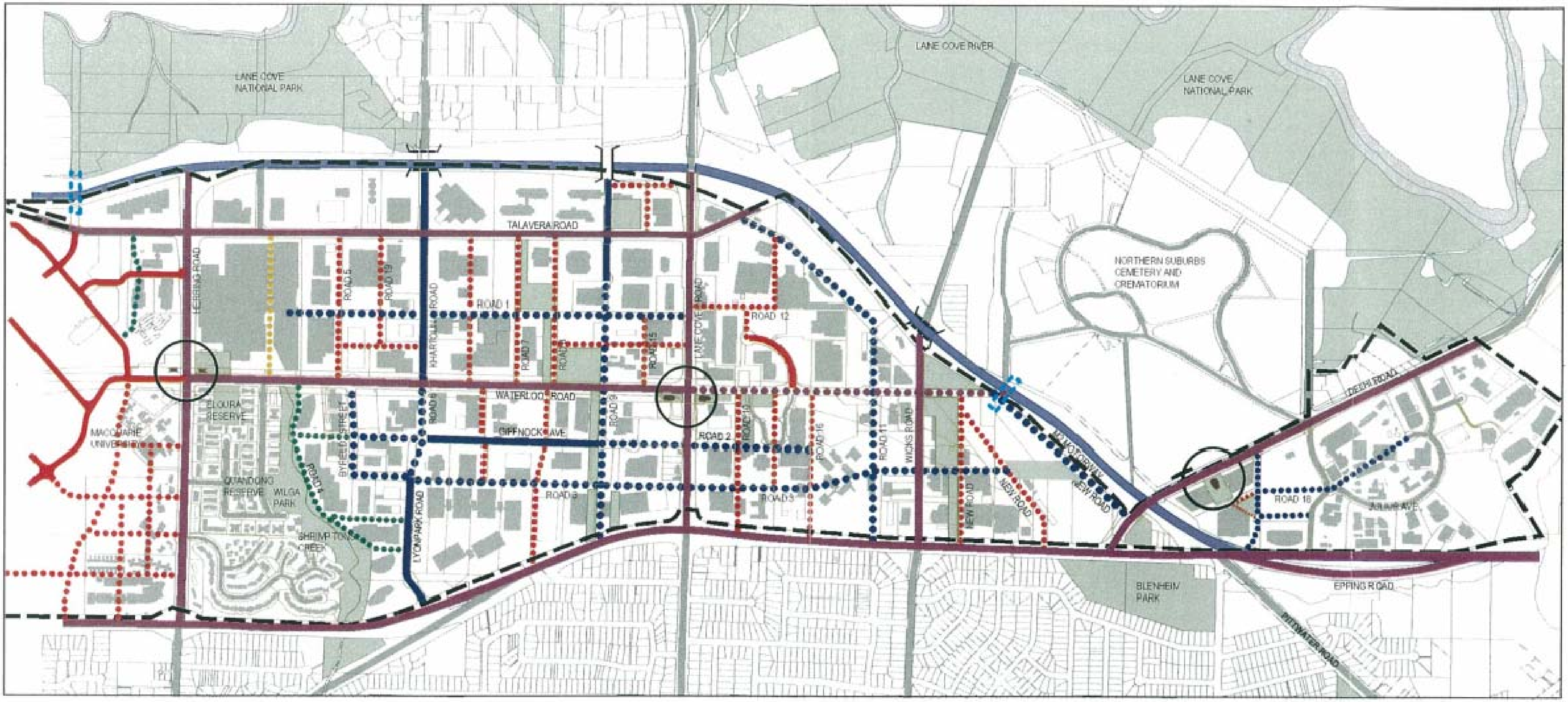
Railway Station entrances

Potential urban village for retail and commercial land uses

Pedestrian movement potential

High

Low



- new or modified public streets - type1 streets
  4 traffic lanes, parking on both sides
- existing public streets - type1 streets
- new public streets - type2 streets
  2 traffic lanes, parking on both sides, 2 cycleway
- existing public street - type2 streets
- new public streets - type3 streets
  2 traffic lanes, one side parking, 2 cycleway
- potential future public roads (subject to testing)
- existing public streets - type3 streets
- type4 public streets
  1 traffic lane, one footpath
- existing public streets
- existing underpass
- potential bridge
- site boundary
- existing property boundaries
- location of train stations
- M2 Motorway
- new public street
  type and width TBC
- new shared pedestrian & cycle links over the M2 are to be implemented. Final locations are subject to negotiation with landowners including Transurban and the outcomes of Macquarie Park Integrated Transport & Movement Study

1.9 Executive Summary Context

The Space Syntax Report recognises the urban design principles and objectives described in the Master Plan 2004, Local Environment Plan Macquarie Park (LEP 137) and Development Control Plan (DCP 2008).

Space Syntax has modelled, analysed and assessed the DCP, the Macquarie University Concept Plan and the DCP precinct concept plans to test their likely functional performance by objectively investigating their proposed pedestrian, cycling, vehicle and rail movement infrastructures.

In close consultation with CoR, Space Syntax has strategically designed an economically productive pedestrian infrastructure for incorporation in the DCP, precinct concept plans and major site masterplans (greater than 15,000m²).

The Space Syntax Report forms the Pedestrian Movement Infrastructure component of the Macquarie Park Integrated Traffic and Movement Study. The Traffic Study component by Traffix Consultants (2008) concluded that, if there is a modal shift of 40% from private to public transport, then the capacity of the proposed DCP street network will satisfy future traffic demands to 2031. The Space Syntax Report is integrated with the Traffic Study as it concludes that the proposed DCP street network would complement the future performance of the Space Syntax proposed pedestrian infrastructure, as well as provide the basis for an improved local movement economy.

The Space Syntax Report complements CoR's:

(i) Integrated Traffic and Land Use Study (ITLUS 2007) by assessing the appropriate distribution of land uses according to pedestrian movement-sensitive street locations, and

(ii) the CoR Bike Plan 2008 by providing natural route choice data about the cycling performance of the Plan, apart from simple trip generators.

The Report also informs CoR on:

(i) The implementation of Macquarie University Campus Concept Plan 2006 by helping to optimise the economic success of its pedestrian movement infrastructure and proposed land uses.

(ii) Ministry of Transport's Bus Corridor Strategy 2007 by helping locate bus stops in pedestrian movement sensitive street segments, and

(iii) Transport Infrastructure and Development Corporation's (TIDC) North Ryde Station masterplan and TIDC's and RailCorp's Station Access Management Plans (forthcoming), by improving the pedestrian performance of the DCP to extend its pedestrian efficiency.

(iv) Macquarie Centre's Masterplan (forthcoming , following stage one DA approval in December 2008) by optimising the pedestrian wayfinding and intelligibility of the reconfigured building layout to improve its economic performance, and its relationship with the surrounding urban area,

(v) Macquarie University's Station North development by maximising the functional performance of its pedestrian movement potential and its relationship with Macquarie Park.

The Space Syntax Report can be integrated with CoR's Plans and Strategies for Macquarie Park. The Report concludes that the implementation of the proposed Pedestrian Structure Plan will contribute to the functional performance of the two potential urban villages shown in dotted lines on to he Plan (figures 1.3 to and 1.6).

Implementation of development controls in the DCP would enable the pedestrian movement potential in these potential urban villages to be capitalised on with active street frontages, reduced set-backs and pedestrian movement-sensitive land uses. The resulting increase in economic activity, social cohesion and urban safety would attract more people to work and live in a viable Macquarie Park.

The advent of local movement economies for Macquarie Park with increased pedestrian performance, would also improve local employment opportunities, increase public safety, reduce car dependence and increase energy efficiencies.

Space Syntax Report

Space Syntax has delivered an objective database and strategic advice that can be expanded and updated over time.

CoR can use the evidence-based advice as:
(i)a *strategic design* tool for evaluating and improving economic vitality and social cohesion in future urban development, and

(ii)a *negotiation* tool for brokering agreements between public and private stakeholders.

Successful urban development fundamentally relies on high levels of pedestrian and vehicle movement to generate economic vitality, social cohesion and public safety. This Report provides objective advice on how efficient movement infrastructures can maximise economic and social value, in terms of passing trade.

Developments that only rely on locating commercial and retail facilities as "attractor destinations" tend not to achieve their economic potential. This Report shows how to strategically design an intelligible movement infrastructure for Macquarie Park where the "attractor buildings" work productively as part of an integrated urban layout to improve functional performance.

Pedestrian Structure Plan

The Pedestrian Structure Plan underwent a complex strategic design process - working in close consultation with CoR.

The key features of the Pedestrian Structure Plan are:
(i)increased pedestrian route choice,
(ii)strategic cross-block routes,
(iii)pedestrian ways throughout the two potential urban centres, and
(iv)strategic connections that spatially integrate local and global movement across the site, and
(v)improved socio-economic performance.

The proposed Pedestrian Structure Plan should be regarded as a co-equal movement infrastructure with the vehicle infrastructure it shares. Efficient pedestrian movement infrastructures work best when pedestrians have a safe, easily navigable, combined network of street paths and pedestrian only ways to improve their ability to move about on foot. The vehicle infrastructure of cycling and trafficable streets, and the public transport system, help deliver pedestrians from afar who do not live in the local urban area.

The Plan's effectiveness will be diminished if the pedestrian infrastructure is treated as an isolated, add-on network to the vehicle traffic system. The transactional world of commerce and social cohesion is made viable by combining high levels of pedestrian and vehicle movement. Both movement networks should work together to produce the desired land use outcomes for Macquarie Park.

Implementation of the Pedestrian Structure Plan

Implementation of the Pedestrian Structure Plan will help achieve a range of outcomes identified by CoR and its stakeholder partners, both public and private, for various strategies and plans,
(i)including implementation of the recommendations in the:

- Macquarie Park Traffic Study (2008)
- Public Domain Manual (2008)
- CoR Bike Plan (2008)
- Precincts Plans In Macquarie Park DCP (2008),

and complementary CoR's strategies for active transport, water sensitive urban design, the forthcoming Open Space Strategy, and Development Applications, Consent proposals, DDA requirements, station access plans, retail and centres policy and the Waterloo Road Master Plan.

Partial implementation of the Pedestrian Structure Plan would greatly reduce its functional performance across Macquarie Park because the infrastructure acts as an interdependent whole rather than in selected parts. Each part of the infrastructure acts in concert with every other part. Spatial Accessibility modelling would clearly show the diminished effect of any partial implementation.

Successful implementation means putting pedestrians on an equal footing with vehicles. It will additionally depend on the provision of a highly accessible, integrated public transport system, with appropriate management and regulation of traffic (eg parking policy, congestion management and road augmentation) to support the increased pedestrianisation of Macquarie Park. Cost effectiveness would be achieved by its early implementation and guided by the CoR planning requirements.

Benefits

The Pedestrian Structure Plan will enable Macquarie Park to reduce its over reliance on vehicles (without removing them) and sustain the potential urban villages with new public transport options. A greatly improved pedestrian movement infrastructure will generate:

(i)economic viability,
more people use more facilities which increases economic return by attracting even more diverse facilities,

(ii)social cohesion,
more opportunity for people to meet other people in the public realm for improved social interaction, and

(ii)urban safety,
more people see other people owing to increased pedestrian activity in streets and public spaces which improves the natural surveillance of the public realm.

1.11 Executive Summary Recommendations

Planning

(i)The Pedestrian Structure Plan recommends that new land uses should be distributed according to their degree of sensitivity to pedestrian movement, so as to produce greater diversity for Macquarie Park. Movement-rich street segments would have retail, commercial and cultural land uses along them. Residential land uses would be located on quieter streets with lower pedestrian potential but not too low as to be unsafe.

(ii)The pedestrian infrastructure is composed of pedestrian only ways and street paths. It should be unencumbered by public art, signs, street furniture and landscaping features that impede movement sightlines. Objects should not be placed in the way of pedestrian movement desire lines.

(iii)"Safer by Design" guidelines should be used for pedestrian movement ease and safety – pedestrian crossing lights, phased traffic lights, zebra crossings, traffic islands and adequate street lighting. To avoid public safety problems and reduced pedestrian movement potential, there should be preferably no grade separation (underpasses or overpasses) used in the pedestrian movement infrastructure.

(iv) Public spaces such as courtyards, squares and plazas that are used for stationary pedestrian activities, such as stopping, sitting and mixing, should be located to maximise multi-directional movement across public spaces.

(v) Where pedestrian and cycling infrastructures overlap, apart from on streets, provision should be made to have separate cycle ways along the same route to ensure pedestrian safety.

Design and Construction

(i) The recommended width of pedestrian pathways, whether in pedestrian only ways or as paths along streets is 3.5 metres, which enables one couple to easily pass, another couple moving in the opposite direction.

(ii) Shared pedestrian paths with bicycles are not recommended. Cycles are non-motorised vehicles and are suited to share the street network with the same requirements as other vehicles. The physical safety of pedestrians is paramount.

(iii) Good quality concrete footpaths are the minimum requirement for all pedestrian paths, whether for pedestrian only ways or paths along designated streets. Signage should be kept to a minimum and be clearly seen at eye height. lighting along all paths is required. Street furniture, such as seats and benches, should be located at regular intervals along streets and pedestrian only ways, and should face pedestrian movement.

(iv) At the interface with major street intersections, pedestrians should have phased traffic lights, timed to allow a reasonable crossing time on the same alignment. Where bicycle ways coincide with pedestrian ways, pedestrians should have right of way, indicated by pathway markings, such as zebra crossings.

Ownership and operation

(i) Public ownership of pedestrian ways is preferred. Public access across private land should be secured as a condition of consent.

(ii) Pedestrian ways are part of the public domain and should be preferably accessible at all hours throughout the day and night, and be open to the air.

(iii) Where pedestrian ways pass through new buildings, they must be unrestricted and available for public trading hours each weekday and at the weekend.

(iv) Rights of way or public easements across private land would be best achieved through conditions of consent.

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Public Transport

(i)Master Plans for private sites should incorporate proposed pedestrian ways as shown in the Pedestrian Structure Plan

(ii) Master Plans for train, bus, and cycle infrastructures should be spatially integrated with the Pedestrian Structure Plan.

Priority Sites and Activities

The following sites require priority implementation of the Pedestrian Structure Plan at a detailed level:

(i)Station North precinct and Herring Road,

(ii)Shrimpton's Creek and Byfield Street,

(iii)Coolinga Street, Epping Road to Talavera Road.

2.1 Background Movement Economies

SPATIAL ACCESSIBILITY AND MOVEMENT INFRASTRUCTURES

Spatial accessibility is the degree of ease that people and vehicles have when moving around urban environments. Block size, street layout, building form, character, connectivity and directness - all contribute to spatial accessibility. Although it is often easy to determine accessibility from a single given location to any other (we often do this in our head when giving directions), it becomes extremely difficult to determine accessibility from tens of thousands of different origins and destinations, as is the case in real urban environments.

Space Syntax research throughout the world, has found that despite the wide range of origins and destinations within cities, there are relatively stable movement patterns. The pattern of journeys used by most people, most of the time, is relatively tractable and predictable. When viewed from this perspective, the evidence is clear that what is most important is not the specific origin and destination, but the character and patterns of the journeys themselves – the ***movement infrastructure***.

This Report shows how the essential factors of spatial accessibility, pedestrian and vehicular movement, street morphology, land use patterns, building frontages and transport node locations interact to influence urban outcomes, such as improved land value and urban safety.

MOVEMENT ECONOMIES

For many years fashionable experiments have produced different urban layouts for the property investment industry - leaving a legacy of under-performing developments. While design experimentation is needed to match the industry's changing demands, it is important to test development proposals with objective evidence to determine their feasibility before building them.

In this regard cities have two main functions. In their urban centres, urban layout is shaped to generate movement and encounters between people, producing activity and trade, whereas in residential areas movement and activity are more controlled. When urban centres are structured with highly intelligible layouts, they work well because they naturally generate pedestrian and vehicular movement for easy access to many facilities. Movement-seeking land uses (retail commercial and cultural) migrate to movement-rich streets, producing greater multiplier effects, which attract even more land uses. Urban layouts can then accommodate greater densities and more diverse land uses, and build self-generating urban centres with critical economic mass.

The process is called the ***movement economy***. It is a dynamic relationship between the spatial accessibility of urban layouts, pedestrian and vehicular movement, and the distribution of land uses.

When spatial accessibility, movement patterns and land uses do not correspond with each other, then economically unsustainable, anti-social environments emerge. Poorly laid out, fragmented developments fail to realise their economic potential, social networks fail to cohere and property assets become under-used or abused through lack of access, causing public safety problems.

Once the primary relationship between the urban layout of buildings and movement infrastructures is integrated, as in the Pedestrian Structure Plan, different types of land uses would act as multipliers for each other which makes urban centres grow successfully.

The Report's outcomes can be used to:

Guide Investment

- to improve return by unlocking urban value.

Inform Strategic Design

- to forecast key economic multipliers for productive movement infrastructures.

Support Negotiation

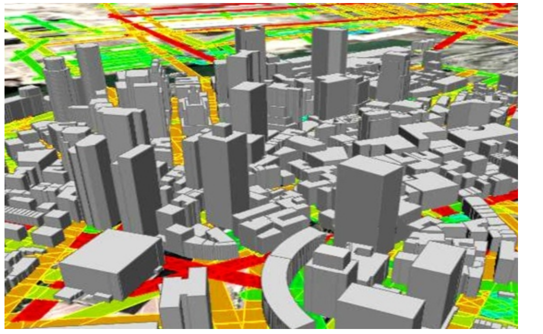
- to inform stakeholder consultations with objective evidence.

References:

Hillier, B. (1996) "Cities as movement economies", *Urban Design International 1 (1), p 41-60.*

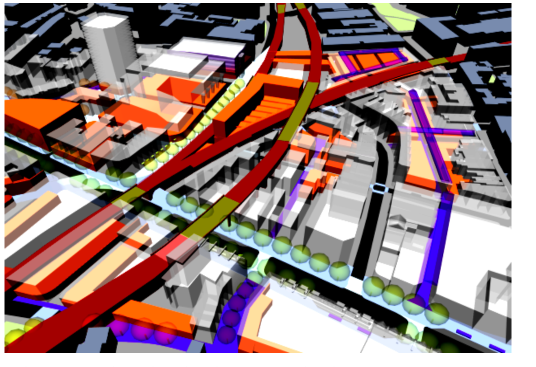
Hillier, B. (1996) "Space is the Machine", *Cambridge University Press, p168-170.*

MOVEMENT ECONOMY PROJECTS



Boston, USA, Spatial Accessibility Modelling showing the relationship between its pedestrian movement infrastructure, attractor buildings and land uses.

Jeddah, Saudi Arabia, showing a movement economy model proposal for the city centre.



Brixton, London showing how a productive movement infrastructure would improve tertiary and secondary retail to become primary retail with greater pedestrian activity.

2.2 Background Space Syntax Methodology

Analysis and Planning

Urban analysis and urban planning simultaneously combine two key factors: first, the economic and social activities that take place in cities, and second, the physical form of the urban environment. The relationship between urban activity and physical form matters most in urban practice, as both quantitative and qualitative components. Space Syntax's methodology uniquely works to directly relate the effects of each factor on the other.

Space Syntax specialises in the analysis and design of all scales of urban environments and, in particular, the strategic design of pedestrian infrastructures and public spaces which lie at the heart of urban economic and social performance in cities. The company makes empirical observations of pedestrian and vehicular activity patterns, identifies the important urban factors that influence these patterns, and then use bespoke software to incorporate these factors into models that forecast the effects of movement on the location of mixed land uses.

Spatial Accessibility analysis

Both the urban grain and structure of an urban place contribute to its accessibility, which can be defined as the ability and degree of ease that people have when moving around in the built environment. Space Syntax 's methodology analyses the configuration of urban layout to determine route choice strategies and preferences for pedestrians, cyclists and vehicles, and simulate their journeys.

In peer-reviewed publications across the world, these techniques have been demonstrated as the most efficient way of assessing the accessibility of urban environments, and indexing the ease of movement in urban areas, for most people for most of the time. The index is referred to as Spatial Accessibility. An understanding of spatial accessibility is used to establish the hierarchy of routes within the public domain network.

Spatial Accessibility analysis of cities and towns is performed using the spatial accessibility model as its base information. The models are constructed as an accurate scale maps, by drawing the longest and fewest straight lines, or "lines of sight and movement" that pass through all accessible space in an urban area. The resulting pattern of intersecting lines is then digitised and inter-relationships among the lines (route choices) are analysed using a bespoke software package.

Spatial Accessibility values are then calculated from the spatial accessibility model by first selecting a line at random, then calculating how many other lines must be used, wholly or in part, to reach every other line in the model. When each line in the network is calculated, some lines require fewer changes of direction than others in order to cover the rest of the spatial accessibility model.

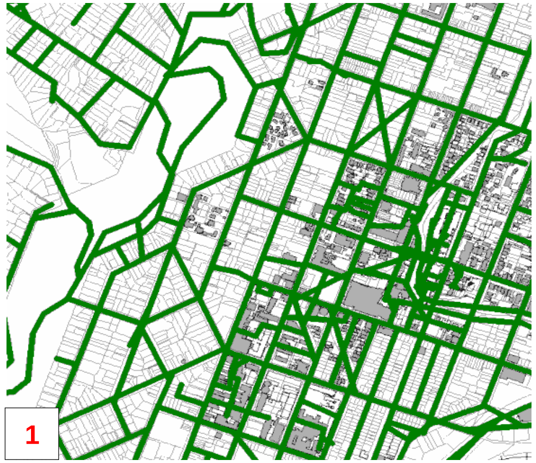
The spatial accessibility value assigned to each line reflects the complexity of routes from that line to all the others within the network. This complexity influences movement in two ways.

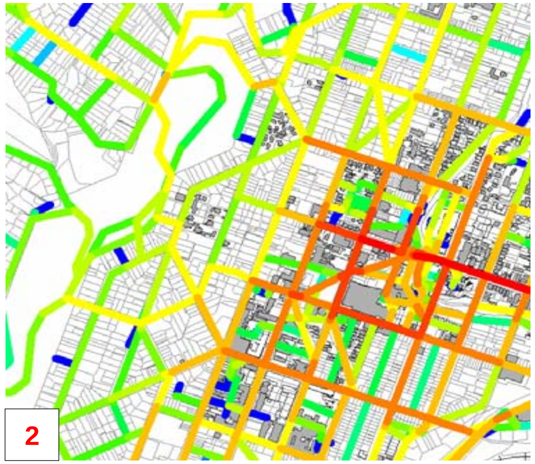
First, a highly accessible line is more easily accessed than a segregated one because it can be reached by simpler routes from all other lines, and it receives a high degree of "to movement".

Second, an accessible line is more likely to be selected as part of a route between other pairs of lines, as it will attract more "through movement". The combination of "to" and "through" movement makes spatial accessibility values a significant measure to estimate movement potentials whether pedestrian or vehicular.

Spatial accessibility corresponds to movement potential for each street segment of either the pedestrian or vehicle infrastructures.

High spatial accessibility (movement potential) is shown in red-orange routes through yellow to low spatial accessibility in green-blue routes.





1. *Example of an unprocessed spatial network map showing all pedestrian routes in dark green*

2. *Example of a processed spatial accessibility map after mathematical values are assigned to each line (route), in this case, for the pedestrian infrastructure.*

Spatial accessibility (movement potential)

- **High**
- **Medium**
- **Low**

2.3 Background Work Tasks Completed

Task 1
Spatial Accessibility Modelling

Movement infrastructures in cities are composed of pedestrian, cycling, vehicle and rail networks. To investigate the movement infrastructure for Macquarie Park, the urban layout was analysed to a distance of 3 kilometres from the site. The 28 km^2 area models show all pedestrian, cycling and vehicle routes that locally form on the site and more widely extend into the regional movement networks.

Space Syntax analysis represents all the publicly accessible spaces as a map of the longest and fewest set of straight lines (axial lines) of movement directions that pass through all the accessible space in an urban area, known as Spatial Accessibility Models.

These models are understood as a map of lines of potential movement that can be quantitatively analysed. Spatial accessibility values are gained by calculating the likelihood that each line (in this case 3,600 lines) would be used to reach every other line in the Spatial Accessibility Model.

The models measure the relationship from each space to every other space in each network. The results show the range of spaces from the most accessible to the least accessible in the network. Results are displayed as thematic maps which are coloured to show high movement potential in red – orange through to low movement potential in green-blue.

Task 2
Pedestrian Observation Study

A quantitative observation survey of pedestrian activity, movement rates and public space use patterns produced empirical data on how people were currently moving on foot within the site; to and from transport nodes and carparks, taking account of weekday and weekend movement. The data provides a more accurate spatial diagnosis of the existing *pedestrian movement infrastructure*, including the effect of local attractors.

Pedestrian movement levels were recorded by observers at 63 locations covering street segments across the site, on Wednesday 31 Ocober 2007 and Saturday 10 November 2007. Each street segment was observed for ten time periods, from 6:30am to 7.30pm. The total number of people counted was 5,468 on the weekday and 2,375 at the weekend - a total of 7,843.

The results were statistically analysed to obtain average hourly pedestrian movement rates across the day according to seven two-hour time periods.

- 06:00-08:00 (very early morning)
- 08:00-10:00 (early morning),
- 10.00-12:00 (late morning),
- 12:00-14:00 (lunchtime),
- 14:00-16:00 (afternoon),
- 16:00-18:00 (late afternoon) and
- 18:00-20:00 (evening).

Data was collected for three categories:

- (i) workers
- (ii) locals (people familiar with the area), and
- (iii) students.

Task 3
Urban Structure Analyses

(land uses, building entrances, building frontages, block sizes and rail transport nodes)

Existing pedestrian movement in Macquarie Park is primarily influenced by spatial accessibility which in turn affects the degree of economic activity, social cohesion and urban safety.

Pedestrian movement is also driven by patterns of land use (retail, commercial cultural and residential facilities), the way in which building frontages interface with the public realm (do they turn their backs on streets, or orient themselves to face the street) and transport attractors (train stations, bus stops and car parks).

The results of these analyses provided the basis for evaluating and strategically designing a baseline movement economy model to help the future sustainable viability of Macquarie Park.

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Task 4
Strategic Design recommendations

This was an extensive, iterative process where the Spatial Accessibility models was rebuilt many times. Firstly, it was to test proposed DCP options, and finally to evaluate the most viable pedestrian movement infrastructure and its urban form to produce two potential urban centres.

The generation and evaluation of the strategic design improvements compared the likely effects that each option would have on patterns of pedestrian and vehicle activity, before the other multiplier effects of land use, building density and transport nodes would take effect. The resulting models provides comparative evidence on how well each design option matched the desired development outcome for Macquarie Park.

Efficient movement infrastructures influence patterns of land value and social cohesion, the pattern of land uses (retail and commercial facilities), transport attractors (rail stations, bus stops and car parks) and the way in which buildings directly interface with the public realm. These development issues are combined with the results of the Spatial Accessibility analyses and strategic design options to provide a clear picture of an optimal potential urban structure for Macquarie Park – the Pedestrian Structure Plan.

RESEARCH FINDINGS

Pedestrian Route Choice

Empirical research, from Space Syntax studies throughout the world, has shown that pedestrians exhibit a number of spatially-related tendencies that affect pedestrian route choice decisions.

Most people, most of the time will:

(i) use spaces that lie on the most simple path towards their seen or unseen destination;

(ii) select the longest direct leg earlier in a journey, when faced with route options;

(iii) minimise directional changes along a journey to avoid back-tracking;

(iv) select spaces that offer natural surveillance / deterrence, such as those with active frontages and clear indications of land use and ownership;

(v) select routes which allow them to link into "chain" destinations, and so facilitate multi-purpose journeys.

Multiplying all these other factors, as well as having the presence or absence of other people along routes or in spaces, will greatly affect route choice preferences.

Space Syntax strategic design maximises these preferences in pedestrian infrastructures as well as shows their integration with cycling, vehicle and transport infrastructures.

Public Space Use

Our research shows the primary influences on pedestrian activity and public space use are:

1 Good accessibility from the surrounding urban area - successful public spaces are located at strategic points in the pedestrian movement infrastructure (such as at the intersections of important pedestrian movement routes).

2 Proximity to high levels of pedestrian movement - good public spaces are located close to the routes with high levels of pedestrian movement.

3 Movement routes pass through the body of the space - to achieve good levels of use, it is important that the routes bring pedestrian movement from several directions through the heart of the space, and do not just skirt around the edges.

4 Multi-directional views into the surrounding urban area - people are more likely to use public spaces or squares where they can see where they are going and feel safe. Similarly, people prefer to stay where they have good visibility from within a public space into the surrounding areas.

5 Adjacency of "live-uses" - some land uses such as specialised retail and catering attract activity over the effects of spatial layout, and contribute to the natural surveillance of public space by providing increased co-presence of pedestrians.

Urban Centres: Average visitor weekly spending[1]

Train	**$125**	(baseline	**0%**)
Taxi / cycle	$152	(increase	22%)
Bus	**$171**	(increase	**37%**)
Car	$174	(increase	39%)
Walking	**$238**	(increase	**90%**)

People who most contribute to the local economy in cohesive urban centres are those who walk. Their average weekly spending exceeds all other modes of transport. The way people move, dwell or stop within the public realm influences their spending and their contribution to the economic viability and social health of urban centres, as well as their public safety.

*1 **Reference:** "Town Centre Survey 2003-2004, Summary Report",* July 2004, by Accent Marketing Research for Transport for London (TfL), Surface Transport London (above figures adjusted to 2008 Australian dollar). The finding shows that the mode of transport used to access urban centres has an impact on the average spending of visitors.

MODELLING TECHNIQUES

Space Syntax is an internationally applied methodology for understanding the socio-economic sustainability of cities. The evidence-based approach investigates urban performance before design experimentation commences. The methodology has been developed and continuously improved over the past 30 years and has strong research foundations in over 50 universities throughout the world. It has been applied in hundreds of urban planning projects by leading developers, and national, state and city state authorities.

Local applications

The methodology used has been successfully applied in major projects (Parramatta Civic Place, Green Square, Auburn Town Centre, Penrith Lakes and Newcastle's Hunter Street Mall). In Parramatta it forecast improved economic benefit when Council re-opened the Church Street Mall to vehicle traffic. Space Syntax analysis was also applied to the $1.6 billion Civic Place Project by designing a productive movement infrastructure of strategic pedestrian routes to help improve the functional performance of the proposed mixed land uses.

Baseline data

The company uses the most accurate Geographic Information System (GIS) data available that show existing urban layouts. This includes cadastral data; building footprints; roads and streets; under- and overpasses; motorways; bridges and pedestrian crossings; bus and rail transport networks, interchanges, stations and stops; land use maps; and development proposals, for the project site and the surrounding urban area.

2.5 Background Assumptions, Constraints and Outcomes

Modelling assumptions

Space Syntax models analyse urban street networks though the use of road centreline-like measurements called *axial lines*. These lines are used as mathematical representations of the “least line set” of all public open spaces within a city. This differs from traditional strict road centreline measurements because pedestrians are less influenced by centre restrictions than vehicles, and are therefore able to make full use of the urban spatial networks represented by the open spaces between buildings. These axial lines are then analysed using topological analysis as a measure of accessibility, and have been found to correlate significantly with pedestrian movement in a wide variety of Australian, European, Asian and American cities.

Spatial Accessibility modelling breaks down each axial line into its individual street segments, then analyses all lines for the angular difference between them. This allows for a higher resolution of analysis (than origin-destination modelling) which can be conducted street by street, on a junction by junction basis, and a more subtle measurement of topological depth along curving streets.

Each street is treated as a separate node of a graph and is assigned a fractional depth value to each line based on the angle of intersection that it meets with its neighbouring lines. The extent of topological depth change usually varies between 0 (where segments meet end to end with no change of direction) and 1 (which represents a 90 degree change of direction). Spatial Accessibility models are coloured to correspond with the mathematical results that lie behind each axial segment. High spatial accessibility (movement potential) is shown in red-orange routes through yellow to low spatial accessibility, which are shown in green-blue routes.

In this way angular segment analysis provides realistic models of the urban environment that take into account the more subtle measures of configurational change. The role of spatial accessibility in pedestrian movement is documented in the following sources:

Dalton, N., (2001), “Fractional Configuration Analysis and a Solution to the Manhattan Problem”, *Proceedings from the 3rd International Space Syntax Symposium, Atlanta, Georgia, USA.*

Hillier, B., Penn, A., Hanson, J., Grajewski, T. and Xu, J, (1993), “Natural movement: or configuration and attraction in urban pedestrian movement”, *Environment & Planning B: Planning & Design, 19, p 29-66.*

Hillier, B., and Ida, S., (2005), “Network effects and psychological effects: a theory of urban movement”, *Proceedings from the 5th International Space Syntax Symposium, Delft, Holland.*

Penn, A., Hillier, B, Banister, D., Xu, J., (1998), “Configurational modelling of urban movement networks”, *Environment & Planning B: Planning & Design, 25, p 59-84.*

Turner, A., (2001), “Angular Analysis”, *Proceedings from the 3rd International Space Syntax Symposium, Atlanta, Georgia, USA.*

Turner, A., (2005), “Could a road-centre line be an axial line in disguise”, *Proceedings from the 5th International Space Syntax Symposium, Delft, Holland.*

Penn, A., (2003), “Space Syntax and Spatial Cognition, or Why the Axial Line?” *Environment & Planning B: Planning & Design, 35, p 30-65.*

Raford, N., Chiaradia, A. and Gil, J. (2007) “Space Syntax: The Role of Urban Form in Cyclist Route Choice in Central London”. *Institute of Transportation Studies, UC Traffic Safety Center, University of California, Berkeley, 5, p 1-18.*

Constraints

Macquarie Park is a desirable commercial office location, although it would perform economically and socially better if it had lively, local urban villages, where the levels of pedestrian and vehicle activity and movement are high. Urban multiplier effects, in which busy land uses are the attraction for generating more diverse land which grow vibrant local centres, are missing.

The site has some physical constraints. It is roughly equivalent in size to Melbourne’s city centre - yet there are few streets and they form very large blocks with buildings that are set well back from the street frontages, many well-landscaped. These very large block sizes and set-back buildings are two factors that promote high car–dependency because it is easier to get around Macquarie Park in vehicles than on foot. The distances around the blocks and to the buildings are too far to walk easily. Poor diversity of land uses along those streets provides little attraction for high levels of pedestrian movement which are usually associated with successful urban centres.

The relatively few number of streets for such a large site tends to increase traffic trips and exacerbate congestion on the major arteries at peak times. The few signalised traffic lights and few pedestrian crossings lead to increased vehicle speed across Macquarie Park, and potential safety issues for pedestrians. The DCP 2008 addresses some of these factors by proposing an increased number and variety of streets, greater building densities and more landscaped open spaces. Encouraging people to walk and cycle instead of drive is feasible when practical options are available.

The implementation of this Report’s recommendations could be hampered by landowners’ resistance to providing pedestrian ways across private land. Evidence-based discussions are required to highlight the economic and social benefits to landowners arising from pedestrian ways across their land.

Outcomes

The Space Syntax Report expands the DCP recommendations by suggesting that a set of more strategically located pedestrian only ways, the Pedestrian Structure Plan, in combination with the DCP’s proposed new streets, would lay the foundation for two potential urban villages at Macquarie Park.